INDUSTRIAL DEVELOPMENT REPORT 2002/2003

Competing through innovation and learning

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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Foreword

THE CURRENT PREDICAMENT OF MOST DEVELOPING COUNTRIES AND the state of the global economy deflate the optimism in the United Nations Millennium Declaration and the Millennium Development Goals. The problem is not just the apparent wedge between targets and trends. It is the more fundamental differences in what to expect of the future and how to get there.

Take equity and efficiency. Proponents of each see themselves as offering the best possible way to maximize both social fairness and economic progress in the long run. But even a partial marriage of the two (often) polar views is not yet in sight, despite the development community's sorely felt need.

Productivity growth, equity, poverty eradication and security can all reinforce one another. But for that to happen requires attentiveness to the widespread access to wealth-creating assets, especially through education, the basis for acquiring skills and grasping opportunities. Countries need to pass thresholds on the route to becoming productivity-driven economies. They also need to put in place strategies and policies to sustain productivity gains over time. UNIDO's research agenda centres on these efforts—to advance today's development agenda.

With more ability to create wealth, people and countries can achieve sustainable livelihoods, begin to attack poverty and have the rule of law take hold. But this requires a massive mobilization of skills and capabilities, while fostering greater equity. In turn, an economic and social system that offers the right public goods and that rewards the opportunities for equitable and efficient growth is the best guarantee for the rule of law and security for all.

Poor countries stay poor when low productivity leaves poverty and inequity untouched, slowing growth and hobbling the innovative forces of society. The challenge for policymakers is to move to a virtuous circle where productivity gains reduce poverty and enhance social equity—which can then feed economic growth.

A strand of contemporary thought on development holds that reducing poverty and promoting equity need not compromise growth. UNIDO strongly subscribes to this view. Indeed, UNIDO views social progress as an essential part of sustained growth. To break the negative links between equity and efficiency, direct policy action is needed to enhance the complementarities among equity, productivity and growth.

Recent cases of countries catching up strongly suggest that improvements in equity and reductions in absolute poverty do much for attaining sustainable productivity increases and for sharply narrowing the income gap with the advanced economies. That productivity growth has the salutary effect of also favouring further improvements in social equity.

The ingredients of growth with equity

Development thought now stresses innovation, technological change and other intangibles at least as much as capital accumulation. Trickle-down effects through cross-border capital and technology flows have benefited only a handful of developing countries. Why? Because those are the only countries that paid attention to increasing productivity and creating a good climate for investment. Too many other countries are still missing the domestic links between productivity growth, equity and poverty. And they are not taking advantage of increasing returns and agglomeration economies. Their real problems: weak commitments to development and poor implementation of policy reforms.

So, trickle-down effects, though desirable, now seem far from automatic. Needed instead is deliberate action. Developing countries have to foster the diffusion of technology to them and within them, both in quantity and quality. They also have to break the negative links between low equality and low productivity. In short, they need development policies directed explicitly to reducing poverty. Only with such policies will it be possible for a substantial part of the developing country population to share in the benefits of globalization.

Economic growth, so essential for eradicating poverty, rests on the accumulation of physical and human capital and, very importantly, on the gains in productivity. Catching up rapidly rests, in addition, on a fast rate of structural transformation.

Normally associated with the initial phases of catching up quickly are rapid capital accumulation, dramatic increases in labour participation and the large-scale absorption of foreign technology. To maximize productivity, each requires significant learning—so that society can assimilate, adapt, master, develop and efficiently use foreign technology. This learning, and the institutional and policy setups that enable it, starts with mobilizing domestic innovative capabilities to fuel sustained structural change.

Opening the economy fosters both domestic competition and inflows of embodied and disembodied technology. And given the drive to export, it spurs the domestic diffusion of international productivity and quality standards through exposure to international competition.

As countries begin to catch up, innovation-driven productivity gains have to become the engine of growth. The reason is that input-driven growth eventually runs into rapidly diminishing returns—unless supported by the assimilation, adaptation and mastery of rapidly changing technologies. In a world where continuous innovation and international competition drive one another, countries have to devote special effort to keeping up with the advancing technological frontier.

Faced with this challenge, the development agenda needs to give pride of place to policies for sustainable productivity growth. Countries have to establish framework conditions for the rich interplay of resources, markets and institutions. They have to expose themselves to the spurs of competition in the international economy. And they have to supply the public goods needed to match gains in efficiency with improvements in equity.

The predicament of the least developed countries

The least developed countries, still struggling to meet the basic human needs of their population, have had their health, social and economic standards slip over the last few decades. Indeed, the real per capita income of 30 developing countries is lower today than it was 35 years ago.

For the more advanced developing countries the development priority is to deepen and upgrade their links with the world economy so that they can apply their innovative capabilities to international competition and domestic development. For the least developed countries the key development priority is to take the first steps towards being able to do this. They need to set policies that allow them to take a greater part in international trade, investment and technology flows. Yes, macroeconomic stability and a sound incentive system are important. But so is attending to basic human needs, strong institutions and the building of social capital.

Shortcomings of today's policy models

Much economic reform in developing countries was based on the assumption that equity and wealth creation would come from market-led structural reforms. But the record shows that countries heeding the prescriptions saw equity deteriorate—and efficiency gains turned out to be short-lived and elusive.

The reason is that the policy reform packages of the 1990s were unbalanced—in the best of cases having only two of the three legs to support a durable social consensus in the fight against poverty and the drive for sustainable development. Macroeconomic and institutional reforms have made some difference. But the third leg—ensuring enduring productivity gains by mobilizing the innovative potential of society—has been missing.

Innovation and technological learning were expected to follow. But for the most part they did not. Hence the attenuated effect of the macroeconomic and institutional reforms. Overcoming this deficit is still a major task—one that UNIDO addresses as a fundamental part of its mandate.

Spreading access to income-generating assets

The ability of a social system to achieve high rates of economic growth and at the same time improve equity lies in its capacity to ensure ample access to income-generating assets across the population. That is one of the key lessons from the recent industrialization experience.

The most sustainable income-generating assets are not necessarily physical or financial—they are human, embodied in people and institutions. These assets comprise entrepreneurial, management, technical and scientific knowledge as well as governance systems and codes of conduct. A society that makes universal access to knowledge and skills a key priority is much more likely to marry equity and efficiency than a society that does not.

Investing in formal education is just one aspect of this. An innovative and competitive private sector is essential. So are institutions and incentives geared to eradicating corruption, ensuring the rule of law, promoting social capital and easing resource reallocation. At the base, of course, is a competitive business environment and sound macroeconomic management. Efficiency with equity can be achieved only when markets, agents and institutions interact to diffuse the fruits of technical progress and so to improve all sectors of society.

Providing greater symmetry in the costs and benefits of international compacts

The new development round of trade negotiations addresses the perception that the opportunities to draw on the benefits of the Uruguay Round agreements have not been evenly distributed across countries.

The substantial protectionism still prevailing in international trade is clearly biased against activities in which developing countries enjoy greater comparative advantages, such as agriculture and labour-intensive manufactures. Moreover, developing countries can take advantage of market access to industrialized countries only by conforming to their stringent sanitary, phytosanitary and other regulations and standards. To do this, they have to overcome their technical and scientific underdevelopment.

A rule-based international system in which most members cannot play is doomed. Developing countries, especially the least developed, should not be held to standards they cannot meet today. What would be fair is to hold them to relaxed standards they can meet—and to give them assistance for increasing their capacities. Only a major concerted effort by the international community to remove obstacles to market access and support developing countries' capacity building to conform with the rules can redress intercountry disparities.

Caring about future generations

Natural resources are as much for creating wealth as for improving human welfare. When economic activity is harmful to the environment, resource productivity today is augmented at the expense of resource productivity tomorrow.

To the extent that the neglect of natural capital affects global commons, international norms need to be set and complied with—just as when the health, safety and security of the population are at stake. But developing countries have to conform to the emerging international norms as well, and for this they need home-grown scientific and technical capability.

* * *

These are the main messages of this report, the first of a new UNIDO series devoted to the various dimensions of industrial development highlighted in this foreword. This new series is intended to build on development policy experience and to advance the frontiers of current thinking, with a focus on the least developed countries.

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Director-General
UNIDO

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Explanatory notes

References to dollar ($) are to U.S. dollars, unless otherwise specified.

Billion means 1,000 million.

References to tonnes are to metric tonnes, unless otherwise specified.

A slash (1990/1991) indicates a crop year or a financial year.

Country classifications by income levels are from World Bank (2001b) *World Development Indicators 2001*. Economies are divided according to 1999 gross national income (GNI) per capita, calculated using the *World Bank Atlas* method. The income groups are low income, $755 of less; lower middle income, $756–$2,995; upper middle income, $2,996–$9,265; and high income, $9,266 or more.

The designation of least developed country follows the United Nations definitions, which is based on three criteria: low income (less than $900 estimated GDP per capita, three-year average), weak human resources and economic vulnerability.

The following symbols are used in tables:

Two dots (..) indicate that data are not available or are not separately reported.
A dash (—) indicates that the amount is nil or negligible.
na is not applicable.

Totals may not add precisely because of rounding.

The UNIDO Scoreboard database on selected indicators of industrial performance and drivers draws on numerous databases, as detailed in the technical annex.

The following abbreviations appear in this publication.

BIPM	Bureau International des Poids et Mesures
BIS	Bureau of Indian Standards
CIP	competitive industrial performance
CO_2	carbon dioxide
COTEX	Consortium of Textile Exporters
CPC	China Productivity Centre
EDF	Enterprise Development Fund
EPZs	export processing zones
EU	European Union
FDI	foreign direct investment
GATT	General Agreement on Tariffs and Trade
GATS	General Agreement on Trade in Services
GDI	gross domestic investment
GDP	gross domestic product
GNI	gross national income
GNP	gross national product
HKPC	Hong Kong Productivity Council
ICICI	Industrial Credit and Investment Corporation of India
IMF	International Monetary Fund
ISO	International Organization for Standardization
ITMIN	Industrial Technology and Market Information Network
ITRI	Industrial Technology Research Institute
JPC-SED	Japan Productivity Centre for Socio-Economic Development
MAC	Manufacturing Advisory Centres

MEP	Manufacturing Extension Partnership
MHT	medium and high tech
MIDA	Malaysian Investment Development Agency
MFA	Multi-Fibre Arrangement
MVA	manufacturing value added
NAFTA	North American Free Trade Agreement
NAMAC	National Manufacturing Advisory Centre
NCPC	National Cleaner Production Centres
NCS	Network Computer Systems
NGOs	non-governmental organizations
NIST	National Institute for Standards and Technology
OBM	own brand manufacturing
ODM	own design manufacturing
OECD	Organisation for Economic Co-operation and Development
OEM	original equipment manufacturing
PSB	Productivity and Standards Board
R&D	research and development
SAR	Special Administrative Region of China (Hong Kong)
SDF	Skills Development Fund
SERCOTEC	Servicio de Cooperación Técnica
TRIMS	trade-related investment measures
TRIPS	Trade-Related Intellectual Property Rights
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
USIMINAS	Usinas Siderúrgicos de Minas Gerais SA
WTO	World Trade Organization

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Overview

WHAT IS THE STATE OF INDUSTRIAL DEVELOPMENT AROUND THE world? Perhaps the clearest impression is that of diversity and divergence. A few developing economies have done very well in recent years in coping with the fast-changing industrial scene. But others, a disturbingly large number, have done badly. This is hardly news. It is now well known that economic performance, particularly industrial performance, is highly variable among developing economies. This is accepted as part of the hard reality of development and globalization. Early models of inevitable convergence, based on simple neoclassical growth models, have given way to more diffuse analyses stressing that structural, institutional and social factors may continue to drive economies apart.

UNIDO endeavors to build on the consensus for macroeconomic stability, institutional reform and open trade and investment. It takes it as given that technological change will continue at a rapid pace—and that economies will be knitted together by freer flows of information and productive factors and by the international rules of trade and investment. In this setting, the ability to compete internationally will be the basic condition for growth in the industrial sector. Relying on such static endowments as primary resources and cheap unskilled labour may be a good way to start, but it is a bad way to continue.

Most of the effort has to come from within economies, providing the right environment for capability building and investing in the necessary factors and institutions. But such local efforts should be helped from outside. Opening markets completely in developed economies will help greatly, but much more is needed to narrow the widening gap between economies and to build industrial capabilities in developing economies. Indeed, this is the mission of UNIDO—building and enhancing industrial capabilities. UNIDO continues to work to narrow that gap and to ensure the international community's support with financial and other resources. It is with this purpose that UNIDO launches its first *Industrial Development Report.*

This report shows starkly how wide the dispersion is in levels of industrial development, how much it has grown and, most important, how it reflects structural factors. Those structural factors are difficult to alter in the short to medium term—and often cannot be left to reverse themselves. Nor can they be expected to improve simply by exposing economies to rapid liberalization and globalization. They thus raise strong policy concerns. The international community and national governments together have to address the growing structural gaps that drive divergence. If they do not, there is a real risk of serious long-term marginalization of many countries from the dynamics of industrial development. The clear solution is to follow the high road to competitiveness—to develop capabilities and increase productivity growth through concerted innovation and learning.

The report also shows that successful developing economies have used widely differing strategies to build industrial capabilities and compete in world markets: building capabilities through domestic research and development (R&D), through foreign direct investment or through a combination of the two. Some, but relatively few, have succeeded by drawing in foreign technology largely at arm's length while building strong technological and innovative capabilities in local firms. Others, a larger number, have gone some way by plugging into global value chains, becoming suppliers of labour-intensive products and components, without having strong domestic capabilities. Of these economies, a few have managed to combine their reliance on foreign direct investment with strong industrial policy, targeting the activities they wish to enter and the functions they wish to upgrade. Others have tapped the potential of foreign direct investment by more passive policies, benefiting from sound economic management, pro-business attitudes, attractive locations and plain good luck. The less successful developing economies—and there are many—have not managed to follow any of these strategies effectively.

At first sight, the best strategy for developing economies without strong technological capabilities is to find their way into the production systems of global value chains and let local capabilities develop slowly. While recent experience of global production systems shows that this works, some caution is called for. Latecomers entering global production systems will find it difficult to sustain growth as wages rise—unless they can raise their skill, technological and institutional bases. Plugging into global value chains does not by itself ensure that participants will upgrade their capabilities. Yet such upgrading is essential. Moreover, global production systems are highly concentrated, and the concentration rises with the sophistication of the technology.

With globalization and liberalization on the rise, economies must be internationally competitive to prosper and grow. Governments have reduced or are reducing restrictions on trade, international finance and foreign direct investment. Domestic liberalization is being strengthened by new international rules of the game for economic activity. Production across national boundaries is being integrated under common ownership or control—often in the hands of a small number of large private companies—making it even more difficult to isolate economies from world market forces. Technical change is underpinning these processes. The result is that enterprises are exposed to global competition with an immediacy and intensity rarely seen before.

How can countries see where they stand?

The Scoreboard introduced in this report provides information on crucial aspects of industrial development and competitiveness. It has two parts: an index of a country's ability to produce and export manufactures, and benchmarks of the structural drivers of industrial performance.

Benchmarking industrial performance

The competitive industrial performance (CIP) index measures the ability of countries to produce and export manufactures competitively. It is constructed from four indicators: manufacturing value added per capita, manufactured exports per capita, and the shares of medium- and high-tech products in manufacturing value added and in manufactured exports. The first two indicators tell about industrial capacity. The other two reflect technological complexity and industrial upgrading.

A ranking of 87 economies (selected on the basis of data availability for inter-economy comparison) by the CIP index reveals a general and expected pattern: industrialized economies congregate near the top, transition economies and middle-income developing economies around the middle, low-income developing economies and least developed economies at the bottom. Looking at the regional averages for developing economies shows East Asia leading the CIP ranking in 1998, followed by Latin America and the Caribbean, Middle East and North Africa, South Asia and Sub-Saharan Africa.

The stability of the CIP ranking over time confirms that industrial performance is path-dependent and difficult to change. But there have been some leaps. Major improvements have been experienced since 1985 by middle-income developing economies (China, Costa Rica, Malaysia, Mexico, the Philippines and Thailand). Enhanced industrial performance in these economies has been triggered, to a great extent, by their insertion into global value chains through transnational corporations.

Low-income economies remain at the bottom in the CIP index and the gap between least developed economies and other developing economies widened during the period 1985–1998. This points to growing industrial divergence within developing economies. Low-income economies have not moved up the technology ladder. Evidence suggests that 42 developing economies had a technology structure in 1998 similar to that in 1985. Only 16 developing economies (of the 58 in our sample) have shown dynamic production and export structures towards technology-intensive products.

Industrial production and manufactured exports within developing economies are highly concentrated. The top 5 countries account for 60 percent of developing country industrial production and 61 percent of exports. By contrast, the bottom 30 countries account for only 2 percent and 1 percent. Most worrying, these shares declined during 1985–1998.

Benchmarking the "drivers" of industrial performance

Industrial performance is the outcome of many social, political and economic factors interacting in complex and dynamic ways. The purpose here is to benchmark economies on their key structural variables—referred to here as drivers—using available data. This report focuses on five proxy variables for drivers directly relevant to industry: skills, technological effort, inward foreign direct investment, royalty and technical payments abroad and modern infrastructure.

Singapore led developing economies (and the world) in foreign direct investment per capita in 1998, while Hong Kong Special Administrative Region (SAR) of China was in fifth place. Other developing economies among the top 20 recipients of foreign direct investment were Malaysia and Chile; one transition economy, Hungary, also ranked among the top 20. Singapore and Hong Kong SAR ranked among the top 5 in payments for technology per capita, followed in the developing world by Malaysia, Taiwan Province of China and the

Republic of Korea. Singapore ranked third in physical infrastructure, with Bahrain and Hong Kong SAR also in the top 20.

The ranking of economies by each driver of industrial performance shows considerable stability over time (just as the ranking by the CIP index does). Thus the ranking of economies by R&D spending per capita for 1998 is highly correlated with that for 1985, and so on. Even so, some countries changed their relative position significantly between 1985 and 1998, such as Uruguay in the skills index, Ecuador in R&D per capita and Tunisia in foreign direct investment per capita.

Indigenous technological effort (proxied by enterprise R&D) appears to be one of the most important factors for improving industrial performance, in industrialized and developing countries alike. Foreign direct investment has become central to competitive performance (especially in fast-moving industries) as global production systems have grown in importance. And skills and infrastructure continue to be key drivers.

But indigenous technological capabilities do not always match industrial performance. Some economies with high capabilities have "underperformed" due to a disabling regulatory environment, macroeconomic instability and other fundamental factors. Bahrain, Hong Kong SAR and Panama are among them. Similarly, economies with relatively low capabilities have "overperformed", rapidly upgrading their export structures, led by transnational corporations. They include Malaysia, Mexico, the Philippines and Thailand.

Among developing economies, industrial capabilities are highly concentrated, with East Asia leading in all factors. Industrial divergence among developing economies is even more acute when looking at technological capabilities. For instance, the bottom 30 economies account for only 2 percent of developing economy foreign direct investment inflows in 1998, and their R&D expenditure, technology license payments and Internet hosts are almost negligible.

Innovation and learning drive industrial development

The report demonstrates that building technological capabilities is a long, costly and risky process, which many developing economies cannot afford entirely on their own. But the emergent global setting opens up alternatives for developing economies to build up such capabilities. Although external sources can be used by developing economies to stimulate industrialization, building domestic industrial capabilities is a must if industrial growth is to be rewarding and sustainable. In today's interdependent world, connectivity to the external sources of technology and market access remains vital for industrial success. Tapping into global value chains, especially in knowledge-driven sectors, can be a good means to enter global markets and gain access to new technology and knowhow.

Enterprises in developing countries generally start the innovation and learning process by importing new technology; they then invest in building their capabilities to master the tacit elements. How much they invest depends on the incentives thrown up by markets, mainly by the competition faced in foreign and domestic markets, as well as on the ability to assess complementary supporting activities. Enterprises draw on internal and external resources—both foreign and domestic—to build their capabilities. The process starts with capabilities needed to master the technology for production purposes and may deepen over time into improving the technology and creating new technology.

Linking, leveraging and learning capture what enterprises—and countries—have to do to enable their technological development.

- *Linking*—connecting with outsiders to acquire needed technologies and skills.
- *Leveraging*—going beyond arms-length transactions to squeeze as much as possible from the new relationships with those outsiders.
- *Learning*—making the many efforts to master process and product technologies, consciously building the foundation for improving current technologies and creating new ones.

Whatever the process, enterprises have to start with their initial complement of resources, technologies, skills and capabilities. It is what they do with these elements that counts. The most important thing an enterprise can do is accelerate its acquisition of capabilities by looking overseas to obtain information, purchase machinery, acquire bits of technology, bring in consultants and so on. An important part of this can be linking up with other enterprises or institutions, locally or overseas, through formal or informal ties. Strategically, it makes a lot of difference what choice is made—but the choices are also heavily constrained by the enterprise's competence and the options available to it.

Latching onto global value chains

The report shows how firms and economies can build a foundation for ongoing innovation and learning by competing in global value chains. Spread around the world, enterprises in global value chains perform related activities to bring a product (or service) from design and product development to production, marketing and sales and to consumption, after-sales services and eventual recycling. The advantage of latching onto global value chains is that firms can seek involvement at their level of technological competence.

Competing in global value chains can build foundations for industrial innovation and learning. Crucial factors for latching onto a global value chain are not only the hard facts of price, quality and punctuality but also the willingness to learn and to absorb advice from the lead enterprises. Global value chains can thus unleash enterprises—but they can also constrain them. Particularly in manufacturing, the insertion of local activities in wider networks is an opportunity for developing countries to upgrade their capabilities.

But entering global value chains does not provide an assured ride up a capability escalator. It is often a fast track to acquiring production capabilities, but moving further up the chain can lead to conflicts with existing customers. Some firms even have had their capabilities downgraded as a result of their integration in global value chains. So, it makes sense for latecomers to use all the resources they can acquire from the advanced world, in return for providing such services as low-cost manufacturing. But this requires a strategic choice to use the links for domestic development.

Helping firms solve problems and grasp opportunities

The report also details how—and whether—support institutions can help firms meet the information, skill, finance and other needs that are difficult to satisfy in open markets. A nurturing environment is required to foster vibrant industrial development. And ensuring access to vital services that support innovation and learning is a critical part of establishing that environment. Many of these services are supplied through the market in industrialized countries, but even these countries find it necessary to augment what is supplied through the market with subsidized services. Various considerations provide ample justification for the provision of subsidized services to support the process of innovation and learning—even more for developing countries.

Many types of institutions are essential in supporting innovation and learning by firms. Infrastructure determines the cost of operation and interacting with the outside world. Training and specialized education are very important, as are financial services. The focus here is on the institutions directly supporting the innovation and learning efforts of firms.

What principles, then, should guide the provision of the subsidized services for innovation and learning? The report considers three to be paramount.

- First, support institutions should be established and managed and subsidized services provided within the framework of the national strategy for industrial development.
- Second, as a general rule, subsidized provision of industrial services has more justification the more widely shared the specific services rendered.
- Third, the services and organizations should not be supplied solely by government. As quickly as is feasible, they should be supplied in public-private partnerships or by private firms and associations—with subsidies, if justified, or without, if the market can supply the services.

Formulating strategies

Developing economies can build competitive industrial capabilities in the current setting. Also clear is that building these capabilities needs extensive policy support. The success of developing economies that employed industrial development policies in export-oriented environments—with complementary policies to build skills, technological capabilities and supporting institutions and to leverage foreign resources—shows that such strategies can radically transform the industrial landscape in just a few decades.

The report argues that the basis of any coherently framed industrial strategy is a national vision of industrial development—a vision to get on the high road to competitiveness by increasing productivity growth through concerted innovation and learning. Foresight exercises offer a disciplined means for determining targets and the ways to achieve them in formulating industrial development strategies. The focus of these exercises in developing economies differs from that in industrialized economies in that the objective is to catch up with the global technological frontier, not to remain on, or at the forefront of, the changing frontier. Even so, developing economies require foresight in relation to existing industries—not simply for keeping up but also for catching up to a shifting frontier—and in relation to industrial activities for which potential competitive advantage is within grasp.

The report makes three major points on the policy process. First, policy needs vary with the level of development. As markets and institutions become more efficient and complex, the need for direct interventions falls and the potential costs rise. Second, industrial development policy must be systemic. No strategy can succeed unless it dovetails physical investment in capacity with technology development, skill building, cluster strengthening and so on. Third, policies must correspond to the phase of learning and so must change accordingly: policies in the infant phases of capability building must differ from those in the mature phase, when R&D and frontier innovation become vital.

Enhancing capacities to sustain productivity growth

Industrial development can drive human development and national development. By attending to the drivers of industrial development countries can greatly improve their potential industrial performance. Needed are policies to ensure sustained productivity growth with an emphasis on equitable distribution. Only when countries achieve this will they turn onto the high road to development, drawing fully on world trade and investment flows and connecting their people to the global economy.

Developing economies have to deliberately mobilize the key ingredients of productivity growth and spread them widely. Getting the macroeconomy right and opening up to trade and investment is only a first step. And it is one that needs to be handled carefully: many countries have rushed into it without adequate preparation. If they stop here and make no deliberate effort to build up the widest possible base of higher order skills, capabilities and institutions, growth will slow down or grind to a halt.

Countries have to build the capacities to take on, at competitive levels, more complex activities that use emerging technologies and sustain rising wages. This entails building the institutions and providing the support to create new skills, information and capabilities. These ingredients of success are hardly a secret. What is difficult is to devise and implement practical strategies to suit the specific needs of particular developing economies.

The task is broad and challenging. It is also slow, difficult and detailed. It requires understanding and tackling the basics of small, incremental changes on which received theory provides little guidance. It entails constant adaptation and learning on the part of policymakers. And it has to call forth the cooperation of a range of agents, private and public, as well as new forms of governance that are difficult to introduce.

In all this, countries need consciously to build their technological capabilities through concerted innovation and learning. To get the productivity gains promised by such efforts they need, in addition, to put in place the institutions to support their proactive integration into the global flows of trade, capital and technology. Again, the international community can do much to support these efforts—and again, UNIDO will work to ensure that such support is forthcoming.

Part 1
Assessing where countries stand

1 New technologies, new systems, new rules

THE INDUSTRIAL SCENE IS CHANGING QUICKLY—DRIVEN BY constantly emerging, rapidly spreading new technologies that are altering the relationships between enterprises and other entities and influencing how enterprises are organized and managed. National and international rules and regulations are also changing, improving the functioning of markets. Although many of these changes offer enormous benefits to developing countries that can use them in their economic interest, countries that cannot could be marginalized and excluded. Countries at all levels of development face the same challenge: ensuring that industrial enterprises become and remain internationally competitive.

Becoming internationally competitive can be much harder than it sounds. Why? Because industrial competitiveness does not result from merely opening economies to global trade, investment and technology flows—though, if done carefully, that can be important. Nor does it mean cutting wages—a response that is, at best, a short-term defensive strategy (often termed the "low road") incompatible with sustained growth. Instead, industrial competitiveness requires building capabilities in the use of new technologies (the "high road").

To develop those technological capabilities, countries have to acquire enterprise-specific knowledge, skills and practices through an incremental learning process. This process can be slow and difficult. Depending on the country and the technology, it can involve heavy costs and great risks and uncertainties. But if countries fail to build the capabilities to compete internationally, they can become bystanders at the technological feast, stuck with the crumbs—stuck with simple manufacturing activities that do not lead to sustained, diversified growth.

Capability development takes place primarily in enterprises. It is, however, strongly conditioned by the environment in which enterprises operate. Responding to market, policy and technological signals, enterprises are sensitive to macroeconomic changes, growth prospects, national security issues and physical and intellectual property rights. They need a variety of inputs from markets, institutions and other enterprises to build and strengthen capabilities. These inputs—including finance, skills, machines, information and technical knowledge—have to keep pace with rapid technical change and intense competition. Thus capability building requires complex interaction among actors. The policy challenge for developing countries is to foster dynamic competitiveness.

The complexity of the capability building process varies by industry. It also varies by a country's level of industrial development. With industrialized countries constantly increasing their competitiveness and strengthening technology systems, capability development is crucial in developing countries—and requires strong policy support. Policy needs are even greater in the world's least developed countries. This chapter assesses the opportunities and challenges that the new industrial scene creates for the the process of industrialization in developing countries.

Assessing technical progress—its promise for growth

Recent scientific and technical advances provide a wealth of productive knowledge. Such knowledge, applied properly, can raise incomes and employment in developing countries. A rice producer in India, a goods transporter in the United Republic of Tanzania, a small fruit processor in Thailand, an automobile component manufacturer in Brazil—all can benefit from new technologies. The rapid pace of technical progress shows no signs of slowing, and its reach is pervasive, affecting nearly every aspect of life.

Except if directly taught, productive knowledge can move from innovator to user only if it is codified into transmittable form—into information. New technologies facilitate such codification and transmission, allowing knowledge to spread faster and cheaper than ever before.[1] Moreover, it is not only

Box 1.1 Technology and innovation

Opportunities

- The technology structure of production and exports matters for long-term development.
- With adaptive capabilities, technology can be upgraded to increase competitiveness in all countries and industries and at all technological levels.
- Technological upgrading can be achieved by pursuing a strategy of innovation based on linking, leveraging and learning.
- Technological upgrading is facilitated by entering into high-tech global value chains, even at the assembly level (for export-oriented operations).

Challenges

- Stricter intellectual property rights have raised the "entry fee" for technological upgrading.
- Low-tech, low-wage, resource-based industrialization is a slow-growth strategy. Sustainable growth requires rapid increases in wages and productivity.
- Large-scale investments are required in information and communication technologies, infrastructure and capabilities.
- Narrowing the "economic divide" requires bridging the "digital divide".
- Replicating East Asia's rapid, technology-led growth will be difficult given the new global setting, new rules, different preconditions and new competition from China and India.

knowledge that moves more easily: so do products, money, skills, machines and other inputs into production. Thus industry remains the focal point of technical change and diffusion. Accordingly, this report's main concern is to determine why many developing countries are unable to use new industrial technologies efficiently.

With falling costs of distance, the economic world is shrinking rapidly and irreversibly. *Globalization,* the term that describes this process, has huge technological potential to change—and improve—economic life. But it also carries costs and risks (box 1.1).

The ability to move information easily does not mean that productive technologies spread easily or that their benefits are distributed equally. On the contrary, resources tend to flow to relatively few countries—those able to use them efficiently and profitably. Because globalization lacks inherent forces to balance such divergence, it is not always an engine of beneficial and sustainable economic integration.[2] Indeed, it can also be a powerful force for deprivation, inequality, marginalization and ecological disruption.

Statistics on global deprivation and inequality, though well known, are worth reiterating. About half of the world's people—around 3 billion—live on less than $2 a day. Around 1.2 billion people struggle on less than $l a day (the yardstick of extreme poverty). Some 15 percent more people live in poverty in developing countries than 10 years ago; 800 million lack access to health care; and 500 million are not expected to survive to age 40. Women and children suffer the most: 10 million children under five died in 1999, mostly from preventable diseases.[3] In 1960 per capita incomes in the richest 5 percent of countries were 30 times those in the poorest 5 percent. By 1997 they were 74 times as high.

Inequality has also increased in the manufacturing industry, both between industrialized and developing countries and within the developing world. In 1985 per capita manufacturing value added in the most industrialized 5 percent of countries was 297 times that in the least industrialized 5 percent—while in 2000 it was 344 times as high. The industrial leaders among developing countries did quite well. But in 1985 per capita manufacturing value added in the five leading developing countries was 276 times that in the five laggards—and in 2000 was 437 times as high.

To the extent that manufacturing remains a driving force in sustained development—and the next section argues that it does—the growing divergence in manufacturing performance presages a similar divergence in economic performance more generally. But if the international economy is to promote political and social stability, it cannot sustain this pattern for long. The broad acceptance of global integration in a democratic framework requires that the process benefit all participants—and that the benefits be reasonably equitably distributed. This is not the case today, creating hardship and raising resistance to further reform. Unless the divergence is reversed, the promise of growth based on technical progress may remain just that—a promise that marginalized people no longer believe in.

Being competitive in manufacturing—the imperative

Is industry still important for economic development? Most analysts would say yes. Since the industrial revolution, manufacturing has been the main engine for growth and for transforming the economic structure of poor countries. It has been the catalyst for shifting them from simple, low-value activities with poor growth prospects to activities with high productivity, increasing returns and strong growth potential.[4] The rapid growth of technology-driven economic activity does not change this, despite the rising share of services in income and the much-hyped growth of the "new economy". Indeed, rapid technical progress makes industrialization even more important for developing countries (box 1.2).

With globalization and liberalization on the rise, countries must be internationally competitive to survive and grow. That was not the case when industrial development started in today's industrialized countries and most newly industrializing economies. Many governments used import protection, subsidies, procurement and other measures to promote industrial enterprises and catch up with the leaders. The leaders, in turn, tried to protect their positions through measures such as prohibiting the emigration of skilled workers and even (in early nineteenth century England) banning the export of machinery.[5] In the early days of industrialization, high transport and communication costs also provided natural protection. In addition, different countries adopted different technical standards, and governments rarely bought goods from foreign suppliers. Finally, consumers often knew little about competing foreign products.

Things are very different today. Governments have reduced or are reducing restrictions on trade, international finance and foreign direct investment (FDI). Domestic liberalization is being strengthened by new international rules of the game for economic activity. Production across national boundaries is being integrated under common ownership or control—often in the

Box 1.2 Industry as the engine of growth

Industry has long been the main source, user and diffuser of technical progress and associated skills and attitudes. No other productive activity comes close. Industry's special role can be understood only in a world of dynamic learning and technical change, where large enterprises strive to increase their size and capabilities to realize economies of scale and societies constantly transform their structures and habits. In this world the manufacturing industry is not just an ingredient of development—it is the essential ingredient.

Applying technological progress to production. Manufacturing is the main vehicle for applying technological progress to production. Agriculture also benefits from technical progress, but at a much slower pace than manufacturing. Manufacturing can apply a limitless variety of inputs and equipment. Moreover, many industrial technologies involve increasing returns to scale and offer enormous potential for further learning and incremental improvements. That is why the shift from low- to high-productivity activities always involves a shift from agriculture and traditional services to industry. In recent years information and communication services have also attracted innovative activity. But that innovation was only possible because of technological advances in the hardware of information processing and telecommunications.

Driving innovation. Manufacturing is the main source of innovation. Research and development by private industrial enterprises accounts for the bulk of innovation in industrialized countries; these enterprises also finance significant research and development in universities and other laboratories. Moreover, formal research and development is only part of the technology development process. A significant portion occurs in the engineering, production, procurement, quality management and other departments of enterprises. The scope for such innovation is enormous in manufacturing, perhaps more so than in other activities.

Diffusing innovation. Manufacturing is often the hub for diffusing innovation to other activities, providing capital goods and transmitting new technical and organizational knowledge. Historically, the capital goods sector served as such a hub; today the electronics industry is the hub. In particular, the use of information technologies by all activities involves the considerable spread of new technologies, accompanied by close interaction between suppliers and users.

Developing new skills and attitudes. Manufacturing is a vital source of new skills and attitudes, transforming traditional economic structures. It creates an industrial work ethic, spreading the discipline and organization required in modern societies. It fosters entrepreneurial capabilities, with small enterprises as the springboard, and it develops new managerial and technological capabilities, the core of modernization and competitiveness.

Leading institutional development. Manufacturing has led the development of modern institutions and legal structures such as joint stock companies, accounting standards and corporate governance norms.

Producing beneficial externalities. The innovation and skills created in manufacturing provide large benefits for other activities. Agriculture gains from richer consumers, better equipment and inputs, and improved storage, transport, distribution and processing facilities. Services gain from better equipment and skills.

Stimulating modern services. Manufacturing provides the direct demand that stimulates the growth of many modern services. It is often the largest customer for banking, transport, insurance, communications, advertising and utilities. It creates markets for new services and skills, particularly important for finance, education and logistics. It is also the source of new service enterprises, many of them originally part of manufacturing enterprises and hived off to provide design, logistics, maintenance, training and other services.

Generating dynamic comparative advantage. Manufacturing is the main source of dynamic comparative advantage, the shift from primary to more advanced—and generally more dynamic and higher-value—manufactured exports. Manufacturing now accounts for about 90 percent of global visible trade, a share that has grown steadily over time. Terms of trade for manufactures have also improved steadily. Although modern service exports are also growing, much of this growth comes from industrialized countries that have built modern skills and capabilities through manufacturing. Few countries are able to sell high-value services (excluding tourism) without first undergoing industrial development.

Internationalizing economies. The internationalization of an economy often follows the spread of transnational manufacturing corporations, banks, transport providers, advertisers and so on setting up shop around the world to serve their customers. The current phase of globalization, with integrated facilities across countries, is led by manufacturing enterprises.

Modernizing enterprises. The exposure to foreign markets, enterprises, skills and practices that manufacturing brings can be the catalyst for modernizing national industrial enterprises, as in the Tiger economies of East Asia. Without industrial development, such modernization would not have been possible.

Sources: UNIDO; Chenery, Robinson and Syrquin (1986).

hands of a small number of large private companies—making it even more difficult to isolate countries from world market forces. Technical change is underpinning these processes. The result is that enterprises are exposed to global competition with an immediacy and intensity rarely seen before.

Thus it is essential for enterprises and countries to deal with the increase in international competition. To compete internationally, enterprises not only have to be efficient, they also require a supportive economic and business environment.

- Governments must provide appropriate conditions: political security, good macroeconomic management, sound and enforceable legal and property rights, transparent and predictable policies, well-functioning institutions and a business environment with low transaction costs.

- Suppliers of physical and service inputs and infrastructure must meet international standards of cost, quality and delivery.

- Markets for labour, capital and information, along with their supporting institutions, must work reasonably efficiently.

- Enterprises must be encouraged to invest in building new capabilities, mounting competitive strategies and developing networks and clusters for achieving efficiency and dynamism.

The needs of competitiveness thus stretch well beyond the front-line enterprises that face international rivals, encompassing other enterprises, activities, institutions and policies—and applying to developing and industrialized countries alike. For latecomers to industrialization that lack the required capabilities, structures and institutions, globalization can pose considerable challenges. But countries that can address these challenges have enormous opportunities for growth. How well countries cope depends on their ability to link with foreign partners and leverage additional resources—particularly technology and knowledge—for development. But success in these areas requires investing in and facilitating learning efforts to adopt, adapt and improve on the resources acquired.

Competition is constantly taking new forms. Low costs are important—but so are innovation, flexibility, reliability, service and quality. In industrialized countries new products, processes and services are the main drivers of competitiveness. Enterprises in developing countries do not innovate in this sense and cannot rely on these mechanisms to achieve competitiveness. They compete by using imported technologies together with lower labour and other costs—and, where relevant, natural resources. Using new technologies efficiently, however, requires considerable technological and managerial effort.

Mastering technologies to competitive standards requires new skills, technical information, organizational techniques and marketing and supply chain methods. The hardware of new technologies, along with blueprints and instructions, can be imported. But its efficient deployment necessarily involves local learning. This process is continuous, because technologies change constantly. Industrial development also entails a constant shift from simple to complex technologies—only then can wages and living standards rise. This means moving both across industries (from low- to medium- and high-tech) and within industries (from low to high value-added activities).[6]

None of this is easy, even for countries that do not innovate at the frontier. It is not easy because achieving technical and managerial efficiency takes considerable effort. Opening the economy to world markets does not, in most developing countries, ensure that enterprises will secure the right technologies and, more important, use them at best practice levels. A user of new technologies—new to the user, that is, rather than the world—has to master their tacit elements to achieve best practice. In this process the user has to build new skills, collect new information, set up new systems and forge new links with other actors.

This process, often requiring costly and risky learning, is in many ways similar to real innovation in industrialized countries. The content, risk, cost and duration of the effort vary—by technology, industry, actor and context. Becoming competitive requires widespread technological effort, which is a constant process of innovation and learning. The efficiency of this innovation and learning determines the success or failure of industrial development. How this occurs in developing countries is the theme of this report.

That the world's industrial setting is changing is evident, but many changes are not new by historical standards. In some ways the global economy was more open a hundred years ago. There were fewer barriers to trade and investment, and there was greater certainty about security and exchange rates. Technical progress, however, has integrated the world economy much more closely today, and the interaction of several factors has created a qualitatively different setting for industrial activity. Product, service, financial and information markets are better linked, each in a state of constant ferment.

The many features of the new setting can be grouped in three clusters: those driven by new technologies, those driven by new innovation, managerial and organizational systems in enterprises and those driven by new international rules and regulations.

Exploring and exploiting new technologies

Today's technical change is unprecedented in pace and scope. Information and communication technologies are at the core of such change, making spectacular advances. In 1930 a one-minute telephone call from New York to London cost $300 in today's prices; today it costs a few cents.[7] The cost of 1 megahertz of processing power fell from $7,600 in 1970 to 17 cents in 1999—a 99.9 percent decline over the same period. The cost of sending 1 trillion bits fell from $150,000 to 12 cents. The entire contents of the U.S. Library of Congress can now be transmitted across the country for $40; soon it may be stored on one computer chip. All of this is revolutionary, but the pace of innovation continues to accelerate. Thus it is not surprising that there is so much interest in knowledge societies and the "weightless" economy.[8]

Information and communication technologies, the most visible face of technical progress, also affect the pace of innovation. Today information can be processed at rates unthinkable just 10 or 20 years ago.[9] But these technologies are also important in mundane low-tech activities, often opening unexpected opportunities to entrepreneurs in developing countries (box 1.3).

Information and communication technologies can also significantly boost economic performance, though there is much debate about their precise effect on recent economic growth.[10] Developing economies with fast growth in consumption of information and communication technologies—India, the Republic of Korea, Taiwan Province of China and Thailand—also appear to have the fastest growth in productivity and gross domestic product (GDP). In Canada, the United Kingdom and the United States between 1990 and 1996, about half the growth contributed by fixed investment is estimated to have come from information and communication technologies.[11] Accelerating the adoption of these technologies are their falling prices, which are dropping faster than those for other capital goods.

Box 1.3 Innovative uses of information and communication technologies in developing countries

In rural southern Ghana, petrol stations place orders by telephone—a task that entailed travelling to Accra. In Zimbabwe a company generated $15 million in new business by advertising on the Internet. In the mountains of Lao People's Democratic Republic and Myanmar, drivers of yak caravans use mobile telephones to call ahead and find the best route to deliver their goods to market. Fishers off the shores of Kerala, India, make phone calls from 7 kilometres out to sea to determine which market is paying the most for their catch, then sail there. Farmers in some remote Indian villages get weather and price information on the Internet. And in Bangalore, India, a non-profit trust is promoting a $200 computing device to provide rural dwellers with the same information.

Source: Baxter, Perkin and Mulligan (2001, background paper).

Information and communication technologies can change—and improve—innovation by integrating diverse production systems and formerly unrelated technologies.[12] They can also change the geography of industrial activity, bringing together locations once separated by high communication and transport costs. In addition, they can create new opportunities for learning in developing countries, using electronic links to access global knowledge on an unprecedented scale. Distance learning, if properly organized, can be quite successful.[13] It is partly in response to these possibilities that many governments are opening their economies to international flows of products, knowledge and resources.

Quite apart from the massive increase in the use of information and communication technologies, the information content of industrial activities is rising rapidly. About half of the value of a new car lies in its information content—design, process management, marketing, sales and so on. In industrialized countries the weightless part of economic activity seems set to dominate life,[14] but it is also going to play a larger role in industrial activity in developing countries.[15]

Can information and communication technologies facilitate leapfrogging and catching up by developing countries? Can latecomers without industrial bases jump to the forefront without going through traditional industrialization? The Internet became economically useful to enterprises in industrialized countries only around 1997, and its potential is just beginning to be exploited. Countries with no background in information and communication technologies and without a large traditional industrial base can use the Internet to promote growth and employment. Developing countries' lack of old computer systems is an advantage. New technologies that do not require fixed communication networks may enable developing countries to leapfrog stages of technological development. In Africa satellites and new wireless technologies may make it possible to bypass fixed telephone landlines (box 1.4). Moreover, as computing reaches mobile telephony, millions of users in Africa may come online.

Still, the evidence so far does not offer great hopes for leapfrogging. As noted, most countries that have succeeded

Box 1.4 Internet access in Ghana—impressive but expensive

Africa boasts many technology success stories and centres of excellence. One of them is Ghana, which aspires to be an Internet and rapid communications hub for West Africa. Although there is no "one size fits all" solution for the best adoption of these technologies, Ghana suggests basic principles for all developing countries. Ghana was the fourth Sub-Saharan country to go online, after South Africa, Botswana and Zambia. Accra's only full-service Internet access provider, Network Computer Systems (NCS), offers a gateway to global communications.

NCS pioneered Internet access in Ghana in late 1994, before many users in Europe had even heard of the technology. NCS subscribers are a cosmopolitan blend of embassies, chief executives, non-governmental organizations, companies and ministries. Ghana's government, which began promoting the adoption of the technology in 1995, deserves some of the credit for Accra's Internet preeminence.

Ghana's Internet structure and capacity are ahead of those in the 14 French-speaking countries of West Africa, where electronic networking consists primarily of email, bulletin boards, database access, news feeds and small file transfers. Ghana's true Internet connectivity offers much more, including instant access to messages, browsing through hypertext links, access to newsgroups on thousands of subjects and even video transfers.

Costs continue to be an issue, however. NCS charges an annual registration fee of $100 and a monthly use fee of $100. But with the average Ghanaian journalist earning less than $150 a month, the cost of a laptop computer is equal to a year's salary. So, while Internet technology appears promising and tantalizing, it is unaffordable for all but the richest people in Ghana.

To broaden access, cyber cafés have mushroomed all over Accra, and in 2001 the number of Internet users doubled to about 100,000. Similar growth is expected over the next two or three years. But Ghana faces hurdles to developing a thriving online economy. Although there is high demand for basic services, headier ambitions have been thwarted by Ghana's economic crisis. In addition, dreams of e-commerce and international online trading have not been realized.

Source: Baxter, Perkin and Mulligan (2001, background paper).

with information and communication technologies (in both hardware and software) have been relatively industrialized. Effective use of these technologies requires massive investment in infrastructure and, more important, in new skills and capabilities—investment that is beyond the means of most developing countries.[16] Moreover, industrialized countries show that considerable time can pass before the benefits of information and communication technologies are realized. A critical mass of technology diffusion—in coverage, organizational adaptation and learning—is needed for widespread productivity gains.[17]

Organizational and managerial changes at the industrial level, redesigning processes and developing new business cultures, are also needed. Productivity gains often arise not directly from technologies but from the higher productivity of new systems, procedures, skills and attitudes. In many developing countries the critical mass of information and communication technologies and the necessary skills and organizational and managerial capabilities—the main determinants of productivity gains—may not exist for some time.

Using new systems for innovation, management and organization

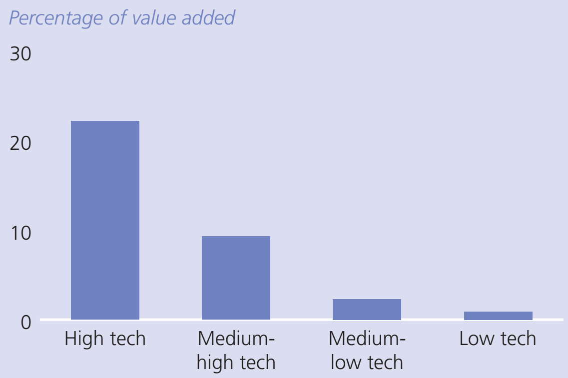
New innovation systems are widening differences between enterprises, industries, countries and regions. At the same time, new managerial and organizational systems are changing relationships between and within enterprises.

Main actors in innovation

With rapid technical change, the growing divergence in technological opportunities between activities leads to rising differences in innovative activities between industries. One good indicator of innovation is spending on research and development (R&D).[18] In 1994 high-tech industries in the countries that form the Organisation for Economic Co-operation and Development (OECD) spent nearly 25 times more of their value added on R&D than did low-tech industries (figure 1.1). In industrialized countries high-tech and medium-high-tech industries account for nearly three-quarters of business R&D.

Innovative activities introduce new products, create new demand and substitute for old products more rapidly than do stable activities. As a result R&D-intensive output and exports grow faster than other industrial activities.[19] Between 1980 and 1997 medium- and high-tech exports grew faster than other manufactured exports. These complex products now

Figure 1.1 Research and development spending by industry, OECD countries, 1994



Source: Baxter, Perkin and Mulligan (2001, background paper).

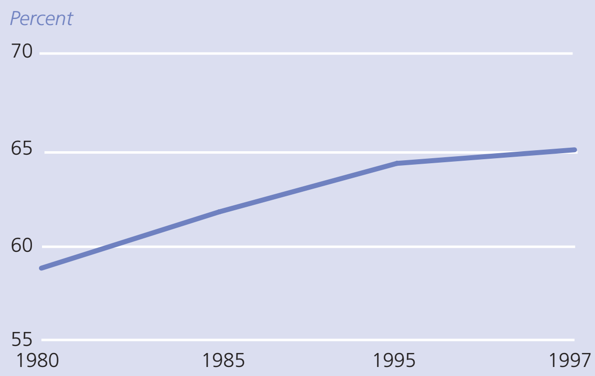
account for two-thirds of the world's dynamic exports, gaining ground on low-tech and resource-based activities (figure 1.2).

The most high-tech products—advanced electronics, aerospace, precision instruments, pharmaceuticals—have grown much faster than all other groups.[20] The five fastest-growing products in world trade during 1980–1997 were high-tech information and communication technologies, driven by a flood of new products and their growing application in other activities. But the high-tech industry is highly cyclical. Like many investment goods, it takes the lead in both downward and upward business cycles. And with the world economy slowing, it is heading downwards.

Enterprises have always been the main investors in new technologies, particularly in industrialized countries. In OECD countries enterprises conducted 69 percent of total R&D in 1997, up from 66 percent in 1981. The share of higher education institutes remained constant at 17 percent, while that of government fell from 15 percent to 11 percent. Private non-profit institutions account for the rest.[21] Among enterprises, manufacturing remains the main source of R&D. But the share of services, driven by software, is rising—accounting for 15 percent of the OECD total in 1997.[22] Distinctions between manufacturing and services are somewhat arbitrary, however, as the lines between them blur and industrial enterprises contract functions to independent enterprises.

To cope with global competition and the growing complexity of knowledge, enterprises are specializing in their core competencies. As a result large enterprises no longer develop all their innovation in-house, but increasingly procure it from other enterprises. Several channels, discussed later in the report, provide access to the required knowledge. Innovation surveys suggest that inter-enterprise collaboration is the most important.[23]

Figure 1.2 Share of medium- and high-tech products in global dynamic exports, 1980–1997



Source: UNIDO calculations based on Comtrade database.

Enterprises share innovation in two ways. The first is with enterprises in the same value chain, such as for automobiles. Major manufacturers work with first-tier suppliers in developing new models, expecting them to design and develop new components and sub-assemblies.[24] This process facilitates faster, riskier and more expensive innovation. It also raises the technological distance between first-tier suppliers, generally with strong R&D capabilities, and suppliers that lack such capabilities. This can have implications for enterprises in developing countries supplying (or hoping to supply) global value chains. The increasing use of information and communication technologies for business-to-business relations makes it easier for such enterprises to plug into supply chains. But the tightening technological links between lead enterprises and first-tier suppliers threaten to exclude them from the upper echelons of the supply hierarchy.

The second way enterprises share innovation is between competitors in and across countries. This trend is driven by the rising costs and risks of innovation (particularly in the basic, pre-commercial stages), which lead to more frequent use of strategic alliances and research consortiums. Some 5,100 strategic alliances were formed between 1990 and 1998—mainly by enterprises from the United States, which are part of 80 percent of known agreements (half with a partner from outside the United States). Enterprises in Europe participated in 42 percent of the alliances, and those in Japan in 15 percent, along with some enterprises from elsewhere.[25] Governments that would otherwise oppose such collaboration on antitrust grounds now often permit or support it, even when they maintain stringent antitrust measures.[26]

Faster technical change, growing industrial links with science, multiple nodes of innovation and falling costs of transmitting information raise the significance of innovation networks.[27] Such networks are spreading over wide areas. Geographic agglomeration remains important for some technologies and types of interaction that require direct contact—Silicon Valley is an excellent example—but it is becoming less so for others. Some networks spread across cities, others over regions, still others around the globe. Plugging into the relevant network, or concentric series of networks, is critical to competitive technology development.[28]

Given the risks and economies of scale, R&D tends to be concentrated at the enterprise level. In the United States the top 100 enterprises, in terms of turnover, accounted for nearly two-thirds of R&D in 1995, and in 1997 the top 20 accounted for one-third. Of the 35,000 enterprises doing R&D, just 1 percent performed nearly 70 percent of the total.[29] Not surprisingly, R&D is even more concentrated in small industrialized countries. In Switzerland three enterprises accounted for 81 percent of R&D in the 1980s, and in the Netherlands four accounted for nearly 70 percent. But technical change is reducing concentration.[30] In addition, the list of leading enterprises for R&D is changing rapidly: in the United States some 40 percent of the top performers in 1994 were not on the list 10 years before.

Interactions between industrial innovators and external agents—such as research laboratories and universities—are also changing. New technologies need closer links to basic science even for commercial innovation, with biotechnology as a good example. Technology clusters near knowledge centres with significant concentrations of universities and research centres are an important competitive advantage. As a result industrial enterprises are spending more to sponsor R&D in such centres and tap their expertise.

In many industries, relations with technology institutions—such as standards and metrology bodies and support agencies for small and medium-size enterprises—also become important in enterprise technological activity. Most industrialized countries have an array of institutions providing specialized technical inputs to industry. Given the public goods that they produce, many depend on government subsidies, as with Germany's Fraunhofer institutes (box 1.5). Industry associations, export agencies and the like can also provide support and technical assistance. Together these institutions create an environment rich in various kinds of information—crucial for fostering sustained growth in industrial innovation and learning (chapter 8).

Box 1.5 Cooperative contracting for research and development in Germany

Many countries recognize the need for research centres that can conduct technological work for industry and combine it with publicly funded long-term research. One of the best models, Germany's Fraunhofer-Gesellschaft, was created in 1949 and has become Europe's leading organization for institutes of applied research. It performs research for industry, services enterprises and the government, providing rapid, economical and practical solutions to technical and organizational problems. In addition, within the framework of technology programmes in the European Union, it participates in industrial consortiums to make industry in Europe more competitive.

Fraunhofer-Gesellschaft's 56 specialized institutes—funded by Germany's central government, regional governments and private industry—help develop new technologies for industry and other uses. It has nearly 11,000 staff members (mainly scientists and engineers) and an annual budget of about 900 million euros (just under $1 billion), more than 80 percent of which comes from contract research. About two-thirds of contract revenue comes from industrial and publicly financed research projects and one-third from the federal and Länder governments. Small and medium-size enterprises account for a large portion of research contracts: in 2000, enterprises with fewer than 100 employees provided nearly 25 percent of Fraunhofer's budget and those with fewer than 500 employees about 45 percent. Research for the government is aimed at longer-term social and economic problems, such as the environment.

Fraunhofer scientists specialize in a broad range of complex research. When needed, several institutes pool their expertise to develop system solutions. Researchers move easily between science and industry, and more than half of the institutes are headed by academics. Fraunhofer institutes can handle clusters of technologies that universities cannot, and their practical orientation makes them valuable to clients. Companies of all sizes and types use the institutes as high-tech laboratories for development work, special services and organizational and strategic issues. In addition, the Fraunhofer institutes increasingly collaborate with affiliate institutes in Asia, Europe and the United States.

Source: http://www.fraunhofer.de/english/index.html.

New ways of organizing and managing enterprises

New technologies affect relationships between enterprises—that is, industrial structure and organization. They also affect relationships within enterprises—the way they are managed. Both developments influence the organization and management of global production systems and encourage global enterprises to cut inventory costs and ensure reliable procurement and delivery (box 1.6). The just-in-time system is the best-known manifestation of this, but there are others.

Changes between enterprises

Pressures for specialization, increasing the reliance on suppliers, mean that manufacturers have to manage supply and value chains.[31]

These new organizational systems are not easy to set up and manage, particularly in developing countries. The systems require advanced infrastructure, new contracting mechanisms, greater trust and openness, and new skills and management techniques.[32] To manage supply chains effectively, many large enterprises in OECD countries have had to broaden their managerial and technological competence. Information flows, logistics and networking are the new weapons in the competitive armoury, with large potential benefits from lower costs and increased flexibility. In many developing countries, however, policy and business cultures are not conducive to these changes.

For two reasons, electronic commerce technologies offer faster, more efficient and potentially more cost-effective ways of connecting enterprises.[33] First, these technologies are cheaper and easier to automate in ubiquitous processes such as distribution, sales, after-sales service and inventory management. Electronic data interchange is especially

Box 1.6 New ways of organizing and managing enterprises

Opportunities

- Clustering, networking and specialization increase efficiency and productivity.
- New managerial methods and production techniques also enhance efficiency and productivity.
- Information and communication technologies provide access to new knowledge on management methods, production techniques, marketing and export opportunities (e-commerce).

Challenges

- Increased competition at all levels in both export and domestic markets due to trade liberalization.
- New skills and capabilities required to master information technology—especially for new design, production and marketing systems.

suited to supply chain management but may be replaced by the Internet for small suppliers. Second, e-commerce technologies can be applied all along the value chain in an integrated manner—something not possible with earlier technologies.

Efficiency gains through e-commerce applications include:

- *Lower sales costs.* In the past, errors forced large enterprises to rework about a quarter of their orders. E-commerce now allows enterprises to check that orders are internally consistent and that orders, receipts and invoices match. General Electric's Trading Post Network, for example, significantly reduced ordering errors. It also cut material costs by 5–20 percent because competition increased among suppliers and the length of the procurement cycle was cut in half.
- *Cheaper customer support.* Cisco Systems, the world's largest supplier of routers for Internet traffic, has moved 70 percent of its customer support online—eliminating 250,000 telephone calls a month and saving more than $500 million, about 17 percent of its operating costs.
- *Cheaper, faster procurement.* Typical procurement orders cost $80–125 to process for low-value requisitions and much more for complex orders (in some cases exceeding the value of the purchase). The use of electronic data interchange can cut these costs by 10–50 percent. MCI has cut its personal computer purchasing cycle from 4–6 weeks to 24 hours, while Bell South has shortened the time required to approve an expense account from 3 weeks to 2 days.
- *Smaller inventories.* In the United States the average value of inventories is 2.3 percent of annual (non-farm) sales and 4.2 percent of final goods sales. Each stage of the value chain holds significant inventories: 37 percent by manufacturers, 25 percent by wholesalers and 27 percent by retailers. E-commerce can also significantly reduce costs on inventories held.
- *Better forecasts of consumer demand.* E-commerce enables more accurate forecasts of consumer demand and increased customization of orders. Collaborative forecasting is expected to cut inventory levels in the United States by 25–30 percent, or $250–300 billion (OECD 2000a, p. 48).

Another change is the growing importance in several industries of the geographic clustering of enterprises, particularly small and medium-size enterprises.[34] The benefits of agglomeration arise from external economies such as the availability of information or proximity to pools of suppliers, customers and skilled workers. Clusters are more advanced than passive agglomerations, where enterprises realize external economies just by being there. Combining networking, specialization and joint action,[35] clusters could overcome many of the disadvantages associated with small size.

Many high-tech clusters have emerged in industrialized countries, inspiring much analysis and policy.[36] Many active, competitive clusters also exist in developing countries.[37] But their technological dynamism is often limited,[38] posing severe challenges in the emerging competitive setting. Such clusters need to shift from realizing largely static external economies to building dynamic capabilities based on new technologies, skills and networks.

Changes within enterprises

Enterprises are experiencing important changes in internal management and organization. The need to facilitate information flows is causing enterprises not only to introduce information and communication technologies but also to cut management hierarchies and build new tools to handle information—calling for new skills throughout.[39] On the shop floor the use of new technologies requires new skills—and more continuous training, multiple skills, work teams and the close involvement of workers in quality and productivity improvements.[40] Information technology is now pervasive in work methods, plant layouts and process control, quality management, continuous improvement, lean production and just-in-time inventory systems. Other information technology applications include computer-aided design, manufacturing and engineering, manufacturing and enterprise resource planning, product data management, automation, robotics and flexible manufacturing systems. Information and communication technologies are also being used to automate design, manufacturing and coordination—changing and improving the innovation process.[41]

None of this is easy, even in industrialized countries with sophisticated enterprises, ample skills and strong support institutions. The need for new systems and increased interaction with external agents is disruptive to the internal organization of enterprises.[42] But enterprises that master the new culture and technologies find it easier to manage operations over long distances. Information and communication technologies also make it feasible for enterprises to separate functions and processes—locating them, almost regardless of distance, where cost, efficiency and market needs dictate.

By better managing global networks and spreading activities around the world, enterprises can minimize costs and optimize flexibility and logistics. These possibilities also apply to other activities in the value chain—services, marketing, R&D—that are also relocating within tightly coordinated international systems. Of all the activities in the value chain, R&D is the slowest to shift, but here too there are signs of change.

For several reasons, these activities are not relocated evenly across countries. For example, some activities have to be concentrated in a few sites to reap the benefits of scale economies, agglomeration economies, skill and supplier availability and logistics possibilities. Others can be spread more widely because there are fewer scale or cluster economies—or because of the need to be near material inputs or final customers. Other reasons for choosing certain locations may be strategic, including the locations of competitors, need to spread risk, access to innovative work and benefits of first-mover advantages. Countries that insert themselves into the global value chain early can develop skill, technological, supply and infrastructure advantages that build up over time. Moreover, the success of a few sourcing activities can attract other transnational corporations, as direct suppliers or as followers, looking for locations with good images and reputations.

In addition, several traditional factors make certain locations more attractive for foreign direct investment—political and macroeconomic stability, welcoming policies and so on. Low wages for unskilled workers increasingly count for less in all but the simplest low-tech activities.

Globalized production and new global enterprises

Globalization means different things to different people. In this report it signifies the tighter links between all markets affecting industrial activity—for final products and for inputs such as raw materials, intermediate goods, machinery, finance, technology and, in many cases, high-level skills. It has many manifestations: increased trade, investment, licensing, joint ventures, alliances, networks and subcontracting activities. In most the lead players are transnational corporations from industrialized countries, the main drivers of technical change and the most important agents for transferring technologies and production across the world. But enterprises from newly industrializing economies are also enthusiastic participants.

The international role of transnational corporations has been rising steadily, with growing shares of global production, trade, technology transfer and investment. In manufacturing perhaps the most visible manifestation of their activity is the rise of global industrial value chains, linking the entire sequence of activities—raw material extraction, production, design, R&D, marketing and delivery. Of course, many industrial value chains have long been global in the sense that their materials, components or products have been traded across national boundaries. But some distinct organizational features of emerging global value chains are worth noting:

- Value chains are organized internationally under the common governance of private enterprises. These enterprises may hold an equity stake in activities in different countries, thus becoming transnational. Or they may have other market or non-market links with local enterprises (through subcontracting, joint ventures, strategic alliances or buying arrangements). Where economies of scale in innovation, production, logistics and marketing are important, the number of key players tends to fall over time. With policy liberalization, the key players rationalize production facilities across countries, often reinforcing their central role. The organization of the global value chain and the strategies of the leading players can affect the entry, upgrading and dynamism of the constituent units.
- The role of transnational corporations in global value chains (of ownership stakes in activities overseas) is rising, though there are significant differences by industry. In low-tech activities, where it is relatively easy for local enterprises to achieve best practice, arrangements tend to be loose and diverse. Some transnational corporations set up affiliates; others contract local enterprises. Independent buyers often control significant segments of the market, contracting local enterprises and providing specifications, technical assistance and inputs. In high-tech activities, by contrast, links tend to be much tighter because of the need for close coordination, rigorous quality and training needs and the desire to keep valuable technologies within the enterprise. In some of these industries, market leaders are taking specialization to its logical conclusion by

renouncing manufacturing altogether. They confine themselves to R&D, design, marketing and after-sales service, letting contract manufacturers handle the entire production process.[43] Even in high-tech industries the production systems of transnational corporations are not closed: there is a growing tendency to outsource functions and inputs to capable suppliers. Thus transnational value chains can encompass local enterprises in host countries, with the spread and nature of the links depending on the technologies used, the capabilities of local enterprises and the strategy of the competitors.

- Industrial activities are being disintegrated across countries by function and stage of production, while remaining tightly linked to ensure the efficiency of the process. Thus an enterprise may design a semiconductor in the United States with an affiliate in India, buy the wafer from a foundry in Taiwan Province of China, assemble and test the chip in the Philippines and use an independent logistics company to ship it to Germany and market it all over Europe. Accounting may be in one country and back-office functions in another. These divisions, taking advantage of small differences in cost, logistics, skills and efficiency, are made feasible by new communication and management techniques.

- Different stages of the chain have different levels of value added and technology and so impose different capability needs for participants. Those at the bottom of the chain, with the simplest requirements, are most vulnerable to the erosion of competitive advantages (if the location offers primarily cheap semiskilled labour, it will tend to lose as wages rise). Thus there is constant pressure to upgrade products and processes within value chains, whether facilities are foreign owned or not.

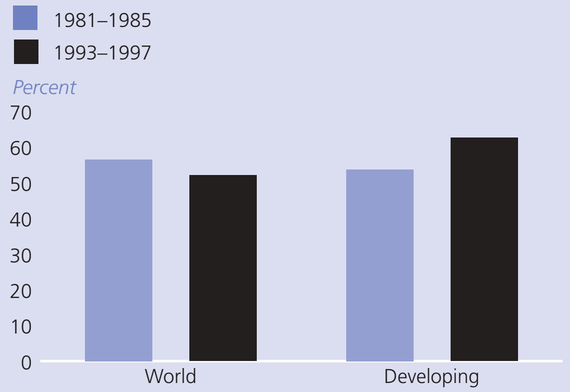
- That capital and technology are mobile does not mean that local capabilities cease to matter. If anything, they matter more because other factors are so mobile and require strong immobile factors to attract them to particular sites.[44] The factors that matter to investors using new technologies and looking for competitive locations are specialized skills, modern infrastructure, strong institutions, low transaction costs, efficient local suppliers, clusters of enterprises and providers of business support services. Thus the spread of transnational corporations promises much to developing countries in investment, technology, skills and market access. But flows of FDI are highly uneven and concentrated. The share of the top five recipients of FDI has declined for the world but risen for developing countries (figure 1.3). Part of this unevenness is due to political, social and policy factors that may deter investment. Part, however, is due to structural economic factors that lead transnational corporations to concentrate in countries.

These structural factors affect FDI location as political and other framework factors converge. Clusters again emerge as an important factor in attracting transnational corporations in activities where complementary factors and capabilities agglomerate. They are particularly important in knowledge- and skill-intensive activities, where the proximity of specialized suppliers, consultants and research and teaching institutes can be critical to competitive dynamism. The evidence suggests that FDI location is increasingly based on such localized factors rather than on general factors of the host country.[45] Governments seeking to tap FDI for industrial development have to pay attention to this new reality.

Transnational corporations look for efficient complementary factors in making their location decisions, but they also invest in raising the quality of local factors once they have invested. They train employees in new skills, help develop local suppliers, interact with and improve local institutions and so on. In 1989 Hewlett-Packard, one of the world's leading electronics companies, started operations in Bangalore, India, with about 10 people, basically to sell hardware. Still growing, it now employs more than 1,000 engineers. Apart from its sales arm, it has two large software development and R&D operations, one in Bangalore and another in Chennai. The second centre collaborates intensively with the locally owned Tata Consultancy Services.

Hewlett-Packard has forged strong links with other local enterprises—including 25 small and medium-size enterprises—and local research institutions. Its Bangalore affiliate interacts closely with the Indian Institute of Science and funds research in universities around the city. It also helps colleges in the locality develop courses and train teachers. Its

Figure 1.3 Share of top five countries in foreign direct investment receipts



Sources: World Bank (2000); UNCTAD (1995, 1999) and national statistics.
Note: Annual averages calculated for available data for 1981–1985 and 1993–1997.

engineering employees, who receive six months of rigorous in-house training, are encouraged to take out patents on their research (some 60 have been granted). Many travel regularly to Israel and the United States, where the enterprise also has R&D centres.

There is a minimum of capabilities in host countries below which it is not economical for transnational corporations to locate facilities or invest in further upgrading. The more advanced the technologies and functions being deployed, the higher the local capabilities required. It is up to the host country to ensure that it reaches the critical level. Moreover, it has to ensure that as wages and other costs rise, the quality of local factors improves to attract more complex technologies and functions—such as design and R&D. In other words, successful participation in the systems of transnational corporations requires constant efforts to build and improve local capabilities. The spread of global chains intensifies this need as more countries compete for high-value FDI.

Several features of recent FDI are of direct concern to industrial development:

- *Fast growth.* FDI flows are growing faster than other economic aggregates such as GDP, world exports and national gross fixed capital formation. As a result the share of international production—that under the control of transnational corporations and their affiliates—in global production is steadily increasing. If production by independent enterprises linked to transnational corporations is added, the share is rising even faster.

- *World trade dominance.* Transnational corporations dominate the world's visible trade, handling about two-thirds. This share is growing rapidly in activities with significant scale economies in innovation, production and marketing. These are the high-value end of the manufacturing spectrum, and countries that want to enter these dynamic segments increasingly have to rely on transnational corporations.

- *Global production systems.* Of the visible trade in the hands of transnational corporations, about one-third is within corporate systems—between different parts of the same enterprises. Important parts of such internalized trade are integrated international production systems, where transnational corporations allocate different functions or stages of production to different countries. In several high-tech activities (semiconductors, hard-disk drives) the bulk of world trade is within such systems.

- *Beyond production.* Transnational corporations are also placing accounting, engineering and marketing in affiliates—often high-value activities that boost local competitiveness and capabilities.

- *Even research and development.* Though one of the least mobile functions internationally, R&D is also being transferred overseas. Many transnational corporations, particularly those from small countries, have long conducted R&D abroad. For instance, more than half the patents filed by transnational corporations from Belgium, the Netherlands, Switzerland and the United Kingdom originate in their affiliates.[46] In many host countries foreign affiliates account for large parts of enterprise R&D. More than half of industrial R&D in Ireland, Malaysia and Singapore occurs in affiliates of transnational corporations (figure 1.4).[47] Even so, developing countries still account for a small share of overseas R&D by transnational corporations. Developing countries account for less than 10 percent of R&D for transnational corporations in the United States (UNCTAD 1999). The pattern is probably similar for other industrialized countries. This is not surprising: R&D is highly skill-, scale- and linkage-intensive, and most developing countries lack the necessary capabilities.[48]

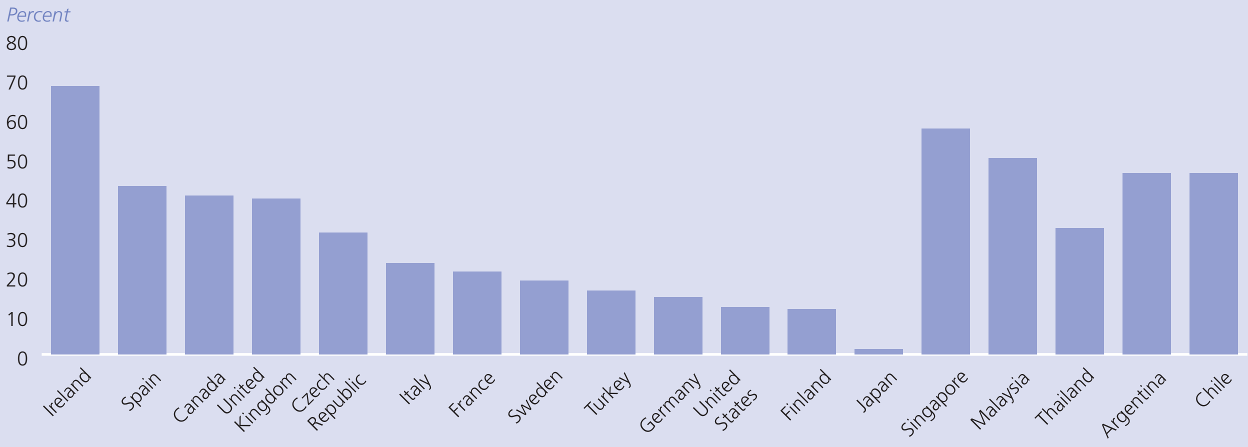
- *Innovation dominance.* Innovation is dominated by large transnational corporations. Many are unwilling to part with valuable technologies without a substantial equity stake—making FDI the most important, and often the only, source of advanced technologies.

- *Exports.* Transnational corporations are often central to local exports of technology-intensive products. Many such products are difficult to export independently because of the advanced technologies involved and the need for expensive branding, distribution and after-sales servicing. About two-thirds of consumer electronic exports from the Republic of Korea and Taiwan Province of China are original equipment manufacture.[49] Transnational corporations are also active in exports of low-tech products, where market information, branding, distribution and design are important.

- *Preferences for entry by mergers and acquisitions.* Cross-border mergers and acquisitions are the preferred mode of entry for transnational corporations, particularly in industrialized countries.[50] In 2001 the recession and falling share prices slowed mergers and acquisitions, cutting FDI in industrialized countries by about 40 percent (UNCTAD estimate). The decline is less marked in developing countries but still likely to cause some fall in FDI.

- *Even services.* FDI in services is rising rapidly as formerly homebound providers (as in utilities) privatize and globalize.

Figure 1.4 Shares of foreign affiliates in research and development, 1996–1998



Source: OECD (1999b) and national sources.

Telecommunications, power and water enterprises are good examples.

Heeding new international rules and regulations

Rules for international economic activity are changing, allowing it to respond as much as possible to market signals. Opaque rules and differences in trade and investment barriers impede the flow of products, capital, technology, information and skills across countries. New rules are designed to minimize costs and barriers—and to lead to more uniform national policies (box 1.7).

The best-known rules are those negotiated multilaterally under the General Agreement on Tariffs and Trade (GATT), now administered by the World Trade Organization (WTO). The WTO administers and embodies three main agreements:

Box 1.7 New international rules and regulations

Opportunities

- By aiming to level the playing field, new rules encourage enterprises to spread their operations across the globe and domestic competitors to improve their capabilities.
- More uniform rules and regulations facilitate the globalization of industry.

Challenge

- Eliminating policies that foster learning by infant industries hinders the development of new technological capabilities.

the updated version of the 1994 GATT, the General Agreement on Trade in Services (GATS) and the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). (The WTO also administers four plurilateral agreements—on government procurement and on trade in civil aircraft, dairy products and bovine meat—not conditional on WTO membership.) The main agreements are complemented by multilateral agreements on safeguards, anti-dumping, subsidies, state trading enterprises and balance of payments measures. WTO agreements also include rules on the treatment of goods when they enter importing countries, including customs valuation, technical barriers to trade and import licensing. These agreements are intended to prevent the use of these measures for protectionist purposes.

GATT was a provisional agreement among contracting parties and was not a legal institution. In contrast, WTO agreements are ratified by member countries and are permanent, with a sound legal basis. The three main agreements—the 1994 GATT, GATS and TRIPS—form the WTO's institutional structure and are subject to a single set of rules and a single system for resolving disputes. Unlike with GATT, WTO members automatically commit to all WTO agreements, with only a few minor exceptions.

Other, less formal rules on trade, FDI and financial liberalization have been issued by the World Bank, International Monetary Fund (IMF) and aid donors. There are also international conventions on minimum labour standards. Several rules result from standards set internationally (for example, the International Organization for Standardization, or ISO) or by dominant regions or countries (such as the European Union or the United States). In addition, some rules are negotiated in regional trade agreements or bilaterally. (Most FDI rules are bilateral.)

The new rules offer benefits but also impose costs. They reduce the scope for intervention in trade and investment—important because in many developing countries such interventions have been costly and inefficient. Increased reliance on markets can improve resource allocation and stimulate efficiency and dynamism. By reducing the risk, uncertainty and transaction costs associated with international transactions, the new rules may also raise the quantity and quality of FDI in developing countries. In addition, by strengthening intellectual property rights, the new rules may stimulate innovation and facilitate technology transfer.

The costs result from liberalizing when markets and supporting institutions are deficient, as they often are in developing countries.[51] The judicious use of infant industry protection, local content rules, FDI restrictions and lax intellectual property rights has yielded spectacular benefits in East Asia.[52] Strong intellectual property rights can raise the cost of products and technologies and restrict a valuable avenue for local learning without promoting innovation. Rapid liberalization can impose additional costs, giving an economy too little time to prepare for full market competition. Without the capabilities to attract and use technologies and resources productively, and facing the full forces of competition, poor countries may not draw enough of either. Instead they may lose part of the productive structure they have built up. By renouncing tools that foster learning, they may retard the development of new capabilities.

The net balance of benefits and costs remains unclear—particularly because it can vary by country and period. The underlying issue is whether the costs of market failure exceed those of government failure, and if the balance can be changed (an issue not explored here).

New standards and quality regulations

Although most countries are cutting tariffs and quantitative restrictions on trade, standards and various forms of certification have emerged as new entry barriers. Most of the new barriers relate to processes (not, as with tariffs, to products) and include quality standards (ISO 9000), environmental standards (ISO 14000) and labour standards (SA 8000). In addition, many countries have technical regulations, industrial standards and testing and certification procedures designed to protect public safety and health.

Standards offer many potential benefits for developing countries. They can be a source of technology transfer and a means of monitoring markets and obtaining information on competitors (box 1.8). They can also be a means of rationalizing costs based on codified best international practices, and can reduce technical transaction costs, information asymmetries and uncertainties between sellers and buyers, possibly enabling them to foster innovation.

Box 1.8 New standards and quality regulations

Opportunities

- Standards can facilitate technology transfer based on codified best international practices.
- Standards can facilitate international market access because they are becoming increasingly important for global buyers and as criteria for awarding contracts.

Challenges

- Standards can substantially increase the costs of entering international markets.
- Skills and capabilities must be substantially upgraded to meet the new standards, master new technologies and establish the required institutional information.

But standards can also impose costs on developing countries, forcing them to upgrade skills and capabilities, master new techniques and establish an institutional infrastructure (accreditation, metrology, standardization and technical support and information). If these costs are very high for a country (relative to its economy and exports), standards can pose a barrier to exporting (box 1.9).

More stringent environmental norms and regulations

The growing emphasis on environmental and social norms—such as child labour—can affect industrial and export development in developing countries. Pressures from consumer groups, non-governmental organizations (NGOs) and other bodies have led buyers to impose higher environmental standards on suppliers from developing countries, imposing compliance costs on enterprises. But compliance can also benefit society and the competitive positions of enterprises in developing countries (box 1.10).[53] Moreover, the private costs of compliance have not been very high, at least in industrialized countries. In the United States, for example, they are estimated at 0.6 percent of production value. Although there are no data on the costs of environmental compliance for industry in developing countries, case studies suggest that the costs would be similar or even less.

The key to using environmental pressures for competitive benefit lies in building the capabilities to transform a potential cost into an opportunity. Countries with weak capabilities may find that compliance costs damage competitiveness. It

Box 1.9 Standards and technical regulations as barriers to developing country exports

Standards and technical regulations provide many benefits to producers and consumers, not least of which is their information value. But they can also create trade barriers and segment markets—as when, for example, countries impose standards for colour televisions that differ from international norms, or protect domestic producers by issuing tailor-made standards such as requiring imported cars to have rain wipers on their headlights.

Different countries have different incentives to use standards and technical regulations for protection purposes. For some countries with low tariff protection, liberalizing standards and technical barriers can provide greater economic benefits than further tariff reductions. Whether standards help or hinder exports of developing countries depends on the products being exported and on a country's level of established standards. Exports can also be affected by higher costs resulting from duplicative testing performed by importers to assess conformity with standards. These duplicative tests are sometimes a response to the perceived weaknesses of standards organizations in developing countries.

A recent example shows the effect that standards can have on exports from developing countries. The European Union (EU) banned imports of fish caught in Kenya's Lake Victoria because salmonella was detected in a shipment and, later, because cases of cholera emerged in Kenya. Because of the ban, EU fish imports from Kenya dropped 25–37 percent—a serious blow because the EU market accounted for 95 percent of Kenya's fish exports. Improving hygienic conditions to reduce the risks of similar actions was estimated to cost $5.8 million.

Many country-specific technical regulations and industrial standards, created to protect public safety and health, instead become barriers to trade. To avoid such barriers, the WTO developed the Agreement on Sanitary and Phytosanitary Measures and the Agreement on Technical Barriers to Trade. The Agreement on Sanitary and Phytosanitary Measures recognizes the right of member countries to introduce regulations that protect human and animal health from food-borne risks, human health from animal- and plant-carried diseases, and animals and plants from pests and diseases. These regulations should be based on scientific principles, should not be maintained without sufficient scientific evidence and should not be applied in a way that constitutes a disguised restriction on international trade. The agreement also states that when determining sanitary and phytosanitary protection, members should minimize the negative effects on trade. But are developing countries in a position to identify when this occurs? And when they identify such instances; are they in a position to challenge decisions by industrialized countries "based on" scientific principles?

The Agreement on Technical Barriers to Trade states that product standards adopted to protect public health and safety, preserve the environment and serve other consumer interests should not pose unnecessary obstacles to international trade. The agreement encourages member countries to use international standards but does not require them to change their levels of protection. It also sets out a code of good practice to guide central government bodies in preparing, adopting and applying standards and describes how local government and non-governmental bodies should apply their own regulations.

The agreement's overarching principle is non-discrimination. Fair and equitable procedures must be used when deciding whether a product conforms with national standards, and methods that would give domestically produced goods an unfair advantage are discouraged. To avoid duplicative testing, the agreement also encourages countries to recognize each other's testing procedures.

Manufacturers and exporters need to know the latest standards in their prospective markets. Developing standards and technical barriers requires a powerful scientific and technical base, which can take decades to build and which industrialized countries have established. Thus it is not surprising that these countries have the highest number of new standards notifications to the WTO.

In countries with low levels of protection, standards and technical regulations may provide more protection than traditional trade barriers. Nevertheless, many standards and technical regulations appear to be applied to heavily protected goods—particularly in industrialized countries. These include agricultural and agroindustrial products as well as textiles, clothing and footwear. Thus any industry- or trade-related technical assistance from international organizations should be complemented by careful analysis of the traditional trade barriers facing the main exports of the countries receiving such assistance.

Developing countries face serious difficulties in implementing the Agreement on Sanitary and Phytosanitary Measures and the Agreement on Technical Barriers to Trade. A September 2001 WTO document includes several proposals to facilitate and reduce the costs associated with the implementation and administration of several WTO agreements, including these two. But the proposals do not go far enough, offering at best marginal improvements to an issue that appears to require a complete rethinking. Indeed, a huge gap exists between these reforms and the needs of developing countries.

Source: UNIDO.

Box 1.10 More stringent environmental norms and conditions

Opportunity

- Environmental compliance has positive effects on society and on the competitiveness of complying enterprises through increased innovation, lower costs, better resource use and first-mover advantages.

Challenge

- Developing countries lack expertise with accrediting and auditing systems for environmental compliance.

then becomes attractive for them to engage in a race to the bottom, lowering environmental standards to attract or retain industrial activity. Many developing countries—particularly the least developed—lack the capabilities to use environmental technologies. They even lack the basic capabilities to run the institutional (accreditation and auditing) framework for environmental compliance.

Stricter intellectual property rights

Industrial and technological development will be influenced by the TRIPS agreement. The agreement could affect invest-

Box 1.11 Stricter intellectual property rights

Opportunity

- Stricter intellectual property rights should stimulate innovation, learning and risk taking in industrialized and newly industrializing economies.

Challenge

- Stricter intellectual property rights can raise the cost of technology imports for developing countries and limit their ability to reverse engineer and learn from foreign technologies.

ment, technology transfer and innovation—and thus the accumulation of technological capabilities (box 1.11). Predicting its net result is difficult. Empirical evidence is scanty, the processes are complex and the effects are highly context-specific. It is widely accepted that stricter intellectual property rights can have negative effects on developing countries, particularly those low on the industrial and technological ladder.[54] Such rights may not stimulate local innovation and may not promote overseas innovation relevant to these countries' needs. They are also likely to raise the cost of technology imports—through higher licensing fees and product prices, more advanced skill needs to manage the new regime and greater scope for monopolistic practices by holders of intellectual property rights. Finally, stricter intellectual property rights can constrain technology development through copying and reverse engineering—activities used to great effect by newly industrialized economies and, earlier, by many industrialized countries (box 1.12).

At the same time, the TRIPS agreement offers benefits.[55] Stricter intellectual property rights stimulate innovation—in industrialized countries and newly industrialized economies and even in least developed countries with nascent technological activity. Stricter rights can also boost FDI and sales of advanced technologies (by innovators who need to protect proprietary knowledge). Still, the net benefits will depend on a country's level of industrial and technological development. In the least developed countries the benefits may take a long time to materialize, and in present value terms (future values discounted at an appropriate interest rate) the costs may outweigh the benefits. Many developing countries are understandably concerned about this important topic, which requires further investigation.

Box 1.12 The case for strong protection of intellectual property rights

Protection of intellectual property rights has played an ambiguous role in technological and industrial development. Many of today's industrialized economies relied on slack intellectual property rights to promote the technological development of their enterprises, shifting to stricter rules only when they had achieved technological parity with the leaders. The most technologically dynamic East Asian Tigers—the Republic of Korea and Taiwan Province of China—used copying and reverse engineering for long periods to promote local enterprises, only recently adopting stricter intellectual property rights.

Protection of intellectual property rights is based on the premise that innovative activity is seriously constrained if innovators cannot reap the fruits of innovation. Thus copyrights protect the rights of authors (books, music, software), trademark registration protects unique trade logos and symbols, and patents protect the rights of inventions with industrial applicability (products as well as processes). For technology development, patents are most relevant.

Patents are supposed to spur innovation. They grant exclusive rights of use, sale and manufacture to owners of intellectual property, compensating them for undertaking expensive and risky innovative activities. But in exchange, owners must disclose the invention on the patent document for "anyone skilled in the art to be able to replicate". Thus patents are a trade-off: a market distortion is created in exchange for disclosing information on the technology. This disclosure is intended to benefit society by disseminating new technologies and encouraging competitors to invent around it, encouraging a second round of innovation.

Advocacy of strong intellectual property rights presumes that the benefits of appropriation for innovators and disclosure for competitors outweigh the drawbacks of market distortions, making intellectual property rights beneficial to society. This presumption, almost impossible to test empirically, remains the subject of debate. Most developing countries, seeing themselves as users of existing technologies rather than makers of new ones, consider it premature to adopt Western models of intellectual property right protection. Indeed, technological catch-up could be constrained if developing countries enforced stronger intellectual property rights. Stricter rights could raise the cost of technology imports and restrict the ability to learn through reverse engineering.

This argument has some merit. In the absence of a domestic industry lobby, low-income countries have strong intellectual property rights. And for obvious reasons, high-income countries also protect intellectual property rights very strongly. Middle-income countries offer the least protection for intellectual property rights.

Two developments may change the shape of things to come. First, investment flows are seeking global destinations, and enterprises' ability to protect their knowledge assets is a critical determinant in choosing destinations. Second, all WTO members that are signatories to the TRIPS agreement have agreed to reform their intellectual property rights regimes by 2004. Though the eventual benefits of this universal protection remain to be seen, for now such reform is a bitter pill for domestic industry and consumers to swallow.

The challenge will be to help developing countries design policies and instruments that are in line with their technology-follower positions—and that balance proprietary motives with access, efficiency and distributional considerations. Doing so would direct attention to drafting competition policies, price regulations and targeted subsidies and other transfer mechanisms that mitigate the potential negative effects of stronger intellectual property rights. Finally, alternative methods of encouraging local innovation may have to be devised to fit particular needs, such as protection and compensation for uses of indigenous knowledge in some societies.

Sources: Based on Chang (2001, background paper) and Luthria (2000).

The case for stronger intellectual property rights is easier to make for economies such as Brazil, India, the Republic of Korea, Singapore and Taiwan Province of China, with their strong technological bases. In these economies weak intellectual property rights can deter transfers of valuable technologies and investments in risky R&D by domestic enterprises. But a case can be made for less stringent application of the TRIPS agreement in the least developed countries, with more exclusions and longer grace periods,[56] so that they can participate meaningfully in global industrial activity.

Notes

1. Dicken (1998); Freeman and Perez (1988).

2. Streeten (2001) argues that globalization is not "international integration": it is partial international integration that, for various reasons, leads to national disintegration. Because industrialized countries have less demand for low-skilled workers, income gaps are widening in these countries. Meanwhile, developing countries seeking to prevent a brain drain are forced to pay higher wages to skilled workers, worsening income distributions in these countries as well. In addition, developing countries have less tax revenue available to pay for social services, though the need for them is rising. Moreover, elites in developing countries are adopting the values of their counterparts in industrialized countries and so neglecting essential social services such as education and health care. And minorities are trying to break away to share directly in the benefits of globalization. In sum, "globalization has led to polarization" (p. 54).

3. World Bank (2001b).

4. Chenery, Robinson and Syrquin (1986).

5. Reinert (1995).

6. Chenery, Robinson and Syrquin (1986).

7. *The Economist* (2000b), p. 10.

8. Quah (1999).

9. Dodgson, Gann and Salter (2001).

10. Gordon (2000); Pohjola (1998).

11. OECD (2000a, p. 39).

12. Cantwell and Santangelo (2000).

13. *Financial Times,* 18 June 2001.

14. Quah (1999).

15. Dicken (1998).

16. Pigato (2001).

17. Freeman and Perez (1988).

18. OECD (1999b) defines high-tech industries as manufacturers of aircraft, office and computing equipment, pharmaceuticals and communications equipment. Medium-high-tech industries are professional goods, chemicals (excluding drugs), electrical machinery, non-electrical machinery, motor vehicles and other transport equipment. Low-tech industries are paper, textiles and apparel, leather, food, beverages, tobacco and wood products. The remaining activities fall in the medium-low-tech category.

19. In 78 countries accounting for more than 95 percent of global production, high-tech production grew 5.9 percent a year in 1980–1997, compared with 2.7 percent for other manufacturing activity, and high-tech exports grew 10.8 percent, compared with 7.3 percent for other manufactured exports (NSF 2000).

20. Lall (2000).

21. Data are from OECD (1999b). Business accounted for a larger share of R&D in Japan (73 percent), Sweden and Switzerland (68 percent each) and the United States (64 percent). But its share was lower in Canada, France, Italy, the Netherlands and Spain, where government accounted for more than half of R&D.

22. In the United States, for example, the share of service enterprises in R&D rose from 4 percent in 1980 to 20 percent in 1997. In some countries the share of services is far higher—hitting 37 percent in Canada and 32 percent in Denmark and Norway. But among other industrial leaders, such as Germany and Japan, manufacturing still accounts for a large share of innovation, and services account for only about 4 percent of R&D funding.

23. OECD (2000a, p. 32).

24. Humphrey (2000).

25. In Europe the most active participants were enterprises from the United Kingdom (1,036 alliances), Germany (994), France (715) and the Netherlands (680). Other participants included enterprises from the Republic of Korea (119), former Soviet Union (90), China (86), Australia (63), Israel (51) and Taiwan Province of China (48). Data are from NSF (2000, pp. 2–57).

26. OECD (2000a, p. 33).

27. Mansell and Wehn (1998); OECD (2000a).

28. Dicken (1998); Radosevic (1999).

29. NSF (1998).

30. Concentration of innovation between countries is also very high. See chapter 3 for data on developed and developing countries separately.

31. The supply chain approach—which came first—focuses on activities that include getting raw materials and assemblies into a manufacturing operation smoothly and economically. The value chain approach has a different focus and a larger scope. Value chain analysis looks at every step from raw materials to the end user, down to disposal of the packaging or product after use. The goal is to deliver maximum value to the end user for the least possible cost. Thus supply chain management is a subset of value chain analysis.

32. Mansell and Wehn (1998).

33. OECD (2000a).

34. Best (1990); Humphrey and Schmitz (1998); Nadvi (2001); Schmitz (1999a).

35. Pyke and others (1990).

36. Swann and others (1998). Recent research on geographic agglomeration suggests that agglomeration economies develop cumulatively through an accretion of learning, skills and networks (Krugman 1991; Venables 1996).

37. Schmitz and Nadvi (1999).

38. Bell and Albu (1999).

39. ILO (2001).

40. ILO (1998).

41. Dodgson and others (2001).

42. Pavitt (2001).

43. The trend is most marked in electronics enterprises in the United States, but it is spreading to other industries and countries. By early 2000 contracted manufacturers accounted for about 11 percent of the market for electronics hardware. The largest, Solectron, was set to sell $20 billion in products by the end of 2000. See *The Economist* (2000a) and Sturgeon (1997).

44. Narula and Dunning (2000).

45. UNCTAD (2001).

46. Cantwell and Janne (1998).

47. The data come from OECD (1999a), Wong (2000), Rasiah (2000) and private communications from Peter Brimble on Thailand and Daniel Chudnovsky on Argentina and Chile.

48. R&D in developing countries tends to be concentrated in a few economies. For transnational corporations from the United States those economies are Argentina, Brazil, Hong Kong Special Administrative Region (SAR) of China, Malaysia, Mexico and Taiwan Province of China.

49. Hobday (1995). In 1985 more than 40 percent of the Republic of Korea's exports were original equipment manufacture, and in 1990 about three-quarters of its electronics exports were original equipment manufacture (Cyhn 2001).

50. Though it is difficult to compare data for FDI and mergers and acquisitions, about 80 percent of recent FDI in OECD countries has been in mergers and acquisitions (UNCTAD estimate). Mergers and acquisitions have also been important in Latin America and, since its financial crisis, in East Asia.

51. Stiglitz (1996).

52. Lall (1996).

53. Environmental standards can trigger innovation not just in greener production but also in new ways of cutting costs and material and energy waste. Such standards can also create first-mover advantages for regulated enterprises.

54. UNDP (2001); UNCTAD (1996); Maskus (2000); World Bank (2001a).

55. Maskus (2000).

56. World Bank (2001a).

2 Global industrial activity

The new industrial setting is changing the nature and pattern of global industrial activity. Production, trade and innovation are shifting between activities and countries. Rapid technical change is boosting some activities and shrinking others. Economies are exploiting to different degrees the opportunities from new technologies, freer trade and more mobile productive resources. As a result there have been big variations in industrial performance—in, say, the growth of output and exports or the upgrading of manufacturing's technological structure. These variations are particularly marked in developing countries, where industrial capabilities vary considerably. But they are also evident in industrialized countries. (Detailed tables on selected indicators of industrial performance and drivers at regional and income levels are presented in the statistical annex.)

Today's industrial performance and its drivers are as exciting as they are worrisome. As a group, developing countries are doing fairly well on almost all measures of performance. They are increasing their shares of global production and exports. They are moving up the technological ladder, enlarging their bases of human capital, deepening their technological activity and attracting larger portions of mobile resources.

Yet the picture is worrying because industrial performance and its drivers are diverging rather than converging, with success confined to a few developing countries. Much of the divergence appears to be a long-term phenomenon, responding to structural factors that develop cumulatively. The implication is that globalization and liberalization may not reverse the divergence. To achieve long-term, sustainable industrial development, countries and firms need a concerted strategy for industrial restructuring and upgrading—for moving from simple to more advanced technologies.

Today's map of global industrial activity shows the following features (table 3.2 shows country coverage by region):

- Manufacturing activity remains heavily concentrated in industrialized countries, though developing countries are increasing their share. But in intensity of industrialization (measured by manufacturing value added per capita), developing countries still lag far behind.

- Among developing regions, East Asia (including China) is the best industrial performer in most respects, though it lags slightly in manufacturing value added per capita. It has the highest growth rates in manufacturing production and exports. It is far more export oriented than other developing regions. It has a more technologically advanced structure and is rapidly improving all the main drivers of industrial performance. And (excluding China) it has a commanding lead in skill creation, research and development (R&D) and technology licensing.

- Latin America and the Caribbean leads developing regions in manufacturing value added per capita and foreign direct investment. It has strong skills, an established export base and good infrastructure for information and communication technologies, and it leverages foreign technology effectively. But its manufacturing production and exports are based on a weak technological structure, particularly if Mexico is excluded. The region lags well behind East Asia in R&D and licensing. Even Mexico, the outlier in technology upgrading because of the North American Free Trade Agreement (NAFTA), suffers from a weak R&D base.

- South Asia has attained decent manufacturing growth but performs poorly in production per capita and exports. Its export structure is weak and stagnant. It lags in skills creation, technological effort and physical infrastructure—and is relatively isolated from inflows of technology. The region's two largest economies, India and Pakistan, have not attracted much foreign direct investment to export activity between 1993 and 1997.

- The Middle East and North Africa has achieved fair manufacturing value added per capita, a reasonable base of skills and infrastructure, and good access to foreign technology.

But its industrial and export structures are not geared to technology upgrading, and its technological effort is weak.

- Sub-Saharan Africa, excluding South Africa, lags behind all other regions in almost all respects. The technological structure of its industrial production and exports is regressing.
- Industrial activity and capabilities are highly concentrated in a few leading economies both in industrialized and developing countries. Although this concentration is declining in industrialized countries, it is rising in developing countries in production, exports and technology imports.
- The 30 poorest countries are losing ground in most measures of industrial performance and its drivers, except for a slightly rising share of tertiary technical enrolments. Technologically, these countries are extremely weak and vulnerable. The situation is similar in the 12 least developed countries, which are seeing diminutions in their already minuscule shares of world industrial production and exports.

This reinforces a general impression of highly uneven industrial development, combining spectacular and sustained successes with dismal and prolonged failures. These disparities are not temporary and will not correct themselves over time. Structural drivers of industrial development are slow, difficult and expensive to change, and the new global setting only raises their importance. Some of the drivers can improve only through greater reliance on market forces. But most need strong policy support.

Reviewing trends in industrial performance

To assess industrial performance, this report examines manufacturing value added and manufactured exports and their technological composition.

Manufacturing value added

Global manufacturing value added (MVA) grew about 7 percent a year during 1985–1998. Although industrialized countries still dominate the total, their share is falling—with growth rates in developing countries nearly 2 percentage points higher. Still, MVA per capita in industrialized countries was about 17 times that in developing countries compared with about 18 times in 1985. Moreover, in 1985 MVA per capita in industrialized countries was 83 times that in the world's least developed countries—and by 1998 had jumped to 144 times, revealing a dramatic plunge in the intensity of industrial activity in the least developed countries relative to industrialized countries. During the same period MVA per capita in developing countries relative to the least developed countries rose from nearly 5:1 to about 9:1.

Divergence in MVA also widened by region. Between 1985 and 1998 East Asia increased its share of the developing world's total from 43 percent to 53 percent, lowering the shares of all other developing regions except the Middle East and North Africa. China accounted for 56 percent of East Asia's growth in MVA. Latin America and the Caribbean remained the most industrialized developing region in per capita terms,[1] but its growth failed to keep pace with East Asia's, and it suffered the largest fall in regional shares of MVA—about 7 percentage points. South Asia had reasonable growth but remained the least industrialized region after Sub-Saharan Africa (excluding South Africa).

Sub-Saharan Africa (excluding South Africa) accounted for only 1 percent of the developing world's MVA in 1998, down from nearly 3 percent in 1985. Per capita, it was the least industrialized region, and unlike other regions, its per capita values declined. The least developed countries experienced good growth, but from a small initial base. Bangladesh accounted for 31 percent of this group's MVA in 1985 and 53 percent in 1998. Without Bangladesh, the least developed countries accounted for 0.5 percent of the developing world's in 1985 and for nearly zero in 1998.

Manufactured exports

Manufactured exports have grown faster than MVA in every region, reflecting the internationalization of industry. Developing countries again performed better than industrialized countries in both manufacturing growth and exports. By 1998 they had raised their share of world manufactured exports by 8 percentage points (compared with about 2 points for MVA). Per capita exports from industrialized countries were 15 times those from developing countries in 1998, down from 22 times in 1985.

The gap in manufactured exports per capita between industrialized countries and the least developed countries widened from 192:1 to 212:1, as did that between developing countries and the least developed countries, from around 9:1 to 14:1. Thus the least developed countries fared much worse in exporting than in MVA. Industrial performance improved for other developing countries—but weakened for the least developed countries.

East Asia dominated developing country exports of manufactured goods even more than it did MVA, accounting for nearly two-thirds of the total in 1998.[2] Its rapid growth is reflected in reduced shares for all other developing regions. The largest fall in share, 4 percentage points, occurred in Latin America and the Caribbean—and excluding Mexico the fall was a massive 10 percentage points. The share of the Middle East and North Africa fell to 3 percent of the developing country total in 1998.

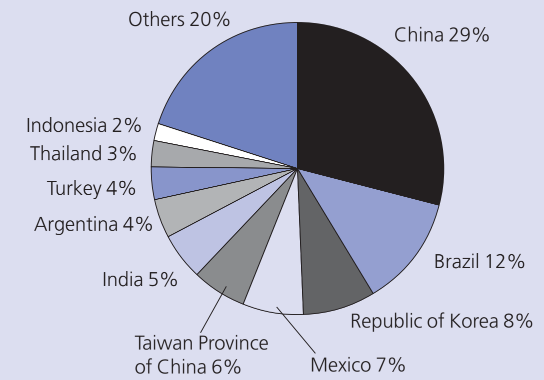
Sub-Saharan Africa saw its small share of manufactured exports drop by half. Moreover, in 1998 Mauritius accounted for about a third of the region's $5 billion in manufactured exports (excluding South Africa). In per capita terms, exports from East Asia (excluding China) were 100 times those from Sub-Saharan Africa (excluding South Africa), 13 times those from South Asia and 6 times those from Latin America and the Caribbean.

The least developed countries accounted for 1 percent of manufactured exports from developing countries in both 1985 and 1998. Because of its success with apparel, Bangladesh dominated this group's exports more than its MVA, moving from 58 percent of the total in 1985 to 78 percent in 1998.

Data on MVA and manufactured exports indicate that:

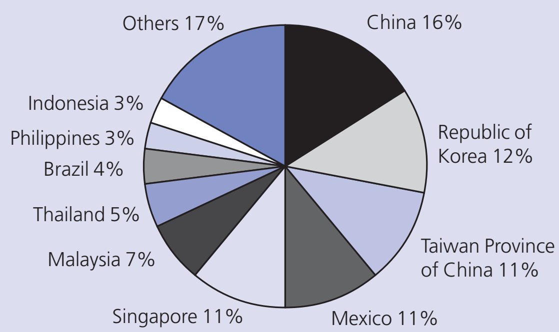
- MVA and exports are highly concentrated in industrialized countries, though the share of developing countries is increasing for both. Manufacturing production is more concentrated than exports.
- The main producing and exporting countries are generally similar, but there are exceptions. Brazil is a leading producer but not exporter. Belgium and the Netherlands are leading exporters but not producers.
- Country concentrations in world shares of MVA and manufactured exports are declining, mainly due to the declining share of the United States in MVA and the declining shares of most industrialized countries in exports.
- Country concentrations are rising among developing economies, particularly in exports. Developing economy leaders in MVA are geographically dispersed, with five from East Asia (China, Indonesia, Republic of Korea, Taiwan Province of China, Thailand), three from Latin America and the Caribbean (Argentina, Brazil, Mexico) and one from South Asia (India; figure 2.1). This is not the case for exporters—eight are from East Asia (adding Malaysia, the Philippines and Singapore to the leading producers of MVA) and two are from Latin America and the Caribbean (Brazil, Mexico; figure 2.2). China led both groups in 1998, raising its share by 7 percentage points in MVA and 14 points in exports since 1985.

Figure 2.1 National shares of developing world manufacturing value added, 1998



Source: UNIDO Scoreboard database (see technical annex).

Figure 2.2 National shares of developing world manufactured exports, 1998



Source: UNIDO Scoreboard database (see technical annex).

- The 30 poorest developing countries now account for 0.5 percent of world MVA and 0.3 percent of exports.

Technological structure of manufacturing value added and exports

MVA and manufactured exports are becoming more technology-intensive, moving from low-tech and resource-based products to medium- and high-tech products. Classifications of manufactured products by technology intensity are provided in box 2.1.

Medium- and high-tech products now account for more than 60 percent of global manufactured exports, mainly because of rapid growth of high-tech exports.[3] In international trade, however, another factor is at play: the rise in integrated global production

Box 2.1 Manufactured products by technology intensity

There are many ways to classify manufactured products by technology intensity. The classifications used in this report are based on those of OECD countries but exclude unprocessed primary commodities.

Resource-based manufactures: mainly processed foods and tobacco, simple wood products, refined petroleum products, dyes, leather (not leather products), precious stones and organic chemicals. The products can be simple and labour-intensive (simple food or leather processing) or intensive in capital, scale and skills (petroleum refining or modern processed foods). Competitive advantage in these products generally—but not always—arises from the local availability of natural resources.

Low-tech manufactures: mainly textiles, garments, footwear, other leather products, toys, simple metal and plastic products, furniture and glassware. These products tend to have stable, well-diffused technologies largely embodied in capital equipment, with low R&D expenditures and skill requirements and low economies of scale. Labour costs tend to be a major element of cost, and the products tend to be undifferentiated, at least at the mass-produced (nonfashion) end of the scale. Barriers to entry are relatively low; competitive advantages in these products—of interest to developing countries—come from price rather than quality or brand names.

Medium-tech manufactures: heavy industry products such as automobiles, industrial chemicals, machinery and relatively standard electrical and electronic products. The products tend to have complex but not fast-changing technologies, with moderate levels of R&D expenditures but advanced engineering and design skills and large scales of production. In engineering products there is emphasis on product design and development capabilities as well as extensive supplier and subcontractor networks. Barriers to entry tend to be high because of capital requirements and strong learning effects in operation, design and (for some products) product differentiation. Innovation and learning in the engineering segment increasingly involves cooperation in the value chain between manufacturers, suppliers and sometimes customers (for large items of equipment).

High-tech manufactures: complex electrical and electronic (including telecommunications) products, aerospace, precision instruments, fine chemicals and pharmaceuticals. These products, with advanced and fast-changing technologies and complex skill needs, have the highest entry barriers. The most innovative ones call for large R&D investment, advanced technology infrastructure and close interaction between firms, universities and research institutions. But many activities, particularly in electronics, have final processes with simple technologies, where low wages can be an important competitive factor. The high value-to-weight ratio (for example, electronics products have a higher unit value relative to their weight than automotive products) of these products allows segments of the value chain to be broken up and located across long distances.

The data do not allow the same classifications for MVA as for exports: MVA data have more gaps and the categories are often broader. Thus MVA is divided into three categories—resource-based, low-tech and medium-plus-high-tech—while exports are divided into four. Note that MVA and export data do not distinguish countries by their genuine domestic capabilities in technology-intensive activities. The normal presumption is that production and exports reveal domestic technological capabilities, but the spread of high-tech assembly activity to low-wage countries belies this. Countries with low technological capabilities can appear technologically advanced, giving a misleading picture of industrial performance. This problem is not possible to solve by refining available data on MVA and exports. Thus other evidence on the spread of global integrated production systems dominated by transnational corporations and on local technological effort is used to arrive at a fairly realistic picture of national technological capabilities. The distinction between genuine technological capabilities and high-tech assembly is important, and the implications are discussed more fully in later chapters.

systems governed by transnational corporations. The relocation of different stages of production in different countries results in considerable intrafirm trade. Integrated production systems are most prominent in information and communication technology industries, where the high value-to-weight ratio of the product makes it economical to ship products and components around the world in search of fine differences in cost.

Developing countries have less technology-intensive production and exports than do industrialized countries, but the gap is narrowing. The technological upgrading of developing country exports is faster than that of MVA (figures 2.3 and 2.4). High-tech products are experiencing the fastest growth in export shares and, if current growth rates continue, will soon overtake low-tech exports. Indeed, in 1998 developing country exports of electronics ($265 billion) were much larger than exports of textiles, clothing and footwear ($170 billion). But high-tech exports, far more than manufactured exports generally, are highly concentrated in a few countries.

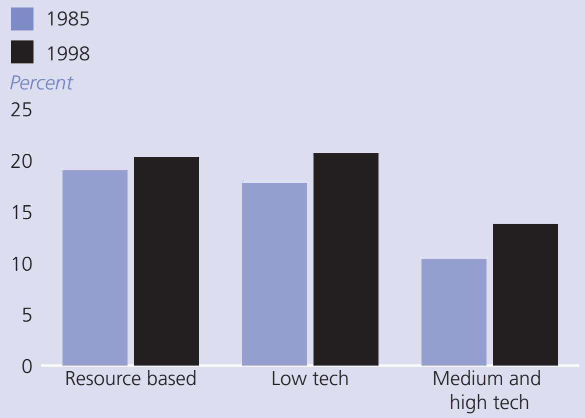
Low-income countries (excluding China and India) have far less technology-intensive production and exports than other developing countries, and their upgrading is much slower.[4] Indeed, between 1985 and 1998 their technological structure of production and exports actually regressed. The least developed countries have the lowest technology composition for both production and exports, with that for exports deteriorating.

East Asia has the developing world's most complex industrial production and exports and the fastest technological upgrading. Latin America and the Caribbean has achieved strong technological upgrading, but mainly because of Mexico (driven by NAFTA and concentrated in the maquiladoras on the U.S. border). South Asian exports are low-tech (out of line with its production structure, which reflects India's heavy industry strategy), and upgrading is slow. Sub-Saharan Africa has experienced some technological downgrading because of rising shares of resource-based industries.

Assessing global export performance based on technology intensity

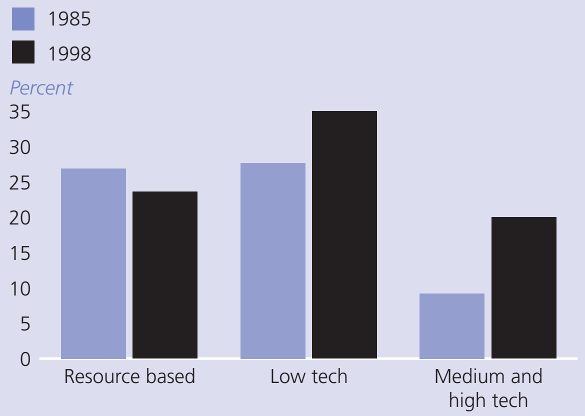
The top 5 and 10 exporters in 1985 and 1998 are shown in figure 2.5 according to the technology intensity of their prod-

Figure 2.3 Developing country share of world manufacturing value added by technology intensity, 1985 and 1998



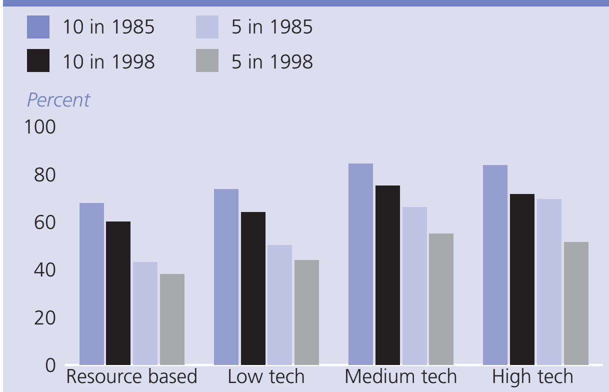
Source: UNIDO Scoreboard database (see technical annex).

Figure 2.4 Developing country share of world manufactured exports by technology intensity, 1985 and 1998



Source: UNIDO Scoreboard database (see technical annex).

Figure 2.5 Shares of world manufactured exports of top 5 and 10 exporters by technology intensity, 1985 and 1998



Source: UNIDO Scoreboard database (see technical annex).

ucts. Although country concentrations are falling for every product group, they remain high. Complex (medium- and high-tech) products have much higher country concentrations than simple (resource-based and low-tech) products.

High-tech exports

In 1985 and 1998 the top exporters of high-tech manufactured products were the United States, Japan, Germany and the United Kingdom (table 2.1)—suggesting that the leading exporters have deep, enduring capabilities. Otherwise, there was more fluidity among the top 25 exporters. Several industrialized economies lost rank significantly (five or more places): Austria, Belgium, Canada, Denmark, Italy and Switzerland.

Among developing economies the leading exporters were Singapore, Taiwan Province of China and the Republic of Korea, with Singapore making an impressive leap (from 11th

Table 2.1 Top 25 exporters of high-tech products, 1985 and 1998 (millions of dollars)

	1985		1998	
Rank	Economy	High-tech exports	Economy	High-tech exports
1	United States	41,859	United States	170,513
2	Japan	35,731	Japan	109,627
3	Germany	21,795	Germany	83,324
4	United Kingdom	13,013	United Kingdom	68,276
5	France	12,141	Singapore	58,678
6	Italy	7,063	France	57,025
7	Netherlands	5,195	Taiwan Province of China	36,944
8	Taiwan Province of China	4,480	Netherlands	33,930
9	Canada	4,478	Korea, Republic of	32,830
10	Switzerland	4,381	Malaysia	30,926
11	Singapore	3,879	China	30,518
12	Sweden	3,862	Mexico	27,579
13	Korea, Republic of	3,541	Italy	23,023
14	Belgium	2,827	Ireland	22,801
15	Hong Kong SAR	2,269	Sweden	18,358
16	Ireland	2,123	Canada	18,106
17	Austria	1,464	Philippines	18,081
18	Denmark	1,356	Switzerland	17,331
19	Malaysia	1,277	Belgium	14,897
20	Spain	1,255	Thailand	12,667
21	Israel	942	Finland	9,955
22	Mexico	717	Spain	8,696
23	Finland	716	Austria	6,519
24	Poland	665	Israel	6,247
25	Brazil	599	Denmark	5,810
Total for top 25		177,628		922,661
World total		179,380		952,685
Share of top 25 in world total (percent)		99		97

Source: Calculated from UN Comtrade database.

to 5th place). Mexico and Malaysia were also strong performers, with Mexico jumping from 22nd to 12th place and Malaysia from 19th to 10th. China's performance was particularly noteworthy: not among the top 25 exporters in 1985, it was in 11th place in 1998. The Philippines and Thailand were also new entrants.

High-tech exports are highly concentrated, with the top 25 countries accounting for 97–99 percent of world high-tech exports in both years. The top 10 accounted for 84 percent of the total in 1985 and 69 percent in 1998, and the top 5 for 72 percent and 52 percent.

The high, stable level of export concentration suggests two trends. The first is that, despite the spread of global production systems, most high-tech exports remain in a few industrialized countries. Second, there are exceptions to this. Some developing countries have become major exporters and have built up strong first-mover advantages. China, which is a new entrant, shows strong competitive capabilities across a range of high-tech exports.

Medium-tech exports

Medium-tech exports also show a fair amount of stability, with the same industrialized countries (with slightly shifting ranks) in the top eight places in both 1985 and 1998 (table 2.2). Among developing countries the Republic of Korea was a leading exporter in both years, followed by Mexico (which rose from 23rd to 10th place) and China (absent in 1985, and in 13th place in 1998). Malaysia was another new entrant.

The country concentration of medium-tech exports is not very different from that of high-tech exports and fell slightly over time. The top 25 countries accounted for 99 percent of world medium-tech exports in 1985 and 96 percent in 1998. The shares of the top 10 countries were 84 percent and 75 percent, and of the top 5 countries, 66 percent and 56 percent.

In some ways medium-tech exports show national technological capabilities better than do high-tech exports. The assembly activities of transnational corporations play a role here too, but less so than in high-tech exports, because strong export performance in medium-tech is often based on deeper local manufacturing. Mobility plays a role as well. Parts and components of high-tech equipment can often be shipped around the world more easily than those of heavy industries. In the Republic of Korea and Taiwan Province of China medium-tech exports are led by domestic firms, while in Brazil, Malaysia, Mexico and Singapore they are led by transnational corporations. (China is a mix.) In both groups medium- and high-tech exports are the outcome of long processes of domestic technological capability building—as in the automobile industry in Brazil and Mexico and the electronics in Malaysia and Singapore.

Table 2.2 Top 25 exporters of medium-tech products, 1985 and 1998 (millions of dollars)

	1985		1998	
Rank	Economy	Medium-tech exports	Economy	Medium-tech exports
1	Japan	101,697	Germany	232,429
2	Germany	79,256	Japan	190,735
3	United States	54,514	United States	189,215
4	France	28,357	France	97,154
5	Italy	25,500	Italy	93,003
6	Canada	23,274	United Kingdom	84,013
7	United Kingdom	20,702	Canada	58,724
8	Belgium	14,177	Belgium	56,975
9	Sweden	11,184	Korea, Republic of	42,366
10	Netherlands	10,543	Mexico	40,332
11	Korea, Republic of	10,362	Spain	40,301
12	Switzerland	10,308	Netherlands	35,884
13	Spain	6,506	China	30,853
14	Austria	5,887	Switzerland	29,657
15	Taiwan Province of China	5,818	Taiwan Province of China	27,761
16	Singapore	3,708	Sweden	24,898
17	Brazil	3,612	Austria	19,719
18	Finland	3,378	Singapore	18,214
19	Denmark	2,999	Malaysia	12,001
20	Hong Kong SAR	2,940	Brazil	10,926
21	Poland	1,953	Czech Republic	10,675
22	Norway	1,395	Finland	10,363
23	Mexico	1,375	Denmark	8,534
24	Ireland	1,160	Portugal	7,801
25	Portugal	1,019	Hungary	7,772
Total for top 25		431,624		1,380,304
World total		437,990		1,444,987
Share of top 25 in world total (percent)		99		96

Source: Calculated from UN Comtrade database.

Low-tech exports

Four of the top five low-tech exporters in 1985 and 1998 were industrialized countries, with the United States rising in rank and Japan declining (table 2.3). The number of developing countries in the top 25 low-tech exporters is similar to that in other technology categories—with seven developing countries in 1985 and eight in 1998. More interesting, the leading exporters were also similar, with most East Asian Tiger economies in the group, along with Mexico. But there are also important differences. China, not among the top 25 exporters in 1985, was the global leader in 1998. Yet its low-tech strengths do not detract from its strong performance in medium- and high-tech products.

Table 2.3 Top 25 exporters of low-tech products, 1985 and 1998 (millions of dollars)

	1985		1998	
Rank	Economy	Low-tech exports	Economy	Low-tech exports
1	Germany	25,263	China	76,463
2	Italy	24,756	Italy	70,208
3	Japan	21,301	Germany	66,756
4	Taiwan Province of China	14,604	United States	55,554
5	France	13,139	France	36,697
6	Korea, Republic of	11,523	Taiwan Province of China	30,716
7	Hong Kong SAR	9,683	United Kingdom	30,022
8	United States	9,086	Japan	29,629
9	Belgium	8,082	Belgium	25,647
10	United Kingdom	8,059	Korea, Republic of	23,054
11	Netherlands	5,246	Mexico	17,522
12	Spain	4,707	Netherlands	16,755
13	Austria	4,535	Spain	14,961
14	Switzerland	4,458	Canada	14,518
15	Sweden	4,295	Austria	12,932
16	Canada	2,965	Hong Kong SAR	12,263
17	Brazil	2,590	Switzerland	11,504
18	Portugal	2,256	Turkey	11,259
19	Turkey	2,235	India	9,851
20	Finland	2,097	Thailand	9,221
21	Denmark	2,091	Sweden	9,216
22	India	1,950	Portugal	8,592
23	Singapore	1,369	Poland	7,825
24	Greece	1,045	Denmark	7,008
25	Israel	1,031	Czech Republic	7,002
Total for top 25		188,365		615,175
World total		197,376		694,138
Share of top 25 in world total (percent)		95		89

Source: Calculated from UN Comtrade database.

Table 2.4 Top 25 exporters of resource-based products, 1985 and 1998 (millions of dollars)

	1985		1998	
Rank	Economy	Resource-based exports	Economy	Resource-based exports
1	United States	22,065	United States	61,055
2	Germany	21,795	Germany	54,575
3	France	17,130	France	41,185
4	Netherlands	17,012	Belgium	34,400
5	Canada	14,759	United Kingdom	34,380
6	Italy	12,713	Canada	32,624
7	United Kingdom	12,200	Netherlands	29,741
8	Belgium	11,306	Italy	28,266
9	Japan	9,105	Japan	23,333
10	Sweden	7,927	Ireland	16,651
11	Singapore	6,883	Spain	15,989
12	Spain	5,523	China	15,091
13	Finland	5,462	Sweden	14,493
14	Brazil	5,320	Finland	14,280
15	Switzerland	5,051	Singapore	13,764
16	Denmark	2,962	Switzerland	12,251
17	Austria	2,912	Korea, Republic of	11,829
18	Taiwan Province of China	2,735	Brazil	11,742
19	Venezuela	2,577	Malaysia	9,891
20	Malaysia	2,553	Israel	7,902
21	Korea, Republic of	2,380	Austria	7,802
22	Ireland	2,197	Thailand	7,027
23	Israel	2,001	Denmark	6,282
24	Australia	1,776	Mexico	6,117
25	India	1,745	India	6,102
Total for top 25		198,089		516,772
World total		215,418		593,812
Share of top 25 in world total (percent)		92		87

Source: Calculated from UN Comtrade database.

Brazil, revealing competitive weaknesses in low-tech products, was absent from the list in 1998. Hong Kong Special Administrative Region (SAR) of China also weakened, but a significant part of China's low-tech exports is based on the operation of Hong Kong SAR firms.

Low-tech exports are less concentrated than high- or medium-tech exports. But country concentrations are still high. The top 25 countries accounted for 95 percent of low-tech exports in 1985 and 89 percent in 1998, the top 10 countries for 74 percent and 64 percent, and the top 5 countries for 50 percent and 44 percent. That so many industrialized countries persistently lead in these exports, despite high and rising wages, suggests that cheap unskilled labour is not a dominant competitive advantage. Low wages for productive and skilled workers do matter, as China shows, but strong advantages based on skills, technology and organization persist over time. Thus developing countries that want to establish a long-term lead, outlasting rising wages, have to develop such advantages.

Resource-based exports

Industrialized countries made up the top 10 exporters of resource-based products, with the United States, Germany and France leading in both 1985 and 1998 (table 2.4). Many developing countries rely heavily on primary exports, but competitiveness in processed primary products is firmly in the hands of industrialized countries, many without a large domestic resource base. Again, technology—mainly the ability to handle large, capital-intensive and complex processing facilities—is of great importance. So are complex organization (large integrated production facilities across nations), marketing and branding.

In 1985 Singapore was the leading developing economy exporter of resource-based products—reflecting its large petrochemical processing facilities. China led in 1998. The Republic of Korea and Taiwan Province of China were also among the main resource-based exporters, despite their lack of domestic resources. Other leading developing economies included resource-rich Brazil, Malaysia, Mexico and Thailand. India appears in the group because of its major business of cutting (imported) gems. Of the four technology groups, resource-based exports are the least concentrated by country. The top 10 exporters accounted for 68 percent of the total in 1985 and 60 percent in 1998, and the top 5 for 43 percent and 38 percent.

Focusing on drivers of industrial performance

Industrial performance reflects the complex interaction of many factors, including institutions, skills, technologies, infrastructure, networking, political and social stability and other factors. It is not possible to quantify all these in a comparable way across countries. It is also not necessary here to include macroeconomic variables analyzed regularly (and in great depth) by other agencies. Mapping the structural influences on industrial performance—termed *drivers,* for convenience—calls for selectivity and simplification. This report focuses on five drivers directly relevant to industry and for which comparable data are available: skills, technological effort, inward foreign direct investment, royalty and technical payments abroad and modern infrastructure.

Skills

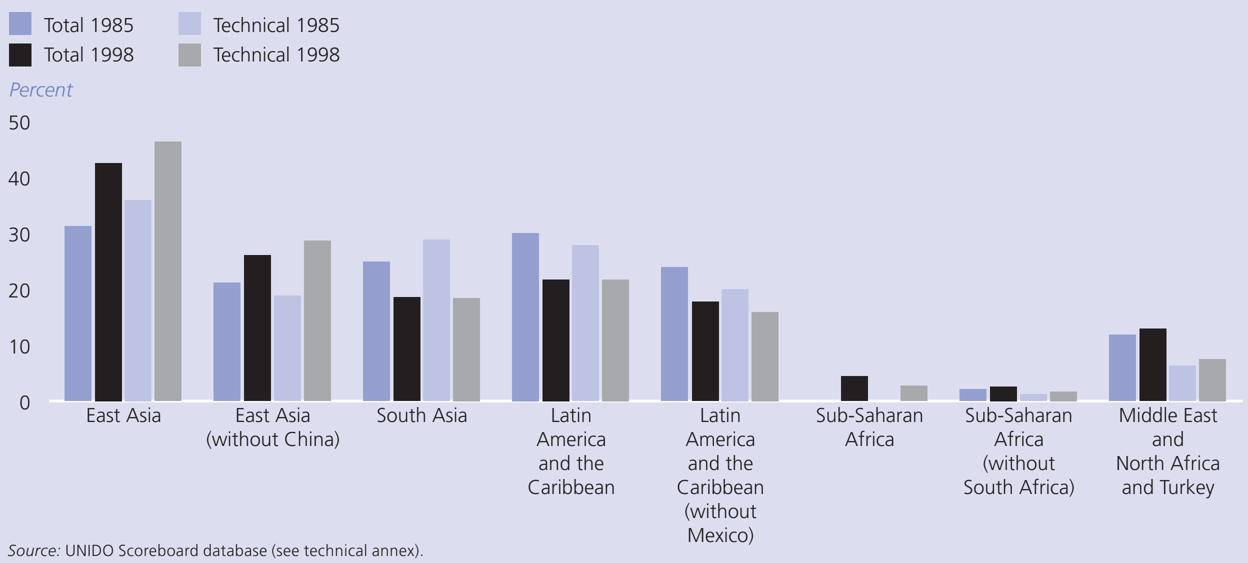
Skills have always been important for industrial performance. But they have become even more crucial because of the explosive growth of the weightless economy and the high information content of industrial activities. It is difficult to quantify a country's stock of industrial skills. Few countries publish data on people's skills by discipline. And even if they did, it would be impossible to estimate levels of relevant, up-to-date skills.

As a result most comparisons of industrial skills use flows rather than stocks: current education enrolments at the primary, secondary and tertiary levels. Such measures have two main drawbacks. First, they ignore on-the-job learning—experience and training—which in many countries is a major source of skill formation. Second, enrolment data do not take into account the significant differences across countries in education quality, completion rates and relevance to industrial needs.

Lacking better data, this report relies on formal enrolment figures. Which level of education is most relevant for industrial performance? Primary enrolments may not be as relevant as secondary and tertiary because most countries have achieved universal primary education and much of modern industry requires higher level skills.[5] In line with the classic work of Harbison and Myers (1964), this report assumes that secondary and tertiary enrolments are the most relevant skill indicators and that tertiary enrolments should be weighted more heavily than secondary.[6]

Developing countries account for a large share of the world's tertiary enrolments—more than twice their shares of MVA and exports, and nearly nine times their share of global R&D. Tertiary enrolments grow slowly in all regions, but they grow

Figure 2.6 Distribution of tertiary enrolments in developing regions, total and technical subjects, 1985 and 1998



Source: UNIDO Scoreboard database (see technical annex).

faster in developing than in industrialized countries. Still, the intensity of skill creation (measured by enrolments per 1,000 people) is far lower in developing than in industrialized and transition economies.

In terms of the number of students, lower-middle-income countries do slightly better than high-income and upper-middle-income countries in total tertiary enrolments and slightly worse in technical enrolments. Transition economies have the highest intensity of technical skill creation. Low-income countries have achieved significant growth in general tertiary enrolments, but from very small bases.

The distribution of tertiary enrolments in developing regions has a pattern similar to that for MVA and manufactured exports, with a strong lead by East Asia (figure 2.6). South Asia's performance is better here because of high enrolments in India, but its shares of global and developing country enrolments fell between 1987 and 1995. In 1995 Sub-Saharan Africa (excluding South Africa) accounted for less than 2 percent of technical enrolments in developing countries—though it had the second-fastest growth rate (after East Asia). Per capita, its enrolments were 6 percent of those in East Asia (excluding China) and 9 percent of those in Latin America and the Caribbean.

Among developing countries, China and India dominate total and technical tertiary enrolments—together accounting for a third of the total—followed by Indonesia and the Republic of Korea. Among industrialized countries the United States and the Russian Federation have the most students enrolled in technical education, accounting for nearly one-quarter of the world total.

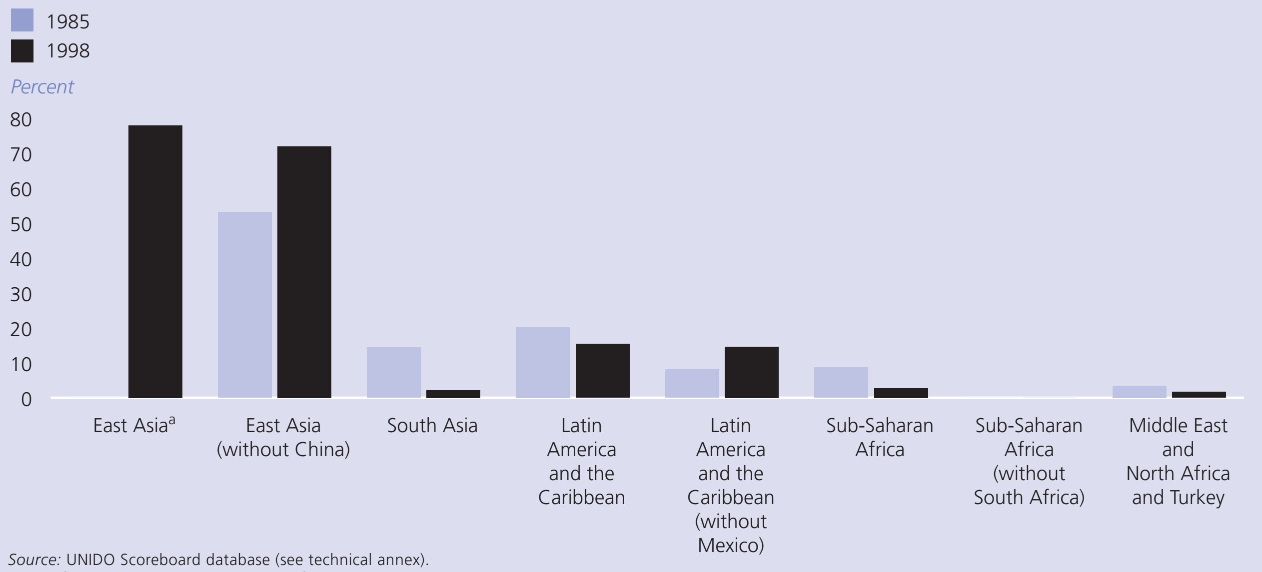
Technological effort

Technological effort is a crucial driver of industrial development, even for industrial latecomers. Countries that import technologies must engage in conscious learning to master the technologies and adapt them to local conditions. The more advanced and complex the technology, the greater the learning effort required.

Much of this effort cannot be quantified. It occurs in almost all parts of an enterprise, and much of it is informal. Some does take the form of formal R&D, however. R&D becomes more significant as a country's industrial structure develops and firms use more advanced technologies—even in firms not innovating at technological frontiers, because R&D is needed to understand, adapt, imitate and improve imported technologies. R&D is also vital to keeping track of technological progress elsewhere in the world. These imitative and monitoring functions of R&D are prominent even in industrialized countries.

Because comparable information on R&D spending is available across countries, these data are used here as a proxy for technological effort.[7] Data on R&D financed by productive enterprises—as defined by the United Nations Educational, Scientific and Cultural Organization (UNESCO)—are preferred to data on total national spending on R&D because enterprise

Figure 2.7 Regional distribution of developing world R&D financed by productive enterprises, 1985 and 1998



Source: UNIDO Scoreboard database (see technical annex).
a. Data for 1985 are missing because data for China are missing.

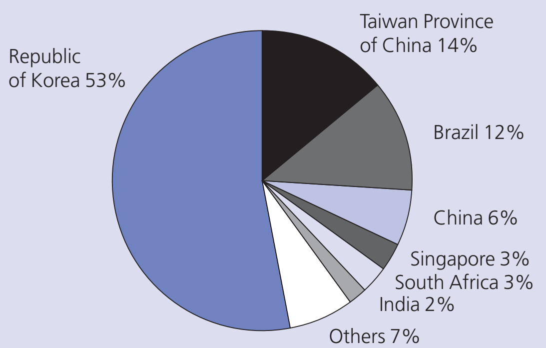
R&D is more directly related to industry (total R&D spending also includes agriculture, defence, health and so on). Moreover, in most developing countries government-financed R&D, often the bulk of national R&D, goes to state or university laboratories, with little impact on industrial innovation.

Around the world, enterprise-financed R&D grew 10 percent a year between 1985 and 1995–1998 (using the most recent available data), reflecting the growing importance of technological effort. Developing country R&D grew faster (18 percent a year) but from a low base, accounting for just 5 percent of the world total in 1998. Per capita R&D in developing countries was only 1.0 percent of that in industrialized countries, up from 0.5 percent in 1985. High- and upper-middle-income developing countries accounted for nearly 90 percent of the group's total. In the poorest countries (excluding China and India) R&D was practically nonexistent. During this period R&D as a share of world MVA rose from around 4 percent to 6 percent.

Among developing regions, East Asia has a stronger lead in enterprise-financed R&D than in production, exports or skills (figure 2.7). Including China, the region accounts for nearly four-fifths of the developing world total. The shares of all other developing regions decreased, particularly in South Asia (from 14 percent to 2 percent). In both 1985 and 1998 Sub-Saharan Africa (excluding South Africa) had no share of the total.

The developing world's enterprise-financed R&D is also highly concentrated (figure 2.8). In 1998 the Republic of Korea accounted for more than half of the total, and the two next biggest sources—Taiwan Province of China and Brazil—together accounted for more than a quarter. Almost all R&D funded by enterprises occurred in 10 economies, and none occurred in the 30 economies at the bottom of the list.

Figure 2.8 Leading developing economies in R&D financed by productive enterprises, 1998



Source: UNIDO Scoreboard database (see technical annex).

Among industrialized countries the United States, Japan and Germany were at the top, accounting for 82 percent of the world total in 1985 and 75 percent in 1998—though their shares changed. Germany's share fell 10 percentage points and that of the United States fell 3 points, while Japan gained about 6 points.

Inward foreign direct investment

Foreign direct investment (FDI) is an important way of transmitting skills, knowledge and technology to developing countries and so is an important driver of industrial performance. Transnational corporations, generally the leading innovators in their industries, are engaging in more technology transfer—reflecting the rising cost and pace of technical progress and the reluctance of innovators to sell valuable technologies to independent firms.[8] Transnational corporations also provide capital, skills, managerial know-how and access to markets.

Countries can accelerate their industrial development by plugging into integrated global production systems—governed by transnational corporations—and becoming global or regional supply centres, particularly in high-tech activities. Independent firms in developing countries can participate in these systems, but few have the capabilities to meet the extremely high technical standards.[9] Most countries that have entered these systems in recent years have done so through FDI.

Transnational corporations, though good at transferring operational technologies, are far less so interested in transferring or fostering deeper technological capabilities. It is often not economical for transnational corporations to relocate R&D at the same pace as production. Agglomeration, linkages, cumulative learning and economies of scale make it costly to spread R&D overseas—particularly to developing countries short on high-level skills, advanced infrastructure and supporting research institutions. Thus most developing countries do not attract the research activities of transnational corporations.[10] So, although FDI is important for industrial performance, it may not be the best way to deepen technological activity in developing countries.

The ideal FDI measure for assessing industrial performance would be inflows into manufacturing (and within that, into domestic and export production). But this kind of disaggregation is generally not possible: for most countries the only available measures are inward FDI flows and stocks. This report uses flows, averaged over three years to minimize variations.[11] The inability to distinguish FDI for manufacturing and FDI for other sectors should be taken into account, particularly in regions—such as Latin America—where a large portion of FDI goes into utilities and banking.

Around the world, FDI inflows grew more than 15 percent a year between 1981–1985 and 1993–1997. This growth was faster than that for global MVA (about 7 percent) and manufactured exports (10 percent). Developing countries achieved faster FDI growth (18 percent) than industrialized countries (about 14 percent) and in 1993–1997 accounted for one-third of world FDI inflows.

The Middle East and North Africa has seen a large decrease in its share of world and developing country FDI. Latin America and the Caribbean retained its share of the developing country total (about 30 percent). Sub-Saharan Africa (excluding South Africa) experienced a small decrease in its world share, while its developing country share halved. Per capita flows are lowest in South Asia—$2 in 1993–1997, less than half that in Sub-Saharan Africa (excluding South Africa) and only 3 percent of that in East Asia and Latin America and the Caribbean. Although South Asia's shares have increased (it has the fastest growth in flows), it has a long way to go before it catches up with other regions.

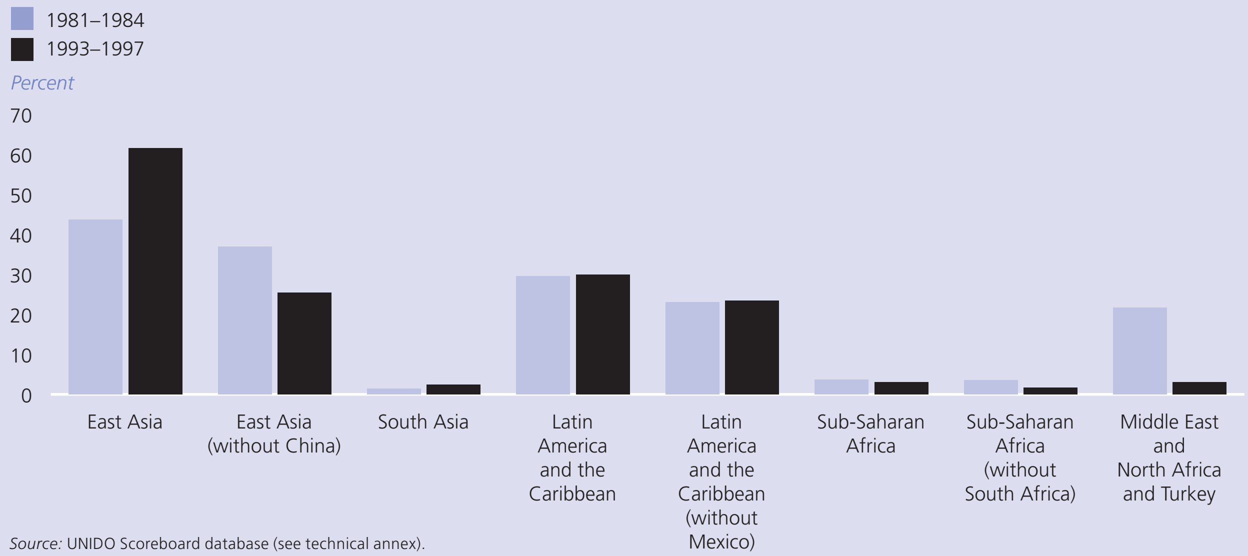
In India and Pakistan export-oriented FDI is lower than the average for the developing world. The same is true for most of Sub-Saharan Africa, where most FDI goes into resource extraction, which is concentrated in oil-exporting economies. Latin America and the Caribbean has the highest per capita FDI among developing regions. But much of the region's FDI goes into industrial activities oriented towards the domestic market and into privatized utilities. The main exception is the automobile industry in Argentina, Brazil and Mexico, where transnational corporations have invested large amounts and improved export competitiveness enormously. Apart from Costa Rica and Mexico there has been little FDI in high-tech export-oriented activities in Latin America.

China's dominates FDI flows to developing countries, followed by Singapore, Brazil and Mexico (figure 2.9). In 1993–1997 nearly 80 percent of FDI in developing countries went to 10 countries.

Royalty and technical payments abroad

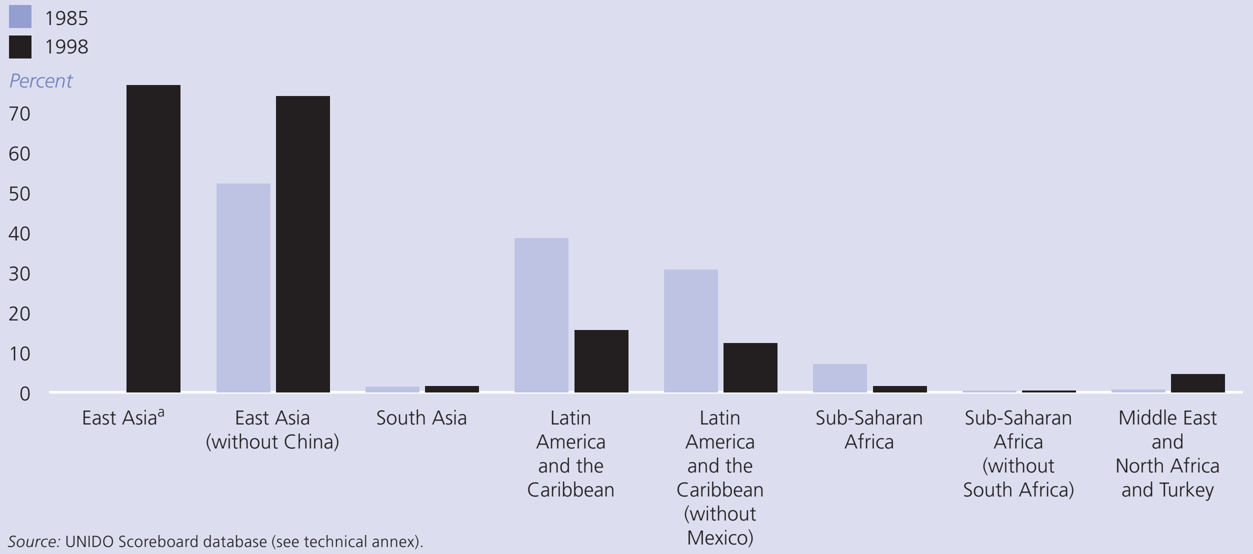
Royalty and technical payments abroad are meant to capture arm's-length purchases of know-how, patents, licences and blueprints—imports of embodied technology in non-equity forms.[12] Some countries do not publish royalty data, and values have to be imputed by looking at ratios of royalty payments to total service payments by similar countries. Moreover, royalties and technical fees are not always for industrial technology—some of them go for service sector purchases of know-how, brand names and franchises. Royalty payments often include non–arm's length transactions, with significant flows between the affiliates and parents of transnational corporations. Many of the largest spenders on licensing (Hong Kong SAR, Ireland, Singapore)

Figure 2.9 Regional distribution of foreign direct investment inflows, 1981–1984 and 1993–1997



Source: UNIDO Scoreboard database (see technical annex).

Figure 2.10 Regional distribution of royalty payments, 1985 and 1998

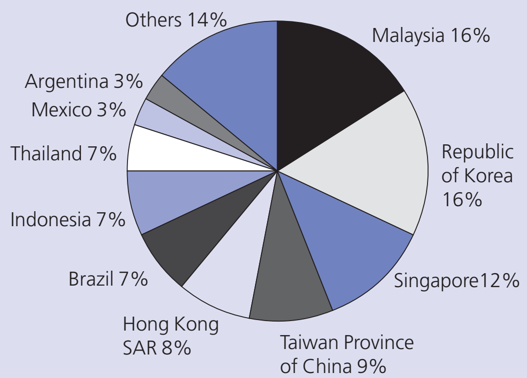


Source: UNIDO Scoreboard database (see technical annex).
a. Data for 1985 are missing because data for China are missing.

have a strong presence of transnational corporations, and a substantial share of the payments are made by these corporations' systems. But while the statistical correlation between FDI and royalty payments is positive, it is not very high (0.43)—suggesting that arm's-length transactions account for a significant portion of the total. Thus this variable is the best available proxy for technology purchases by local firms.

Technology licence payments rose 17 percent a year in 1985–1998, even faster than FDI flows. The world leaders are the United States and Japan, which are also the largest industrial innovators and technology exporters. The growth of their technology exports suggests that innovators are specializing and that technology markets are becoming quite integrated.

Figure 2.11 Leading developing economies in royalty fees, 1998



Source: UNIDO Scoreboard database (see technical annex).

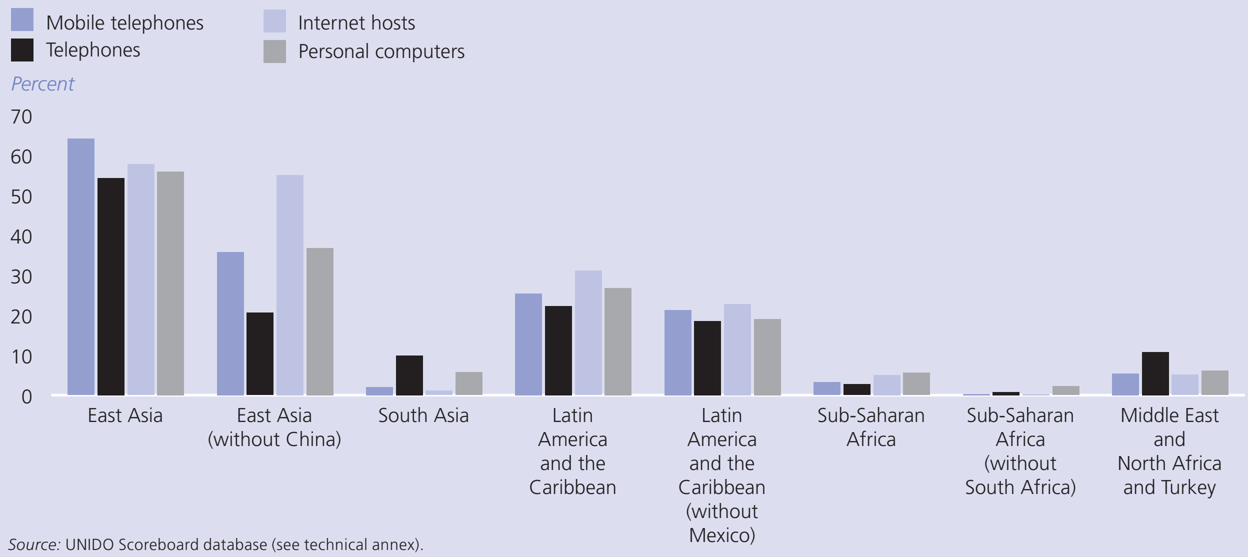
East Asia pays far more royalty fees than any other developing region (figure 2.10). East Asia (excluding China) also has by far the highest per capita spending on these fees (about $27), in line with its high-tech specialization. That the region also spends the most on R&D and receives the most FDI suggests that these different modes of acquiring and developing technology complement each other. South Asia and Sub-Saharan Africa (excluding South Africa) spend the least per capita on royalties (less than $0.25 each), suggesting a massive—and possibly harmful—gap in accessing world technologies. In 1998, 10 countries accounted for 86 percent of the developing world's spending on royalty fees (figure 2.11). The bottom 30 countries accounted for almost none.

Modern infrastructure

National data on traditional infrastructure—railways, roads, ports, water supplies—are not readily available. Data on modern infrastructure—related to information and communication technologies—are easier to collect, so this report uses data on telephone mainlines, mobile telephones, personal computers and Internet hosts for each country.

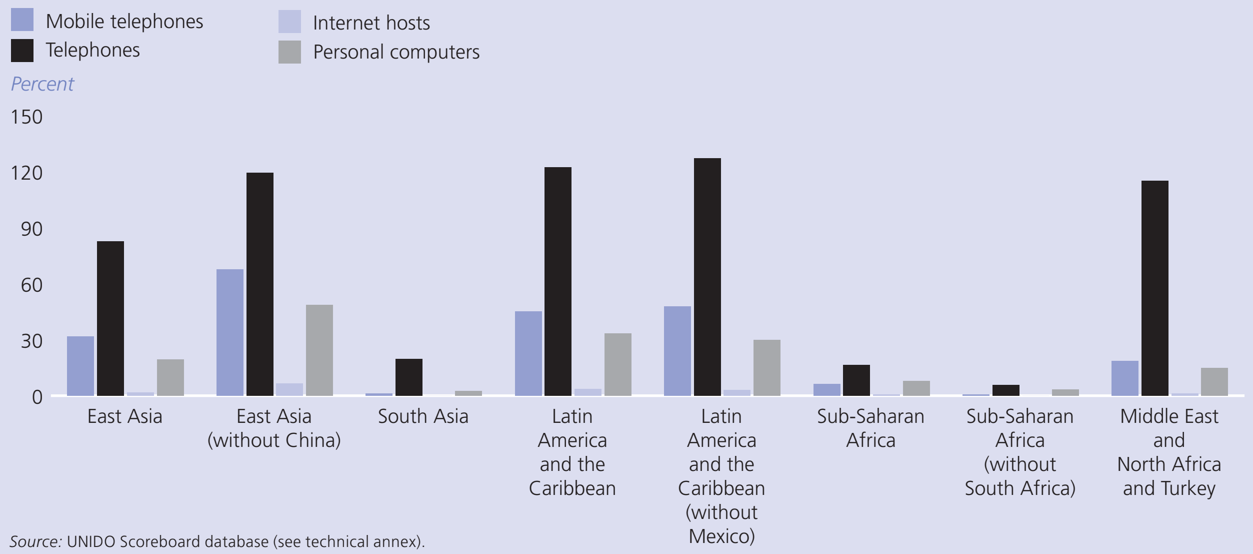
The distribution of modern infrastructure is similar to that for other drivers, with East Asia in the lead (figure 2.12). But Latin

Figure 2.12 Regional distribution of information and communication technologies, 1998–2001



Source: UNIDO Scoreboard database (see technical annex).

Figure 2.13 Regional distribution of information and communication technologies per 1,000 population, 1998–2001



Source: UNIDO Scoreboard database (see technical annex).

America and the Caribbean also does well, reflecting its high per capita incomes. South Asia and Sub-Saharan Africa (excluding South Africa) do quite poorly. Adjusted for population size, South Asia deteriorates considerably relative to East Asia (excluding China), while Latin America and the Caribbean does fairly well—particularly on telephones (figure 2.13). But for advanced information and communication technologies (personal computers and Internet hosts), East Asia (excluding China) retains the lead among developing regions. South Asia performs poorly, even compared with Sub-Saharan Africa (excluding South Africa).

Notes

1. East Asia (excluding China) was catching up rapidly, however, and its 1998 figure is an aberration—reflecting the immediate effects of the previous year's financial crisis.

2. Note that the value of manufactured exports from East Asia, particularly East Asia (excluding China), exceeds the region's MVA. This is because the value of manufactured exports is a gross figure (including the value of inputs) while MVA is net of inputs.

3. MVA data do not distinguish between medium- and high-tech industries, so they are combined.

4. Country classifications by income level are from World Bank (2001b).

5. In some developing countries, however, primary education remains the main source of skill formation. These countries skill have high illiteracy rates, and their industrial sectors are concentrated in simple activities that do not require high-level skills. But including primary enrolment rates in the skill measure does not noticeably change country rankings; all rankings of skill levels are closely correlated.

6. This report recalculates the Harbison-Myers index for 1985 and 1998. The index measures a country's average share of the relevant age groups enrolled in secondary and tertiary education, with tertiary given a weight of five. In addition, the report uses two other measures to capture the creation of high-level skills: the number of students enrolled at the tertiary level in all subjects and the number enrolled at the tertiary level in technical subjects (defined as mathematics, computing, engineering and pure science). These two measures use population as the deflator (unlike the Harbison-Myers index, which uses the relevant age group as the deflator). The Harbison-Myers index and tertiary technical enrolment measures are significantly correlated, with a correlation coefficient of 0.87. Both measures are also highly correlated with the Barro and Lee (1993, 1996) measure based on countries' average number of years of education. In other words, countries that invest in secondary and general tertiary education also produce technically skilled workforces. Harbison-Myers indexes are shown in annex table 3.5 and tertiary technical enrolments in annex table 3.6. The starting year for the enrolment data is 1987 because it provides broader country coverage. Because enrolment indicators tend to change slowly, this does not significantly affect comparisons with 1985 data for other indicators. Harbison and Myers (1964) calculated their index using 1958 data. For a comparison of their rankings for 1958 with data for 1995, see Lall (1999).

7. An alternative measure of effort, *patents taken out in the United States,* was also calculated. Although industrialized countries often use this as a measure of innovative output, it is more relevant to frontier innovation than R&D effort. But R&D and United States patenting, appropriately deflated, are closely correlated: countries that spend a lot on R&D also take out a lot of patents overseas.

8. Radosevic (1999).

9. For discussions of technical standards in the electronics industry, see Ernst (1997, 2000), Hobday (1995), Mathews and Cho (2000).

10. See Lall (2001b). Developing countries account for an extremely small share of R&D by transnational corporations. In the mid-1990s less than 1 percent of R&D by transnational corporations based in the United States occurred in developing countries (while 11 percent was in other industrialized countries). Even this small share was highly concentrated, with nearly two-thirds in Brazil, Mexico and Singapore (in declining order of importance). Still, even though the amount spent on R&D in developing countries is low relative to corporate R&D, it can account for a substantial share of national R&D in host economies.

11. Flows are preferred for two reasons. First, stocks are calculated at historical values and can give a misleading picture of the current value of foreign investment assets. Second, flows give a better picture of current FDI activity and so are more relevant to explaining current performance. Still, a comparison of the two datasets for the sample yielded similar rankings, so the choice between flows and stocks does not make much practical difference.

12. Capital goods are also a type of "embodied" technology import but are not included in externalized technology imports for several reasons. First, the data capture a large element of equipment imports for nonindustrial investment. Second, they include re-export of equipment, particularly by *entrepôt* centres like Hong Kong SAR and Singapore, biasing the results in their favour. Third, the data include components of capital goods for export processing, making export-oriented countries in electronics appear to be very large importers of technology.

3 Benchmarking industrial performance

Policymakers across the world keep close track of other countries' industrial performance. This trend is growing, as the Web sites of many government ministries, research institutes, consultancies and international organizations show. Industrial performance, productivity, innovativeness, skills, foreign direct investment inflows and the like are constantly compared at varying levels of detail. This concern with comparative industrial performance reflects global competition and the usefulness of comparisons for policy purposes. The systematic use of comparisons, or *benchmarking,* clearly serves a strong need.[1]

Benchmarks are needed because it is difficult to assess national industrial performance on the basis of a priori norms. For many facets of performance there are no norms in economic theory. Are manufacturing production, exports and employment growing fast enough, given a country's resources, industrial structure and level of technology? Are domestic enterprises sufficiently innovative, or workers sufficiently skilled? Is the industrial infrastructure coping adequately with the needs of the new economy? Is the economy participating fully in international knowledge flows? These and many similar questions cannot be addressed using only theoretical parameters.

The best guide when addressing such important questions comes from the performance of other (comparable) economies. If they are doing consistently better, something is clearly amiss at home. Even where a priori engineering parameters exist—say, for an industrial plant—benchmarking against best practice is still useful. It helps operators to see whether equipment can be "stretched" to perform better or workers reorganized to become more productive. Wherever performance can be improved, benchmarking is a useful tool.

The sheer pace of change in the national and international economic and technological environment also makes it far more difficult for governments to assess domestic performance without looking at other economies. The need for benchmarking is all the greater for countries undergoing wrenching internal structural and policy shifts.

Benchmarking can be conducted at many levels—enterprise, industry, institution, government or government department. It can focus on specific matters, such as capital and labour costs, infrastructure, technology, innovation, skills or the environment. The more specific the level, the easier it is to derive quantitative benchmarks; the more general the level, the harder it is to define what is relevant and, often, how to measure it. So, benchmarking industrial performance is easier than benchmarking national competitiveness. Still, even the level of industry is quite general, with complexities and variations that broad benchmarks cannot take into account. National benchmarks should thus be seen as useful preliminary indicators of relative performance. As an aid to policymaking, they have to be supplemented by detailed analysis by country and activity. It is just as important to bring in the qualitative institutional and policy variables that such benchmarks have to leave out.

The Scoreboard introduced in this report provides useful information on crucial aspects of industrial development.[2] It provides a simple tool that countries can use to assess their position with respect to industrial performance (box 3.1) and its structural features (discussed in chapter 4). The Scoreboard is an analytical tool using published hard data to explain differences in industrial performance and capabilities. It is merely a series of benchmarks (which will be improved and enlarged over time). In the next chapter, however, some simple statistical analysis is conducted using the Scoreboard to check how closely industrial performance relates to a given set of capability factors and whether their structural features have changed over time. The Scoreboard focuses on manufacturing and on a small number of structural variables on which hard data are available.

Benchmarking industrial performance: the competitive industrial performance index

A ranking of economies by the competitive industrial performance (CIP) index reveals a general pattern that is as expected:

Box 3.1 The competitive industrial performance index

The competitive industrial performance (CIP) index focuses on the national ability to produce manufactures competitively. Since it is difficult to find a single indicator that captures all the dimensions of competitive production, the CIP index is constructed from four basic indicators of industrial performance.

1. *Manufacturing value added (MVA) per capita.* MVA would automatically capture the competitiveness of industrial activity if all production from all countries were fully and equally exposed to international competition—but it is not. Trade and other policies limit the exposure of domestic industry to international competition. So do natural barriers to trade, such as high transport costs, poor access to natural resources, differences in taste, legal and institutional variations and information gaps. Production for home markets (particularly in countries with large markets or with strong import substitution policies) faces less intense competition than production for export.

2. *Manufactured exports per capita.* The export measure indicates how competitive industrial activity is in one set of markets. It also captures another important aspect of industrial performance: the ability of national industry to keep pace with technological change, at least in exported products. Exports can be taken to demonstrate that producers are using competitive (modern) technologies. This is important because the technology measures below do not capture technological upgrading within broad product groups. The export indicator partially offsets this inability.

3. *Share of medium- and high-tech activities in MVA.* The higher the share of medium- and high-tech activities in MVA, the more technologically complex is the industrial structure of a country, and the more competitive is the country's industrial performance. Industrial development generally entails moving up from resource-based and low-tech to medium- and high-tech activities (Chenery, Robinson and Syrquin 1986). Technology-intensive structures are better for growth and development. Technologically complex activities offer greater learning potential and lend themselves more to sustained productivity growth (because of the greater potential for applying new scientific knowledge). Many have stronger spillover benefits, especially hub activities that disseminate technology across different activities. Historically this role was played by the capital goods sector; today the subsector of electronic technologies is vital (Mowery and Rosenberg 1989). As seen in the previous chapter, high-tech activities also enjoy better growth prospects. And they often have dynamic international production systems.

   Even so, structural change is not automatic or easy because of the slow, incremental and path-dependent nature of learning. Many low-tech and resource-based industries can also have bursts of rapid growth; activities within these industries can have high-tech segments. And industries can shift between technological categories over time. Still, the technological complexity measure offers insights into the ability of countries to sustain growth in the new global setting.

4. *Share of medium- and high-tech products in manufactured exports.* The share of medium- and high-tech products in manufactured exports is considered separate from the share in MVA, because in certain circumstances the two differ significantly. In large import-substituting developing economies, for example, the structure of MVA tends to be more complex than that of exports.

   The values for each of the four variables are standardized for the sample to range from zero (worst performers) to one (best performers). The composite index is calculated as a simple average of the four standardized basic indicators. No weights are assigned to any of the basic indicators. The effect of each basic indicator on the final rank is also analyzed separately (see annex tables A3.1 and A3.2).

   The technological breakdown of MVA is far from perfect. The main reason for this is the lack of consistent cross-country data at the level of disaggregation required for fine distinctions by technological intensity. Moreover, as noted in the previous chapter, it is impossible to distinguish between industrial (or export) structures based on genuine technological capabilities and those based on low-tech assembly in high-tech industries. This problem is more acute for export data: countries with large shares of high-tech assembly in total exports appear among advanced industrial performers (the Philippines is a good example). But the developing countries affected by this data problem are relatively few, and their identities are well known.

industrialized countries congregate near the top, transition economies and middle-income developing countries around the middle, low-income developing countries and least developed countries at the bottom (table 3.1).

In general, *CIP ranks changed little* between 1985 and 1998. The correlation coefficient between the index values for the two years is 0.940, supporting the argument that performance is the outcome of slow and incremental processes. Moreover, since all countries are trying to raise their industrial performance, achieving relative improvements is difficult.

Leaps in the rankings are nevertheless possible. Between 1985 and 1998, 22 countries changed ranks by 10 or more places. Countries near the top and bottom tend to have relatively stable positions, while those in the middle are more volatile. The main cause of the large upward leaps appears to be participation in integrated global production networks, which sharply raises the share of complex products in exports (and, over a longer period, in MVA).

Among the top 40 ranking economies the largest improvements were in China, Ireland, Thailand, the Philippines, Malaysia, Costa Rica and Hungary, with Mexico, Singapore, the Republic of Korea and Taiwan Province of China close behind (figure 3.1). All of these, except for the Republic of Korea and Taiwan Province of China, have experienced a significant increase in the presence of transnational corporations in export manufacturing. The Republic of Korea and Taiwan Province of China are more strongly linked to integrated global production systems through such arrangements as original equipment manufacturing than through foreign direct investment. Among the bottom 40 countries the largest improvement was in Indonesia, again with a strong presence of transnational corporations in export manufacturing.

Table 3.1 Ranking of economies by the competitive industrial performance index, 1985 and 1998

Rank 1998	Rank 1985	Economy	Index value 1998	Index value 1985
1	6	Singapore	0.883	0.587
2	1	Switzerland	0.751	0.808
3	15	Ireland	0.739	0.379
4	2	Japan	0.696	0.725
5	3	Germany	0.632	0.635
6	5	United States	0.564	0.599
7	4	Sweden	0.562	0.633
8	7	Finland	0.538	0.494
9	8	Belgium	0.495	0.489
10	12	United Kingdom	0.473	0.426
11	10	France	0.465	0.450
12	11	Austria	0.453	0.445
13	13	Denmark	0.443	0.424
14	14	Netherlands	0.429	0.398
15	19	Taiwan Province of China	0.412	0.292
16	9	Canada	0.407	0.474
17	16	Italy	0.384	0.379
18	22	Korea, Republic of	0.370	0.247
19	21	Spain	0.319	0.259
20	20	Israel	0.301	0.290
21	17	Norway	0.301	0.348
22	30	Malaysia	0.278	0.116
23	28	Mexico	0.246	0.125
24	..	Czech Republic	0.243	..
25	45	Philippines	0.241	0.044
26	26	Portugal	0.240	0.159
27	34	Hungary	0.239	0.088
28	..	Slovenia	0.221	..
29	23	Australia	0.211	0.214
30	18	Hong Kong SAR	0.204	0.320
31	24	New Zealand	0.186	0.188
32	43	Thailand	0.172	0.058
33	27	Brazil	0.149	0.140
34	25	Poland	0.143	0.176
35	29	Argentina	0.140	0.122
36	44	Costa Rica	0.129	0.053
37	61	China	0.126	0.021
38	36	Turkey	0.108	0.082
39	32	South Africa	0.108	0.096
40	33	Greece	0.102	0.093
41	37	Romania	0.095	0.072
42	31	Bahrain	0.089	0.099
43	42	Uruguay	0.087	0.062
44	..	Russian Federation	0.077	..
45	40	Tunisia	0.068	0.064
46	35	Venezuela	0.060	0.085
47	53	Chile	0.056	0.030
48	56	Guatemala	0.056	0.028
49	65	Indonesia	0.054	0.012
50	50	India	0.054	0.034
51	38	Zimbabwe	0.052	0.071
52	57	El Salvador	0.051	0.027
53	46	Morocco	0.048	0.038
54	41	Saudi Arabia	0.047	0.063
55	49	Colombia	0.041	0.035
56	47	Mauritius	0.041	0.037
57	67	Egypt	0.038	0.012
58	48	Peru	0.035	0.037
59	39	Oman	0.032	0.069
60	55	Pakistan	0.031	0.028
61	58	Ecuador	0.025	0.025
62	64	Kenya	0.025	0.013
63	60	Jordan	0.024	0.022
64	66	Honduras	0.023	0.012
65	52	Jamaica	0.022	0.032
66	51	Panama	0.022	0.032
67	69	Bolivia	0.021	0.009
68	..	Albania	0.021	..
69	71	Sri Lanka	0.017	0.008
70	62	Nicaragua	0.017	0.020
71	63	Paraguay	0.015	0.013
72	..	Mozambique	0.013	..
73	74	Bangladesh	0.011	0.008
74	54	Algeria	0.009	0.029
75	72	Cameroon	0.008	0.008
76	59	Senegal	0.008	0.023
77	68	Zambia	0.007	0.010
78	75	Nigeria	0.006	0.006
79	79	Nepal	0.006	0.001
80	70	Tanzania, United Republic of	0.005	0.009
81	78	Malawi	0.003	0.003
82	73	Madagascar	0.003	0.008
83	77	Central African Republic	0.003	0.003
84	80	Uganda	0.003	0.001
85	..	Yemen	0.001	..
86	76	Ghana	0.001	0.006
87	..	Ethiopia	0.000	..

Source: UNIDO Scoreboard database (see technical annex).

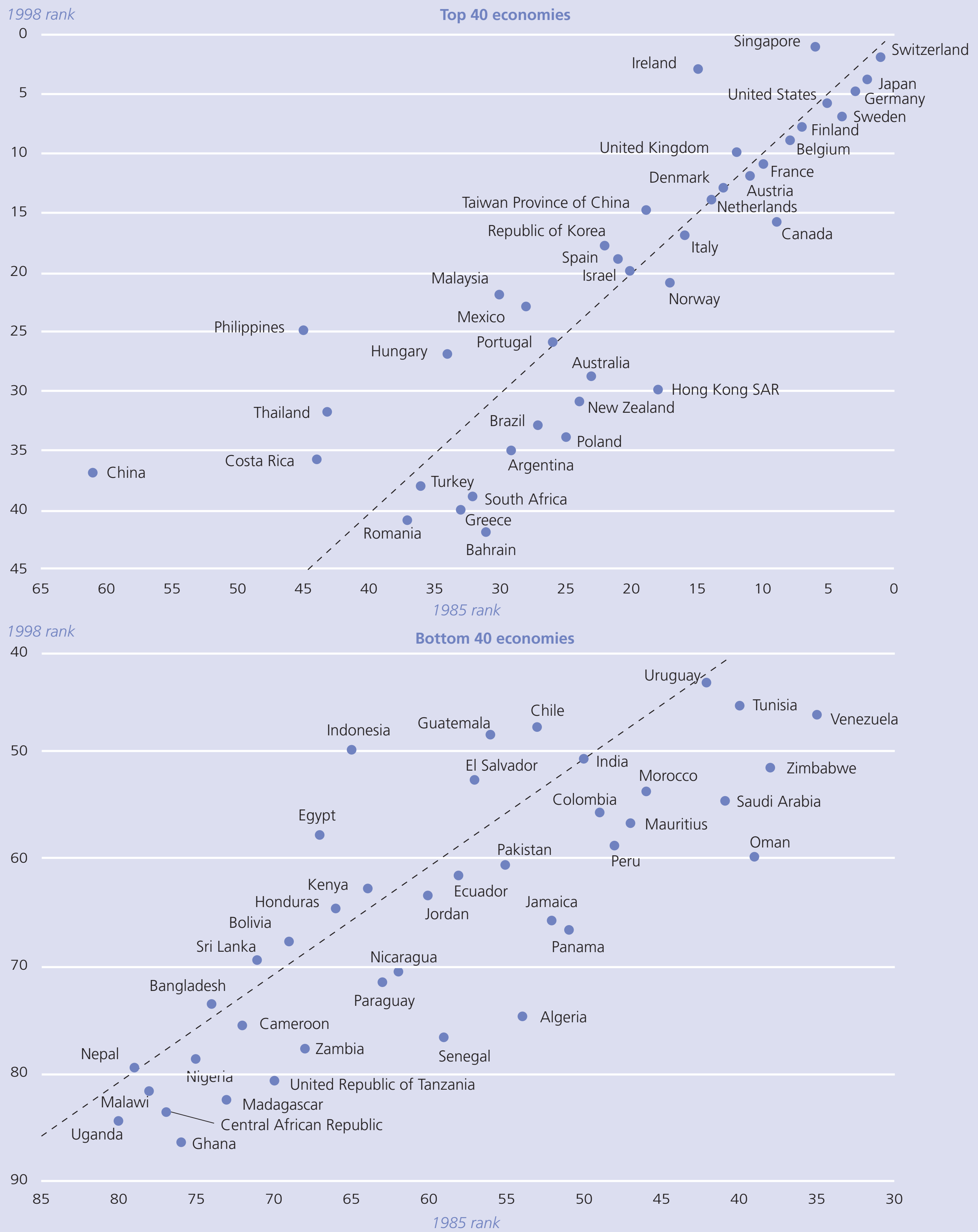
Economies losing rank significantly include Hong Kong Special Administrative Region (SAR) of China, Bahrain, Poland, New Zealand and Canada among the top 40, and Oman, Algeria, Senegal, Zimbabwe, Saudi Arabia, Jamaica and Venezuela among the bottom 40.

Industrialized and transition economies

Switzerland led the industrialized countries in both years (table 3.2). In 1985 it also led the world, but Singapore had overtaken it by 1998. Ireland had the biggest jump in rank in the group, improving its position from 15th to third. The major industrial powers—Japan, Germany and the United States—near the top of the scale, saw a deterioration in their positions as a result of the improved positions of Singapore and Ireland. Of the top 20, all but five are mature industrialized countries. The exceptions, apart from Ireland and Israel, are three East Asian Tigers—the Republic of Korea, Singapore and Taiwan Province of China.

Among transition economies the leaders are the Czech Republic, Hungary and Slovenia. Hungary, the only one of these three for which 1985 data are available, improved its

Figure 3.1 Changes in ranking by the competitive industrial performance index between 1985 and 1998



Source: UNIDO Scoreboard database (see technical annex).
Note: Economies on the line had the same rank in both years, while those above the line had a higher rank in 1998 than in 1985, and those below it a lower one.

Table 3.2 **Ranking of economies by the competitive industrial performance index, by region or country group, 1985 and 1998**

Region or country group	Rank 1998	Rank 1985	Economy
Industrialized countries			
	2	1	Switzerland
	3	15	Ireland
	4	2	Japan
	5	3	Germany
	6	5	United States
	7	4	Sweden
	8	7	Finland
	9	8	Belgium
	10	12	United Kingdom
	11	10	France
	12	11	Austria
	13	13	Denmark
	14	14	Netherlands
	16	9	Canada
	17	16	Italy
	19	21	Spain
	20	20	Israel
	21	17	Norway
	26	26	Portugal
	29	23	Australia
	31	24	New Zealand
	40	33	Greece
Transition economies			
	24	..	Czech Republic
	27	34	Hungary
	28	..	Slovenia
	34	25	Poland
	41	37	Romania
	44	..	Russian Federation
	68	..	Albania
	68	..	Albania
Latin America and the Caribbean			
	23	28	Mexico
	33	27	Brazil
	35	29	Argentina
	36	44	Costa Rica
	43	42	Uruguay
	46	35	Venezuela
	47	53	Chile
	48	56	Guatemala
	52	57	El Salvador
	55	49	Colombia
	58	48	Peru
	61	58	Ecuador
	64	66	Honduras
	65	52	Jamaica
	66	51	Panama
	67	69	Bolivia
	70	62	Nicaragua
	71	63	Paraguay

Region or country group	Rank 1998	Rank 1985	Economy
East Asia and the Pacific			
	1	6	Singapore
	15	19	Taiwan Province of China
	18	22	Korea, Republic of
	22	30	Malaysia
	25	45	Philippines
	30	18	Hong Kong SAR
	32	43	Thailand
	37	61	China
	49	65	Indonesia
South Asia			
	50	50	India
	60	55	Pakistan
	69	71	Sri Lanka
	73	74	Bangladesh
	79	79	Nepal
Sub-Saharan Africa			
	39	32	South Africa
	51	38	Zimbabwe
	56	47	Mauritius
	62	64	Kenya
	72	..	Mozambique
	75	72	Cameroon
	76	59	Senegal
	77	68	Zambia
	78	75	Nigeria
	80	70	Tanzania, United Republic of
	81	78	Malawi
	82	73	Madagascar
	83	77	Central African Republic
	84	80	Uganda
	86	76	Ghana
	87	..	Ethiopia
Middle East and North Africa and Turkey			
	38	36	Turkey
	42	31	Bahrain
	45	40	Tunisia
	53	46	Morocco
	54	41	Saudi Arabia
	57	67	Egypt
	59	39	Oman
	63	60	Jordan
	74	54	Algeria
	85	..	Yemen

Source: UNIDO Scoreboard database (see technical annex).

position by seven places, while those of Poland and Romania deteriorated. The lowest ranked transition economy is Albania, at 68th in the world.

Developing economies

Among the developing regions East Asia led in both years and also had the greatest improvement in ranks over the period. There is wide dispersion within the region, however. Singapore led East Asia in both years, ranking sixth and first. Its nearest rival was Taiwan Province of China, ranking 13 places lower in 1985 and 14 lower in 1998—followed by the Republic of Korea, which joined the top 20 in 1998. Most of the economies that improved their ranks are in East Asia: China (which improved its rank by 24 places), the Philippines (20), Indonesia (16) and Thailand (11). Hong Kong SAR is the only one in the region whose position worsened, by 12 places.

In Latin America and the Caribbean, Mexico, Costa Rica, Chile and Guatemala improved their positions while those of other countries deteriorated. Of the 18 countries in this region, 7 improved and 11 worsened over the period.

In the Middle East and North Africa only one country improved its ranking, Egypt, by 10 places. Others in the region had the steepest declines in the sample: Algeria and Oman (by 20 places each) and Saudi Arabia (13).

In South Asia, India (ranked 50th) leads, followed by Pakistan, Sri Lanka, Bangladesh and Nepal. Only Sri Lanka and Bangladesh improved their rankings, and only slightly.

In Sub-Saharan Africa the leader by far is South Africa (at 39th), followed by Zimbabwe and Mauritius (at 51st and 56th),[3] both with large declines. Most other African countries congregate at the bottom. Of the 16 Sub-Saharan African countries, only Kenya improved its rank. Of the 20 lowest ranking countries, 12 are in Sub-Saharan Africa.

Least developed countries

Not surprisingly, the 12 least developed countries in the sample are near the bottom of the world rankings, along with Algeria (which suffered a massive deterioration in performance over the period) and three other African countries, Cameroon, Nigeria and Ghana.

Among the least developed countries Bangladesh and Nepal had stable rankings over the period (because of a rise in their CIP index values; table 3.3). But for most other countries the picture is less sanguine. Senegal recorded a large fall (one of the largest in the sample), as did Madagascar, the United Republic of Tanzania and Zambia. Since the sample coverage differs between 1985 and 1998, the changes reflect both shifts in relative industrial performance and the entry of new countries. Bangladesh and Nepal maintained their ranks because of an upgrading of the technological structure of their exports, while Senegal lost rank largely because of a downgrading of its export structure.

Basic indicators of industrial performance—a useful source of information

Analysis of country rankings for each basic indicator in the CIP index provides useful information. As each new indicator is added to the base—per capita MVA—the position of a country shifts. The ranks at each stage illustrate different aspects

Table 3.3 Ranking of least developed countries by the competitive industrial performance index, 1985 and 1998

1985			1998		
Overall rank	Economy	CIP value	Overall rank	Economy	CIP value
59	Senegal	0.023	72	Mozambique	0.013
68	Zambia	0.010	73	Bangladesh	0.011
70	Tanzania, United Republic of	0.009	76	Senegal	0.008
73	Madagascar	0.008	77	Zambia	0.007
74	Bangladesh	0.008	79	Nepal	0.006
77	Central African Republic	0.003	80	Tanzania, United Republic of	0.005
78	Malawi	0.003	81	Malawi	0.003
79	Nepal	0.001	82	Madagascar	0.003
80	Uganda	0.001	83	Central African Republic	0.003
			84	Uganda	0.003
			85	Yemen	0.001
			87	Ethiopia	0.000

Source: Annex tables A3.1 and A3.2.
Note: The 1985 sample is smaller than the 1998 sample because no 1985 data are available for Mozambique, Yemen and Ethiopia.

of competitive industrial performance, as examples from the 1998 index show.

Take the largest industrialized economy (by total value of production and exports), the United States. It ranks seventh in per capita MVA, below Switzerland and Japan—and below even Ireland and Singapore (the use of population to normalize indicators works against large countries but remains a good way to adjust for country size). When per capita exports are added, the United States falls to 13th, reflecting the stronger pull of its domestic market relative to that of other highly industrialized competitors. But its rank improves when the indicators of complexity of MVA and exports are added, showing its relative technological strength. In contrast, New Zealand loses rank significantly: while it ranks 21st in MVA per capita, it ends up 31st, mainly because its manufactured exports are far less technology intensive than its production.

Now consider some developing countries. Singapore starts at fourth but rises to first place because of its high exports per capita and large shares of high-tech products in production and exports. The Philippines experiences more volatility in its position: it starts at 60th in MVA per capita and ends up at 25th in the composite index because of the large share of high-tech products in its exports (the second largest share in the world, after Japan's). Similarly, China starts at 55th and finishes at 37th, again mainly because of the technology intensity of its manufactured exports. Zimbabwe shows a comparable pattern, rising from 69th to 51st. Chile provides a counterexample. Its final rank (47th) is 10 places lower than its starting rank because its manufactured exports are far less technologically sophisticated than its MVA, pulling it down by 11 places.

So, rankings by the basic indicators in the CIP index can provide interesting insights into comparative national performance. The main cause of variation in ranks is the technological structure of exports. When this variable is introduced, the ranks of 16 countries change by 10 or more places, with seven improving and nine worsening. Adding the other two variables causes far smaller shifts in ranks. The countries whose positions improved the most with the addition of the export structure variable are the Philippines, India, Zimbabwe, China and Kenya. Several of these (India, Zimbabwe and Kenya) do not have particularly technology-intensive exports—they move up the scale because their exports are more complex than those of other countries near them in the rankings. Those whose positions deteriorated the most with the export structure variable are Mauritius, Jamaica, Bahrain and Saudi Arabia, followed closely by Chile, Peru and Algeria.

Adding the technological structure of MVA or exports had little effect on the comparative industrial performance of the least developed countries as a group: these countries congregate near the bottom of the ranking even if only MVA per capita is used as the index (annex tables A3.1 and A3.2). Including these variables has some effects on individual countries, of course, but the variables are not biased against least developed countries. For example, adding the export structure to MVA and exports per capita leads to a significant deterioration in the ranks of Senegal and Yemen in 1998, but to a significant improvement for Mozambique, Nepal and the United Republic of Tanzania.

The four components of the CIP index are highly correlated with one another. The strongest correlation is between MVA per capita and the technological structure of MVA: the higher the level of industrialization, the more complex is the structure of production (table 3.4). Similarly, the higher the level of exports per capita, the more sophisticated is the MVA structure, and the higher the level of industrialization, the larger are per capita exports. The weakest (though still statistically significant) correlation is between export intensity and export structure.

Table 3.4 Correlation between components of the competitive industrial performance index, 1998

Component	MVA per capita	Manufactured exports per capita	Share of medium- and high-tech activities in MVA	Share of medium- and high-tech products in manufactured exports
MVA per capita	1.000			
Manufactured exports per capita	0.717**	1.000		
Share of medium- and high-tech activities in MVA	0.968**	0.752**	1.000	
Share of medium- and high-tech products in manufactured exports	0.732**	0.574**	0.719**	1.000

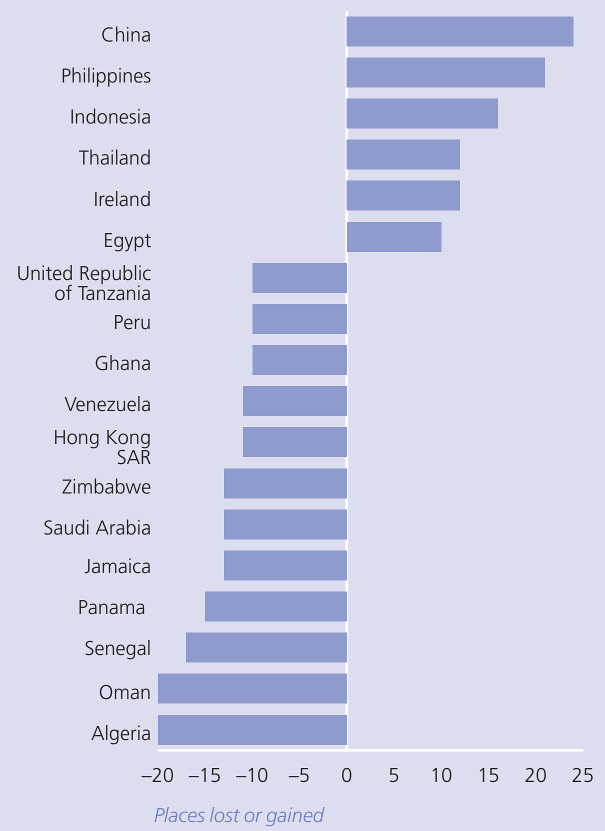
Source: UNIDO Scoreboard database (see technical annex).
** Significant at the 1 percent level.

Winners and losers in CIP ranks

Which economies experienced exceptionally large shifts in CIP ranks between 1985 and 1998? Six "winners" gained 10 or more places, and 12 "losers" lost 10 or more (figure 3.2). The main reasons for this volatility are shifts in relative MVA per capita and in the complexity of MVA and exports. Underlying factors may include political turmoil, natural disasters or declining terms of trade. Since many of these are external to industry, they are not germane to the general analytical and policy discussion here.

For this report the most important factor—one that can lead to great volatility in rankings and is more relevant for analysis and policy—is rapid upgrading of technological structures. For all the winners except Egypt (where MVA rose rapidly), the entry into high-tech integrated global production systems has been the most dynamic new element in industry. That is not to say that this strategy is the only way to upgrade technology in developing countries. In fact, it may not even be the best and most sustainable way: it introduces new production technologies and raises exports, but it may not develop or deepen local capabilities if the country fails to move beyond final assembly of high-tech products. Latecomers that have managed to build genuine technological capabilities in complex activities have generally done it through a slower, costlier and riskier process of advancing from assembly to real manufacturing, and from there to local design and development. They have done much of this without investment by transnational corporations—even restricting foreign entry to encourage the development of deeper capabilities in local enterprises.

Figure 3.2 Winners and losers in competitive insustrial performance rankings between 1985 and 1998



Source: UNIDO Scoreboard database (see technical annex).

Clustering countries to discern patterns in industrial performance

One useful way to analyze competitive industrial performance is through cluster analysis (for details see the technical annex). The technique allows the number of clusters to be specified in advance.

Industrial performance over time

Cluster analysis is first used here to group countries based on similarities in the behaviour of three variables: the CIP index values in 1985 and 1998 and the change in the index value between those two years. The analysis captures how countries cluster according to the level of industrial performance and the change in that performance. The analysis is conducted separately for industrialized and transition economies and for developing economies.

For industrialized and transition economies four clusters were chosen, covering the 25 countries with data for both 1985 and 1998. The first cluster has only one country, Ireland (table 3.5). Ireland stands out in the group because of its high CIP index value in 1998 and the large change in this value since 1985—no other economy has a similar combination. In the second cluster are the industrial giants, Japan, Germany and the United States, and two smaller highly industrialized countries, Sweden and Switzerland. These countries have a high and relatively stable average CIP index value in both years (though the value showed a small decline from 1985 to 1998). In the third cluster are most other Western European countries along with Canada and Israel; these have a lower average CIP index value in both years (but the value rose slightly). In the fourth cluster are the weaker industrialized economies in Europe (Greece and Portugal), all the transition economies for which there are data for both years and Australia and New Zealand. This cluster has even lower CIP index values but a slightly larger increase between 1985 and 1998.

Table 3.5 Cluster analysis of competitive industrial performance for industrialized and selected transition economies, 1985 and 1998

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
CIP 1998 (mean value)	0.74	0.64	0.42	0.17
CIP 1985 (mean value)	0.38	0.68	0.41	0.14
	Ireland	Germany	Austria	Australia
		Japan	Belgium	Greece
		Sweden	Canada	Hungary
		Switzerland	Denmark	New Zealand
		United States	Finland	Poland
			France	Portugal
			Israel	Romania
			Italy	
			Netherlands	
			Norway	
			Spain	
			United Kingdom	

Source: See technical annex.
Note: The table excludes Albania, the Czech Republic, the Russian Federation and Slovenia, for which no 1985 data are available.

Now let us look at the results of a cluster analysis for developing economies (table 3.6). Five clusters are specified to take account of the larger number of economies in this group (52). Interestingly, the two smaller Tiger economies in East Asia, Hong Kong SAR and Singapore, each form an individual cluster. Each has a performance that is quite different from that of the rest of the developing world and from that of each other. Singapore has the highest CIP index value of all the clusters in both years, and the value rises over time. The Republic of Korea and Taiwan Province of China form another cluster, with moderately high and rising CIP index values.

The fourth cluster includes 11 countries, with low to medium CIP index values.[4] This group includes several major industrializing economies (Argentina, Brazil, China, Mexico, South Africa and Turkey) as well as the fast-growing new Tigers in Asia (Malaysia, the Philippines and Thailand) and one in Latin America and the Caribbean (Costa Rica). There is also an outlier, Bahrain. The fifth cluster contains the remaining countries, with very low and stable CIP index values. These countries have weak or stagnant industrial and export values and structures. India falls into this group despite its large industrial sector.

Evolution of industrial and export structures

Cluster analysis can also spotlight differences in the evolution of countries' industrial and export structures—that is, in the shift of their MVA and export structures up the technological scale. First consider four clusters for the industrialized and transition economies (figure 3.3):

Table 3.6 Cluster analysis of competitive industrial performance for developing economies, 1985 and 1998

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
CIP 1998 (mean value)	0.88	0.39	0.20	0.16	0.03
CIP 1985 (mean value)	0.59	0.27	0.32	0.09	0.03
	Singapore	Korea, Republic of	Hong Kong SAR	Argentina	Other developing countries
		Taiwan Province of China		Bahrain	
				Brazil	
				China	
				Costa Rica	
				Malaysia	
				Mexico	
				Philippines	
				South Africa	
				Thailand	
				Turkey	

Source: See technical annex.
Note: The table excludes Ethiopia and Yemen, for which no 1985 data are available.

- The leading cluster (Germany, Japan, Sweden, Switzerland, the United States), which has the highest MVA per capita and the most technology-intensive production and exports, had a significant rise in MVA per capita and some improvement in the technological structure of both MVA and exports between 1985 and 1998.

- The second cluster, with Belgium, Ireland and the Netherlands, had a rapid rise in MVA per capita and a rapid upgrading of industrial and export structures.

- The third cluster, with eight mature industrialized countries, resembles the first cluster but has a smaller average MVA per capita.

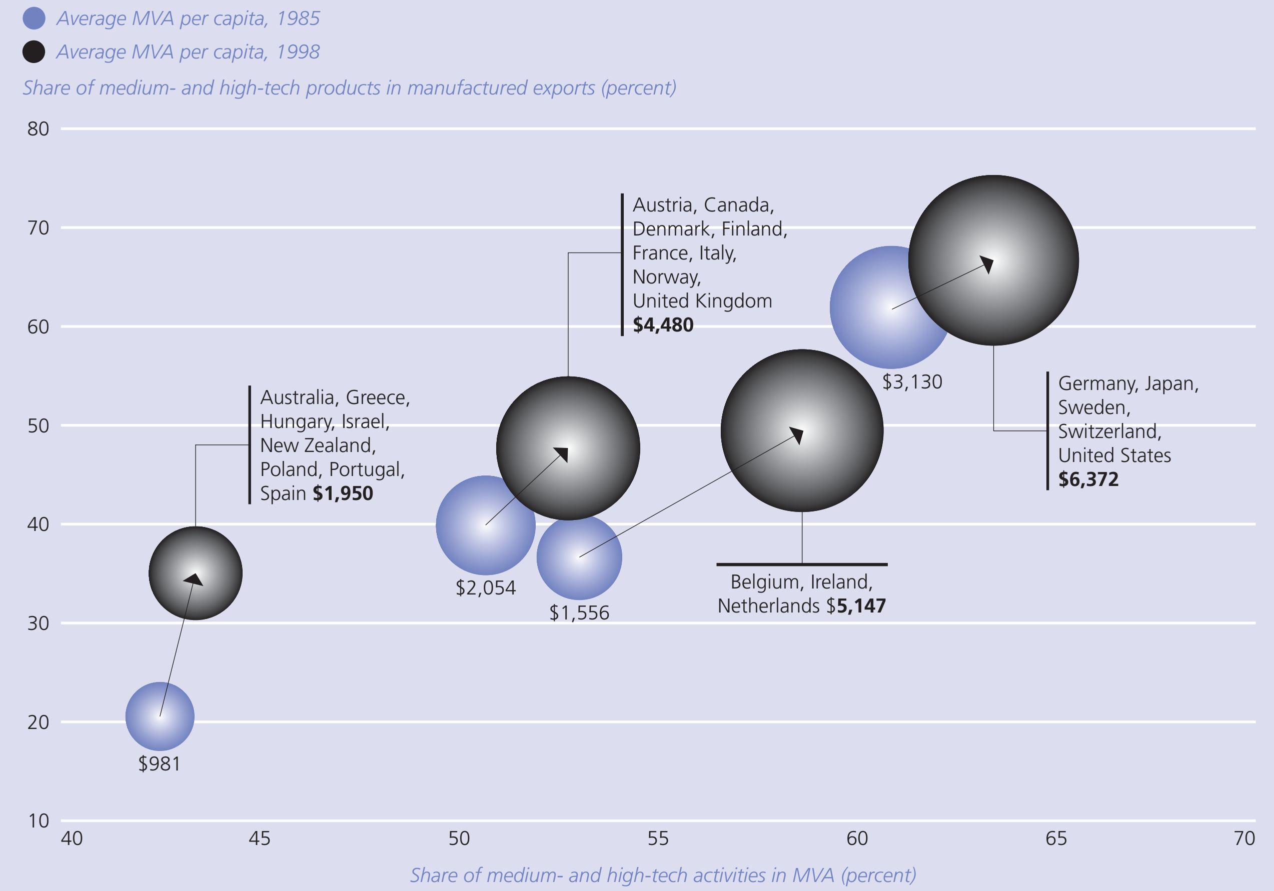
- The last cluster had the lowest average MVA per capita and the least technology-intensive MVA and exports in 1998. But it also had a rapid improvement in the technological composition of exports (and a somewhat less rapid one for MVA).

Now consider the developing economies, with seven clusters (figure 3.4):

- Singapore and Hong Kong SAR again form clusters of their own, with strong differences in rates of upgrading and growth. Singapore showed rapid improvement in MVA per capita and technological sophistication, while Hong Kong SAR showed practically no change in MVA per capita and export structure, though it had some improvement in MVA structure.

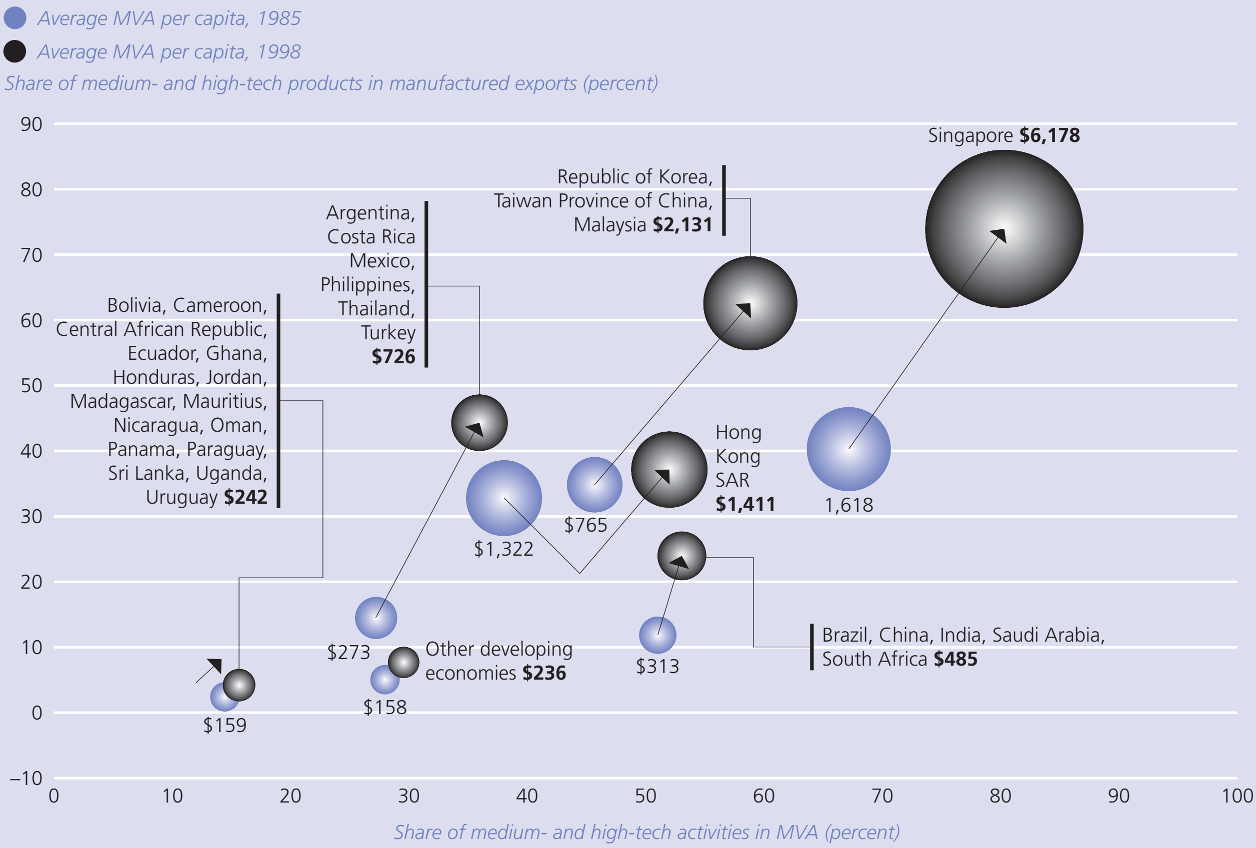
- The Republic of Korea, Malaysia and Taiwan Province of China form a dynamic cluster, with high rates of growth in MVA per capita and rapid rises in the technological complexity of production and exports.

Figure 3.3 Cluster analysis of technological evolution of industry in industrialized and transition economies, 1985–1998



Source: UNIDO Scoreboard database (see technical annex).

Figure 3.4 Cluster analysis of technological evolution of industry in developing economies, 1985–1998



Source: UNIDO Scoreboard database (see technical annex).

- Another dynamic cluster has two new Asian Tigers, the Philippines and Thailand, along with Argentina, Costa Rica, Mexico and Turkey.
- The next cluster contains three industrial giants in the developing world, Brazil, China and India, along with Saudi Arabia and South Africa. With medium to low MVA per capita, these countries are upgrading their export structures but less so their industrial structures.[5]
- The last two clusters, with 43 countries, have much lower MVA per capita and, on average, negligible upgrading of MVA and export structures. These are the laggards.

The results of cluster analysis clearly illustrate patterns of industrial performance. But the technique glosses over national differences in particular aspects of performance. More detailed analysis is called for in making specific country comparisons. What this analysis does show, however, is how widely dispersed developing countries are—and how they are diverging rather than converging.

Explaining export performance

Enterprises are much more successful at exporting from some countries than from others. A large literature explores the role of trade and industrial policies in export success. Rather than add to this literature, here the intention is to focus on aspects on which the CIP index throws some light.

The identities of the leading and lagging exporters in 1998—as assessed by manufactured exports as a share of MVA and medium- and high-tech exports as a share of medium- and high-tech MVA—suggest an interplay of several factors in explaining export performance (table 3.7). The main factors are the size of the domestic economy, competitive capabilities, the nature of the trade regime and the intensity of participation in integrated global production systems.

There are several large industrialized economies in the group with low export propensities. Since all these countries have open trade and investment regimes, the main explanation must be the size of the domestic market: large economies have an inherent propensity to export less relative to production than do small economies.[6] For Japan and the United States, countries with open regimes and strong technological capabilities, market size is clearly the main explanation of the low export propensities (in absolute terms, these are among the world's leading exporters). For other industrialized countries other factors may also matter. For example, the low export ratio for Australia, a medium-size economy, may reflect competitive weaknesses in industry.

Size also matters in the developing world, but trade policies and capabilities probably play a larger role. Thus weak export performance in large countries, such as India, reflects not just the large market size but also the legacy of strong inward-looking policies, the small presence of transnational corporations and competitive weaknesses in manufacturing. Brazil has a relatively open economy and a large presence of transnational corporations. Nevertheless, it had a weak showing, perhaps because transnational corporations do little high-tech exporting and local enterprises (apart from obvious exceptions like the aircraft producer Embraer) lack strong competitive capabilities.[7] As the data on Brazil's export structure show, high-tech products play a surprisingly small role in the developing world's second largest industrial power.

Now consider export performance in medium- and high-tech products. In the top 15 performers foreign direct investment clearly plays an important role. Most of the highly export-oriented countries have a strong presence of transnational corporations. This feature is combined with strong domestic technological capabilities in some countries (Belgium, the Netherlands, Singapore) and with modest domestic technological capabilities in others (Costa Rica, Malaysia, the Philippines). The strong showing by this second group shows that it is possible for newcomers without a technological base to upgrade their industrial structure and performance by leveraging participation in integrated global production systems. Even in relatively large economies, such as Mexico, such participation can offset the pull of the home market.

China, despite its size, does not appear among the bottom 15 for medium- and high-tech exports as it does for total manufactured exports. Its medium- and high-tech sector is apparently far more competitive than the rest of its manufacturing. In China, as in Mexico, foreign enterprises in special export zones contribute a significant share of medium- and high-tech exports. Chile is among the laggards in technology-intensive exports despite its open (and fairly small) economy, strong presence of transnational corporations and high skill levels. Its weak performance reflects in part its comparative advantage in resource-based activities, but also in part its inability to enter global production systems.

Table 3.7 Leading and lagging exporters, 1998

Manufactured exports as a percentage of total MVA				Medium- and high-tech exports as a percentage of medium- and high-tech MVA			
Top 15 exporters		Bottom 15 exporters		Top 15 exporters		Bottom 15 exporters	
Economy	Value	Economy	Value	Economy	Value	Economy	Value
Singapore	529.5	Russian Federation	54.0	Singapore	566.4	Romania	66.6
Belgium	338.5	Turkey	51.9	Philippines	524.1	Russian Federation	65.9
Malaysia	371.4	Morocco	51.0	Costa Rica	478.5	South Africa	65.8
Hong Kong SAR	245.2	China	47.2	Czech Republic	462.6	Greece	63.4
Netherlands	225.0	Australia	46.3	Hungary	445.7	Japan	56.5
Ireland	222.3	Uruguay	41.9	Belgium	385.9	Venezuela	47.7
Hungary	213.0	Japan	41.4	Malaysia	382.5	New Zealand	43.4
Philippines	197.2	India	40.5	Mexico	380.4	United States	39.3
Mauritius	187.0	United States	38.4	Hong Kong SAR	296.4	Turkey	38.5
Costa Rica	174.4	Colombia	32.3	Netherlands	291.7	Argentina	38.1
Czech Republic	159.2	Argentina	26.5	Poland	232.7	Brazil	35.4
Sweden	158.6	Brazil	25.7	Portugal	221.4	Colombia	31.4
Canada	154.3	Ecuador	22.0	Slovenia	191.3	Chile	28.5
Taiwan Province of China	144.2	Peru	15.5	Austria	186.4	Australia	23.7
Denmark	143.4	Egypt	11.2	Thailand	179.8	India	23.5

Source: UNIDO Scoreboard database (see technical annex).
Note: The values can be well over 100 because the numerator (exports) is in terms of total value while the denominator (manufacturing value added, or MVA) is only the value added. The table includes only economies with manufactured exports of more than $1 billion in 1998.

Linking the structure of exports to their growth

Does the technological structure of a country's exports affect the growth of that country's manufactured exports? Econometric analysis suggests that it does. The analysis, covering the 80 countries for which data are available for both 1985 and 1998, regressed the annual growth of manufactured exports on two measures of structure: the technological composition in the base year and the change in structure over time. The first measure is the share of medium- and high-tech products in each country's manufactured exports in 1985. The second is the share of medium- and high-tech exports in 1998 minus the share in 1985.

The initial technological structure captures the relative performance of countries in the dynamic segments of trade, while changes in the technological structure capture the effects of technological upgrading. Countries with advanced initial structures are expected to have slower upgrading.

The sample was divided into two groups: large exporters, with manufactured exports exceeding $1 billion in 1985 (46 countries), and others (34). This sorting differentiates countries by level of industrial development, based on the premise that the technological structures of large exporters will differ significantly from those of small exporters and have different effects on performance in exports. The means of the variables for the two groups support this premise. The average share of medium- and high-tech products for large exporters in 1985 was eight times that for small exporters. Both groups upgraded the technological structure of their exports over time, but the change for large exporters was smaller.

Table 3.8 Correlation between industrial performance measures and carbon dioxide emissions, 1998

Variable	CO2 emissions per capita	CO2 emissions per unit of GDP
CIP 1998	0.655**	–0.289**
MVA per capita	0.630**	–0.341**
Manufactured exports per capita	0.570**	–0.07
Share of medium- and high-tech activities in MVA	0.495**	–0.228*
Share of medium- and high-tech products in manufactured exports	0.530**	–0.165

Source: UNIDO Scoreboard database (see technical annex).

* Significant at the 5 percent level.

** Significant at the 1 percent level.

The regression results suggest that the initial technological structure and subsequent changes affect export growth in the expected direction for large as well as small exporters (annex table A3.3). The equations explain performance better for the large exporters because technological factors are more important for the export performance of relatively advanced economies. But the technological structure of exports also matters for small exporters—more so, in fact, than do improvements in the structure. For large exporters, by contrast, changes over time are more important than the initial technological structure. Even though these exporters are technologically sophisticated in the initial period—and thus well positioned to benefit from the rapid growth of technology-intensive exports—they are able to accelerate export growth through further technological upgrading.

Linking industrial performance and environmental sustainability

The relationship between industrial performance and environmental sustainability is of growing concern to governments—and among the main areas of activity for UNIDO. Although calculating comprehensive national indices of environmental performance is difficult because of data limitations, it is still important to take this aspect of industrial development into account. Yet little cross-country research has been done on the links between industrialization and environmental degradation. There are several possible reasons for this. Appropriate cross-country environmental data are scarce, and isolating the effects of industrial activity on the environment from those of other factors is very difficult. It is also difficult to analyze meaningfully the environmental data that are available. Take industrial emissions of carbon dioxide (CO_2). Low emission rates could mean that a country has tackled industrial pollution effectively or that it has low levels of industrial activity. Most environmental indicators do not make such distinctions, so causal connections are difficult to establish.

One measure of environmental performance for which data are available for all countries in the sample is CO_2 emissions in 1998. An analysis was done to find the correlation between national CO_2 emissions, normalized by population and by GDP, and the components of the CIP index for 1998 (table 3.8).[8]

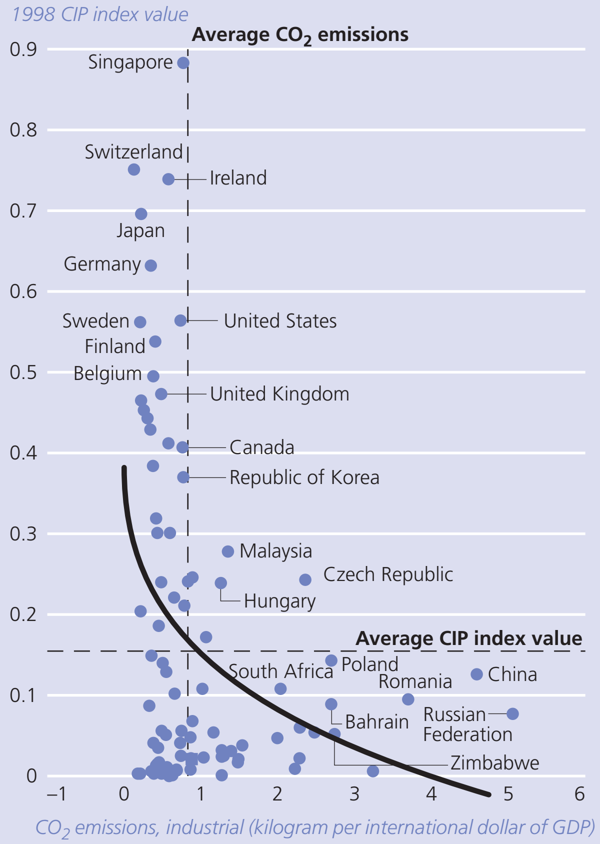
The two measures of emissions give very different results. CO_2 emissions normalized by population are positively correlated (at a 1 percent level of significance) with all components of the CIP index: not surprisingly, the more industrialized a country, the higher are its emissions per capita. CO_2 emissions normalized by GDP are negatively (and mostly significantly) correlated with the components of the CIP index. This suggests, again not sur-

Table 3.9 Biggest and smallest polluters, 1998

Top 15 by CO_2 emissions				Bottom 15 by CO_2 emissions			
CIP rank	Per capita	CIP rank	Per unit of GDP	CIP rank	Per capita	CIP rank	Per unit of GDP
1	Singapore	44	Russian Federation	72	Mozambique	2	Switzerland
42	Bahrain	37	China	84	Uganda	84	Uganda
6	United States	41	Romania	87	Ethiopia	7	Sweden
29	Australia	78	Nigeria	81	Malawi	83	Central African Republic
21	Norway	51	Zimbabwe	83	Central African Republic	30	Hong Kong SAR
16	Canada	34	Poland	79	Nepal	11	France
54	Saudi Arabia	42	Bahrain	80	Tanzania, United Republic of	4	Japan
44	Russian Federation	50	India	82	Madagascar	12	Austria
24	Czech Republic	24	Czech Republic	73	Bangladesh	13	Denmark
5	Germany	46	Venezuela	86	Ghana	43	Uruguay
9	Belgium	65	Jamaica	62	Kenya	14	Netherlands
13	Denmark	74	Algeria	77	Zambia	5	Germany
20	Israel	39	South Africa	69	Sri Lanka	79	Nepal
8	Finland	54	Saudi Arabia	76	Senegal	33	Brazil
4	Japan	57	Egypt	75	Cameroon	17	Italy

Source: Calculations based on CO_2 emissions data from World Bank (2001b).

Figure 3.5 Regression of competitive industrial performance index values on carbon dioxide emissions (log model), 1998



Sources: UNIDO Scoreboard database (see technical annex) and World Bank (2001b).
Note: International dollars are U.S. dollars adjusted for purchasing power parity.

prisingly, that more industrialized economies are more efficient at dealing with emissions relative to their income.

A comparison of the top and bottom 15 polluters—ranked by CO_2 emissions normalized by both population and GDP—provides some interesting detail (table 3.9). Singapore, the United States, Germany, Belgium, Denmark, Finland and Japan are among the largest polluters in per capita terms because of their large industrial bases—these countries rank among the top 20 on the CIP index. Countries with the lowest CO_2 emissions per capita, many of them in Africa and South Asia, rank at the bottom on the CIP index. When emissions are normalized by GDP, the identities of the top and bottom 15 polluters change dramatically. The best industrial performers are not among the largest polluters. Most transition economies have very high CO_2 emissions relative to their industrial base, with the Russian Federation ranking highest on this measure. The two developing giants, China and India, are among the 15 biggest polluters. And Switzerland is the "cleanest" country in the world.

A regression of CIP index values on emissions (normalized by GDP) shows that there is a clear negative relationship between the two (figure 3.5). But the regression explains only 15 percent of the variation in emissions—clearly, other factors are also important in determining emissions (though these cannot be investigated here). Almost all countries with strong performance on the CIP index appear to be relatively "clean", while the largest polluters generally score below the average on the CIP index. As noted, transition economies (the Russian Federation, Romania and Poland) have particularly high emissions relative to the size of their economies.

Interestingly, a comparison with emissions in 1985 (not shown in the figure) shows that countries that have had large jumps in CIP ranks (China, Hungary, Malaysia and Thailand) have also had substantial increases in CO_2 emissions relative to GDP. This suggests that rapid industrial growth can raise the propensity to pollute, at least until some level of industrial maturity is attained. This inverted-U-shaped relationship between emissions and industrialization needs to be investigated in detail.

Notes

1. Benchmarking has been widely used by enterprises as a tool for evaluating performance, learning from best practices and understanding how best practices are achieved. In recent years government agencies and other institutions (such as universities) have also discovered its value. Benchmarking has spread beyond Europe and the United States to the developing world, where many countries are conducting competitiveness analyses based on benchmarking of one another and global leaders.

2. The UNIDO Scoreboard complements existing competitiveness indices. The best known are the World Economic Forum's current competitiveness and growth competitiveness indices, in the *Global Competitiveness Report* (http://www.weforum.org), and the International Institute for Management Development's world competitiveness scoreboard, in the *World Competitiveness Yearbook* (http://www.imd.ch/wcy/wcy.cfm). (For an analysis of these indices see Lall 2001b.) While the UNIDO Scoreboard focuses on manufacturing and a small number of structural variables, other indices use large numbers of variables and rely heavily on qualitative responses. Moreover, the UNIDO Scoreboard is modular, making it possible to easily add new variables.

3. Mauritius's export profile dominated by garments, while the CIP index emphasizes only medium- and high-tech activities.

4. Because the cluster analysis uses CIP scores rather than ranks, some countries appear to be wrongly placed. While Argentina and Brazil lost rank over time, they are clustered in a group with rising performance scores on average. Both these countries in fact raised their CIP scores—Argentina from 0.122 to 0.140 and Brazil from 0.140 to 0.149—but fell in the rankings because other countries improved their scores faster.

5. All countries in a cluster need not perform equally well in all aspects. China upgraded its export structure relatively rapidly in comparison with the others in its group, but had similar MVA and exports per capita.

6. There is a presumption that large economies, because they allow domestic economies of scale and scope, will tend to have deeper industrial sectors (with more medium- and high-tech production) and a larger share of technology-intensive exports. The sample data suggest that this presumption is true. The size of the economy (GDP) is correlated positively (and significantly at the 1 percent level) with the share of medium- and high-tech products in MVA (0.39) and exports (0.44) for the sample (coefficients are shown here for 1998, but those for 1985 are similar). The correlations are stronger for developing than for industrialized countries. But size has a stronger correlation with MVA structure (0.60) in developing countries than with export structure (0.49). Size has no statistical correlation with the growth of MVA or exports in industrialized countries, but it has a positive correlation with the growth of exports (but not MVA) in developing countries.

7. Brazil had a weak showing despite the growth of automobile exports by transnational corporations; clearly the amounts are insufficient to offset low export activity in other industries.

8. Manufacturing value added was also used to normalize emissions. The results were essentially the same as those for GDP.

4 Benchmarking the drivers of industrial performance

Industrial performance is the outcome of many social, political and economic factors interacting in complex and dynamic ways. These interactions are often specific to each country, reflecting its history, culture, legal system, legal and institutional framework, social capital, political and social conditions and ways of doing business. Industrial performance also reflects macroeconomic policies as well as policies relating to technology and education. These factors need not be only national: the outside world can strongly affect industrial activity and performance. With globalization, the role of external factors and rules is growing rapidly.

It is not possible to benchmark countries on all these factors. The purpose here is more modest: to benchmark countries on their key structural variables—referred to here as drivers—using available data. The drivers chosen for benchmarking are *skills, local technological effort* (research and development, or R&D), *foreign direct investment, licensing payments abroad* (royalties) and *physical infrastructure.*[1] As in chapter 2, the objective is not a full econometric explanation of the determinants of industrial performance, but a useful positioning of countries with respect to important structural variables to help policymakers.

Benchmarking countries, even by a few structural variables, raises difficulties. There are problems relating to the availability and definitions of variables, discussed in chapter 3. There may also be problems relating to the complementarity of the variables. Benchmarking implicitly assumes that each driver of industrial performance complements the others for the entire sample. For example, it takes for granted that higher skills, R&D and inward foreign direct investment all work towards improving industrial performance. While this might seem plausible, it is easy to think of exceptions.

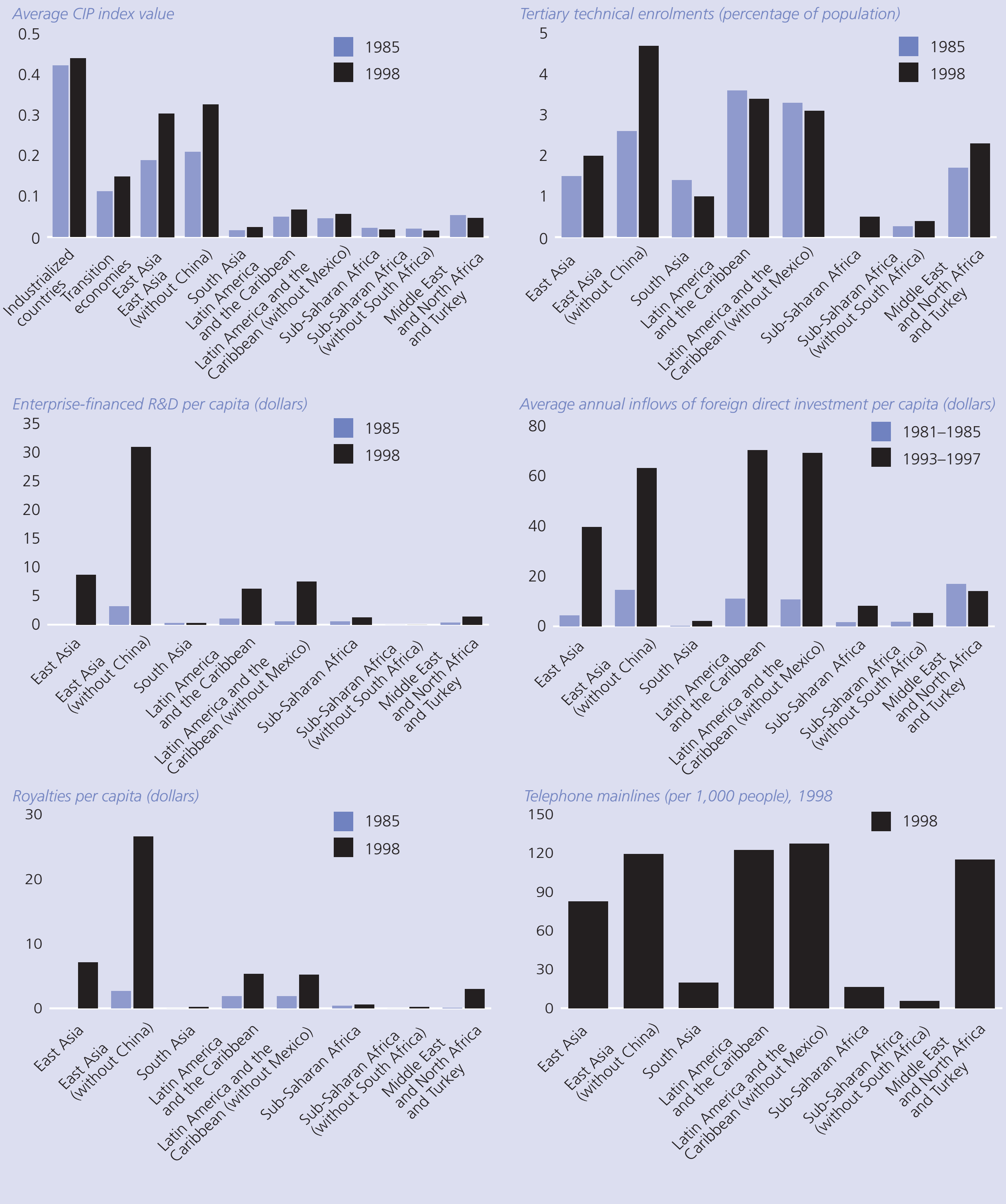
For example, domestic R&D and foreign direct investment may complement each other in some countries but compete in others. Foreign direct investment is effective in transferring and deploying production technology in host countries, but it may be less so in building or transferring deeper innovative capabilities. It is often uneconomical for transnational corporations to set up R&D facilities and build appropriate technological capabilities in host countries—even in those with the industrial sophistication that makes such efforts feasible. That is why Japan, the Republic of Korea and Taiwan Province of China, with strong technological ambitions, restricted foreign direct investment at critical stages of industrialization, when they sought to develop local innovative capabilities. They forced domestic enterprises to license or copy foreign technologies and invest in the capabilities to absorb and improve on them.[2]

For many developing countries, however, there is no real conflict between domestic R&D and foreign direct investment. Domestic R&D (formal domestic R&D spending by productive enterprises) is generally low or negligible, so foreign direct investment is often one of the best ways of gaining access to new technologies, information and skills. Nor is there a conflict between R&D and foreign direct investment for industrialized countries: strong local capabilities attract R&D by transnational corporations and benefit from it.

It is for newly industrializing economies, in the middle, that there are possible non-complementarities. Even here the conflict is real only for countries with the skills and incentives to build genuine R&D capabilities by restricting foreign direct investment. Many countries that pursued this strategy were unable to build efficient innovative capabilities; instead, they simply suffered from growing technological gaps. Nevertheless, some did build advanced technological and innovative capabilities by restricting foreign direct investment. For these countries, treating R&D and foreign direct investment as complements biases the benchmarking, making their average capabilities appear lower (because of their relatively weak performance in foreign direct investment). Even in these countries, however, the conflict between the two occurs in specific phases of industrial development—and diminishes thereafter.

Taking account of such complexities in building the benchmarks is difficult, since there is no a priori way of distinguishing one

Figure 4.1 Competitive industrial performance and its drivers by region, 1981–1985, 1985, 1993–1997 and 1998



Sources: UNIDO Scoreboard database (see technical annex).
Note: Data are unweighted averages. For details on telephone mainlines per 1,000 people by country for 1985 and 1998, see table A2.23 on page 175.

set of countries or one development phase from another. The most practical way is to proceed with benchmarking and, as done here, take up these caveats in the analysis.

The sample economies were ranked by each driver of industrial performance in both 1985 and 1998 (appendix table A4.1; see figure 4.1 for a snapshot of industrial performance and structural drivers by region). A few highlights of the rankings are worth mentioning.

Most of the top 20 economies are industrialized, but there are notable exceptions. The Republic of Korea led the world in skills in both years, because of its high tertiary enrolments and high share of technical students in the population. The Russian Federation ranked sixth in 1998, and Taiwan Province of China eighth. Finland moved up in the skill ranking between 1985 and 1998, displacing the United States of America in second place. In R&D spending per capita Germany fell from first place to fifth, with Switzerland taking the top slot. The leading developing economy was again the Republic of Korea, in 13th place, followed by Singapore (in 14th place, just ahead of the United Kingdom) and Taiwan Province of China (20th).

Singapore led the developing world (and the world as a whole) in foreign direct investment per capita in 1998, followed by Hong Kong Special Administrative Region (SAR) of China in fifth place. Other developing economies among the top 20 recipients of foreign direct investment were Malaysia and Chile; one transition economy, Hungary, also ranked among the top 20. Singapore and Hong Kong SAR ranked among the top 5 in royalties per capita, followed, in the developing world, by Malaysia, Taiwan Province of China and the Republic of Korea. Singapore ranked third in physical infrastructure, with Bahrain and Hong Kong SAR also in the top 20.

Box 4.1 Highlights of the Scoreboard analysis

The analysis of industrial performance and drivers points to the following main messages:

- The correlation between the CIP index and the drivers of industrial performance is positive and significant.
- There is a surprising degree of consistency in the relationship between the CIP index and the drivers over time.
- Most drivers are also related to each of the others, so that it makes sense to have more of everything.
- There are many ways of combining the drivers, however, and successful countries have used varying strategies.
- The rankings of economies by the drivers are stable over time, as would be expected for such structural variables.
- Despite the general stability in rankings, some countries changed their relative position significantly.
- The impact of the drivers on industrial performance also changes over time, with foreign direct investment in particular gaining in significance because of the rise of integrated production systems.
- While foreign direct investment remains a small share of global investment, it plays a vital role in the industrial performance of a growing number of countries. At the same time, it remains highly concentrated, particularly in its deployment of sourcing for high-tech products and components.
- Domestic technological effort, as measured by R&D financed by productive enterprises, is the most consistent and significant of the drivers. But this R&D variable should not be assessed in isolation: the ability to undertake technological effort clearly depends on the availability of skilled manpower and access to foreign technologies. The analysis shows that these are crucial factors in industrial performance, though the importance of technology licensing appears to be declining.
- Physical infrastructure is strongly associated with industrial growth and technology upgrading, but probably as a permissive rather than a causal factor.
- The drivers are unevenly distributed in the developing world, and the distribution is growing more uneven. East Asia dominates in almost every variable, while Sub-Saharan Africa is consistently the weakest.

Stability and complementarity of drivers

The ranking of economies by each driver of industrial performance shows considerable stability over time (just as the ranking by the competitive industrial performance, or CIP, index does). Thus the ranking of economies by R&D spending per capita for 1998 is highly correlated with that for 1985, and so on.[3] This is not surprising: it is naturally difficult for economies to significantly shift their relative position with respect to structural drivers in the short to medium term.[4] Even so, some countries changed their relative position significantly between 1985 and 1998, such as Uruguay in the skills index, Ecuador in R&D per capita and Tunisia in foreign direct investment per capita (box 4.1).

Each driver is positively correlated with the others, suggesting that there are underlying structural relationships between them and that they generally reinforce one another. Thus greater innovative activity is related to higher technical skills, greater foreign direct investment inflows to higher royalty payments and so on. But the strength and significance of the relationships between the drivers vary (table 4.1). Moreover, such correlations do not reflect causal links, though some may well reflect an indirect link—say, through higher incomes. Thus richer countries tend to have more of each driver on a per capita basis. This is why the infrastructure variable has such high correlations with most others. That being said, it is

Table 4.1 Correlation between drivers of industrial performance, 1998

Driver	Skills	R&D	Royalties	Foreign direct investment	Infrastructure
Skills	1.000				
Research and development	0.537**	1.000			
Royalties	0.249*	0.197	1.000		
Foreign direct investment	0.380**	0.396**	0.430**	1.000	
Infrastructure	0.828**	0.687**	0.295**	0.611**	1.000

Source: UNIDO Scoreboard database (see technical annex).

* Significant at the 5 percent level.

** Significant at the 1 percent level.

also likely that many drivers do feed into one another, with skills and R&D an obvious example.

Whatever the underlying mechanisms, the correlations suggest that overall in the sample of economies the drivers complement rather than offset one another. This supports a general presumption that industrial development requires all structural drivers to grow—but not necessarily in tandem at all stages of development. It is still possible, of course, that countries need different combinations of drivers at different levels of industrialization. Less industrialized economies may need more infrastructure and basic skills, for example, while more industrialized ones need more R&D and advanced skills.

It is also possible to combine the drivers in different ways in line with different development strategies. Recall, for example, the tradeoff between deepening technology through domestic R&D and importing readymade technology through foreign direct investment. Countries have responded in different ways to this tradeoff. Some, like the Republic of Korea, restricted inward foreign direct investment and promoted domestic R&D. Others, like Ireland and Singapore, have targeted high-tech foreign direct investment and used policies to increase innovative activity by transnational corporations. Still others—the majority—have had no explicit technology strategies for R&D or foreign direct investment, leaving technology upgrading to market forces.

Aggregate analysis of this type cannot capture differences across particular industries and countries in the patterns of competitiveness and globalization. Each industrial activity in a country may perform at a different level, and each certainly faces different technological and competitive conditions. The organization of global value chains differs significantly, with different structures and agents dominating and coordinating activity. Each industrial activity needs different drivers and institutions. Policy has to be based on these specifics; the broad benchmarks in the Scoreboard provide only the starting point.[5]

Trends in industrial capacity building

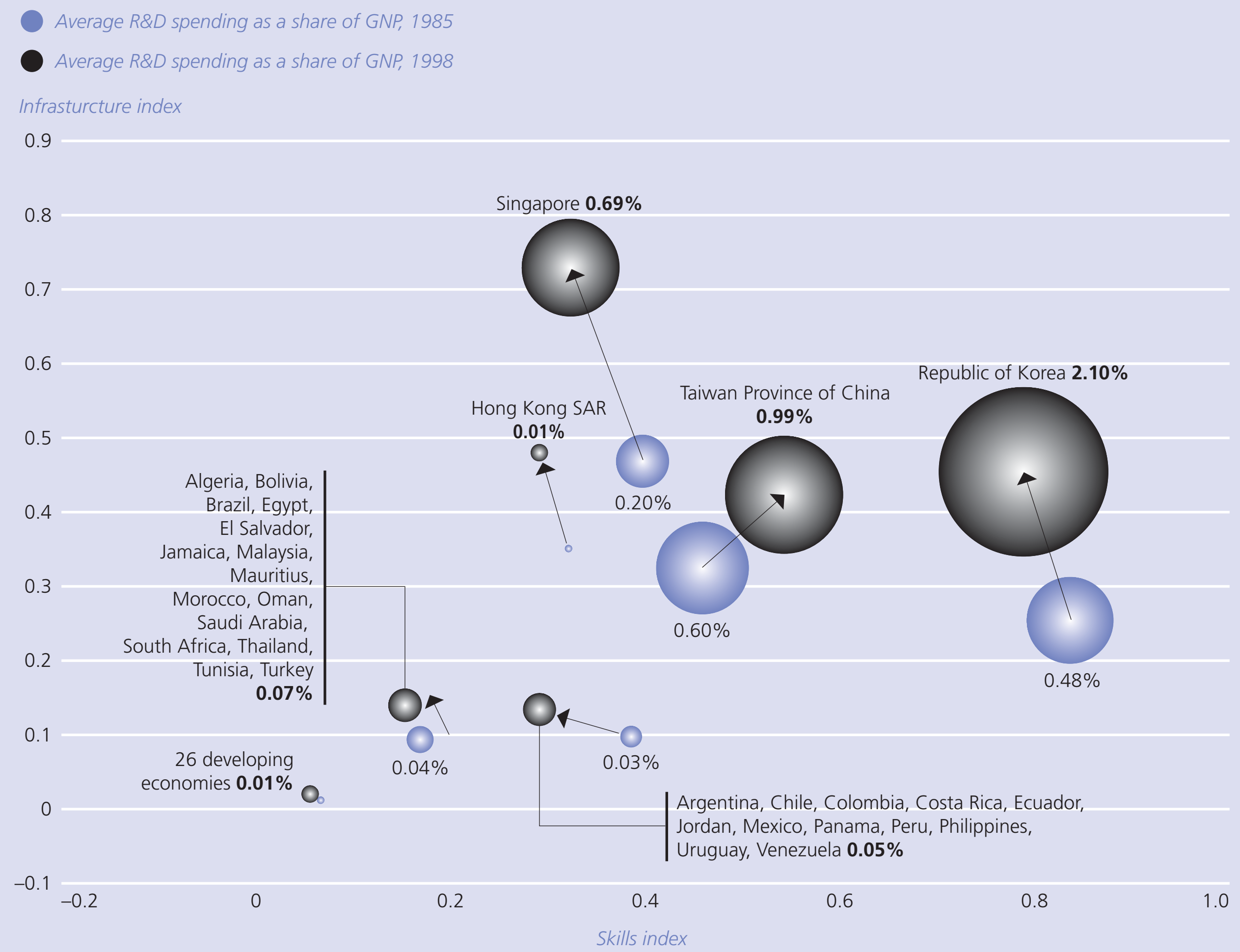
The drivers of industrial performance tend to grow together as countries develop and their industrial sectors mature. But countries can combine the drivers in different ways: recent economic history reveals that there is no single road to industrial success. The differences in strategy reflect many factors that cannot be explored here—market size, geographic location, natural resources, external pressures, political economy and history, initial base of skills and capabilities and so on. Even so, it is instructive to illustrate the main differences in strategies for building industrial drivers. Cluster analysis can again be used to do this (see the technical annex on the technique).

Skills, R&D and infrastructure

The cluster analysis looks first at the three domestic capability drivers—skills, R&D and infrastructure. For this exercise R&D spending is normalized by GNP to capture national differences in the allocation of resources to technological effort. The skill and infrastructure drivers are measured by composite indices so that each economy's position reflects its relative rank rather than an absolute value for the driver. Consider these highlights of the results for developing economies (figure 4.2):

- Each of the four mature Asian Tigers forms a cluster of its own, showing significant differences from one another and from the rest of the developing economies. While all four raised their R&D effort between 1985 and 1998, Hong Kong SAR lags behind the other three—its strategy is clearly to use technologies developed elsewhere rather than to invent new technologies locally. Hong Kong SAR also lags behind the other three in skills, but has relatively strong physical infrastructure. The Republic of Korea leads strongly in both skills and R&D, though its relative skill

Figure 4.2 Cluster analysis of skills, infrastructure and R&D in developing economies, 1985 and 1998



Source: UNIDO Scoreboard database (see technical annex).
Note: Where bubbles have no value, R&D spending was negligible. The infrastructure index is an average of the standardized scores for traditional infrastructure (commercial energy use) and modern infrastructure (telephone mainlines). The skills index is an average of the scores for the Harbison-Myers index (see chapter 2) and tertiary technical enrolments.

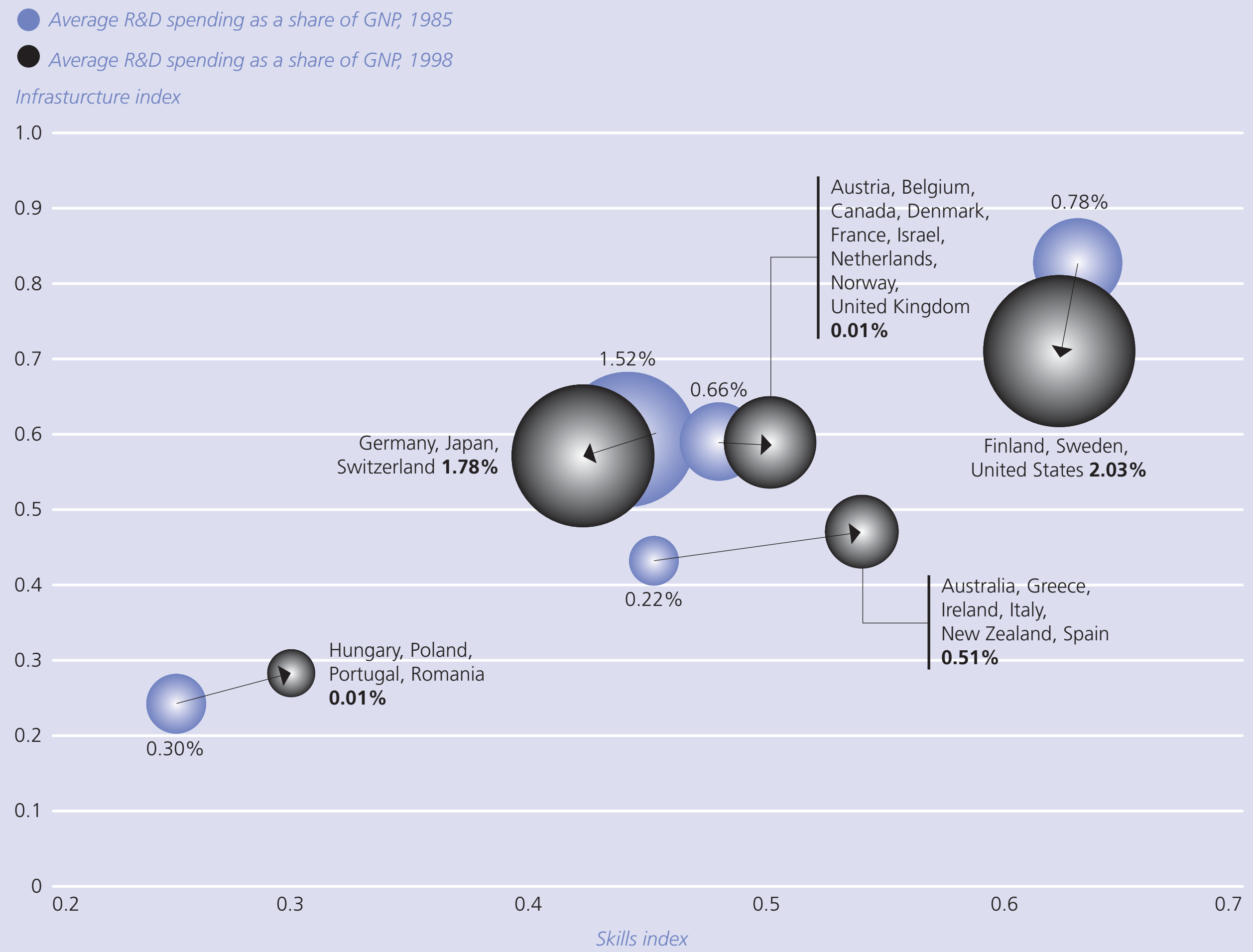
intensity declined slightly over time. Singapore leads in physical infrastructure. Taiwan Province of China improved its position for all three drivers, but lags behind the Republic of Korea in each one.

- The next two developing country clusters, well below the Asian Tigers in each of these drivers, are about equal in infrastructure and R&D effort but one has significantly higher skill levels than the other. But this cluster—comprising Argentina, Chile, Mexico, the Philippines and others—also had a relative decline in skills, though its infrastructure index improved over the period.
- The bottom cluster, with 26 countries (including all the least developed countries) is weak in all three drivers, with minuscule R&D spending, low skills and poor infrastructure.

The findings for industrialized and transition economies show a similar variation in performance (figure 4.3):

- All the clusters had rising R&D spending except for that comprising the three transition economies (Hungary, Poland and Romania) and Portugal. The decline in R&D spending in transition economies, possibly a temporary response to liberalization, may reverse itself in time.
- The two clusters with the largest R&D efforts comprise the major industrialized countries—Japan, Germany and the United States—along with Finland, Sweden and Switzerland. The group with the United States and the two Scandinavian countries had the largest average R&D effort of all the industrialized countries in 1998. Both clusters show small relative declines in the skills and infrastructure indices.

Figure 4.3 Cluster analysis of skills, infrastructure and R&D in industrialized and transition economies, 1985 and 1998



Source: UNIDO Scoreboard database (see technical annex).
Note: The infrastructure index is an average of the standardized scores for traditional infrastructure (commercial energy use) and modern infrastructure (telephone mainlines). The skills index is an average of the scores for the Harbison-Myers index (see chapter 2) and tertiary technical enrolments.

- The third group (including the Benelux countries, Canada, France, Israel and the United Kingdom) has a lower average R&D effort but improved in all three drivers.

- A fourth cluster with low R&D (including Australia, Ireland and Italy) has even lower average levels of R&D but registered a significant rise in relative skill levels.

Technological effort and inventiveness

Now consider a composite index of technological effort and inventiveness based on two indicators, R&D financed by productive enterprises and patents taken out internationally (in this case in the United States).[6] The index is the average of the two variables, which have been standardized, with equal weight assigned to both. The value of the composite index ranges from zero to one.

As expected, there is a strong and significant correlation between the input measure, R&D effort, and the output measure, patents (reflected in a coefficient of 0.85). But the two measures yield somewhat different rankings of economies (see annex table A4.1 and table 4.2). For example, Hong Kong SAR ranks low in R&D spending (40th) but high in patents (16th), as does Taiwan Province of China (20th and 4th). By contrast, Brazil ranks 27th in R&D spending and 42nd in patents, while China ranks 44th and 56th. The variations may be due to several factors, such as foreign companies' affiliates patenting technology based on R&D elsewhere, differences in the quality or orientation of R&D and differences in the propensity to take out international patents. Without more detailed country analysis, deciphering the underlying forces is difficult.[7]

The 59 economies with positive values for the index of technological effort and inventiveness can be divided into three groups by performance: high, moderate and low (figure 4.4):

Table 4.2 Patents taken out internationally, 1998

Rank	Economy	Patents per 1,000 people
1	United States	3.297
2	Japan	2.412
3	Switzerland	1.884
4	Taiwan Province of China	1.622
5	Sweden	1.421
6	Israel	1.275
7	Germany	1.134
8	Finland	1.118
9	Canada	1.090
10	Denmark	1.005
11	Netherlands	0.817
12	Belgium	0.699
13	Korea, Republic of	0.657
14	France	0.650
15	United Kingdom	0.601
16	Hong Kong SAR	0.540
17	Austria	0.511
18	Norway	0.490
19	Australia	0.402
20	Singapore	0.386
21	New Zealand	0.356
22	Italy	0.305
23	Ireland	0.200
24	Slovenia	0.076
25	Spain	0.072
26	Hungary	0.045
27	South Africa	0.030
28	Malaysia	0.017
29	Greece	0.016
30	Bahrain	0.016
31	Venezuela	0.013
32	Russian Federation	0.012
33	Argentina	0.011
34	Chile	0.011
35	Uruguay	0.009
36	Portugal	0.009
37	Mexico	0.009
38	Czech Republic	0.008
39	Saudi Arabia	0.006
40	Ecuador	0.006
41	Costa Rica	0.006
42	Brazil	0.005
43	Jordan	0.004
44	Poland	0.004
45	Jamaica	0.004
46	Philippines	0.003
47	Thailand	0.002
48	Guatemala	0.002
49	Colombia	0.002
50	Honduras	0.002
51	Bolivia	0.001
52	Tunisia	0.001
53	Sri Lanka	0.001
54	India	0.001
55	Morocco	0.001
56	China	0.001
57	Turkey	0.000
58	Indonesia	0.000
59	Peru	0.000

Source: U.S. Patent Office.
Note: In this case *internationally* refers to the United States.

- Japan leads the world and the *high performers,* with Switzerland and the United States close behind. This group includes most of the industrialized countries (exceptions include Greece, Portugal and Spain), but also four Asian Tigers (Taiwan Province of China, the Republic of Korea, Singapore and Hong Kong SAR).

- The *moderate performers* include most transition economies and the largest Latin American economies (Brazil, Argentina, Chile and Mexico) along with Costa Rica, Venezuela and Uruguay. Malaysia is the only Asian country here. South Africa, Turkey and Bahrain are also in this group.

- The *low performers* include large countries with complex industrial sectors and a high absolute value of R&D activity (China, India) and export-oriented economies with relatively modest R&D activity and a high reliance on transnational corporations (Indonesia, Thailand). They also include countries with small industrial sectors, low exports and little R&D activity (Panama, Jamaica, Bolivia, Kenya).[8]

Strategies for enhancing industrial performance

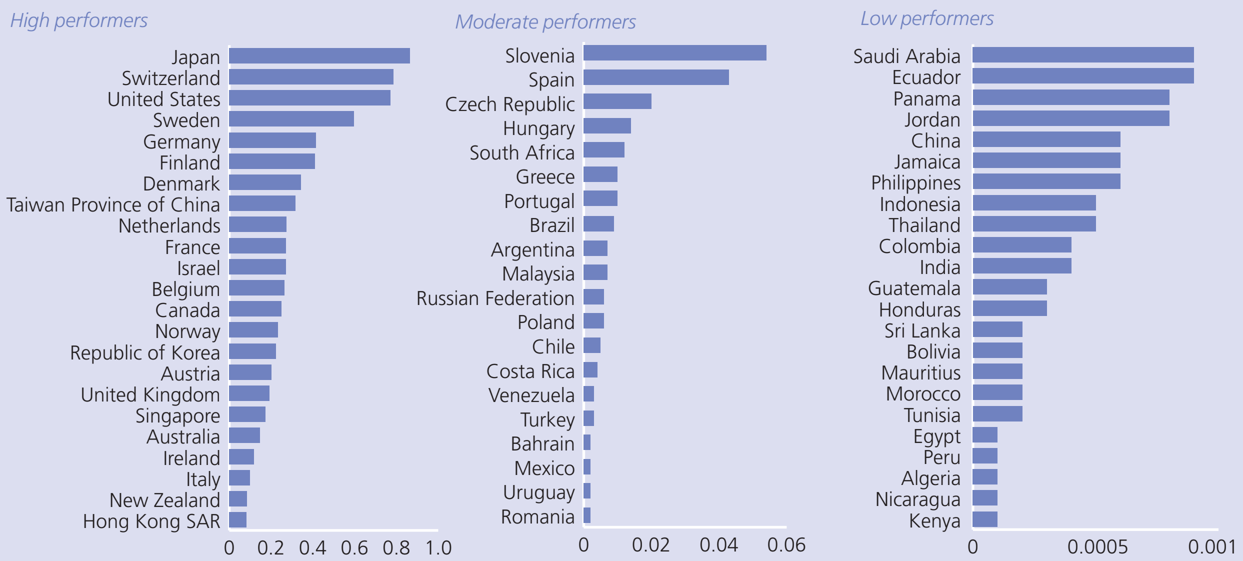
Turn now to the different patterns of reliance on domestic R&D effort (financed by productive enterprises) and foreign direct investment. Using R&D spending as a share of GNP and foreign direct investment as a share of gross domestic investment allows a more direct assessment of national allocations of resources between these two modes of acquiring new technology. While both modes have resulted in greater use of technology by the industrial sector, they may have led to different outcomes in performance.

Cluster analysis, with the sample economies sorted into seven groups in 1985 and 1998, reveals interesting patterns in the economies' relative reliance on R&D or foreign direct investment for each year and over time. The patterns for 1985 show the following (figure 4.5):

- The most successful countries—those with the highest CIP indices—formed four clusters. Of these, the cluster containing Germany, Japan and Switzerland had the highest CIP score. This group had the greatest reliance on R&D and the least on foreign direct investment.

- Singapore, which formed the second most successful cluster on its own, had the opposite characteristics: very low R&D spending and extremely heavy reliance on foreign direct investment.

Figure 4.4 Economies by technological effort and inventiveness index, 1998



Source: UNIDO calculations based on data from U.S. Patent Office (see technical annex).

- Two other successful clusters were fairly close to each other—one comprising Canada, Finland, the Republic of Korea and the United States, and the other consisting of most other industrialized countries plus Taiwan Province of China. Both clusters had fairly high R&D spending, higher than the average for the successful industrial performers. But the first, with a higher CIP score, had a distinctly lower orientation towards foreign direct investment, while the second struck a balance between R&D effort and foreign direct investment.

- The rest of the developing world and several industrialized countries fell into three clusters. Each had low R&D spending but different degrees of reliance on foreign direct investment. The best performing of these clusters included Hong Kong SAR, Greece, New Zealand, Portugal and Spain, along with the Philippines, Argentina, Mexico and some other Latin American and Caribbean countries. These economies had a moderately high reliance on foreign direct investment, but also R&D spending higher than the average for the low-performing clusters.

- The next group, combining the lowest R&D spending with high reliance on foreign direct investment, included 14 developing countries, ranging from Brazil and Malaysia to least developed countries like the Central African Republic and Ghana.

- The remaining 25 developing countries (and Albania) combined very low R&D spending with similarly low foreign direct investment.

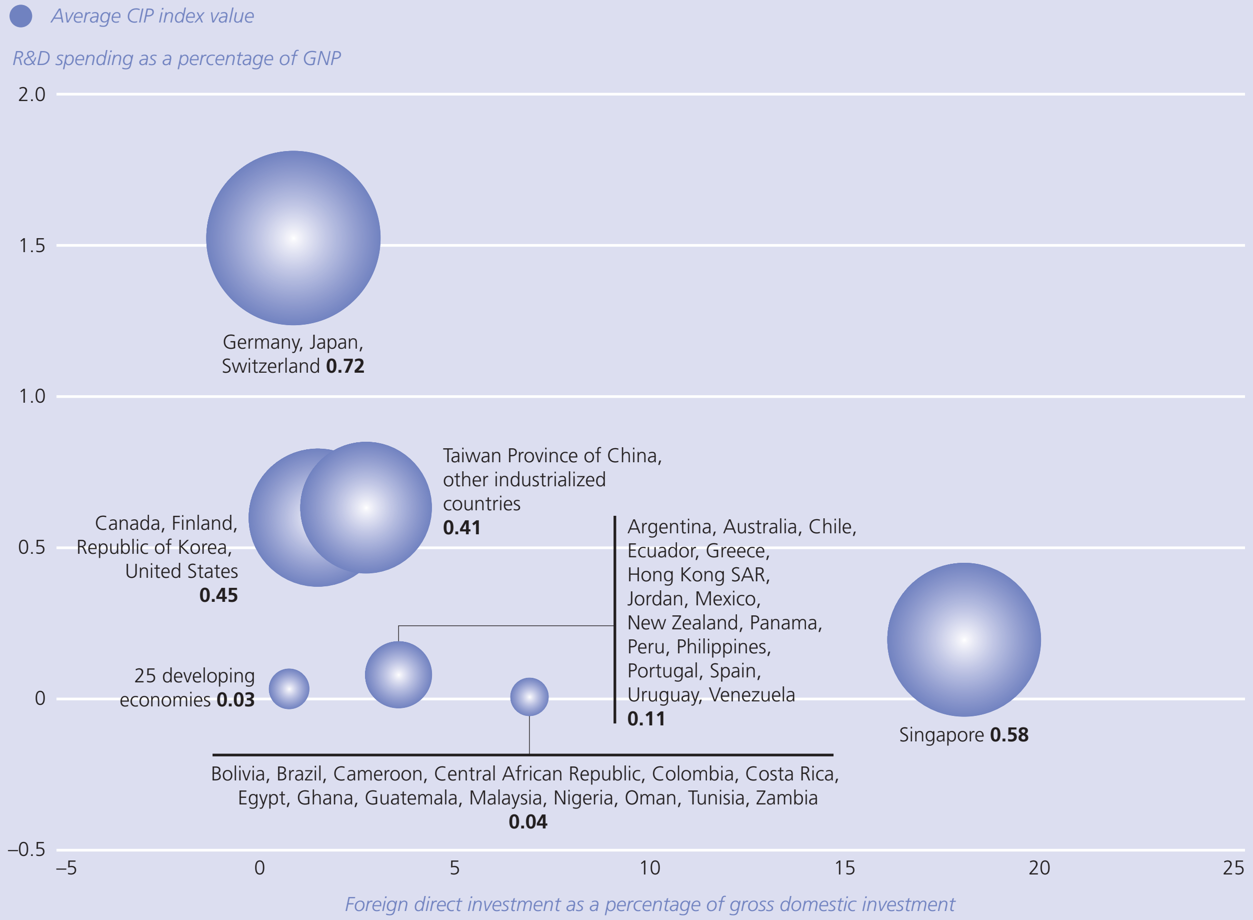
By 1998 there was a general shift towards greater reliance on foreign direct investment in all groups, a clear indication of the growing role of transnational corporations in the world economy. In the leading economies there was also a greater propensity to invest in R&D, but this did not hold for many developing countries lower on the industrialization ladder. For 1998 there were five successful clusters, with a composition that was quite different (figure 4.6).

- The cluster with the highest average CIP score included Belgium, Ireland and Singapore. In contrast with the group that had the highest CIP index in 1985, this cluster depended on foreign direct investment rather than R&D. It did, however, have moderate R&D activity.

- The second cluster, very close in average CIP score to the first, contained Germany, Japan and Switzerland (this was the leading cluster in 1985). This group continued to rely on domestic R&D, and their R&D spending rose as a share of GNP. But foreign direct investment also played a larger role in domestic investment than before.

- The third cluster included only Sweden, with high R&D spending as well as high reliance on foreign direct

Figure 4.5 Cluster analysis of industrial performance, R&D and foreign direct investment, 1985



Source: UNIDO Scoreboard database (see technical annex).

investment. But the high level of foreign direct investment was something of an aberration: Sweden has traditionally had a very limited foreign presence, though recent waves of foreign mergers and acquisitions have raised the level of foreign direct investment. The underlying trend for Sweden is greater reliance on domestic R&D.

- The fourth cluster with a high average CIP score included Finland, the Republic of Korea and the United States. This cluster was similar to the second: it had high reliance on domestic R&D and relatively low reliance on foreign direct investment (though slightly higher than the second cluster's).

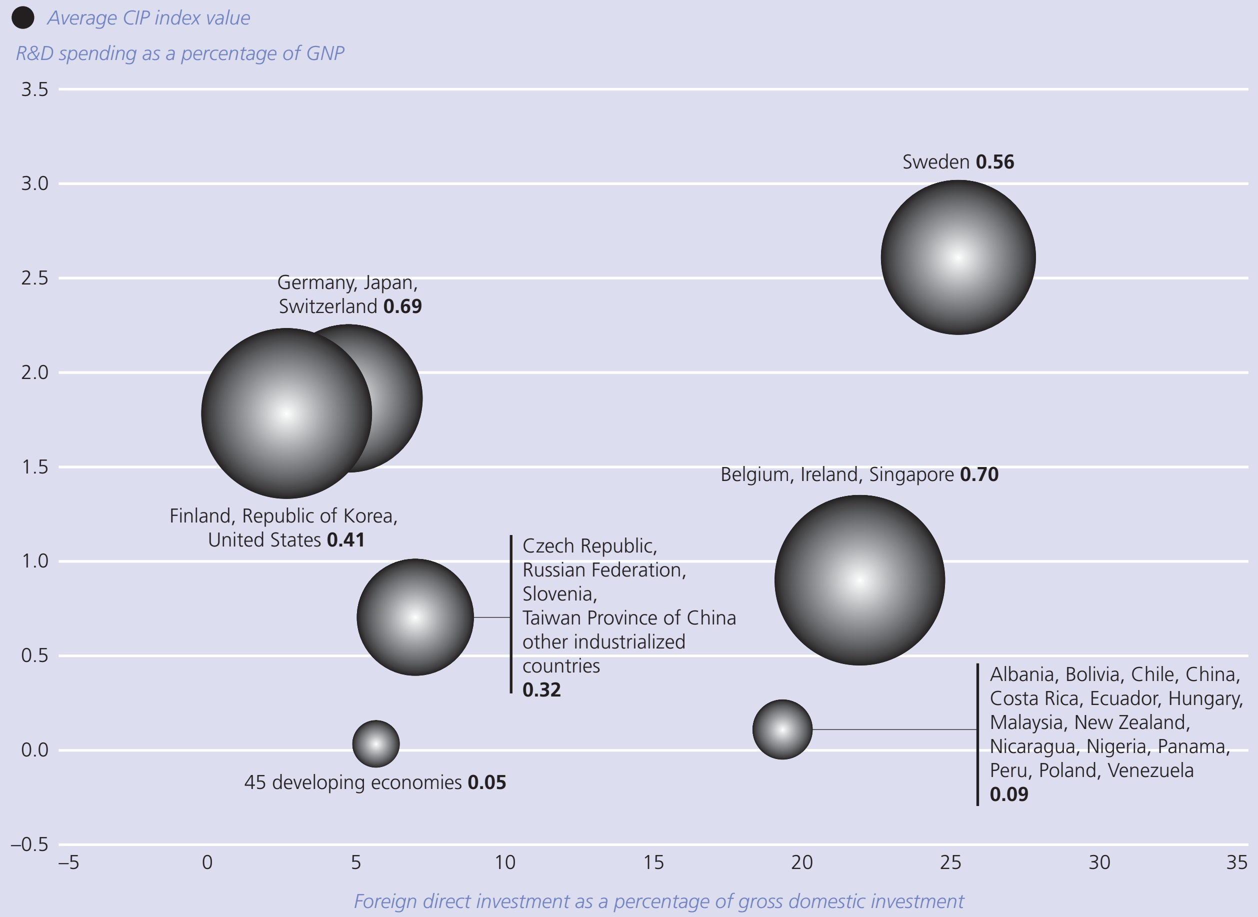
- The fifth cluster contained most other industrialized countries (except New Zealand, which appeared in the sixth cluster) with Taiwan Province of China and three transition economies. This group showed a balance between R&D and foreign direct investment.

- The sixth cluster had a relatively high reliance on foreign direct investment and a very weak domestic R&D effort. It included New Zealand along with Albania, Chile, China, Hungary, Malaysia, Poland and eight other developing countries.

- The cluster with the weakest performance contained the other 45 developing countries. These countries had little domestic R&D and moderate foreign direct investment (but foreign direct investment played a larger role in this group than it did in the bottom group in 1985).

The cluster analyses lead to four main conclusions. First, while the leading industrialized economies rely heavily on domestic R&D efforts, their reliance on foreign direct investment has increased. In most of these countries inward foreign direct investment serves two purposes: it brings in new technology, but it also helps transnational corporations to tap local R&D. Technology flows strongly in both directions between these countries as they increasingly specialize in innovation. The

Figure 4.6 Cluster analysis of competitive industrial performance, R&D and foreign direct investment, 1998



Source: UNIDO Scoreboard database (see technical annex).

Republic of Korea had the strongest technological position among the developing economies in both years, with a low reliance on foreign direct investment.

Second, the strong showing by Ireland and Singapore suggests that industrial latecomers can achieve an impressive performance by relying heavily on foreign direct investment. This reliance does not preclude growth of their domestic R&D effort, though their R&D levels still lag behind those in countries with more autonomous strategies.

Third, most developing countries continue to languish at the bottom of the technological ladder, with no perceptible rise in domestic R&D. Some have managed to attract fair amounts of foreign direct investment (as a share of domestic investment), but only a few have managed to break into integrated global production systems.

Fourth, where successful, both the strategy based on R&D and that based on foreign direct investment involve acquiring foreign technology, but in different ways. The strategy based on domestic R&D is more autonomous and involves large investments in skills. For industrial latecomers it is also a riskier strategy, because it tends to involve extensive use of industrial policy. The strategy centred on foreign direct investment can take countries a long way without a need for strong local R&D. But countries that succeed with this strategy tend to raise their investments in R&D over time, with transnational corporations shifting some innovative functions to these countries. Relatively few countries have managed to combine heavy dependence on foreign direct investment with strong growth in innovative capabilities (domestic R&D), and those that have done so relied extensively on industrial policy (as in Ireland and Singapore).

R&D, foreign direct investment and high-tech exports

The relationships between R&D, foreign direct investment and high-tech exports show more clearly the differences between the two modes of acquiring technology. Given the importance of high-tech exports in industrial performance, analysing the roles of domestic R&D and inflows of technology through foreign direct investment separately is instructive.

The competitiveness of high-tech exporters (particularly in electronics) can be traced to domestic innovation or to participation in integrated global production systems. Comparing the intensity of R&D and foreign direct investment in a country with its high-tech export performance gives an indication of the relative importance of these drivers of industrial performance (table 4.3). An analysis of R&D spending per unit of high-tech exports and per unit of inward foreign direct investment was conducted for all major exporters of high-tech products—those with high-tech exports of more than $5 billion—in 1998.[9] These 26 economies include nine developing economies—all those in East Asia (except Indonesia) plus Mexico.

As expected, economies with high R&D spending per unit of high-tech exports and per unit of inward foreign direct investment have a strong technological base. Those ranking highest on these measures, not surprisingly, are the major industrial powers; they also generally lead in high-tech exports (in value terms). At the bottom of the scale are developing countries, specializing in assembly and testing.

This method of distinguishing competitive strategies clearly has some merit. The analysis leads to some interesting findings:

- Japan, which has followed an autonomous R&D-based strategy, led the world in R&D spending per unit of high-tech exports in 1998. In 1985, however, Germany held this place, followed by the United States. Clearly, global production systems have spread faster to other industrialized countries than to Japan. The degree to which Japan

Table 4.3 Reliance of major high-tech exporters on domestic R&D and foreign direct investment, 1985 and 1998

Rank[a]			R&D per dollar of high-tech exports (dollars)		R&D per dollar of inward foreign direct investment (dollars)		High-tech exports (billions of dollars)		High-tech products as a share of manufactured exports (percentage)	
1998	1985	Economy	1998	1985	1998	1985	1998	1985	1998	1985
1	3	Japan	0.937	0.635	100.40	62.42	114.9	36.6	29.6	20.8
2	2	United States	0.622	0.686	1.75	1.68	196.9	53.3	31.0	25.8
3	1	Germany	0.368	0.816	5.01	13.09	92.7	24.3	17.1	13.2
4	6	Switzerland	0.331	0.282	1.35	2.33	18.3	4.7	23.2	17.0
5	9	Sweden	0.283	0.231	0.71	3.33	20.4	4.1	24.7	13.4
6	8	France	0.266	0.245	0.76	1.67	65.1	14.3	21.6	14.6
7	18	Korea, Republic of	0.264	0.119	5.90	3.50	36.0	3.7	27.2	12.2
8	5	Austria	0.233	0.284	0.65	2.19	7.4	1.6	12.2	9.2
9	11	Denmark	0.225	0.228	0.57	5.50	7.6	1.8	16.0	10.9
10	10	Spain	0.213	0.229	0.28	0.20	10.2	1.5	9.3	6.0
11	15	Italy	0.210	0.141	1.45	0.97	24.5	7.5	10.1	9.5
12	4	Finland	0.200	0.342	1.45	2.95	10.5	0.8	24.4	5.7
13	7	Canada	0.177	0.278	0.52	0.98	23.8	6.2	11.1	7.1
14	19	Belgium	0.159	0.105	0.26	0.20	17.4	3.5	9.7	6.4
15	13	United Kingdom	0.134	0.167	0.49	0.72	76.3	17.9	28.2	17.6
16	12	Israel	0.113	0.211	0.67	2.76	6.6	1.1	28.3	17.0
17	14	Netherlands	0.098	0.164	0.34	0.78	40.8	6.9	24.3	10.2
18	17	Taiwan Province of China	0.068	0.131	1.50	1.37	38.6	4.7	35.0	15.4
19	26	China	0.033	0.000	0.03	0.00	33.5	0.3	18.2	1.2
20	21	Ireland	0.022	0.019	0.38	0.31	25.2	2.7	39.3	25.8
21	23	Singapore	0.010	0.008	0.07	0.02	62.3	4.7	56.7	20.4
22	16	Mexico	0.004	0.134	0.02	0.28	31.3	1.9	26.6	8.6
23	25	Malaysia	0.004	0.001	0.03	0.00	34.3	2.3	46.9	14.8
24	24	Hong Kong SAR	0.002	0.003	0.00	0.00	6.0	2.4	24.5	14.2
25	20	Thailand	0.001	0.043	0.01	0.03	15.6	0.2	28.3	2.4
26	22	Philippines	0.000	0.014	0.01	0.07	19.0	0.3	64.3	5.8

Source: UNIDO Scoreboard database (see technical annex).
Note: Includes only economies with high-tech exports of more than $5 billion in 1998.
a. Based on R&D spending per unit of high-tech exports.

relies on R&D rather than foreign direct investment is strikingly illustrated by figures for R&D spending per unit of foreign direct investment: in 1998 this figure for Japan ($100) was 20 times that for Germany ($5).

- The United States has maintained a stable profile in both ratios. By contrast, Germany had a sharp decline in R&D spending per unit of both high-tech exports and foreign direct investment, indicating its growing participation in global production systems. The United Kingdom, the fourth largest high-tech exporter in 1998, had a surprisingly low R&D ratio, indicating its growing importance as a base for the operations of transnational corporations in electronics.

- Ireland ranked lowest among industrialized countries in R&D spending per unit of high-tech exports, bearing out the dominant role of transnational corporations in building its competitiveness.

- The Republic of Korea had the second highest R&D spending per unit of foreign direct investment, after Japan, in 1998.[10] Taiwan Province of China also had relatively high R&D spending per unit of foreign direct investment, followed by China (though with a very low value of $0.03 in 1998).

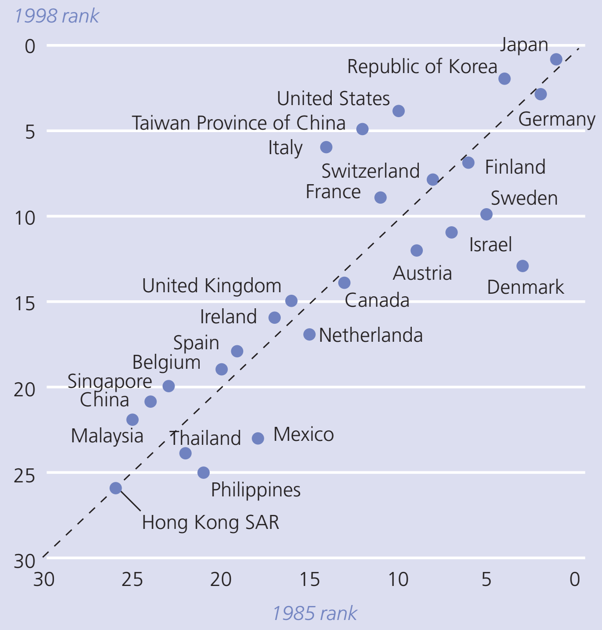
- Other developing countries depend heavily on transnational corporations for their high-tech exports, though Singapore has a relatively strong R&D base compared with others in this group.[11]

- Four developing countries increased the share of high-tech products in their manufactured exports by 26 or more percentage points—Singapore, Malaysia, Thailand and the Philippines. Each is producing and selling within integrated global production systems.

A scatter diagram illustrates the relationship between R&D spending per unit of foreign direct investment in 1985 and 1998 (figure 4.7). Economies on the line—including Hong Kong SAR, Japan and Switzerland—had no change in rank by R&D spending per unit of foreign direct investment. Those above the line increased their relative reliance on R&D for the export of high-tech manufactures, while those below it increased their reliance on foreign direct investment.

Italy, Taiwan Province of China and the United States show the biggest rise in ranks by dependence on domestic R&D. But some countries ranking high in reliance on foreign direct investment and very low in R&D in 1985—China, Malaysia and Singapore—also had big increases. In Malaysia and Singapore the rise in R&D ranks is due mainly to technological deepening by transnational corporations—and in China it is also due to R&D by local enterprises. In Singapore foreign enterprises perform around 57 percent of the R&D in manufacturing—in Malaysia, 50 percent.[12] Ireland, the European economy with the highest rank by reliance on foreign direct investment, also had an increase in local R&D, again led by transnational corporations. Foreign enterprises accounted for 68 percent of Ireland's manufacturing R&D in 1996.[13]

Figure 4.7 Ranking of economies by R&D spending per unit of foreign direct investment, 1985 and 1998



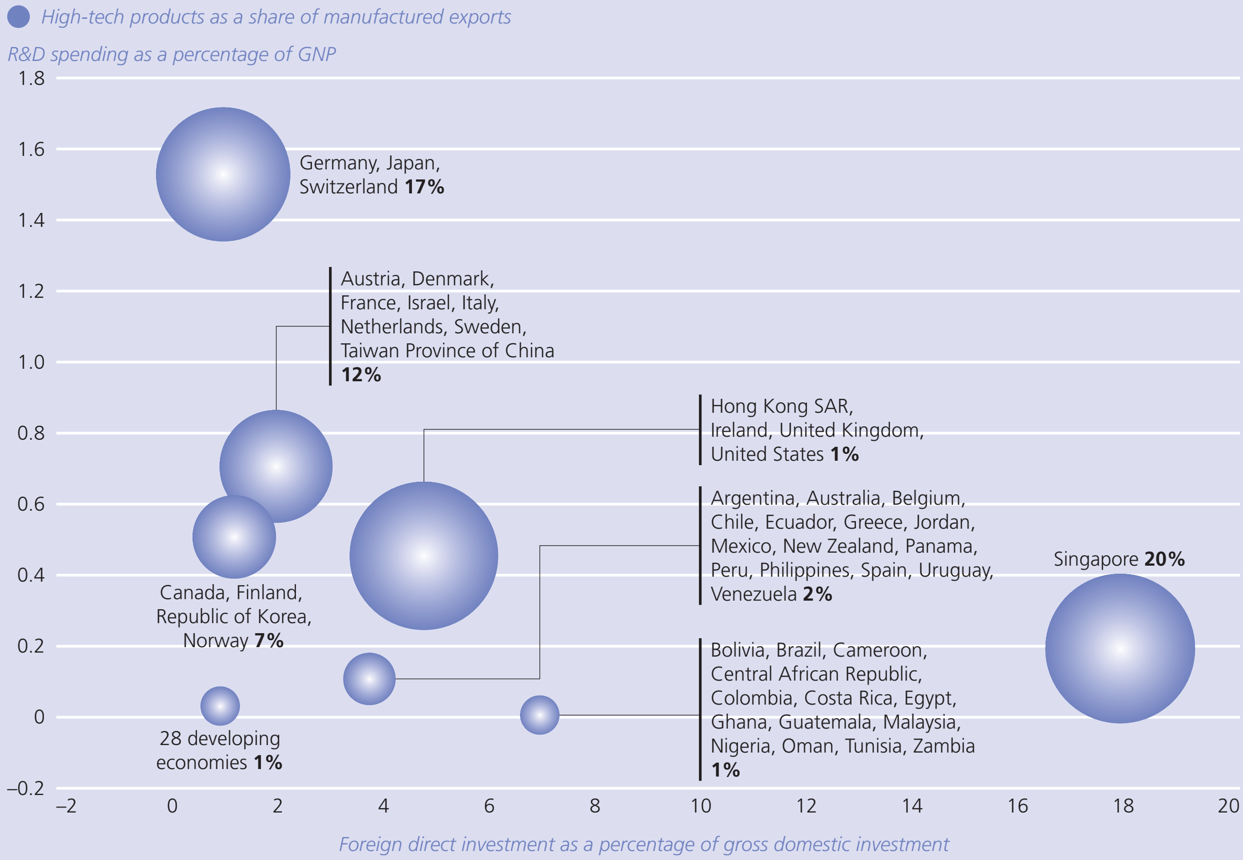
Source: UNIDO Scoreboard database (see technical annex).

Countries that rose in the ranking by reliance on foreign direct investment over the period include Denmark, Sweden and Israel at the high end and Mexico, the Philippines and Thailand at the low end. Again, however, the high level of foreign direct investment in Sweden in 1998 was something of an aberration.

These differences in strategy can be further explored with the help of cluster analysis for R&D, foreign direct investment and high-tech exports in 1985 and 1998 (see figures 4.8 and 4.9, which include all economies in the sample). The changes in the clusters between the two years throw new light on the strategies.

In 1985 the largest bubble was for Singapore, for which high-tech products accounted for 20 percent of manufactured exports. Singapore stood apart from other clusters, with very

Figure 4.8 Cluster analysis of R&D, foreign direct investment and high-tech exports, 1985



Source: UNIDO Scoreboard database (see technical annex).

high foreign direct investment and relatively low R&D. Economies in another cluster, including Ireland, the United Kingdom and the United States, had fairly large shares (averaging 21 percent) of high-tech products in their manufactured exports, with a balanced mix of foreign direct investment and R&D. Germany, Japan and Switzerland (with high-tech products averaging 17 percent of their manufactured exports) clustered together as countries highly dependent on R&D. Most developing countries had small shares of high-tech exports and low R&D, with differing degrees of reliance on foreign direct investment.

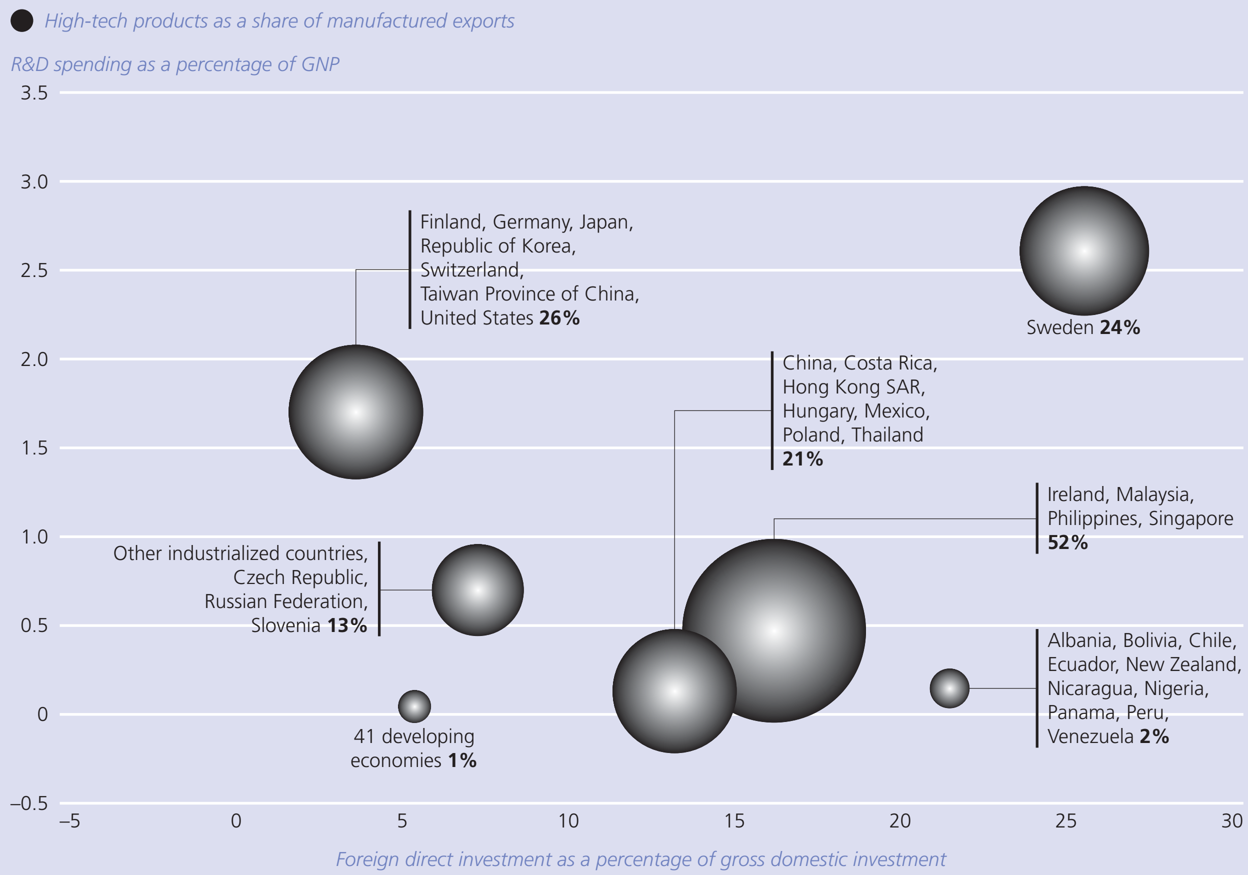
By 1998 there had been a general move towards greater reliance on foreign direct investment and larger shares of high-tech products in manufactured exports. The cluster with the largest share (52 percent) included Ireland, Malaysia, the Philippines and Singapore—all highly dependent on foreign direct investment. The economies most dependent on R&D (including the Republic of Korea and Taiwan Province of China) were also more reliant on foreign direct investment in 1998 than in 1985. Most developing countries, however, continued to have very small shares of high-tech products in their manufactured exports.

Do the drivers explain performance?

That there is a positive relationship between industrial performance and its drivers is apparent from even a cursory look at the data (see figure 4.1). Regions that do well in one tend to do well in the other. This conclusion is borne out by the results of statistical analyses of the relationship between industrial performance and its drivers (box 4.2).

- Technology in the generic sense—domestic R&D as well as access to foreign technology through foreign direct investment and licensing—has a powerful influence on industrial performance.

Figure 4.9 Cluster analysis of R&D, foreign direct investment and high-tech exports, 1998



Source: UNIDO Scoreboard database (see technical annex).

- Among the drivers of industrial performance, R&D is statistically the most important, in both 1985 and 1998 and over time. This finding highlights the need for domestic technological effort even at low levels of industrial development. While the causation may run in both directions (the more industrialized countries become, the more they invest in R&D), theory does suggest that the causation from R&D to industrial performance is likely to be predominant. The capability building literature shows that technological effort (formal and informal) is as critical a driver of competitive industrial performance in developing countries as it is in industrialized countries.[14]

- Licensing foreign technology is also statistically significant, but its role appears to be diminishing.

- The role of foreign direct investment, by contrast, has grown in significance. This corresponds with the evidence on the increasing role of integrated production systems in the world economy, on the rising importance of technology transfer by transnational corporations and on their export activity as a dynamic element in the industrial competitiveness of developing countries.

- The significance of skills is also increasing, again entirely in line with the conventional wisdom on the importance of human capital and technology for competitive industrial performance. It is reassuring, however, to see that the statistical findings confirm this for such a broad sample.[15]

- Infrastructure remains important in both 1985 and 1998.

In sum, the results show that the set of structural drivers is strongly associated with industrial performance and that the association is broadly in the expected direction for the entire sample. Clearly, a full exploration of cross-country differences in industrial performance and its drivers would require a much more ambitious effort, with many more qualitative variables, data on many more years to capture lags and econometric tests for feedback and simultaneity.

Box 4.2 The relationship between industrial performance and its drivers: results of statistical analyses

Multiple regression analysis was used to explore the relationship between industrial performance and its drivers. The dependent variable was the CIP index in 1985 or 1998, and the independent variables were per capita R&D, foreign direct investment, royalty payments and the indices for skills and infrastructure in the appropriate years. To control for differences arising from levels of development not captured by other variables, a dummy variable was added, taking the value 0 for industrialized and transition economies and 1 for developing, countries. Regressions were conducted separately for the two years. Performance in 1998 was also regressed on drivers in 1985 to capture the impact of the initial stock of drivers on subsequent performance. (See the table for the three sets of results.)

Results for 1985. The equation explains 93 percent of the variation in the CIP index. R&D per capita shows up as the most important influence, followed by royalties and infrastructure. The skill variable is significant at the 10 percent level. Foreign direct investment is not significant and has a negative sign. The dummy variable for developing countries has a significant and negative effect. This result suggests that with the structural drivers taken into account, being a developing country has an independent negative effect (capturing a range of other potential factors) on industrial performance.

Results for 1998. All independent variables except the development dummy variable are now positive and significant, explaining 88 percent of the variation in the CIP index. The dummy variable for developing countries is no longer significant, suggesting that the level of development does not affect performance. In other words, the only significant effects arise from the drivers. R&D is again the most important driver, followed by royalties. Foreign direct investment is now significant and positive, suggesting that the contribution of transnational corporations to industrial performance has grown over the period. The skills index is also significant and positive, and its coefficient is higher than in 1985, suggesting that high-level skills are becoming increasingly important to industrial competitiveness.

Results for 1985–98. The results are broadly similar to those for 1985, with interesting variations. Skills are far more important and significant—the base in 1985 seems to have a strong positive influence on performance in 1998. R&D remains significant and important, suggesting continuity and cumulativeness. Foreign direct investment is insignificant; clearly, its positive impact grows over the period. Infrastructure loses significance, suggesting that current patterns of infrastructure investment are more closely related to industrial performance. The dummy variable has a significant negative effect; being a developing country in 1985 held back industrial performance in 1998.

Regression results for competitive industrial performance and its drivers, 1985 and 1998

	75 economies[a]		85 economies[b]		75 economies[c]	
Independent variable	**Standard coefficient**	***t*-statistic**	**Standard coefficient**	***t*-statistic**	**Standard coefficient**	***t*-statistic**
Skills	0.090*	1.832	0.130*	1.822	0.261***	2.911
Research and development	0.443***	9.300	0.466***	8.846	0.493***	5.270
Foreign direct investment	–0.112	–1.575	0.183***	3.379	0.074	0.651
Royalties	0.384***	5.228	0.253***	5.986	0.342**	2.902
Infrastructure	0.204**	2.240	0.196**	2.018	–0.125	–0.851
Development dummy variable	–0.203***	–3.188	–0.024	–0.401	–0.299**	–2.922
	Adjusted R^2 = 0.928		Adjusted R^2 = 0.881		Adjusted R^2 = 0.809	

Source: UNIDO Scoreboard database (see technical annex).
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
Note: All statistical tests for functionality, heteroskedasticity and collinearity are satisfied. The potential problem raised by the high correlation between the drivers does not affect the result.
a. The dependent variable is the CIP index for 1985; the independent variables refer to 1985.
b. The dependent variable is the CIP index for 1998; the independent variables refer to 1998.
c. The dependent variable is the CIP index for 1998; the independent variables refer to 1985.

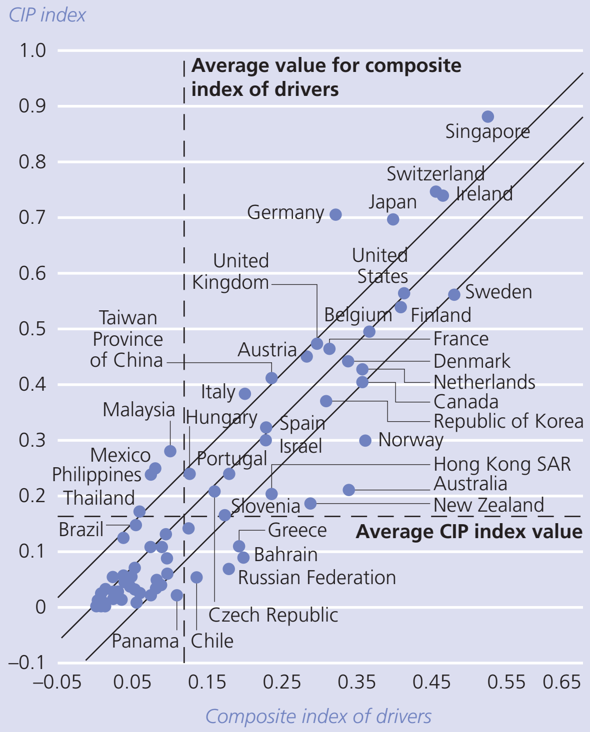
Balance between drivers and performance

The positive relationship between performance and its drivers holds broadly for the entire sample. Behind that overall relationship, however, lie interesting differences among countries. Some countries perform in line with their stock of drivers; some do better than warranted by the stock; and some do worse.

To explain these differences requires a composite index of drivers for each country, derived by averaging the normalized scores for the five drivers. A scatter diagram illustrates how the sample economies are spread according to this composite index and the CIP index in 1998 (figure 4.10):

- Most economies have a balance between industrial performance and its drivers.
- Industrialized countries are largely balanced at the high end, with performance and drivers above the average for the sample.
- Most developing economies are balanced at the low end, with a large cluster at the bottom left.

Figure 4.10 Competitive industrial performance index and average drivers of industrial performance in selected economies, 1998



Source: UNIDO Scoreboard database (see technical annex).
Note: The range around the central diagonal, given by the standard deviation of the sample mean, is the "normal" range within which an economy's industrial performance is in balance with its drivers. Economies above the top diagonal line perform better than warranted by their composite index of drivers (stock of drivers), those below the lower diagonal line worse. The average values for the indices are derived for the entire sample of economies.

- Four developing economies have above-average performance and drivers—the mature Asian Tigers, which earlier analysis also showed to be outliers in the developing world.

- Some developing countries have above-average CIP indices but below-average drivers (Malaysia, Mexico, the Philippines and Thailand).

- Some countries have above-average drivers but below-average CIP indices (Bahrain, Chile, Greece and the Russian Federation).

- Some economies lie outside the normal range, performing better or worse than warranted by their drivers.

This divergence between performance and drivers could stem from a range of factors. It could be caused by factors not quantified here, such as macroeconomic or political factors, industrial policies, institutional differences or external market access conditions (an obvious example is the effect on Mexico of the North American Free Trade Agreement). The divergence may be due to ephemeral factors, such as wars, civil unrest or natural disasters. And it could be related to measurement problems. The measures may not properly capture the underlying structural variables. For example, the R&D measure might not properly capture differences among countries in technological effort, or the figures on foreign direct investment might misrepresent participation by transnational corporations in manufacturing, particularly in export-oriented activities. Or the measures may not capture strategic differences in the use of structural drivers. For example, economies with similar levels of foreign direct investment might target different types of investors—as Singapore targets high-tech transnational corporations but Hong Kong SAR does not—with corresponding effects on the structure and growth of production and exports.

A matrix that sorts developing economies into four groups—balanced high, balanced low, overperformers and underperformers—sheds further light on the relationship between performance and its drivers (table 4.4). Balanced economies are those in which industrial performance is consistent with their composite index of drivers—with both at the high or low end. Overperformers have an industrial performance higher than expected given their drivers (based on the average for the entire sample)—and underperformers an industrial performance lower than expected.

In 1998 three-quarters of the economies in the sample were balanced low. The four Asian Tigers were in the top left-hand quadrant, with high performance and high average drivers (like most mature industrialized countries). Of these, the Republic of Korea was balanced high, while Singapore and Taiwan Province of China were overperformers—that is, their CIP indices were higher than the level commensurate with their stock of drivers. Hong Kong SAR, by contrast, was an underperformer, though it had been an overperformer in 1985. Argentina had been in the balanced high group and Brazil among the overperformers in 1985, but both were in the balanced low group by 1998. Chile joined Hong Kong SAR as an underperformer in 1998, along with Bahrain and Panama.

The overperformers in 1998, apart from Taiwan Province of China, have undergone rapid export growth and technological upgrading in recent years by plugging into global production networks as major supply bases. The strong foreign presence in high-tech export activity has enabled many of them to overcome gaps in domestic industrial capabilities. While this strategy is creditable and may offer lessons to other countries, overperformance may also indicate vulnerability. Take the Philippines, with a high-tech export structure that involves little local value added and is essentially driven by low wages. The country is, moreover, highly dependent on semi-

Table 4.4 Developing economies by industrial performance and average capabilities, 1985 and 1998

Year	Overperformers (industrial performance higher than drivers)	Balanced high (industrial performance and drivers in balance)	Underperformers (industrial performance lower than drivers)
1998	Singapore Taiwan Province of China Malaysia Mexico Philippines Thailand	Korea, Republic of	Bahrain Chile Hong Kong SAR Panama
1985	Brazil Hong Kong SAR Zimbabwe	Argentina Korea, Republic of Taiwan Province of China Singapore	Ecuador Panama Jordan

Balanced low
All other developing economies (45 in 1998 and 44 in 1985)

Source: UNIDO Scoreboard database (see technical annex).

Note: The analysis is based on the difference between the CIP index and the composite index of the five drivers. Balanced economies have values within the range defined by the standardized mean plus or minus its standard deviation. Overperformers have values above that range, and underperformers values below that range. Balanced high and low economies have values above and below the standardized mean of the CIP index and the composite index of drivers.

conductors for much of its export growth. That dependence makes it vulnerable to an erosion of competitiveness: rising wages, changing technologies, failing fortunes for the semiconductor industry and the like can easily lead to a rapid falloff in performance. Thus strong performance based on weak drivers immediately raises questions about sustainability and signals a need to expand the base of drivers.

Some economies that have been successful in raising GDP—such as Hong Kong SAR and Chile—are nevertheless in the group of underperformers. Why? One reason is that the Scoreboard deals with manufacturing rather than GDP performance. The second is that the categorization is based on the ratio of industrial performance to drivers. An economy may rank high in industrial performance yet still be an underperformer if its CIP index falls below the band for countries with similar stocks of drivers. This might occur, for example, if its drivers are directed into non-manufacturing activities that yield relatively high incomes without showing up in the CIP index. Such factors explain the outcomes for Hong Kong SAR and Chile.

Hong Kong SAR has had high income and respectable rates of growth over a long period. Some years ago it was also a strong industrial performer, with large and rapidly growing exports backed by a strong base of skills, infrastructure and foreign direct investment. But in the past decade or so its engine of growth has shifted to services, and much of its industrial activity has shifted to other, lower-wage countries. As a result, its performance in the CIP index does not match its drivers (which continue to improve): its export structure remains relatively low tech. The share of manufacturing in GDP has declined dramatically, from nearly 30 percent in the 1960s to 5.7 percent by 1999; moreover, manufacturing output stagnated or declined in the 1990s.[16] So, it is not surprising that Hong Kong SAR underperformed in 1998 relative to its base of drivers. But its service industry has the unique advantage of access to the giant Chinese market, allowing respectable economic growth despite industrial decline.

Chile is similar in some ways, but it has not undergone such marked deindustrialization. It also has a relatively strong base of drivers, particularly skills and foreign direct investment, in which it ranks highest in Latin America. Unlike Hong Kong SAR, it is a resource-rich economy, with copper accounting for most of its traditional exports. In recent years, with government assistance, the economy has developed other resource-based activities for export (mainly wine, farmed fish and pulp and paper). Chile lags in manufacturing value added (MVA) per capita and in the technological structure of MVA and exports—the reason that it underperforms in the Scoreboard. Even so, Chile's manufacturing has grown at reasonable rates—at least by Latin American (if not East Asian) standards; it grew by 4.6 percent a year in the 1990s (well below its GDP growth of 6.7 percent).[17] The share of manufacturing in GDP has fallen from 21 percent in the mid-1980s to 15 percent today.[18]

Using the Scoreboard for formulating industrial strategy

There are three main steps involved in using the Scoreboard and going beyond it to formulate industrial strategy (table 4.5). The first is to identify the main *comparators* that provide the benchmarks for a country. These can be of four types:

- *Neighbours* that share similar advantages and disadvantages of location or resources. For example, India might choose Pakistan as one benchmark because of similarities in the costs of transport to their main markets, their common specialization in cotton-based manufactured exports and their similar wage costs.
- *Immediate competitors* in industrial activities relevant to the country. Some of these may be neighbours—others

Table 4.5 Using the Scoreboard—and going beyond it

Step		Some important issues
1. Identify comparators	1.1 Identify neighbours 1.2 Identify immediate competitors 1.3 Identify potential competitors 1.4 Identify role models	● Which comparators can provide useful information? ● For which activities are the comparators useful? ● What is a manageable number of comparators?
2. Benchmark performance	2.1 Compare overall industrial performance 2.2 Compare basic indicators of industrial performance 2.3 Trace competitive strengths and weaknesses with respect to different sets of comparators	● How has the country performed over time in global or regional rankings? ● Is the industrial structure suited to growth and the best use of local resources and capabilities? ● Which comparators have been more successful than the country or vice versa? How far from or close to selected benchmarks is the country? ● In which aspect of performance does the country lead or lag? Does the performance of comparators suggest cause for concern about any aspect of performance? ● Is there a need for more detailed technical benchmarking of particular industries, clusters or technologies?
3. Benchmark drivers	3.1 Compare individual elements of drivers 3.2 Trace competitive strengths and weaknesses with respect to different sets of comparators 3.3 Assess which drivers are most important for improved performance 3.4 Add new data and analysis as necessary	● What are the relative strengths and weaknesses in the capabilities of the selected country? ● Do the general indicators capture the underlying drivers at work? If not, how can they be refined? ● Which drivers constitute the most critical constraints to industrial growth and competitiveness? ● Is there enough information to evaluate non-quantifiable variables such as linkages, institutions and governance? If not, how can more information be obtained?

may be located across the world. In automobiles Brazil might compete directly with Mexico in some products and with Europe or Asia in others, while in shoes its competitor might be India or China.

- *Potential competitors*—countries likely to emerge as challengers in the near future. Many economies in East Asia regard the entry of China into technology-intensive activities as a major threat.
- *Role models*—countries more advanced in industry and technology and thus able to provide benchmarks to which to aspire. Many developing countries look to the East Asian Tigers or the new Tigers (the second wave of export-oriented countries, such as Malaysia and Thailand) as countries that have successfully overcome latecomer disadvantages. Others look to mature industrialized countries for long-term benchmarks.

Once comparators have been identified, the next step is to compare the country's *industrial performance* (the CIP index) with its benchmarks. Since data on each basic component of the index are given separately, each element can be benchmarked and evaluated separately—breaking down the components of performance is useful to identify where strengths and weaknesses lie. This general benchmarking can be supplemented by more detailed benchmarking at the level of industry, technology or cluster.

The third step is to benchmark the *drivers.* This can be done using the data in the Scoreboard, for the current position as well as for changes over time. Bear in mind that some measures are aggregate and may need to be extended and refined to draw comparisons with other countries. Even as they stand, however, the measures allow analysis of drivers and performance that can show broad areas of strength and weakness.

But if the analysis is to lead to policies, the Scoreboard must be supplemented by *deeper analysis* of the policy and regulatory regime, institutions, linkages and factors that could not be taken into account in the quantitative comparisons. Many of these can also be benchmarked against selected comparators, though it is difficult to do this for the large sample used in the Scoreboard. Most country competitiveness analyses do just this, but such analyses have to be based on painstaking collection of detailed information and careful qualitative analysis.

Appendix 4.A. Statistical table

Table A4.1 Ranking of economies by the drivers of industrial performance, 1985 and 1998

	Skills index		R&D spending per capita by productive enterprises		Foreign direct investment per capita		Royalties per capita		Infrastructure index	
Rank	1998	1985	1998	1985	1998	1985	1998	1985	1998	1985
1	Korea, Republic of	Korea, Republic of	Switzerland	Germany	Singapore	Singapore	Ireland	Singapore	United States	United States
2	Finland	United States	Japan	Switzerland	Belgium	New Zealand	Singapore	Hong Kong SAR	Canada	Canada
3	Australia	Canada	Sweden	Japan	Sweden	Switzerland	Netherlands	Netherlands	Singapore	Sweden
4	Canada	Finland	United States	United States	New Zealand	Australia	Hong Kong SAR	Switzerland	Sweden	Finland
5	United States	Argentina	Germany	Sweden	Hong Kong SAR	Belgium	Switzerland	Belgium	Norway	Norway
6	Russian Federation	New Zealand	Finland	Denmark	Netherlands	Oman	Malaysia	New Zealand	Bahrain	Denmark
7	Spain	Spain	Denmark	Norway	Norway	Netherlands	Belgium	Sweden	Finland	Germany
8	Taiwan Province of China	Sweden	France	Netherlands	Denmark	Hong Kong SAR	Sweden	Canada	Switzerland	Switzerland
9	New Zealand	Germany	Norway	Canada	Switzerland	United States	United Kingdom	Australia	Denmark	Australia
10	United Kingdom	Denmark	Belgium	France	Ireland	United Kingdom	Austria	Finland	Netherlands	Netherlands
11	Norway	Belgium	Netherlands	Austria	Australia	Malaysia	Finland	Ireland	Australia	France
12	Ireland	France	Austria	Finland	United Kingdom	Canada	Norway	Japan	France	Belgium
13	Austria	Norway	Korea, Republic of	Israel	France	Ireland	Japan	Norway	Belgium	New Zealand
14	Sweden	Taiwan Province of China	Singapore	United Kingdom	Austria	Greece	New Zealand	France	Germany	United Kingdom
15	Germany	Uruguay	United Kingdom	Belgium	Canada	Spain	Canada	Germany	United Kingdom	Japan
16	Netherlands	Israel	Ireland	Taiwan Province of China	United States	Norway	Taiwan Province of China	Austria	Japan	Austria
17	France	Ireland	Australia	New Zealand	Finland	France	Germany	United Kingdom	New Zealand	Singapore
18	Denmark	Australia	Canada	Italy	Hungary	Sweden	Australia	Argentina	Hong Kong SAR	Czech Republic
19	Greece	Ecuador	Israel	Singapore	Malaysia	Tunisia	Korea, Republic of	Taiwan Province of China	Austria	Italy
20	Belgium	Austria	Taiwan Province of China	Hungary	Chile	Jordan	Spain	Korea, Republic of	Greece	Greece
21	Portugal	Panama	Italy	Ireland	Israel	Austria	France	Spain	Korea, Republic of	Israel
22	Japan	Greece	Slovenia	Australia	Panama	Costa Rica	United States	Israel	Israel	Hong Kong SAR
23	Israel	Japan	Spain	Korea, Republic of	Spain	Israel	Israel	Italy	Ireland	Saudi Arabia
24	Italy	Czech Republic	New Zealand	Spain	Argentina	Chile	Portugal	Panama	Italy	Ireland
25	Chile	Netherlands	Czech Republic	South Africa	Portugal	Italy	Hungary	United States	Taiwan Province of China	Taiwan Province of China
26	Argentina	Switzerland	Portugal	Poland	Czech Republic	Portugal	Italy	Ecuador	Czech Republic	Spain
27	Switzerland	United Kingdom	Brazil	Greece	Costa Rica	Colombia	Slovenia	Egypt	Spain	Poland
28	Slovenia	Philippines	Greece	Mexico	Mexico	Finland	Thailand	South Africa	Slovenia	Romania
29	Panama	Venezuela	South Africa	Romania	Greece	Cameroon	Argentina	Costa Rica	Portugal	Korea, Republic of

Table A4.1 Ranking of economies by the drivers of industrial performance, 1985 and 1998 (continued)

Rank	Skills index 1998	Skills index 1985	R&D spending per capita by productive enterprises 1998	R&D spending per capita by productive enterprises 1985	Foreign direct investment per capita 1998	Foreign direct investment per capita 1985	Royalties per capita 1998	Royalties per capita 1985	Infrastructure index 1998	Infrastructure index 1985
30	Philippines	Singapore	Hungary	Jordan	Slovenia	Argentina	Jamaica	Portugal	Hungary	Hungary
31	Singapore	Italy	Argentina	Chile	Peru	Mexico	Czech Republic	Denmark	Mauritius	South Africa
32	Peru	Peru	Poland	Turkey	Venezuela	Egypt	Denmark	Uruguay	Russian Federation.	Venezuela
33	Bahrain	Chile	Russian Federation.	Portugal	Poland	Brazil	Brazil	Malaysia	Saudi Arabia	Portugal
34	Poland	Jordan	Malaysia	Brazil	Germany	Denmark	Egypt	Indonesia	Poland	Argentina
35	Czech Republic	Hong Kong SAR	Costa Rica	Ecuador	Taiwan Province of China	Panama	Panama	Chile	Turkey	Oman
36	Hong Kong SAR	Mexico	Chile	India	Italy	Taiwan Province of China	Morocco	Mexico	Malaysia	Mexico
37	Romania	Costa Rica	Turkey	Tunisia	Colombia	Germany	Costa Rica	Thailand	Uruguay	Jordan
38	Venezuela	Romania	Romania	Malaysia	Jamaica	Guatemala	Ecuador	Poland	Argentina	Malaysia
39	Colombia	Poland	Venezuela	Thailand	Brazil	S Arabia	Greece	Jamaica	Chile	Uruguay
40	Jordan	Colombia	Hong Kong SAR	Philippines	Bolivia	Venezuela	Mexico	Greece	Romania	Panama
41	Costa Rica	Egypt	Mexico	Indonesia	Ecuador	Ecuador	Poland	Zimbabwe	South Africa	Turkey
42	Uruguay	Bolivia	Panama	*Kenya*	Uruguay	Thailand	Indonesia	Honduras	Jamaica	Costa Rica
43	Mexico	Portugal	Uruguay	*Madagascar*	Tunisia	Nigeria	South Africa	Morocco	Venezuela	Brazil
44	Bolivia	El Salvador	China	*Malawi*	Paraguay	Paraguay	Chile	Bolivia	Oman	Colombia
45	Algeria	Hungary	Indonesia	*Jamaica*	Thailand	Bolivia	Peru	Philippines	Colombia	Algeria
46	Turkey	South Africa	India	*Argentina*	Oman	Honduras	Philippines	El Salvador	Costa Rica	Chile
47	Ecuador	Turkey	Mauritius	*Costa Rica*	South Africa	Mauritius	Turkey	Brazil	Panama	Jamaica
48	Hungary	Morocco	Thailand	*Venezuela*	Korea, Republic of	Uruguay	Uruguay	Colombia	Mexico	Ecuador
49	South Africa	Thailand	Egypt	*Hong Kong SAR*	China	Korea, Republic of	Kenya	Peru	Brazil	Tunisia
50	Thailand	Saudi Arabia	Colombia	*Panama*	Mauritius	Zambia	Colombia	Turkey	Thailand	Mauritius
51	El Salvador	Algeria	Jordan	*Uruguay*	Romania	South Africa	El Salvador	Tunisia	Jordan	Egypt
52	Tunisia	Brazil	Guatemala	*China*	Philippines	Japan	Romania	Cameroon	Tunisia	Peru
53	Egypt	Honduras	Algeria	*Mauritius*	Indonesia	Sri Lanka	Honduras	Kenya	China	Bolivia
54	Morocco	Nicaragua	Saudi Arabia	*Egypt*	Albania	Morocco	Madagascar	Pakistan	El Salvador	Zimbabwe
55	Indonesia	Tunisia	Peru	*Colombia*	Morocco	Central African Republic	Bolivia	Romania	Ecuador	China
56	Saudi Arabia	Malaysia	Morocco	*Guatemala*	Nicaragua	El Salvador	Zimbabwe	*Algeria*	Algeria	El Salvador
57	Nicaragua	Sri Lanka	Philippines	*Algeria*	Jordan	Yemen	China	*Senegal*	Peru	Nicaragua
58	Brazil	Paraguay	Honduras	*Saudi Arabia*	Russian Federation	Turkey	Tunisia	*India*	Paraguay	Thailand
59	Malaysia	India	Nicaragua	*Peru*	Saudi Arabia	Indonesia	Senegal	*Nigeria*	Bolivia	Paraguay
60	Honduras	Jamaica	Sri Lanka	*Morocco*	Nigeria	Senegal	India	*Ghana*	Egypt	Philippines
61	Jamaica	Indonesia	*Yemen*	*Honduras*	Egypt	Peru	Pakistan	*Madagascar*	Morocco	Morocco
62	China	Guatemala	Tunisia	*Nicaragua*	Turkey	Philippines	Tanzania, United Republic of	*Paraguay*	Guatemala	Guatemala
63	Sri Lanka	Oman	*Malawi*	*Sri Lanka*	Honduras	Kenya	Paraguay	*Bangladesh*	Honduras	Zambia
64	Paraguay	China	*Madagascar*	*Yemen*	Sri Lanka	Pakistan	Cameroon	*China*	Philippines	Yemen
65	Guatemala	Zimbabwe	*Kenya*	*Albania*	Guatemala	China	*Bangladesh*	*Russian Federation*	Indonesia	Honduras
66	Albania	Nepal	*Jamaica*	*Bahrain*	Ghana	Ghana	*Russian Federation*	*Albania*	Zimbabwe	Indonesia
67	India	Mauritius	*Ecuador*	*Bangladesh*	Yemen	Poland	*Albania*	*Bahrain*	Nicaragua	Pakistan
68	Zimbabwe	Madagascar	*Albania*	Bolivia	Japan	Tanzania, United Republic of	*Algeria*	*Central African Republic*	Sri Lanka	India
69	Mauritius	Bangladesh	*Bahrain*	*Cameroon*	Zambia	Madagascar	*Bahrain*	*Ethiopia*	Albania	Nigeria
70	Oman	Ghana	*Bangladesh*	*Central African Republic*	Senegal	Malawi	*Central African Republic*	*Guatemala*	India	Kenya

Table A4.1 Ranking of economies by the drivers of industrial performance, 1985 and 1998 (continued)

Rank	Skills index 1998	Skills index 1985	R&D spending per capita by productive enterprises 1998	R&D spending per capita by productive enterprises 1985	Foreign direct investment per capita 1998	Foreign direct investment per capita 1985	Royalties per capita 1998	Royalties per capita 1985	Infrastructure index 1998	Infrastructure index 1985
71	Nepal	Pakistan	*Bolivia*	*El Salvador*	Uganda	India	*Ethiopia*	*Jordan*	Pakistan	Senegal
72	Nigeria	Nigeria	*Cameroon*	*Ethiopia*	Pakistan	Mozambique	*Ghana*	*Malawi*	Nigeria	Cameroon
73	Bangladesh	Cameroon	*Central African Republic*	*Ghana*	Zimbabwe	Zimbabwe	*Guatemala*	*Mauritius*	Zambia	Sri Lanka
74	Cameroon	Senegal	*El Salvador*	*Mozambique*	Tanzania, United Republic of	Ethiopia	*Jordan*	*Mozambique*	Kenya	Ghana
75	Pakistan	Kenya	*Ethiopia*	*Nepal*	Mozambique	Nepal	*Malawi*	*Nepal*	Senegal	Malawi
76	Madagascar	Zambia	*Ghana*	*Nigeria*	El Salvador	Bangladesh	*Mauritius*	*Nicaragua*	Mozambique	Mozambique
77	Senegal	Ethiopia	*Mozambique*	*Oman*	India	Uganda	*Mozambique*	*Oman*	Ghana	Madagascar
78	Yemen	Uganda	*Nepal*	*Pakistan*	Bahrain	Algeria	*Nepal*	*Saudi Arabia*	Tanzania, United Republic of	Tanzania, United Republic of
79	Ghana	Central African Republic	*Nigeria*	*Paraguay*	Cameroon	Jamaica	*Nicaragua*	*Sri Lanka*	Cameroon	Bangladesh
80	Zambia	Malawi	*Oman*	*Senegal*	Madagascar	Bahrain	*Nigeria*	*Uganda*	Nepal	Uganda
81	Kenya	Tanzania, United Republic of	*Pakistan*	*Tanzania, United Republic of*	Nepal	***Hungary***	*Oman*	*Venezuela*	Yemen.	Central African Republic
82	Uganda	Mozambique	*Paraguay*	*Uganda*	Kenya	***Czech Republic***	*Saudi Arabia*	*Zambia*	Ethiopia	Ethiopia
83	Central African Republic	Albania	*Senegal*	*Zambia*	Central African Republic	***Slovenia***	*Sri Lanka*	***Hungary***	Malawi	Nepal
84	Ethiopia	Bahrain	*Tanzania, United Republic of*	*Zimbabwe*	Algeria	***Romania***	*Uganda*	***Slovenia***	Bangladesh	***Albania***
85	Mozambique	Russian Federation	*Uganda*	***Russian Federation***	Bangladesh	***Albania***	*Venezuela*	***Czech Republic***	Madagascar	***Bahrain***
86	Malawi	Slovenia	*Zambia*	***Slovenia***	Malawi	***Nicaragua***	*Yemen*	***Tanzania, United Republic of***	Uganda	***Russian Federation***
87	Tanzania, United Republic of	Yemen	*Zimbabwe*	***Czech Republic***	Ethiopia	***Russian Federation***	*Zambia*	***Yemen***	Central African Republic	***Slovenia***

Source: UNIDO Scoreboard database (see technical annex).

Note: Economies in italics have negligible values, and those in bold italics have missing data. These economies are not ranked in the analysis; their location in the table is incidental.

Appendix 4.B. Country cases from the UNIDO Scoreboard

This appendix illustrates how the Scoreboard can help in analyzing industrial performance and its drivers. It uses selected country cases from different regions and occasionally supplements the Scoreboard data with other information to enrich the analysis. As noted in the chapter, however, using the Scoreboard in country analysis would require much more detailed information than that here.

Industrialized countries

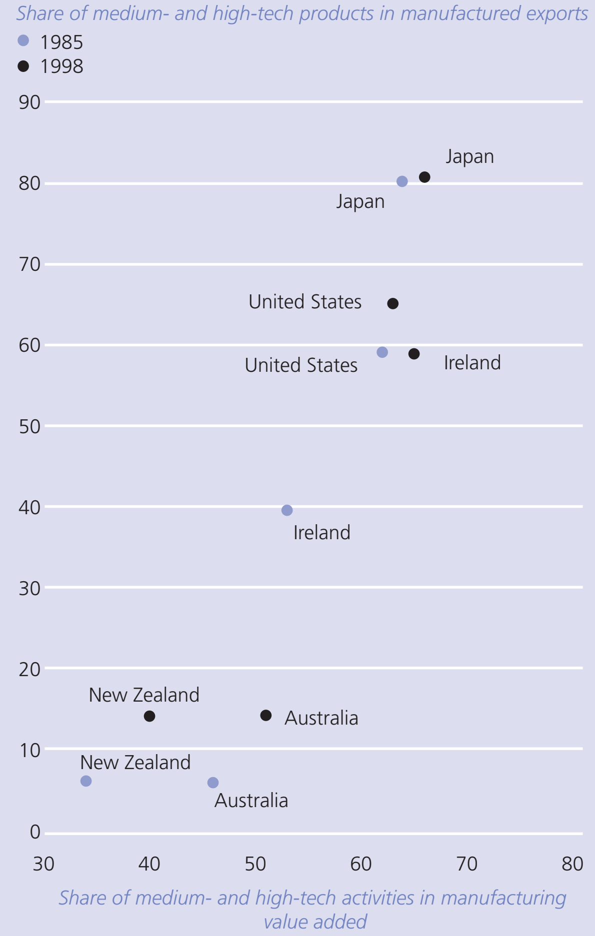
As would be expected, industrialized countries as a group lead the sample in both industrial performance and its drivers. Their rankings have remained relatively stable over time—again as would be expected for countries with mature industrial sectors that cannot change structural parameters much over the medium term. Nevertheless, there are some interesting shifts, so some structural change is clearly possible. The most striking case is that of Ireland, which improved its ranking by the competitive industrial performance (CIP) index by 12 places between 1985 and 1998. At the other end of the spectrum is New Zealand, which lost 7 places.

IRELAND

One of the most dynamic industrialized economies, Ireland improved its CIP rank from 15th in 1985 to third in 1998, just behind Singapore and Switzerland. Not only has it significantly increased industrial production and manufactured exports per capita, it has also achieved high levels of technological sophistication in both (figure A4.1). Yet despite the fairly large share of medium- and high-tech products in its manufactured exports, its rank by this measure fell from 12th to 17th over the period. The main reason is the rise in the ranks by such developing economies as Singapore, the Philippines, Mexico, Malaysia and Taiwan Province of China, with their even more technology-intensive export structures.

Ireland's drivers match its dynamic performance. Figure A4.2 shows shifts in Ireland's ranks for each indicator of industrial performance and each of the five drivers (a move towards the centre signifies an improvement in rank). Ireland's manufacturing value added (MVA) and manufactured exports per capita rose rapidly in 1985–1998, propelling the country to close to the top of the ranking for these measures. Total MVA grew by 13.6 percent a year and manufactured exports by 15.8 percent (two or more percentage points higher than the average for industrialized countries). The share of medium- and high-tech products in MVA rose by 12 percentage points, and their share in manufactured exports by 11 percentage points.

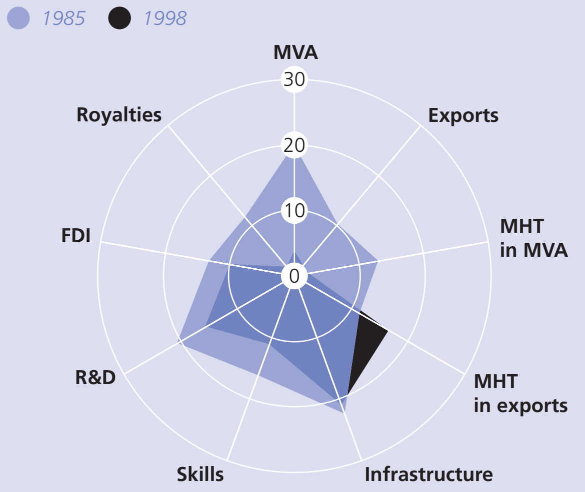
Figure A4.1 Technological structure of manufacturing production and exports in selected industrialized countries (percent)



Source: UNIDO Scoreboard database (see technical annex).

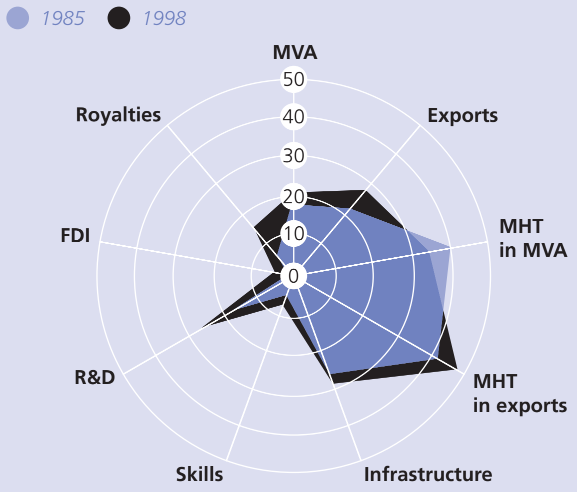
Ireland's success was driven mainly by foreign direct investment combined with a massive upgrading of human capital. Starting from a weak inherited technological and industrial base, Ireland used incentives and targeting to attract transnational corporations into high-tech activities.[19] Access to the European Union's market was, of course, an important magnet for transnational corporations. Ireland drew heavily on EU assistance to develop its physical infrastructure. Inward foreign direct investment grew rapidly in 1985–1998 (at 19 percent a year on a per capita basis). Payments of royalties and licensing fees to foreign firms also rose sharply, reaching $6 billion by 1998, around 9 percent of global royalty payments (and the highest level in per capita terms). Ireland's drive into sophisticated manufacturing and software activities required many skilled workers, and the country became a global leader in enrolments. It now ranks higher than Germany, the United

Figure A4.2 Changing ranks in industrial performance indicators and drivers for Ireland



Source: UNIDO Scoreboard database (see technical annex).

Figure A4.3 Changing ranks in industrial performance indicators and drivers for New Zealand



Source: UNIDO Scoreboard database (see technical annex).

Kingdom or the United States in tertiary students enrolled in technical subjects as a share of the population.

The Industrial Development Authority of Ireland, an organization with highly qualified staff and a strong private sector orientation, managed the promotion and targeting of foreign direct investment. But the authority (later, Enterprise Ireland) was more than an investment promotion agency. It also managed industrial policy and so was able to ensure that the needs of foreign investors were met. This strategy making and coordination function allowed it to mastermind the technological upgrading of the industrial sector (much as the Singapore Economic Development Board has done in that country). The authority later mounted strategies to strengthen links between local suppliers and affiliates of transnational corporations and to induce affiliates to deepen local technological activity and undertake research and development (R&D).[20] As a consequence, enterprise-financed R&D per capita rose from $14 in 1985 to $153 in 1998; total enterprise-financed R&D grew by 20 percent a year. Ireland now ranks ahead of Australia, Canada, Israel and Taiwan Province of China in enterprise-funded R&D. Although affiliates of transnational corporations perform most of the R&D, local companies are also increasing R&D efforts.

New Zealand

New Zealand presents something of contrast to Ireland (figure A4.3). Its growth rates for MVA and manufactured exports per capita have been lower than the average for industrialized economies, pulling it down in the rankings by these measures by three and six places. More important, the share of medium- and high-tech products in its manufactured exports (14.5 percent) is now the lowest in the industrialized world. And the share of complex activities in its MVA exceeds only that of Greece and Portugal among industrialized countries. A number of newly industrializing and transition economies now rank higher than New Zealand by various measures of industrial performance.

Still, New Zealand is strong in some drivers of industrial performance. It has one of the largest skill bases in the world (though its ranking by the skills index has declined over time). Its foreign direct investment inflows are among the largest in the world on a per capita basis, and as a share of GDP (4.8 percent) they exceed those to Belgium (3.9 percent), Sweden (3.6 percent) and the Netherlands (2.6 percent). Other drivers are not as strong. New Zealand lags behind other industrialized countries in infrastructure and R&D. Although enterprise-financed R&D per capita doubled in nominal terms between 1985 and 1998, the level in 1998 was an eighth of the average for industrialized countries and only a third of that in Australia, another resource-rich industrialized country. What is more, R&D declined as a share of GDP in New Zealand. Foreign direct investment goes less into manufacturing than into services, and little is aimed at high-tech activity.

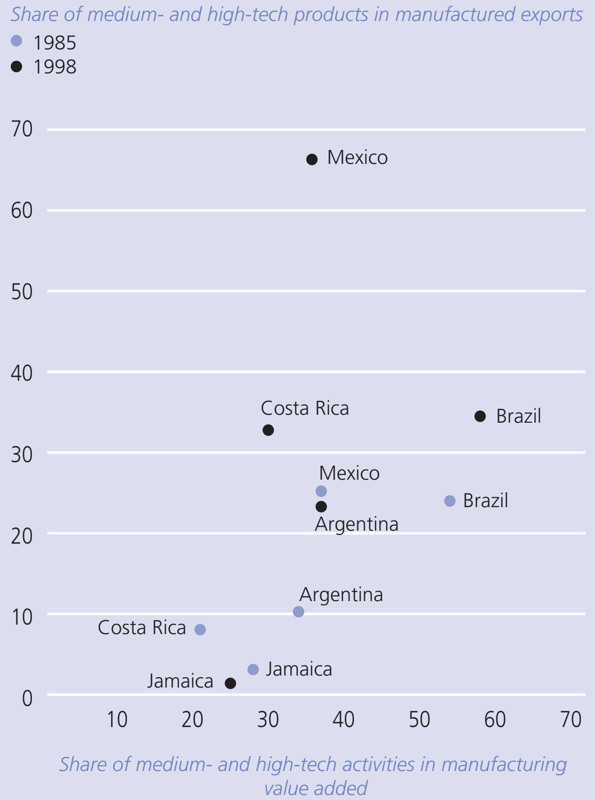
Developing countries

Latin America and the Caribbean

Industrial performance has been variable in Latin America and the Caribbean. Of the 18 countries from that region in the sample, 7 (Bolivia, Chile, Costa Rica, El Salvador, Guatemala, Honduras and Mexico) improved their CIP ranks between 1985 and 1998, while 11 saw their ranks deteriorate. The laggards include large, industrialized economies like Argentina and Brazil. Compared with the rest of the developing world, the region is relatively well placed in most drivers of industrial performance but lags in domestic technological effort.

Mexico and Jamaica illustrate the range of experience in the region: the first performs relatively well in the Scoreboard, while the second does not. Their ranks by performance and drivers show, at least in part, the reasons for the differences in outcomes for the two.

Figure A4.4 Technological structure of manufacturing production and exports in selected countries in Latin America and the Caribbean (percent)



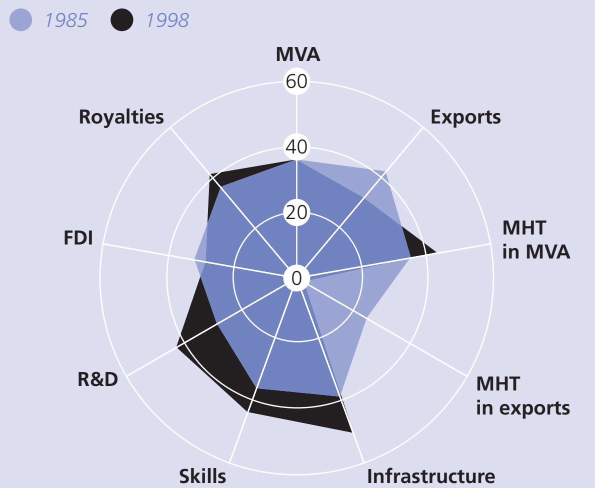
Source: UNIDO Scoreboard database (see technical annex).

Mexico. Mexico led the region in 1998 in industrial performance, having overtaken Brazil in the period since 1985. It recorded an impressive increase in manufactured exports, with annual growth of 21.4 percent, and vigorously upgraded the technological structure of these exports (figure A4.4). In fact, Mexico now has one of the most technology-intensive export structures in the world, ranking ahead of the United States and behind only Japan, the Philippines and Singapore.

But Mexico's production record is less impressive. While its annual growth in MVA in 1985–1998 (6.2 percent) exceeded the average for Latin America and the Caribbean (5.9 percent), it fell short of the average for East Asia (9.3 percent). More important, the share of medium- and high-tech products in MVA has declined over time. This differentiates Mexico from Brazil, the other Latin American industrial giant. While Brazil has a less technology-intensive export structure, its MVA structure is far more complex (ranking Brazil 13th globally) and has become more so over time. Mexico's domestic industrial sector seems to be on a different trajectory than its export sector.

The main driver of Mexico's industrial performance is activity by transnational corporations in the *maquiladoras* on the U.S. border. Average annual per capita inflows of foreign direct investment grew from $16.5 in 1981–1985 to $102.4 in 1993–1997. In 1998 Mexico's foreign direct investment inflows (as a share of GDP) exceeded those to Hong Kong

Figure A4.5 Changing ranks in industrial performance indicators and drivers for Mexico

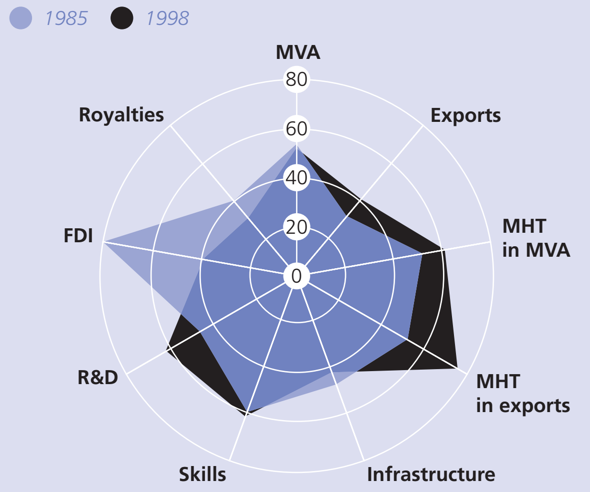


Source: UNIDO Scoreboard database (see technical annex).

Special Administrative Region (SAR) of China, Thailand, the Philippines and Indonesia. But this high dependence on internalized technology transfer has done nothing to enhance domestic innovation; on the contrary, enterprise-financed R&D spending per capita in 1998 was half that in 1985, and Mexico's rank dropped by 13 places (figure A4.5). Enterprise-financed R&D fell as a share of GNP by nearly 8 percent a year over the period. Just as worrying is that Mexico's skill base and physical infrastructure are deteriorating relative to those of competitors. Moreover, the maquiladoras have only weak links to local industry for inputs and technology.[21]

The domestic content of export production in Mexico remains low, though it is rising slowly.[22] The real drivers of its industrial success have been low labour costs, locational advantages and the privileges gained through the North American Free Trade Agreement (NAFTA). Despite its large and well-established industrial sector, Mexico makes little use of the modern drivers of industrial competitiveness. Unless the domestic content of industrial activity increases, with a better match between export and MVA structures, the sustainability of the country's industrial growth remains open to question.

Figure A4.6 Changing ranks in industrial performance indicators and drivers for Jamaica



Source: UNIDO Scoreboard database (see technical annex).

Jamaica. Jamaica lies almost at the other end of the technological spectrum. It suffered the largest deterioration in CIP ranks in the region between 1985 and 1998, falling from 52nd to 65th. Although its MVA and manufactured exports have grown at respectable rates since 1985 (6.7 percent and 6.9 percent), it has not kept pace with competitors. Moreover, the technological structure of Jamaica's MVA and exports has regressed. The country now has one of the smallest shares of medium- and high-tech manufactured exports in the sample, leading it to lose 22 places in the rankings by this measure.

Jamaica's experience can be contrasted with that of neighbouring Costa Rica, which has managed a rapid transition from resource-based and labour-intensive exports to technology-intensive industrial activity. Costa Rica has achieved this success through targeted foreign direct investment policies and skill creation—the leading example of Irish- or Singapore-style industrial policy in Latin America and the Caribbean. It has attracted a $500 million semiconductor plant from Intel,[23] which has transformed its production and export structure and is leading to extensive spillover benefits.[24]

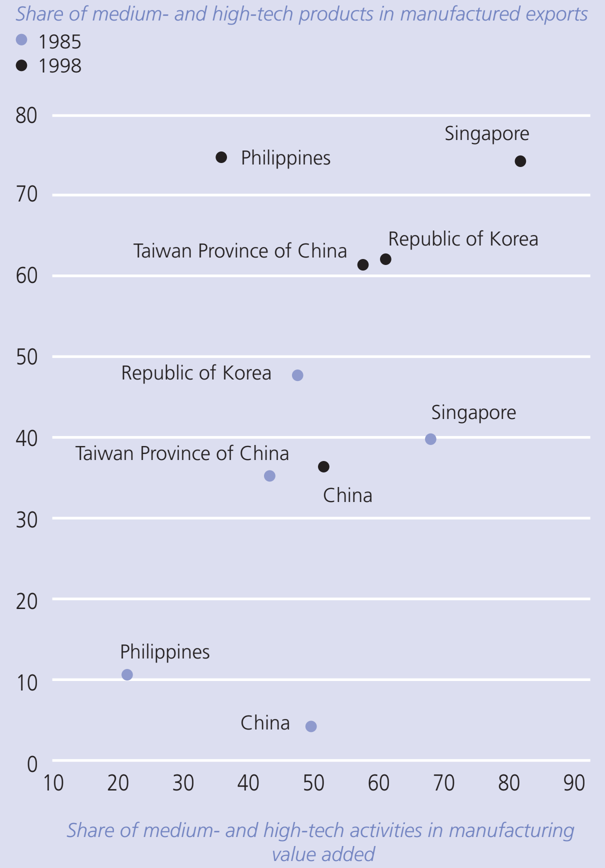
Jamaica performs poorly in some industrial drivers, ranking fairly low on the skills index (where its rank has stagnated) and with negligible enterprise-financed R&D (figure A4.6). But its foreign direct investment rank has improved sharply (by 41 places), with per capita inflows rising from negative figures in 1985 to almost $60 in 1998. This record is misleading, however, since the negative inflows in 1985 were clearly an aberration. More important is that the investment seems to have done little to improve Jamaica's industrial structure or competitiveness; most probably went into services and utilities.

Jamaica has used its locational advantages and low wages to build up some (labour-intensive) exports, but its export industry has remained concentrated in low-tech activities (the country's export structure is among the least technology intensive in the sample). With no technological upgrading over time, Jamaica has a weak base for future industrial growth. Its exports will come under increasing threat from lower-wage countries, particularly those in other regions, as trade is further liberalized and its special access to the U.S. market is reduced. Without a move up the technological ladder (probably best achieved by emulating Costa Rica), Jamaica may find itself increasingly marginalized in industry.

East Asia

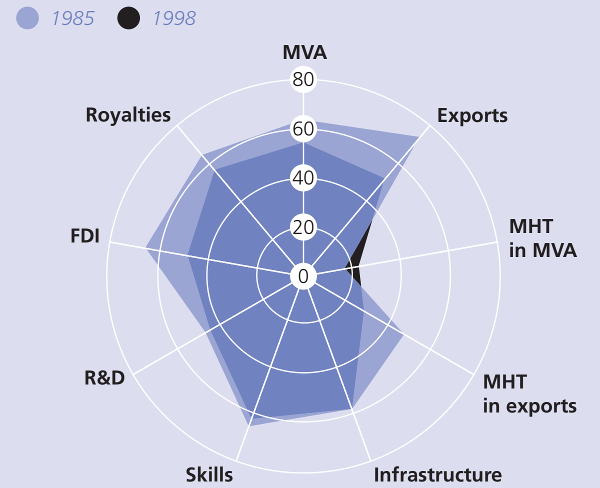
East Asia leads the developing world in industrial performance as well as in its drivers. While there is much diversity among East Asian economies, the leaders in the region are among the global leaders in several indicators (figure A4.7). Since the experience of the Republic of Korea, Singapore and Taiwan Province of China is fairly well known,[25] the focus here is on two other economies, China and the Philippines. China is of obvious interest: it is the leading industrial power in the developing world and poses a strong competitive challenge to other economies in the region and elsewhere—across the entire technological spectrum. The Philippines is not a major industrial power, but its experience offers interesting lessons,

Figure A4.7 Technological structure of manufacturing production and exports in selected economies in East Asia (percent)



Source: UNIDO Scoreboard database (see technical annex).

Figure A4.8 Changing ranks in industrial performance indicators and drivers for China



Source: UNIDO Scoreboard database (see technical annex).

both positive and negative. Much like Mexico, it shows that integration into high-tech global production systems can boost national performance.

China. China rose in the CIP ranks by 24 places between 1985 and 1998—the largest jump in the sample. Its rank in three of four performance indicators improved significantly, with only its rank in the technological structure of MVA deteriorating (figure A4.8). China combines strong growth in per capita MVA and manufactured exports—averaging 9.8 percent and 29.1 percent a year in 1985–1998—with rapid upgrading of its export structure.

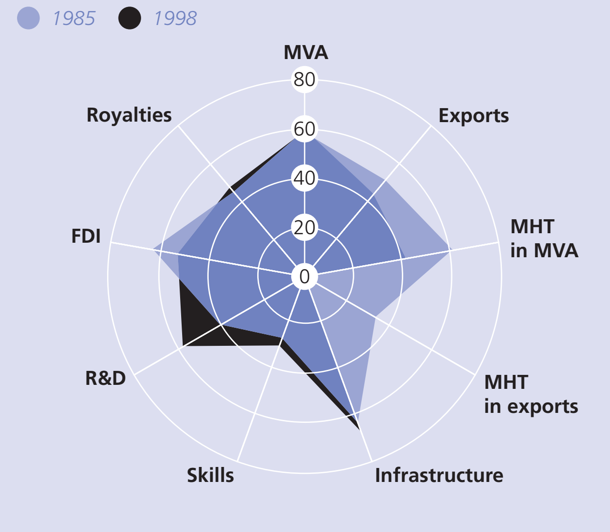
China exploits competitive advantages in both labour-intensive and technology-based (assembly) activities. Its special economic zones, with a strong presence of exporters from Hong Kong SAR and Taiwan Province of China, drive the low-tech activity. And transnational corporations and some dynamic domestic firms drive exports of technologically complex products. Exports are balanced almost evenly between local and foreign firms: in 1998 local firms accounted for 52 percent, and foreign firms for 48 percent, of total exports.

China sharply increased its imports of foreign technology in 1985–1998, as reflected in its improved ranks in foreign direct investment and royalty payments. In 1998 only the United States received more foreign direct investment (in absolute terms). China also has slightly improved its ranks in skills and R&D. It invests almost as much in enterprise-financed R&D (in absolute terms) as the Russian Federation and nearly three times as much as India.

China accounts for 17 percent of tertiary enrolments in the developing world and lags behind only the United States and the Russian Federation in the number of tertiary students enrolled in technical subjects. Even so, China's skill base appears weak relative to its size. Moreover, its infrastructure rank did not improve in 1985–1998. While China is rapidly strengthening both these drivers of industrial performance, it still has some distance to go before it matches the region's leading industrializing economies.

Philippines. The Philippines moved up 20 places in the CIP ranking, from 45th in 1985 to 25th in 1998—higher than industrialized countries such as Australia, New Zealand and Portugal and transition economies such as Hungary and Slovenia. Rapid growth in manufactured exports (more than 20 percent a year in 1985–1998) and improvements in its

Figure A4.9 Changing ranks in industrial performance indicators and drivers for the Philippines



Source: UNIDO Scoreboard database (see technical annex).

export structure account for its success, rather than growing MVA or better capabilities (figure A4.9). Like Mexico, it shows that countries with relatively weak drivers can upgrade rapidly by plugging into high-tech global production systems. And like Mexico, it is not assured of continued success, because its domestic base for growth remains weak. In fact, lacking the locational advantages of Mexico and with a much narrower export specialization, the Philippines is more vulnerable to technical change and emerging competition.[26]

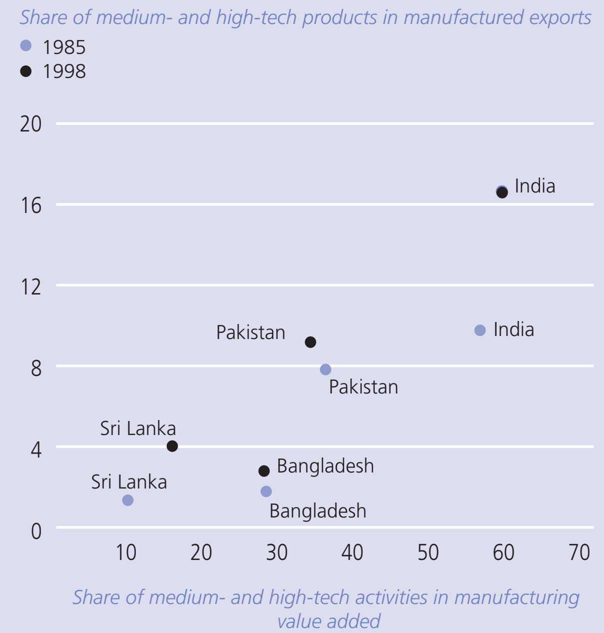
Medium- and high-tech products increased from 10.5 percent of the Philippines' manufactured exports in 1985 to 74.4 percent in 1998, and the country's recent export growth has been among the strongest in the region (it fared better than most other large exporters during the East Asian financial crisis). The Philippines has overtaken Malaysia as the main base in the region for assembly and testing of semiconductors for transnational corporations, and this product accounts for more than 70 percent of manufactured exports. But manufacturing production has grown slowly (by 4.8 percent a year), leading to a loss of three places in the MVA per capita ranks. The structure of MVA is biased towards low-tech and resource-based activities, creating a sharp disparity in technological complexity between exports and domestic production (see figure A4.7). The local content of semiconductor assembly remains low, and traditional labour-intensive exports (such as apparel) are weakening. Other technology-intensive export activities have yet to take root.

There is a lack of "connectivity" between the Philippines' high-tech export activity and its domestic drivers, reflected in the fact that its rank fell by 17 places in R&D, 4 places in the infrastructure index and 2 places in the skills index. The only driver of industrial performance in which its rank improved is foreign direct investment, underlining the fragility of the country's industrial success.

South Asia

The industrial performance of South Asia is strikingly different from that of East Asia. South Asia ranks low in the CIP index and has weak drivers of industrial performance, comparable to those of Sub-Saharan Africa except for skills. This may seem surprising in view of the region's history of heavy industrialization and the recent surge in software exports by India, its main industrial economy. But even India has a relatively weak base of industrial capabilities relative to the size of its economy. Moreover, small islands of technological success, as in software, do not reflect the dynamism and competitiveness of the industrial sector as a whole. Export structures in the region are relatively weak, though India has a complex MVA structure (figure A4.10). Other economies

Figure A4.10 Technological structure of manufacturing production and exports in selected countries in South Asia (percent)



Source: UNIDO Scoreboard database (see technical annex).

have less advanced industrial sectors, though their export patterns look surprisingly similar to that of India.

India. India led South Asia in the CIP ranking in 1998, though its rank had changed little since 1985. During this 13-year span India's industrial structure remained static, and the country was overtaken in the CIP ranking by such economies as China and Indonesia, mainly because of their greater orientation towards technologically complex export industries. India had annual growth of MVA (5.1 percent) lower than the region's average (5.5 percent), and its MVA per capita in 1998 ($65.2) was similar to that of Cameroon ($64.6) and Nigeria ($62.2). Its manufactured exports reached only $26.4 per capita in 1998, less than in Senegal ($34.5), Cameroon ($34) or Kenya ($28.3). The annual growth of its manufactured exports (11.6 percent), while healthy, was less than the region's average (12.4 percent), which was in turn lower than the average for all developing economies (13.3 percent) and for East Asia (14.5 percent).

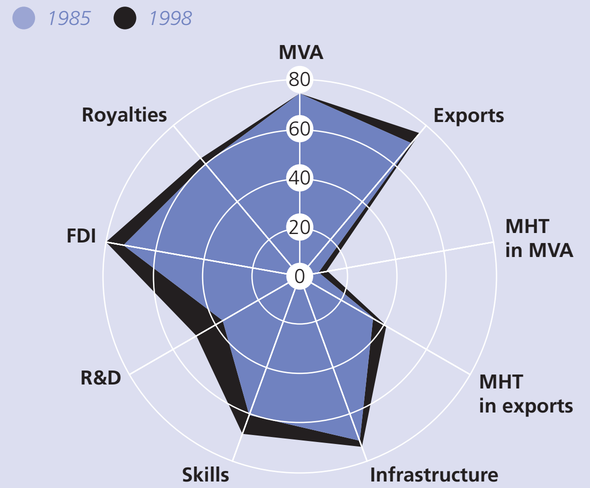
What really distinguishes India from other countries in South Asia—and from Africa—is the depth and complexity of its industrial structure (see figure A4.10). Medium- and high-tech products accounted for almost 60 percent of India's MVA in 1998, compared with less than 10 percent for its neighbours. In fact, India ranked 12th globally in the technological complexity of MVA, ahead of Taiwan Province of China, Brazil or China—a legacy of its prolonged import substitution strategy emphasizing heavy industry.

But this strategy has also left India's diverse manufacturing sector with large technological and competitive gaps relative to world frontiers (figure A4.11). India's manufactured exports have a strikingly different structure than its manufacturing production, with low-tech products (textiles and clothing) and resource-based activities (diamond cutting) accounting for 62 percent. The gap between the two structures reflects the competitive gap in large sections of Indian industry. India's most dynamic export activity—software—is not captured by the figures, which exclude services.

This competitive gap in manufacturing is the result not only of past trade policies but also of weaknesses in industrial drivers.[27] The country's skill base is weak and deteriorating relative to those of competitors. The absolute numbers are, of course, large—India accounted for 16.3 percent of tertiary enrolments in the developing world in 1998, and it ranked behind only the United States, the Russian Federation and China in tertiary enrolments in technical areas.

But the number of tertiary students enrolled in technical subjects is small relative to India's population, and in contrast to the numbers in most other regions, it has declined since 1985.

Figure A4.11 Changing ranks in industrial performance indicators and drivers for India



Source: UNIDO Scoreboard database (see technical annex).

Still, the absolute number of technically qualified people is large, allowing India to foster nodes of skill-intensive activity. That explains the presence of software exports and of some competitive firms in complex activities. The real skill constraint will arise when India tries to upgrade technologies in a large range of activities to compete in liberalized markets.

Other industrial drivers in India are also weak. Lags in infrastructure are widespread, a well-known problem confirmed by the Scoreboard data. More striking is that India is falling further behind its competitors in this driver of industrial performance. Moreover, enterprise-financed R&D was the same on a per capita basis in 1998 as in 1985 and declining as a share of GNP. Inward foreign direct investment has risen significantly in recent years, but the growth has not been enough to reverse a decline in India's rank by this indicator. And in sharp contrast to foreign direct investment in China, little in India goes into export-oriented manufacturing. That puts India at risk of losing out on links with the most dynamic part of industrial export activity, integrated production systems in technology-intensive activities.

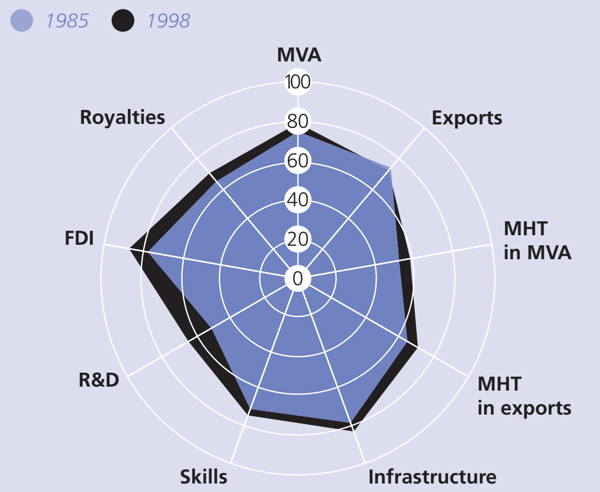
Bangladesh. Bangladesh ranked 73rd in the CIP index in 1998. Despite respectable industrial growth—MVA per capita rose by 6.6 percent a year between 1985 and 1998, from $33.5 to $59.6, and manufactured exports per capita by 14.7 percent, from $8.1 to $37.3—it had gained only one place in the performance ranks. Part of the explanation lies in its overwhelming specialization in low-tech products, primarily clothing (which accounts for 90 percent of manufactured exports).

This specialization grew rather than diminished over the period, as other exports failed to grow.

This stagnation in technological development has worrying implications, not only because of what it denotes about industrial upgrading but also because clothing exports have grown on the back of quota protection under the Multi-Fibre Arrangement (MFA), which ends in 2004. Like other countries that have built manufactured exports on the basis of the MFA, Bangladesh faces a serious adjustment problem once competition with more efficient developing countries opens up fully. While some clothing exporters will clearly survive, they may not drive export growth in the way they have in the past—and there are few signs of other dynamic manufacturing exporters replacing them.

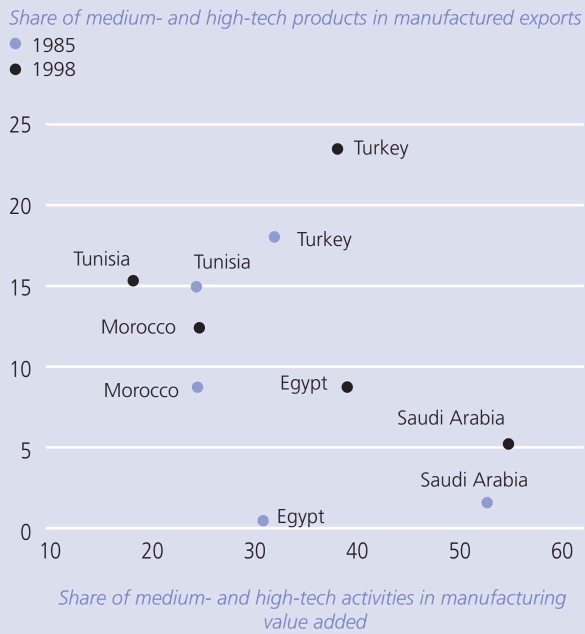
Bangladesh also does poorly in other drivers of industrial performance (figure A4.12). Enterprise-financed R&D is negligible. Foreign direct investment inflows have risen, but reached only $0.3 per capita in 1998 (ranking Bangladesh third from the bottom in the sample). Some foreign direct investment goes into export-oriented activity, but since clothing is a labour-intensive activity, the values involved are quite small. Infrastructure is weak, with Bangladesh ranking fourth from the bottom by this indicator. It had only three telephone mainlines per 1,000 people in 1998, even fewer than Malawi, Mozambique, Nigeria and the United Republic of Tanzania. Bangladesh lost four places in the combined infrastructure index, ranking 84th in 1998. Its skill base is weak and is deteriorating relative to that of competitors. Like Mauritius, Morocco, Sri Lanka and other countries (particularly in Central America) that have reached the first rung of industrial development on the basis of clothing, Bangladesh will need to greatly improve its industrial capabilities if it is to sustain industrial growth.

Figure A4.12 Changing ranks in industrial performance indicators and drivers for Bangladesh



Source: UNIDO Scoreboard database (see technical annex).

Figure A4.13 Technological structure of manufacturing production and exports in Turkey and selected countries in the Middle East and North Africa (percent)



Source: UNIDO Scoreboard database (see technical annex).

Middle East and North Africa and Turkey

In industrial capabilities the Middle East and North Africa typically ranks at about the middle among developing regions, generally just after Latin America and the Caribbean. It has a relatively good base of skills and infrastructure, but lags in technological activity. Turkey specializes heavily in low-tech exports, with relatively slow upgrading over time (figure A4.13). Some countries, like Egypt, have a long history of import-substituting industrialization led by the state. Saudi Arabia's export structure continues to be dominated by resource-based products. An increase in the share of medium- and high-tech products in manufactured exports over the years is indicative of the move towards export diversification.

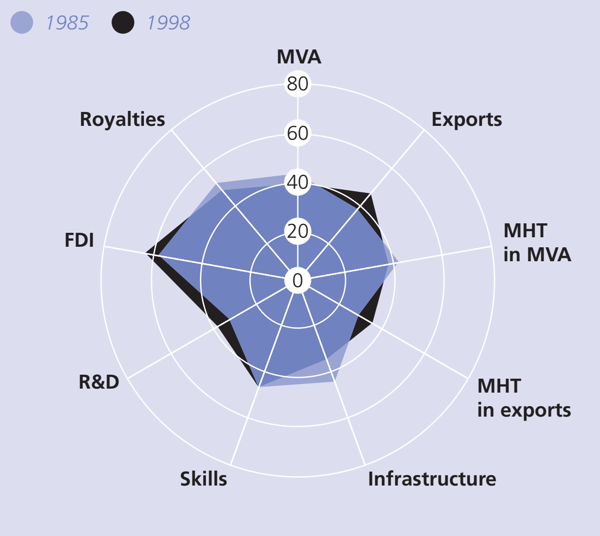
Turkey. Turkey placed 38th in the CIP ranking in 1998, leading the Middle East and North Africa despite having lost two places since 1985. It ranked just behind China and a little ahead of Greece, Romania and the Russian Federation. Despite reasonable industrial growth in 1985–1998, Turkey has not kept up with many newly industrializing countries—the Philippines, Thailand, Costa Rica and China have all jumped ahead in the CIP ranking.

Turkey's total MVA grew by 10.3 percent a year between 1985 and 1998, and its total manufactured exports by 11.2 percent. Technologically complex industries raised their share in manufacturing production from 32 to 38 percent and in manufactured exports from 18 to 23 percent. That gave Turkey a more technology-intensive export structure than that of countries in the Middle East and North Africa, with the exception of Saudi Arabia. Saudi Arabia's technology-intensive export structure is due largely to its petrochemical facilities.

Even so, Turkey is not technologically advanced by the standards of East Asia or Latin America and the Caribbean. Most of its exports come from the clothing sector, where it has capitalized on low wages relative to those in Europe and on access to the EU market. It has high wages by Asian standards, however, and will soon face severe competition from lower-cost countries, particularly China (whose exports of clothing and textiles rose from $2 billion in 1985 to almost $53 billion in 1998). Turkey will need to move into much higher quality segments, which require advanced design and marketing skills, in order to sustain a competitive edge here.

In industrial drivers Turkey has both strengths and weaknesses (figure A4.14). It falls very low in the foreign direct investment ranking, despite its strong EU connection. Although per capita inflows of foreign direct investment rose from $1.7 in 1985 to $12 in 1998, the average for developing countries is twice as high, and the average for the world six times as high. Tertiary enrolments in technical subjects are relatively low, with Turkey ranking 46th in the skills index in 1998 (up one place since 1985), lagging behind Bahrain and Jordan in the region. It fares better relative to the rest of the region in enterprise-financed R&D. But it lags behind much of Europe and several developing economies, such as the Republic of Korea, Taiwan Province of China, Brazil, South Africa, Malaysia, Chile and Costa Rica. Infrastructure, especially for information and communication technology, has improved greatly, with Turkey's rank by the infrastructure index rising by nine places (to 35th) between 1985 and 1998.

Figure A4.14 Changing ranks in industrial performance indicators and drivers for Turkey



Source: UNIDO Scoreboard database (see technical annex).

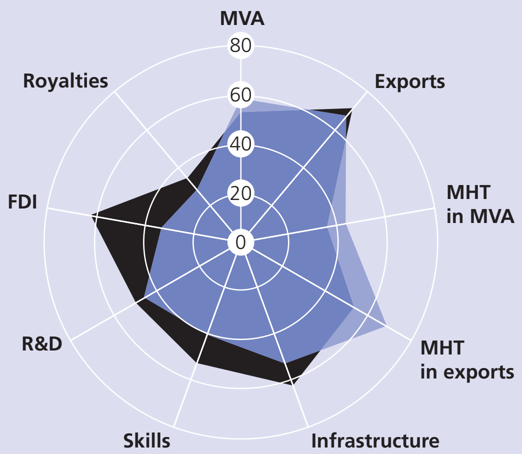
Egypt. Egypt improved its CIP rank by 10 places, reaching 57th in 1998, the only country in the Middle East and North Africa to climb in this ranking. Its MVA grew by 9.5 percent a year between 1985 and 1998, more than the average for the developing world and for the region (7.7 percent). Manufactured exports grew even faster (13 percent), though the level remains low—$36.5 per capita in 1998, less than those of Tunisia, Turkey, Pakistan, Bangladesh or Zimbabwe. Its domestic market orientation, a legacy of socialist and import substitution policies, is changing. But as in India, the policy of import substitution left a sharp divergence between MVA and export structures. Medium- and high-tech products account for a much larger share of MVA (39 percent) than of exports (8.8 percent).

While Egypt is abandoning its past industrial strategies, it still has a long way to go in industrial drivers (figure A4.15). Per capita inflows of foreign direct investment remain very low ($13.3 in 1998) and have fallen over time (from $15.5 in 1985). As a result, Egypt's rank by this indicator dropped by 29 places. Enterprise-financed R&D per capita, while rising, reached only $0.2 in 1998—4.3 percent of the average for developing countries and 14.3 percent of that for the Middle East and North Africa.

Egypt is also losing ground to other developing countries in skills and infrastructure. The number of tertiary students enrolled in technical subjects declined from 75,000 in 1985 (0.15 percent of the population) to 70,000 in 1995 (0.12 percent), pushing Egypt nine places lower in the ranks. In the infrastructure index Egypt ranked 63rd in 1998, just ahead of the Central African Republic and Morocco, but it had lost nine places since 1985.

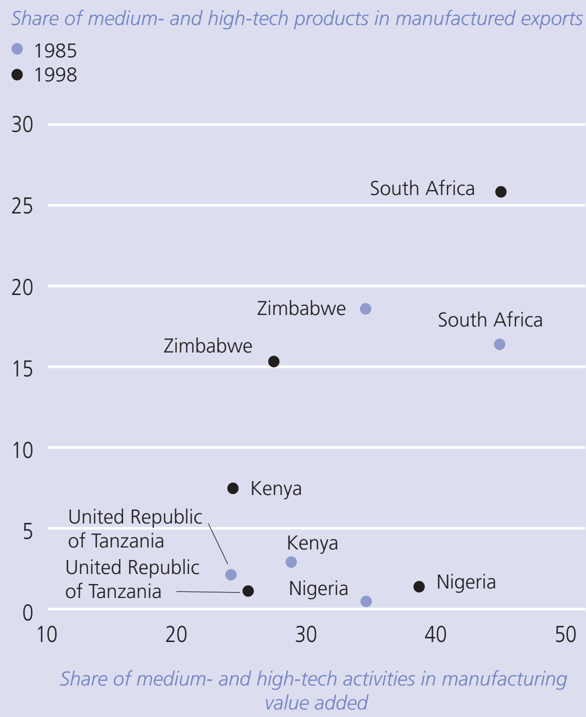
This record suggests that Egypt can take advantage of its long industrial history, low wages and favourable location near Europe only if it is able to attract more foreign direct investment and improve its base of skills, technology and infrastructure.

Figure A4.15 Changing ranks in industrial performance indicators and drivers for Egypt



Source: UNIDO Scoreboard database (see technical annex).

Figure A4.16 Technological structure of manufacturing production and exports in selected countries in Sub-Saharan Africa (percent)



Source: UNIDO Scoreboard database (see technical annex).

Sub-Saharan Africa

Sub-Saharan Africa lags behind the other developing regions in all indicators of industrial performance and capabilities. Of the 15 African countries included in the Scoreboard, 14 fell in the CIP ranking between 1985 and 1998 (the exception was Kenya). Even the regional leaders dropped substantially, South Africa by 7 places, Zimbabwe by 13 and Mauritius by 9. The regional laggards—Uganda, Ghana and Ethiopia—have the weakest industrial performance in the world. Moreover, Kenya's improvement in the ranking had little to do with its industrial performance; instead, it was due primarily to the greater deterioration in the ranks of other countries in the region.

The region's drivers are also weak. Take tertiary enrolment in technical subjects. In 1985 Morocco had almost the same number of tertiary students enrolled in technical subjects as all of Sub-Saharan Africa excluding South Africa. In 1998 Turkey had more students in technical subjects than Sub-Saharan Africa, this time including South Africa. In the composite skills index, 15 of 16 countries in the region ranked among the bottom 20.

Sub-Saharan Africa also ranks last among regions in the infrastructure index. It accounts for less than 1 percent of the world's telephone mainlines, mobile phones and computers. According to the *Economist* (9 September 2000), only 3.1 million of the world's 360 million Internet users are in Africa, with most of these in South Africa and northern Africa. Foreign direct investment has largely passed Africa by. Although total and per capita inflows have grown since the mid-1980s, the region's share of flows to the developing world fell from 3.7 percent in 1985 to 3 percent in 1998. All this is not say that there has been no progress. The region has seen improvement in most indicators, but its ranks by these indicators are deteriorating. In a competitive world that is what matters more. Economies must improve faster to stay in the same place.

Zimbabwe and the United Republic of Tanzania illustrate different aspects of the disappointing industrial performance of Sub-Saharan Africa. Zimbabwe, the most industrialized country in the region (after South Africa), has failed to build on inherited advantages. The United Republic of Tanzania, one of the least industrialized, has failed to build new advantages. Both countries experienced a wholesale worsening in industrial performance and its drivers between 1985 and 1998. Take industrial production. MVA per capita fell from $31 to $15.8 in the United Republic of Tanzania and from $123 to $77 in Zimbabwe. This record of decline is not uncommon in the region: MVA per capita also decreased in Cameroon, the Central African Republic, Madagascar, Nigeria and Zambia.

Zimbabwe. Zimbabwe built a relatively deep and diverse industrial structure during the period of economic isolation under the Unilateral Declaration of Independence, with the capability to manufacture a range of simple capital and intermediate goods in addition to basic consumer products.[28] But it has failed to upgrade this technological base since gaining independence in 1980. In the 1990s there was some liberalization in Zimbabwe and manufactured exports grew by 7.1 percent a year, with mainly resource-based (mineral) products going to industrialized countries and simple machinery and intermediates to neighbouring countries. But many firms were unable to upgrade enough to cope with import competition at home and in neighbouring export markets. Growth slackened, MVA declined, and exports failed to diversify and take off. Recent political uncertainties have exacerbated the situation.

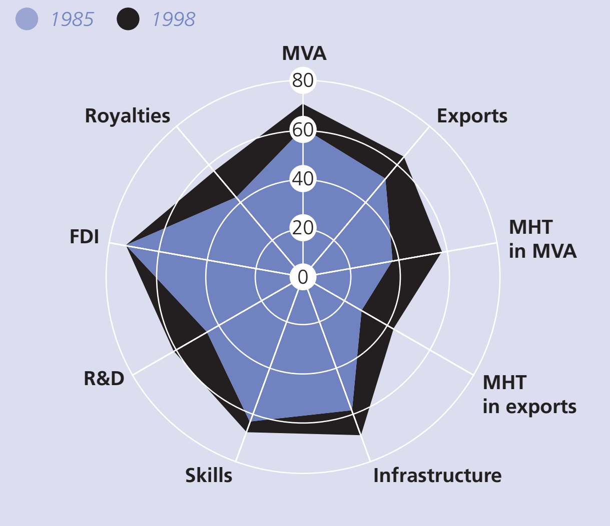
Between 1985 and 1998 the share of medium- and high-tech products in Zimbabwe's MVA and manufactured exports declined (figure A4.16). As a result, the country lost 16 places in the ranking for export structure and 21 places in the ranking for MVA structure. Zimbabwe ranks relatively well in the region in human capital, coming second (after South Africa) in the skills index in 1998. But that ranked it only 68th in the world, three places lower than in 1985 (figure A4.17). As in most Sub-Saharan African countries, enterprise-financed R&D is negligible in Zimbabwe, and it has fallen in the R&D ranking because of the entry of countries above it with some R&D. Foreign direct investment inflows rose from zero per capita in 1985, but remain at very low levels—with little going into manufacturing and almost none into export-oriented manufacturing. Royalty payments have declined marginally despite exposure to competition. And infrastructure has declined in relative terms.

Thus Zimbabwe has failed to capitalize on its initial industrial advantages. Part of the reason for this is political, but structural factors also explain why its enterprises have failed to cope with international competition.[29] The liberalization of the economy has not been accompanied by measures to improve drivers, and there is a serious risk that the existing base of learning and capabilities will be eroded.

United Republic of Tanzania. In the United Republic of Tanzania MVA declined by 2 percent a year between 1985 and 1998. The country's manufactured exports grew by 3.8 percent a year, but from a tiny base. Medium- and high-tech products accounted for only 1.5 percent of manufactured exports in 1998 (down from 2.3 percent in 1985) and for 25 percent of MVA. The country fell in the rankings in each of these indicators (figure A4.18).

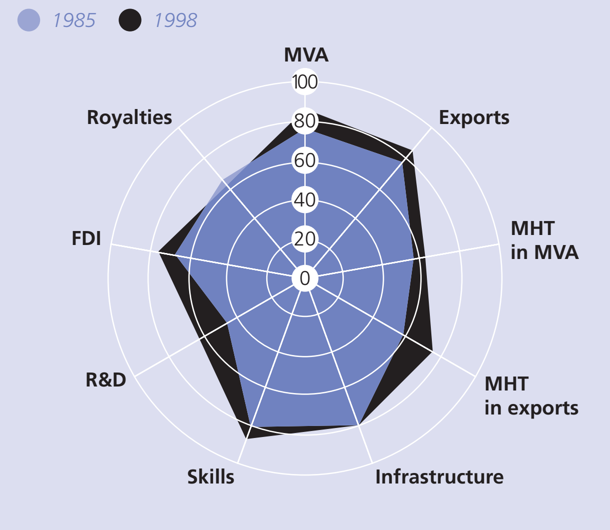
The base of capabilities in the United Republic of Tanzania is very weak. The country ranked lowest in the world in the skills index in 1998, having fallen in the ranking since 1985. Its R&D effort is negligible. Inflows of foreign direct investment amounted to

Figure A4.17 Changing ranks in industrial performance indicators and drivers for Zimbabwe



Source: UNIDO Scoreboard database (see technical annex).

Figure A4.18 Changing ranks in industrial performance indicators and drivers for the United Republic of Tanzania



Source: UNIDO Scoreboard database (see technical annex).

only $3.3 per capita in 1998; though the investments flows had increased since 1985 ($0.4), they have been directed largely to resource-based activities. Royalties are minuscule, and infrastructure among the poorest. But while Bangladesh, with even weaker infrastructure, has managed to build manufactured exports on the basis of clothing, the United Republic of Tanzania has failed to do this despite even lower wages. Studies show that capabilities at the enterprise level are weak even by Sub-Saharan African standards. Simple entry-level activities such as clothing and footwear are dying in the face of import competition from Asia.[30] The country's institutional structure for supporting industry is fragmented and ineffective.[31]

The United Republic of Tanzania seems to epitomize the problems facing the least developed countries in industrializing in an open environment with weak industrial structures and capabilities. There is no quick fix for these structural problems: the drivers of industrial growth have to be improved in all dimensions. This is difficult, in part because least developed countries also often lack the capabilities needed to design and implement the necessary strategies. Merely opening to global market forces is not enough. That is exactly what the United Republic of Tanzania has done, with meagre reward. The challenge is to find strategies within the reach of least developed countries—and the financial and, even more important, human resources that they need to mount those strategies.

Notes

1. Macroeconomic variables extensively analysed by other institutions—inflation rates, real effective exchange rates, interest rates and so on—were left out of the benchmarking analysis. And several more structural variables were quantified but discarded because of poor data or lack of theoretical justification. The list of drivers may, of course, be enlarged in subsequent editions of the report.

2. See Amsden (2001), Rodrigo (2001) and Lall (1996). This conflict may resolve itself once R&D capabilities are established. The experiences of Ireland and Singapore also show that with careful targeting, incentives and skill building, it is possible to induce transnational corporations to invest in local R&D (see chapter 2).

3. The correlation coefficients between the two years are 0.950 for Harbison-Myers index, 0.876 for tertiary technical enrolments, 0.896 for R&D, 0.895 for foreign direct investment, 0.399 for royalties and 0.958 for infrastructure. Each is significant at the 1 percent level.

4. The ranking of economies by structural drivers cannot capture changes in the nature or quality of a driver, however. A stable rank by inward foreign direct investment for a country, for example, may coincide with a change in the orientation of the investment from domestic to export production or from manufacturing to services.

5. With all its simplifications the Scoreboard manages, with parsimonious use of data, to identify and provide information on important structural features of industrial performance. The trends revealed are reassuring, since it would be difficult to take seriously an exercise that yielded intuitively implausible results. Even so, some detailed findings are unexpected. Much can be done to improve the Scoreboard, of course. New variables can be added as meaningful and comparable cross-country data emerge. The measures can be refined—say, with finer disaggregation of technological categories in production and exports. And they can be extended over longer periods, which would give a clearer and more robust picture of trends and lags. Future editions of this report will carry improved versions of the Scoreboard.

6. Patents taken out internationally are often used as a measure of inventive output of high quality (for example, by Cantwell and Janne 1998 and Porter and Stern 2000). But the use of patents—domestic or international—as an indicator of inventiveness is subject to caveats. Many patents are not exploited and so do not constitute "technology" in terms of practical application. Even the number of patents used in production may not indicate their economic significance. But because taking out patents in the United States is expensive, the practice tends to be confined to large innovators likely to exploit the patents in their activities or use them as a legal instrument for trading technology with other companies. This makes international patents a better indicator of inventiveness than local patents.

7. The Scoreboard uses R&D as the variable for technological effort because it is more relevant to developing countries than patenting in the United States.

8. This diversity is not surprising, as benchmarking (with indicators normalized by population) leads to fairly low scores for all these countries. But the underlying structural differences have to be borne in mind when using the Scoreboard for further analysis.

9. The two ratios—R&D spending per unit of high-tech exports and R&D spending per unit of inward foreign direct investment—are strongly correlated, with a coefficient of 0.745 in 1998.

10. But note the enormous difference in R&D per capita between the Republic of Korea ($5.90) and Japan ($100.40).

11. See, for example, Best (2001), Hobday (1995), Lall (1996) and Mathews and Cho (2000).

12. Wong (1999b); Rasiah (2000).

13. OECD (1999a).

14. Although the R&D measure is perhaps a crude one with respect to informal technological effort, there is still likely to be a real correlation between R&D and the intensity and quality of informal effort.

15. The unmeasured influences captured by the developing country dummy variable grow less important over time. Thus while being a developing country had a negative effect on performance in 1985, this effect vanishes by 1998, when structural drivers explain much of the variation in performance.

16. This is based on data from the Hong Kong Census and Statistics Department (http://www.info.gov.hk/censtatd/eng/hkstat/hkinf/production/production_index.html). The index of production for all manufacturing industry stood at 103.1 in 1999 and 100.9 in 2000, with 1986 = 100.

17. The data are from Banco de Chile (http://sie.aplicaciones.cl/basededatoseconomicos/900base.asp?usuIdioma=I) and are in constant Chilean pesos.

18. These examples illustrate how the balance between industrial performance and its drivers may be interpreted and used. But the simplifications and approximations inherent in many of the measures must always be borne in mind: the Scoreboard is meant as a preliminary guide, not as a honed tool for precise measurement. Moreover, its practical use requires the analyst to adapt it to specific needs and to seek more information.

19. Wells and Wint (1990); Barry (1999); O'Hearn (1998).

20. UNCTAD (2000).

21. Cimoli (2000).

22. UNCTAD (2000).

23. Spar (1998).

24. UNDP (2001, box 4.2).

25. See for example Lall (1996).

26. Lall (2001b).

27. Lall (2001b).

28. Lall and others (1997).

29. Lall (1999b).

30. Lall (1999b).

31. Lall (2001b).

Part 2
Laying the foundations for industrial competitiveness

5 Innovation and learning to drive industrial development

Countries can sustain industrial growth today only if the key players—individual enterprises—are able to develop competitive capabilities. Building capabilities requires conscious technological and other effort. And this effort is not very different whether an enterprise is creating new technologies or learning the efficient use of technologies brought from other countries. Whether such effort is undertaken, and how well it is managed, varies from enterprise to enterprise, according to its management, strategy and resources. But it also depends vitally on the economic environment in which the enterprise functions.

The environment reflects complex interactions among the incentives, factor markets and institutions facing an enterprise. Incentives are the signals emanating from the market: competitive pressures at home and abroad, growth prospects and the like. Factor markets include all the inputs that enterprises need, from information and capital to skilled and unskilled labour, components and infrastructure. Institutions are both the rules of the game (legal and cultural) and the intermediary agencies (standards, quality, training and so on) that supplement or embody factor markets. Each country has its own mixture of incentives, factors and institutions, reflecting its history, policies and business practices. These form an innovation and learning system. A strong system tends to produce a larger number and diversity of competitive industrial enterprises, a weak system relatively few.

The primary incentives for technological effort arise from competition, which reflects the structure of the market and government policies on trade, foreign direct investment, ownership and domestic competition. A more competitive setting generally results in greater technological effort, with one important caveat—there may be legitimate reasons to protect infant industries to help them overcome the initial costs of learning (see below). Flexible and responsive factor markets are vital to building and deploying industrial capabilities. Clear and supportive rules of the game induce enterprises to make long-term investments in innovation and learning. And efficient intermediary institutions are essential to help enterprises undertake the kinds of effort they cannot manage on their own. The learning process for the enterprise remains difficult and uncertain, but its progress and dynamism depend on the system in which it is embedded.[1]

Countries undergo costly, uncertain, prolonged and unpredictable learning, even when the technologies are well known abroad. Entry into different technologies involves different innovation and learning processes, and the difficulties rise with the depth of capabilities acquired. Just opening to international trade, investment and knowledge flows does not ensure that countries learn efficiently, though many policy analysts often assume that it does. And when a new technology is launched, using it in production does not by itself ensure that enough learning occurs. In other words countries need to engage in purposive and directed effort to create new capabilities and to capture the externalities generated by collective learning. They have to provide ample access to new information and knowledge, but they also have to promote domestic investment in learning.

National industrial innovation and learning are path-dependent and cumulative. The initial base of capabilities and learning determines how well countries cope with new technologies. Patterns of specialization are difficult to change quickly. Growing national technological maturity requires the industrial sector to move from easy to complex technologies and, within given technologies, from know-how to know-why. At each stage, there may be costs, risks, delays and externalities, all likely to rise at higher levels of technology and capability development.

In the less developed countries incentives are often skewed, factors lacking and support organizations missing or irrelevant. This makes triply daunting the challenges facing the smaller enterprises that dominate these economies.

This chapter looks at the process of innovation and learning at the enterprise and cluster level. It shows what it takes for enterprises and clusters of enterprises to become competitive in today's fast-moving global economy. It focuses on efforts to link up with global players to acquire new technology—and to leverage those acquisitions in ways that get as much as possible from the new relationships.

Becoming competitive takes a lot of effort

Becoming competitive does not mean seeking temporary advantages that can raise market share for a short period through currency depreciation and wage cuts that tend to forgo longer run possibilities—known as the low road to competitiveness. Sustaining growth in the long run entails strengthening competitive advantages and building new capabilities on the high road to competitiveness. In today's technology-driven world, whether a country takes the high road depends mainly on the extent and efficiency of its enterprises' enhanced adaptive capabilities to deploy new production and management technologies, upgrade them over time and ultimately create new technologies. This whole set of activities and capability building is here termed *innovation and learning.*

Enterprises do not build industrial capabilities on their own. They react to signals from markets. They draw on information, skills and inputs from others—not just suppliers and customers but also competitors. They raise funds in capital markets to finance innovation and learning activities. They seek skilled workers from labour markets, at least where the local economy has the new skills they need. They similarly seek specialized technical assistance from technology institutions like standards and quality agencies, research and development (R&D) institutes and universities and technical extension bodies. Innovating and learning are interactive processes that work best in dense networks of efficient enterprises, institutions and markets.

Enterprises thus innovate and learn as parts of a collective larger, interconnected group.[2] They have to manage and adapt their internal systems of control, interaction, information and effort to absorb or create new understanding. Each of them has its own culture and way of doing things, some better suited to innovation and learning than others. Adapting enterprise routines to competitive pressures is slow and evolutionary—not instantaneous, as is assumed in economic models of enterprise behaviour.[3]

Since capability building occurs in specific market and institutional contexts, its pace, depth and spread depend on the efficiency of markets and institutions. Not surprisingly, the process faces more difficulties in developing countries than in industrialized countries because of their far greater market and institutional deficiencies. In many developing countries, building competitive capabilities even in simple, low-tech activities is demanding. And technical change is a process of continually raising the thresholds.

The success of enterprises (and clusters of enterprises) in upgrading their capabilities depends on many factors, not all of them under the enterprises' control. Apart from its own efforts, which count for a lot, it needs access to information (accurate and current) and to knowledge and expertise. It also needs infrastructure—in the form of, say, basic and dependable power supplies. If it is an exporter, it needs access to export facilities, such as a reliable airport, and honest and efficient customs services. It also needs intangible infrastructure, such as efficient corporate administration agencies free of graft and corruption. Lack of these features all too often bring down small, local enterprises, despite their best endeavours.

The interactions inherent in innovation and learning constitute a coherent (if chaotic) system of incentives, factors and institutions to which firms and clusters respond in their technological effort. Reflecting the quality, density and interaction of the various elements, such systems can differ greatly in their ability to stimulate or retard innovation and learning. And given market and institutional failures, their efficacy also reflects the impact of government policy on the various elements. Governments can improve some elements of the systems. More important, they can coordinate the many elements to form a coherent strategy for industrial and technological development. Where this has been done efficiently, as in some East Asian economies, the results have been spectacular.[4]

If technology exists elsewhere and it can be transferred, surely all that developing countries need to do is to allow it to flow in? According to conventional wisdom, this requires countries only to open their economies to inflows of investment and knowledge, set the framework conditions right and allow competitive markets to allocate foreign and domestic resources to their appropriate uses. Competitiveness must follow if these things are done. In this view technology is considered something of distinct and separate concern only to economies at the frontiers of basic research and innovation: processes of technological change and innovation are not thought central to development efforts.

This greatly oversimplifies the industrial process. It assumes that technologies can be fully embodied in machines, blueprints, instructions and so on, and moved like physical products to new locations and deployed efficiently without further effort. This can be very misleading, for technology has many tacit elements that require a new user to build skills, knowledge and institutional routines (capabilities). Mastery of these tacit elements is needed everywhere, but it is particularly difficult in developing countries, where enterprises lack the initial base of technical skills and knowledge on which to graft new technology. Enterprises have to learn to learn.[5] And there often is fairly little in the local industrial environment surrounding them that can help them in their learning process.

The capability-building process is uncertain and incremental, thus far removed from the optimizing process of textbook theory with known and certain outcomes. How efficiently technologies are used depends on the efficacy of this evolutionary effort. There is no predictable learning curve for all enterprises to travel down.

Enterprises do not have a clear knowledge of the available set of technologies or of how to operate any new technology efficiently. Finding the right technology at the right price involves cost and risk, particularly for enterprises in a developing country. Using the new technology involves further effort to master its features: it entails search, experimentation and new information and learning. Making the technology work efficiently under new conditions involves further effort to adapt it to local demand, scales of production, worker skills and raw materials.

Technological effort does not end with mastery. All technologies can be improved by minor adjustments, calling for further effort and new capabilities. If the international frontier in the technology moves ahead—as it nearly always does—the firm has to adapt and master the new versions to stay competitive. At some stage, a dynamic enterprise may separate its monitoring, learning process, improvement and related functions into a separate formal R&D department, with its own budget and management. This department need not devote itself to creating 'breakthrough' innovations. Much R&D, even in developed countries, is devoted to monitoring, copying and adapting the innovations of others. And in developing countries the main function of R&D is to leverage, learn, adapt and improve imported technologies.

While using any new technology effectively involves building new capabilities, the uncertainty and difficulty vary from case to case. And they rise with the complexity of the technology and the novelty of the effort. The effort depends on three things: the initial capabilities of the enterprise, the support it can draw upon from the enterprise's environment and the novelty of the technology relative to its existing stock of knowledge. The same technology may be almost costless to absorb for an enterprise in an industrialized country but very costly and difficult to learn for an enterprise in an industrializing one.

Technological efforts can occur almost anywhere in the enterprise—in R&D, on the shop floor, in process or product engineering departments. The ideas and impetus may come from these units or from marketing, procurement or quality management. They may also come from outside the enterprise. Indeed, much technical information comes from equipment and material suppliers, contractors and buyers (particularly from discriminating foreign buyers). And some can come from extension services, technology institutions, universities, trade fairs or even competitors. Ultimately, however, capability building is institutional: it has to reach through the whole enterprise and reach all members—otherwise it cannot affect performance.

A very similar process of capability building has to take place in such non-technical functions as marketing, procurement, training and financial management. The technical and other processes have to interact and influence each other, since building capability often involves changing institutional processes or routines and launching new ways of managing information and people. The organizational aspects of innovation may be as important as the technical.[6]

The whole innovation and learning process is a conscious and purposive activity—and often uncertain, costly and difficult activity—by the enterprise interacting with the environment. That is why this report treats innovation and learning as different aspects of the same process of building new capabilities (table 5.1).

Start small and see what you can become

Enterprises in developing countries generally start the innovation and learning process by importing new technology; they then invest in building their capabilities to master the tacit elements (figure 5.1). How much they invest depends on the incentives thrown up by markets, mainly by the competition faced in foreign and domestic markets. Enterprises draw upon internal and external resources to build their capabilities. The process starts with capabilities needed to master the technology for production purposes and may deepen over time into improving the technology and creating new technology.

Linking, leveraging and learning captures what firms—and countries as well—have to do to foster their technological development.[7]

- Linking—connecting with outsiders to acquire needed technologies and skills.
- Leveraging—going beyond arms-length transactions to squeeze as much as possible from the new relationships with those outsiders.

Table 5.1 Technological and organizational capabilities within firms

Nature of capacity building strategy and effort	Investment		Production		
	Pre-investment	Project execution	Process engineering	Product engineering	Industrial engineering and HRD
Basic					
Simple, routine: based mainly on internal effort and experience	Pre-feasibility and feasibility studies, site selection, scheduling, arranging finance	Routine engineering of civil works, ancillary services, erection and commissioning	Debugging plant; routine process coordination; quality management; routine maintenance; process quality certification	Assimilation of basic product design; product quality management and certification; minor adaptations to meet market needs	Workflow scheduling; time/motion studies; innovative management and optimization; skill upgrading and training
Intermediate					
Adaptive, duplicative: based on search, experimentation and inter-firm and other cooperation	Search for sources of technology, equipment. Contract negotiation	Equipment procurement, detailed engineering, staff recruitment and training	Capacity stretching; adapt/improve technology; use new techniques (JIT, TQM, etc.); routinized process engineering; preventive maintenance	Product quality/ design improvement; licensing new technology; reverse engineering; continuous monitoring of global technologies	Continuous and systematic productivity analysis and benchmarking; skill audit and formalized training; supply chain/logistics management; advanced inventory control
Advanced					
Innovative, risky: based on purposive effort, R&D and advanced forms of collaboration	Own project outline and design capability. World class project management capabilities	Basic process engineering, equipment design and start up. Turnkey capability	Continuous process improvement; process innovation; basic research; use of new process design methods. Organizational capacity for generating, codifying, socializing knowledge	Mastery of product design methods; new product innovation; basic research. Strategic alliances. Organizational capacity for innovation and risk taking	World-class industrial engineering and supply chain capabilities, training systems, inventory management

Source: Based on Lall (1992).
Note: HRD is human resources development. This is only an illustrative list of capabilities within a manufacturing firm. It does not include several types of capability, such as financial management, labour relations, logistics and so on.

- Learning—making the many efforts to master process and product technologies, consciously building the foundation for improving current technologies—and creating new ones.

Enterprises have to start somewhere. Most latecomer enterprises in developing countries start with few resources and few connections. They need to acquire a minimal complement of skills, resources and capabilities just to be players. How this is done depends on a variety of circumstances. An enterprise may be a traditional supplier to an enterprise in a traditional industrial sector like textiles that is suddenly hit by policy reforms that bring in foreign competition—or gets taken over by a more enterprising entrepreneur. It may be a staid family operation that is taken under new management by a son or daughter who has received a business education abroad. It may be a government-owned enterprise that is privatized, beginning life anew in a competitive world.

Whatever the process, enterprises have to start with its initial complement of resources, technologies, skills and capabilities. And it is what it does with these things that counts. The most important thing that an enterprise can do is to accelerate its acquisition of capabilities by looking overseas to obtain

Technology		Marketing	
Domestic	Foreign	Domestic	Foreign
Local procurement systems and procedures, drawing in available knowledge from institutions	Foreign sourcing; information from suppliers; industry networking; accessing public information	Market research; distribution and servicing systems; some advertising	Export market analysis; links with buyers and other export channels. Design/ packaging capability
Technology transfer to and from local suppliers/buyers; coordination in design and manufacture; links with technology and other institutions. Capacity to take collective action	Vertical technology transfer; systematic coordination of international knowledge sources; links with technology institutions overseas	Dedicated marketing department. Systematic monitoring, feedback analysis. Branding and differentiation	Systematic market building and analysis of foreign markets. Alliances and networks abroad. Brand introduction. OEM arrangements
Continuous links with R&D institutions and universities. Licensing own technology to others. Deep innovative links with other firms. Specialization in context of networks and clusters	Cooperative R&D; strategic alliances; advanced leveraging strategies for new technologies. Foreign acquisitions, direct investment	Advanced brand creation; coordination with retailers/ buyers; advanced distribution systems	Brand deepening. ODM and OBM arrangements. Own marketing and design channels and affiliates abroad

information, purchase machinery, acquire bits of technology, bring in consultants and so on. An important part of this can be linking up with other enterprises or institutions, locally or overseas, through formal or informal ties (box 5.1). Strategically it makes a lot of difference what choice is made—but the choices are also heavily constrained by the enterprise's competence and the options available to it.

The linking, leveraging and learning strategy of industrial innovation has to start with an in-depth analysis of key factors of competitiveness, and the various options for linking a developing firm to sources of knowledge. This *linking* stage has to provide answers to the questions: Where are we, and where do we want to go? This step also includes the identification of partners with whom capability enhancement is feasible. The *leveraging* phase requires a strategic choice and specifies the means of knowledge acquisition. It answers questions of the type: How do we get what we want? The final step involves the actual process of capability enhancement through *learning*. Different forms of learning are feasible—there is learning by doing, learning by interacting, learning by monitoring, learning by formal training. The choice will depend on the type of linkage and leverage involved. The learning process is difficult and complex; it lies at the heart of the arduous process of industrial innovation and development.

Capturing linkage opportunities is thus just half the story for latecomer enterprises in developing countries. The other aspect is the way that enterprises use the links established to leverage skills, knowledge and technology from the enterprises contracting with them. This is what drives the process of technological innovation within a networked system.

So, if resources are lacking, leveraging them from external sources is the obvious way to proceed. The concept of *resource leverage* comes from strategic management of firms.[8] The concept has been used as a means of explaining how the best competitors in the world stay abreast of new developments, by ensuring that through alliances and various forms of joint ventures, they identify and secure access to the resources needed to keep diversifying their product portfolio. But the same idea underpins the strategy of enterprises in developing countries.[9]

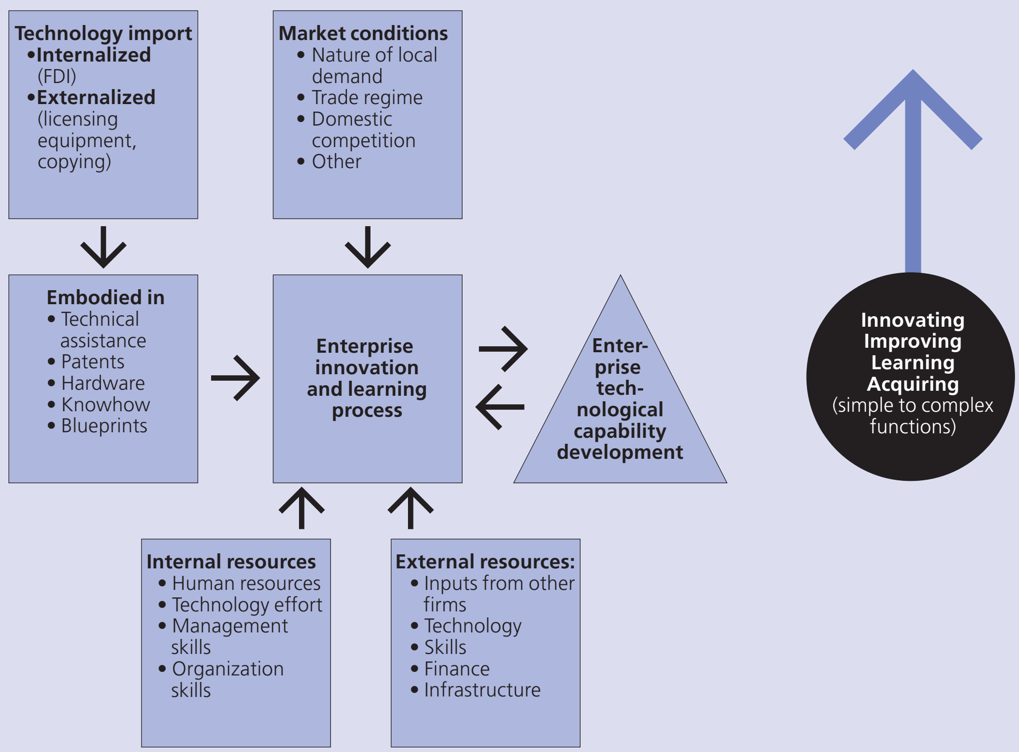
Using technology better

For enterprises using existing technologies at levels below best practice, innovation and learning can lead to better use of technology—to higher capacity use, lower reject rates, reduced inputs or improved product quality. Much innovation in developing countries is of this type. And it does not require much in new investment—critical here are the learned capabilities.

Bedi Investments in Kenya exemplifies an enterprise in a new phase of its technological learning trajectory. A textiles and garments producer, Bedi has been building its basic competences, using international standards—in this case International Organization for Standardization (ISO) 9000 quality manufacturing standards—as its benchmark. Such standards represent the minimum attributes an enterprise needs to enter world markets and claim a place in global networks.

Bedi was established in 1972 by a Kenyan entrepreneur as a small family-run garment firm producing for the local market.[10] Over the years, it integrated backward into making fab-

Figure 5.1 Enterprise innovation and learning



rics and yarns—and emerged as one of the most modern integrated textile-garment plants in the country. Now managed by the founder's three sons, all graduates in engineering or business from schools in the United Kingdom, it has a good base of technical staff by local standards (2 percent of employees are engineers and technicians).

Bedi's adoption of ISO 9000 in the early 1990s was stimulated by a foreign buyer that provided Bedi with information about the ISO programme and helped with implementation. Initially, the buyer arranged for an audit by a qualified consultant from abroad. It then helped Bedi implement the post-audit changes, including purchases of new equipment, calibration tests, training of workers and quality personnel and a detailed monitoring system. The buyer also helped Bedi with verification and certification by an independent accredited agency. In 1994 Bedi had a 26-strong quality control department (7 percent of employees), and its internal reject rate was under 1 percent. The ISO 9000 system doubled Bedi's labour productivity growth to 6 percent a year (between 1984–1989 and 1989–1994).

Bedi now has good capacity to search and negotiate terms for imported technology. It has one of the best production capabilities in the Kenyan garment industry (a strong emphasis on quality control, well-maintained equipment, negligible equipment breakdown rates and frequent changes in plant layout). And it has good technological linkages with foreign buyers and equipment suppliers. But it still lacks independent design capabilities, relying heavily on foreign buyers for product designs, common for enterprises in the early stages of export development.

Another good example comes from Tema Steel, set up by the Ghanaian government in the late 1970s to smelt steel from scrap and to make billets and rods for the construction industry.[11] A British firm set up the plant on a turnkey basis with almost no participation by local personnel. The turnkey supplier recruited and trained staff, but the local base of steelmaking capabilities was practically nil. One of the two blast furnaces could not be made to work, the layout was highly inefficient and the training was insufficient to ensure the smooth operation of the technology.

Box 5.1 Linking up with others—to start the processes of leveraging and learning

The interlinked character of economic systems provides the opportunities for enterprises to make connections with potential sources of technology and skills. Enterprises operate in clusters, or in value chains of one kind or another, some implicit, others explicit, some tightly organized, others not. Some links involve providing services directly to a leading enterprise, either upwards in the value chain as a supplier, or downwards, as a distributor (based frequently on FDI arrangements). Some involve outsourcing and original equipment manufacturing (OEM) contracting. Some involve technology licensing. Each of these represents a strategic choice for the lead enterprises, but it is precisely these choices that create opportunities for developing country latecomers, which they are quick to seize and to turn into opportunities for leveraging and learning.

FDI links: forward and backward linkage

The simplest linkages involve being engaged in contractual supply of goods or services. Transnationals moving into a new market usually need local firms as suppliers of maintenance services or as suppliers of simple materials and components. These can be upgraded to encompass more demanding tasks, involving more added value, as the incumbent builds longer term relations. These are captured in many countries as "vendor partnership" programs—such as the Intel vendor partnership program with supplier firms in Malaysia. These are all described as backward linkages.

Correspondingly, forward linkages can be established when a local enterprise takes on the distribution of a product range for an existing incumbent, often on an exclusive basis in the local enterprise's domestic market. Many of today's giants from the developing world, such as the information technology firm Acer from Taiwan Province of China, began life as such simple distributors of advanced enterprises' products, taking advantage of these forward linkages to leverage knowledge and market access from their partner.

Outsourcing

In the 1960s and 1970s advanced firms in industrialized countries exported some of their manufacturing of mature products to low-cost production platforms in Asia and Latin America, as many garment companies did with the cutting and sewing parts of their value chains. Latecomer countries benefited from these decisions in raising their "social capital", and soon individual latecomer enterprises were bidding for parts of the manufacturing cycle, as for testing and packaging activities in the semiconductor industry.

OEM contracting can be considered a form of outsourcing where the activities contracted to a third party are critical, high value-adding parts of the process entailed in contracting to manufacture the entire product. Electronics and information technology companies like IBM, Apple, or Texas Instruments outsourced the production of entire products like personal computers to latecomer firms in East Asia, securing strategic advantages in low-cost production, but also offering the latecomers valuable learning and leveraging opportunities. Many personal computer firms in Taiwan Province of China—Acer, Mitac and Tatung—established themselves with the help of such OEM contracting.

Second sourcing is a related concept, where a supplier of critical high-tech products like memory chips or logic chips seeks an outside "second source" to back up its own supplies (in case of problems in meeting a customer's order) or to take over the more mature products as the innovator moves on to the newer products. Again, this strategy on the part of incumbents creates numerous opportunities for an agile latecomer to grasp a business opportunity and use it as a leveraging and learning experience.

Technology licensing

Samsung from the Republic of Korea got into semiconductors by securing a product design from Micron, a small U.S. firm. Later, Samsung secured access to microprocessor technology by licensing it from DEC (which became part of Compaq, which is now part of HP). DEC's interest was served by widening the field of applications for its Alpha chip.

Source: UNIDO.

Later, an Italian consultancy was brought in, again on a turnkey basis, to set up an expensive casting machine and a foundry. It also changed the rolling mill to enlarge its product range, making its operation even more complex. Again, given the lack of local capabilities, neither the casting machine nor the foundry could be brought into operation by Tema Steel, and operational efficiency declined even further. Some 17 years after starting, the plant was running at only 10 percent of design capacity, with much of its main equipment unused, resulting in high costs and enormous losses. Much of the plant in use was badly in need of repair and upgrading. Very few qualified steel technicians or engineers were on staff, and the staff received practically no training. There was no systematic attempt to learn the technology better or to bring in new knowledge from outside. There was no supplier or consultancy industry locally for steel making, so there was no networking with other enterprises. As a result, few competitive capabilities were built over the 17 years of operation.

In 1991 the plant was sold to an Indian steel company, which brought in 17 employees with experience in steel (only two were graduate engineers) to take charge of the technical functions of the plant. With very little new investment in equipment, the new employees started to refurbish the machinery and improve maintenance and every area of operations.

Within a year capacity use was up threefold, with the rolling mill working two shifts and the furnaces three shifts for six days a week. The blast furnace that had never been used was commissioned by changing a few controls. The first furnace was upgraded to run continuously. The continuous casting machine was also brought into operation by inserting some missing items that the previous technicians had not even been able to identify. Various motors that had died from neglect were refurbished and put into use. The foundry was commissioned, and new refractory products developed. Quality management was improved to match UK standards (and so meet import competition). Training programmes were launched in-house for local staff in all technical functions, because most of the Indian temporary staff were due to return home in another year or two.

Tema shows what capabilities do for the operation of imported technology. It also shows how learning can be transfered from one developing country (where considerable learning had taken place) to another (where almost no learning of that kind had occurred).

Adapting and improving processes and products

Other manifestations of innovation and learning are improvements and adaptations to products and processes, drawing on in-house technical efforts, outside sources of knowledge and interaction with leading international enterprises. Minor improvements and adaptations are part of gaining capabilities in efficient production. But major improvements and adaptations require higher levels of enterprise skill and competence—and generally a more advanced industrial system and infrastructure.

Tatung, the largest electronics manufacturer in Taiwan Province of China, was one of the country's leading industrial conglomerates in the 1990s.[12] In 30 years it had advanced from making simple consumer electronics (black and white televisions) to computers, colour displays and television monitors. By the mid-1990s its electronics sales exceeded $1 billion and it had eight overseas subsidiaries (including those in the United States, Japan, Germany and Ireland).

Tatung initially assimilated manufacturing know-how by acquiring mature process technologies for household appliances and consumer electronics from U.S. and Japanese companies through technical assistance deals and joint ventures. It later learned many of its technological skills through original equipment manufacture or OEM, whereby Tatung undertook contract manufacturing of electronics products for foreign transnationals, for sale under their own brand names. Transnationals often assisted Tatung with selecting equipment, training engineers and providing advice on technology and management for OEM.

By the late 1980s Tatung was exporting about half its colour televisions, personal computers and hard disk drives under OEM. Most of this embodied little original R&D, but the company invested considerable effort in assimilating technology and closing process and product technology gaps with its competitors. It developed the ability to absorb and adapt advanced foreign technology and modify, re-engineer and redesign consumer goods for different types of customers in regional markets. Its in-house engineering capabilities were used to scale down production processes, adjust capital to labour ratios and implement continuous improvements in production technology. By the 1990s the firm had a 500-strong team of engineers and technicians doing applied R&D.

Having established sales offices in industrialized countries in the 1970s, Tatung later set up overseas production facilities to improve its competitive position in those markets, reinforcing its brand image and acquiring advanced technologies and skills. By the mid-1990s it had eight manufacturing operations abroad making televisions, washing machines, refrigerators and other household items. Thus by establishing plants overseas, Tatung now exports technology.

Moving up the value chain

An enterprise in the initial phases of industrial development in the typical developing country starts with simple assembly and packaging operations. If very successful in deepening its skills and capabilities, it can move into more complex manufacture—say, of critical components, which can be at a much higher technological level, involving far more sophisticated process management and larger scales. Semiconductor enterprises in Malaysia made such moves up the value chain, as affiliates of leading transnational corporations upgraded their facilities to run state-of-the-art process technologies at massive capacities.[13]

Further moves up the value chain are possible—right up to invention. The enterprise can do process or equipment design in complex technologies, take on product design and engineering and finally do basic or blue skies R&D. Most leading local enterprises in the Republic of Korea and Taiwan Province of China have reached this stage, as have many affiliates of transnational corporations in high-tech industries in Singapore. A similar progression is also possible in services—and does not need a highly developed industrial network or infrastructure. But there is still a discrete learning process that has to be undergone and financed. And having a base of skills outside the enterprise is critical.

ArtinSoft is one of the world's leading providers of database and programming language migration software. Its main product ("Freedom") is a programming tool that uses artificial intelligence technologies to enable enterprises to change their software systems into newer computing languages (Java, the Internet language; and Visual Basic, Microsoft's prime language). In eight years the firm has grown from three penniless new graduate engineers and their professor to a 200-employee enterprise, which has attracted the attention of global players such as Oracle and Intel.

Founded in 1993 and located, with two computers, in a rented farmhouse in the hills, the company was a spin-off of the

Institute of Technology in Cartago, Costa Rica. A teacher with a Ph.D. in artificial intelligence encouraged three of his best master's students in computer science to pursue his vision—the development of fast, secure and cost-effective migration software. To support their research, the foursome developed a "bread and butter" product, an Enterprise Resource Planning and Scheduling software product to support larger Costa Rican businesses. Close proximity to the clients, low cost and accessibility (in Spanish) made it a commercial success in Costa Rica and the region. With this product ArtinSoft acquired the experience and capital to develop "Freedom."

In 1998 Oracle asked one of its main clients, a large European software company, to approach ArtinSoft to manage an important migration project. The project was completed successfully and at very low cost. This gave it the opportunity to interact with world players and build a global reputation. It later attracted the attention of Intel Communications fund, which invests in companies working on porting applications. In February 2001 the Fund invested in ArtinSoft to upgrade and develop new migration systems to bring the applications closer to Intel's technologies.

ArtinSoft benefited from being in Costa Rica, which has one of the most qualified information technology workforces in Central and Latin America. This is so in part because the government's Informatica Educativa scheme, which provides each school with at least one computer and helps youngsters to develop skills in the new information technologies.

Moving into more complex activities

While all technologies need effort to leverage and learn, clearly there are differences in the intensity, cost, risk and duration of effort involved. All industries, even the simplest, have relatively difficult functions (clothing design) and all have relatively simple ones (final assembly and packaging). However, it still makes sense to describe an activity as "easy" on average if it has a preponderance of relatively simple functions. This is the justification for the divisions of high, medium and low technology. The greater the role of difficult technologies, the higher the level of technology in this sense. Final assembly and packaging are relatively easy functions in most industrial activities. Making critical components in large volume is more difficult. Designing new products or processes is even more difficult, while innovating on the frontiers of knowledge is the most difficult of all. At each stage, the building of capabilities becomes more difficult and costly, with growing demands on the supporting industrial environment and institutions.

Easy technologies can be learned fairly quickly, with few new skills, small amounts of new information and minor changes to organization. The assembly of clothing for export is easy in this sense. With a semi-skilled and disciplined workforce and a few knowledgeable technical and managerial staff, it is possible to set up a plant and reach competitive standards in a few weeks or months.

By contrast, difficult technologies need a long time and considerable accumulation of skills, knowledge, experience and organizational changes to master. The ability to efficiently run a large steel plant, a modern automobile factory (not a simple assembly plant) or a complex machine-tool manufacturing facility can take many years of cumulative capability building. Enterprises cannot become competitive without going through this process—no matter what their level of development.

Interactions among the three main areas of technological capability—production, investment and innovation—are also essential in moving into more complex activities. Operating productive facilities makes it easier to expand those facilities or to establish new ones. Such production and investment capabilities make it easier to develop new technologies that are cheaper and better suited to local conditions. And that innovation capability makes it easier to improve operations and undertake new investments.

Activities differ not only in their technological needs but also in the economic rewards they yield: in general, technologically complex activities yield greater development benefits to successful adopters, at both the firm and economy levels. Complex industrial activities offer greater scope for learning—and lead to learning more advanced and diverse skills. Technology-intensive activities generally offer better prospects for the continued application of new knowledge to production. So, activities that rely heavily on R&D (and have greater technological opportunity) enjoy a larger stream of innovations and so faster rises in productivity.

Note that the borders between these capabilities are blurred—and that their difficulty is in the eye of the beholder. Once possessed, the capabilities look easier. And as firms learn, what seemed difficult, or looked impossible, becomes easier. Unless they run into a technological brick wall.

Combinations and progressions

Brazil's Usinas Siderúrgicos de Minas Gerais SA (Usiminas) shows how successful technological development depends on a long-term effort to build systematically on foreign technological inputs and on accumulated experience. It also highlights the uncertainty and unpredictability of the technological trajectory. Usiminas started with foreign technical assistance but quickly absorbed it, adopting the imported technology and then building a capacity to adapt to the local operating conditions.Usiminas shows that an enterprise (or a country) does not need to do everything itself to expand and modernize its industrial production. It is possible to start with only the barest production capability and, with that as foundation, to build increasingly the base of other technological capabilities.[14] But this takes time—decades rather than years. There are no dramatic short-cuts to acquiring technological competence.

Usiminas traces its origins to the 1950s, when the Brazilian government and firms in the industrial province of Minas Gerais wished to build a steel firm capable of adding value to the region's iron ore production and of feeding steel to downstream industrial users. After much deliberation and intelligence-gathering (such as sending teams to visit foreign steel plants to gain first-hand experience of different processes) a decision was taken to start with coke-based blast furnace technology using a "basic oxygen" process rather than electric arc technology. Usiminas then entered a consortium with 30 Japanese steel makers and steel equipment suppliers. The Japanese arranged generous export credits for the required steel-making equipment and agreed to pass full responsibility to the Brazilians after they had developed sufficient capability to run the plant.

The firms in the Japanese consortium undertook the basic engineering and project management of the construction of the mill, working closely with local managers and providing training for Brazilian engineers in Japanese steel mills. The basic capabilities were acquired in this fashion. Start-up operations proceeded for three years under Japanese oversight.

With the Brazilian takeover a new administrative structure was put in place, and there followed six years of financial stringency during which the Brazilian engineers managed to double capacity without further investment. This was accomplished through a variety of testing and experimental approaches that allowed the Brazilians to "tweak" the technology inherited from the Japanese. New special steels, such as thick ship-plate, were introduced through licensing and technical assistance contracts. These efforts were undertaken in conjunction with intensive benchmarking of the plant's technical performance and procedures against foreign plants, in an effort to close the gap between the Usiminas operation and the world technological frontier.

Next came a period of expansion, as the government invested in greater capacity and as the market for the plant's steel expanded. The company had to develop a set of capabilities associated with investment, planning and project implementation, quite different from the capabilities involved in plant operation. The company's specialist engineering department was expanded to achieve these goals, working this time with a variety of equipment suppliers as well as the Japanese, and having foreign experts review the expansion plans as a precautionary measure. The company was by now providing technical advice to its downstream users, so much that it spun off a new business, Usiminas Mecânica, as a subsidiary to produce capital goods for the steel industry and foster the use of steel in Brazil's machinery and construction sectors. By then the company was in a position to export technical services to neighboring countries.

Technological capability within Usiminas reached the point that early in the 1990s the company could be successfully passed across to the private sector, where it has continued to perform well. By the late 1990s it was one of the top steel groups in Latin America.

Nine features of innovation and learning

The need for innovation and learning exists in all cases, even when the seller of the technology provides advice and assistance. But the extent and costs of learning vary by technology, enterprise and country.[15] Innovation and earning call for conscious, purposive and incremental efforts—to collect new information, try things out, create new skills and operational routines and forge new external relationships.[16] This process is strikingly different from textbook depictions of how technology is transferred and used in developing countries. Summarized here are the nine most important features of technology capability development.[17]

1. *Conscious and purposive.* Learning is a real and significant process. Vital to industrial development, innovation and learning are primarily conscious and purposive rather than automatic and passive.

2. *Risky and costly.* Enterprises do not have full information on technical alternatives. Instead, they function with imperfect, variable and rather hazy knowledge of technologies they are using. As a result, there is no uniform, predictable learning curve. Each enterprise has a different innovation and learning experience, depending on its initial situation and subsequent efforts. Each faces an element of risk, uncertainty and additional cost in innovation and learning.

3. *Not obvious.* Enterprises may not know how to build up the necessary capabilities. In a developing country, knowledge of traditional, stable and simple technologies may not be a good base for knowing how to master modern technologies. So, enterprises may not be able to predict

if, when, how and at what cost they would learn enough to become fully competitive, even if the technology is well known and mature elsewhere. This adds to the uncertainty and risk of the learning process.

4. *Path-dependent.* Firms cope with these conditions by developing organizational and managerial routines, which they adapt over time as they collect new information, learn from experience and imitate other firms. So, technological trajectories tend to be path-dependent and cumulative. Once embarked on, they are difficult to change suddenly (for countries and for enterprises), and patterns of specialization tend to persist over long periods.

5. *Highly specific.* The innovation and learning process is technology specific, since technologies differ in their learning requirements. For instance, some technologies are more embodied in equipment while others have more tacit elements. Process technologies (like chemicals or paper) are more embodied than engineering technologies (machinery, automobiles or electronics), and demand different (often less) effort. Capabilities built in one manufacturing activity may not be easily transferable to another, and policies to promote innovation and learning in one may not be very useful in another. Similarly, different technologies can involve different breadth of skills and knowledge, with some needing a relatively narrow range of specialization and others a very wide range.

6. *Many complex interlinkages.* Technological innovation and learning in a firm do not take place in isolation: the process is rife with externalities and interlinkages. The most important direct interactions are with suppliers of inputs or capital goods, competitors, customers, consultants and technology suppliers. Technological linkages also occur with firms in unrelated industries, technology institutes, extension services and universities, industry associations and training institutions. Many such linkages take place informally and are not mediated by markets. Not all are deliberate or cooperative: some learning involves imitating and stealing knowledge. Where information and skills flow around a set of related activities, clusters of enterprises and industries come together. Tapping these cluster effects can be very effective in accelerating technological competence.

   Different technologies have different degrees of interaction with outside sources of knowledge (enterprises, consultants, equipment suppliers or technology institutions). These differences in turn lead to different learning costs, risks and duration. A set of policies conducive to the development of one set of capabilities may therefore not be suited to another.

7. *Many levels of effort.* Capability building involves effort at all levels: procurement, production, process or product engineering, quality management, maintenance, inventory control, outbound logistics, marketing and other outside links. What appear to be routine and easy technical functions, like quality management or maintenance, can be very difficult to master in a developing country. Most learning in developing countries arises in such mundane technical activities. But formal R&D becomes important in complex technologies, where even efficient absorption requires search and experimentation.

8. *Many depths of development.* Technological development can take place to different depths. The attainment of a minimum level of operational capability (know-how) is essential to all industrial activity. This may not lead automatically to deeper capabilities, the ability to understand the principles of the technology (know-why). The deeper the levels of technological capabilities, the higher the cost, risk and duration involved. It is possible for an enterprise to use imported technologies without developing the ability to decode the processes to significantly adapt, improve or reproduce them—or to create new products or processes. But this is not optimal for long-term capability development. Without technological deepening the enterprise or country remains dependent on external sources for major expansion or improvement to its technologies—a costly and possibly inefficient outcome.

   The development of know-why is an important part of overall innovation and learning. It allows a firm to select the new technologies that it needs, lower the costs of buying them, adapt and improve on them more effectively, add more value by using its own knowledge in production and develop autonomous innovative capabilities. The lack of these deeper capabilities may also restrict an enterprise's ability to move up the technology scale—even in using higher levels of know-how in its given activity, diversifying into other activities or coping with unexpected demands of technological change. Note that even good follower strategies, in which enterprises efficiently imitate and adapt technologies developed by others (common for efficient enterprises in developing countries), require good know-why capabilities.

9. *Foreign plus domestic.* Technological interactions occur within and across countries. Imported technology provides the most important initial input into technological innovation and learning in developing countries. And since technologies change constantly, access to foreign sources of innovation remains vital to continuing technological progress. But technology imports do not substitute for the development of indigenous capability—the effi-

cacy with which imported technologies are used depends on local efforts. Domestic technological effort and technology imports are largely complementary. But not all modes of importing technology are equally conducive to indigenous learning. Much depends on how the technology is packaged with complementary factors: whether it is available from other sources, how fast it is changing, how developed local capabilities are and the policies adopted to stimulate transfer and deepening. Transfers internal to a firm, as from a transnational corporation parent to its affiliate, are efficient means of providing the latest know-how, but they tend to be slow in building know-why in the affiliate.

To sum up, considerable technological effort is involved in industrial development. This effort can be called innovation, since it differs only in intensity and emphasis (not in kind) from the effort to create new products and processes. Such innovation arises at any point in the value chain—from design and procurement to production, R&D and marketing.

Chapter 6 shows how firms and countries can build a foundation for ongoing innovation and learning by competing in global value chains. Chapter 7 describes what governments can do—legitimately and effectively—to help firms grasp new opportunities and solve technological problems. Chapter 8 makes the case that building competitive industrial capabilities needs extensive policy support—spelling out the framework imperatives, the elements of industrial strategy and the principles for government conduct of that strategy.

Notes

For further details on sources, information and the literature on subjects covered here, see the background papers.

1. Lall (1992).

2. Enos (1992).

3. Nelson and Winter (1982).

4. There is a large literature on the role of governments in industrial development in East Asia. See World Bank (1993), Amsden (1989), Wade (1990), Stiglitz (1996), Rodrik (1996), Westphal (forthcoming), Lall (1996) and Rodrigo (2001).

5. Stiglitz (1987).

6. Nonaka (1994); Teece (2000).

7. The linking, leveraging and learning framework comes from introducing a strategic perspective (from the literature of strategic management) to the prospects for a special kind of firm, namely the latecomer firm (see Mathews and Cho 2000 and Mathews 2001, background paper). Each of the terms has a long history—*linkage* from the literature on networks and global value chains, *leverage* from management strategy (Prahalad and Hamel 1990) and *learning* with sources too numerous to mention.

8. Prahalad and Hamel (1990); Hamel and Prahalad (1994); Mathews and Cho (2000).

9. Mathews (2002).

10. Wignaraja and Ikiara (1999).

11. Lall and others (1994).

12. Hobday (1995).

13. Rasiah (2000).

14. Dahlman, Ross-Larson and Westphal (1987).

15. Ernst, Ganiatsos and Mytelka (1995).

16. The theoretical antecedents are evolutionary theories developed by Nelson and Winter (1982). For extensions and related approaches, see Dosi, Teece and Chytry (1998) and Metcalfe (1995).

17. Based on Lall (2000).

6 Innovation and learning in global value chains

Global value chains spanning functions, processes and countries provide a means for accelerating the development of enterprises and countries, providing openings that developing country enterprises can exploit to upgrade their capabilities. For such enterprises, or local clusters of enterprises, the task is to insert themselves into the wider networks. This takes discipline, to attain the higher world standards. It also takes an initial base of technological capability, built through purposive innovation and learning. But the effort should be worth it, for it offers access to markets and the knowledge of players in the world economy.

The advantage of global value chains is that enterprises can seek involvement at their level of technological competence. In Mexico garment producers were vertically integrated in supplier networks that did not offer much scope for skills enhancement and innovation. With the North American Free Trade Agreement (NAFTA), however, buyer groups from the United States started to create alternative global value chains that offered enterprises much greater scope for expanding their functional responsibilities (from narrow job completion to design and manufacture), termed "full package" production. This replicates the experience decades earlier when electronics and garment contract firms in East Asia pulled themselves up the capability ladder to higher and higher levels in global value chains.

Competing in a global value chain can build a foundation for the industrial innovation and learning described in chapter 5. There are many paths for this:

- *Process innovation,* improving the efficiency of transforming inputs into outputs. Internal processes become significantly better than those of rivals, both within links in the chain (more inventory turnovers, less scrap) and between links (more frequent, smaller and on-time deliveries).

- *Product innovation,* leading to better quality, lower priced and more differentiated products, as well as shorter times to market for new products.

- *Functional innovation,* assuming responsibility for new activities in the global value chain. That can involve extending involvement from contract manufacturing to design and marketing or incorporating logistics within the contracted work.

- *Interchain innovation,* moving to new and more profitable chains. Enterprises in Taiwan Province of China moved from the manufacture of transistor radios to calculators, to televisions, to computer monitors, to laptops and now to Wireless Application Protocol telephones.

Some enterprises even latch onto several global value chains, providing further opportunities for linking to local enterprises connected with them (box 6.1). Such firms lift themselves—and those connected with them in supply chains—to new levels of performance and quality, driving forward the momentum of collective industrial development.

Such industrial learning is a long and strenuous process, with no short-cuts or magic solutions. The global value chains offer convenient structures to fashion this process, but they really offer only a starting point for the enterprise's technological effort.

Links in the chains

The metaphor of global value chains captures the links among enterprises spread across a variety of locations around the world (figure 6.1). These enterprises perform a sequence of related dependent activities to bring a product or service from conception through the different phases of production to delivery to final consumers and to final disposal after use. The metaphor of global value chains is now being joined by the metaphor of value networks of specialist enterprises, suggesting rays fanning out from nodes rather than links in a chain.

The global value chains are not just a teeming mass of complementary enterprises. They are an organized set of interconnected

Box 6.1 Jumping into the lead—in global value chains

The Ammar and Sarah knitwear group, founded in 1982, has been Pakistan's leading knitwear group since 1988 because of its international connections in global buyer- and producer-led global value chains—and its commitment to state-of-the-art technology and management. It now has a knitted products line encompassing men's and boys' wear and women's and girls' wear in cotton, knitted tops and bottoms, with and without Lycra, in a broad range of fabric finishes.

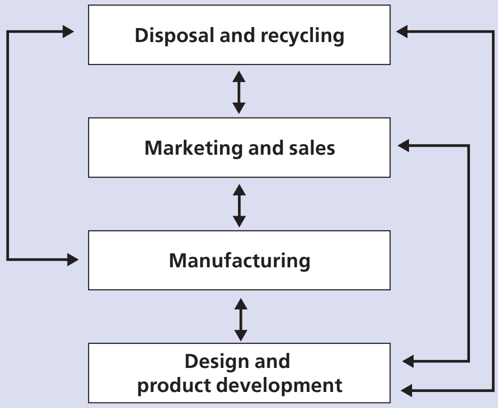
Ammar and Sarah's key to securing contracts from global buyers and producers is using the most advanced computer-aided technology, whether for washing, dyeing, cutting, knitting or stitching. That gives it great flexibility and lead time of 45 to 75 days in responding to new orders (not the full season lag in traditional firms). The company's major customers are all global buyers (Target, Arrow, Nautica, Haggar, Eddie Bauer, Vantage, Timberland, Alexander Julian Colors, Land Rover, Tommy Hilfiger, Nike and Damani Dada) or global producers (Levi Strauss and Sarah Lee).

Why the attraction of Ammar and Sarah? It can exploit its low labour and infrastructure costs (for as long as they last). It can purchase the most advanced technical equipment to provide flexible and high-quality manufacturing services. It can recruit graduates trained in advanced technical institutes abroad. And its entrepreneurial founders can put their Harvard business training to good effect. These are all ways for a new firm to accelerate its catchup. Unlike the incumbents, it is not burdened with technologies and practices inherited from earlier eras.

The prospects for Ammar and Sarah—prepared to make the international global value chain connections, to invest in state-of-the-art equipment and to compete on quality and speed of service rather than least cost—are promising.

Source: Ammar and Sarah marketing brochure (2000).

Figure 6.1 Simple value chain



Source: UNIDO.

networks of enterprises linked with each other through multiple interactions and linkages—a worldwide web of inter-enterprise connections. The focus of interest is not just on the enterprises. It is also on the shifting links and contractual relations among them. Enterprises expand their product lines, and expand internationally by forging new links with enterprises already active in the global economy, dominated by criss-crossing global value chains encompassing research and development, production, logistics, marketing and exchange, where all the links are between enterprises rather than between countries.

The global value chain provides two insights about innovation and learning. First, creating value is not confined to production. Products are brought to market through a combination of activities. So, innovation can involve improving capabilities in production, developing new capabilities outside production (design and marketing skills), diversifying customers and market destinations, developing the capacity to introduce new products or to imitate leading innovators quickly and successfully.

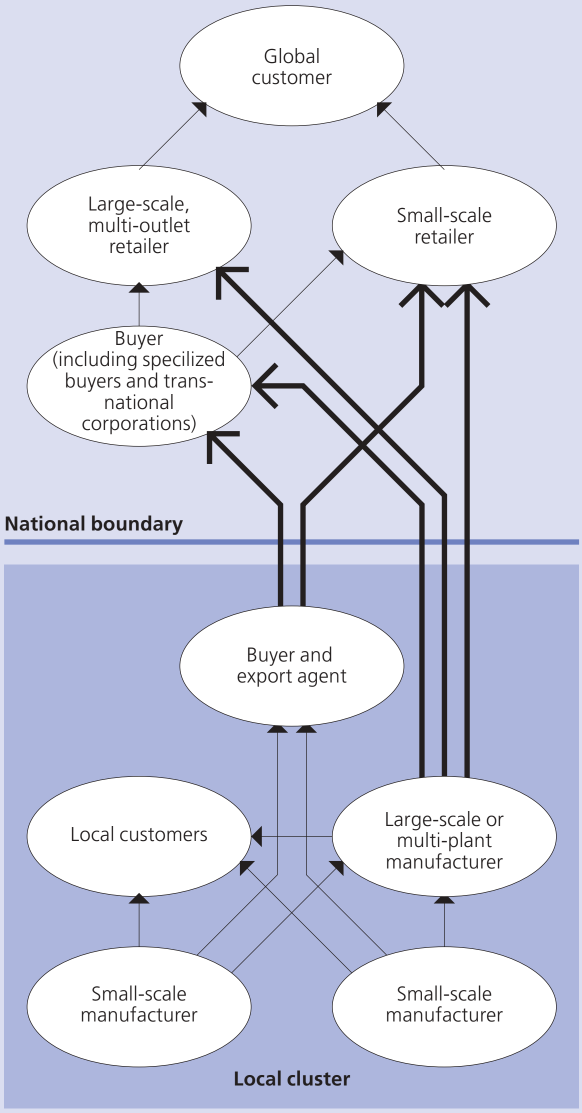
Second, more international trade is taking place between formally independent enterprises in networks than through arm's-length transactions or intra-enterprise trade. The lead enterprises in global value chains play a major role in organizing trade. They range from the transnational producers that source inputs from suppliers around the globe to the retail chains that do not make goods but organize production at locations around the world.

The impetus for the formation of these global value chains lies with enterprises in the advanced countries, either as buyers or producers. But the decision to latch onto these global value chains, or networks, lies with the latecomer enterprise in the developing country (figure 6.2). Links are not just between enterprises. Depending on the specific needs of a firm, it might be appropriate to link with universities or nonmarket institutions. The links can also be vertical (backward to suppliers or forward to clients) or horizontal (in consortia).

Crucial factors for latching onto the global supply chain are not only the hard facts of price, quality and punctuality but also the willingness to learn and to absorb advice from the lead enterprises. Global value chains can thus unleash enterprises—but they can also constrain them (box 6.2). A strategic perspective sees such linking and innovation possibilities as opportunities for enterprises, not as barriers to further development. Particularly in manufacturing, the insertion of local activities in wider networks is a great opportunity for developing countries to upgrade their capabilities.

The types of global value chains depend on speed of change, learning needs, scale economies, transaction and coordination costs, value-to-weight ratios and logistics. "Easy" technologies can give rise to buyer-driven chains, while "difficult" technologies with close coordination needs, proprietary technologies and the like can promote supplier-driven chains coordinated by transnational corporations. Some analysts distinguish global value chains that are buyer-driven from those

Figure 6.2 Linking local producers and global buyers



Source: Kaplinsky and Readman (2000).

Box 6.2 Pluses and minuses of being in a global value chain

In the late 1960s the Sinos Valley shoe cluster, in the South of Brazil, was made up mainly of small firms producing for the domestic market. With the arrival of buyers from the United States, and stimulated by local initiatives and Brazilian government export incentives, the characteristics of the cluster began to change. The buyers looked for large volumes of standardized products and encouraged a rapid increase factory size. They also helped their suppliers raise process standards and product quality. They also eased the considerable risks of entering export markets. They studied the market, developed models, worked out the product specifications, helped choose technology and organize production, inspected quality on site and set up transport and payment arrangements.

The firms in Sinos Valley concentrated on production and the organization of their own local supply chains, while the buyers were responsible for product definition (and hence, market knowledge) and logistics. This greatly reduced the investment and risks in entering export markets, but it also confined firms in the Valley to a narrow range of functions. Becoming very competent in these functions, they benefited from rapid growth in export sales in the 1970s and 1980s. But they also depended on the buyers, evident when Chinese producers undercut Brazilian products in the United States market in the early 1990s.

This is a danger inherent in global value chains. Global buyers actively scout for new sources of supply, and substitution by new sources is always a threat to existing suppliers. Indeed, some of Brazil's main buyers in the United States helped to build Chinese export capability. As a result, the Brazilian producers were faced with sharply declining prices for their products in North America. But by reorganizing their factories and local supply chains, they raised quality, reduced batch size and increased speed. Indeed, the buyers helped them switch to a new way of producing.

The advances in production were not matched, however, by advances in marketing—even though firms tried. The Brazilian producers worked out a collective strategy of raising Brazil's image in the world footwear markets, strengthening design capabilities, and exhibiting in significant numbers at the world's main trade fairs. But the proposed strategy was not put into practice, mainly because a small number of very influential export manufacturers did not support it. They feared that advancing into design and marketing would upset the relationship with their main foreign buyer, which accounted for more than 80 percent of their output and close to 40 percent of the cluster's output.

Source: Schmitz (1995, 1999b).

that are producer-driven (table 6.1). Global value chains can also be regional or national, providing a local latecomer enterprise with opportunities to be pulled into a wider network of activities through contracting its services to enterprises beyond its immediate environment.

Staying nimble in the turmoil of global value chains

Entering global value chains does not provide an automatic move up the capability ladder. It is often a fast track to acquiring production capabilities, but moving further up the chain can lead to conflicts with existing customers.[1] Some enterprises even have had their capabilities downgraded as a result of their integration in global value chains. So, it makes sense for latecomers to use all the resources they can acquire from the advanced world, in return for providing such services as low-cost manufacturing. But the tradeoff can be exploited to the advantage of the latecomer only if there is a strategic choice to use the links to gain knowledge—to learn.

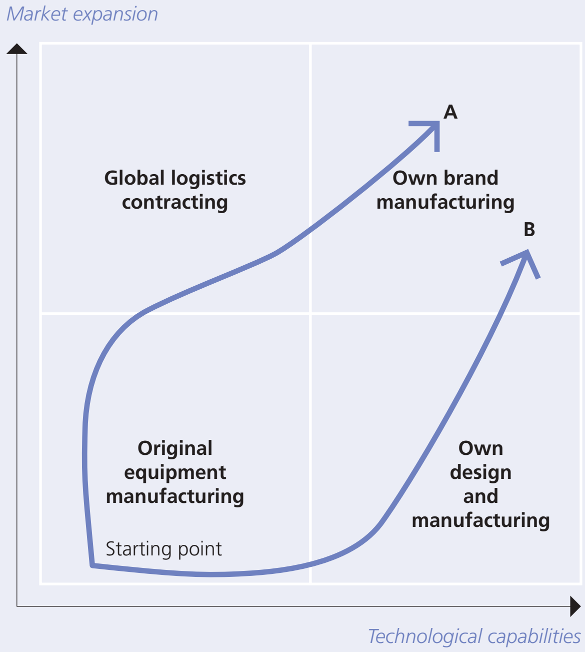
Innovation within global value chains moves along two dimensions of leverage strategies: market expansion and technological capabilities. Own brand manufacturing, usually the most

Table 6.1 Characteristics of producer-driven and buyer-driven global value chains

Characteristics	Producer-driven chains	Buyer-driven chains
Driver of global chains	Industrial capital	Commercial capital
Core competencies	Research and development (R&D), production	Design, marketing
Sectors	Consumer goods, intermediate goods, capital goods	Non-durable consumer goods
Typical industries	Automobiles, computers, aircraft	Apparel, footwear, toys
Ownership	Transnational corporations	Local enterprises, predominantly in developing countries
Main network links	Investment-based	Trade-based

Source: Gereffi (1999b).

Figure 6.3 Leverage paths within two dimensions



Source: Mathews and Cho (2000).

profitable segment of a global value chain, requires both market and technological competencies (figure 6.3).[2] Path A represents a trajectory along which many of the activities entailed in original equipment manufacturing, all of them initially accomplished domestically along with key activities, are relocated to production facilities in third countries, giving rise to "triangle manufacturing". Capability enhancement is centered on mastering the complex of logistical functions required when sourcing and combining inputs from a number of different producers and locations. Path B by contrast focuses on capability enhancement through expanding functional responsibilities, from original equipment manufacturing to including some responsibility for design, leading the enterprise to then market its own designs under its own brand. Enterprises pursue market niches by developing unique production capabilities, often of a technological form. But the process of developing such capabilities creates new market opportunities in the form of a redesigned product to meet customer needs better. The interactive process is endless.

The insertion of a local enterprise in a global value chain—instigated by a buyer or a producer—puts great pressure on the enterprise to meet demanding quality, reliability and logistics standards. But the buyer or producer also wants to be able to make rapid product adjustments (in response to shifting patterns of consumer demand in their stores, for example), and so there is also great pressure to change product lines quickly and reliably. The endpoint is an enterprise that has attained full "lean production" capabilities in flexibility and agility.

Then there is the all-important step of moving from one functional specialization to another. The move from production to design might seem a small step in itself—but it is a huge step for a latecomer enterprise looking to build its capabilities. It is the first step towards self-sufficiency, where the enterprise might no longer be entirely dependent on the global value chain for its survival. This step is sometimes taken by the individual enterprise itself—as with East Asian electronics firms. They moved through phases of original equipment manufacturing, where the buyer enterprise gives all specifications to contracting firms, to own design and manufacture, where the buyer enterprise simply gives broad specifications and allows the contractor to fill in the details, to own brand manufacturing, where the enterprise is fully fledged and produces its own line of branded products.

Last is the all-important break from one global value chain to another. Of course inserting an enterprise or local cluster into a global value chain is an important step—but the smart enterprise or cluster does not have to see its horizons limited. Always seeking ways of spreading its involvement across two or more global value chains, it looks to expand its options and capabilities. This leverages skills, enhances capabilities and reduces the risk of being tied to a single global value chain. In Taiwan Province of China, television producers in the electronics industry used global value chains instigated by buyers in the United States like J.C. Penney and Kmart to leverage the skills in mass production of television sets. They then transferred these skills to produce computer monitors for such computer producers as Hewlett Packard, IBM and Apple, which were building quite different global value chains. This cross-insertion builds a variety of capabilities and provides a platform of independence for the developing enterprise.

The chapter now turns to the global value chains for garments and for wood furniture. The first shows the dynamics within a global value chain, dynamics that demand considerable nimbleness from the enterprises and local clusters working in them. The second shows what a local cluster has to do to move into a global value chain.

Trust and triangles in garments

The apparel industry is labour-intensive, with labour accounting for 60 percent of production costs.[3] Asia has become the dominant region of production. This trend started in the 1950s and 1960s as the industry shifted from Europe and the United States to Japan. The second shift was from Japan to Hong Kong Special Administrative Region (SAR) of China, Taiwan Province of China and the Republic of Korea, which dominated in the 1970s and 1980s. In the 1990s production shifted to China and other Asian countries and to some Latin American countries.

The big export drivers in the apparel business have been quotas and preferential tariffs. Quotas on apparel and textiles items will continue to be regulated by the Multi-fibre Arrangement (MFA) until it expires in 2005. Used by the United States, Canada and various European nations since the early 1970s to impose quantitative limits on imports, the clear intent was to protect industrialized country enterprises from a flood of low-cost imports that threatened to disrupt major domestic industries.

The long-run result was just the opposite. Protection in industrialized countries heightened the competitive capabilities of developing country manufacturers, who learned to make sophisticated products that were more profitable than simple ones. In recent years the European Union and NAFTA have granted preferential tariffs within regional markets, shifting global sourcing dynamics in these regional markets.

The clothing global value chain ranges from raw materials processing and production of textiles and manufacturing garments, to marketing and retail (figure 6.4). Aside from the upstream activities there are four stages of moving up the chain:[4]

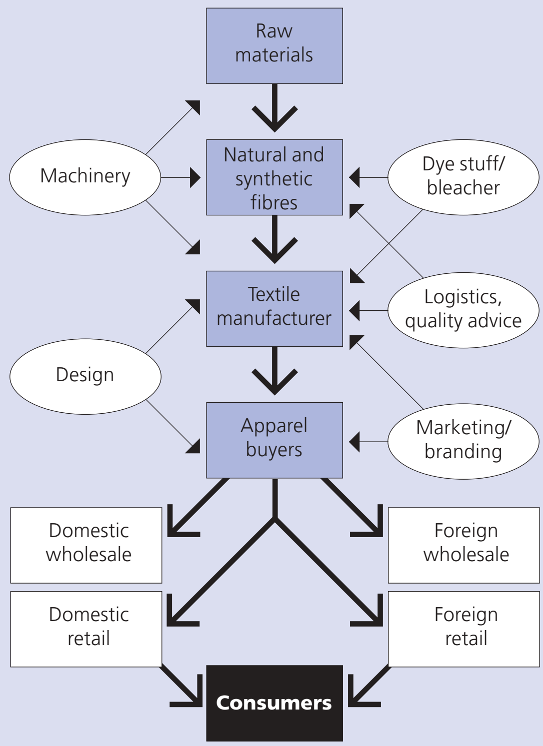
1. *Assembly of imported products* (typically in export processing zones near major ports).

2. *Original equipment manufacturing.* Production for transnational corporations (design specification comes from foreign company, which is responsible for marketing and branding). Supplier lacks control over distribution. A variant is global logistics contracting.

3. *Own design manufacturing.* Design of products sold under the brand of foreign firms.

4. *Own brand manufacturing.* Sale of own branded products.

Figure 6.4 Apparel value chain



Source: Appelbaum and Gereffi (1994).

Entry barriers are low for most garment factories, but they get progressively higher in the move upstream to textiles and fibres.

Three global buyers

The apparel chain has three categories of buyers: retailers, branded marketers and branded manufacturers. The retailers account for 50 percent of imports, branded marketers and branded manufacturers 20 percent each, and various others for the rest.

Retailer

Such international retailers as Wal-Mart and Sears Roebuck, once the apparel manufacturers' main customers, are now their competitors. In the 1980s many retailers began to compete directly with the national brand names of apparel producers and marketers by expanding their sourcing of "private label" merchandise. These products are sold more cheaply than the national brands, yet they are also more profitable to the retailers, who can eliminate the middlemen in the chain. Private label goods were about 25 percent of the apparel market in the United States in 1993.

While retailing and marketing are becoming more concentrated, manufacturing is splintering. Today's superior information flows give retailers far better day-to-day market knowledge about consumer purchasing decisions, allowing them to demand more from their suppliers in better inventory management, faster responses and more frequent deliveries. As each type of buyer in the apparel commodity chain has become more active in offshore sourcing, the competition between retailers, marketers and manufacturers has intensified, blurring the traditional boundaries between these enterprises and realigning interests within the chain.

BRANDED MARKETER

Well-known manufacturers without factories—such as athletic footwear companies (Nike, Adidas, Puma) and fashion-oriented apparel companies (The Gap, Liz Claiborne)—carry out no production. Instead, they just design and market their goods. As pioneers in global sourcing they provided knowledge that later allowed overseas suppliers to upgrade their own positions in the apparel chain.

To deal with new competition, branded marketers are discontinuing some support functions (such as pattern grading and sample making) and reassigning them to contractors. They are instructing contractors where to obtain needed components, reducing their own purchase and redistribution activities. They are shrinking their supply chains, using fewer but more capable manufacturers. They are adopting more stringent vendor certification systems to improve performance. And they are shifting their sourcing configuration from Asia to the Western Hemisphere. Marketers (and retailers even more) now recognize that overseas contractors can manage all aspects of production, which offers linking and leveraging opportunities for contractors to move into designing and branding.

BRANDED MANUFACTURER

Apparel manufacturers, such as Levi Strauss, have been caught in a squeeze because foreign producers can often provide the same quantity, quality and service as domestic producers, but at lower prices. In the United States and Europe, the attitude among many smaller and mid-sized apparel manufacturers is "If you can't beat them, join them." Feeling that they are unable to compete with the low cost of foreign-made goods, they are defecting to the ranks of importers.

The decision of many larger manufacturers in industrialized countries is no longer whether to engage in foreign production but how to organize and manage it. They supply intermediate inputs (cut fabric, thread, buttons and other trim) to extensive networks of offshore suppliers, typically in neighbouring countries with reciprocal trade agreements that allow goods assembled offshore to be reimported with a tariff charged only on the value added by foreign labour. This kind of international subcontracting system exists in every region of the world. It is called the 807/9802 program or "production sharing" in the United States (USITC 1997), where the sourcing networks of U.S. manufacturers are predominantly in Mexico, Central America and the Caribbean because of low wages and proximity to the market. The trend for the branded manufacturers is to de-emphasize production in favour of marketing by capitalizing on brand names and retail outlets. Sara Lee Corporation, one of the largest apparel producers in the United States, recently announced its move out of making the brand-name goods it sells.

Latching onto the global value chain

The first step for garment manufacturers in developing countries is to become linked to branded manufacturers. The easiest way has been to engage in contract manufacturing under U.S. tariff schedule provision 807/9802. But those activities—often performed in export processing zones—have low value added. Enterprises in the United States engaged in production sharing have an incentive to minimize locally purchased inputs since only components made in the United States are exempt from import duties when the finished product is shipped back to the United States (box 6.3). There is a similar system in Europe, known as outward processing trade, with the principal suppliers located in North Africa and Eastern Europe. The same holds in Asia generally, where manufacturers from relatively high-wage economies like Hong Kong SAR have outward processing arrangements with China and other low-wage nations.

The next stage after export processing is to link with global retailers or branded marketers in original equipment manufacturing or full-package production. Compared with the mere assembly of imported inputs, full-package production fundamentally changes the relationship between buyer and supplier in a direction that gives far more autonomy and learning potential for industrial innovation to the supplying enterprise. Full-package production is needed because the retailers and marketers that order the garments have limited knowledge of their manufacturing details. Hong Kong SAR, Taiwan Province of China, Republic of Korea and China used the full-package route to create an enduring edge in export-oriented development.

Box 6.3 Races to the bottom

The Dominican Republic has an especially large dependence on export processing zone assembly using the U.S. 807/9802 trade regime. The share of export processing zones in official manufacturing employment increased from 23 percent in 1981 to 56 percent in 1989, when they generated more than 20 percent of foreign exchange earnings. Investors in the United States account for more than half (54 percent) of the companies operating in the zones, followed by firms from the Dominican Republic (22 percent), Republic of Korea (11 percent) and Taiwan Province of China (3 percent).

The rivalry among export processing zones in neighbouring countries to offer transnational companies the lowest wages fosters a perverse "competitive devaluation", where currency depreciations are seen to increase international competitiveness. Export growth in the Dominican Republic's export processing zones skyrocketed after a very sharp depreciation of its currency against the dollar in 1985. Similarly, Mexico's export expansion was facilitated by recurrent devaluations of the peso, most notably in 1994–95.

Hourly compensation rates for apparel workers in the early 1990s were $1.08 in Mexico, $0.88 in Costa Rica, $0.64 in the Dominican Republic and $0.48 in Honduras, compared with $8.13 in the United States. It may make sense for one country to devalue its currency to attract users of unskilled labour to their production sites. But the advantages quickly evaporate when other nations simultaneously engage in wage-depressing devaluations, which lower local standards of living while doing nothing to improve productivity.

Source: Kaplinsky (1993); ILO (1995).

But NAFTA, along with a relative decline in the importance of East Asian apparel exports to the United States, has now created favourable conditions for extending full-package production to the North American setting (box 6.4).

Prominent apparel suppliers to Europe, such as Turkey and several East European economies, also appear to be adopting the full-package model. Manufacturers from those countries need to acquire the skills and resources to move into the more diversified activities associated with full-package production. The arrangement offers further innovation opportunities towards own brand manufacture. It enhances the ability of local entrepreneurs to learn the preferences of foreign buyers, including international standards for the price, quality and delivery of export merchandise. It also generates substantial backward linkages in the domestic economy because original equipment manufacture contractors are expected to develop reliable sources of supply for many inputs, including those to be imported. The supplier learns much about the downstream and upstream segments of the apparel commodity chain from the buyer. This tacit knowledge can later become a powerful competitive weapon.

One of the most important mechanisms facilitating the shift to higher value-added activities for mature export industries like apparel in East Asia is the process of "triangle manufacturing" (global logistics contracting). The essence of triangle manufacturing, initiated by the East Asians in the 1970s and 1980s, is that global buyers place their orders with the manufacturers they have sourced from in the past; those manufacturers then shift some or all of the requested production to affiliated offshore factories in low-wage countries (China, Guatemala, Indonesia). These offshore factories can be wholly owned subsidiaries, joint-venture partners or simply independent overseas contractors. The triangle is completed when the finished goods are shipped directly to the overseas buyer under the U.S. import quotas issued to the exporting nation.

Box 6.4 Linking to the leaders

The key factor in Mexico's ongoing transition from assembly to original equipment manufacture (or full-package) production has been NAFTA, which began to remove the U.S. restrictions that had virtually locked Mexico into assembly. The maquiladora system effectively conditioned Mexico's access to the U.S. market on the use of its inputs. More of the apparel supply chain—cutting, washing and producing textiles—is relocating to Mexico as U.S. restrictions on each of these stages is eliminated.

But NAFTA does not guarantee Mexico's success. While the massive peso devaluations of 1994–95 made Mexico very attractive as a production site for U.S. apparel manufacturers with international subcontracting operations, Mexico has traditionally lacked the infrastructure and supporting industries to do full-package production of garments. Textile and apparel companies in the United States have been expanding their investments in Mexico at a rapid and accelerating pace. So Mexico is now better positioned to provide the quantity and quality of inputs needed for original equipment manufacture of standard apparel items, such as jeans, knit shirts, trousers and underwear. But Mexico is still lagging in the fashion-oriented, women's wear categories.

The solution to completing the transition to full-package supply, and developing new production and marketing niches, is to forge links to the kinds of lead enterprises that can supply technology and tutelage. Mexico needs to develop new and better networks to compete with East Asian suppliers for the U.S. full-package market. Enterprises in the United States have already shown a strong interest in transferring missing pieces of the North American apparel supply chain to Mexico. A real problem to be confronted, though, is who controls critical nodes of the chain and how to manage the dependency relationships this implies.

Thus far, enterprises in the United States are in clear control of the design and marketing segments of the apparel chain, while Mexican companies are in a good position to maintain and coordinate the production networks in apparel. But textile manufacturers in the United States, and to a lesser degree Mexico, are making strong bids to integrate a broad package of apparel services that would increase their leverage over smaller garment contractors.

Mexico is likely to retain a mix of assembly plants linked to U.S. branded manufacturers and a new set of full-package producers linked to private-label retailers and marketers. As more of the critical apparel inputs become available in Mexico, inputs from the United States will decline and traditional Mexican assembly plants will be replaced by full-package manufacturers or by clusters of related enterprises that compete through localized networks, such as the jeans producers in Torreón.

Source: UNIDO.

Triangle manufacturing thus changes the status of original equipment manufacture from established suppliers for retailers and designers in the United States to middlemen in buyer-driven commodity chains that can include as many as 50 to 60 exporting countries (box 6.5).

Opportunity and initiative in wood furniture

In 1998 the furniture industry, with global trade of close to $45 billion, was the largest traditional, low-tech sector, exceeding both apparel ($41 billion) and footwear ($34 billion).[5]

Although furniture is a resource- and labour-intensive product, many of the major furniture exporting countries are industrially advanced (table 6.2). Italy is far and away the leader, with net exports of $7.8 billion in 1998. Developing countries in the top 10 are China, Mexico, Malaysia, Romania and Indonesia.

The wooden furniture global value chain starts with the provision of seed inputs, chemicals, equipment and water for the forestry sector (figure 6.5). Cut logs pass to the sawmill industry, which obtains its primary capital inputs from the machinery industry. Sawn timber moves to the furniture manufacturers who, in turn, obtain inputs from the machinery, adhesives and paint and other industries and also draw on design and branding skills from the service sector. Depending on the market served, the furniture then passes through various intermediary stages until it reaches the final customer, who after use consigns the furniture for recycling. The chain is very heterogeneous due to the many market segments (office, kitchen, bedroom, dining room and living room) and within these segments the many market niches (high volume, price sensitive, design intensive, brand-intensive, and so on).

Three major buying agents facilitate the entry of wood furniture producers into final markets:

- *Large multinational retailers,* with both retail outlets and suppliers in many countries. (For example, IKEA sources from 2,000 suppliers in 52 countries and has more than 300 outlets in three continents)
- *Small retailers,* purchasing directly from a limited number of suppliers in a limited number of countries.
- *Specialized medium-size buyers,* sourcing from many countries and on-selling to retail outlets, predominantly in a single country or region. It is not atypical for these buyers to have more than 1,500 suppliers, in many coun-

Box 6.5 From trust to triangles to own brand manufacturing

The East Asians did not employ the production-sharing provisions established by the 807/9802 U.S. trade regime in apparel because their great distance from the United States made textile imports from the United States impractical. In addition, textile mills in the United States did not have the production capability or mentality to supply the diverse array of fabrics favoured by the designers of women's wear and fashion-oriented apparel, which became the specialty of the East Asian exporters. Both factors created an original equipment manufacture niche, adroitly exploited, for East Asian apparel companies.

Highly successful textile and apparel exporters from Hong Kong SAR, Taiwan Province of China and Republic of Korea (preceded by Japan, followed by China) progressed through a sequence of export roles from assembly to original equipment manufacture to own brand manufacture. They developed and refined their original equipment manufacture capabilities in the 1960s and 1970s by establishing close ties with retailers and marketers in the United States, and then "learning by watching" to use these foreign partners as role models to build East Asia's export capabilities.

The performance trust built up through many successful business transactions with these U.S. buyers enabled East Asian suppliers to internationalize their original equipment manufacture expertise through triangle manufacturing. The East Asian manufacturers became intermediaries between the buyers in the United States and hundreds of apparel factories in Asia and other developing regions to take advantage of lower labour costs and favourable quotas around the world. The creation of these global sourcing networks helped the East Asians sustain their international competitiveness when domestic economic conditions and quota constraints threatened the original, bilateral original equipment manufacture relationships.

The East Asians have been moving beyond original equipment manufacture in many ways. They have shifted to higher value upstream products in the apparel commodity chain (exports of textiles and fibres, rather than apparel). They have been moving downstream to own brand manufacture in apparel. And they have been aggressively investing in efforts to switch to other global product chains. The Republic of Korea is the most advanced of the East Asians in own brand manufacture, with its brands of automobiles (Hyundai), electronic products (Samsung) and household appliances (Samsung and Goldstar), among other items, being sold in North America, Europe and Japan. Companies in Taiwan Province of China have pursued own brand manufacture in computers, bicycles, sporting equipment and shoes, but not in apparel.

Clothing companies in Hong Kong SAR have been the most successful in shifting from original equipment manufacture to own brand manufacture. The women's clothing chain, Episode, controlled by Hong Kong SAR's Fang Brothers Group, one of the foremost original equipment manufacture suppliers for Liz Claiborne in the 1970s and 1980s, has stores in 26 countries, only a third of which are in Asia. Giordano, Hong Kong SAR's most famous clothing brand, has added to its initial base of garment factories 200 stores in Hong Kong SAR and China, and another 300 retail outlets scattered across Southeast Asia and Republic of Korea. Hang Ten, a less-expensive line, has 200 stores in Taiwan Province of China, making it the largest foreign-clothing franchise on the island.

Source: UNIDO; Granitsas (1998); Gereffi (1997, 2000).

Table 6.2 Global furniture trade—top 10 net exporting countries, 1994 and 1998

	Net export value (millions of dollars)	
	1994	1998
Italy	6,105	7,831
China	1,381	2,725
Canada	32	1,804
Denmark	1,412	1,323
Mexico	259	1,190
Malaysia	698	1,052
Spain	251	741
Sweden	254	494
Romania	375	382
Indonesia	754	339

Source: http://www.intracen.org.

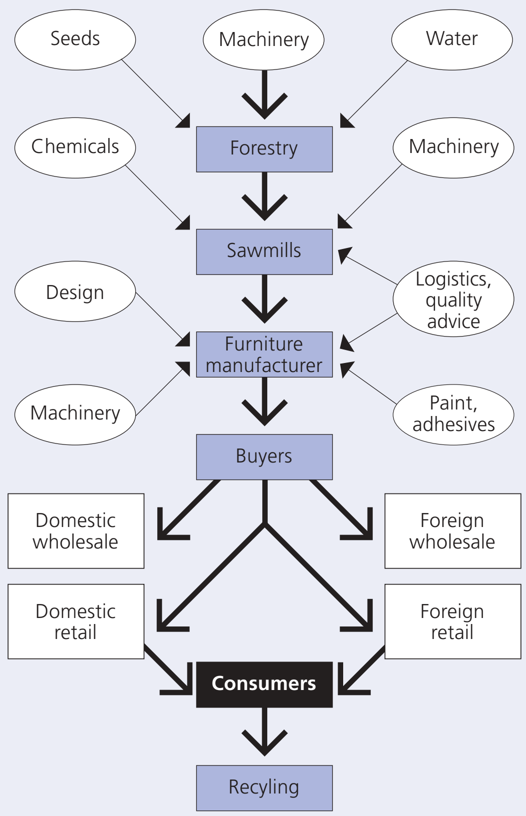
tries; even the smaller specialized buyers will typically source from more than 100 suppliers.

In general, buyers serve different market segments. Often these segments are distinctively different, but the growing capabilities of world class manufactures means that there is a diminishing trade-off between critical success factors. For example, the large retailers are increasingly able to offer low prices and high quality, and low prices and variety. Suppliers confront a much more demanding set of critical success factors when they sell to global retailers than when they sell to small retailers and specialist buyers. Not only are almost all the critical success factors considered important, but they are also all ranked as being of higher order importance.

The innovation challenge confronting part of the wood furniture global value chain in South Africa is symptomatic of a more general challenge facing other furniture exporting countries. South Africa's wood furniture global value chain has been on a suboptimal trajectory since its pine furniture has faced increasing price competition in overseas markets. The unit prices of its exports, measured in dollars, fell by 250 percent between 1992 and 1999. Moreover, South African products have been considered cheap, but of low quality and poor delivery reliability. As a consequence IKEA, the major global buyer, decided to move out of South Africa (to Eastern Europe and East Asia).

This has placed the South African wooden furniture firms in a dilemma. An effective response was found, after much searching, in the context of the global trend towards environmental responsibility. South Africa is the home of a commercially grown semi-hardwood named saligna. Furniture based on saligna offered the potential to become a low-cost and environmentally acceptable alternative to increasingly scarce and highly priced traditional hardwoods such as teak and mahogany.

Figure 6.5 Links in the wood furniture value chain



The opportunity

One of the key dynamic market forces in the global timber products industry is the move (primarily by the industrial countries) towards environmental responsibility. For most developing countries, this threatens their exports because their timber product industries have traditionally drawn on indigenous hardwood forests.

South Africa, however, happens to be uniquely placed to take advantage of this opportunity. The most outstanding feature of saligna (a species of Eucalyptus hardwood) is that in South Africa it is a commercially grown semi-hardwood distinguishing it from other hardwood species grown in indigenous forests in the developing world. Although saligna is not a traditional hardwood, it has the ability to take colouring well and can therefore be treated to look like virtually any wood, including all the species of threatened hardwoods.

Traditionally saligna was grown for use in the local mining industry, but the changeover to concrete mining supports has led to a sharp decline in domestic demand. In the context of growing environmental concerns in final markets, therefore, the existence of the previously low-priority saligna hardwood plantations, with unused capacity, offers unexpected potential for exporting of furniture to Europe and North America. It is also an opportunity that offers the potential to move furniture producers into new market niches, with higher unit prices.

The innovation challenge

Grasping this opportunity requires inter-chain innovations, a reorientation from the previous trajectory of the wooden furniture global value chain, which has traditionally focused on the export of pine furniture into increasingly price-competitive markets. This reorientation entails substantial inter-chain innovation through simultaneous and carefully coordinated process, product and funtional innovations.

PROCESS INNOVATION

The primary challenge was to increase the supply of clear saligna hardwood, at an affordable price. This challenge exists both because of competing uses (in pulp and paper), for which clarity is unimportant, and because the sawmills serving furniture manufacturers were geared for cutting softwoods (pine) rather than hardwoods (saligna). The mills had also operated in a sellers' market for many years, and consequently were unresponsive to the needs of the manufacturers, delivering at unpredictable intervals, with varying quality and in inconvenient take-it-or-leave-it product specifications. An additional processing problem was that manufacturers needed to learn how to work with saligna, and to be effective, this required close collaboration with the sawmills (for example, in regard to knowledge about timber density).

Perhaps most important, the key determinant of timber costs was the gestation period of the trees. Traditionally, saligna had been cut at an age of 23 years, but it was thought possible to reduce this considerably, to around 12 years; given high interests costs (a real interest rate of more than 10 percent), the financial benefits to this innovation would be considerable. But to be effective it required close collaboration between growers, the sawmills and the manufactures. Thus, process innovation could only be achieved in the saligna furniture global value chain through a combination of enterprise-specific innovations and inter-enterprise collaboration to enhance communication within the chain and to address important chain-specific problems.

PRODUCT INNOVATION

In itself, process innovation would not produce sufficient benefits. The problem was that alternative uses for saligna in paper and pulp meant that unless the final furniture products could be positioned within a relatively higher product niche than South Africa's pine furniture exports, the manufacturers would not be able to survive paying the market price for the timber input.

An additional product innovation challenge was that the specific properties of saligna (when compared with pine), and especially of young saligna, meant that the designs used for pine furniture could not always be translated into the new type of wood. Product redesign—design for manufacture—was therefore a necessity, which required many furniture manufacturers to venture into new territory, and this could not be done in isolation from the sawmills. Finally, one of the virtues of saligna was its ability to absorb finishes, and this required the manufacturers to work closely with lacquer and paint suppliers, particularly because environmental pressures in Europe are forcing a move to water-based finishes (one of the main areas of competitive advantage of Italian producers).

FUNCTIONAL INNOVATION

If new designs were to be introduced, who would take responsibility for this high value-added activity? Would the saligna industry fall back on the pattern in the pine industry, where global buyers provided design templates for manufacturers, or where manufacturers continued to produce standard items such as garden benches? Alternatively, would there be a surge in domestic design capabilities, and if so, would these be lodged in South African buyers, furniture manufactures or in specialized design houses? Just as saligna furniture represented a transition within the wood furniture chain from softwood to a hardwood, were there also opportunities to move from saligna furniture to other saligna-based products such as garage doors (a big export item), industrial products and toys?

The initiative

To stimulate innovation, a first saligna network workshop was organized in late 1998 by a university-based research project. It was well attended by government departments, manufacturers, timber traders, industry specialists (both academic and consultants) and timber growers and sawmills. It successfully brought together stakeholders from all levels of the saligna global value chain with a view to promoting cooperative problem resolution. The involvement of a number of competing enterprises at each level of the global value chain created a situation where a failure to cooperate held the risk of missing out on benefits enjoyed by competitors. The workshop gave birth to the Saligna Global Value Chain Group (SVC Group), a cooperative national network of stakeholders spread throughout the global value chain.

Technical working groups, led by the sawmills, worked on a variety of issues for improving knowledge flows. A questionnaire was sent to all timber product customers to try to establish optimal sizes and to get consensus on a range of dimensions that manufacturers felt most comfortable with. The mills then experimented with new grading systems to see if this could increase the total availability of clear wood. They also began to collect more accurate data on total demand in order to determine overall existing and potential supply and usage of saligna in South Africa.

The full flowering of a Salinga furniture global value chain remains a work in progress, with much yet to be achieved to realize the promise that may inhere in exports of salinga furniture to advanced country markets. So far, the activities of the SVC Group have yielded the greatest efficiency gains in the areas of:

- Generating information in all three of the innovation trajectories—process, product and function.
- Markedly improving inter-enterprise process and supply chain efficiency between the mills and manufacturers.
- Important product development occurring both within and between linkages through the young tree and wood density experiments.
- Internal enterprise process innovation primarily of a technical nature.
- Some gains in changing the mix of activities within enterprises and up the global value chain through emphasizing design, finishing and marketing.

Innovation in the production processes of the firms in the global value chain was not an explicit focus of the activities of the SVC group. But work on the numerous supply issues between the sawmills and the manufacturers in the global value chain did in fact have an innovation impact on the internal production processes of the manufacturers, through challenging the technical parameters of what they could produce.

Working local to go global

Enterprises are thus part of a local industrial fabric. Despite globalization and new communication technologies, geographical proximity and local sources of competitiveness are still important. The local advantages of synergy have been well documented in recent case studies on industrial clusters. They show the passive and active gains that clustering can provide to enterprises. The passive gains arise from agglomeration economies; the active, from inter-enterprise cooperation. The success and failure of clusters depend on achieving dynamic synergy within the cluster and on being nimble in the interactions with the outside world.

For developing countries the capturing of cluster benefits is difficult and elusive. If it is hard to start individual enterprises, it is harder still to start clusters—or to get enterprises to cooperate locally, as customers and suppliers of each other, rather than as cut-throat competitors. In the long run developing country clusters will have to be inserted into a wider cluster—into a global value chain—if they to survive in the face of continuing global competition.

Notes

For further details on sources, information and the literature on subjects covered here, see the background papers.

1. Schmitz (1999b).

2. Similar innovation models are offered by scholars in the formerly developing countries, such as Korea (Kim 1998, 1999).

3. This section draws on Mathews (2001, background paper).

4. Gereffi (1999b).

5. This section draws on the Web site of the UNCTAD-WTO International Trade Centre: http://www.intracen.org and Kaplinski (2001, background paper).

7 Supporting innovation and learning by firms

SUPPORT INSTITUTIONS AFFECT HOW—AND WHETHER—FIRMS MEET the information, skill, finance and other needs that are difficult to satisfy in open markets. Infrastructure determines the cost of operation and interacting with the outside world. A nurturing environment is required to foster vibrant industrial development. And ensuring access to vital services that support innovation and learning is a critical part of establishing that environment. Many of these services are supplied through the market in advanced countries, but even these countries find it necessary to augment what is supplied through the market with subsidized services. Various considerations provide ample justification for the provision of subsidized services to support the process of innovation and learning—even more for developing countries. Most important: what is being provided is, to a greater or lesser degree, depending on the service, a public good—in short, knowledge (or information) in one form or another.

It is widely appreciated that knowledge is indeed a public good, one to be made available at a price no greater than the marginal cost of its dissemination. But the costs of searching for and translating even freely available information into terms useful to local firms are not trivial. And there are great economies in centralizing these activities in organizations with special capabilities to carry them out. Efficiency requires that these costs, separate from the vastly lesser variable costs of dissemination, be borne but once. Otherwise each potential beneficiary of the same information would have to replicate the search and translation costs that would far better be shared, as fixed costs, in some way among all the potential beneficiaries.

There are good reasons for not imposing on beneficiaries the full, or even partial, sharing of the fixed costs of establishing and maintaining technology support organizations. One is found in the pronounced economies of scale inherent in their operations. These justify providing the services well in advance of the point where the market would be large enough to sustain the delivery of their services by private entities. Other reasons are found in the externalities generated through the use of these services to achieve higher productivity with existing resources. In many instances the benefits from higher productivity cannot be fully captured by the firms that receive the services. Some (often most) of the benefits spill over to other economic agents in the form of externalities.[1] These reasons have particular force in developing countries, where markets for industrial services are only beginning to be developed—and where externalities related to technology transfer and effective absorption are particularly pronounced.[2]

Market failures not directly related to the provision of industrial services typically afford additional justification in less developed countries. The most obvious example involves financial sector failings in lending for technological efforts. Financial institutions in most developing countries are ill-equipped to appraise properly projects that entail technological efforts of kinds not previously undertaken locally. Even where they can conduct proper appraisals, they typically require collateral in forms that greatly raise the cost of borrowing or preclude it. So the services that ought to be used will go unused unless provided at lower cost to the recipient.

Finally, constraints on public policy often mean that the provision of industrial services is the only practicable means of subsidizing technological efforts that should, according to first-best principles, be subsidized directly. Indeed, such constraints lie at the heart of the rationale for infant-industry promotion through protectionist means. Given that such means are no longer tolerated under international trade conventions, the promotion of innovation and learning through subsidized industrial services provision has to be thought as having much greater importance—much greater.

The World Trade Organization (WTO) affords little scope for policies that have been used successfully in the past to accelerate industrial and technological development. In an important sense, all that is left in the way of major policies to developing countries is to provide industrial services in the forms discussed in this chapter. That makes the direction and management of organizations that provide these services all the more important.

Many types of institutions are essential in supporting the innovation and learning by firms. Training and specialized education are very important, as are financial services. The focus here, however, is on the institutions directly supporting the innovation and learning efforts of firms.

Helping firms grasp opportunities and solve problems

What principles, then, should guide provision of subsidized services for innovation and learning? Three are paramount.

- First, support institutions should be established and managed, and subsidized services should be provided in strict accord with the framework of the national strategy for industrial development (chapter 8). This is in line with the observation by many commentators that the problem is often not the absence of such institutions—it is that existing institutions cannot be justified on the basis of the benefits from the services they provide (where services are indeed provided). If there is no demonstrated need for the delivery of some service, demonstrated within the parameters of the national strategy, the service should not be provided.
- Second, as a general rule, subsidized provision of industrial services has greater justification the more widely shared the specific services rendered. The closer some service comes to serving only one or a few firms, the more difficult it becomes to justify subsidized delivery on the grounds just enumerated.
- Third, the services should not be supplied solely by government. As quickly as is feasible, they should be supplied in public-private partnerships or by private firms and associations—with subsidies, if justified, or without, if the market can supply the services. Indeed, the reliance on

Box 7.1 Institutional support to technological efforts of firms

Basic industrial services

- Promote inward investment
- Provide export services
- Provide management services
  - Collect marketing information
  - Collect data on exports and imports
  - Provide managerial consulting
- Provide financial services (accounting, tax assistance, investment advice)

Technology Information Centres

- Provide information technology to firms, including networks, software, Internet capabilities, intranet, and databases
- Perform troubleshooting, assistance, and repair to firms
- Provide training in informational technology applications

Metrology, Standards, Testing, and Quality Control Centres

- Define domestic standards
- Assist firms in meeting International Organization for Standardization (ISO) compliance standards
  - Train firms in ISO standards and regulatory requirements
  - Test products to ensure compliance with standards
  - Provide technical assistance to firms
- Help firms with calibration of instruments
  - Maintain calibrated standards and calibration equipment
  - Calibrate firms' machinery

Productivity Centres

- Improve quality
- Improve productivity, efficiency
- Provide training

Technological Extension Agencies

- Extend available technology to businesses lacking technical capabilities
- Help firms use cleaner production technologies
- Provide information on available technology
- Identify problems and use access to technology sources to solve problems
- Serve as external consultants and assist firms with trouble-shooting
- Promote cooperation of small and medium-size enterprises with larger research and cluster initiatives (South Africa MAC program)

Research and Development Laboratories

- Design new processes and products.
- Train businesses through demonstration, participation and extension
- Implement new technologies
  - Import and learn foreign technology
  - Adapt foreign technologies to local needs
  - Integrate these technologies into economy in collaboration with firms

Source: UNIDO.

private associations to deliver subsidized services has greatly improved the efficiency, relevance and quality of public services—and strengthened the cooperation between firms and the support organizations.

Institutions that support the technological efforts of firms reflect the wide variety of industrial activities and needs related to them (box 7.1). Some organizations offer general services, meeting needs that are not specific to particular industries. Information centres that are effectively gateways to the vast pool of knowledge that is available at no cost from the source are an example. So too are organizations devoted to the identification and fostering of latent entrepreneurial talent. Other organizations offer specific services of general use across the industrial sector. Productivity centres, for example, have often focused on disseminating modern methods of quality control or assurance. Still other organizations are closely identified with the industries they serve, for they require specialized human and physical assets to deliver services specific to the needs of these industries.

Among these organizations there is further differentiation by degree of involvement in solving technical problems specific to individual firms. There is also differentiation according to the breadth or depth of the organization's capacities. Typically, the more highly specialized is the organization, the deeper are its capabilities and the closer are its competencies to the global technological frontier. Research and development (R&D) institutes actively involved in the initial transfers of foreign technology to domestic industries have the most sophisticated capabilities.

Many developing countries have set up such support institutions copied from developed countries. Unfortunately, a large number of such institutions do not function well (box 7.2). They tend to be of poor quality, with inadequate equipment and poorly motivated and remunerated staff. Their services are often out of touch with the needs of the industrial sector and are offered passively. Their objectives—like creating new or appropriate technologies—can be unrealistic. Frequently, their incentive and management systems are not geared to providing services to firms.

Box 7.2 Reforming poorly performing organizations

It is possible to reform long-irrelevant public sector technology institutions, and many developed and newly industrializing countries are doing just that. In the late 1980s the World Bank launched an Industrial Technology Development Project in India. One important component was promoting industry-sponsored research at a number of public research institutes as well as at the Indian Institutes of Technology, other universities and private research foundations. This component, the Sponsored R&D (SPREAD) Fund, was aimed at promoting research awareness especially among small and medium-size companies and changing the culture of research laboratories and higher education establishments towards an emphasis on serving the needs of industry as articulated by the firms themselves.

The fund is administered by a newly established technology cell in the Industrial Credit and Investment Corporation of India (ICICI), a private sector development bank started by the World Bank. This technology cell helped firms identify the appropriate research institute, develop their business plans, coordinate with the institute and generally hold the hands of new entrepreneurs (as a venture capitalist would). The funds were given as conditional loans rather than grants, and enterprises had to provide matching funds from their own resources.

By the end of 1997 around 100 firms had contracted 95 projects under this programme, with an average project size of $400,000 and an average loan component of $170,000. So far, there have been no failures, though three or four projects were likely to be cancelled. Most of the companies using the programme had never contracted research to a public research institute before; most were small and medium size. Some 50 technology institutes were involved, including 5 institutes of technology or science, 12 universities, 5 private research foundations and 28 government laboratories. Overall, the project has been highly successful in technological terms; the subsidy element has been minimal and most firms claim that they will continue their links with the research institutions in the future.

A number of elements account for the success of the project. A private sector–oriented matchmaking intermediary (ICICI, a well-established private financial institution with intimate knowledge of industry) administered the funds and overcame information and trust barriers between researchers and business. A technically oriented unit in this intermediary assessed the viability of applications and remained involved as the projects developed (more like venture capitalists than bankers). The finance was given in the form of loans rather than grants, with a substantial matching contribution by entrepreneurs. There was a significant effort to help technology institutions understand the needs of industry and change their operating culture.

Source: World Bank.

Investment promotion agencies

Support for technological development does not come only from organizations that directly assist technological efforts by firms. It comes as well from organizations that support industrial development more generally. Investment promotion agencies play a particularly important role. Investment is, after all, the vehicle through which technology embedded in physical capital is acquired. But attracting foreign direct investment (FDI) is a complex matter, and this is so not simply because it may serve as an important conduit of disembodied technology into local firms. Properly conducted, the promotion of foreign investment can serve as a vital tool for enriching the indigenous base of technological capabilities.

Attracting the right kind of foreign direct investment for the development of a thriving industrial sector requires a good deal more than simply establishing the proper general policy environment, one that is "business friendly." It also requires dedicated effort in a wide range of activities ranging from the identification of suitable inward-investment prospects (or foreign partners) to the active servicing of the strategic needs of foreign-invested firms once established in the country, including development of skills, recruitment services and identification and upgrading of local suppliers. This is in part because of the vigorous competition among countries to attract foreign direct investment, but it is equally because investment promotion can be an instrument of overall industrial development by exploiting the potential complementarities between local and foreign undertakings.

Prospective investors can seize opportunities, yielding mutual advantage to them and the host country only if they are aware of them. But knowledge of foreign investment opportunities is necessarily highly imperfect, subject to severe misperceptions and lack of essential information. In short, the market for foreign direct investment does not function effectively unless the countries and regions that seek its benefits devote sufficient resources to publicizing business opportunities in terms meaningful to prospective investors who have a sophisticated understanding of their own needs.

Investment opportunities that will dynamically change and enrich the local industrial base must be distinguished from those that simply take advantage of the existing base. The first warrant special priority in promotional efforts. Such opportunities do not simply exist. They are created by first identifying the elements required—specialized skills, specific infrastructural requirements, particular university resources, and so on—and then by seeing to the coordinated realization of each element. Coordination is crucial. It requires that the promotion agency have the authority to ensure meaningful cooperation among all entities whose activities must be coordinated to achieve a successful outcome. The agency must be subject to proper oversight at the highest levels of government, achieved in part through audits of the agency's own disciplined and continual monitoring and evaluation of its activities.

The advanced countries—Ireland and Singapore, also the United States (at the state level), for example—practise a highly sophisticated form of investment promotion designed to achieve strategic industrial development objectives. Extensive study of successful agencies in both advanced and developing countries shows that an effective program of investment promotion entails many activities (box 7.3).[3] Success is the result of following a coherently integrated approach that responds effectively to the industrial sector's evolutionary development.

The Malaysian Investment Development Agency (MIDA) is an example of a successful investment promotion agency.[4] Established in 1967 it serves as the lead agency for orchestrating the country's industrial development and has responsibilities for meeting the needs of local and foreign investors in manufacturing. It assesses and advises on industrial and trade policies affecting the sector, formulates detailed plans for the sector's continued development, oversees industrial site development and handles applications for investment incentives. To attract foreign direct investment, MIDA maintains an extensive network of overseas and local regional offices and conducts investment missions to countries from which it sources carefully targeted inward investment. MIDA consults widely and regularly with stakeholders on the design and implementation of its various activities.

Malaysia's success in attracting foreign direct investment is manifest. More than 3,000 projects involving firms from 40 countries have been implemented since the mid-1960s. The manufacturing sector has grown rapidly and now accounts for 30 percent of GNP and 85 percent of total exports. MIDA has contributed to this record since its inception. Early it seized the opportunity to attract electronics production, which became the basis of Malaysia's flourishing high-tech export industries. With its regionally focused sister institution, the Penang Development Corporation, MIDA fostered the evolution of a thriving high-tech cluster in Penang. Over time MIDA has also worked aggressively to create industrial clusters sparked by inward investment in other regions of Malaysia. It has stimulated the development of local firms capable of supplying a variety of high-quality inputs to its foreign-invested firms, establishing a base of industrial competencies that enables foreign-invested firms to operate at ever higher levels of productivity as they move to higher value-added activities.

Industrial parks and export processing zones

The establishment of industrial parks, especially export processing zones (EPZs), is a crucial initiative. Industrial parks are developed and subdivided into plots according to a comprehensive plan with provision for roads, transport and public utilities for the use of a group of industrialists. Parks may go beyond physical infrastructure to satisfy the corporate and technological needs of tenants, providing a variety of common facilities and support services, such as consulting, financial services, training, technical guidance, information services, joint research facilities and business support services (hotel and conference rooms).

Parks may also provide a pleasant environment to attract skilled employees and foreign investors. This entails providing facilities such as housing, medical services, shopping and educational establishments. While economic or political reasons

Box 7.3 Activities involved in successful investment promotion

1. Laying the proper foundations

- Establishing the economic development policy context
  - Implementing macroeconomic, trade and industrial policies
  - Providing for the establishment of supportive infrastructure
  - Articulating regional development priorities
  - Determining the nature and scope of special incentives to attract foreign direct investment
  - Determining the objectives for industrial development and inward investment

- Agreeing on the rationale for attracting inward investment—its developmental role
  - Identifying key sectors or industrial clusters where foreign direct investment is to be sought
  - Discriminating among new ventures, expansion of existing operations
  - Setting priorities among forms—subsidiaries, joint ventures, mergers and acquisitions

- Ensuring an adequate structure of investment promotion
  - Deciding on a single national agency or regionally focused agencies
  - Ensuring the autonomy required for independent operation responsive to business interests
  - Determining mechanisms of coordination with responsible government departments

- Assessing competitive positioning
  - Knowing potential locations' pluses and minuses in attracting priority investments
  - Developing tailored selling points for specific possibilities within key sectors

2. Mounting a well targeted promotional campaign among selected foreign investors

- Setting the stage for contacts with individual foreign prospects
  - Establishing an image that is both accurate and appropriately inviting
  - Maintaining and managing a permanent presence overseas where warranted
  - Participating in conferences and events at which foreign investors congregate
  - Undertaking specifically designed missions to make contact with prospective investors

- Targeted contacts with individual investors
  - Identifying the most attractive potential investors
  - Establishing and maintaining relationships with these investors

3. Meeting the needs of interested investors

- Ensuring proper reception and facilitating detailed assessments by prospective investors
  - Assigning a single staff member to provide continuity and coordination among local entities
  - Developing a thorough understanding of the potential investor's needs
  - Providing information on how the investor's specific needs can be met
  - Facilitating site visits and meetings with relevant local parties
  - Specifying the incentives to be made available, including supporting activities
  - Enabling all necessary arrangements and clearances to be made on a one-stop basis

- Facilitating implementation of inward investment
  - At a minimum, ensuring that the investor's reasonable expectations are fully met
  - Trouble-shooting as necessary to remove obstacles

- Providing post-investment service to ensure that potential benefits are realized
  - Supporting follow-on investments in expansions and upgrading
  - Encouraging development and growth of local suppliers
  - Embedding the foreign-invested firm within cooperative networks of supporting institutions
  - Encouraging firm efforts to attract other foreign investments

4. Moving to the next stage of industrial development

- Building a strategy based on past promotional activity

- Implementing the strategy through strategic activities
  - Continuing to upgrade infrastructure and establish industrial sites
  - Tending to the broadening and deepening of related local value chains
  - Supporting related cluster developments to increase value-added levels
  - Ensuring continued innovation and learning within existing firms and networks
  - Working with firms on skills development to ensure continued industrial progression

Source: Based on and adapted from Loewendahl (2001).

may mean that nationwide provision of such infrastructure is impossible, the creation of these conditions is feasible within the confines of a park.

By providing adequate physical infrastructure and a legal and institutional framework, industrial parks reduce costs and risks of all kinds. They pool resources to make and market goods and meet large orders. And they breed off-shoot companies and provide fertile ground for cross-fertilization of ideas.

EPZs are useful for countries working to establish an export-oriented manufacturing sector while lacking the technical or administrative capacity to develop a countrywide system to allow exporters duty-free access to imported equipment and materials. Science and technology parks are intended for technologically advanced industries and emphasize the high-level support services such activities need: marketing, technical consultancy through networking with local R&D institutions, advisory services on finance and venture capital and search for joint venture partners.

The types of facilities, services and amenities that a park provides depend on the types of industries targeted and the failures the parks are intended to overcome. These vary with a country's level of development. Taiwan Province of China's early EPZs, for example, provided basic infrastructure and, especially important, freedom from red tape. These incentives were targeted at light industries, such as textiles and apparel, plastic products and electrical appliances, that could use the country's plentiful and cheap labour. As countrywide infrastructure improved and administrative procedures with it, parks providing these features became redundant and unnecessary.

Taiwan Province of China established its first EPZ in the southern port city of Kaohsiung in 1965 as part of an outward-looking export-oriented industrialization strategy.[5] Two other zones were established in Nantze and Taichung in 1969 when applications from investors to set up in the Kaohsiung EPZ flooded in in excess of the space available. The purpose of these EPZs was to increase exports by attracting foreign investment. This was to be accomplished by combining in one place the advantages of a free trade zone, an industrial estate, and all the relevant administrative offices of the government. Firms in the EPZ were offered complete exemption from customs duties, commodity and sales taxes, as well as other incentives. In addition to duty- and tax-free imported inputs, the EPZ provided good infrastructure facilities and simplified procedures for trade and remittances.

This simplification and "one-stop" access to incentives were particularly valuable. Whereas firms outside of the EPZ had to obtain duty- and tax-free imported inputs by means of a rebate system, location within the EPZ allowed firms to avoid all the formalities connected with obtaining these rebates. EPZs thus provided the important benefit of the cutting red tape so that investors could start their projects quickly and could run them with minimum bureaucratic fuss. The main constraint facing firms within the EPZ was that they were required to export all of their production, keeping it out of the domestic market.

EPZs were very important in placing Taiwan Province of China squarely on the path of export-led industrialization. Arrivals of foreign direct investment roughly doubled within the first year after the Kaohsiung zone's establishment. Total arrivals averaged $12 million a year from 1961 to 1965 and $44 million a year over the five years after 1966.[6] But as infrastructure facilities improved rapidly and regulatory procedures were rationalized the importance of EPZs diminished over time, accounting for only 7–9 percent of the country's cumulative exports since the 1960s. Bonded factories, which are like mini-EPZs located outside the formal zones, have been responsible over time for a much larger share. Since the 1980s, little new investment has occurred in the EPZs, reflecting their redundancy as infrastructure and duty-free procedures have improved outside of them. The administrative costs of the tax rebate system have been substantially reduced, particularly as the result of the establishment bonded factories and warehouses, lowering the value of circumventing this red tape.

Science and technology parks are at the other end of the spectrum from most EPZs in level of services. An example is China's Suzhou Technology Park.[7] Suzhou Park is made up of three institutions: Suzhou New and High-Technology Service Centre, Suzhou International Business Incubator and China Suzhou Pioneering Park for Overseas Chinese Scholars. The first incubator was set up in 1994, and the China Suzhou Pioneering Park for Overseas Chinese Scholars was created in 1998. The park now houses 300 enterprises. Ninety percent of these firms were set up by overseas Chinese and 10 percent by R&D institutes and universities. Twenty percent are high technology enterprises. In 2000 the park employed 3,000 people, 100 with Ph.D.s.

Suzhou Park's success is linked to the services it provides. The government provided seed money and attracted venture capital from abroad; additionally, banks and financial organizations provide flexible loans to firms. The park includes an incubation site of 38,000 square meters. It provides Internet connections every 10 square meters, conference rooms, a multi-media room, a technical trading room, information centres, product testing centres and public laboratories. The park includes an accounting office, law firm, business planning space and other services. Import-export services, such as customs declaration and a bonded warehouse, are provided free. Human resources support in the form of recruitment events and a database help firms identify people with the right skills. Additional services are provided in the form of management and business training by university professors and successful entrepreneurs, assistance in introducing new products and membership in the Shanghai Technology Stock Exchange.

Information services

Providing information services requires information specialists who are also technically savvy. These services are the least dependent on prior targeting and the like. Serving as an "intelligent" gateway to globally available, searchable knowledge bases—intelligent by virtue of their trained staff—information services offer a truly generic service, of equal potential use to all comers (box 7.4). As such, they are the closest among service organizations to providing a public good having universal value. But many information centres also routinely produce material to disseminate the results of the continuing search.

An example is Sri Lanka's Industrial Technology and Market Information Network (ITMIN), a commercially managed and

Box 7.4 Available on the Internet

Information services online can now provide instant, free or for-fee access to technical information and International Organization for Standardization (ISO) compliance requirements. As an experiment, a student with little knowledge of technology (neither an engineer nor a scientist) spent three hours looking for specific technical information on the Internet and in that brief time was able to find a great deal of technical information.

The hunt began at the National Institute for Standards and Technology (NIST) in the United States. While the bulk of highly technical, specific material is available only through purchase, the volume of information on the site and relevant links gave a sense of what information is available and what information a manufacturer would need to stay compliant and competitive. NIST publishes a Ceramics WebBook that offers free databases on most materials. For example, a manufacturer that uses alumina could find measurements on porosity, density and flexural strength for varied sizes of grains and different pressures, information that would help the manufacturer meet compliance requirements and learn how the product would hold up under various stresses. The following additional links were found:

American National Standards Institute (ANSI). ANSI maintains a list of international and regional standards institutions with links to their sites, as well as a list of domestic standards.

International Electrotechnical Commission (IEC). IEC provides information on electrotechnical materials and their categorization. It offers an online database of the new, standardized electrotechnical vocabulary so manufacturers can understand terms used in ISO standards and begin using a common vocabulary.

British Standards Online. This site offers bibliographic information about standards and sells BSI publications. For a fee a business or individual could subscribe to the Web site and have access to substantial information online.

Singapore Productivity and Standards Board (PSB). The PSB's Web site houses a full eShop where pamphlets, information on standards, and documentation can all be purchased. "Sparks" and "plugs" were searched and eShop found pertinent documents available for S$20 and S$54. The site also links to many other Singapore programs that assist businesses, including the new A*STAR, Agency for Science, Technology, and Research (previously National Science and Technology Board).

While the bulk of technical information is available only for a fee, these sites all contained relevant information for each country on compliance, regulation, necessary paperwork and the like. For a manufacturer needing information on a particular product or process, online information might be the fastest, most efficient and most reliable source.

Similarly, government agencies and policy analysts looking for useful knowledge of how things are done by other governments could find a wealth of information from the same kind of search.

Sources: http://www.ceramics.nist.gov/webbook/webbook.htm; http://www.ansi.org/public/library/internet/intl_reg.html; http://domino.iec.ch/iev/iev.nsf/Welcome?OpenForm; http://www.bsi-global.com/index.html; http://www.psb.gov.sg/index.html.

oriented public company funded by public and private shareholders and originally developed by UNIDO under a United Nations Development Programme–financed project.[8] Operating in three areas—information, Internet service and training—it provides information services to a broad range of businesses that previously lacked access to global information networks.

- The information group's staff receive extensive training in processing and marketing industrial and technical manufacturing information. ITMIN provides current information on technology transfer, business intelligence, electronic publishing, market surveys and investment opportunities. It researches technologies relevant to Sri Lankan firms and publishes a monthly list of adoptable technologies for Sri Lankan firms. These information services provide Sri Lankan companies with tools for decisionmaking on available technology, production, investment and export markets.
- ITMIN offers Internet hosting, training and customized services ranging from Web page development to networked intranets).
- ITMIN offers general classes in computer applications and designs customized private training programs for firms. There are special programs in information technology for managers, accountants and secretaries.

Standards and metrology

The globalization of value chains—with a multitude of firms acting as interconnected suppliers, intermediaries and marketers—has been sustained by the parallel drive towards the standardization of practices and procedures. Firm interactions along the value chain require conformity with agreed standard business practices in contracting, accounting, project management, environment management and the communication of product design and engineering information.

Standards would be meaningless in the absence of the ability to make precise measurements of the various attributes—chemical, electrical, physical, and so on—of the produced outcomes at each stage along the value chain, using common modes of measurement across international boundaries, with assurance that measured magnitudes are precisely correct within agreed error tolerances. Metrology is thus the essential foundation upon which standards rest. This foundation is maintained through a carefully linked hierarchy of metrological agencies—some autonomous and responsible only for metrology, others embedded with organizations having linked responsibilities—at the international, regional, national, and intranational levels. At the apex is the Bureau International des Poids et Mesures (BIPM) in Paris, France, which has been assigned by international convention the task of assuring an evolving basis for a single, coherent system of measurements thought out the world, one traceably linked to the International Standard of Units which is continually augmented as technologies are developed over time.

The BIPM is responsible for certifying and calibrating the units of measure that are maintained by national agencies, which are in turn ultimately responsible for certifying and calibrating the units of measure and instruments of measurement that are employed in producing firms, research laboratories, universities, and the like. In turn, just as the BIPM must ensure the establishment of new standard units to keep abreast of evolving technologies, so too must each national agency ensure that its metrological assets and competencies develop sufficiently in advance of the evolving needs of the industrial base that it serves. At the same time it must provide training and consultancy services sufficient to develop the requisite measurement capabilities of the various entities functioning within its client base.

The International Organization for Standardization (ISO), a worldwide federation of national standards bodies, introduced the best-known standards being used today, the ISO 9000 series.[9] While the vast majority of ISO standards are specific to a particular product, material or process, ISO 9000 refers to a "generic management system" standard, specifically one centred on quality control. Quality management is what the organization does to enhance customer satisfaction by continually striving to meet customer and applicable regulatory requirements in the most cost-effective manner possible. ISO 9000 certification is quickly becoming an imperative for potential exporters, signaling quality and reliability to foreign buyers, retailers and transnational corporations seeking local partners and sub-contractors.

A high-ranking priority for a developing country is therefore to have a local institution entitled to grant ISO 9000 certification to domestic firms. A standards institution can disseminate best practice in an industry by encouraging and helping firms to understand and apply new standards. Such institutions not only manage the process of certification but also provide consultancy services for firms preparing to meet those standards (box 7.5).

Box 7.5 Programmes to help domestic firms achieve standards

Singapore's member body in ISO is the Singapore Productivity and Standards Board (PSB - http://www.psb.gov.sg/). PSB has several programs which are designed to ensure that domestic firms are producing quality products. In order to help firms achieve ISO standards, PSB Certification was created in 2001as a separate corporatized entity born out of PSB. Its purpose is to assess customers' management systems based on national, international, or industry standards, such as ISO 9000. PSB Certification's web site (http://www.psbcert.com/home.htm) provides details for firms as to the application process for becoming certified, even allowing online completion of the initial application form. PSB Certification provides training events such as workshops focusing on providing participants with the knowledge and skills to implement ISO 9000. As PSB Certification is a private sector company, one of its goals is to achieve $12 million revenue in three years' time.

As a public entity PSB itself has several programs to assure quality. For example, the People Developer Standard is a three-year certification scheme that attempts to assure that firms maintain high standards in human resource development. Launched in 1997, the People Developer Standard provides organizations with a systematic process to review their human resources practices, develop staff and improve training effectiveness. This initiative provides a good example of the ways that a country can bring firms up to a desired standard. A variety of assistance programs are offered to this end.

Training programs designed to impart the basic knowledge on how to set up and implement the People Developer systems are provided by PSB, private companies, and educational institutions; PSB has a Skills Development Fund (SDF) which supports 90 percent of course fees. It also has an Enterprise Development Fund (EDF) which assists small and medium-size enterprises to hire external consultants to help set up appropriate systems; the EDP supports up to 70 percent of the consultancy fee. The web site provides a list of consulting firms. Additionally, two-hour, one-on-one discussions with National Assessors are provided free-of-charge in order to clarify the standard's requirements, ensure the correct implementation of the systems, and ascertain readiness to apply for an audit. Half-day, free-of-charge workshops covering application and audit procedures, common pitfalls and critical success factors, and the writing of assessments reports are also held. Similarly, half-day, free-of-charge sharing sessions are held quarterly in order that firms desiring to adopt the People Developer Standard can learn from the experiences of newly certified organizations. Detailed instructions on how to start the process of certification are provided online, as well as information on how to apply (including downloadable application forms) and how to maintain the standard once certified.

Source: http://www.psb.gov.sg.

India is an example of a country that has a formal certification program for ISO 9000 compliance.[10] The Bureau of Indian Standards (BIS), authorized by the government to certify compliance with ISO standards, has the following process for licensing a firm for ISO 9000 standards. Firms are instructed to:

- Establish a documented quality system and ensure its effectiveness.
- Submit an application on prescribed forms along with a completed questionnaire and necessary fees.
- Submit the quality control manual and related documents, when requested.
- Arrange for an audit by a BIS assessment team.
- Take corrective actions on non-conformities observed by assessment team and get them verified.
- Obtain the license, which will enable the company to compete effectively in national and international markets.

After registration of the application BIS examines the firm's quality control manual and quality plan to verify conformity to the relevant standard. After that, BIS arranges a preliminary visit to learn the size, nature of operation and the firm's readiness for the initial audit. An audit team from BIS then visits the firm for the initial audit of compliance with the procedures and activities enumerated in the documents provided and with the relevant ISO standards. If the audit report is satisfactory, the firm is granted a license by BIS for a period of three years. Grant of a license is followed by surveillance audits every six months by BIS auditors to verify implementation and maintenance of the quality system established by the firm.

The phase of export promotion that began in Taiwan Province of China in the 1960s brought with it a concern for quality control of manufactured goods.[11] The reason for this can be understood by looking at the example of bicycles. Although Taiwan Province of China exported virtually no recreational bicycles in the 1970s, as bicycles become popular in the United States, many wholesalers placed orders in Taiwan Province of China solely on the basis of price. Thus Taiwan Province of China began producing bicycles for export. Many of these early bicycles had quality problems and defects, and Taiwan Province of China's chance to enter the world market was at risk. The government responded by commissioning the Metal Industries Development Centre to design testing equipment for bicycle quality control. Combined with technical assistance, this action was instrumental in improving the quality of bicycles. By the mid-1970s, Taiwan Province of China was exporting several million bicycles, and by the early 1980s, it accounted for about half of the world supply.

This concern for quality was present as far back as 1953, when the Taiwan Government first began inspecting the quality of goods that its firms were exporting. Canned foods are another early example of why this was important: the poor quality of some brands was adversely affecting the international reputation of others. Inspecting each good that left the country, or even a sampling, clearly posed a practical difficulty; the magnitude of exports was too great.

The system was redesigned in the mid-1970s to focus on a firm's quality control procedures rather than on individual goods. For example, instead of examining each bicycle shipment for defective bikes, the government now examined the way that bicycle-producing firms ensure that only high quality bicycles are exported. Factories were classified into three categories based on inspection of their quality control procedures. Those scoring below the minimum were not given a license to export. Those scoring the highest were allowed to export without inspection of their merchandise; only their quality control system was reinspected yearly. In addition to having their systems inspected twice a year, those scoring in the middle had a one-in-thirty chance of having individual shipments inspected. The quality control systems of those in the third category were inspected three to four times a year and individual shipments faced a one-in-fifteen chance of being inspected. The inspections were carried out by the Controls Bureau of Standards, part of the Ministry of Economic Affairs, in cooperation with the Bureau of Commodity Inspection and Quarantine (these bureaus are now integrated into the Bureau of Standards, Metrology and Inspection which has an English language Web site[12]).

Productivity centres

Productivity centres are broadly focused, geared more to industrial development than to technological development alone. They work with firms to promote efficiency and productivity in manufacturing, often changing their focus as the problems needing attention change over the course of development.

Productivity centers operate on a national and regional level. At the national level they are generally funded initially by government and promote nationwide awareness of the need for productivity enhancement. Most of these campaigns focus on the positive relationship between employment and productivity growth to combat the fear that increased productivity displaces labourers.

The Japan Productivity Centre, founded in 1955 with funds from the United States as an organization of labour, management and academia, merged in 1994 with the Socio-Economic Congress of Japan to form the Japan Productivity Centre for Socio-Economic Development (JPC-SED).[13] The original guiding principles emphasized that:

- Productivity gains increase employment.
- Labor and management must work together.
- Gains from productivity should be shared by labour, management and the public.

In the 1960s and 1970s the primary focus was on improving the relationship between labour and management through consulting services and seminars. JPC borrowed many of its productivity ideas from Europe and the United States, bringing in foreign experts for seminars and reading foreign publications. After aid from the United States ended in 1962, businesses covered most of the expense for the JPC–SED, with some government help. Programs increased to include graduate courses, information technology programs, robotics and automation training, database assistance, increased managerial training and mental health research on employee reaction to various workplace environments.

The JPC–SED created many spin-off organizations, many focusing on technology-specific improvements, such as the Japan Industrial Engineering Association. Japan soon became a productivity model, creating and hosting a series of international conferences, study tour programmes and workshops for Europeans and Americans. Today the JPC-SED has expanded its productivity models to public agencies, environmental concerns and the social welfare system.

Productivity centres can thus provide vital information and services to private firms. Institutionally, they appear to be quite adept at spawning a network of related support organizations. Together, they are changing as the industrial sector evolves and its needs change. The Asian Tigers invested heavily in setting up and developing such institutions. Even *laissez faire* Hong Kong Special Administrative Region (SAR) of China provides subsidized technology support to its exporting firms, most of them small or medium size (box 7.6).

The national productivity centre provides a general agenda to regional productivity centres. These regional centres provide productivity assistance to firms and may have more local, satellite locations. Productivity centres directly consult and advise firms on management strategies, efficient floor layouts, labour-management relations and workplace environment and environmental concerns, among others. Programs often include a training component, which ranges from single-day seminars to longer courses in business administration, to financed trips and site visits, to appropriate foreign examples of successful factories and plants. In more developed countries productivity centres shift from providing direct advice to helping firms network and find private market consultants and programs for solutions.

Box 7.6 Technology support from the Hong Kong Productivity Council

The Hong Kong Productivity Council (HKPC) was started in 1967 to help the myriad small firms that constitute the bulk of the industrial sector. Its focus has been helping firms upgrade from declining labour-intensive manufacturing to more advanced, high value-added activities. It provides information on international standards and quality and provides training, consultancy and demonstration services on productivity and quality to small firms at subsidized rates, serving over 4,000 firms each year. Its on-line information retrieval system has access to over 600 international databases on a comprehensive range of disciplines. Its technical library subscribes to more than 700 journals and has more than 16,000 reference books.

The HKPC acts as a major technology import, diffusion and development agent for all the main industrial sectors. It identifies relevant new technologies in the international market, builds up its own expertise in those technologies and introduces them to local firms. Successful examples of this approach include surface-mount technology and three-dimensional laser stereo-lithography. HKPC has also developed a number of computer-assisted design, manufacturing and engineering systems for the plastics and moulds industry, of which over 300 have been installed. HKPC provides a range of management and technology courses, reaching some 15,000 participants a year. It also organizes in-house training programmes tailored to individual needs.

To disseminate information technology, HKPC has formed strategic alliances with major computer vendors and provides specially designed software for local industry, consultancy and project management in computerization. HKPC provides consultancy services in ISO 9000 systems and has helped several firms in Hong Kong obtain certification. It assists local firms in automation by designing and developing special-purpose equipment and advanced machines to improve process efficiency.

Because small firms have difficulty getting information on and adopting new technologies the HKPC has always had to subsidize the cost of its services. Despite the growth in the share of revenue-earning work, the government still contributes about half its budget. Market failures affecting access to technical information occur even in a highly sophisticated export-oriented economy with highly developed financial services like Hong Kong SAR.

Source: Lall (1996).

Extension services for small and medium-size enterprises

Technology extension programs, sponsored and coordinated through governments, create networks that help small and medium-size enterprises stay viable in a competitive economy through the use of technology to increase productivity. Technology extension is concerned with creating small but profitable improvements by extending already established technology to smaller firms. While the design of technology extension organizations differs, all of them have relationships with small and medium-size enterprises and with sources of technology. Technology extension programs either provide resources that enable firms to identify needs and find appropriate technological solutions or engage in the actual identification and provision of solutions by means of targeted technical assistance.[14]

An example of an extension program that performs both functions in relation to a critical, narrowly focused technological objective is the national cleaner production centre, which assists firms in achieving best-practice standards in the prevention of pollution (box 7.7). These centres are like productivity centres in that they are intended to serve the full range of a country's industries for a particular objective, but they are otherwise like, and closest to, extension agencies.

In the United States many extension services have been provided locally by university systems. But with the inception of the Manufacturing Extension Partnership (MEP) in 1988 and its coverage of all 50 states by 1997, field personnel from 400 MEP offices connect small and medium-size firms to a large network of both public and private industrial service providers, including university extension services. MEP per-

Box 7.7 National cleaner production centres

The joint UNIDO/United Nations Environment Programme (UNEP) sponsored national cleaner production centres aim to enable developing countries to promote, gain access to and use cleaner production technologies, including technology transfer from abroad. The NCPC's build capacity within a country for the adoption of cleaner production to take place, promoted and chosen by professionals in that country and adjusted to local conditions. These centres can be considered part productivity centre ("environmental control" is not unlike quality control in have cross-cutting, generic elements) and part extension service (focused on the specific needs of specific enterprises). As they've so been operating so far, they appear closer to the productivity centre side.

In January 1995 UNIDO began NCPC programmes in Brazil, China, the Czech Republic, India, Mexico, Slovakia, the United Republic of Tanzania and Zimbabwe. As of September 2001, 23 centres have been funded. The total budget allocated since 1991 amounts to approximately $21 million, with 85 percent of the budget coming from donor countries, 10 percent from multilateral organizations and the remaining portion from self-financing by countries receiving the centres. UNIDO acts as the executing agency with the UNEP's Industry and Environment Programme Activity Centre providing methodology and information. It takes approximately three to five years to fully establish each centre.

An NCPC within a particular country should eventually be able to offer the following six services:

- Short seminars to raise awareness of cleaner production and disseminate general information.
- Training in cleaner production methodology.
- Dissemination of technology information needed for in-plant assessments.
- Technical assistance, including in-plant cleaner production assessments.
- Advice on financing and funding sources for cleaner production.
- Policy advice.

All the centres are engaged in short-term training, dissemination of information on cleaner production and in-plant assessments. Six of the original NCPCs have conducted in-plant assessments at 3–16 enterprises per year, with most falling in the 7–9 range. Some of these assessments were actually several separate in-plant assessments, undertaken by different teams for different production lines. Some NCPCs, such as India's, assist only small and medium-size enterprises, some work with all sizes of enterprises, while others, like those in Brazil and China, deal primarily with large enterprises. Enterprise staff and local, NCPC-contracted consultants jointly identify problems within an enterprise and choose appropriate technological changes. In 1997 and 1998 half the 439 identified cleaner production options were improvements in housekeeping, changes that are easily identifiable and have a high benefit/cost ratio. Overall, only 64 percent of the identified cleaner production options were implemented. Implementation rates vary, with housekeeping measures having the highest implementation rate (76 percent) and changes in process technology having the lowest rate (37 percent). The need for investment and the time required for major technological change help to explain this discrepancy.

This tendency to choose low-investment options becomes reinforced when in-plant assessment staff know of financing constraints and thus recommend low or noninvestment options. Only about 3 percent of the cleaner production options included a transfer of technology, which were all purchases of capital goods rather than purchases of licenses: new equipment, hardware modifications and replacement equipment. However, the cleaner production methodology itself can be viewed as technology transfer as can the information and know-how transferred from foreign experts, consultants, and counterpart (twinned) institutions. The NCPCs did, however, seem to improve local transfer of technology within countries. In Slovakia, enterprises acquired and adapted technology from a local university, and in Brazil, China and Mexico, companies purchased environmentally sound technologies from local producers.

Source: UNIDO.

sonnel identify a firm's needs and problems and assist it in finding appropriate solutions. While MEP was intended to bring cutting-edge technology to small firms, in practice it focuses on bringing more realistic help on existing technologies and management.

Funding for this partnership is provided by state, federal and private funds; firms receiving assistance also pay a portion of the cost. Their fees at most seem to cover 40 percent of MEP operating costs; thus federal and state funding seems necessary to continue providing this consulting service. Many manufacturers who have benefited from MEP programs report increased profits; surveys also suggest that extension services increase employment and generate business growth. Comparative studies have shown that receiving extension services from MEP offices increases the rate of growth and adoption of technology over that of firms not receiving assistance.

In Japan 170 Kohsetsushi centres provide technological support for businesses that have fewer than 300 employees. Unlike extension services in the United States, they provide only technological services—management and financial services are left to other agencies. Charging only nominal fees to their clients, the centres were created and sponsored by the central government, but maintain relationships with local and prefectural governments. They conduct research, have open laboratories for training, test and examine products for compliance, provide advice and guidance and promote technology diffusion and information dissemination. Because of the long-term relationships between large manufacturers and the smaller manufacturers of their inputs, the centres meet the demands of both-sized firms by focusing on the testing and analysis of materials and products—promoting quality, performance and precision while ensuring standards among the input suppliers.

Managers of small firms appreciate and depend on the personalized services that the centres provide and prefer dealing with them than with universities. Traditionally, these small firms simply produced intermediate inputs with new product design and engineering coming down from the larger firms. These same small firms, guided by the Kohsetsushi centres, are now designing new products and spurring technological growth among themselves—innovating themselves rather than simply following larger firms' leads. Without the government-funded, highly localized centres, most of these small firms would not have access to technological advice or capability, to their detriment and that of the larger companies that use their products.

Many developing countries have recognized the need for extension services to help small and medium-size enterprises produce better products with better technology.[15] Chile's Technical Cooperation Service (SERCOTEC) has provided technical support since the 1950s. One successful project provided technical assistance to honey manufacturers in Litueche, replacing traditional hives with modern ones and adding more hives, increasing the overall yield from 600 kilograms a year to 18,000. In Pomaire, Chile, SERCOTEC helped local pottery craftsmen implement the technology of gas ovens that would mimic the traditional wood-burning ovens yet efficiently produce lead-free pottery. This change increased productivity and led to exports to markets demanding lead-free products.

South Africa's National Productivity Institute and Industrial Research Organization have formed a partnership to create the National Manufacturing Advisory Centre (NAMAC). NAMAC is to eventually consist of nine manufacturing advisory centres (MACs)—regional centres that target and advise small manufacturing firms (under 200 employees) in various industries. MACs strive to increase competitiveness and efficiency by upgrading firms' technological capabilities and providing other business support services including financial services, plant layout redesigns and export and marketing information. Individual MACs provide their own services on a for-fee basis and direct firms to appropriate service providers or sources of export intelligence. NAMAC is additionally funded by partnering member organizations and the Danish foreign ministry. Currently, two of the proposed nine centres are fully functional and operating.

The Government of Taiwan Province of China also provides an extensive range of support to its myriad small and medium-size enterprises, allowing them to compete in extremely skill- and technology-intensive industries without being able to invest large amounts in in-house R&D.

Taiwan Province of China's technology infrastructure for supporting its many small and medium-size enterprises is perhaps one of the best anywhere. There are around 700,000 small and medium-size enterprises in Taiwan Province of China, accounting for 70 percent of employment, 55 percent of gross national product (GNP) and 62 percent of total manufactured exports. In 1981 the government set up the Medium and Small Business Administration to support small and medium-size enterprise development and coordinate the several agencies that provided financial, management, accounting, technological and marketing assistance to small and medium-size enterprises. The government covered up to 50–70 percent of consultation fees for management and technical consultancy services for small and medium-size enterprises. The Centre-Satellite Factory Promotion Programme of the Ministry of Economic Affairs integrated smaller factories around a principal one, supported by vendor assistance and productivity raising efforts. By 1989 there were 60 networks with 1,186 satellite factories in operation, mainly in the electronics industry.

The Taiwan Province of China Handicraft Promotion Centre supports handicraft industries, particularly those with export potential. Its main clients have been small entrepreneurs, most with under 20 employees. In addition, the Programme for the Promotion of Technology Transfer maintains close contact with foreign firms with leading-edge technologies to facilitate the transfer of those technologies to Taiwan Province of China.

Serving clusters of small and medium-size enterprises

Small and medium-size enterprises can often work with support agencies to propel their innovation and learning. The fast spread and absorption of new ideas have been documented for today's developing country clusters.[16] Examples range from the autoparts cluster in Kumasi (Ghana), to the clothing cluster of the Western Cape (South Africa), the footwear cluster in Leon (Mexico) and the surgical instrument cluster in Sialkot (Pakistan). Individual small and medium-size enterprises rarely have the resources or connections to tap the global wealth of product and process ideas. So, where can the new ideas come from?

Small and medium-size enterprises have three main ways to gain access to knowhow. The first is by pooling resources and acting together. Joint stands at key international trade fairs are an example. Participating in these fairs is not just about selling—it is also about learning through direct contact with potential customers. The second possibility is to rely on a local technology institute, funded by government or foreign donors, for the import of new technology. A successful example is CETMAM, a technology institute in Curitiba (Brazil), which helped the furniture clusters in the state of Paraná accelerate their product and process innovation. The third possibility is learning through foreign buyers. This route deserves particular attention because some of the most successful developing country clusters operate in buyer-driven chains (chapter 6). In many cases, the global buyers have enabled local producers to innovate in the sphere of production, particularly to raise quality and speed. Such improvements in products and processes are clearly in the interests of the buyers.

Unfortunately, the majority of small and medium-size enterprises clusters in developing countries are underperformers, unable to link, leverage and learn more advanced product and process technologies and to integrate with value chains—on a regional, national or global basis. Moreover, they may be locked into a vicious cycle of cut-throat competition, falling profit margins, deplorable working conditions and mounting environmental degradation.

Cluster development institutions can drive firms to take certain kinds of collective actions, such as collaborating to acquire certain new competencies, while remaining fierce competitors in other product markets (box 7.8). There are many examples of such institutions in East Asia, where the linkage and leverage strategies have been best developed. In Taiwan Province of China, small firms have been encouraged to ally themselves in R&D consortia, where technological guidance is provided by a public sector laboratory. The key organizations within these R&D-promoting institutions are private firms and the laboratories. But important guiding and catalytic roles are also played by government ministries, particularly the Ministry of Economic Affairs (for funding and audit), and by trade associations, which legitimize the R&D consortia in the eyes of their member firms and recruit new firms for membership of the consortia (box 7.9).

Seldom is one form of service sufficient—complementary services required to deal with intertwined or linked problems and opportunities in distinct areas of firm behavior. The more targeted the package of services on specific types of firms, the more likely their usefulness to firms. The greater the participation of firms in defining and designing the services offered, the more likely are better results. Services may be provided publicly (government) or collectively (industry association).

Institutional support for clusters can cost-effectively increase quality and production while supporting a collaborative, innovative environment. Governmental and private sector institutions and organizations can provide necessary training and technical advice, promote cooperation between firms and help link local industries with foreign export markets. Just as most clusters arose spontaneously, so have the private institutions that support them—in organizations of firms, for example.

In both the Leon and Guadalajara footwear clusters in Mexico, the local "*Camara del Calzado*" shoe making entrepreneur's association provides numerous support services to drive the success of each cluster. Leon hosts 51 percent of Mexico's shoe-production, most of it men's and children's footwear. Guadalajara has 22 percent market share, concentrating on women's shoes. Services of the Leon and

Box 7.8 Cluster development in Jaipur, India

Colorful hand-block printing enjoys a long tradition in Jaipur, the capital of Rajasthan, where approximately 550 small and very small firms engage in both hand-block and screen printing and provide employment to almost 10,000 workers. But the ability of the local artisans to penetrate profitable national and world markets was severely constrained. As a result, the artisans were locked in a vicious cycle of cut-throat competition, falling labor standards and mounting degradation of the environment.

An action plan (developed by cluster stakeholders with UNIDO support) for the cluster of Jaipur envisaged enhancing the design, production and marketing capacity of local firms—and developing a product image (including a common brand) in line with current market demand.

Manufacturers already in international markets joined in an export consortium (COTEX—Consortium of Textile Exporters) for the realization of common initiatives. Artisans previously relying on traders for marketing, organized the Calico Printers Co-operative Society (CALICO) to expand their market both domestically and abroad.

- An ad hoc training program was launched to strengthen the marketing competence of CALICO members.
- A demonstration fair was arranged in Jaipur to allow the artisans to make full use of their newly acquired skills.
- Several training courses were organized (on marketing, design, merchandising) in collaboration with key Indian technical institutes.
- Participation in national (New Delhi) and subsequently international fairs (in Florence and in Osaka) was arranged so that artisans could assess their capacity to handle direct meetings with potential buyers on a much larger scale.
- A common brand was created to identify traditional Jaipur products that satisfy strict standards of product quality and production techniques.

One outcome of these activities is that the traditional bitterness and conflict have disappeared. Local producers have learned to trust each other and to cooperate with their local partners (small and medium-size enterprise support institutions, providers of business development). Structural problems are now tackled through collective ventures planned and implemented by the cluster actors themselves. Such ventures include initiatives to enhance technological competence (introduce new production technology, improve inventory management, reduce drudgery), curb pollution (waste processing, cleaner production technology) and increase access to credit (mutual credit guarantee schemes).

Moreover, several producers associations and self-help groups have been established in the cluster, along the lines of COTEX and CALICO. As the collaboration among cluster actors has increased, these representative bodies have started to collaborate with greater frequency, providing a forum for a sustainable clusterwide governance framework.

Source: http://www.unido.org/33112.htmls.

Box 7.9 Leveraging advanced technologies from abroad

Unlike Japan and Republic of Korea, both dominated by giant firms, the most significant players in Taiwan Province of China have been small and medium-size enterprises whose entrepreneurial flexibility and adaptability have been the key to their success. Underpinning this success is the effort of public sector research and development institutes, such as Taiwan's Industrial Technology Research Institute (ITRI). Since its founding in 1973 ITRI has acted as a prime vehicle for leveraging advanced technologies from abroad and rapidly diffusing or disseminating them to Taiwan's enterprises. This cooperation between public and private sectors, to overcome the scale disadvantages of Taiwan's small firms, is characteristic of the country's technological innovation strategies and of new high-tech sectors.

Taiwan's current dominance of mobile personal computers (PCs), for example, rests at least in part on a public-private consortium that rushed a product to world markets in 1991. Taiwan's strong performance in communications products such as data switches, which now dominate in PC networks, similarly rests on a consortium that worked with ITRI to produce a switch to match the Ethernet standard, in 1992/93. When IBM introduced a new PC based on its PowerPC microprocessor, in June 1995, Taiwan firms exhibited a range of computing products based on the same processor just one day later. Again this achievement rested on a carefully nurtured R&D consortium involving both IBM and Motorola, joint developers of the PowerPC, as external parties. These successes were followed by many more R&D alliances in digital communications and multimedia areas.

Taiwan Province of China is emerging as a potentially strong player in the automotive industry, particularly in the expanding China market, driven by its development of a 1.2 litre 4-valve engine; again, this is the product of a public-private collaborative research endeavour involving three companies, which have now jointly created a new Taiwan Engine Company to produce the product.

The R&D consortium is an inter-organizational form that Taiwan has adapted as a vehicle for catch-up industry creation and technological innovation. Some of these consortia have been more successful than others—but all seem to have learned organizational lessons from the early cases where government contributed all the funds, and research tasks were formulated in generic and overly ambitious terms for the companies to take advantage of them.

The more recent R&D alliances have been more focused, more tightly organized and managed, and have involved participant firms much more directly in co-developing a core technology or new technological standard which the firms can incorporate, through adoption and adaptation, in their own products. The basic model of the alliances a process in which R&D costs can be shared, and risks reduced, by bringing many small firms together to work with ITRI, the main vehicle for leveraging. The goal is the rapid adoption of new technological standards, products or processes developed elsewhere, and their rapid diffusion to as many firms as possible.

Sources: Mathews and Cho (2000); Mathews (forthcoming).

Guadalajara *camaras* include trade fairs; business support in financial, legal, and managerial advice and training; and such technical assistance as bringing in foreign experts. Membership fees from firms and profits from the trade fairs fund the *camaras*.

The associations also promote cooperation and closer integration among firms by working with them on the standardization of measurement systems and by forming "agrupamentos industriales". These loose groups are composed of many firms that agree to visit each other's factories. These visits allow knowledge exchange, promote discussion and trust and increase innovation and collaboration. Member firms are also required to have external experts audit their plants, which leads to greater efficiency as problems are diagnosed and resolved.

The *camaras* are important in helping their members respond to the cheap imports that have flooded Mexico's no longer protected domestic shoe market, enabling members to increase the quality of inputs and become more efficient. The *camaras* have also provided an effective means of looking to higher end shoe markets in the United States. Because the success of shoe manufacturers often depends on the current shoe fashion and what sells, the *camaras* pay special attention to fashion trends and help firms adjust their manufacturing to meet the market's needs.

A Ministry of Industries program additionally encourages joint marketing, joint brand names and *empresas integradoras* that form groups to buy inputs and sell output collectively. Local credit unions have developed within the clusters to facilitate better loan access and encourage this collective input purchasing. Research has shown that the local initiatives taken by these various institutions have significantly influenced the sector and resulted in numerous positive externalities.

India's Tiruppur cluster of cotton knitwear manufacturers uses local institutions for assistance with marketing, exportation and design innovation. The governmental Apparel Export Promotion Council administers a quota system that limits what producers can export under bilateral trade agreements, promotes exports and also helps local companies understand bilateral trade agreements. This organization creates market survey teams, actively finds new markets, organizes trade delegations and collects data on knitwear trade. The Tiruppur Exporters Association also explores new markets and collects marketing data. With 248 regular members and 134 associate members the association has also put in place a self-financed industrial complex for export knitwear producers with production facilities for 157 firms. It is now working to improve local infrastructure by financing sewage treatment and more telephone lines.

To complement marketing and export promotion by these institutions, the autonomous South Indian Textiles Research Association (SITRA) researches and tests cotton fibers to create finer-count cotton and develops new spinning and weaving techniques. It plans to build a training centre and research laboratory that would test cloth and dyes for compliance with standards and would research incorporating design technology into Tiruppur knitwear manufacturing. Government grants, revenue from services and assets and membership fees fund SITRA, with member mills paying both admission and recurring fees per spindle, rotor and shuttleloom. Despite labour being cheaper elsewhere in India, this knitwear cluster continues to grow and successfully export, aided by local institutional support.

Thus the public and private sectors together have created local institutions to provide support that collectively benefits the cluster. This emergence of private, membership-based institutions signals that firms in the cluster see the potential gains from collaboration and find it cost-effective to join institutions. Similarly, government bodies see cluster support as an investment in the sector's global viability and the country's economic health.

Research and development laboratories

Most of the industrial R&D that is relevant to the needs of developing countries is what might be termed "transfer-related" R&D. Unlike "inventive" R&D, which takes place on the global technological frontier and seeks truly novel products and processes, transfer-related R&D aims at the assimilation, adaptation and improvement of technologies transferred from elsewhere. Simple in-plant experimentation to learn the optimal configuration of process and product parameters is but one form of low-level transfer-related R&D. At the highest level, such R&D takes place in specialized, sophisticated labs that are very much like their counterparts in industrialized countries in terms of equipment and staffing.

Because of their limited resources, small and medium-size enterprises are generally unable to engage in other than relatively low-level transfer-related R&D. Government-sponsored R&D laboratories thus have a critical role to play in developing and transferring technology to small and medium-size enterprises. Recognizing this, the government of Taiwan Province of China established a number of such laboratories that have very effectively served the needs of the many small and medium-size enterprises that form the bulk of the industrial sector.[17] The activities of these laboratories, most of which are specialized to serve a particular industry, have over time encompassed many levels of transfer-related R&D.

Several technology research institutes provide R&D support to the private sector. The China Textile Research Centre, set up in 1959 to inspect exports, expanded to include training, quality systems, technology development and directly acquiring foreign technology. The Metal Industries Development Centre was set up in 1963 to work on practical development, testing and quality control work in metal-working industries. It later established a computer-aided design and manufacturing centre to provide training and software to firms in this industry. The Precision Instrument Development Centre fabricated instruments and promoted the instrument manufacturing industry, and later moved into advanced areas like vacuum and electro-optics technology.

At the apex stands the Industrial Technology Research Institute (ITRI), established in 1973 under the direction of the Ministry of Economic Affairs, which has specialized in the transfer of sophisticated, frontier-or-close to frontier, technology to introduce entirely new industries into the fabric of the economy's industrial sector. The technology is sourced (searched for and assessed) by ITRI, then mastered by its staff, in the course of carrying out what adaptations appear warranted in the local context, then extended to firms. Sometimes the transfer involves formal modes of foreign supply (licensing), other times it does not. ITRI's role has progressed from being the singular implementer of the first steps (singular in the sense of without much cooperation by firms, some of which were accomplishing similar transfers on their own) to being the coordinator of collaborative consortia of key firms involved in cooperatively undertaking transfers.

An example of a success story of upgrading the technology of an existing industry is the bicycle industry. In 1984 the Materials Research Laboratories division of ITRI, working in close cooperation with a local producer, Ih Ching Company, developed a carbon fiber-epoxy composite rapier wheel for shuttle-less weaving machines. This technology was adapted to another use in 1987, again in a successful collaboration. Together, Materials Research Laboratory and a local bicycle company, Giant Machine Co., developed an advanced bicycle frame made of a carbon-epoxy composite. This technology was systematically transferred to local firms. This, together with its upgrading, led to a revival of Taiwan Province of China's bicycle exports in the 1990s. Taiwan Province of china's bicycle industry is now one of the world's most advanced and successful.[18]

Sequencing priorities

In thinking about sequencing, having an ITRI comes later. By its nature, it is highly sophisticated and requires highly qualified human capital. Sectorally focused R&D institutes meant to complement extension services prove useful much earlier, in sequential terms, than an ITRI clone.

The highest priority at the outset should probably be given to general service organizations having relatively limited requirements for highly skilled technical personnel. This would enable serving the greatest number of potential clients without need to predetermine which industrial sub-sectors should be given priority. That would in part be learned through the operations of the initial organizations, as could the details of administering service organizations and linking them effectively to individual firms and their needs and problems. Certainly, high priority should go to the reform of existing organizations that serve, or could be reformed to serve, industries in which the country should readily be able to realize a competitive advantage.

As a general rule, organizations—whether newly formed or being reformed—should not seek staffing at a level of technical expertise too far in advance of that in the firms to be served, certainly not at the outset. The point is to gain the advantages of incremental learning, starting with modest means and expectations, learning as experience is accumulated on what works and what does not. The point is equally to ensure the capability for effectively serving firms in small, manageable ways before investing large sums to secure technical expertise without knowing that it can be effectively deployed in ways that will increase firms' levels of productivity.

Notes

For further details on sources, information and the literature on subjects covered here, see the background papers.

1. Benefits that accrue to service recipients increase the general tax base from which government revenues are derived, providing an indirect means of overtly recovering fixed costs, one that figures prominently in some discussions of service provision in the developed countries.

2. See Pack and Westphal (1986, pp. 102–126).

3. Loewendahl (2001).

4. MIDA and Malaysian government documents on the Web; UNIDO; Lall (1996).

5. This discussion of EPZs in Taiwan Province of China draws on Dahlman and Sanaikone (1990), Galenson (1979) and Wade (1990).

6. Schive (1990).

7. Dahlman and Aubert (2001).

8. For more information, see http://www.itmin.net/, http://www.itmin.net/information/services.html.Unido, or http://www.unido.org/doc/100438.htmls.

9. http://www.iso.ch.

10. http://www.bis.org.in/cert2.htm.

11. This section draws on Dahlman and Sananikone (1990).

12. http://www.bsmi.gov.tw/english/e_n_hpg.htm.

13. http://www.jpc-sed.or.jp/eng/.

14. This section draws on Shapira (1992, 1998) and Kolodny and others (2001).

15. This discussion of SERCOTEC and NAMAC draws on Shapira (1992, 1998) and Kolodny and others (2001).

16. This section draws on *World Development,* special issue on Industrial Clusters in Developing Countries; Institute of Development Studies Research, Globalization—Industrial Clusters in Developing Countries; http://www.unido.org/doc/331101.htmls.

17. Hou and Gee (1993).

18. Mathews and Cho (2000).

8 The way forward

INDUSTRY CAN BE A POWERFUL ENGINE FOR GROWTH AND STRUCTURAL transformation in developing countries. It remains vital to innovation and to the creation of new skills, organizations and attitudes. It lies at the core of technology transfer, learning and diffusion. It is thus essential for ensuring sustained productivity growth. And its importance is increasing.

To be emphasized is the enormous productive potential of new technologies and organizational methods (such as plugging into global value chains). There is enough productive knowledge around to transform standards of living in many poor countries, if they could build the capabilities (and raise the investment resources) to exploit them. The continuing disparity in competitive capabilities raises urgent problems, and it is vital to reverse this. The widespread liberalization of trade, investment and information flows is making it possible for industrial activity to encompass the developing world and to transfer resources to their enterprises. In short: the potential of harnessing industrialization for sustained development has never been greater. And the costs for countries that fail to realize this potential have never been larger.

So far, only a small number of developing countries are realizing the full benefits of industrialization. The data clearly show that industrial performance is diverging within the developing world—a few successful economies are pulling away from the rest. And there are few signs of reversal. Nor does this appear to be simply a delayed reaction to globalization and liberalization. If it were, it would have corrected itself by now.

The divergence of the groups of developing countries reflects the development of strong drivers of industrialization in only a handful of them. And it is highly likely that countries will diverge even more. Vexing and undesirable, this needs to be reversed.

The developing countries can build competitive industrial capabilities in the current setting. This is not in doubt. Also clear is that building these capabilities, faced by pervasive market and institutional failures, needs extensive policy support. But policy interventions in developing countries do not have a happy history: inefficiency and waste have marked the post-war experience of planning, import-substitution and state-led industrialization. Even so, the countries that employed industrial policy in export-oriented environments—with complementary policies to build skills, technological capabilities and supporting institutions and to leverage foreign resources—show that such strategies can radically transform the industrial landscape in less than a generation.

A natural starting point in formulating national strategies and policies is for countries to benchmark their industrial performance along the lines detailed in chapter 3. They can also benchmark the drivers of that performance by looking at the key structural variables—at local technological effort, at foreign direct investment, at licensing royalties paid abroad, at physical infrastructure (chapter 4). That way, they can position themselves to see what technological capabilities to develop, what global value chains to latch onto and what services to support for innovation and learning. These efforts cannot be left to detached policymakers alone. Needed are broad coalitions of public, private, civil and academic players, committed to agreeing on a vision that can give direction to their industrial strategy.

As this chapter stresses, however, a country's industrial policies have to be couched in the broader developmental perspective of creating wealth and enhancing welfare. The idea is not just to promote industry. It is to promote efficiency throughout the economy—to sustain productivity growth and to ensure that the benefits are distributed equitably. That requires paying great attention to the framework conditions of political, social and macroeconomic stability—not just for industry but for all of society. It also requires putting in place the institutional foundations, again not just for industry but for all of society.

Framework conditions—cannot be ignored

Successful, sustained industrial development can take place only if the economic and political conditions are right. On this the consensus is widespread. The most fundamental conditions are clearly political, social and macroeconomic stability. Without them, investors of all kinds, local and foreign, will shy away, and the signals investors respond to may be distorted. High inflation rates will induce investors to eschew long-term projects in favour of short-term ones—and to shift from productive activities to those where payoffs are quicker and larger (property or stocks). Overvalued exchange rates will discriminate against exportable activities. An unstable political or social climate can induce short-term investments or drive them overseas. And so on.

Along with stability is an equally important need for clarity and predictability in the policy environment. Otherwise, capacity building and capability accumulation will suffer. These factors are even more important for internationally mobile resources, such as foreign direct investment. Some international investors may be willing to accept high levels of risk. But they will demand high premiums, tending to focus on quickly extracted resources rather than on building long-term competence.

Good policymaking goes beyond clarity and predictability—it increasingly entails transparency and participation. Transparency in the policy process inspires confidence. Participation ensures trust and the flow of information. Indeed, networking between governments and the other main actors is perhaps as important for effective policy design and implementation as it is for innovation. Why? Because policies, while predictable in broad terms, also have to be flexible and adaptable in their details and application. In a world of constant change, it is not always possible to correctly anticipate policy needs or to predict the consequences of particular measures. For processes as complex as industrial restructuring, upgrading and innovation, it is imperative to build in policy learning and flexibility.[1] Coherent strategy has, in other words, to be a learning process involving major stakeholders—exchanging information and sharing in implementation.

Being competitive entails greater openness to markets, to imported technology, to information flows—indeed, to new ideas. Export competitiveness, in particular, requires close and frictionless contact with foreign sources and customers. It also requires low business transaction costs (dealing with rules, regulations and the bureaucracy) and good governance. To attract export-oriented foreign direct investment, especially in high-tech industries, requires a very efficient business environment. The growing significance of efficient supply chain management means that locations must offer more than good transport infrastructure. Also needed are rapid import and export procedures. In general there is a move away from discretionary procedures in dealing with the private sector and towards simple, universal rules that are easy to understand and comply with.

The Asian Tigers built up these framework conditions. They had a leadership committed to competitive industrial development, complemented by a broad education base and a fairly equitable income distribution. The government bureaucracy was skilled and highly respected—more important, it was relatively insulated from day-to-day politics and able to respond pragmatically to change. These attributes were not inherent to Asian society. Quite the contrary, these policy capabilities were built up in a long process of experimenting, making mistakes, changing and learning—very similar to the process of building industrial capabilities.[2] This policy learning may not be replicable in its entirety. But as studies note, it does offer lessons to other countries.[3] Improving the bureaucracy, its base of skills and information, its coherence and linkages with the private sector—all these are things that governments can do elsewhere. The pace will depend on circumstances, but the process is clear—gradual and cumulative, advancing a step at a time.

Of the many framework imperatives required for dynamic industrial development, each is necessary but collectively they cannot be shown to be sufficient (box 8.1). Indeed, the list in box 8.1 is not a list of policies—it is a list of framework imperatives to pay attention to. Each country has to use that list as a starting point for designing the policies best suited to its conditions and aspirations. The East Asian countries paid careful attention to each, but no two countries attained each in precisely the same way. Indeed, the considerable diversity among the East Asians' attainment of the imperatives reinforces the previous message: each country must design its own strategy with the expectation that it will, in the details, contain unique elements. The diversity among all countries will be as apparent in policy design and implementation as in institutions and organizations.

The framework imperatives are of fundamental importance for achieving and maintaining internationally competitive production, at the outset and as industrial development unfolds. Their vital significance can be seen wherever there is an apparent competitive advantage that is not being realized. Clothing production in Senegal (box 8.2) provides a fruitful illustration of this point, fruitful because it highlights two critical corollaries. One is that the imperatives are not easily or trivially put into practice. Reforms to implement them have more often been problematically incomplete. The other is that the framework imperatives must be seen as vital instruments of a coherently framed strategy, aggressively pursued.

Box 8.1 Framework imperatives for effective industrialization

1. Policies assuring macroeconomic stability—within rather narrow limits, and both in reality and in expectation—are important to encourage rapid factor accumulation and allocation in accord with comparative advantage (dynamic and static) as well as to make possible quick and effective responses to disruptive shocks. They are reflected in:
   - Relatively low inflation rates and positive real interest rates.
   - Fiscal balance (between government revenues and expenditures).
   - Real (purchasing power parity) exchange rates maintained at levels not greatly overvalued, if at all, relative to free-trade exchange rates.

2. Policies have to ensure resource allocation in accord with dynamic (or potential) comparative advantage, where ensuring is to be understood in the sense of maximizing the likelihood that allocative decisions are made on the basis of rapidly achieving and then maintaining internationally competitive production, whether sales are in open competition on world markets or on the domestic market in unprotected, unsubsidized competition with imports.

3. Rapid accumulation of physical and human capital—that is, the rapid growth of factor inputs—requires:
   - Forward-looking provision of infrastructure, sufficient to avoid problematic bottlenecks.
   - Expeditious attainment, first, of universal primary education—then, secondary education.
   - Attention to technical training and to technical education (engineering and scientific) at the tertiary level.

4. Successful agricultural development is important for equitable development—and to ensure that appropriate balance is maintained across sectors as each develops.

5. Institutions are required to enable effective commerce among economic agents:
   - Contractual arrangements, explicit or implicit, having adequate sanction, formal or informal.
   - Incentives, whether rooted in individualism and private property or in social solidarity pacts of one kind or another, free from being undermined by capricious authority.
   - Mechanisms fostering adaptive institutional and organizational change in the context of underlying social stability.

6. Competent bureaucracies are needed to orchestrate the development process effectively.

Source: Westphal (forthcoming).

Box 8.2 Comparative advantage—to be realized

Senegal should, from all appearances, have a strong competitive advantage in exporting clothing. At least that is the opinion of knowledgeable experts who have examined its prospects closely. Among its advantages are a location close to European markets and, very important, a vibrant informal sector of thousands of highly skilled, hard working tailors who produce for the high end of the local market. Senegal has also undertaken reforms to bring its policies into closer conformity with the fundamental imperatives. It has put in place what appears to be a typical package of investment and export incentives designed to attract foreign investment to its export processing free-trade zone.

But Senegal's export performance in clothing is below what would be expected on the basis of the reforms already undertaken. Why? A careful field study, including interviews, found that formal sector clothing producers were frustrated in their attempts to export. Among the reasons:

- Difficulties obtaining on-time deliveries from local fabric producers, and deficiencies in their quality control.
- Inadequate access to finance required to upgrade plant and equipment and to increase employment; insufficient technological capability to export in large volume.
- Absence of managerial and marketing knowledge to sell in export markets, with no practicable notion of how to attract foreign buyers or partner with foreign firms to enter clothing value chains.
- Poor quality of infrastructure (leading, for example, to frequent electricity blackouts) and government services (in contrast to the favored treatment of large fabric producers).
- Locational disadvantages due to being far removed from sources of imported fabrics.
- Training institutes incapable of providing useful training, and other supporting institutions ineffective in providing useful support.

The Government of Senegal has initiated consultations with the private sector to address these deficiencies. With UNIDO assistance, it plans to formulate a strategy to upgrade the competitiveness and capabilities of the textile sector, including establishing a textile center to promote exports.

Source: UNIDO and Golub and Mbaye (2000).

The objectives of policy reform must be stated in precise, operational terms, terms sufficient to permit meaningful monitoring of their achievement, this to enable the revision of policy or its implementation when necessary to accomplish the objectives sought. Strategies aggressively pursued are no less relevant to accomplishing sufficient policy reform than they are to achieving continued technological development, this even though the purpose in one case is to unleash market forces toward productive ends and in the other to supplement those forces so as to overcome market failures.

Regardless of their necessity, the framework imperatives are not sufficient to enable sustained innovation and learning leading to continued industrial development. And they certainly are not sufficient if the imperative of resource allocation in accord with dynamic comparative advantage is conceived in narrow terms, adequate only to ensure the realization of static comparative advantage based on existing resources and competencies. This can be seen wherever the achievement of a significant competitive advantage in one area does not unleash a chain-reaction of innovation and learning that leads to a deepening of that advantage and a broadening of competitive advantage in unrelated areas (box 8.3).

The framework imperatives reflect two successive generations of international consensus about the conditions required for

Box 8.3 Broadening competitive advantage is far from automatic

The Mauritius clothing industry embarked on a successful path of exporting in the 1970s, and clothing exports continue to be the mainstay of its industrial sector. Careful reading of the studies to ascertain the basis of Mauritian success leaves no doubt that its exports are in large part the result of adherence to the framework imperatives. Not only do exporters in Mauritius benefit from a virtual free-trade regime governing their activity—they also enjoy an institutional setting that is free of the features that militate against profitable private entrepreneurial activity.

But adherence to the fundamentals in Mauritius entails export promotion in the presence of high levels of import protection. Moreover, serendipitous factors, some the product of its history, have played an undeniably important role. Its favorable institutional conditions derive from its particular social and political history, and it enjoys important trade preferences under the Multi-Fibre Arrangement. In turn, its colonial heritage includes a small community of well-connected ethnic Chinese who were instrumental in attracting Hong Kong Special Administrative Region (SAR) of China firms to initiate clothing exports from Mauritius. Hong Kong SAR-owned firms remain an important presence in the sector.

It is not enough simply to have succeeded at the outset; an evolving strategy is required if the momentum once gained is not to be lost. Here Mauritius has failed. Having created a successful albeit narrowly focused export enclave, the government has no promising strategy to exploit its potential linkages into the rest of the industrial economy or to foster deeper competitive advantages in clothing exports or to broaden the scope of the country's industrial competitive advantages beyond clothing. In short, Mauritius seems to lack a strategy for ensuring that innovation and learning will lead to continued industrial success.

Sources: Romer (1993); Rodrik (1990); Subramanian and Roy (2001); Lall and Wignaraja (1998).

accelerated economic development and thus about what should be the objectives of reform. The first generation centered on the so-called Washington Consensus regarding the necessity for macroeconomic stability and—using the popular aphorism—"getting the prices right". The results of first generation reforms—of policies affecting resource accumulation and allocation—in the countries that seriously undertook them were distinctly mixed. Thus were born the second generation of reform imperatives focused on achieving a constellation of enabling economic, political and social institutions.

Policy reform sometimes requires a degree of radical institutional reform, while fundamental changes in the overall institutional setting often take place only over comparatively long periods in what is at best a loosely coordinated fashion. But there is ample reason to believe that policy and institutional reforms taken together are insufficient to trigger the activities of innovation and learning required to achieve rapid productivity growth in the industrial sector. Chile, for example, has realized substantial development gains from its reforms of policies and institutions, but dynamic forces leading to rapidly increasing productivity have not taken hold in its industrial sector. What is missing in such cases is what was present in East Asia: a recognition of the necessity to serve the innovation and learning needs of firms.

A third generation of reforms, one that emphasizes the critical importance of innovation and learning, is at hand.[4]

What is needed

Industrial catch-up has been accelerating. What the Republic of Korea and Taiwan Province of China achieved in three decades took Japan much longer; Japan industrialized much faster than early predecessors, and today China seems set to overtake the records set by the Republic of Korea and Taiwan Province of China. Yet many latecomers are failing to catch up at all in the same technological, trade, investment and information environment. Their industrial capabilities are inadequate to the challenge of competitive growth. The explanation for the different development of national capabilities lies first in the presence or absence of the framework imperatives—then in the attention to innovation, learning and industrial development in a coherent country strategy and policy framework.

Policies must thus be changed, reoriented to focus squarely on domestic innovation and learning, on the building of industrial capabilities by linking to global markets and leveraging foreign resources. The objective of industrial strategies and policies is to develop and sustain competitiveness and productivity growth—the only viable way to promote industrialization today.

This simple but vital objective has many ramifications. At the outset, it usually entails the restructuring and upgrading of industrial activities. This in turn involves developing new capabilities, productive facilities and links with global value chains. To sustain long-term growth, leading to higher wages, also entails moving up the quality and technological ladder, within existing activities and across them, from simple to complex. Industrial maturation inevitably involves such structural upgrading in manufacturing, with the promise of significant benefits.

Over the past half century far-reaching institutional and technological changes have fostered the extensive vertical separation of production into separable, sequenced activities—from raw materials extraction through intermediate stages of production to sale of finished products. These changes have been associated with the appearance of global value chains spanning many of the world's most important industries, and they have opened multiple entry points for less developed countries to engage in export processing. These changes have also been associated with greatly enhanced flows of technology among countries, enabling developing countries to take advantage of many of those entry points. Thus a number of developing countries have in recent years succeeded in becoming major players within dynamic global value chains.

A few have done so by building skills and technological capabilities within indigenous firms, to achieve entry as participants in globalized production. But most developing countries have done it by undertaking labour-intensive functions for transnational corporations in more formally integrated production systems. Transnational corporations have always established production facilities in other countries, but the traditional mode has been to replicate entire facilities overseas. The forces of globalization, including the emergence of new technologies facilitating information communication and organizational innovation, have radically transformed the ways in which transnational corporations operate.

Transnational corporations now separate production processes (and such functions as accounting, marketing, servicing and even research and development) into small slices and locate them across the globe to take advantage of fine differences in labour cost, delivery, skill, innovation capabilities, suppliers and so on. They can manage far-flung sites as a coherent whole to further the competitive position of the corporation. For newcomers participating in such systems opens enormous opportunities which can be more readily seized than can entry through more autonomous means. Newcomers can take on functions for which they are suited rather than the entire manufacturing or service process—all the while enjoying access to massive new markets. They can also enter dynamic activities with great opportunities for technological learning and spillovers.

Choosing points of entry to promote the development of new activities requires great care, however. The economic and policy context is very different today than when the Asian Tigers mounted their industrial policies. Innovation has accelerated, and economic space has diminished. The rules of the game are also very different. These changes constrain countries from committing some of the more egregious policy mistakes of the past—but they also preclude the use of tools that have proved very effective in early stages of industrialization (in the mature industrialized countries, not just the newly industrializing ones). For example, promoting industries is now more circumscribed by trading rules—but the criteria for determining what to promote remain unchanged (box 8.4).

Strategy starts with a clear vision

Governments across the world now have to mount strategies to enhance the competitiveness and support the productivity growth of their firms. And if economies with the most advanced markets and institutions feel the need to undertake competitiveness strategies, the need on the part of poor countries, with much weaker markets and institutions, must be correspondingly greater.

Public efforts require direction. And without vision, there can be no focused direction. Nor can the direction be fixed—it demands constant monitoring and revision, as every success story details. Vision is not only about the broad dimensions of strategy, it is also very importantly about the technologies and industries to be promoted.

The basis of any industrial strategy is a national vision of industrial development. Vision is needed to coordinate and direct policies because it is possible to adopt a range of different development paths. In the textbook case of market failures, policies aim to restore a unique competitive equilibrium. In a world of imperfect markets, externalities, cumulativeness and path-dependence, there is no unique optimum but a range of possible "*multiple equilibria*", some producing low growth or stagnation and others dynamism and high growth.[5] Industrial success is the result of countries' ability to move across these equilibria—to keep jumping to the next curve. Each move needs coherent policies across a range of markets to exploit technological spillovers, scale and scope economies and dynamic learning.

The government has to decide on the broad national objectives—economic and non-economic—that cannot be thrown up by markets. The strategy may be explicit or implicit, but it provides the parameters within which all other allocation decisions are made. For instance, one government may decide explicitly to promote industrial deepening, greater indigenization of technological activity or the creation of large conglomerates to internalize various markets.[6] Another may opt for leaving all choices to free markets (not intervening is as much a strategic choice as intervening). These choices reflect many things: resources, location, external pressures, political circumstances and ideologies as well as rational calculations of how to develop national industrial and technological resources. The four mature Asian Tigers adopted completely different strategies in these respects (box 8.5).

The next level of strategy has to do with the *design and implementation* of specific policies and programmes.[7] Policies may be market friendly in that they seek to improve markets and institutions without favouring some over others. For instance, the government may subsidize R&D by enterprises for a period to create a technology culture in local industry or strengthen

Box 8.4 What to promote?

There is no sense denying that the formulation and implementation of industrial development strategy are an imperfect art. Efforts to quantify the costs and benefits of industrial promotion activities can at best yield rough approximations to what is in principle wanted. There are various reasons why this is true, but none is more pertinent here than the fact that many of the benefits sought by industrial promotion are imperfectly foreseen, while others are not foreseeable in any detail. Technological efforts leading to innovation and learning take place in an extensive profusion of cascading changes. Individual changes beget—sometimes in compulsive sequences, sometimes as serendipitous outgrowths—follow-on efforts and changes. And that process continues over the evolutionary course of a vibrant industrial sector.

But this reality is not reason enough to eschew cost-benefit determinations. Careful attention to the explicit enumeration of costs (typically relatively well-perceived) and foreseeable benefits (many poorly perceived) and to the quantification of those amenable to some degree of quantification are the only practical way of imposing discipline on actions taken in pursuit of industrialization. And some means of discipline is required to ensure some success in the pursuit of strategy. Blind faith in outcomes to justify costs incurred is no guide to effective action.

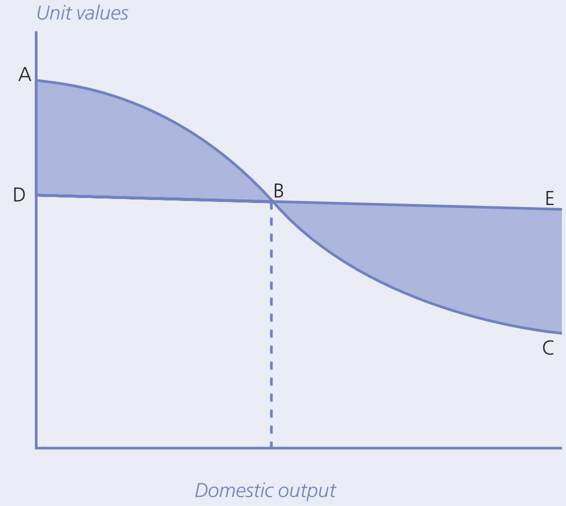
The accepted test for whether a particular activity should be promoted is the so-called Mill-Bastable test. The box figure illustrates its application in the traditional context of import substitution, but here with the additional expectation of eventual exports. The pronouncedly downward trending curve ABC represents the trajectory of the unit cost of domestic production, while the slightly downward tending line DBE shows the trajectory of the world price of the product in question; both trajectories are with respect to cumulative domestic output, measured on the horizontal axis. The unit cost of domestic production is initially above the world price owing to the absence of mature capabilities in the local industry; it falls with cumulative production as technological efforts—assumed here to occur, as occur they must to achieve maturity—leading to adaptive innovations and technological learning bear increasing fruit. The world price falls because of technological changes continuously occurring in other producing countries.

The test is passed in its most stringent form, but for the neglect of time discounting, only if the area representing initial excess costs, ABD, is exceeded by the area of eventual gains due to the competitive advantage reflected in unit cost being less than world price, BCE extended into the future until the point where the competitive advantage is lost, typically to a more lately developing country.[a] But the test just stated is in fact too stringent, because it neglects the externalities that may spillover as technological efforts undertaken to achieve competitiveness in the activity contribute in multiple, cascading ways to technological developments in relation to other activities. Required is some estimate of the discounted value of these spillovers, which must be added to the direct value of discounted competitive gains in order to arrive at the proper magnitude for comparison with the value of excess costs.

The Mill-Bastable test reflects two essential principles that must, if only qualitatively, guide the prior assessment of promotional undertakings if they are to be sensibly pursued. The first is that the expected competitive gains must exceed the initial excess costs, both taken in total magnitude. Thus it is not sufficient simply to become minimally competitive in the sense of unit cost equal to world price (including transport and transaction costs); a true competitive advantage must be foreseen. The second principle is that conditions in other economies must not be thought static and unchanging; the target to be achieved is a moving target, one moving continually against the country's advantage. Thus it is imperative to take account of what is likely to happen elsewhere as it may affect production costs in other countries.

It may be obvious that these principles as here illustrated have immediate application only to the direct promotion, as through import protection, of activities to produce existing tradable goods. But the scope for direct promotion is now greatly restricted compared with what was possible in the past, so that reliance must now be placed on indirect means of promotion, through such means as the provision of industrial services. This makes the task of benefit-cost analysis all the more difficult. But it does not in any way invalidate the principles just stated or render them any less important. The foregoing statement applies equally when outcomes do not simply replicate what is available from foreign sources.

The cost, benefit and duration of infancy



Source: Bell and others (1984, pp. 102–106).

a. Time discounting of excess costs and competitive gains is not reflected in the figure but must be applied in computing the net benefit of the activity's promotion.

incentives for employee training. Or policies may be selective, aiming to promote particular activities or clusters to tap dynamic learning possibilities, capture exceptional spillover benefits or attract the most promising global value chain activities. Both approaches are theoretically justifiable in the presence of market failures, and they are entirely complementary. The choice of appropriate instruments depends on the nature of the failures and the capabilities of the government to undertake policies effectively. However, the more selective are the policies chosen, the greater are the competence, information, objectivity and flexibility required of the bureaucracy.

The choice of *appropriate measures* involves creating the mechanisms to implement policies. Implementation may

Box 8.5 Four Tigers—four broad visions

The four Asian Tigers were the first countries in the developing world to launch an export-oriented manufacturing strategy. While Hong Kong SAR was always free trade, the other three—Singapore, the Republic of Korea and Taiwan Province of China—turned from import substitution to export orientation in the early 1960s. They led the first wave of labour-intensive industrial exports: garments, textiles, toys, footwear and the like. Over the 1970s and 1980s they upgraded their export structures in different ways, depending on their differing visions of what they wanted their development paths to consist of. This depended in turn on their social and political structures, resource endowments, size and history.

In Hong Kong SAR the vision of the colonial government was market-driven resource allocation, with no particular ambition to develop local manufacturing. Although Hong Kong SAR was once the leader in the developing world in manufactured exports, this vision led to quality improvement in labour-intensive exports but to relatively little structural deepening. As a result, with rising wages, most manufacturing shifted to lower wage countries, and industrial and export growth stagnated or turned negative. The export structure remained at low technology levels, the lowest among the Tigers.

In Singapore, by contrast, the government had a strong vision of technological upgrading and deepening. This led it to intervene extensively in investment patterns, skill development and infrastructure building while retaining a free trade setting. The result was considerable deepening, allowing Singapore to combine high and rising wages (nearly 20 percent higher than in Hong Kong SAR) with output and export growth. Singapore moved rapidly from low-tech activities to petrochemicals and then producer electronics and equipment, simultaneously raising its technological levels from simple assembly to high-end manufacturing, design and development. Transnational corporations, providing state-of-the-art technologies and access to their global networks, dominated the process. While Singapore developed a very high-tech export structure, however, its research base stayed small and the main sources of innovation remained overseas.

The Republic of Korea and Taiwan Province of China also had very strong visions of industrial development, this time with larger ambitions for national enterprises. Transnational corporations were allowed a much smaller role, though foreign technology was tapped extensively in other forms. Their governments used infant industry protection (offsetting its harmful effects by strong export incentives), credit allocation and subsidies, foreign direct investment restriction and skills and technology support. And they did this in ways to induce local firms to enter difficult activities, raise local content and take on advanced technological functions. The Republic of Korea's interventions were more pervasive and detailed. They involved fostering the *chaebol,* the conglomerates that spearheaded its heavy industry and high technology drive, learned the most advanced technologies and became major transnational corporations in their own right. Taiwan Province of China intervened less directly in the industrial structure, though it used public enterprises to enter several heavy industries. It supported its small and medium-size enterprise dominated structure with an array of technology, training, finance and export marketing policies and institutions. Because of their far-reaching efforts, the Republic of Korea and Taiwan Province of China have the greatest technological depth in the developing world, and their exports embody the most intense learning.

A vision gone sour

Some of the Republic of Korea's seeming policy successes later turned sour. The Asian financial crisis dramatically exposed the substantial risk inherent in the pursuit of an ambitious vision by aggressively interventionist means. The risk is that policies, while proving to be highly effective in the medium term, can have seriously detrimental consequences for long-term institutional development. The Korean government's practice of directing the allocation of credit severely retarded the development of modern financial institutions—and stifled the establishment of a adequate regulatory system. In turn, its promotion of the *chaebol* ultimately created a number of differently dysfunctional private entities whose exploitation of the policy regime resulted in unwise investments—leading in some cases to excess capacity, in others to bankruptcy in whole or in part. In a very real sense, then, the high costs imposed on the people of the Republic of Korea by the crisis-induced recession and the subsequent vigorous pursuit of systemic policy reform are the price paid for the government's earlier inability to rectify growing institutional deficiencies. Taiwan Province of China did not foster *chaebol*-like enterprises, but otherwise followed a similar though distinct set of policies. It has paid a far lesser price by managing the long-term consequences of directed credit more effectively.

Sources: Amsden (1989); Wade (1990); Lall (1996); Westphal (forthcoming).

need new institutions (in the public or private sector) to support, interact with and link market agents. In the public sector, for example, the government has to provide the technological public goods needed by industry, such as basic research, extension services, standards and metrology. In the private sector institutions may include business associations, consortia or large private conglomerates (like the *chaebol* in Korea) that can overcome deficient markets for capital, skills, information and entrepreneurship.

Keep in mind that it is the process that is critical—not the instruments. The actual policies used must be specific to each strategy and context. That makes the policy process more an art than a science. Since mistakes are inevitable, the government has to be flexible and responsive to changing circumstances—policy has to build in *learning* and *adjustment*.[8]

Some final points on the strategy process. First, policy needs vary with the level of development. As markets and institutions become more efficient and complex, the need for direct interventions falls and their potential costs rise. Second, industrial policy must be *systemic.* No strategy can succeed unless it dovetails physical investment in capacity with technology development, skill building, cluster strengthening and so on. Third, policies must correspond to the phase of learning and so must change accordingly: policies in the infant phases of capability building must differ from those in the mature phase, when R&D and frontier innovation become vital.

Governments require disciplined means of strategy formulation, implementation and monitoring, with monitoring being imperative for determining whether and in what respects an ongoing strategy warrants revision. Two very important tools that impose discipline within a process that embeds global knowledge in the articulation and pursuit of development objectives are finding increasing acceptance and use among developing countries: benchmarking and foresight exercises.

Benchmarking has long been used by successful industrial firms, first in the industrialized countries, as means of achieving best-practice levels of productivity, which can only be determined on the basis of comparative information across the universe of similar firms. It relies on the identification of measurable factors that are critically related to overall productivity, factors that are subject to the firm's control either directly or indirectly. Knowledge of the best values attained in relation to these factors across other firms provides targets that, if achieved, will result in the best-practice level of overall productivity within the individual firm. Targets set in this fashion act as powerful devices for focusing technological and related efforts toward the achievement of objectives that can be realized by searching for and using global knowledge pertaining to the factor and its relationship to overall productivity.

Benchmarking has immediate application where relationships between contributing factors and desired results are well known and easily quantified in simple terms; for example, in industries where engineering relationships dominate in determining productivity. It is less readily applied by organizations that provide services, such as those discussed in chapter 7, where the relationships between service norms and outcomes are complex owing to many factors beyond the control of the organization. Even so, benchmarking exercises are prevalent among the exemplars of global best-practice in serving the needs of industry.

Benchmarking is yet more difficult in the policy arena, and this for a variety of reasons, central among them the necessity to recognize that policies must often be tailored in conformity with national values and the institutional setting. Nonetheless, there has recently been substantial progress in bringing the discipline of benchmarking to the service of policy analysis and formulation. Just as information centers, extension agencies and the like play a vital role enabling benchmarking practices by industrial firms, so too can international agencies exercise a profound influence by providing the information and supporting technical assistance required for agency and policy benchmarking by developing country governments.[9]

In the process of selecting industries for promotion, technology foresight exercises, done hand in hand with the private sector, are particularly useful as a means to comprehend emerging global trends, enabling both firms and the government to formulate detailed strategies in areas that seem sensible.[10] Having originated decades ago in Japan and France, they are now in widespread use in the industrialized countries, where their application focuses on forecasting the course of global technological change in relation to the country's industrial strengths and weaknesses, to guide public science and technology policies and expenditures (Martin 1996). Even comparatively non-interventionist governments, like that of the United States, recognize that foresight exercises are vitally important owing to the fact that firms cannot remain competitive without relying extensively on complementary private and public sources of knowledge whose continuing development must in some fashion be coordinated within a common vision of how the future might unfold.

Similar exercises are now also being undertaken by many developing countries, with UNIDO's assistance. The focus of these exercises differs in that the objective relates to steps being taken to catch up with the global technological frontier, not to steps necessary to remain on, or at the forefront of, the changing frontier. Even so, developing countries require foresight in relation to existing industries, not simply for keeping up but also for catching up to a shifting frontier, and in relation to industrial activities for which potential competitive advantage is within grasp. They additionally require foresight not only about technological trends, but also about pending changes in the international ordering of economic activity—where, for example, new modes of accomplishing the division of labor among countries may seriously affect the way in which opportunities may be seized.

But foresight exercises, wherever conducted, are not simply about external factors, or emerging global trends. They are also fundamentally about internal factors, or assessing a country's industrial strengths and weaknesses in sufficient detail to ascertain where change efforts are required, and this even if only to come closer to existing best practice. Indeed, in developing countries much of the work most useful for foresight exercises goes into developing a vision of a future in which existing resources are used with greater productivity as a consequence of a diverse variety of technological and other efforts enabled by technology transfers from sources both internal and external to the country.

In days gone by, some countries—the Republic of Korea in the 1960s and 1970s, for example—practiced a form of visionary benchmarking, comparing their industrial structure with that over the past of some exemplary, more advanced country (for the Republic of Korea, Japan), to determine the activities next in line for development. Such benchmarking may still provide some, albeit limited, useful guidance. But vastly more important, indeed fundamentally essential, are targets and actions determined by the collaborative engagement of industrialists, technologists, academics, government agency officials and other importantly involved parties in coordinated deliberations based on intimate knowledge of the reality that is and that could be. Indeed, such deliberations lay at the heart of the Republic of Korea's planning activity in the mid-1960s and were, in a very real sense, instrumental in the Republic of Korea's embarking on the path of rapid industrialization.[11]

Then, as now (see box 8.6), the value of the exercise inheres not so much in the formulated vision but in the common understanding by both public and private actors engaged in its achievement of the steps that each must take if it is to be realized.

Box 8.6 Foresight in Hungary

Hungary's Technology Foresight Program adapted the conventional advanced-country type of exercise to its strategic needs in becoming fully integrated into the European socio-economic system. Seven sectorally focused panels made up of industrialists, academics, government officials, and other stakeholders were formed to assess strengths and weaknesses together with opportunities and threats in their sectors, with the aim of formulating visions and recommending policies and programs necessary for their fulfillment.

Complementing their effort was a large scale survey using the Delphi method (a disciplined means of aggregating individual forecasts of emerging trends stated in detailed terms) that was focused on probable external changes. The program was carefully orchestrated to achieve the greatest possible awareness and participation, toward the end of developing a strong consensus centered around its outcome. Thus the core exercise, which required two years to complete, was preceded by an initial stage devoted to promoting understanding of its importance, and followed by a terminal stage during which results were disseminated and widely discussed. To enable meaningful discussion and to further the objective of achieving consensus around a plan of vigorous action to achieve effective integration and robust economic development, three alternative visions of the future were presented, with only one of them having been fleshed out in considerable micro detail.

Hungary's experience in its foresight exercise demonstrates that the methodology can be of great value to developing countries and transition economies alike. Individuals having important responsibilities within the private and public sectors gained in their understanding that innovation is an inherently collaborative enterprise that entails mutual effort and learning among cooperating entities. The exercise additionally led to an enhanced awareness of the importance of communication within and across organizational boundaries, while at the same time it strengthened existing, and established new, network relationships, both formal and informal, among the parties engaged in innovation. Moreover, it reinforced the comprehension that innovation and learning do not only relate to technical matters, but also to economic, organizational, and social factors as well.

Hungary's experience is also significant in showing that foresight exercises both can and must, if they are to yield fruitful results, be tailored to the capabilities and institutional settings of the countries in which they take place. And to the central matter at issue, which in Hungary's case was enhanced integration within the larger European system; in many developing countries it would importantly involve greater integration into the world economy to enable greater levels of productivity. Foresight exercises by no means need be as complex and long-lasting as was Hungary's. Simpler, shorter, and more narrowly focused exercises can add real value in formulating and implementing intelligent strategies for industrial development.

Source: UNIDO.

Five principles for government conduct of national strategy

1. *Set priorities for policy intervention in line with the vision.* Resources—financial and human—for policy intervention are necessarily limited, even in rich countries. They are far more constrained in poorer countries. That makes it essential to mobilize resources and set priorities in line with the national development vision. The priorities will depend on the circumstances of each country, of course, and these are likely to vary with the level of development. At higher levels the most pressing needs tend to revolve around innovation and specialized skills and infrastructure. At lower levels they revolve around building entry-level competencies, strengthening resource-based and labour-intensive industrial activities, upgrading smaller enterprises or providing basic infrastructure.

2. *Leverage national resources with foreign ones—in global value chains.* The most effective means of connectivity to technological resources will often be through value chains, and, as noted in chapter 6, it is vital to understand the nature of each chain and the lead players in it. But sustaining linkages requires building complementary capabilities locally. Linking and leveraging strategies will again vary with the level of industrial development and with national strategic priorities. Countries with strong industrial and technological bases can follow strategies pioneered by the Asian Tigers. Those with weaker bases have to use more modest strategies, helping firms and clusters to connect with global players and climb up the value chain from modest levels, relying more heavily on direct foreign investment.

3. *Coordinate the vision, the framework conditions and the drivers.* Competitiveness-enhancing strategy involves close coordination of the vision, the framework conditions and the drivers. Most governments do not formally exercise such a coordinating function, since it cuts across traditional lines of responsibility in domestic ministries and agencies. Coordination tends to be dispersed and ad hoc, based on implicit rather than explicit objectives and strategies. This may be effective where drivers are fairly well developed, when decisionmakers agree on priorities and actions and when the line ministries exchange information to support each other. But it is not effective in other situations. In particular, where a country has to mount major policy changes and embark on significant

structural change, there is a need for a formal mechanism to formulate strategy and coordinate the development of industrial drivers.

The coordinating function does not necessarily need a new agency; it may be exercised by a group of existing ministries and institutions. But the function can be carried out only if its execution is placed close to the apex of policymaking. Effective coordination, wherever it is located, needs regular secretariat support for the collection and analysis of data—locally and in international benchmarks and immediate competitors. The data need to cover production, trade and productivity performance, the major drivers and the lead institutions. Everything has to be based on a sound understanding of technological and market trends.

4. *Build skills, knowledge and bureaucratic competence.* The conduct of strategy can be very demanding in skills, information and bureaucratic competence. But many measures can reduce the pressures on national governments. The private sector can contribute much to the design and implementation of policy, relieving government of many difficult data collection and analysis functions. Indeed, the private sector is much better placed to gauge productivity, technological and market trends at the individual activity level than is the government. What the government needs to do is provide a higher strategic and structural perspective—and to distill diverse private sector views into a coherent vision of development for the medium term.

5. *Enlist the key actors in the international community in strategy formulation.* The international community can help in strategy formulation. Apart from material assistance, it can provide valuable information on—and analysis of—benchmarks, institutions and policies in other countries. Many competitiveness analyses by industrialized countries are publicly available. And technology and training institutions are often willing to provide aid or sell their services. Aid agencies furnish technical assistance, often drawing upon the services of industrial experts. Consultants provide analyses of competitiveness as a whole and of its various components; their services tend to be expensive, but they possess a wealth of experience and data. In addition, there is a need for analytical support for governments at a higher level, particularly in evaluating different strategic approaches and the lessons of experience in other countries.

International dimensions

The desired, appropriate level of openness may not entail completely free markets for trade and investment or the removal of all such policies as local content rules and performance requirements, as envisioned in negotiations for trade-related investment measures (TRIMS). Indeed, the optimal level of openness and the ideal pace of trade liberalization remain a matter for debate.[12] Accepting that many countries have intervened excessively in trade (and to the detriment of their industrialization), it does not follow, given the market and institutional failures facing the acquisition of technological capabilities, that completely free trade is a desirable objective, certainly not in the near future, for developing countries. That some interventions were wrongly designed or implemented does not imply that all interventions are inefficient or distorting.

Theory suggests that where deficient markets give distorted signals to economic actors, intervention is needed to restore efficiency. Careful trade interventions, set in the context of strong export orientation and balanced by stringent performance requirements can work well. Going further back in history, trade and other interventions were used extensively to promote industrial catch-up in the presently developed countries. Qualifications of the same nature apply to TRIMS-related policies.

Similar considerations apply to the widespread application of stricter intellectual property rights in the developing world (under agreements for trade-related intellectual property rights, TRIPS). There is a growing feeling that the universal application of TRIPS offers little to countries at low levels of industrial and technological development, while imposing additional short-term costs on them as importers of technology.[13] There may be long-term rewards to them in accepting TRIPS, but the gains may well be negative in present value terms (after discounting future gains at a reasonable interest rate). Careful analysis is needed of whether existing rules are flexible enough to allow the losers to prolong their grace periods or whether the rules need to be changed.

Building capabilities is a costly, demanding and continuous process—and no amount of good policy can get around the problem of severe resource constraints in most developing countries. As the gap widens between the more successful and less successful countries, the benefits of modern technology and globalization appear further out of reach to many. This raises social and political stresses, threatening the pace of economic reform and integration and affecting the stability of the international economic system.

Current development aid practice attaches less weight to the industrial sector than it did in the past. Perhaps donors assume that market forces (liberalization and globalization) will suffice for industrial development. This is wrong. The upgrading and regeneration of manufacturing need support from aid donors. True, the current donor emphasis on education, infrastructure and micro or small enterprises does feed into industrial development. But it does so at one remove. It does not directly address the needs of industrial restructuring by the formal enterprise sector—or the specific skill and technological needs of modern industry. And for reasons just noted, it cannot be taken for granted that national governments in developing countries will on their own be able to meet these needs. Without a substantial increase in assistance, many viable activities may go under—and many more promising activities may never be launched.

The time is ripe for a new international agenda on industrial development—and for a new vision of how developed countries and international agencies can best assist industrial development. Countries have to be helped in their efforts to build competitiveness, attract resources, use more productive technologies and enter larger, more dynamic markets. Otherwise the enormous potential of economic integration and globalization may be lost to a large part of the developing world.

Most of the effort has to come from within countries, providing the right environment for capability building and investing in the necessary factors and institutions. But such local efforts should be helped from outside. Opening markets completely in industrialized countries will help greatly, but much more is needed to narrow the widening gap between countries and to build industrial capabilities in developing countries. Indeed, this is the mission of UNIDO—all of our activities deal directly with building and enhancing industrial capabilities. We will continue working to narrow that gap and to ensure support for that work with financial and other resources.

Notes

For further details on sources, information and the literature on subjects covered here, see the background papers.

1. Lall and Teubal (1998).

2. See Cheng and others (1999) and Evans (1999) for analyses of this process. The Tigers set up specific institutions to manage industrialization strategy (such as the Economic Development Board in Singapore, the Economic Development Bureau in Taiwan Province of China and the Economic Planning Board in the Republic of Korea). They reformed traditional bureaucratic structures, focusing on the few critical ministries responsible for industrial policy. They had frequent and active interaction with private companies and associations.

3. World Bank (1993); Evans (1999).

4. See Magariños (2001). Magariños' discussion also identifies other key aspects—relating to environmental sustainability and the equitable distribution of productivity gains—plus additional elements missing from the current consensus that for similarly now-obvious reasons require inclusion in the third-generation consensus.

5. On the possibility of multiple equilibria and the need to shift across them see Redding (1999), Rodrik (1996), Stokey (1991) and Stiglitz (1996).

6. Most strategic choices at this level have to do with identifying groups of activities that have the greatest potential for dynamic growth or create most beneficial externalities for other activities (Lall and Teubal 1998). To the extent that such activities involve greater risk and learning costs, coordination problems and capital market failures, free markets cannot lead to their development. Only deliberate promotion would lead private agents to enter such activities in a coherent fashion and on a scale necessary to make the local value chain efficient. Examples would be the strategic targeting of heavy or high-tech industries in Japan and the Republic of Korea, or the targeting of information technology in many industrialized countries. Once activities and clusters are identified, governments have to set priorities between competing uses, taking into account complex feedbacks and linkages.

7. Industrial policy needs are not "discovered" by computing a substitute for a perfectly competitive equilibrium from an innumerable number of shadow prices. They are built up in a more mundane manner by looking for ways to build on the existing base of technical and other capabilities and to push them to exploit future opportunities offered by markets, technologies, externalities and international value chains. Industrial policy in the Asian Tigers did not rely on collecting vast amounts of information to calculate the "optimal" set of activities. It did, however, involve, considering in detail available technological and market information and the experience of more industrialized countries. But beyond this, the process was akin to creating rather than picking winners: the governments acted rather like venture capitalists. And, despite mistakes, on average they achieved good results in their strategies (Stiglitz 1996).

8. Teubal (1996, 1997).

9. For extensive discussion along these lines, see Sercovich and others (1999).

10. Martin (1996).

11. Adelman and Westphal (1979).

12. Lall (2001b); Rodrik (2001).

13. See chapter 1 and McCulloch and others (2001), UNCTAD (1996), UNDP (2001), World Bank (2001a).

Technical annex

UNIDO Scoreboard database

Exports

Data source: UN Commodity Trade Statistics (Comtrade) database. The technological classification of exports is based on the Standard International Trade Classification (SITC) revision 2 (table A.1).

Data adjustments: Export data refer to 1985 and 1998 except for Panama and South Africa (1986 rather than 1985) and Ethiopia, Malawi, Senegal, Yemen and Zambia (1997 rather than 1998).

- Export data for Singapore for 1998 were scaled down by 40 percent to reflect re-exports.
- Data were adjusted to account for re-exports for Bolivia (high-tech products in 1998), the Central African Republic (medium-tech process engineering products in 1998), El Salvador (high-tech electronics in 1985), Guatemala (high-tech products in 1985), Jordan (medium- and high-tech products in 1985) and Mozambique, Nigeria and Uganda (all three for medium-tech products in 1985).
- Data for 1985 were unavailable for Albania, the Czech Republic, Romania, the Russian Federation, Slovenia and Yemen.

Table A.1 Technological classification of exports according to SITC revision 2

Type of exports	SITC sections, divisions or groups
Resource based	01 (excl. 011), 023, 024, 035, 037, 046, 047, 048, 056, 058, 06, 073, 098, 1 (excl.121), 233, 247, 248, 25, 264, 265, 269, 323, 334, 335, 4, 51, 512 (excl. 512 and 513), 52 (excl. 524), 53 (excl. 533), 551, 592, 62, 63, 641, 66 (excl. 665 and 666), 68
Low tech	61, 642, 65 (excl. 653), 665, 666, 67 (excl. 671, 672 and 678), 69, 82, 83, 84, 85, 89 (excl. 892 and 896)
Medium tech	266, 267, 512, 513, 533, 55 (excl. 551), 56, 57, 58, 59 (excl. 592), 653, 671, 672, 678, 711, 713, 714, 72, 73, 74, 762, 763, 772, 773, 775, 78, 79 (excl. 792), 81, 872, 873, 88 (excl. 881), 95
High tech	524, 54, 712, 716, 718, 75, 761, 764, 77 (excl. 772, 773 and 775), 792, 871, 874, 881

Manufacturing value added

TOTAL MANUFACTURING VALUE ADDED

Data source: UNIDO National Accounts database.

Data adjustments: Data for total manufacturing value added (MVA) refer to 1985 and 1998 and are based on national accounts statistics from the United Nations Statistics Division, supplemented by national statistics. Missing values were “now cast” using the best econometric model.

SECTORAL MANUFACTURING VALUE ADDED

Data source: UNIDO Industrial Statistics database.

Data adjustments: Because only some of the sample economies report industrial statistics according to the International Standard Industrial Classification of All Economic Activities, Third Revision (ISIC revision 3), data reported according to ISIC revision 3 were converted to ISIC revision 2. To fill in missing values, the ISIC revision 2 series was supplemented with the ISIC revision 3 series. The data were “now cast” to 1998 using the best econometric model. The data were then aggregated using the technological classification of ISIC revision 2 (table A.2).

Because reporting of data at the group (four-digit) level of ISIC is inadequate to allow separation of medium- and high-tech products, the category "high-tech manufacturing" was not

Table A.2 Technological classification of manufacturing value added according to ISIC revision 2

Type of manufacturing	ISIC divisions, major groups or groups
Resource based	31, 331, 341, 353, 354, 355, 362, 369
Low tech	32, 332, 361, 381, 390
Medium and high tech	342, 351, 352, 356, 37, 38 (excl. 381)
High tech	3522, 3852, 3832, 3845, 3849, 385

used; instead, medium- and high-tech products were combined in one category. The sectoral shares of value added were then calculated in relation to the total for all manufacturing sectors.

- Data on MVA by technological classification refer to 1985 and 1998 except for the Central African Republic (data for resource-based MVA refer to 1993 rather than 1998), the Czech Republic and Nigeria (data for low-tech MVA refer to 1995 rather than 1998), Jamaica (data for resource-based MVA refer to 1996 rather than 1998), Jordan (data for resource-based MVA refer to 1997 rather than 1998), Madagascar (data for medium- and high-tech and low-tech MVA refer to 1993 rather than 1998), Mauritius (data for medium- and high-tech and resource-based MVA refer to 1997 rather than 1998), Mexico (data for medium- and high-tech MVA refer to 1994 rather than 1998), Pakistan (data for low-tech MVA refer to 1996 rather than 1998), Saudi Arabia (data refer to 1989 and 1997) and Zimbabwe (data for medium- and high-tech MVA refer to 1995 rather than 1998).
- Data for 1985 were unavailable for Albania, the Czech Republic, Ethiopia, Mozambique, Romania, the Russian Federation, Slovenia and Yemen.

Note: Because of differences in compilation methods and statistical definitions, the figures for sectoral value added from the Industrial Statistics database do not sum to the manufacturing value added reported in the national accounts data.

Research and development financed by productive enterprises

Data sources: Calculated on the basis of data from UNESCO, *Statistical Yearbook 1994* and *Statistical Yearbook 1998;* OECD, *Science, Technology and Industry Scoreboard 1999;* Iberoamerican Network of Science and Technology Indicators (http://www.ricyt.edu.ar); and central banks and other national statistical sources.

Data adjustments: Data refer to 1985 and 1997–1998. Where data were unavailable for those years, values for the closest year available were used.

- Values for OECD countries for 1997–1998 were calculated based on data from OECD, *Science, Technology and Industry Scoreboard 1999.*
- Values for Latin American countries were calculated based on data from the Iberoamerican Network of Science and Technology.
- Data for 1985 were unavailable for Albania, Bahrain, the Czech Republic, the Russian Federation and Slovenia.
- Many countries, particularly in Sub-Saharan Africa, do not report data on R&D financed by productive enterprises. Because of the weak industrial structures of these countries, R&D per capita was assumed to be negligible.

Foreign direct investment inflows

Data sources: World Bank, *World Development Indicators 2000;* UNCTAD, *World Investment Report 1995* and *World Investment Report 1999;* and national statistical sources.

Data adjustments: Data refer to average annual inflows of foreign direct investment during 1981–1985 and 1993–1997.

- Data for 1998 for Bahrain, Belgium, Saudi Arabia and South Africa are from UNCTAD, *World Investment Report 1999.* Data from that source may refer to periods that do not correspond exactly with 1981–1985 and 1993–1997.
- Data for Taiwan Province of China are from Taiwan Province of China, Council for Economic Planning and Development, *Taiwan Statistical Data Book 1998.*
- Data for 1985 were unavailable for Albania, Bahrain, the Czech Republic, Hungary, Nicaragua, Romania, the Russian Federation and Slovenia.

Technology licensing payments

Data sources: World Bank, *World Development Indicators 2000;* central banks; and International Monetary Fund, *Balance of Payments Statistics Yearbook 1999.*

Data adjustments: Data refer to 1985 and 1998. Where data were unavailable for those years, values for the closest year available were used.

- Data for 1985 were unavailable for Japan; data for the closest year available (1984) were used instead.
- Countries for which data for 1998 were unavailable and data for the closest year available were used instead are Albania (1994), Algeria (1991), Bahrain (1995), Cameroon (1995), the Central African Republic (1992), Greece (1997), Guatemala (1993), Jordan (1994), Malawi (1994), Mozambique (1992), Pakistan (1997), Senegal (1997), Sri Lanka (1995), Uganda (1997) and Zimbabwe (1994).
- Balance of payments data from the International Monetary Fund's *Balance of Payments Statistics Yearbook 1999* and national central bank reports were used to calculate licensing payments for Denmark, Hong Kong SAR, Switzerland, Taiwan Province of China and Turkey.
- For countries that do not report technology licensing payments in their balance of payments (Indonesia, Malaysia and Singapore), a proxy value was calculated based on the ratio of licensing payments to payments for "other services" for similar economies. For Malaysia and Singapore royalty payments were assumed to be 25 percent of other services (a ratio similar to that for Taiwan Province of China); for Indonesia they were assumed to be 11 percent (the same ratio as that for Thailand).
- For countries reporting data for 1998 but not 1985, the ratio of royalty payments to other services in 1998 was applied to 1985. Data on payments for other services are from the International Monetary Fund's *Balance of Payments Statistics Yearbook 1999.*
- Data for 1985 were unavailable for Albania, the Czech Republic, Hungary, Romania, the Russian Federation, Slovenia and Yemen.

Skills

Data sources: UNESCO, *Statistical Yearbook 1994* and *Statistical Yearbook 1998;* World Bank, *World Development Indicators 2000;* and national statistical sources.

Data adjustments: Data refer to 1985 and 1997–1998 (latest year available). Where data were unavailable for those years, values for the closest year available were used.

- Data for the Harbison-Myers index in 1985 were unavailable for Albania, Bahrain, the Russian Federation and Slovenia.
- Data for tertiary technical enrolments were unavailable for Albania, Bahrain, the Czech Republic, the Russian Federation, Slovenia and Yemen.

Infrastructure

Data sources: Calculated based on data from World Bank, *World Development Indicators 2001;* OECD, *Science, Technology and Industry Statistics* (http://www.oecd.org/statistics); Telecordia Technologies (http://www.netsizer.com); and African Internet Connectivity (http://www.sn.apc.org).

Data adjustments: Data refer to 1985 and 1998. Where data were unavailable for 1998, values for the closest year available were used.

- Countries for which data for telephone mainlines in 1998 were unavailable and data for the closest year available were used instead are Cameroon (1997), Guatemala (1997), Jamaica (1997), Kenya (1997), Yemen (1997) and Zimbabwe (1997).
- Countries for which data for mobile phones in 1998 were unavailable and data for the closest year available were used instead are Cameroon (1997), Ghana (1997), Jamaica (1996) and Kenya (1997).
- Countries for which data for computers in 1998 were unavailable and data for the closest year available were used instead are Algeria (1997), Cameroon (1995), Ghana (1997), Jordan (1997), Kenya (1997), Madagascar (1997), Morocco (1997), Mozambique (1997), Nigeria (1997), Senegal (1997), Sri Lanka (1997), the United Republic of Tanzania (1997), Uganda (1997), Yemen (1997) and Zimbabwe (1997).
- Data for commercial energy use in 1985 were unavailable for Albania, Bahrain, the Russian Federation, Slovenia and Yemen.
- Data on Internet hosts refer to 2001 and are from Telecordia Technologies.
- Data on information and communication technology for Africa not available in the World Bank's *World Development Indicators 2001* are from African Internet Connectivity.

- Data for Taiwan Province of China are from Taiwan Province of China, Council for Economic Planning and Development, *Taiwan Statistical Data Book 1998.*

Industrial Performance Scoreboard

UNIDO's Industrial Performance Scoreboard was developed in four stages. In the first stage a database of industrial indicators (both output and input factors) for 1985 and 1998 was created for as many countries as possible. Indicators were chosen on the basis of the availability of cross-country data. Four performance indicators—MVA per capita, manufactured exports per capita, the share of medium- and high-tech activities in manufacturing production and the share of medium- and high-tech products in manufactured exports—were chosen for the competitive industrial performance (CIP) index.

In the second stage individual indices of performance $I_{j,i}$ were standardized according to the general formula

$$I_{j,\,i} = \frac{X_{j,\,i} - \text{Min}(X_{j,\,i})}{\text{Max}(X_{j,\,i}) - \text{Min}(X_{j,\,i})},$$

where $X_{j,i}$ is the i th country value of the j th performance variable. Therefore the highest country in the ranking has a score of 1 and the lowest a score of 0.

The third stage consisted of testing the feasibility of computing a composite index based on the four performance indicators selected. Positive and statistically significant correlations between the four performance variables confirmed that a composite index could be constructed as a proxy for overall industrial performance.

The CIP index was constructed using the standardized values of the four performance indicators, according to this general formula:

$$CIP_{(\alpha)} = \left(\frac{w_1 I_{1,\,i}^{\alpha} + w_2 I_{2,\,i}^{\alpha} + w_3 I_{3,\,i}^{\alpha} + w_4 I_{4,\,i}^{\alpha}}{w_1 + w_2 + w_3 + w_4} \right)^{\frac{1}{\alpha}},$$

where $I_{j,i}$ represents the ith value of the four individual indices, w_n the weights given to the indices and α a parameter to control how the variations and weights in the individual indices affect the CIP index.

Initially, a different weight w_j was assigned to each performance indicator $I_{j,i}$. Stability tests confirmed that the weights did not significantly affect ranks, however, so equal weights were allocated to the four performance indicators. With $w_1 = w_2 = w_3 = w_4 = 1$, the general formula then became the following:

$$CIP_i(\alpha) = \frac{1}{4}\left[I_{1,\,i}^{\alpha} + I_{2,\,i}^{\alpha} + I_{3,\,i}^{\alpha} + I_{4,\,i}^{\alpha} \right]^{\frac{1}{\alpha}}$$

To further simplify, $\alpha = 1$ was chosen, and the result is the simple arithmetic mean of $I_{1,i}$, $I_{2,i}$, $I_{3,i}$ and $I_{4,i}$. Thus,

$$CIP_i = CIP_i(1) = \frac{1}{4}\sum_{j=1}^{4} I_{j,\,i}$$

Cluster analysis

Cluster analysis is a statistical technique for identifying relatively homogeneous groups of cases according to their quantitative features. The version used for the report is K-means cluster analysis, which is used to cluster large numbers of observations, with squared Euclidean distance (the sum of the squared differences over all the variables) employed to identify a specified number of clusters. The algorithm used for determining the membership of clusters is based on nearest centroid sorting. The values obtained for each cluster are simply the standardized average values of the variables for cases in the clusters. However, data presented in the report have been de-standardized to show averages of real values.

Statistical annex

Table A2.1 Manufacturing value added by income level and region, 1985 and 1998

Country group, income level or region	1985 Value (billions of dollars)	1985 World shares (percent)	1985 Developing economies' shares (percent)	1985 Per capita (dollars)	1998[a] Value (billions of dollars)	1998[a] World shares (percent)	1998[a] Developing economies' shares (percent)	1998[a] Per capita (dollars)	Growth rate 1985–1998 Total	Growth rate 1985–1998 Per capita
World	2,480.0	100	na	619	5,636.1	100	na	1,094	6.5	4.5
Industrialized economies	2,003.3	80.8	na	2,579	4,240.8	75.2	na	5,040	5.9	5.3
Transition economies	..	..	na	..	169.5	3.0	na	725	..	..
Developing economies	476.6	19.2	100	147	1,225.8	21.7	100	300	7.5	5.6
High and upper-middle income	222.9	9.0	46.8	578	560.2	9.9	45.7	1,161	7.3	5.5
Lower-middle income	92.4	3.7	19.4	176	210.4	3.7	17.2	311	6.5	4.5
Low income	161.3	6.5	33.8	70	455.2	8.1	37.1	156	8.3	6.4
Low income (without China and India)	22.2	0.9	4.7	44	35.8	0.6	2.9	51	3.8	1.2
Least developed countries[b]	5.6	0.2	0.7	31	12.1	0.2	0.6	35	6.2	1.2
East Asia	203.7	8.2	42.7	145	649.8	11.5	53.0	387	9.3	7.8
East Asia (without China)	98.0	3.9	20.6	278	294.3	5.2	24.0	668	8.8	7.0
South Asia	42.0	1.7	8.8	42	83.6	1.5	6.8	65	5.5	3.4
Latin America and the Caribbean	171.1	6.9	35.9	462	360.0	6.4	29.4	771	5.9	4.0
Latin America and the Caribbean (without Mexico)	133.9	5.4	28.1	454	278.1	4.9	22.7	750	5.8	3.9
Sub-Saharan Africa	24.1	1.0	5.1	83	38.2	0.7	3.1	92	3.6	0.8
Sub-Saharan Africa (without South Africa)	12.7	0.5	2.7	49	15.1	0.3	1.2	40	1.4	–1.4
Middle East and North Africa and Turkey	35.8	1.4	7.5	202	94.1	1.7	7.7	392	7.7	5.3

Source: UNIDO Scoreboard database (see technical annex).

Note: Data on manufacturing value added cover only the 87 economies in the Scoreboard sample: they are expected to account for a very high proportion of the world total.

a. The 1998 data reflect sharp drops in production in many economies, particularly in East Asia.

b. Includes only 12 of 49 least developed countries.

Table A2.2 **Manufactured exports by income level and region, 1985 and 1998**

Country group, income level or region	1985 Value (billions of dollars)	1985 World shares (percent)	1985 Developing economies' shares (percent)	1985 Per capita (dollars)	1998 Value (billions of dollars)	1998 World shares (percent)	1998 Developing economies' shares (percent)	1998 Per capita (dollars)	Growth rate 1985–1998 Total	Growth rate 1985–1998 Per capita
World	1,239.2	100	na	292.5	4,230.0	100	na	821.0	9.9	8.3
Industrialized economies	1,045.0	84.3	na	1,345.2	3,125.5	73.9	na	3,714.4	8.8	8.1
Transition economies	..	..	na	..	117.1	2.8	na	500.7	..	..
Developing economies	194	15.7	100	60.2	987.4	23.3	100	242.2	13.3	11.3
High and upper-middle income	143.0	11.5	73.6	371.0	614.5	14.5	62.2	1,273.5	11.9	10.0
Lower-middle income	33.8	2.7	17.4	64.2	159.8	3.8	16.2	236.2	12.7	10.5
Low income	17.5	1.4	9.0	7.6	213.2	5.0	21.6	73.1	21.2	19.1
Low income (without China and India)	5.3	0.4	2.7	10.5	19.7	0.5	2.0	28.1	10.7	7.9
Least developed countries[a]	1.4	0.1	0.7	7.0	6.0	0.1	0.6	17.5	12.0	7.3
East Asia	118	9.5	60.6	84	686	16.0	65.9	409	14.5	12.9
East Asia (without China)	112	9.0	57.5	317	519	12.1	49.8	1,178	12.5	10.6
South Asia	9	0.8	4.9	9	41	1.0	4.0	32	12.4	10.2
Latin America and the Caribbean	43	3.5	22.1	116	188	4.4	18.1	404	12.0	10.1
Latin America and the Caribbean (without Mexico)	35	2.8	17.8	117	85	2.0	8.1	229	7.1	5.3
Sub-Saharan Africa	7	0.6	3.7	25	19	0.4	1.8	45	8.0	4.6
Sub-Saharan Africa (without South Africa)	2	0.2	1.1	8	5	0.1	0.5	14	7.3	4.4
Middle East and North Africa and Turkey	17	1.4	8.8	96	53	1.2	5.1	220	9.1	6.6

Source: UNIDO Scoreboard database (see technical annex).

Note: Export data are for all economies in the world, not only the 87 economies in the Scoreboard.

a. Includes only 12 of 49 least developed countries.

Table A2.3 Technological structure of industrial activity by income level and region, 1985 and 1998 (percent)

Manufacturing value added

Country group, income level or region	1985 Resource based	1985 Low tech	1985 Medium and high tech	1998 Resource based	1998 Low tech	1998 Medium and high tech	Change in medium and high tech, 1985 to 1998 (percentage point)
World	27.1	16.2	56.8	27.1	14.1	58.7	1.9
Industrialized economies	25.5	15.3	59.3	25.5	13.3	61.2	1.9
Transition economies	..	..	..	45.1	12.7	42.2	..
Developing economies	37.1	20.4	42.5	33.7	17.6	48.7	6.2
High and upper-middle income	33.9	20.5	45.6	30.5	16.1	53.4	7.8
Lower-middle income	54.0	19.9	26.1	43.9	20.7	35.4	9.3
Low income	32.5	20.6	46.9	31.7	18.4	49.9	3.0
Low income (without China and India)	52.4	21.3	26.4	47.6	27.0	25.4	–1.0
Least developed countries[a]	52.1	25.0	22.9	44.4	31.6	24.0	1.1
East Asia	31.9	23.8	44.3	28.0	17.6	54.4	10.1
East Asia (without China)	33.1	25.6	41.3	26.4	17.4	56.2	14.9
South Asia	30.3	19.9	49.8	27.6	19.7	52.7	2.9
Latin America and the Caribbean	39.6	18.0	42.5	44.6	15.7	39.7	–2.8
Latin America and the Caribbean (without Mexico)	38.7	17.8	43.5	42.2	14.2	43.7	–0.2
Sub-Saharan Africa	42.7	18.7	38.6	43.6	18.8	37.6	–1.0
Sub-Saharan Africa (without South Africa)	51.8	21.6	26.5	55.3	20.5	24.2	–2.3
Middle East and North Africa and Turkey	48.6	20.7	30.7	41.4	21.8	36.8	6.1

Manufactured exports

Country group, income level or region	1985 Resource based	1985 Low tech	1985 Medium tech	1985 High tech	1985 Medium and high tech	1998 Resource based	1998 Low tech	1998 Medium tech	1998 High tech	1998 Medium and high tech	Change in medium and high tech, 1985 to 1998 (percentage point)
World	23.7	18.6	40.9	16.8	57.7	17.4	18.8	38.7	25.1	63.8	6.1
Industrialized economies	21.0	16.1	44.7	18.2	62.9	16.8	15.5	43.3	24.5	67.8	4.8
Transition economies	..	..	..	..	..	26.4	26.7	34.9	12.0	46.9	..
Developing economies	34.1	32.2	21.9	11.6	33.5	18.2	28.0	25.6	28.2	53.8	20.3
High and upper-middle income	26.8	32.7	25.7	14.8	40.5	15.8	19.3	30.2	34.8	64.9	24.4
Lower-middle income	62.3	23.4	12.0	2.3	14.3	27.3	30.1	17.1	25.6	42.7	28.4
Low income	39.1	46.8	10.6	3.5	14.1	13.1	51.9	18.4	16.6	35.0	20.9
Low income (without China and India)	37.8	52.0	9.3	0.8	10.1	17.8	72.9	8.2	1.0	9.2	–0.9
Least developed countries[a]	39.6	55.9	3.8	0.7	4.5	12.6	84.0	3.1	0.3	3.4	–1.1
East Asia	22.7	38.2	23.3	15.8	39.1	12.1	28.1	23.6	36.1	59.7	20.6
East Asia (without China)	21.9	37.9	23.9	16.4	40.3	12.8	21.1	24.8	41.4	66.2	25.9
South Asia	32.3	55.8	9.2	2.8	12.0	21.4	62.8	11.4	4.4	15.8	3.8
Latin America and the Caribbean	51.3	16.9	24.8	7.0	31.8	24.9	18.2	37.2	19.7	56.9	25.1
Latin America and the Caribbean (without Mexico)	58.6	17.7	20.4	3.3	23.7	47.1	17.0	28.9	7.0	35.9	12.2
Sub-Saharan Africa	57.9	17.3	18.2	6.6	24.8	45.8	23.3	25.5	5.3	30.8	6.0
Sub-Saharan Africa (without South Africa)	67.8	19.2	11.6	1.4	13.0	50.5	36.8	11.4	1.3	12.7	–0.3
Middle East and North Africa and Turkey	59.9	24.5	14.1	1.5	15.6	39.9	37.6	18.8	3.7	22.5	6.9

Source: UNIDO Scoreboard database (see technical annex).

a. Includes only 12 of 49 least developed countries.

Table A2.4 Ranking by concentration of manufacturing value added and exports in selected economies, 1985 and 1998

1985					1998				
Rank	All economies	World shares (percent)	Developing economies	Developing economies' shares (percent)	Rank	All economies	World shares (percent)	Developing economies	Developing economies' shares (percent)
Manufacturing value added									
1	United States	32.4	China	22.2	1	United States	25.4	China	29.0
2	Japan	16.0	Brazil	14.4	2	Japan	15.9	Brazil	12.3
3	Germany	7.9	Mexico	7.8	3	Germany	8.5	Korea, Republic of	8.0
4	France	4.6	India	7.0	4	China	6.3	Mexico	6.7
5	Italy	4.3	Korea, Republic of	5.7	5	France	5.0	Taiwan Province of China	6.0
	Top 5	65.2	Top 5	57.2		Top 5	61.1	Top 5	62.0
6	China	4.3	Argentina	5.5	6	United Kingdom	4.4	India	5.2
7	United Kingdom	4.0	Taiwan Province of China	4.9	7	Italy	4.2	Argentina	4.3
8	Brazil	2.8	Indonesia	2.9	8	Brazil	2.7	Turkey	3.6
9	Canada	2.4	Venezuela	2.8	9	Canada	1.9	Thailand	2.9
10	Spain	1.8	Turkey	2.6	10	Spain	1.8	Indonesia	1.9
	Top 10	80.4	Top 10	75.9		Top 10	76.1	Top 10	80.0
	Bottom 30	0.8	Bottom 30	4.2		Bottom 30	0.5	Bottom 30	2.4
Manufactured exports									
1	Japan	13.3	Taiwan Province of China	15.0	1	United States	12.8	China	17.0
					2	Germany	12.8	Korea, Republic of	15.0
2	Germany	11.4	Korea, Republic of	12.2					
3	United States	12.6	Singapore	9.8	3	Japan	8.6	Taiwan Province of China	10.7
4	France	6.5	Brazil	9.1	4	France	6.2	Mexico	10.5
5	Italy	5.8	Hong Kong SAR	8.2	5	United Kingdom	5.7	Singapore	10.5
	Top 5	51.0	Top 5	57.1		Top 5	44.7	Top 5	61.1
6	United Kingdom	5.7	Malaysia	4.4	6	Italy	5.3	Malaysia	6.7
7	Canada	4.9	Mexico	4.3	7	China	3.9	Thailand	4.5
8	Netherlands	4.0	Venezuela	3.6	8	Canada	3.8	Brazil	3.9
9	Belgium	3.4	India	3.2	9	Belgium	3.6	Philippines	2.8
10	Taiwan Province of China	2.3	China	3.1	10	Netherlands	3.3	Indonesia	2.7
	Top 10	71.2	Top 10	75.8		Top 10	64.6	Top 10	81.6
	Bottom 30	0.3	Bottom 30	2.2		Bottom 30	0.3	Bottom 30	1.3

Source: UNIDO Scoreboard database (see technical annex).

Table A2.5 Tertiary enrolments, total and technical, by income level and region, 1987 and 1995–1998

Country group, income level or region	1987 Number (thousands)	1987 World shares (percent)	1987 Developing economies' shares (percent)	1987 Number per 1,000 population	1995–1998[a] Number (thousands)	1995–1998[a] World shares (percent)	1995–1998[a] Developing economies' shares (percent)	1995–1998[a] Number per 1,000 population	1995–1998[a] Growth rate (percent)
Total enrolment									
Industrialized economies	26,630	56.5	na	34.3	33,775	44.9	na	40.1	1.8
Transition economies	..	..	na	..	6,157	8.2	na	26.3	..
Developing economies	20,473	43.5	100	6.3	35,346	47.0	100	8.7	4.3
High and upper-middle income	5,998	12.7	29.3	15.6	8,849	11.8	25.0	18.3	3.0
Lower-middle Income	6,741	14.3	32.9	12.8	12,443	16.5	35.2	18.4	4.8
Low income	7,734	16.4	37.8	3.3	14,053	18.7	39.8	4.8	4.7
Low income (without China and India)	1,198	2.5	5.9	2.4	2,644	3.5	7.5	3.8	6.3
Least developed countries[b]	634	1.3	3.1	2.5	785	1.0	2.2	2.3	1.7
East Asia	6,388	14.0	31.2	4.6	15,007	21.1	42.5	9.2	6.8
East Asia (without China)	4,323	9.0	21.1	12.3	9,181	12.9	26.0	21.9	6.0
South Asia	5,087	11.0	24.9	5.1	6,545	9.2	18.5	5.4	2.0
Latin America and the Caribbean	6,142	13.0	30.0	16.6	7,677	10.8	21.7	17.3	1.7
Latin America and the Caribbean (without Mexico)	4,897	10.0	23.9	16.6	6,257	8.8	17.7	17.7	1.9
Sub-Saharan Africa	..	..	..	..	1,542	2.2	4.4	4.0	..
Sub-Saharan Africa (without South Africa)	434	1.0	2.1	1.7	924	1.3	2.6	2.7	6.0
Middle East and North Africa and Turkey	2,419	5.0	11.8	13.6	4,571	6.4	12.9	20.5	5.0
Technical enrolment[c]									
World	9,323	100	na	2.2	14,611	100	na	2.8	3.5
Industrialized economies	4,508	48.4	na	5.8	5,850	40.0	na	7.0	2.0
Transition economies	..	..	na	..	2,090	14.3	na	8.9	..
Developing economies	4,814	51.6	100	1.5	6,670	45.7	100	1.6	2.5
High and upper-middle income	1,400	15.0	29.1	3.6	2,100	14.4	31.5	4.4	3.2
Lower-middle Income	1,136	12.2	23.6	2.2	1,937	13.3	29.0	2.9	4.2
Low income	2,278	24.4	47.3	1.0	2,633	18.0	39.5	0.9	1.1
Low income (without China and India)	223	2.4	4.6	0.4	325	2.2	4.9	0.5	3.0
Least developed countries[d]	135	1.4	2.8	0.5	138	0.9	2.1	0.4	0.1
East Asia	1,726	18.5	35.9	1.2	3,198	21.5	46.3	2.0	4.9
East Asia (without China)	905	9.7	18.8	2.6	1,977	13.3	28.6	4.7	6.2
South Asia	1,384	14.9	28.8	1.4	1,271	8.6	18.4	1.0	–0.7
Latin America and the Caribbean	1,341	14.4	27.8	3.6	1,497	10.1	21.7	3.4	0.9
Latin America and the Caribbean (without Mexico)	965	10.3	20.0	3.3	1,097	7.4	15.9	3.1	1.0
Sub-Saharan Africa	..	..	..	..	185	1.2	2.7	0.5	..
Sub-Saharan Africa (without South Africa)	58	0.6	1.2	0.2	117	0.8	1.7	0.3	5.5
Middle East and North Africa and Turkey	306	3.3	6.3	1.7	519	3.5	7.5	2.3	4.1

Source: UNIDO Scoreboard database (see technical annex).

a. Period for which the most recent enrolment data could be obtained (data were not always available for 1998).

b. Includes only 12 of 49 least developed countries. Bangladesh accounts for 64.8 percent of enrolment in this group in 1985 and 58.7 percent in 1998.

c. Covers engineering, mathematics, computer science and natural sciences.

d. Includes only 12 of 49 least developed countries. Bangladesh accounts for 72.4 percent of enrolments in this group in 1985 and 65.3 percent in 1998.

Table A2.6 Ranking by concentration of tertiary enrolments, total and technical, in selected economies, 1987 and 1995–1998

1987					1995–1998[a]				
Rank	All economies	World shares (percent)	Developing economies	Developing economies' shares (percent)	Rank	All economies	World shares (percent)	Developing economies	Developing economies' shares (percent)
Total enrolment									
1	United States	29.1	India	21.8	1	United States	19.2	China	16.5
2	India	9.5	China	10.1	2	China	7.7	India	15.8
3	Japan	5.3	Korea, Republic of	7.4	3	India	7.4	Indonesia	6.5
4	China	4.4	Brazil	7.2	4	Russian Federation	5.9	Korea, Republic of	6.3
5	France	3.9	Mexico	6.1	5	Japan	5.2	Philippines	5.2
	Top 5	52.2	Top 5	52.6		Top 5	45.4	Top 5	50.3
6	Germany	3.5	Philippines	5.9	6	Indonesia	3.1	Brazil	4.9
7	Korea, Republic of	3.2	Indonesia	4.8	7	Korea, Republic of	3.0	Mexico	4.0
8	Brazil	3.1	Argentina	3.7	8	Germany	2.8	Thailand	3.5
9	Mexico	2.6	Egypt	2.9	9	France	2.8	Turkey	3.3
10	Italy	2.6	Turkey	2.6	10	Canada	2.7	Argentina	3.0
	Top 10	67.2	Top 10	72.4		Top 10	59.7	Top 10	69.0
	Bottom 30	0.5	Bottom 30	1.1		Bottom 30	0.6	Bottom 30	2.1
Technical enrolment									
1	United States	19.6	India	25.6	1	United States	12.3	China	18.3
2	India	13.2	China	17.1	2	Russian Federation	12.0	India	16.3
3	China	8.8	Mexico	7.8	3	China	8.4	Korea, Republic of	11.1
4	Japan	5.4	Korea, Republic of	6.7	4	India	7.4	Indonesia	6.6
5	Germany	4.9	Philippines	5.6	5	Japan	5.5	Mexico	6.0
	Top 5	51.8	Top 5	62.8		Top 5	45.6	Top 5	58.3
6	Mexico	4.0	Brazil	4.7	6	Korea, Republic of	5.1	Philippines	5.8
7	Korea, Republic of	3.4	Argentina	4.4	7	Germany	4.3	Brazil	4.3
8	France	3.3	Indonesia	2.9	8	United Kingdom	3.0	Taiwan Province of China	3.4
					9				
9	United Kingdom	3.3	Colombia	2.4	10	Indonesia	3.0	Colombia	3.0
10	Philippines	2.9	Taiwan Province of China	2.4		Mexico	2.7	Argentina	2.4
	Top 10	68.8	Top 10	79.5		Top 10	63.7	Top 10	77.2
	Bottom 30	0.9	Bottom 30	1.7		Bottom 30	1.3	Bottom 30	2.8

Source: UNIDO Scoreboard database (see technical annex).

a. Period for which the most recent enrolment data could be obtained (data were not always available for 1998).

Table A2.7 R&D financed by enterprises by income level and region, 1985 and 1995–1998

Country group, income level or region	1985: Value (millions of dollars)	1985: World shares (percent)	1985: Developing economies' shares (percent)	1985: Per capita (dollars)	1985: As a share of manu-facturing value added (percent)	1995–1998[a]: Value (millions of dollars)	1995–1998[a]: World shares (percent)	1995–1998[a]: Developing economies' shares (percent)	1995–1998[a]: Per capita (dollars)	1995–1998[a]: As a share of manu-facturing value added (percent)	Growth rate 1985 to 1995–1998 (percent)
World	97,133.6	100	na	22.9	3.9	353,288.9	100	na	71.4	6.3	10.4
Industrialized economies	95,034.1	97.8	na	122.3	4.7	333,088.6	94.3	na	402.4	7.9	10.1
Transition economies	--	..	na	..	..	2,078.7	0.6	na	8.8	1.6	..
Developing economies	2,099.6	2.2	100	0.6	0.4	18,121.7	5.1	100	4.6	1.5	18.0
High and upper-middle income	1,698	1.7	80.9	4.4	..	16,057	4.5	88.6	33.3	..	18.9
Lower-middle income	98	0.1	4.7	0.2	..	569	0.2	3.1	0.8	..	14.5
Low income	303	0.3	14.5	0.1	..	1,496	0.4	8.3	0.5	..	13.1
Low income (without China and India)	—	—	—	—	—	1	—	—	—	—	17.7
Least developed countries[b]	—	—	—	—	—	—	—	—	—	—	—
East Asia	..	..	..	..	..	14,125.8	4.0	77.9	8.7	2.2	..
East Asia (without China)	1,115.1	1.1	53.1	3.2	1.1	13,028.4	3.7	71.9	31.0	4.4	20.8
South Asia	303.3	0.3	14.4	0.3	0.7	397.6	0.1	2.2	0.3	0.5	2.1
Latin America and the Caribbean	423.1	0.4	20.2	1.1	0.2	2,783.7	0.8	15.4	6.3	0.8	15.6
Latin America and the Caribbean (without Mexico)	170.9	0.2	8.1	0.6	0.1	2,647.2	0.7	14.6	7.5	1.0	23.5
Sub-Saharan Africa	183.7	0.2	8.7	0.6	0.7	501.2	0.1	2.8	1.3	1.3	8.0
Sub-Saharan Africa (without South Africa)	0.1	—	—	—	—	0.4	—	—	—	—	11.3
Middle East and North Africa and Turkey	74.3	0.1	3.5	0.4	0.2	313.3	0.1	1.7	1.4	0.3	11.7

Source: UNIDO Scoreboard database (see technical annex).

a. Period for which the most recent R&D data could be obtained (data were not always available for 1998).

b. Includes only 12 of 49 least developed countries.

Table A2.8 Ranking by concentration of R&D financed by enterprises in selected economies, 1985 and 1995–1998

	1985					1995–1998[a]			
Rank	All economies	World shares (percent)	Developing economies	Developing economies' shares (percent)	Rank	All economies	World shares (percent)	Developing economies	Developing economies' shares (percent)
1	United States	37.6	Taiwan Province of China	29.3	1	United States	34.7	Korea, Republic of	52.4
2	Japan	23.9	Korea, Republic of	21.0	2	Japan	30.5	Taiwan Province of China	14.4
3	Germany	20.4	India	14.4	3	Germany	9.7	Brazil	12.1
4	France	3.6	Mexico	12.0	4	France	4.9	China	6.1
5	United Kingdom	3.1	South Africa	8.7	5	United Kingdom	2.9	Singapore	3.3
	Top 5	88.6	Top 5	85.6		Top 5	82.6	Top 5	88.2
6	Canada	1.8	Brazil	7.0	6	Korea, Republic of	2.7	South Africa	2.8
7	Switzerland	1.4	Turkey	3.2	7	Switzerland	1.7	India	2.2
8	Netherlands	1.2	Singapore	1.7	8	Sweden	1.6	Argentina	1.6
9	Italy	1.1	Chile	0.9	9	Italy	1.5	Turkey	1.6
10	Sweden	1.0	Indonesia	0.4	10	Canada	1.2	Indonesia	0.8
	Top 10	95.0	Top 10	98.8		Top 10	91.3	Top 10	97.2
	Bottom 30	—	Bottom 30	—		Bottom 30	—	Bottom 30	—

Source: UNIDO Scoreboard database (see technical annex).

a. Period for which the most recent R&D data could be obtained (data were not always available for 1998).

Table A2.9 **Foreign direct investment inflows by income level and region, 1981–1985 and 1993–1998**

Country group, income level or region	1981–1985 Average value[a] (millions of dollars)	1981–1985 World shares (percent)	1981–1985 Developing economies' shares (percent)	1981–1985 Per capita (dollars)	1993–1998 Average value[a] (millions of dollars)	1993–1998 World shares (percent)	1993–1998 Developing economies' shares (percent)	1993–1998 Per capita (dollars)	1993–1998 Growth rate (percent)
World	56,375.4	100.0	na	13.3	314,045.6	100.0	na	63.4	15.4
Industrialized economies	42,541.8	75.5	na	54.8	199,982.5	63.7	na	241.6	13.8
Transition economies	..	..	na	..	9,597.5	3.1	na	40.8	..
Developing economies	13,833.6	24.5	100.0	4.3	104,465.6	33.3	100.0	26.9	18.4
High and upper-middle income	9,676.4	17.2	69.9	25.1	43,785.2	13.9	41.9	95.0	13.4
Lower-middle Income	2,505.2	4.4	18.1	4.8	18,280.0	5.8	17.5	28.5	18.0
Low income	1,652.0	2.9	11.9	0.7	42,400.4	13.5	40.6	15.2	31.1
Low income (without China and India)	657.7	1.2	4.8	1.3	2,945.5	0.9	2.8	4.5	13.3
Least developed countries[b]	41.1	0.1	0.3	0.2	547.6	0.2	0.5	1.6	22.0
East Asia	6,038.5	10.7	43.7	4.3	64,377.9	20.5	61.6	39.7	21.8
East Asia (without China)	5,104.3	9.1	36.9	14.5	26,565.0	8.5	25.4	63.3	14.7
South Asia	196.6	0.3	1.4	0.2	2,522.9	0.8	2.4	2.1	23.7
Latin America and the Caribbean	4,091.1	7.3	29.6	11.1	31,291.1	10.0	29.9	70.4	18.5
Latin America and the Caribbean (without Mexico)	3,194.2	5.7	23.1	10.8	24,485.0	7.8	23.4	69.3	18.5
Sub-Saharan Africa	508.7	0.9	3.7	1.7	3,155.0	1.0	3.0	8.2	16.4
Sub-Saharan Africa (without South Africa)	501.7	0.9	3.6	1.9	1,822.4	0.6	1.7	5.3	11.3
Middle East and North Africa and Turkey	2,998.7	5.3	21.7	16.9	3,196.6	1.0	3.1	14.1	0.5

Source: UNIDO Scoreboard database (see technical annex).

a. Annual averages calculated for the periods 1981–1985 and 1993–1998.

b. Includes only 12 of 49 least developed countries.

Table A2.10 Technology licence payments abroad by income level and region, 1985 and 1998

Country group, income level or region	1985[a] Value (billions of dollars)	World shares (percent)	Developing economies' shares (percent)	Per capita value (dollars)	1998[a] Value (billions of dollars)	World shares (percent)	Developing economies' shares (percent)	Per capita value (dollars)	Growth rate (percent)
World	11,091.8	100	na	2.6	70,471.0	100	na	14.2	16.7
Industrialized economies	9,286.9	83.7	na	12	54,825.4	77.8	na	66.2	15.9
Transition economies	..	..	na	..	583.8	0.8	na	2.5	..
Developing economies	1,804.9	16.3	100	0.6	15,061.8	21.4	100	3.9	19.3
High and upper-middle income	1,230.1	11.1	68.2	3.2	11,409.7	16.2	75.8	23.6	18.7
Lower-middle income	539.9	4.9	29.9	1.0	2,937.8	4.2	19.5	4.3	13.9
Low income	34.9	0.3	1.9	—	714.3	1.0	4.7	0.2	26.1
Low income (without China and India)	9.7	0.1	0.5	—	93.5	0.1	0.6	0.1	19.0
Least developed countries[b]	0.2	—	—	—	21.8	—	0.1	0.1	42.3
East Asia	..	..	..	..	11,568.3	16.4	76.8	7.1	..
East Asia (without China)	942.3	8.5	52.2	2.7	11,148.3	15.8	74.0	26.6	22.9
South Asia	25.1	0.2	1.4	0	225.6	0.3	1.5	0.2	20.1
Latin America and the Caribbean	696.9	6.3	38.6	1.9	2,348.8	3.3	15.6	5.3	10.7
Latin America and the Caribbean (without Mexico)	554.9	5.0	30.7	1.9	1,847.8	2.6	12.3	5.2	10.5
Sub-Saharan Africa	127.8	1.2	7.1	0.4	229.0	0.3	1.5	0.6	5.0
Sub-Saharan Africa (without South Africa)	7.5	0.1	0.4	—	63.6	0.1	0.4	0.2	19.5
Middle East and North Africa and Turkey	12.8	0.1	0.7	0.1	690.1	1.0	4.6	3.0	39.4

Source: UNIDO Scoreboard database (see technical annex).

a. When data for 1985 or 1998 were not available, data for closest years were used.

b. Includes only 12 of 49 least developed countries.

Table A2.11 Ranking by concentration in technology licence payments abroad in selected economies, 1985 and 1998

1985					1998				
Rank	All economies	World shares (percent)	Developing economies	Developing economies' shares (percent)	Rank	All economies	World shares (percent)	Developing economies	Developing economies' shares (percent)
1	Japan	20.5	Indonesia	21.3	1	United States	16.0	Malaysia	15.9
2	Germany	11.0	Korea, Republic of	17.9	2	Japan	12.7	Korea, Republic of	15.7
3	United States	10.5	Taiwan Province of China	9.5	3	Ireland	8.8	Singapore	11.7
4	France	8.9	Mexico	7.9	4	United Kingdom	8.7	Taiwan Province of China	9.4
5	United Kingdom	7.3	South Africa	6.7	5	Germany	6.9	Hong Kong SAR	8.2
	Top 5	58.1	Top 5	63.3		Top 5	53.2	Top 5	61.0
6	Netherlands	6.6	Thailand	2.5	6	Netherlands	4.2	Brazil	7.1
7	Argentina	3.8	Ecuador	2.3	7	France	3.9	Indonesia	6.7
8	Belgium	3.8	Brazil	1.7	8	Malaysia	3.4	Thailand	5.3
9	Australia	3.5	India	1.4	9	Korea, Republic of	3.4	Mexico	3.3
10	Indonesia	3.5	Chile	1.3	10	Canada	2.9	Argentina	2.8
	Top 10	79.3	Top 10	72.5		Top 10	71.0	Top 10	86.2
	Bottom 30	—	Bottom 30	—		Bottom 30	0.1	Bottom 30	0.3

Source: UNIDO Scoreboard database (see technical annex).

Table A2.12 Information and communication technologies infrastructure by income level and region, 1998 and 2001

Country group, income level or region	Number (thousands)	World shares (percent)	Developing economies' shares (percent)	Per 1,000 people	Number (thousands)	World shares (percent)	Developing economies' shares (percent)	Per 1,000 people
Personal computers, 1998					**Internet hosts, 2001**			
World	334.3	100	na	64.9	106.1	100	na	20.6
Industrialized economies	266.3	79.6	na	316.5	99.7	94.0	na	118.5
Transition economies	10.0	3.0	na	43.4	1.1	1.0	na	4.8
Developing economies	58.1	17.4	100	14.2	5.3	5.0	100	1.3
High and upper-middle income	32.6	9.7	56.1	67.5	4.6	4.3	87.0	9.4
Lower-middle Income	9.9	3.0	17.0	14.6	0.5	0.5	9.1	0.7
Low income	15.6	4.7	26.9	5.4	0.2	0.2	3.9	0.1
Low income (without China and India)	2.0	0.6	3.2	2.7	—	—	0.3	—
Least developed countries[a]	0.3	0.1	0.5	0.8	—	0	—	—
East Asia	32.4	9.7	55.9	19.3	3.0	2.9	57.7	1.8
East Asia (without China)	21.4	6.4	36.8	48.6	2.9	2.7	55.0	6.6
South Asia	3.3	1.0	5.7	2.6	0.1	0.1	1.1	-
Latin America and the Caribbean	15.5	4.6	26.8	33.3	1.6	1.5	31.1	3.5
Latin America and the Caribbean (without Mexico)	11.0	3.3	19.0	29.8	1.2	1.1	22.8	3.2
Sub-Saharan Africa	3.2	1.0	5.6	7.8	0.3	0.2	5.0	0.6
Sub-Saharan Africa (without South Africa)	1.3	0.4	2.2	3.4	—	—	0.3	—
Middle East and North Africa and Turkey	3.6	1.1	6.1	14.8	0.3	0.3	5.1	1.1
Telephone mainlines, 1998					**Mobile telephones, 1998**			
World	785.4	100	na	152.5	312.3	100	na	60.6
Industrialized economies	480.5	61.2	na	571.1	223.6	71.6	na	265.8
Transition economies	49.3	6.3	na	214.0	5.5	1.8	na	23.9
Developing economies	255.6	32.5	100	62.6	83.2	26.6	100	20.4
High and upper-middle income	88.6	11.3	34.7	183.6	43.4	13.9	52.2	90.0
Lower-middle Income	53.1	6.8	20.8	78.5	14.3	4.6	17.2	21.1
Low income	113.9	14.5	44.6	39.0	25.5	8.2	30.6	8.7
Low income (without China and India)	6.0	0.8	2.4	8.8	1.0	0.2	0.9	1.1
Least developed countries[a]	1.5	0.2	0.6	4.4	0.2	0.1	0.3	0.6
East Asia	138.8	17.7	54.3	82.7	53.3	17.1	64.1	31.8
East Asia (without China)	52.5	6.7	20.6	119.3	29.8	9.5	35.8	67.7
South Asia	25.2	3.2	9.9	19.7	1.6	0.5	2.0	1.3
Latin America and the Caribbean	57.1	7.3	22.3	122.3	21.1	6.8	25.4	45.2
Latin America and the Caribbean (without Mexico)	47.2	6.0	18.5	127.2	17.8	5.7	21.3	47.9
Sub-Saharan Africa	6.9	0.9	2.7	16.5	2.6	0.8	3.2	6.3
Sub-Saharan Africa (without South Africa)	2.1	0.3	0.8	5.7	0.3	0.1	0.3	0.8
Middle East and North Africa and Turkey	27.6	3.5	10.8	115.0	4.5	1.4	5.4	18.7

Source: UNIDO Scoreboard database (see technical annex).

a. Includes only 12 of 49 least developed countries.

Table A2.13 Comparison of main industrial performance and capability indicators by income level and region, 1985–1998, selected years

Country group, income level or region	Manufacturing valued added per capita (dollars)		Exports per capita (dollars)		Tertiary technical enrolment per 1,000 people		R&D financed by enterprises per capita (dollars)		Foreign direct investment inflows per capita (dollars)		Royalties per capita[a] (dollars)	
	1985	1998	1985	1998	1987	1995	1985	1998	1981–1985	1993–1997	1985	1998
World	619	1,094	293	821	2.2	2.8	22.9	71.4	13.3	63.4	2.6	14.2
Industrial economies	2,579	5,040	1,345	3,714	5.8	7.0	122.3	402.4	54.8	241.6	12	66.2
Transition economies	..	725	..	501	..	8.9	..	8.8	..	40.8	..	2.5
Developing economies	147	300	60	242	1.5	1.6	0.7	4.6	4.3	26.9	0.6	3.9
High and upper-middle	578	1,161	371	1,274	3.6	4.4	4.4	33.3	25.1	95.0	3.2	23.6
Lower-middle	176	311	64	236	2.2	2.9	0.2	0.8	4.8	28.5	1.0	4.3
Low	70	156	8	73	1.0	0.9	0.1	0.5	0.7	15.2	—	0.2
Low (without China and India)	44	51	11	28	0.4	0.5	—	—	1.3	4.5	—	0.1
Least developed countries[b]	31	35	7	18	0.5	0.4	—	—	0.2	1.6	—	0.1
East Asia	145	387	84	409	1.2	2.0	..	8.7	4.3	39.7	na	7.1
East Asia (without China)	278	668	317	1,178	2.6	4.7	3.2	31.0	14.5	63.3	2.7	26.6
South Asia	42	65	9	32	1.4	1.0	0.3	0.3	0.2	2.1	—	0.2
Latin America and the Caribbean	462	771	116	404	3.6	3.4	1.1	6.3	11.1	70.4	1.9	5.3
Latin America and the Caribbean (without Mexico)	454	750	117	229	3.3	3.1	0.6	7.5	10.8	69.3	1.9	5.2
Sub-Saharan Africa	83	92	25	45	..	0.5	0.6	1.3	1.7	8.2	0.4	0.6
Sub-Saharan Africa (without South Africa)	49	40	8	14	0.2	0.3	—	—	1.9	5.3	—	0.2
Middle East and North Africa and Turkey	202	392	96	220	1.7	2.3	0.4	1.4	16.9	14.1	0.1	3.0
Share, top 10	75.9	80.0	75.8	81.6	79.5	77.2	98.8	97.2	78.5	78.8	72.5	86.2
Share, bottom 30	4.2	2.4	2.2	1.3	1.7	2.8	—	—	2.4	1.8	—	0.3
Share, least developed countries[b]	0.7	0.6	0.7	0.6	2.8	2.1	—	—	0.3	0.5	—	0.1

Source: UNIDO Scoreboard database (see technical annex).

a. Technology licence payments.

b. Includes only 12 of 49 least developed countries.

Table A2.14 Ranking by manufacturing value added, 1985 and 1998

Rank by manufacturing value added per capita 1998	Rank by manufacturing value added per capita 1985	Economy	Manufacturing value added per capita (dollars) 1998	Manufacturing value added per capita (dollars) 1985	Manufacturing value added (millions of dollars) 1998	Manufacturing value added (millions of dollars) 1985
1	1	Switzerland	8,314.7	3,861.2	59,084	24,982
2	3	Japan	7,083.5	3,286.8	895,425	396,890
3	19	Ireland	7,042.9	1,337.1	26,094	4,733
4	16	Singapore	6,178.4	1,681.1	19,545	4,174
5	5	Germany	5,866.3	2,530.6	481,315	196,622
6	6	Finland	5,557.4	2,493.6	28,637	12,224
7	2	United States	5,300.8	3,372.3	1,432,800	802,347
8	4	Sweden	5,295.4	2,599.4	46,874	21,705
9	9	Austria	5,191.2	2,048.3	41,935	15,475
10	11	Denmark	4,776.3	1,873.9	25,319	9,583
11	8	France	4,761.9	2,084.1	280,223	114,982
12	13	Belgium	4,445.9	1,769.7	45,366	17,445
13	14	United Kingdom	4,179.0	1,738.7	246,789	98,558
14	12	Italy	4,082.1	1,873.5	235,087	106,027
15	17	Netherlands	3,953.4	1,562.3	62,061	22,641
16	10	Norway	3,803.2	1,898.3	16,856	7,884
17	7	Canada	3,489.2	2,263.1	105,725	58,710
18	21	Taiwan Province of China	3,351.2	1,260.3	73,183	23,316
19	28	Portugal	2,631.2	708.2	26,228	7,090
20	22	Spain	2,620.9	1,153.2	103,186	44,293
21	18	New Zealand	2,611.2	1,498.8	9,902	4,903
22	23	Israel	2,598.8	971.5	15,497	4,112
23	15	Australia	2,488.3	1,692.5	46,658	26,670
24	..	Slovenia	2,365.0	..	4,687	..
25	29	Korea, Republic of	2,107.8	668.1	97,866	27,264
26	..	Czech Republic	1,612.4	..	16,600	..
27	25	Bahrain	1,577.4	869.8	1,014	370
28	26	Argentina	1,475.2	862.2	53,293	26,130
29	20	Hong Kong SAR	1,411.0	1,322.0	9,435	7,213
30	36	Uruguay	1,125.0	463.2	3,700	1,394
31	30	Hungary	947.1	653.3	9,579	6,911
32	37	Malaysia	936.6	368.1	20,774	5,771
33	32	Greece	927.5	548.4	9,753	5,448
34	34	Brazil	912.0	507.6	151,274	68,640
35	35	Mexico	854.6	494.8	81,912	37,342
36	31	Poland	779.2	626.6	30,129	23,311
37	47	Chile	748.8	214.5	11,099	2,584
38	51	Mauritius	738.9	182.5	857	185
39	43	Turkey	695.1	244.1	44,106	12,274
40	..	Russian Federation	662.7	..	97,357	..
41	27	Venezuela	607.3	792.0	14,114	13,573
42	33	Saudi Arabia	605.1	546.4	12,550	6,764
43	45	Peru	584.9	224.7	14,505	4,380
44	55	Thailand	584.5	166.7	35,771	8,528
45	38	South Africa	556.9	366.5	23,056	11,476
46	40	Costa Rica	556.6	327.9	1,963	866
47	24	Romania	466.3	872.9	10,494	19,838
48	49	El Salvador	425.9	200.7	2,580	957
49	54	Tunisia	390.0	174.8	3,641	1,269
50	52	Jamaica	371.9	179.1	958	414
51	39	Ecuador	354.4	332.2	4,315	3,023
52	58	Egypt	326.1	132.6	20,020	6,166
53	48	Colombia	322.2	213.8	13,148	6,769
54	56	Oman	293.3	163.5	675	228
55	63	China	287.0	100.6	355,540	105,698
56	41	Panama	271.3	298.6	750	647
57	53	Paraguay	246.6	178.9	1,287	646
58	44	Guatemala	237.4	228.9	2,564	1,771
59	62	Morocco	219.3	110.3	6,091	2,388
60	57	Philippines	189.7	141.4	14,260	7,731
61	50	Jordan	188.6	196.5	860	519
62	..	Albania	183.8	..	614	..
63	59	Bolivia	177.9	132.3	1,414	780
64	42	Algeria	153.8	264.5	4,602	5,788
65	61	Honduras	138.3	111.7	851	468
66	70	Sri Lanka	124.5	50.8	2,338	804
67	65	Indonesia	115.0	85.6	23,418	13,960
68	69	Senegal	81.7	51.8	739	330
69	60	Zimbabwe	77.4	123.1	905	1,024
70	71	Pakistan	72.6	45.0	9,557	4,264
71	46	Nicaragua	67.0	217.9	321	742
72	72	India	65.2	43.7	63,860	33,471
73	64	Cameroon	64.6	94.3	923	940
74	66	Nigeria	62.2	83.9	7,514	6,979
75	73	Bangladesh	59.6	33.5	7,489	3,280
76	67	Zambia	39.6	76.8	383	515
77	74	Kenya	36.6	31.7	1,072	631
78	..	Yemen	34.1	..	565	..
79	77	Madagascar	26.5	28.3	387	287
80	76	Central African Republic	26.0	30.0	90	78
81	79	Uganda	24.3	10.0	507	142
82	..	Mozambique	22.1	..	375	..
83	78	Malawi	20.6	20.2	217	145
84	80	Nepal	17.6	8.3	403	138
85	75	United Republic of Tanzania	15.8	30.9	509	672
86	68	Ghana	9.2	57.7	169	728
87	..	Ethiopia	7.9	..	484	..

Source: UNIDO Scoreboard database (see technical annex).

Table A2.15 Ranking by manufactured exports, 1985 and 1998

Rank by manufactured exports per capita			Manufactured exports per capita (dollars)		Total manufactured exports (millions of dollars)	
1998	1985	Economy	1998	1985	1998	1985
1	1	Singapore	32,713	7,657.7	103,489	19,014
2	10	Ireland	15,659	2,323.9	58,018	8,227
3	2	Belgium	15,050	4,480.1	153,572	44,165
4	3	Switzerland	10,512	3,983.0	74,702	25,770
5	4	Netherlands	8,894.6	3,514.6	139,628	50,933
6	5	Sweden	8,396.4	3,452.0	74,323	28,824
7	7	Finland	7,917.7	2,561.6	40,800	12,557
8	8	Denmark	6,850.2	2,433.3	36,313	12,444
9	12	Austria	6,615.2	2,106.2	53,438	15,912
10	11	Germany	5,939.0	2,125.1	487,273	165,117
11	9	Canada	5,383.4	2,431.4	163,121	63,074
12	14	Taiwan Province of China	4,833.5	1,572.6	105,554	29,092
13	15	France	4,486.3	1,507.3	264,005	83,157
14	..	Slovenia	4,274.6	..	8,472	..
15	19	United kingdom	4,099.8	1,304.4	242,113	73,937
16	17	Italy	3,958.2	1,313.6	227,949	74,343
17	18	Israel	3,701.7	1,309.1	22,073	5,542
18	6	Hong Kong SAR	3,459.9	2,928.8	23,137	15,979
19	13	Norway	3,432.3	1,876.0	15,212	7,791
20	24	Malaysia	2,973.0	550.3	65,941	8,626
21	16	Japan	2,929.8	1,422.6	370,360	171,785
22	20	Korea, Republic of	2,599.6	711.3	120,700	29,025
23	..	Czech Republic	2,566.6	..	26,423	..
24	25	Spain	2,375.0	544.7	93,505	20,921
25	26	Portugal	2,336.0	544.3	23,285	5,449
26	21	United States	2,034.9	681.9	550,043	162,244
27	46	Hungary	2,017.0	71.3	20,400	754
28	22	New Zealand	1,625.7	632.0	6,165	2,068
29	29	Mauritius	1,433.7	400.2	1,602	407
30	27	Australia	1,151.3	467.8	21,589	7,371
31	41	Mexico	1,081.8	110.5	103,681	8,336
32	43	Costa Rica	970.7	102.3	3,423	270
33	31	Greece	758.0	334.9	7,970	3,327
34	45	Thailand	731.4	71.5	44,760	3,658
35	30	Saudi Arabia	701.8	340.0	14,554	4,209
36	23	Bahrain	687.9	628.6	442	267
37	33	Poland	628.5	186.2	24,302	6,926
38	40	Tunisia	554.1	115.1	5,173	836
39	36	Uruguay	471.8	150.3	1,552	452
40	32	Jamaica	445.9	209.6	1,149	484
41	42	Chile	443.1	102.5	6,568	1,234
42	48	Oman	406.4	64.1	935	90
43	38	Argentina	390.5	122.2	14,108	3,703
44	51	Philippines	374.0	44.4	28,119	2,429
45	39	Turkey	360.7	115.1	22,885	5,790
46	..	Romania	339.0	..	7,630	..
47	28	Venezuela	337.3	409.8	7,841	7,023
48	35	South Africa	322.1	158.5	13,334	4,962
49	37	Brazil	234.4	130.3	38,882	17,617
50	..	Russian Federation	201.9	..	29,659	..
51	55	Sri Lanka	162.1	36.7	3,043	582
52	74	China	135.4	5.8	167,681	6,049
53	60	El Salvador	134.0	22.8	812	109
54	59	Indonesia	132.0	23.7	26,895	3,856
55	62	Guatemala	128.6	21.7	1,389	168
56	49	Morocco	111.9	55.4	3,108	1,200
57	56	Colombia	103.9	33.9	4,241	1,073
58	47	Jordan	103.0	70.7	470	187
59	34	Algeria	95.2	184.9	2,848	4,045
60	44	Peru	90.9	79.1	2,254	1,541
61	61	Bolivia	80.6	22.6	641	133
62	53	Panama	80.3	42.1	222	91
63	54	Ecuador	77.8	40.2	948	366
64	52	Zimbabwe	74.7	43.3	874	360
65	67	Paraguay	66.4	11.2	347	40
66	63	Pakistan	56.4	18.7	7,428	1,776
67	..	Albania	52.8	..	176	..
68	50	Honduras	48.2	47.9	297	201
69	71	Bangladesh	37.3	8.1	4,691	793
70	68	Egypt	36.5	9.8	2,242	458
71	58	Senegal	34.5	24.2	300	154
72	57	Cameroon	34.0	27.0	477	269
73	72	Nicaragua	29.9	6.1	143	21
74	65	Kenya	28.3	17.1	829	341
75	70	India	26.4	8.1	25,855	6,209
76	69	Ghana	21.5	9.4	396	119
77	76	Nepal	16.3	5.1	373	85
78	64	Central African Republic	15.4	18.2	53	48
79	66	Zambia	11.0	11.9	107	80
80	75	Madagascar	8.5	5.1	124	52
81	73	Malawi	5.8	5.9	61	43
82	77	Mozambique	4.2	4.6	60	62
83	78	United Republic of Tanzania	2.9	2.6	93	57
84	..	Yemen	2.0	..	34	..
85	79	Nigeria	1.5	2.6	177	216
86	..	Ethiopia	1.4	..	85	..
87	80	Uganda	0.9	0.2	19	2

Source: UNIDO Scoreboard database (see technical annex).

Table A2.16 Ranking by technological structure of manufacturing value added, 1985 and 1998 (percent)

Rank by share of medium- and high-tech in manufacturing value added 1998	Rank 1985	Economy	Share of high- and medium-tech industry 1998	1985	Share of low-tech and resource-based industry 1998	1985
1	1	Singapore	80	67	20	33
2	2	Japan	66	64	34	36
3	13	Ireland	65	53	35	47
4	3	Germany	64	64	36	36
5	7	Switzerland	63	57	37	43
6	4	United States	63	62	37	38
7	5	United Kingdom	62	58	38	42
8	8	Sweden	61	57	39	43
9	25	Korea, Republic of	60	47	40	53
10	11	Netherlands	60	56	40	44
11	24	Malaysia	60	47	40	53
12	9	India	59	56	41	44
13	12	Brazil	58	54	42	46
14	31	Taiwan Province of China	57	43	43	57
15	14	Saudi Arabia	54	52	46	48
16	15	Israel	54	52	46	48
17	18	France	53	50	47	50
18	26	Finland	53	46	47	54
19	33	Hong Kong SAR	52	38	48	62
20	10	Italy	52	56	48	44
21	22	Canada	51	48	49	52
22	19	China	51	49	49	51
23	21	Denmark	51	48	49	52
24	27	Australia	51	46	49	54
25	17	Belgium	51	50	49	50
26	16	Norway	50	51	50	49
27	23	Austria	50	48	50	52
28	..	Slovenia	50	..	50	..
29	28	Spain	49	44	51	56
30	20	Czech Republic	48	48	52	52
31	6	Hungary	46	58	54	42
32	29	Poland	45	44	55	56
33	30	South Africa	44	44	56	56
34	..	Russian Federation	41	..	59	..
35	40	New Zealand	40	34	60	66
36	55	Indonesia	40	25	60	75
37	44	Egypt	39	31	61	69
38	66	Thailand	39	18	61	82
39	43	Turkey	38	32	62	68
40	38	Nigeria	38	34	62	66
41	39	Argentina	37	34	63	66
42	61	Philippines	36	22	64	78
43	35	Mexico	36	37	64	63
44	46	Colombia	35	30	65	70
45	45	Guatemala	35	30	65	70
46	36	Pakistan	34	36	66	64
47	32	Romania	34	41	66	59
48	62	Senegal	34	21	66	79
49	51	Venezuela	32	28	68	72
50	47	Greece	31	29	69	71
51	41	Portugal	31	33	69	67
52	70	Jordan	31	14	69	86
53	64	Costa Rica	30	21	70	79
54	42	Algeria	29	32	71	68
55	34	Malawi	29	38	71	62
56	49	Bangladesh	28	28	72	72
57	48	El Salvador	28	29	72	71
58	37	Zimbabwe	27	34	73	66
59	65	Chile	26	20	74	80
60	52	Jamaica	25	28	75	72
61	54	Morocco	25	25	75	75
62	59	Peru	25	24	75	76
63	58	United Republic of Tanzania	25	24	75	76
64	57	Zambia	24	25	76	75
65	50	Kenya	24	28	76	72
66	..	Bahrain	22	..	78	.
67	63	Uruguay	21	21	79	79
68	79	Oman	20	10	80	90
69	69	Central African Republic	20	14	80	86
70	..	Yemen	20	..	80	..
71	56	Tunisia	19	25	81	75
72	..	Albania	19	..	81	..
73	75	Ghana	17	12	83	88
74	60	Panama	16	23	84	77
75	78	Sri Lanka	16	10	84	90
76	77	Uganda	15	11	85	89
77	72	Nicaragua	15	14	85	86
78	..	Nepal	15	..	85	..
79	71	Honduras	12	14	88	86
80	..	Mozambique	12	..	88	..
81	73	Mauritius	12	12	88	88
82	80	Bolivia	11	7	89	93
83	67	Cameroon	11	17	89	83
84	74	Paraguay	11	12	89	88
85	53	Ecuador	11	27	89	73
86	68	Madagascar	10	16	90	84
87	76	Ethiopia	9	11	91	89

Source: UNIDO Scoreboard database (see technical annex).

Table A2.17 Ranking by technological structure of manufactured exports, 1985 and 1998 (percent)

Rank by share of medium- and high-tech in manu-factured exports			Complex exports						Simple exports					
			1998			1985			1998			1985		
1998	1985	Economy	High tech	Medium tech	Medium and high tech	High tech	Medium tech	Medium and high tech	Low tech	Resource based	Low tech and resource based	Low tech	Resource based	Low tech and resource based
1	1	Japan	29.6	51.5	81.1	20.8	59.2	80.0	8.0	6.3	14.3	12.4	5.3	17.7
2	34	Philippines	64.3	10.4	74.7	5.8	4.7	10.5	13.8	6.9	20.7	12.8	29.6	42.4
3	13	Singapore	56.7	17.6	74.3	20.4	19.5	39.9	6.6	13.3	19.9	7.2	36.2	43.4
4	24	Mexico	26.6	38.9	65.5	8.6	16.5	25.1	16.9	5.9	22.9	5.0	8.1	13.1
5	3	United States	31.0	34.4	65.4	25.8	33.6	59.4	10.1	11.1	21.2	5.6	13.6	19.1
6	26	Malaysia	46.9	18.2	65.1	14.8	6.3	21.1	9.9	15.0	24.9	4.4	29.6	34.0
7	2	Germany	17.1	47.7	64.8	13.2	48.0	61.3	13.7	11.2	24.9	15.3	13.2	28.6
8	4	Switzerland	23.2	39.7	62.9	17.0	40.0	57.0	15.4	16.4	31.8	17.3	19.6	36.9
9	9	United Kingdom	28.2	34.7	62.9	17.6	28.0	45.6	12.4	14.2	26.7	10.9	16.5	27.4
10	7	Korea, Republic of	27.2	35.1	62.3	12.2	35.7	47.9	19.1	9.8	28.9	39.7	8.2	47.9
11	17	Taiwan Province of China	35.0	26.3	61.3	15.4	20.0	35.4	29.1	5.3	34.3	50.2	9.4	59.6
12	46	Hungary	20.7	38.1	58.8	4.1	1.7	5.8	17.4	12.5	29.9	2.8	0.2	3.0
13	6	France	21.6	36.8	58.4	14.6	34.1	48.7	13.9	15.6	29.4	15.8	20.6	36.4
14	5	Sweden	24.7	33.5	58.2	13.4	38.8	52.2	12.4	19.5	31.9	14.9	27.5	42.4
15	16	Spain	9.3	43.1	52.5	6.0	31.1	37.1	16.0	17.1	33.1	22.5	26.4	48.9
16	..	Czech Republic	11.5	40.4	51.9	..	..	..	26.5	14.9	41.4	..	..	..
17	12	Ireland	39.3	12.0	51.2	25.8	14.1	39.9	10.4	28.7	39.1	12.5	26.7	39.2
18	11	Italy	10.1	40.8	50.9	9.5	34.3	43.8	30.8	12.4	43.3	33.3	17.1	50.3
19	22	Netherlands	24.3	25.7	50.0	10.2	20.7	30.9	12.0	21.3	33.3	10.3	33.4	43.7
20	20	Finland	24.4	25.4	49.8	5.7	26.9	32.6	9.6	35.0	44.6	16.7	43.5	60.2
21	8	Austria	12.2	36.9	49.1	9.2	37.0	46.2	24.2	14.6	38.7	28.5	18.3	46.8
22	10	Canada	11.1	36.0	47.1	7.1	36.9	44.1	8.9	20.0	28.9	4.7	23.4	28.0
23	14	Belgium	9.7	37.1	46.9	6.4	32.1	38.5	16.7	22.4	39.1	18.3	25.6	43.8
24	19	Israel	28.3	17.8	46.1	17.0	16.9	33.9	12.8	35.8	48.6	18.6	36.1	54.7
25	33	Thailand	28.3	16.6	44.9	2.4	11.4	13.8	20.6	15.7	36.3	18.4	19.6	38.0
26	23	Portugal	6.2	33.5	39.7	6.5	18.7	25.2	36.9	19.5	56.5	41.4	29.3	70.7
27	18	Denmark	16.0	23.5	39.5	10.9	24.1	34.9	19.3	17.3	36.6	16.8	23.8	40.6
28	21	Hong Kong SAR	24.5	12.4	36.8	14.2	18.4	32.6	53.0	4.2	57.3	60.6	3.0	63.7
29	48	China	18.2	18.4	36.6	1.2	2.9	4.1	45.6	9.0	54.6	10.3	9.2	19.5
30	15	Poland	8.0	27.7	35.7	9.6	28.2	37.8	32.2	18.2	50.5	13.2	9.4	22.5
31	25	Brazil	6.2	28.1	34.3	3.4	20.5	23.9	11.5	30.2	41.7	14.7	30.2	44.9
32	39	Costa Rica	23.9	8.7	32.6	2.3	5.9	8.1	20.1	11.2	31.3	13.3	5.9	19.2
33	..	Slovenia	11.9	15.9	27.8	..	..	..	27.7	38.1	65.8	..	..	..
34	31	South Africa	4.7	21.2	25.9	4.9	11.6	16.6	12.3	29.9	42.2	9.0	29.4	38.4
35	..	Romania	3.0	20.6	23.6	..	..	..	50.9	17.4	68.3	..	..	..
36	29	Turkey	5.3	18.1	23.5	1.2	17.1	18.2	49.2	12.4	61.7	38.6	15.9	54.5
37	36	Argentina	2.5	20.8	23.3	1.9	8.4	10.3	8.0	24.4	32.4	7.2	26.6	33.8
38	27	Norway	5.6	15.3	21.0	3.0	17.9	20.9	4.6	12.0	16.7	3.8	14.4	18.2
39	35	Greece	4.5	13.4	17.9	1.5	9.1	10.5	29.7	26.5	56.2	31.4	31.4	62.8
40	37	India	5.2	11.4	16.6	2.8	7.0	9.8	38.1	23.6	61.7	31.4	28.1	59.6
41	..	Russian Federation	3.3	13.0	16.3	..	..	..	5.2	18.5	23.7	..	..	..
42	60	Indonesia	5.3	10.2	15.5	0.6	1.3	1.9	18.2	21.4	39.5	3.2	15.6	18.8
43	32	Tunisia	4.3	11.2	15.5	1.1	14.0	15.0	53.7	21.0	74.7	22.2	14.1	36.4
44	28	Zimbabwe	0.9	14.4	15.3	0.6	18.2	18.7	11.4	16.7	28.1	8.8	10.2	19.0
45	50	Guatemala	4.0	11.0	15.0	0.7	3.1	3.8	14.4	24.4	38.8	5.0	11.2	16.3
46	43	Uruguay	2.0	12.6	14.6	0.9	5.5	6.4	23.7	17.8	41.4	36.2	10.4	46.6
47	44	Australia	4.7	9.9	14.6	1.3	5.0	6.3	5.0	21.3	26.3	2.9	24.1	26.9
48	42	New Zealand	4.2	10.3	14.5	1.2	5.3	6.5	8.2	28.3	36.5	9.3	21.3	30.6
49	38	Morocco	0.3	12.2	12.4	0.4	8.5	8.9	22.4	30.0	52.3	15.9	30.6	46.5
50	49	El Salvador	5.7	5.8	11.5	1.6	2.3	3.9	24.1	29.0	53.1	5.2	6.4	11.6
51	51	Venezuela	0.5	9.7	10.3	0.1	3.5	3.5	4.1	31.6	35.7	3.6	36.7	40.3
52	40	Pakistan	0.6	8.6	9.2	0.2	7.8	7.9	74.4	4.5	78.9	53.5	4.1	57.6
53	47	Colombia	2.5	6.5	8.9	0.8	4.8	5.6	11.9	18.3	30.2	6.9	17.7	24.6
54	69	Egypt	2.1	6.6	8.8	0.3	0.4	0.7	30.9	30.5	61.4	8.8	15.4	24.2

Table A2.17 Ranking by technological structure of manufactured exports, 1985 and 1998 (percent) (continued)

Rank by share of medium- and high-tech in manufactured exports			Complex exports						Simple exports					
			1998			1985			1998			1985		
1998	1985	Economy	High tech	Medium tech	Medium and high tech	High tech	Medium tech	Medium and high tech	Low tech	Resource based	Low tech and resource based	Low tech	Resource based	Low tech and resource based
55	54	Kenya	1.6	6.0	7.6	0.7	2.4	3.2	11.8	23.8	35.6	4.3	28.1	32.5
56	57	Chile	0.7	5.6	6.3	0.1	2.2	2.4	3.7	34.3	37.9	0.7	29.7	30.4
57	67	Honduras	0.5	5.5	6.0	0.2	0.9	1.0	7.6	16.9	24.5	4.9	18.7	23.5
58	30	Oman	1.6	4.3	5.8	1.8	16.0	17.7	2.6	5.7	8.3	3.1	4.9	8.0
59	41	Bahrain	0.4	5.3	5.7	4.0	3.3	7.3	4.2	4.1	8.2	1.2	0.9	2.1
60	63	Saudi Arabia		5.2	5.2	—	1.6	1.6	1.5	18.0	19.5	0.4	13.7	14.1
61	61	Jordan	2.6	2.4	5.0	0.5	1.3	1.8	17.6	25.2	42.8	14.8	12.3	27.0
62	80	Bolivia	1.9	3.1	5.0	—	—	—	9.5	34.0	43.5	0.5	19.4	19.8
63	55	Peru	0.8	3.9	4.6	0.2	2.9	3.1	13.1	22.0	35.1	8.7	41.5	50.1
64	73	Ecuador	0.8	3.4	4.2	0.1	0.2	0.3	3.5	14.8	18.3	0.2	12.1	12.3
65	..	Albania	1.8	2.4	4.2	..	..	..	61.0	19.7	80.7	..	..	..
66	56	Panama	2.4	1.7	4.0	1.6	1.1	2.7	10.8	16.6	27.4	10.5	15.0	25.5
67	64	Sri Lanka	1.5	2.5	4.0	0.2	1.2	1.4	59.0	13.2	72.2	25.8	19.5	45.3
68	68	Nicaragua	0.8	3.1	3.9	0.2	0.5	0.7	2.8	19.2	22.0	0.5	6.3	6.8
69	65	Mozambique	1.1	2.3	3.4	0.3	0.8	1.1	2.7	19.1	21.8	17.1	22.9	40.0
70	62	Bangladesh	0.3	2.6	2.9	0.2	1.6	1.8	87.4	2.5	89.9	63.2	16.5	79.7
71	79	Paraguay	0.5	1.7	2.2	—	—	—	8.9	17.3	26.2	1.7	11.5	13.2
72	75	Nepal	0.1	1.7	1.9	0.0	0.2	0.2	74.1	2.3	76.4	53.9	11.7	65.6
73	77	Cameroon	0.1	1.7	1.8	0.1	0.1	0.2	2.6	20.3	23.0	0.5	10.2	10.7
74	66	Zambia	0.1	1.7	1.8	0.1	0.9	1.1	3.7	6.2	9.9	0.2	11.3	11.5
75	53	Jamaica	0.1	1.4	1.5	0.7	2.5	3.2	17.7	70.1	87.8	9.5	77.9	87.3
76	58	United Republic of Tanzania	1.1	0.4	1.5	0.6	1.6	2.3	3.2	11.9	15.1	3.9	10.7	14.6
77	78	Nigeria	—	1.4	1.5	—	—	0.1	1.0	0.1	1.1	0.1	1.3	1.4
78	52	Mauritius	0.2	1.2	1.4	0.1	3.3	3.4	64.8	28.0	92.8	40.0	46.2	86.2
79	45	Senegal	0.2	1.2	1.4	0.9	5.0	5.9	7.6	63.2	70.8	4.7	35.2	39.9
80	72	Malawi	—	0.9	1.0	—	0.5	0.5	5.8	7.3	13.1	3.8	13.3	17.1
81	59	Madagascar	0.3	0.6	0.9	1.2	0.8	2.0	21.1	18.7	39.9	6.4	9.7	16.1
82	74	Central African Republic	0.2	0.6	0.8	—	0.3	0.3	0.1	44.3	44.4	0.2	43.6	43.8
83	76	Uganda	0.1	0.7	0.8	0.2	—	0.2	1.8	0.6	2.4	0.1	0.2	0.4
84	71	Algeria	—	0.7	0.8	—	0.5	0.5	0.2	17.7	18.0	0.1	39.3	39.3
85	70	Ghana	—	0.1	0.1	0.2	0.5	0.6	0.5	22.1	22.5	0.2	21.7	21.8
86	..	Yemen	—	0.1	0.1	..	..	..	0.5	1.1	1.6	..	..	..
87	..	Ethiopia	—	—	0.1	..	..	..	10.8	3.6	14.4	..	..	..

Source: UNIDO Scoreboard database (see technical annex).

Table A2.18 Ranking by Harbison-Myers index of skills

Rank		Economy	Harbison-Myers Index	
1998	1985		1998	1985
1	2	Canada	62.05	39.50
2	18	Australia	50.55	24.20
3	1	United States	50.25	39.60
4	4	Finland	45.05	29.40
5	7	New Zealand	40.80	26.70
6	9	Belgium	38.95	26.25
7	12	Norway	38.85	25.85
8	8	Netherlands	38.35	26.60
9	28	United Kingdom	37.55	19.70
10	6	Korea, Republic of	36.10	26.80
11	16	France	35.90	24.65
12	10	Spain	34.85	26.25
13	15	Sweden	34.45	24.70
14	11	Denmark	34.30	25.95
15	19	Austria	32.80	24.00
16	14	Germany	31.65	24.95
17	..	Russian Federation	30.75	..
18	17	Japan	30.05	24.35
19	22	Ireland	29.90	22.30
20	25	Italy	29.10	20.45
21	20	Greece	28.55	22.95
22	13	Israel	28.35	25.40
23	21	Taiwan Province of China	27.80	22.48
24	41	Portugal	27.20	12.90
25	5	Argentina	26.75	27.80
26	..	Slovenia	25.05	..
27	24	Switzerland	25.00	20.95
28	32	Poland	23.30	16.90
29	37	Singapore	23.05	14.80
30	30	Peru	22.55	18.40
31	3	Uruguay	21.85	30.40
32	23	Philippines	21.60	21.25
33	36	Chile	21.00	15.90
34	34	Costa Rica	20.95	16.50
35	27	Panama	20.20	20.10
36	..	Bahrain	20	..
37	35	Czech Republic	20.00	16.30
38	31	Jordan	18.55	18.00
39	39	Hong Kong SAR	18.45	14.00
40	29	Venezuela	17.75	18.65
41	38	Hungary	17.65	14.60
42	46	South Africa	17.05	11.50
43	42	Romania	16.95	12.80
44	33	Egypt	16.45	16.80
45	48	Thailand	15.55	10.75
46	43	Colombia	15.30	12.55
47	26	Ecuador	15.00	20.25
48	44	Bolivia	14.80	12.00
49	50	Turkey	14.70	9.80
50	47	Saudi Arabia	13.45	11.10
51	40	Mexico	12.95	13.15
52	61	Tunisia	12.55	6.85
53	45	El Salvador	12.05	11.75
54	49	Algeria	11.65	10.20
55	51	Malaysia	11.10	9.20
56	57	Indonesia	10.35	8.30
57	52	Brazil	10.15	9.10
58	53	Sri Lanka	10.05	9.10
59	67	China	9.75	5.15
60	55	Jamaica	9.60	8.50
61	54	Morocco	9.55	8.60
62	56	Nicaragua	9.40	8.50
63	64	Mauritius	9.35	5.75
64	59	Paraguay	8.95	7.30
65	65	Oman	8.95	5.45
66	..	Albania	8.30	..
67	58	Honduras	8.20	7.60
68	62	Zimbabwe	8.15	6.70
69	60	India	8.10	7.10
70	63	Guatemala	6.55	6.40
71	66	Nepal	6.40	5.40
72	73	Nigeria	5.05	3.85
73	74	Yemen	4.45	3.85
74	68	Ghana	4.40	4.75
75	70	Cameroon	4.35	4.05
76	72	Bangladesh	4.30	3.95
77	69	Pakistan	4.10	4.40
78	77	Zambia	3.35	2.85
79	76	Senegal	3.30	2.95
80	75	Kenya	3.20	3.05
81	71	Madagascar	3.10	4.00
82	80	Uganda	1.95	1.75
83	79	Central African Republic	1.70	1.80
84	78	Ethiopia	1.45	1.95
85	81	Malawi	1.00	0.70
86	82	Mozambique	0.90	0.60
87	83	United Republic of Tanzania	0.75	0.55

Source: UNIDO Scoreboard database (see technical annex).

Note: The Harbison-Myers Index is the average of the percentage of the relevant age groups enroled in secondary and tertiary education, with tertiary enrolments given a weight of five.

Table A2.19 Ranking by tertiary enrolments in technical subjects, 1985 and 1998

Rank by tertiary technical enrolment as share of population			Share of population (percent)		Number (thousands of people)	
1998	1985	Economy	1998[a]	1985	1998[a]	1985
1	1	Korea, Republic of	1.65	0.78	742.5	320.7
2	2	Finland	1.33	1.00	68.0	49.2
3	..	Russian Federation	1.18	..	1,749.2	..
4	21	Australia	1.17	0.50	212.0	81.5
5	10	Taiwan Province of China	1.06	0.59	226.8	115.7
6	16	Spain	0.97	0.54	379.7	209.7
7	12	Ireland	0.91	0.58	32.6	20.7
8	23	Austria	0.78	0.50	63.0	37.5
9	11	Germany	0.77	0.58	631.1	454.1
10	17	United Kingdom	0.75	0.54	439.1	305.7
11	40	Portugal	0.73	0.26	72.6	26.2
12	8	Sweden	0.73	0.60	64.5	50.8
13	18	Chile	0.73	0.52	103.1	65.2
14	26	Greece	0.72	0.48	75.0	48.3
15	9	Canada	0.69	0.60	203.2	158.3
16	3	United States	0.68	0.75	1,792.9	1,822.6
17	13	New Zealand	0.68	0.57	24.8	18.8
18	30	Israel	0.68	0.45	37.4	19.8
19	20	Norway	0.67	0.51	29.3	21.2
20	32	Japan	0.64	0.41	808.2	501.6
21	33	Italy	0.64	0.40	364.0	224.9
22	15	France	0.61	0.56	355.1	311.1
23	19	Denmark	0.60	0.52	31.4	26.6
24	7	Panama	0.59	0.60	15.6	13.6
25	39	Netherlands	0.56	0.26	86.6	38.7
26	28	Philippines	0.55	0.47	387.3	271.5
27	..	Bahrain	0.52	..	3.0	..
28	34	Colombia	0.51	0.36	197.1	115.8
29	25	Switzerland	0.51	0.49	36.0	31.8
30	31	Romania	0.49	0.42	111.2	95.8
31	24	Hong Kong SAR	0.49	0.49	30.2	27.5
32	..	Slovenia	0.49	..	9.7	..
33	4	Singapore	0.47	0.71	14.1	18.1
34	5	Argentina	0.47	0.68	162.3	210.9
35	..	Czech Republic	0.46	..	47.9	..
36	29	Peru	0.46	0.47	108.2	94.9
37	14	Venezuela	0.45	0.56	97.9	102.0
38	27	Mexico	0.44	0.48	400.1	375.7
39	22	Belgium	0.43	0.50	43.6	49.4
40	35	Jordan	0.42	0.35	17.5	10.0
41	55	Algeria	0.41	0.13	115.1	29.8
42	43	Poland	0.39	0.23	151.9	85.9
43	37	Costa Rica	0.34	0.31	11.5	8.5
44	36	Bolivia	0.34	0.35	25.4	21.6
45	45	Turkey	0.33	0.22	198.3	114.1
46	42	Uruguay	0.29	0.25	9.3	7.6
47	6	Ecuador	0.29	0.66	32.7	63.2
48	38	El Salvador	0.26	0.28	15.0	13.8
49	41	Morocco	0.25	0.25	66.7	56.8
50	46	Tunisia	0.24	0.19	21.4	13.8
51	63	Indonesia	0.23	0.08	439.1	137.3
52	53	Nicaragua	0.22	0.14	9.7	4.9
53	47	Honduras	0.20	0.19	11.3	8.7
54	49	Thailand	0.19	0.16	110.5	81.8
55	48	Brazil	0.18	0.16	289.3	225.9
56	44	South Africa	0.17	0.22	68.1	68.9
57	56	Guatemala	0.17	0.12	17.0	9.3
58	57	Hungary	0.16	0.11	16.7	11.6
59	62	Malaysia	0.13	0.08	26.7	13.8
60	54	Saudi Arabia	0.12	0.13	23.4	18.5
61	52	Egypt	0.12	0.15	69.6	75.0
62	51	India	0.12	0.15	1,086.3	1,233.8
63	50	Paraguay	0.11	0.16	5.5	6.1
64	60	Jamaica	0.11	0.09	2.9	2.1
65	na	Albania	0.11	0.20	3.6	6.1
66	64	China	0.10	0.08	1,221.0	821.5
67	78	Zimbabwe	0.09	0.01	9.5	0.9
68	61	Sri Lanka	0.08	0.08	15.4	13.8
69	58	Bangladesh	0.08	0.09	90.0	97.9
70	66	Nepal	0.08	0.06	16.0	10.5
71	76	Cameroon	0.06	0.01	8.4	10.0
72	59	Madagascar	0.06	0.09	8.2	9.9
73	70	Nigeria	0.06	0.03	63.3	23.5
74	67	Senegal	0.05	0.05	4.4	3.6
75	69	Pakistan	0.05	0.03	63.4	28.5
76	68	Mauritius	0.04	0.04	0.5	0.4
77	65	Oman	0.04	0.07	0.9	1.0
78	73	Zambia	0.03	0.02	2.7	1.1
79	..	Yemen	0.02	0.01	3.2	1.3
80	71	Kenya	0.02	0.03	4.6	5.5
81	80	Mozambique	0.01	0.01	2.1	0.8
82	72	Uganda	0.01	0.02	2.5	2.7
83	81	Central African Republic	0.01	0.01	0.4	0.2
84	74	Ghana	0.01	0.01	2.1	1.9
85	77	United Republic of Tanzania	0.01	0.01	3.6	0.9
86	75	Ethiopia	0.01	0.01	6.5	5.9
87	79	Malawi	0.01	0.01	0.8	0.5

Source: UNIDO Scoreboard database (see technical annex).

Note: Ranking is based on tertiary technical enrolment as a percentage of the population. Technical subjects include pure science, mathematics and computing and engineering.

a 1998 or latest year available.

Table A2.20 Ranking by productive enterprise–financed research and development, 1985 and 1998

Rank by per capita R&D 1998	Rank by per capita R&D 1985	Economy	Per capita (dollars) 1998[a]	Per capita (dollars) 1985	Total value (billions of dollars) 1998[a]	Total value (billions of dollars) 1985	Share of GNP (percent) 1998[a]	Share of GNP (percent) 1985
1	2	Switzerland	859.9	203.3	6.05	1.32	1.85	1.29
2	3	Japan	858.4	192.3	107.68	23.22	2.08	1.72
3	5	Sweden	653.9	113.0	5.78	0.94	2.61	0.96
4	4	United States	465.9	153.7	122.44	36.57	1.74	0.90
5	1	Germany	418.1	255.5	34.13	19.85	1.42	1.56
6	12	Finland	413.4	53.8	2.11	0.26	1.75	0.50
7	6	Denmark	328.4	80.0	1.72	0.41	1.02	0.74
8	10	France	297.6	63.3	17.30	3.49	1.13	0.67
9	7	Norway	275.5	79.0	1.20	0.33	0.83	0.53
10	15	Belgium	272.7	36.8	2.76	0.36	1.02	0.46
11	8	Netherlands	258.8	78.3	4.00	1.13	1.01	0.89
12	11	Austria	214.4	58.8	1.72	0.44	0.75	0.67
13	23	Korea, Republic of	211.2	10.8	9.50	0.44	2.10	0.48
14	19	Singapore	198.4	14.5	0.59	0.04	0.69	0.20
15	14	United Kingdom	174.5	52.5	10.22	2.98	0.93	0.65
16	21	Ireland	152.8	14.1	0.55	0.05	0.99	0.28
17	22	Australia	148.0	12.0	2.67	0.19	0.79	0.12
18	9	Canada	143.7	66.9	4.22	1.73	0.78	0.51
19	13	Israel	134.0	52.9	0.74	0.22	0.82	0.90
20	16	Taiwan Province of China	122.5	33.3	2.61	0.62	0.99	0.60
21	18	Italy	90.1	18.7	5.16	1.06	0.48	0.25
22	—	Slovenia	73.3	—	0.15	—	0.77	—
23	24	Spain	55.2	8.8	2.16	0.34	0.39	0.21
24	17	New Zealand	50.7	25.8	0.19	0.08	0.33	0.40
25	—	Czech Republic	32.3	—	0.33	—	0.71	—
26	33	Portugal	14.1	1.1	0.14	0.01	0.14	0.05
27	34	Brazil	13.7	1.1	2.19	0.15	0.32	0.07
28	27	Greece	13.5	4.1	0.14	0.04	0.12	0.10
29	25	South Africa	12.8	5.9	0.50	0.18	0.38	0.35
30	20	Hungary	11.3	14.1	0.12	0.15	0.27	0.75
31	46	Argentina	8.5	—	0.29	—	0.11	—
32	26	Poland	8.3	4.6	0.32	0.17	0.27	0.25
33	46	Russian Federation	7.5	—	1.11	—	0.32	—
34	38	Malaysia	6.7	0.2	0.14	0.01	0.17	0.01
35	46	Costa Rica	5.5	—	0.02	—	0.20	—
36	31	Chile	5.3	1.5	0.07	0.02	0.12	0.13
37	32	Turkey	4.8	1.3	0.29	0.07	0.17	0.10
38	29	Romania	2.5	3.1	0.06	0.07	0.16	0.17
39	46	Venezuela	2.3	—	0.05	—	0.07	—
40	46	Hong Kong SAR	1.8	—	0.01	—	0.01	—
41	28	Mexico	1.5	3.3	0.14	0.25	0.05	0.14
42	46	Panama	1.4	—	—	—	0.05	—
43	46	Uruguay	1.1	—	—	—	0.02	—
44	46	China	0.9	—	1.10	—	0.16	—
45	41	Indonesia	0.8	0.1	0.15	0.01	0.08	0.01
46	36	India	0.4	0.4	0.40	0.30	0.12	0.14
47	—	Mauritius	0.3	—	0.01	—	0.01	—
48	39	Thailand	0.3	0.1	0.02	0.01	0.01	0.02
49	—	Egypt	0.2	—	0.01	—	0.02	—
50	—	Colombia	0.2	—	0.01	—	0.01	—
51	30	Jordan	0.2	1.9	—	—	0.01	0.10
52	—	Guatemala	0.1	—	0.01	—	0.01	—
53	—	Algeria	0.1	—	0.01	—	0.01	—
54	—	Saudi Arabia	0.1	—	0.01	—	—	—
55	—	Peru	0.1	—	0.01	—	0.01	—
56	—	Morocco	0.1	—	0.01	—	0.01	—
57	40	Philippines	0.1	0.1	0.01	—	0.01	0.01
58	—	Honduras	0.1	—	0.01	—	0.01	—
59	—	Nicaragua	0.1	—	0.01	—	0.01	—
60	—	Sri Lanka	0.1	—	0.01	—	—	—
61	—	Yemen	—	—	—	—	—	—

Table A2.20 Ranking by productive enterprise–financed research and development, 1985 and 1998 (continued)

Rank by per capita R&D 1998	Rank by per capita R&D 1985	Economy	Per capita (dollars) 1998[a]	Per capita (dollars) 1985	Total value (billions of dollars) 1998[a]	Total value (billions of dollars) 1985	Share of GNP (percent) 1998[a]	Share of GNP (percent) 1985
61	37	Tunisia	—	0.2	—	—	—	—
61	44	Malawi	—	—	—	—	—	—
61	43	Madagascar	—	—	—	—	—	—
61	42	Kenya	—	—	—	—	—	—
61	45	Jamaica	—	—	—	—	—	—
61	35	Ecuador	—	0.5	—	—	—	0.03
61	—	Albania	—	—	—	—	—	—
61	—	Bahrain	—	—	—	—	—	—
61	—	Bangladesh	—	—	—	—	—	—
61	—	Bolivia	—	—	—	—	—	—
61	—	Cameroon	—	—	—	—	—	—
61	—	Central African Republic	—	—	—	—	—	—
61	—	El Salvador	—	—	—	—	—	—
61	—	Ethiopia	—	—	—	—	—	—
61	—	Ghana	—	—	—	—	—	—
61	—	Mozambique	—	—	—	—	—	—
61	—	Nepal	—	—	—	—	—	—
61	—	Nigeria	—	—	—	—	—	—
61	—	Oman	—	—	—	—	—	—
61	—	Pakistan	—	—	—	—	—	—
61	—	Paraguay	—	—	—	—	—	—
61	—	Senegal	—	—	—	—	—	—
61	—	United Republic of Tanzania	—	—	—	—	—	—
61	—	Uganda	—	—	—	—	—	—
61	—	Zambia	—	—	—	—	—	—
61	—	Zimbabwe	—	—	—	—	—	—

Source: UNIDO Scoreboard database (see technical annex).
Note: All economies with negligible values are given the same rank.
a Data for 1998 or latest available year.

Table A2.21 Ranking by foreign direct investment inflows, 1981–1985 and 1993–1997

Rank by per capita foreign direct investment inflows			Per capita (dollars)		Total value (billions of dollars)		Share of gross domestic investment (percent)		Share of GDP (percent)	
1998	1985	Economy	1993–1997	1981–1985	1993–1997	1981–1985	1993–1997	1981–1985	1993–1997	1981–1985
1	1	Singapore	2,536.0	563.4	8.20	1.53	26.54	17.91	9.57	8.36
2	5	Belgium	1,116.2	120.7	10.58	1.84	24.16	7.60	3.91	..
3	18	Sweden	922.5	34.7	8.10	0.28	25.25	1.60	3.66	0.29
4	2	New Zealand	735.0	203.9	2.69	0.62	22.31	10.95	4.79	2.92
5	8	Hong Kong SAR	727.7	103.3	2.75	1.34	10.24	6.90	1.96	..
6	7	Netherlands	711.6	105.9	11.92	1.45	15.50	5.91	3.01	1.13
7	16	Norway	589.3	40.9	2.62	0.17	7.73	1.00	1.81	0.28
8	34	Denmark	551.8	15.2	2.99	0.07	9.60	0.69	1.78	0.13
9	3	Switzerland	529.8	140.0	4.47	0.56	6.60	2.24	1.37	0.55
10	13	Ireland	484.2	51.5	1.47	0.16	15.11	3.91	2.64	0.93
11	4	Australia	376.9	132.4	6.35	1.87	8.82	4.75	1.88	1.15
12	10	United Kingdom	367.6	76.6	20.91	4.13	12.07	5.60	1.90	0.90
13	17	France	362.1	39.4	22.89	2.10	8.59	2.01	1.49	0.40
14	21	Austria	304.6	27.5	2.65	0.20	4.80	1.30	1.15	0.31
15	12	Canada	292.8	69.2	8.06	1.78	8.08	2.56	1.49	0.53
16	9	United States	271.3	79.5	70.00	21.83	5.67	2.66	0.99	0.54
17	28	Finland	260.2	17.8	1.46	0.09	7.57	0.68	1.21	0.17
18	..	Hungary	236.1	..	2.39	..	23.57	..	5.58	..
19	11	Malaysia	229.5	73.6	4.63	1.10	14.10	10.91	5.73	3.81
20	24	Chile	229.4	19.3	3.38	0.13	20.23	6.74	5.26	0.92
21	23	Israel	191.1	19.8	1.11	0.08	5.08	1.53	1.22	0.33
22	35	Panama	189.0	14.1	0.46	0.03	20.74	3.46	6.13	0.59
23	15	Spain	182.3	46.5	7.65	1.71	6.77	5.07	1.38	1.04
24	30	Argentina	149.1	16.6	5.39	0.48	10.34	2.88	1.94	0.58
25	26	Portugal	149.0	18.8	1.53	0.17	6.32	2.91	1.54	0.76
26	..	Czech Republic	132.1	..	1.30	..	8.58	..	2.77	..
27	22	Costa Rica	110.4	22.8	0.37	0.07	15.94	7.04	4.18	1.80
28	31	Mexico	102.4	16.5	6.81	0.90	11.04	2.19	2.49	0.51
29	14	Greece	96.7	47.3	1.08	0.44	4.81	4.39	0.93	1.08
30	..	Slovenia	92.9	..	0.21	..	4.88	..	1.09	..
31	61	Peru	91.1	1.4	2.20	0.02	16.91	0.14	3.85	0.09
32	40	Venezuela	88.4	7.7	1.89	0.10	15.05	0.75	2.53	0.16
33	67	Poland	86.3	0.5	3.13	0.02	13.27	0.11	2.65	0.03
34	37	Germany	77.1	9.7	6.81	1.52	1.32	0.60	0.28	..
35	36	Taiwan Province of China	74.5	10.0	1.74	0.45	2.78	1.50	0.66	..
36	25	Italy	63.0	18.8	3.55	1.09	1.90	1.11	0.33	0.26
37	27	Colombia	62.2	18.6	1.98	0.44	11.29	6.19	2.54	1.33
38	79	Jamaica	58.7	–3.9	0.14	–0.01	10.59	–1.37	3.63	–0.29
39	33	Brazil	49.6	15.4	7.28	1.74	5.06	4.33	1.08	0.83
40	45	Bolivia	49.5	4.7	0.30	0.02	30.89	5.59	5.22	0.90
41	41	Ecuador	46.3	6.1	0.51	0.06	15.75	1.92	3.04	0.38
42	48	Uruguay	42.0	3.3	0.14	—	6.10	0.41	0.81	0.09
43	19	Tunisia	41.2	30.6	0.38	0.20	8.39	7.72	2.22	2.50
44	44	Paraguay	40.6	4.8	0.20	0.01	9.93	1.08	2.27	0.29
45	42	Thailand	38.0	5.6	2.45	0.28	4.07	2.49	1.48	0.72
46	6	Oman	37.3	111.2	0.07	0.15	3.43	6.40	0.63	1.72
47	51	South Africa	37.1	2.8	1.33	0.01	6.28	0.10	1.01	..
48	49	Korea, Republic of	36.8	2.9	1.61	0.13	0.99	0.47	0.36	0.14
49	65	China	30.1	0.8	37.81	0.93	13.54	0.87	5.51	0.31
50	47	Mauritius	25.7	3.4	0.03	—	2.65	1.46	0.74	0.32
51	..	Romania	20.6	..	0.51	..	6.21	..	1.44	..
52	62	Philippines	20.1	1.2	1.54	0.05	8.46	0.67	2.01	0.18
53	59	Indonesia	19.8	1.5	3.66	0.22	6.16	1.00	1.90	0.27
54	..	Albania	19.7	..	0.08	..	20.24	..	3.15	..
55	54	Morocco	19.4	2.4	0.51	0.04	7.72	1.34	1.63	0.35
56	..	Nicaragua	18.8	..	0.07	..	16.79	..	4.50	..
57	20	Jordan	16.1	28.3	0.07	0.07	3.84	3.99	1.01	1.42

Table A2.21 Ranking by foreign direct investment inflows, 1981–1985 and 1993–1997 (continued)

Rank by per capita foreign direct investment inflows 1998	1985	Economy	Per capita (dollars) 1993–1997	1981–1985	Total value (billions of dollars) 1993–1997	1981–1985	Share of gross domestic investment (percent) 1993–1997	1981–1985	Share of GDP (percent) 1993–1997	1981–1985
58	..	Russian Federation	15.4	..	1.98	..	2.52	..	0.56	..
59	39	Saudi Arabia	13.8	7.8	0.42	1.63	1.00	0.20	0.33	..
60	43	Nigeria	13.5	5.2	1.23	0.28	30.72	8.23	5.36	1.03
61	32	Egypt	13.3	15.5	0.78	0.75	7.83	8.43	1.32	2.38
62	58	Turkey	12.0	1.7	0.74	0.09	1.76	0.75	0.43	0.13
63	46	Honduras	11.2	3.9	0.06	0.02	4.92	3.12	1.57	0.48
64	53	Sri Lanka	10.6	2.7	0.19	0.05	5.91	2.99	1.49	0.83
65	38	Guatemala	9.0	9.6	0.09	0.07	4.20	5.68	0.64	0.78
66	66	Ghana	7.9	0.7	0.13	0.01	9.73	4.79	2.19	0.20
67	57	Yemen	7.3	1.9	0.14	0.01	12.03	1.90	2.11	..
68	52	Japan	7.1	2.8	1.07	0.37	0.07	0.10	0.02	0.03
69	50	Zambia	6.7	2.9	0.06	0.01	12.18	5.27	1.75	0.75
70	60	Senegal	6.6	1.5	0.06	0.01	7.58	2.53	1.34	0.34
71	77	Uganda	5.8	—	0.12	—	13.80	—	2.16	—
72	64	Pakistan	5.1	0.9	0.65	0.09	5.66	1.38	1.06	0.26
73	73	Zimbabwe	4.2	—	0.04	—	3.06	0.01	0.61	—
74	68	United Republic of Tanzania	3.3	0.4	0.09	—	9.20	0.30	1.77	..
75	72	Mozambique	3.1	—	0.02	—	10.24	0.23	1.88	0.01
76	56	El Salvador	2.1	2.0	0.01	0.01	0.71	2.22	0.14	0.25
77	71	India	2.1	0.1	1.64	0.06	2.16	0.12	0.51	0.03
78	80	Bahrain	1.7	–36.8	0.01	–0.08	0.76	–6.90	0.14	..
79	29	Cameroon	1.2	16.7	0.01	0.16	1.13	8.05	0.18	2.06
80	69	Madagascar	0.8	0.3	0.01	—	2.81	0.98	0.32	0.08
81	75	Nepal	0.6	—	0.01	—	1.18	0.03	0.28	0.01
82	63	Kenya	0.5	0.9	0.01	0.02	0.92	1.30	0.15	0.25
83	55	Central African Republic	0.4	2.2	—	0.01	3.02	8.50	0.20	0.78
84	78	Algeria	0.4	–0.4	0.01	–0.01	0.07	–0.05	0.02	–0.02
85	76	Bangladesh	0.3	—	0.03	—	0.44	—	0.09	—
86	70	Malawi	0.1	0.1	—	—	0.34	0.33	0.06	0.07
87	74	Ethiopia	0.1	—	0.01	—	0.58	0.08	0.09	0.01

Source: UNIDO Scoreboard database (see technical annex).

Note: Annual averages calculated for available figures within the periods 1981–1985 and 1993–1997.

Table A2.22 Ranking by royalty and licence payments abroad, 1985 and 1998

Rank by payments per capita			Per capita (dollars)		Total value (millions of dollars)		Share of GNP (percent)	
1998	1985	Economy	1998	1985	1998	1985	1998	1985
1	11	Ireland	1,683.1	21.3	6,235.8	75.6	8.998	0.432
2	1	Singapore	559.2	191.1	1,769.0	474.5	1.852	2.589
3	3	Netherlands	188.8	50.6	2,964.5	733.7	0.762	0.573
4	2	Hong Kong SAR	184.7	101.2	1,235.0	552.4	0.781	1.584
5	4	Switzerland	151.7	49.8	1,078.2	322.2	0.380	0.316
6	33	Malaysia	107.8	2.6	2,392.0	41.2	2.942	0.142
7	5	Belgium	107.7	42.5	1,099.2	419.3	0.424	0.529
8	7	Sweden	106.0	34.2	938.5	285.5	0.414	0.290
9	17	United Kingdom	103.7	14.2	6,122.7	807.3	0.484	0.176
10	16	Austria	100.4	15.2	810.9	114.8	0.374	0.174
11	10	Finland	79.8	23.7	411.4	116.1	0.329	0.221
12	13	Norway	76.9	18.5	341.0	77.0	0.224	0.124
13	12	Japan	70.8	18.8	8,947.3	2,270	0.219	0.168
14	6	New Zealand	70.4	36.6	266.9	119.7	0.482	0.567
15	8	Canada	68.4	31.3	2,073.2	812.1	0.357	0.241
16	19	Taiwan Province of China	65.0	9.3	1,419.0	172.0	0.527	0.168
17	15	Germany	59.6	15.7	4,893.4	1,216	0.224	0.096
18	9	Australia	53.8	24.9	1,009.7	392.6	0.261	0.241
19	20	Korea, Republic of	51.0	7.9	2,369.3	322.8	0.594	0.354
20	21	Spain	47.4	6.0	1,866.3	229.2	0.336	0.140
21	14	France	46.2	17.8	2,716.7	981.9	0.185	0.189
22	25	United States	41.8	4.9	11,292	1,170	0.143	0.029
23	22	Israel	35.2	5.9	209.6	24.9	0.217	0.100
24	30	Portugal	29.1	3.3	290.0	33.2	0.273	0.150
25	..	Hungary	21.2	..	214.6	..	0.470	..
26	23	Italy	20.1	5.9	1,154.9	331.8	0.100	0.079
27	..	Slovenia	19.5	..	38.6	.	0.199	..
28	37	Thailand	13.1	0.9	804.0	45.5	0.610	0.119
29	18	Argentina	11.7	13.9	422.0	420.0	0.145	0.502
30	39	Jamaica	11.6	0.8	30.0	1.9	0.667	0.104
31	..	Czech Republic	10.9	..	112.6	..	0.213	..
32	31	Denmark	8.5	3.3	45.3	16.8	0.026	0.030
33	47	Brazil	6.5	0.2	1,075.0	30.0	0.140	0.014
34	27	Egypt	6.4	4.1	392.0	189.4	0.495	0.603
35	24	Panama	6.4	5.2	17.6	11.2	0.212	0.215
36	43	Morocco	6.2	0.5	171.5	11.6	0.498	0.096
37	29	Costa Rica	6.1	3.6	21.5	9.6	0.219	0.264
38	26	Ecuador	5.6	4.6	68.0	42.0	0.370	0.284
39	40	Greece	5.5	0.8	58.0	8.0	0.047	0.020
40	36	Mexico	5.2	1.9	501.0	142.0	0.136	0.081
41	38	Poland	5.0	0.9	195.0	32.4	0.129	0.047
42	34	Indonesia	4.9	2.4	1,002.0	385.0	0.767	0.465
43	28	South Africa	4.0	3.8	165.4	120.3	0.121	0.229
44	35	Chile	3.8	1.9	56.0	23.0	0.076	0.160
45	49	Peru	3.2	0.2	80.0	4.0	0.132	0.023
46	45	Philippines	2.1	0.3	158.0	17.0	0.200	0.057
47	50	Turkey	1.9	0.2	124.0	9.7	0.062	0.014
48	32	Uruguay	1.8	3.0	6.0	8.9	0.030	0.204
49	53	Kenya	1.3	0.1	39.9	1.8	0.391	0.031
50	48	Colombia	1.3	0.2	54.0	7.0	0.054	0.021
51	46	El Salvador	1.1	0.3	6.9	1.4	0.061	0.038
52	55	Romania	0.9	0.16	21.0	1.4	0.069	0.003
53	42	Honduras	0.8	0.5	5.1	2.3	0.111	0.065
54	61	Madagascar	0.6	—	9.8	0.1	0.264	0.005
55	44	Bolivia	0.6	0.4	5.2	2.5	0.065	0.092
56	41	Zimbabwe	0.5	0.6	6.0	4.8	0.084	0.110
57	64	China	0.3	—	420.0	11.0	0.045	0.004
58	51	Tunisia	0.2	0.2	2.6	1.2	0.014	0.015
59	57	Senegal	0.2	—	2.2	0.2	0.047	0.009
60	58	India	0.2	—	200.8	25.1	0.047	0.012
61	54	Pakistan	0.1	0.1	19.7	6.7	0.032	0.020

Table A2.22 Ranking by royalty and licence payments abroad, 1985 and 1998 (continued)

Rank by payments per capita		Economy	Per capita (dollars)		Total value (millions of dollars)		Share of GNP (percent)	
1998	1985		1998	1985	1998	1985	1998	1985
62	..	United Republic of Tanzania	0.1	..	4.7	..	0.065	..
63	62	Paraguay	0.1	—	0.5	—	0.006	0.001
64	52	Cameroon	0.1	0.2	1.0	1.6	0.012	0.021
65	63	Bangladesh	—	—	5.1	1.2	0.012	0.007
65	..	Russian Federation	—	..	2.0	..	0.001	..
65	..	Albania	—	..	—	..	—	..
65	56	Algeria	—	—	—	—	—	—
65	..	Bahrain	—	..	—	..	—	..
65	—	Central African Republic	—	—	—	1.2	—	0.142
65	—	Ethiopia	—	—	—	—	—	—
65	60	Ghana	—	—	—	—	—	—
65	—	Guatemala	—	—	—	—	—	—
65	—	Jordan	—	—	—	0.2	—	0.004
65	—	Malawi	—	—	—	—	—	—
65	—	Mauritius	—	—	—	—	—	—
65	—	Mozambique	—	—	—	—	—	—
65	—	Nepal	—	—	—	—	—	—
65	—	Nicaragua	—	—	—	—	—	—
65	59	Nigeria	—	0.03	—	—	—	—
65	—	Oman	—	—	—	—	—	—
65	—	Saudi Arabia	—	—	—	2.2	—	0.002
65	—	Sri Lanka	—	—	—	—	—	—
65	—	Uganda	—	—	—	—	—	—
65	—	Venezuela	—	—	—	—	—	—
65	—	Yemen	—	..	—	..	—	..
65	—	Zambia	—	—	—	—	—	—

Source: UNIDO Scoreboard database (see technical annex).

Note: Some values are interpolated (see technical annex). All economies with negligible data are given the same rank.

Table A2.23 Ranking by modern physical infrastructure, 1985 and 1998 (number of telephone mainlines)

Rank by lines per 1,000 people 1998	1985	Economy	Per 1,000 people 1998	1985	Total number (thousands) 1998	1985
1	2	Switzerland	675.4	501.6	4,799.3	3,245.4
2	1	Sweden	673.7	627.8	5,963.3	5,242.5
3	4	United States	661.3	486.4	178,751	115,721
4	7	Norway	660.1	423.2	2,925.7	1,757.7
5	3	Denmark	659.7	497.3	3,497.0	2,543.3
6	5	Canada	633.9	481.1	19,206	12,481
7	10	Netherlands	593.1	401.8	9,310.6	5,823.5
8	8	France	569.7	416.6	33,524	22,983
9	9	Germany	566.8	416.1	46,505	32,330
10	16	Singapore	562.0	324.3	1,777.9	805.3
11	17	Hong Kong SAR	557.7	323.4	3,729.2	1,764.4
12	14	United Kingdom	556.9	374.0	32,889	21,200
13	6	Finland	553.9	446.6	2,854.5	2,189.0
14	18	Greece	522.2	313.8	5,491.1	3,116.8
15	12	Australia	512.1	391.9	9,601.4	6,175.1
16	13	Japan	502.7	375.2	63,540	45,300
17	19	Belgium	500.3	307.6	5,104.6	3,032.4
18	15	Austria	491.0	361.1	3,966.1	2,728.3
19	11	New Zealand	479.1	395.8	1,816.8	1,294.8
20	21	Israel	471.1	278.8	2,809.1	1,180.0
21	20	Italy	450.7	304.5	25,954	17,233
22	24	Ireland	434.7	198.6	1,610.4	703.0
23	26	Korea, Republic of	432.7	159.7	20,088	6,517.5
24	23	Taiwan Province of China	420.1	228.5	9,174.8	4,228.0
25	22	Spain	413.7	242.6	16,288	9,317.0
26	27	Portugal	413.5	145.3	4,121.4	1,454.4
27	28	Slovenia	374.8	145.2	742.9	286.5
28	29	Czech Republic	363.9	129.3	3,746.2	1,336.2
29	38	Hungary	335.9	69.8	3,396.8	738.8
30	47	Turkey	254.1	44.4	16,125	2,231.1
31	31	Uruguay	250.4	95.8	823.5	288.1
32	25	Bahrain	245.5	167.4	157.8	71.1
33	40	Poland	227.6	66.9	8,800.4	2,487.5
34	48	Mauritius	213.7	39.0	247.8	39.6
35	46	Chile	205.5	44.5	3,045.8	535.8
36	32	Argentina	202.7	89.9	7,323.6	2,723.0
37	41	Malaysia	197.6	61.5	4,383.7	963.6
38	30	Russian Federation	196.6	102.6	28,879	14,758
39	42	Colombia	173.5	57.3	7,078.7	1,812.8
40	34	Costa Rica	171.8	79.5	605.9	209.9
41	49	Jamaica	165.7	33.2	426.8	76.7
42	33	Romania	162.4	87.6	3,653.4	1,990.2
43	35	Panama	151.3	77.6	418.3	168.1
44	36	Saudi Arabia	142.6	71.6	2,957.8	886.6
45	44	Brazil	120.5	53.3	19,989	7,211.2
46	37	Venezuela	116.7	70.8	2,712	1,213.5
47	39	South Africa	114.6	68.4	4,743	2,141.2
48	45	Mexico	103.6	49.5	9,928.7	3,739.1
49	50	Oman	92.3	29.6	212.6	41.3
50	43	Jordan	85.5	55.9	390.2	147.9
51	62	Thailand	83.5	12.3	5,112.8	630.8
52	52	Tunisia	80.6	26.4	752.2	191.6
53	57	El Salvador	80.0	19.1	484.7	91.1
54	51	Ecuador	78.3	29.5	953.0	268.5
55	77	China	69.6	3.0	86,230	3,120.0
56	53	Bolivia	68.8	26.2	547.1	154.4
57	55	Peru	66.7	21.2	1,654.8	412.3
58	58	Egypt	60.2	18.5	3,696.1	860.4
59	56	Paraguay	55.3	20.9	288.4	75.4
60	64	Morocco	54.4	11.0	1,509.9	238.6
61	54	Algeria	53.2	24.5	1,591.5	536.9
62	59	Guatemala	40.8	16.1	441.1	124.6
63	65	Honduras	38.1	11.0	234.8	45.9
64	66	Philippines	37.0	9.3	2,782.6	510.3
65	60	Nicaragua	31.3	13.4	150.3	45.7
66	63	Albania	30.5	11.2	101.9	33.2
67	70	Sri Lanka	28.4	5.4	532.7	86.2
68	73	Indonesia	27.0	3.7	5,499.9	598.9
69	72	India	22.0	4.1	21,538	3,174.7
70	71	Pakistan	19.4	4.6	2,549.8	440.2
71	61	Zimbabwe	17.3	12.5	201.6	103.7
72	74	Senegal	15.5	3.5	140.1	22.2
73	67	Yemen	13.4	7.0	221.9	70.9
74	69	Kenya	9.2	5.9	269.9	117.6
75	68	Zambia	8.8	6.4	85.5	42.7
76	86	Nepal	8.5	1.2	194.0	20.1
77	76	Ghana	7.5	3.0	138.9	37.6
78	75	Cameroon	5.4	3.0	77.2	29.9
79	78	Mozambique	4.0	2.8	67.6	37.4
80	80	Nigeria	3.8	2.5	462.1	204.3
81	81	United Republic of Tanzania	3.8	2.4	121.9	52.0
82	79	Malawi	3.5	2.7	36.6	19.7
83	85	Bangladesh	3.0	1.5	380.6	150.6
84	83	Madagascar	2.9	2.2	42.1	22.5
85	84	Uganda	2.8	1.7	57.9	24.4
86	82	Ethiopia	2.8	2.3	168.6	100.7
87	87	Central African Republic	2.7	1.0	9.5	2.6

Source: UNIDO Scoreboard database (see technical annex).

Table A2.24 Ranking by traditional physical infrastructure, 1985 and 1998 (kilograms of oil equivalent)

Rank		Economy	Commercial energy use per capita		Rank		Economy	Commercial energy use per capita	
1998	1985		1998	1985	1998	1985		1998	1985
1	..	Bahrain	13,688	..	45	37	Jordan	1,080.7	1,067.3
2	18	Singapore	8,660.5	3,147.8	46	43	Brazil	1,051.0	605.9
3	1	United States	8,075.6	7,448.8	47	50	China	907.0	491.9
4	2	Canada	7,929.9	7,447.7	48	39	Algeria	904.3	868.2
5	4	Finland	6,435.0	5,338.2	49	48	Uruguay	882.8	504.3
6	3	Sweden	5,868.6	5,700.0	50	51	Zimbabwe	865.5	391.4
7	9	Belgium	5,610.9	4,532.7	51	49	Panama	856.2	501.2
8	5	Norway	5,500.8	4,894.3	52	63	Paraguay	824.2	173.3
9	6	Australia	5,483.8	4,690.4	53	53	Costa Rica	768.8	347.1
10	11	Saudi Arabia	4,906.3	4,217.5	54	44	Colombia	761.2	544.7
11	10	Netherlands	4,799.8	4,251.9	55	67	Nigeria	753.3	148.2
12	16	New Zealand	4,434.6	3,467.5	56	47	Tunisia	738.5	515.3
13	7	Germany	4,231.4	4,627.8	57	45	Ecuador	713.2	529.5
14	13	France	4,223.6	3,628.7	58	62	Indonesia	692.5	220.5
15	20	Japan	4,083.5	3,039.5	59	61	El Salvador	690.8	234.2
16	..	Russian Federation	4,018.8	..	60	46	Egypt	655.9	527.0
17	12	Denmark	3,994.3	3,895.0	61	59	Zambia	634.0	236.6
18	8	Czech Republic	3,937.8	4,613.0	62	52	Peru	620.7	380.7
19	14	United Kingdom	3,863.4	3,581.7	63	57	Nicaragua	550.9	295.3
20	29	Korea, Republic of	3,834.5	1,913.5	64	55	Bolivia	547.7	312.5
21	15	Switzerland	3,698.9	3,544.5	65	66	Guatemala	535.6	151.6
22	19	Austria	3,439.1	3,071.9	66	68	Honduras	531.6	145.1
23	24	Ireland	3,411.9	2,519.2	67	58	Philippines	520.2	259.2
24	27	Taiwan Province of China	3,251.4	2,145.2	68	71	Kenya	494.1	100.6
25	..	Slovenia	3,212.6	..	69	65	India	479.1	169.8
26	28	Israel	3,014.2	1,938.6	70	77	Mozambique	460.9	37.7
27	32	Oman	3,003.1	1,736.6	71	78	United Republic of Tanzania	455.3	35.2
28	25	Italy	2,839.1	2,394.4	72	64	Pakistan	442.3	173.1
29	31	Spain	2,729.4	1,868.5	73	54	Mauritius	427.0	345.5
30	17	Poland	2,720.7	3,400.7	74	69	Cameroon	413.4	126.2
31	23	South Africa	2,636.3	2,579.5	75	72	Sri Lanka	385.9	88.7
32	26	Venezuela	2,525.8	2,149.8	76	73	Ghana	383.4	77.8
33	21	Hungary	2,492.5	2,809.1	77	60	Morocco	339.6	236.6
34	30	Greece	2,434.6	1,868.9	78	82	Nepal	320.8	14.5
35	38	Malaysia	2,237.2	970.7	79	..	Albania	317.2	..
36	34	Hong Kong SAR	2,171.8	1,373.0	80	70	Senegal	315.0	123.3
37	36	Portugal	2,051.3	1,140.0	81	81	Ethiopia	286.7	16.7
38	22	Romania	1,956.9	2,791.9	82	..	Yemen	207.9	..
39	35	Argentina	1,729.9	1,297.3	83	76	Bangladesh	196.8	40.3
40	42	Chile	1,573.8	611.2	84	75	Madagascar	56.2	40.5
41	41	Jamaica	1,551.7	699.7	85	74	Malawi	46.3	42.2
42	33	Mexico	1,501.1	1,487.2	86	79	Central African Republic	42.1	33.1
43	56	Thailand	1,319.5	304.5	87	80	Uganda	27.6	25.0
44	40	Turkey	1,140.2	773.1					

Source: UNIDO Scoreboard database (see technical annex).

Table A3.1 Ranking of economies by basic indicators of industrial performance and by composite index of competitive industrial performance, 1998

Rank	Economy	Manufacturing value added per capita index (a)	Economy	(a)+ Manufactured exports per capita index (b)	Economy	(b)+ Share of medium- and high-tech activities in manufacturing value added index (c)	Economy	(c)+ Share of medium-tech and high-tech products in manufactured exports—final index (d)
1	Switzerland	1	Singapore	0.871	Singapore	0.872	Singapore	0.883
2	Japan	0.852	Ireland	0.663	Ireland	0.775	Switzerland	0.751
3	Ireland	0.847	Switzerland	0.661	Switzerland	0.743	Ireland	0.739
4	Singapore	0.743	Belgium	0.497	Japan	0.595	Japan	0.696
5	Germany	0.705	Japan	0.471	Germany	0.576	Germany	0.632
6	Finland	0.668	Finland	0.455	Finland	0.513	United States	0.564
7	United States	0.637	Sweden	0.447	Sweden	0.510	Sweden	0.562
8	Sweden	0.637	Germany	0.443	United States	0.483	Finland	0.538
9	Austria	0.624	Austria	0.413	Belgium	0.467	Belgium	0.495
10	Denmark	0.574	Denmark	0.392	Denmark	0.428	United Kingdom	0.473
11	France	0.572	Netherlands	0.373	Austria	0.402	France	0.465
12	Belgium	0.534	France	0.355	France	0.380	Austria	0.453
13	United Kingdom	0.502	United States	0.350	United Kingdom	0.372	Denmark	0.443
14	Italy	0.490	United Kingdom	0.314	Netherlands	0.366	Netherlands	0.429
15	Netherlands	0.475	Italy	0.306	Canada	0.350	Taiwan Province of China	0.412
16	Norway	0.457	Canada	0.292	Norway	0.315	Canada	0.407
17	Canada	0.419	Norway	0.281	Italy	0.303	Italy	0.384
18	Taiwan Province of China	0.402	Taiwan Province of China	0.275	Taiwan Province of China	0.298	Korea, Republic of	0.370
19	Portugal	0.316	Israel	0.213	Korea, Republic of	0.237	Spain	0.319
20	Spain	0.315	Slovenia	0.207	Australia	0.222	Israel	0.301
21	New Zealand	0.313	Portugal	0.194	Israel	0.212	Norway	0.301
22	Israel	0.312	Spain	0.194	Spain	0.210	Malaysia	0.278
23	Australia	0.299	New Zealand	0.182	New Zealand	0.189	Mexico	0.246
24	Slovenia	0.284	Australia	0.167	Slovenia	0.181	Czech Republic	0.243
25	Korea, Republic of	0.253	Korea, Republic of	0.166	Portugal	0.157	Philippines	0.241
26	Czech Republic	0.193	Hong Kong SAR	0.137	Hong Kong SAR	0.121	Portugal	0.240
27	Bahrain	0.189	Czech Republic	0.136	Czech Republic	0.110	Hungary	0.239
28	Argentina	0.177	Bahrain	0.105	Malaysia	0.103	Slovenia	0.221
29	Hong Kong SAR	0.169	Malaysia	0.101	Bahrain	0.095	Australia	0.211
30	Uruguay	0.134	Argentina	0.094	Argentina	0.090	Hong Kong SAR	0.204
31	Hungary	0.113	Hungary	0.087	Hungary	0.077	New Zealand	0.186
32	Malaysia	0.112	Uruguay	0.074	Greece	0.063	Thailand	0.172
33	Greece	0.111	Mexico	0.067	Mexico	0.058	Brazil	0.149
34	Brazil	0.109	Greece	0.067	Brazil	0.058	Poland	0.143
35	Mexico	0.102	Mauritius	0.065	Uruguay	0.056	Argentina	0.140
36	Poland	0.093	Brazil	0.058	Chile	0.048	Costa Rica	0.129
37	Chile	0.089	Poland	0.056	Mauritius	0.048	China	0.126
38	Mauritius	0.088	Chile	0.051	Turkey	0.048	Turkey	0.108
39	Turkey	0.083	Costa Rica	0.048	Thailand	0.045	South Africa	0.108
40	Russian Federation	0.079	Turkey	0.047	Poland	0.044	Greece	0.102
41	Venezuela	0.072	Saudi Arabia	0.047	Saudi Arabia	0.041	Romania	0.095
42	Saudi Arabia	0.072	Thailand	0.046	Costa Rica	0.038	Bahrain	0.089
43	Peru	0.069	Russian Federation	0.042	Venezuela	0.038	Uruguay	0.087
44	Thailand	0.069	Venezuela	0.041	South Africa	0.037	Russian Federation	0.077
45	South Africa	0.066	South Africa	0.038	Russian Federation	0.036	Tunisia	0.068
46	Costa Rica	0.066	Peru	0.036	Romania	0.030	Venezuela	0.060
47	Romania	0.055	Romania	0.033	Peru	0.027	Chile	0.056
48	El Salvador	0.050	Tunisia	0.031	Tunisia	0.027	Guatemala	0.056
49	Tunisia	0.046	Jamaica	0.029	Jamaica	0.024	Indonesia	0.054
50	Jamaica	0.044	El Salvador	0.027	El Salvador	0.021	India	0.054
51	Ecuador	0.042	Oman	0.023	Oman	0.019	Zimbabwe	0.052
52	Egypt	0.038	Ecuador	0.022	Colombia	0.018	El Salvador	0.051
53	Colombia	0.038	Colombia	0.020	China	0.017	Morocco	0.048

Table A3.1 Ranking of economies by basic indicators of industrial performance and by composite index of competitive industrial performance, 1998 (continued)

Rank	Economy	Manufacturing value added per capita index (a)	Economy	(a)+ Manufactured exports per capita index (b)	Economy	(b)+ Share of medium- and high-tech activities in manufacturing value added index (c)	Economy	(c)+ Share of medium-tech and high-tech products in manufactured exports—final index (d)
54	Oman	0.034	Egypt	0.020	Ecuador	0.016	Saudi Arabia	0.047
55	China	0.034	China	0.019	Egypt	0.015	Colombia	0.041
56	Panama	0.032	Panama	0.017	Philippines	0.015	Mauritius	0.041
57	Paraguay	0.029	Philippines	0.017	Panama	0.013	Egypt	0.038
58	Guatemala	0.028	Guatemala	0.016	Guatemala	0.013	Peru	0.035
59	Morocco	0.025	Paraguay	0.015	Morocco	0.012	Oman	0.032
60	Philippines	0.022	Morocco	0.014	Jordan	0.012	Pakistan	0.031
61	Jordan	0.022	Jordan	0.012	Albania	0.011	Ecuador	0.025
62	Albania	0.021	Bolivia	0.011	Paraguay	0.011	Kenya	0.025
63	Bolivia	0.020	Albania	0.011	Algeria	0.009	Jordan	0.024
64	Algeria	0.018	Algeria	0.010	Indonesia	0.009	Honduras	0.023
65	Honduras	0.016	Sri Lanka	0.009	Bolivia	0.008	Jamaica	0.022
66	Sri Lanka	0.014	Honduras	0.009	Sri Lanka	0.007	Panama	0.022
67	Indonesia	0.013	Indonesia	0.008	Nicaragua	0.007	Bolivia	0.021
68	Senegal	0.009	Zimbabwe	0.005	Honduras	0.006	Albania	0.021
69	Zimbabwe	0.008	Senegal	0.005	Zimbabwe	0.006	Sri Lanka	0.017
70	Pakistan	0.008	Pakistan	0.005	Senegal	0.004	Nicaragua	0.017
71	Nicaragua	0.007	Nicaragua	0.004	India	0.004	Paraguay	0.015
72	India	0.007	Cameroon	0.004	Pakistan	0.004	Mozambique	0.013
73	Cameroon	0.007	India	0.004	Mozambique	0.004	Bangladesh	0.011
74	Nigeria	0.007	Bangladesh	0.004	Cameroon	0.003	Algeria	0.009
75	Bangladesh	0.006	Nigeria	0.003	Bangladesh	0.003	Cameroon	0.008
76	Zambia	0.004	Kenya	0.002	Nigeria	0.002	Senegal	0.008
77	Kenya	0.003	Zambia	0.002	Zambia	0.002	Zambia	0.007
78	Yemen	0.003	Yemen	0.002	Kenya	0.002	Nigeria	0.006
79	Madagascar	0.002	Central African Republic	0.001	Yemen	0.002	Nepal	0.006
80	Central African Republic	0.002	Madagascar	0.001	Central African Republic	0.001	United Republic of Tanzania	0.005
81	Uganda	0.002	Uganda	0.001	Madagascar	0.001	Malawi	0.003
82	Mozambique	0.002	Mozambique	0.001	Malawi	0.001	Madagascar	0.003
83	Malawi	0.002	Malawi	0.001	Uganda	0.001	Central African Republic	0.003
84	Nepal	0.001	Nepal	0.001	Ghana	0.001	Uganda	0.003
85	United Republic of Tanzania	0.001	United Republic of Tanzania	0.001	Nepal	0.001	Yemen	0.001
86	Ghana	0.000	Ghana	0.000	United Republic of Tanzania	0.000	Ghana	0.001
87	Ethiopia	0.000	Ethiopia	0.000	Ethiopia	0.000	Ethiopia	0.000

Source: UNIDO Scoreboard data set (see technical annex).

Note: Ranking is based on individual indicators contained in detailed annex tables for chapter 2. Column b is the average of a and b, c is the average of b and c and d is the average of all individual indices (the final CIP index).

Table A3.2 Ranking of economies by basic indicators of industrial performance and by composite index of competitive industrial performance, 1985

Rank	Economy	Manufacturing value added per capita index (a)	Economy	(a)+ Manufactured exports per capita index (b)	Economy	(b)+ Share of medium- and high-tech activities in manufacturing value added index (c)	Economy	(c)+ Share of medium-tech and high-tech products in manufactured exports—final index (d)
1	Switzerland	1	Switzerland	0.760	Switzerland	0.840	Switzerland	0.808
2	United States	0.873	Singapore	0.717	Japan	0.633	Japan	0.725
3	Japan	0.851	Sweden	0.562	Sweden	0.627	Germany	0.635
4	Sweden	0.673	Belgium	0.521	Singapore	0.616	Sweden	0.633
5	Germany	0.655	Japan	0.518	Germany	0.592	United States	0.599
6	Finland	0.645	Finland	0.490	United States	0.551	Singapore	0.587
7	Canada	0.585	United States	0.481	Finland	0.523	Finland	0.494
8	France	0.539	Germany	0.466	Belgium	0.491	Belgium	0.489
9	Austria	0.529	Canada	0.451	Canada	0.448	Canada	0.474
10	Norway	0.491	Netherlands	0.431	Denmark	0.420	France	0.450
11	Denmark	0.484	Austria	0.402	Netherlands	0.401	Austria	0.445
12	Italy	0.484	Denmark	0.401	Austria	0.401	United Kingdom	0.426
13	Belgium	0.457	France	0.368	France	0.397	Denmark	0.424
14	United Kingdom	0.449	Norway	0.368	United Kingdom	0.378	Netherlands	0.398
15	Australia	0.437	Hong Kong SAR	0.362	Norway	0.377	Ireland	0.379
16	Singapore	0.434	Italy	0.328	Ireland	0.340	Italy	0.379
17	Netherlands	0.403	Ireland	0.324	Italy	0.323	Norway	0.348
18	New Zealand	0.387	United Kingdom	0.310	Hong Kong SAR	0.291	Hong Kong SAR	0.320
19	Ireland	0.345	Taiwan Province of China	0.265	Australia	0.259	Taiwan Province of China	0.292
20	Hong Kong SAR	0.341	Australia	0.249	Israel	0.246	Israel	0.290
21	Taiwan Province of China	0.325	New Zealand	0.235	Taiwan Province of China	0.243	Spain	0.259
22	Spain	0.297	Israel	0.210	New Zealand	0.223	Korea, Republic of	0.247
23	Israel	0.250	Spain	0.184	Spain	0.190	Australia	0.214
24	Romania	0.224	Bahrain	0.153	Korea, Republic of	0.130	New Zealand	0.188
25	Bahrain	0.224	Korea, Republic of	0.132	Argentina	0.120	Poland	0.176
26	Argentina	0.222	Venezuela	0.128	Portugal	0.108	Portugal	0.159
27	Venezuela	0.203	Portugal	0.126	Bahrain	0.102	Brazil	0.140
28	Portugal	0.182	Argentina	0.119	Venezuela	0.099	Mexico	0.125
29	Korea, Republic of	0.171	Romania	0.112	Romania	0.096	Argentina	0.122
30	Hungary	0.167	Poland	0.092	Hungary	0.094	Malaysia	0.116
31	Poland	0.160	Saudi Arabia	0.092	Brazil	0.088	Bahrain	0.099
32	Greece	0.140	Greece	0.092	Greece	0.080	South Africa	0.096
33	Saudi Arabia	0.140	Hungary	0.088	Poland	0.077	Greece	0.093
34	Brazil	0.130	Malaysia	0.083	Saudi Arabia	0.077	Hungary	0.088
35	Mexico	0.126	Brazil	0.073	Malaysia	0.067	Venezuela	0.085
36	Uruguay	0.118	Mexico	0.070	Mexico	0.062	Turkey	0.082
37	Malaysia	0.093	Uruguay	0.069	South Africa	0.059	Romania	0.072
38	South Africa	0.093	South Africa	0.057	Uruguay	0.057	Zimbabwe	0.071
39	Ecuador	0.084	Mauritius	0.049	Costa Rica	0.037	Oman	0.069
40	Costa Rica	0.083	Costa Rica	0.048	Algeria	0.037	Tunisia	0.064
41	Panama	0.075	Algeria	0.045	Peru	0.036	Saudi Arabia	0.063
42	Algeria	0.066	Ecuador	0.045	Mauritius	0.035	Uruguay	0.062
43	Turkey	0.061	Panama	0.040	Turkey	0.034	Thailand	0.058
44	Guatemala	0.057	Turkey	0.038	Panama	0.032	Costa Rica	0.053
45	Peru	0.056	Jamaica	0.036	Ecuador	0.032	Philippines	0.044
46	Nicaragua	0.054	Chile	0.033	Chile	0.030	Morocco	0.038
47	Chile	0.054	Peru	0.033	Jamaica	0.030	Mauritius	0.037
48	Colombia	0.053	Guatemala	0.030	Nicaragua	0.024	Peru	0.037
49	El Salvador	0.050	Tunisia	0.029	Tunisia	0.023	Colombia	0.035
50	Jordan	0.049	Jordan	0.029	Colombia	0.023	India	0.034
51	Mauritius	0.045	Colombia	0.029	Guatemala	0.022	Panama	0.032
52	Jamaica	0.044	Nicaragua	0.028	Jordan	0.021	Jamaica	0.032
53	Paraguay	0.044	El Salvador	0.026	El Salvador	0.020	Chile	0.030

Table A3.2 **Ranking of economies by basic indicators of industrial performance and by composite index of competitive industrial performance, 1985 (continued)**

Rank	Economy	Manufacturing value added per capita index (a)	Economy	(a)+ Manufactured exports per capita index (b)	Economy	(b)+ Share of medium- and high-tech activities in manufacturing value added index (c)	Economy	(c)+ Share of medium-tech and high-tech products in manufactured exports— final index (d)
54	Tunisia	0.043	Thailand	0.025	Thailand	0.020	Algeria	0.029
55	Thailand	0.041	Oman	0.024	Oman	0.018	Pakistan	0.028
56	Oman	0.040	Paraguay	0.023	Paraguay	0.017	Guatemala	0.028
57	Philippines	0.035	Philippines	0.020	Zimbabwe	0.017	El Salvador	0.027
58	Egypt	0.032	Zimbabwe	0.018	Philippines	0.015	Ecuador	0.025
59	Bolivia	0.032	Bolivia	0.018	Morocco	0.013	Senegal	0.023
60	Zimbabwe	0.030	Morocco	0.017	Egypt	0.013	Jordan	0.022
61	Honduras	0.027	Egypt	0.017	Bolivia	0.012	China	0.021
62	Morocco	0.026	Honduras	0.017	Honduras	0.012	Nicaragua	0.020
63	China	0.024	Cameroon	0.013	China	0.011	Paraguay	0.013
64	Cameroon	0.022	China	0.012	Cameroon	0.010	Kenya	0.013
65	Indonesia	0.020	Indonesia	0.012	Zambia	0.009	Indonesia	0.012
66	Nigeria	0.020	Nigeria	0.010	Indonesia	0.009	Honduras	0.012
67	Zambia	0.018	Zambia	0.010	Nigeria	0.007	Egypt	0.012
68	Ghana	0.013	Sri Lanka	0.008	Senegal	0.006	Zambia	0.010
69	Senegal	0.011	Senegal	0.007	Sri Lanka	0.006	Bolivia	0.009
70	Sri Lanka	0.011	Ghana	0.007	Ghana	0.005	United Republic of Tanzania	0.009
71	Pakistan	0.010	Pakistan	0.006	Pakistan	0.005	Sri Lanka	0.008
72	India	0.009	India	0.005	India	0.004	Cameroon	0.008
73	Bangladesh	0.007	Kenya	0.004	Kenya	0.004	Madagascar	0.008
74	Kenya	0.006	Central African Republic	0.004	Central African Republic	0.003	Bangladesh	0.008
75	United Republic of Tanzania	0.006	Bangladesh	0.004	Bangladesh	0.003	Nigeria	0.006
76	Central African Republic	0.006	United Republic of Tanzania	0.003	United Republic of Tanzania	0.002	Ghana	0.006
77	Madagascar	0.005	Madagascar	0.003	Madagascar	0.002	Central African Republic	0.003
78	Malawi	0.003	Malawi	0.002	Malawi	0.002	Malawi	0.003
79	Uganda	0.000	Nepal	0.000	Nepal	0.000	Nepal	0.001
80	Nepal	0.000	Uganda	0.000	Uganda	0.000	Uganda	0.001

Source: UNIDO Scoreboard data set (see technical annex).

Note: Ranking is based on individual indicators contained in detailed annex tables for chapter 2. Column b is the average of a and b, c is the average of b and c and d is the average of all individual indices (the final CIP index).

Table A3.3 **Regression results for export structure and growth in manufactured exports**

Independent variable	46 large exporters: Standard coefficient	46 large exporters: t-statistic	46 large exporters: Mean	34 small exporters: Standard coefficient	34 small exporters: t-statistic	34 small exporters: Mean
Share of medium- and high-tech exports in 1985	0.408*	3.026	0.63	0.420*	2.356	0.08
Change in share over time	0.873**	6.452	0.02	0.364*	2.013	0.07
		Adjusted R^2 = 0.489			Adjusted R^2 = 0.131	

Source: Calculations by UNIDO based on UNIDO Scoreboard database (see technical annex).

* Significant at the 5 percent level.

** Significant at the 1 percent level.

Note: The dependent variable is annual compound growth rate of manufactured exports, 1985–1998. The regressions satisfy all statistical tests of heteroskedasticity and collinearity.

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