The Entrepreneurial University

Innovation, academic knowledge creation and regional development in a globalized economy

by

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Summary

The future of high-wage economies as Germany or Japan in a globalized economy depends critically on competence, willingness and freedom to innovate: to create new markets through product and service innovation and to increase productivity through process innovation. Innovation itself depends on the creation, application and diffusion of *new* knowledge, at least in economies at the forefront of technological achievement, which cannot rely on imitation and catching up.

Since a technologically advanced and open economy can only compete by creating new product and technology cycles, the creation and diffusion of the knowledge on which these recombinations are based, has become a factor of utmost importance.

An increasing part of this knowledge is produced in academic research and teaching entities, especially universities. The practical application of this new knowledge, explicit and tacit, is the foundation of growth in mature economies. The embodiment of new knowledge in the process of innovation is the core function of entrepreneurship according to Joseph Schumpeter (1934, 1991).
Universities and industry, up to now relatively separate and distinct institutional spheres, are assuming tasks that were formerly largely the province of the other in the development of new combinations.
New knowledge and ideas, *taken for itself*, i.e. remaining separated from innovation, are *economically* worthless. Research achievements may result in scientific reputation, but for the economic system remain of negligible relevance. For a stationary economy, where entrepreneurs are engaged in reproducing the given, this poses no difficulty. But as soon as development enters, and comparative advantages based on given products and technologies are eroded by newly industrializing economies, the situation transformes fundamentally. The production of new knowledge, to become a valuable economic activity, has to become embedded into new recombinations of resources. This requires a structural coupling of the science and economic systems of society. The traditional division of labour and functions between academic science and academic teaching and industry (applied research, development, innovation) is in question. As the university crosses traditional boundaries through linkages with the economic system, it must devise ways to make it able to communicate with each other.
It is here, in the economic application of new knowledge produced in the science system, that problems multiply. Their solution requires - this is the main thesis of our contribution - the mutation of the tradional

research and teaching university into an entrepreneurial university. As our discussion will show, it is not a paradox (as maintained by Audretsch, 1998), that geographic clusters of innovation emerge at a time when globalization and multinational corporate activity seem to dominate economic activity. Globalization breeds regionalization. What we observe, so far in pioneer regions in the US and the UK, to a lesser extent in Japan, China and Taiwan[1], and continental Europe - the evolution of universities and other research entities into regional centers of innovation - , will fundamentally influence the innovative performance of a nation and ultimately determine the international comparative advantage of mature nations.

1. *Entrepreneurial* university: what does it mean?

What we intend with our contribution is nothing new. The potential and real contributions of universities to economic development have long been discussed. Historians have argued that an important reason why British industry did so poorly in the new chemical products and new electrical equipment industries, which formed the basis of the third and fourth Kondratieff cycles, was the failure of British universities to develop teaching and research capabilities in science and engineering - comparable to German technical universities and US universities. As Chandler (1962, 1977), argues, the tight cooperation between technical universities and companies in these fields enabled German firms to surpass the until then leading industrial nation, Britain, in less than a generation. In a similar vein it has been argued, the dominance of US firms in the basic innovations of the 5th and embryonic 6th Kondratieff to have a lot to do with the *entrepreneurial* quality of American research institutions. Doing first-class research is not sufficient for excellence in innovation. In the US, first class university research[2] was combined with scientific entrepreneurship - to a degree, that observers now begin to worry (Mowery and Ziedonis, 1998) that the structural coupling between science and „money" may may have gone too far.

The university is one of the world's most durable institutions. It must pass now a complex new test.

- The new quality of international competition changes the role and function of universities and research systems dramatically. If these do not become agents of innovation, entrepreneurial universities, they hamper regional and national development and international competitiveness.
- The application of university produced knowledge depends on the quality of entrepreneurship (whose different functions are discussed below). Since knowledge is difficult to transfer, even if diffusion costs are low - knowledge as a public good - the main carriers of knowledge are people who are directly involved in knowledge production. In many cases, this may be researchers themselves. To make this happen requires profound changes in the training of students and scientists, especially in the skills and competences to set up companies as carriers of innovation (the evolutionary function of entrepreneurship, see below).
- Because of the difficulties with knowledge transfer and because of network economies, the application of new scientifically-created knowledge has a strong regional component. To make universities entrepreneurial has thus a strong, positive impact on local/regional development.

In our paper, we focus on the constraints and possibilities of the university system, to become entrepreneurial, to mutate into an agent of innovation and regional development in the Schumpeterian sense.

An entrepreneurial university can mean three things:

1. The university itself, as an organization, becomes entrepreneurial.
2. The members of the university -faculty, students, employees- are turning themselves somehow into entrepreneurs.
3. The interaction of the university with the environmnet, the "structural coupling" between university and region, follows entrepreneurial patterns .

[1] Taiwan created the Hsinchu Science-Based Industrial Park, houses the world's fourth-largest maker of semiconductors, and is attracting an increasing number of biotechnology and optoelectronics firms. The park is linked with two nearby universities and the government's leading science research institute (Dolven, 1998).

[2] "A defining characteristic of the post-war US innovation system is the central role of research universities in the performance of fundamental research." In 1995, universities accounted for more than 61 percent of the basic research performed within in the US (Mowery and Ziedonis, 1998, p. 113).

As our discussion will show, to achieve the second, the first must be accomplished. And to achieve the third, the second is necessary. All three together are necessary and sufficient conditions to make an university "entrepreneurial ". The focus of our analysis lies on the third aspect. But since the third builds on the first two, we need at least sketch on their meaning. This is done in the third and fourth section of the paper.

2. Types, functions and learning of entrepreneurs

The following contains basic distinctions and concepts concerning entrepreneurship. Readers familiar with recent discussion in the theory of entrepreneurship can skip this section.
Entrepreneur is not entrepreneur. We have to make distinctions about different entrepreneurial functions and different entrepreneurial specialisations (see table 1 for these distinctions). It is a curiosity of the entrepreneurship literature, that its best-known all seem to emphasize one particalur part (function) of the entrepreneur's job.
We make three distinctions: between ***functions*** of entrepreneurship, between ***types*** of entrepreneurs and between levels of entrepreneurial ***learning***. An entrepreneurial university must somehow built into its structure these functions, types and modes of learning. According to the prevelance of these, different types of entrepreneuriol university could be distinguished.
If we combine functions and types of entrepreneurs we get a matrix consisting of 16 cells.
In the university context, some combinations of function and type seem more relevant than others. First, the main focus has to be on innovation: applying new - university created knowledge - in practical fields; and on evolution: building up, creating skills and competences, but not only in creating and transferring (new) knowledge (see section 6 on the limitations of knowledge), but by combining evolution with innovation: *creating competences to innovate*[3]. These ideas will be elaborated upon below (in sections 4 and 5).

- **Functions**

Concerning *functions*, we can differentiate between

- routine entrepreneurs
- arbitrageurs
- innovators
- evolutionary entrepreneurs (competence builders).

All entrepreneurs are doers. But what they do are different things.

Routine entrepreneurs redo what they have always done, they reproduce their businesses by producing the same product with the same technology. They populate the "economic core" of any economy and organization, including universities. As Peter Drucker has said, they are doing things right (even if they are doing the wrong things, for instance producing new knowledge within a defunct paradigma).

Arbitrageurs discover and make use of discrepancies in the valuation of products, production factors and assets. At a high level of performance, they are the George Soros types of entrepreneurs.

Innovators are the doers of new things. They put new ideas into practice. Within an university context, this can mean three things:

(1) diffusion of new knowledge *within* the scientific community,
(2) teaching new knowledge to students (the ideal of the Humboldtian university), and
(3) the Schumpeterian interpretation - applying new knowledge in the econonomic system[4].

It is the third possibility, which is most relevant for our question, but (3) may require *intra*-university innovational activities of the second type and knowledge diffusion within the science system.

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[3] We differentiate strictly between innovation and evolution. An innovating economy is not necessarily also an evolutionary system. Evolution hinges on increasing competences, innovation, and most of the things discussed in evolutionary economics as the familiar three stages of „evolution": innovation, diffusion, and feedback, is possible with given competences.
[4] Production of new knowledge is not yet a Schumpeterian activity, if application does not enter. Obviously, production can be part of an innovation *process*, but this commands activities (2) and (3).

Evolutionary entrepreneurs are builders of competence, either with themselves, or by helping others to increase their capabilities. To qualify for this function, they must at least operate at the level of learning 2. Knowledge creation will not do. A teacher who succeeds in increasing the capability of his students is an evolutionary entrepreneurs as a business man who teaches himself the capability of better listening to his customers. If a (potential) entrepreneur learns competences in the university, i.e. in the entrepreneurial university, innovators and evolutionary entrepreneurs become structurally coupled. They co-evolve.

Table 1 contains the main differentiations employed by us. In the rows, the table comprises the four functions of entrepreneurship. These functions can be fulfilled in four types of real-type entrepreneurs, as seen in the columns. Finally, entrepreneurial action in the function-type space of entrepreneurship is characterized by different modes of learning. These levels of learning can be seen in the cells of the matrix.

Table 1: Types, functions and learning level of entrepreneurs

	Personal achiever	Real manager (Intrapreneur)	Expert idea generator	Empathic super salespeople
Routine	Learning 0			
Arbitrage	Learning 0+1			
Innovation	Learning 1			
Evolution	Learning 2+3			

- **Learning**

Table 2 contains an overview of the types of entrepreneurial learning.

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Table 2: Levels of learning

- If an entrepreneur does no learning, reproduces his present condition, we call this **learning 0**.
- An entrepreneur increases his knowlege base, he acquires new knowledge. We call this **learning 1**: learning at the first level.
- An entrepreneur acquires or learns new skills and competences (learning to learn, learning to communicate, learning to manage time, etc.); this is learning at a higher level: **learning 2.**
- An entrepreneur becomes aware that she or he lacks some skill, or competence, or knowledge: **learning 3** (creating awareness and sensititivity for learning to learn new capabilities).
- Learning 2 and 3 can be considered **evolutionary** learning.

Source: Röpke, 1998

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Obviously, these levels of entrepreneurial learning are not independent of each other. Increasing your competence becomes difficult, if you are not aware, that you need higher capabilities at all, and what kind of competence you need to learn. If you remain unconscious of your incompetence, or if you believe, you have already everything you need to make you a successful entrepreneur, you lack the intrinsic motivation to increase your competence, i.e. engage in learning at the second level. To build up the motivation to learn at the second level, to master new capabilities, usually requires learning activity at the third level.

If we look at the second level of learning in relation to learning 1, we observe a similar relationship. For an *entrepreneur* (not a researcher/scientist), to acquire new knowledge in itself is a useless activity. He must "get things done" (Schumpeter), that is, apply new knowledge, acquired at the level of learning 1. He must implement his ideas, realize his vision, follow up his strategy with concrete steps, and so on. Acquiring knowledge *per se* becomes a dead end for an entrepreneur, if he or she lacks the competence to make profitable, value-enhancing use of knowledge.
If an entrepreneur runs into difficulties in the market place, to acquire new knowledge usually does not help. It may even make his position worse, if he continues to operate at the same level of competence. New knowledge

(learning 1) does not automatically increase his competence to make rewarding use of new knowledge. He has to engage into learning 2. He must improve on his capabilities of getting things done.
Acquiring knowledge is inadequate, and in some circumstances may even be harmful. More knowledge makes him aware how many things he does *not* know. More knowledge increases his uncertainty, and may make his entrepreneurial task more difficult (Miron and McClelland, 1979) and thus demotivates him from entering into entrepreneurial activity. Learning 1, increase in knowledge alone, a main activity of univerisity research and teaching, is thus a two-edged sword, if seen from the requirements for successful entrepreneurship. To overcome these difficulties in a university context implies to transform a university into an entrepreneurial university.
Summarizing our argument concerning the learning of entrepreneurs, we state, that

the quality of entrepreneurship is a function of entrepreneurial learning at three levels of learning:

Entrepreneurship = f (3 L).

Table 1 can now be read as follows: An entrepreneur, active in one of the four functions, needs, in order to maintain his functional being (or entrepreneurial "consciousness"), operate at the learning levels indicated in the table. A routine entrepreneur can go along without any learning. If he or she is operating out of an optimal (equilibrium) position, he needs no learning at all (learning 0). This luxury is a realistic option only for routine entrepreneurs. An arbitrageur may need to move to learning 1 (see table 2 for types of learning), acquire new knowledge (for instance learn to master a computer in order to better handle financial data). The same holds for an innovator. She/he must incorporate new knowledge into her/his business to continue to function as an innovator. The innovator has to be an active learner at the first level of learning. Obviously, any of the functional types can mutate (see below for the three types of mutation or '*self-evolution'*), that is improve on his competence through learning 2 and 3. But evolutionary learning is not required to fulfill an entrepreneurs ordinary function (as is indicated in table 1).

In other words: Routine entrepreneurs, arbitrageurs and innovators can do their entrepreneurial job without learning any new capabilities. But they also can self-evolve, "mutate", as fish needed to do to conquer land. In this way they acquire new action possibilities, can roam in spaces hitherto *terra incognita* due to insufficient capabilites.
What does learning mean in the context of entrepreneurial functions? An entrepreneur can learn (and universities can help/promote to do this) in three areas:

1. He learns to do his functional entrepreneurial job better. A routine entrepreneur learns to become a more effective routine entrepreneur, for instance by learning a better way of cost accounting.
2. He learns to move up the functional ladder: a routine entrepreneur is mutating into an arbitrageur or innovator.
3. He learns to equip himself with capabilities that allow him to operate in a new entrepreneurial context: a routine entrepreneur learns to become an employeed manager; or an intrapreneuring innovator sets up his own business, and so on[5].

To do any of these things, she/he first must become an evolutionary entrepreneur, which requires operating at the learning levels 2 and/or 3, evolutionary learning. The university can help him to achieve this, provide him with the knowledge (learning 1) *and* competence to self-evolve into higher entrepreneurial functions and mutate into different entrepreneurial types.

If a routine entrepreneur acquires new capabilities, he mutates, temporarily, into an evolutionary function: to do a better routine job. He can of course also become engaged into arbitrage and innovation, all with his given capabilities, that is, without evolutionary learning. He acts without learning at higher levels.. But his chances to survive in these higher functions - at the level of unconscious incompetence - are limited.

- **Real types**

After combining functions with types of learning, we look now at four types of entrepreneurship. The four functions of entrepreneurship can be practiced in different entrepreneurial specialisations. The psychologist John Miner (1997) has, based on his research on entrepreneurs in the US, differentiated four entrepreneurial types as listed in table 1:

[5] This are the real-type entrepreneurs as based on the classification of John Miner (1997) referred to below.

- *Personal achiever* or autonomous entrepreneur; this is the independently acting, individualist entrepreneur as described by Joseph Schumpeter and David McCllelland.
- *Real manager* or intrapreneur*;* the entrepreneur operating in an organizational context, and differentiated by the first type by a strong desire to influence other people (power motivation).
- *Expert idea generator*; he makes use of knowledge often created by himself, and has a strong motivation to apply his knowledge in innovative ways. This type becomes more relevant, when new knowledge becomes created in science and research or development departments. Very often, this new knowledge can only be skillfully applied by the creater of knowledge himself: he has the motivation and the access to implicit knowledge (knowledge that is difficult to be transferred to other people).
- *Empathic super salespeople* are equipped with an extraordinary level of empathic and communication capabilities; they can enter the worlds of other people easily and therefore have a comparative advantage in 'selling' products/ideas to others.

In later sections, we try to detect these real types of entrepreneurship in university/research systems.

3. The university as an entrepreneurial organization

Given the above distinctions, we can now apply entrepreneurial theory to the university setting. This requires to integrate entrepreneurial functions (routine, etc.), real types (personal achiever, etc), and entrepreneurial learning (0,1,2,3) into the processes of research, teaching, and education of universities. According to table 1, this would give us 16 possibilities or combinations.

From an impact point of view, the last two rows (innovation and evolution) stand out. Innovation is necessary for development, and increasing competences (evolution) for preventing diminishing returns to innovation in the long run. Because we have a separate section 4 on evolutionary entrepreneurship, this leaves us with the innovating or Schumpeterian university. As we saw in the previous section, three possibilities stand out, the first two representing core activities of the traditional university.

If we take Schumpeter's concept of innovation seriously, the traditional university is not yet Schumpeterian, since it restricts itself (or has been forced to do so by government laws and regulations[6]) to collecting, producing and transferring knowledge to other members of the scientific community or to agents in other subsystems of society (economy, art, religion, sport, etc.). The producers and transmitters of this knowledge are part of the innovation process, but mostly not directly engaged or responsible for the application of knowledge, ie. wealth creation. In this function, they may act through the four entrepreneurial types of John Miner. As university people, we have all personal experience in characterising collegues, students and employees according to these types. Personal achievers have a hard time in universities, at least in Europe, while they are actively encouraged in the US to play out their talents. Intrapreneurs and idea generators are, to my knowledge, quite common among the university innovators. On general, innovation in science, as in the economic system, is, and for the same reasons detailed by Schumpeter (1934, pp. 84-88) for commercial businessmen , more an exception than rule among university members.

4. The university as builder of entrepreneurial competences

Universities are often characterized as institutions of 'learning'. But who learns what in universities. Does that what is learned in universities reflect the neccessities of an entrepreneurial society?

As seen from the three levels of learning, universities are operating mostly on the first level, i.e. creating new knowledge - if they are good - and transferring new and traditional knowledge to students: learning 1. Learning 3, the most critical and most productive part of learning, is left out completely, and learning 2 remains widely neglected and may even be negative. At the second learning level, the focus of universities is on analytical competences, training the left side of the brain. Those competences innovative entrepreneurs would primarily need in the market place, are neither taught nor trained, often not even appreciated. Anecdotical evidence does not refute the conclusion, that universities may even negatively contribute to a wholistic development of entrepreneurial competences among its students and staff[7]. Students may leave the university with lower

[6] To what extent government regulation hampers knowledge transfer and entrepreneurial activity of scientists in the 'classical' university in Germany is discussed by Schröter, 1990, pp.144-154.

[7] According to my experience, the level of entrepreneurial competences declines, on average, with the length of stay (enrollment) of students, employees and lecturers/researchers. Simon and Fassnacht, as cited in Ripsas

entrepreneurial competencies compared to the time they enrolled. Universities fail in their job as evolutionary entrepreneurs. This is especially crucial in countries as Germany and some Asian nations including Japan (as compared to the US), because in these countries formidable cultural barriers work against the acquisition of innovativing competences (as compared to the US) in the family, at school and during professional life.
As a consequence, students, when they leave the university, are "highly qualified, but incompetent", as Erich Staudt (1996, 1998) concludes from his research into the competences of German natural science graduates.

In a knowledge-based economy, a science/university system, which is based on the ethics, culture, regulations and career paths adapted to a constellation, where truly novel industrial creation was the prerogative of the economic system, can become a **competence block** *for the further development of the economy.*

The lack of entrepreneurial competences among its staff and students directly contributes to the degree of innovation- or Schumpeterian efficiency of the university system and other research institutions, where university alumni become employed. New knowledge may be produced, even first-rate knowledge, but it does not become economically relevant by way of creating novel product/technology cycles, new wealth, higher output and employment since the knowledge-producers lack the competence of making an innovative use of it.

5. A Schumpeterian view of the university

In Schumpeter's theory, development is caused by innovation, initiated and implemented by entrepreneurs, who depend critically on a smooth access to financial capital to carry out recombinations of the factors of production. The Schumpeterian logic deviates fundamentally from the neoclassical growth model, where growth is driven by factor accumulation: the input logic. State-universities in Europe, with some exceptions, have internalized this view to a surprising degree.
Mainstream (neoclassical) economics sees output growth as a function of input growth. Growth is driven by factors which cause inputs to grow.
In Schumpeterian thinking, neoclassical causality is turned on its head. The growth of 'output' (of an university, as ever measured) is not determined by the growth/accumulation of 'inputs' (money/budget, number of employees, infrastructure, office space, etc). Input growth in the Schumpeterian perspective is not neglected but either a result or a by-product of the innovation process. Input growth *follows* output growth. The input logic is replaced by an innovation logic.

Observing the university through a Schumpeterian lens allows us to construct a different reality of university life. By making a distinction between input and innovation logic[8], we observe, immediately, to what extent university life is dominated by an input logic. As a variant, even usually, at least in Germany, the input logic is constructed in the rather stationary perspective of a zero-sum or win-lose game. Unfortunately, to succeed in such a game, requires skills and competences, whose availability and acquisition make innovation a near impossibility. To become a successful operator in the political game of win-lose allocation breeds innovative-evolutionary failure. This holds for the personal as well as organizational level. The univesity system selects against innovative and evolutionary entrepreneurs and the access to resources via the university allocation-game is decoupled from innovation.
Theory and policy-making on innovation is heavily influenced by input logic, the university/science system being no exception. The importance of knowledge is derived from being "an input in generating innovative activity" (Audretsch, 1998, p. 19). Similarly, in a knowledge based economy, science has to deliver inputs to the economic system: „...efforts to make the science base contribute better to economic growth hinge on the uptake of scientific inputs by business - especially by small technology-based firms and in new growth areas" (Andersson, 1998, p.17).

Also scholars that consider themselves as "Neo-Schumpeterian" operate within such a conceptual framework. What is wrong with such an approach? From our point of view only one thing needs mentioning: The input approach neglects the Schumpeterian contribution. Innovative entrepreneurship remains outside the framework, and it can definitely not be put into the input-output machine without destroying the creative contribution of the innovating entrepreneur.

(1998, p.221) report, that the motivation to start up a business among students *declines* during their life at university, freshmen having a stronger urge than students at higher semesters.

8 These distinctions are elaborated upon in Aßmann and Röpke (1998).

The (Neo-)Schumpeterian approach to university development has - at a first look - a Münchhausen-like quality[9]. It makes two basic propositions:

1. Each university, and the region into which it is embedded, at any time, makes use of only a small degree of the possibilities open to it: the phenomenon of **X-inefficiency**[10]. There are thus available, at any university, at any time, ample opportunities to increase the value of output of an univerisity with a *given* amount of resources. [Since to increase X-efficiency in a university usually would require innovation, the X-inefficiency argument becomes a sub-hypothesis within a Schumpeterian approach].

2. Each university, whatever its historical path of scientific and professional specialization, and hence its comparative advantage, can - by an **innovative recombination** of *given* input - achieve higher output (the core Schumpeterian hypothesis).

Making an university entrepreneurial in a Schumpeterian sense consists thus in reducing X-inefficiency and promoting a creative recombination of input. This view is obviously at odds with conventional approaches, which - by *assuming*[11] that any given input is transformed into output at maximum efficiency (i.e. the level of x-inefficiency is zero) and in addition ruling out endogeneous innovation, *necessarily* needs additional inputs to make a university grow and develop. According to this view, we come naturally to the policy conclusion, that - since university growth is hold back by a lack of resources - an *external* infusion of input is the *sine qua non* for the further development of the university.

While output growth in an university without innovative entrepreneurship depends on a continuous infusion of *input,* a Schumpeterian university produces development *endogenously*: „changes ... arise by its own initiative, *from within"* (Schumpeter 1934, p. 63, our emphasis). Development is created by the *internal* dynamics or the internal conditions of a system, not by the availability or growth of factor input. Similarly, if development is characterized by *qualitative* changes (as new knowledge embodied in new products, technology and organizations), output growth is not a necessary characteristic but a by-product of an innovating university (This does not rule out to „translate" output and its growth into neoclassical or growth-accounting language).

6. The limits of knowledge and the role of innovative entrepreneurship

The thesis of the following section can be summarized as follows: With the type of knowledge produced by universities and similar research organizations, the entrepreneurs making use of this knowledge must increasingly by produced or 'constructed' by the research system itself. If the system fails in doing this, the knowledge may remain idle or underused. Universities must turn into evolutionary entrepreneurial organizations to fulfill their mission in an economy which must increase wealth and create employment by incorporating new knowledge in innovative products and technologies. It is not enough any more to turn out high quality people, if these people, at least some of it, are not provided with, and at the same time, during their academic studies, with the competences to succeed as professional entrepreneurs.

New knowledge has increasingly to be created in the scientific system. Creating new wealth out of this, requires the application of new knowledge. This is the job of entrepreneurs. If universities are an origin of new knowledge, the knowledge must spill over to users. One channel for spillover are adoption and adaption by established firms. Another one are individuals, often those involved in the production of new knowledge, scientists, engineers, students. The organizational structure and cultural traditions and regulations make it difficult for knowledge workers in universities, to develop the knowledge and appropriate the expected value of

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9 Baron Münchhausen succeeded to overcome difficult situations by his own - and often - innovative endeavour: pure self-help.

10 X-(in)-efficiency is a concept originating from Harvey Leibenstein. While the X-efficiency idea is "an extremely simple one" (Leibenstein, 1978, p. 17), it is nevertheless beyond the neoclassical (production-function) approach. The concept assumes, also in regional growth theory, that resources are used, at any time, with the maximum degree of efficiency. When an input is not used efficiently, the norm in any firm and region, "the difference between the actual output and the maximum output attributable to that input is a measure of the degree of X-inefficiency" (Leibenstein, 1978, p. 17).

11We need to stress this to be an assumption of mainstream economics. As every member of an university knows, there is a tremendous lot of wasteful resource-use going on. Even under standard optimal allocation procedures, universities fail. But this is not the question we like to discuss in our contribution. Even with an optimal allocation, or better because of it, innovation need not happen. The university is entrepreneurial in a managerial or routine sense.

the knowlege within the university system. To apply the knowledge developed in research and teaching organizations, may require the knowledge worker

1. to transfer the knowledge to incumbent firms
2. to transfer the knowledge to individuals starting a new firm,
3. to establish a new firm by himself.

Regional value and employment-creation is highly dependent on new firm activity (route 2 and 3). The transfer of new knowledge to incumbent firms is marred by many difficulties, which have given birth to a whole new industry engaged in knowledge transfer. These difficulties reflect the shortcomings of the input logic.

A main problem is, that diffusion and application of new knowledge as simply a transfer from one mind/organization to another one, does not work. Transfer is possible with information, seriously limited with knowledge, and impossible with tacit knowledge. Knowledge exists only as self-knowledge. New knowledge has to be constructed anew by the receiver, and requires - for its innovative application - a new factor combination. This make the simple transfer of knowledge an illusion. That is: an university, who sees a main task in being a transfer agent, cannot be an entrepreneurial university. The knowledge-tranferring university fits well into the input logic, but will not contribute much in developing its members and the region in which is embedded. The agent able to make use of tacit knowledge is the entrepreneur. Entrepreneurial knowledge is mainly of tacit nature. To build a competitive advantage based on knowledge available to anybody (public knowledge) is a heroic task. Tacit knowledge is thus not a public good but available only to the creator/owner. Since it is difficult to diffuse, the competence to make use of this kind of knowledge is crucial for economic development, and especially so in a knowledge-based economy: to make non-tacit, public, including scientific knowledge applicable, or turn knowledge into innovations, it needs to be combined with tacit or entrepreneurial knowledge. The above distinctions are similar to one made in the entrepreneurial literature between idea and opportunity. Many people, including scientists, have ideas, based on their personal knowledge base. But most ideas, as most scientific knowledge,do not turn into wealth-enhancing and productivity-increasing opportunities. What makes opportunities out of ideas is tacit knowledge: the knowledge on how to translate (scientific) ideas into products that consumers are willing to buy from the entrepreneur. The transformation of ideas (knowledge) into opportunities is similar to Schumpeter's distinction between invention and innovation. Ideas, derived from scientific inventions and discoveries are products of the psychic system, opportunities emerge from the structural coupling of the knowledge producer/owner with agents in the market environment, they are structurally-coupled ideas.

The above arguments are main reasons why Schumpeter noted, already in 1911, that it are not incumbent firms which do major innovations, but *newly* established enterprises, the socalled 'starts up' in American language. With the proliferation of the science systems in modern societies, the bottlenecks to knowledge transfer and hence the breakdown of the knowledge production function have become ever more pronounced. We guess, but have no data to prove it, that an increasing amount of the new knowledge created within the science/university complex remains economically idle, i.e. does not become embedded into innovational activity.

In other words: the road leading to the link up of the science and innovation system leads increasingly through newcomer firms. The more revolutionary the science and knowledge, the more start up entrepreneurship is required to create new wealth out of it. The higher the quality of the research knowledge created in a university, the more entrepreneurship is required for its application. What Gary Hamel - echoing the young Schumpeter decades ago - says for innovation in general, can be applied to university knowledge in the same way: "In industry after industry, it is the revolutionaries - usually newcomers- who are creating the new wealth" (Hamel, 1998, p. 7).
In all the new industries on which the present Kondratieff (information/communication technology, etc.) is based, the fusion of science and commercialization, often by the very same people, in personal union, has been the hallmark of new wealth creation. There is no major product/technology cycle, which has been pioneered by established firms. This is another illustration, that the input cum transfer logic does not work: That the new knowledge, on which major innovations are based, does not travel from science to incumbent firms, but travels in the brain and via the experience of those involved in producing the knowledge in the science system.

As an illustration we refer to the development of the American biotechnology industry, which was essentially nonexistent in 1975 and grew to more than 700 active firms over the next 15 years. Zucker et al. (1998) show a tight connection between the intellectual human capital created by frontier research and the founding of biotechnology firms. „At least for this high-tech industry, the growth and location of intellectual human capital was the principal determinant of the growth and location of the industry itself". Intellectual capital flourished around great universities. But academic discoveries were not sufficient in themselves.The development of the

industry was highly dependent on „individuals with **the ability both to invent and to commercialize** these breakthroughs“ (Zucker, 1998, p. 302, our emphasis). As a comparable German illustration, we refer to Quiagen AG, a biotechnology firm founded on the knowledge of a Ph.D. dissertation by the same person doing the research[12]. Also Marburg university provides several examples.
At US universities, it seems also a common practice, that professors take financial stakes in businesses started by former students. A spectacular example is a former dean of the Graduate School of Business at the University of Texas, who co-financed Michael Dell of Dell Computer, who is the second largest shareholder (behind Michael Dell) owning a stake valued at about $ 50 million (Beck, 1998). Professors act, in other words, as informal venture capitalists or business angels. Given the huge information asymmetries in capital/credit markets and the high uncertainty of projects based on recent scientific research, this makes obvious economic sense. (We do not propose the American practice to be imitated elsewhere. But at least the Americans have found a *solution* to an akward problem. Any German university administrator can easily find 1001 reasons, why something like the above cannot happen here- without coming up with an innovative solution of its own.)

7. The limits of professional qualification and the rise of evolutionary entrepreneurship

Universities do two things: they create new knowledge and they transfer this knowledge and the state of the scientific art to students. When students leave the university, they and their teachers believe to have become equipped with the knowledge to pursue a professional career. This at least is the thinking in the West. (In Japan, it is a little bit different. University graduates are assumend, when they enter their professional career in a public or private organization, to know practically nothing. All the professional knowledge they need to learn on the job, within the organization. The learning organization - but not necessarily the entrepreneurial organization - has long become reality in Japan.)
We do not question this assumption, but we want to show its limitation. We see at least two:

1. Professional knowledge in itself is worthless - from an economic point of view. It becomes valuable, if there is a demand for this knowledge, if someone - an entrepreneur, an entrpereneurial organization - is demanding the service of the bearer of this knowledge, to produce goods and services which can be sold in the market place. If there is no demand, no level of professional qualification will make the knowledge and skills acquired in the university of any value.
To make professional knowledge and skills value-adding, requires the fusion of this knowledge and skills with innovative entrepreneurship.
2. What is true for supplying knowledge and skills to entrepreneurial firms is similarly true, if a person supplies it to himself: by becoming an entrepreneur. Here we observe what Michael Gerber (1995) has called the “Fatal Assumption”: The belief that if you understand the technical/professional work of a business, you understand a business that does technical work. The barber opens up a barber shop, the medical doctor a clinic, the accountant an accountancy, and so on.
But “rather than being their greatest single asset, *knowing* to do the technical [professional] work of the business becomes their greatest single liability” (Gerber, 1995, p. 13, added emphasis) into entering and succeeding with an entrepreneurial career.
To make the university entrepreneurially successful, requires to create within its members, especially students, the will and the ability to start their own business. Evolutionary entrepreneurs must enter. If universities stick to their traditional role, they will fail in this. Everybody who establishes his own firm requires qualifications in three dimensions (Gerber:“three-people-in-one”): as a professional/technician, as a manager, as an entrepreneur. The first brings with it the knowledge base for a specific specialization or professional career. The manager does the planning, coordination and controlling. The entrepreneur creates and implements the opportunity. The university system qualifies students in their professional role (as a doctor, engineer, teacher, molecular biologist, even as a manager etc.). But even university trained managers do not learn *how* to manage, even if they learned a lot of theories of how others do and should manage. It is a long way from knowing to doing something differently. If evolutionary entrepreneurship enters, the university contribution shrinks to zero, sometimes to negative (if entrepreneurial skills and competences are eroded because of overstressing the analytic-professional role and unlearning competences while studying).
Even universities in the US fall short of their entrepreneurial role, but at least they have an understanding of their vision in an entrepreneurial society (see box on MIT). Many US universities have by now become

[12] After a slow start, biotechnology is taken off in Germany. There are now more than 170 research-based firms in existence, usually founded by scientists (Wirtschaftskurier, September 1998, p.29).

actively engaged in making their students „entrepreneurial“ (a good account on recent initiatives is given by Ballon, 1998).

MIT Entrepreneurship Center

The Massachusetts Institute of Technology has established a center for the training and promotion of entrepreneurship among its students, researchers and staff. The center is based on the following philosophy:

„MIT scientists, engineers, and managers believe that it is not enough merely to invent a new product, concept or technology. The measure of success is global commercialization and widespread acceptance of their innovations“ (MIT, 1997).

„The mission of the MIT Entreprepreneurship Center is to train and develop managers who will make high tech ventures successful. To that end, we offer educational programs to inspire, train and coach new generations of entrepreneurs from all part of MIT“ (MIT, 1997; our emphasis).

MIT is not satisfied with the production of knowledge, patents and degrees. MIT wants these things to be applied for commercial use [= innovation], and it tries to train its own members to become competent enough „to make high tech ventures successful“. That is, MIT is surely operating on the level of learning 1 (the traditional task of an university), but also becomes engaged in evolutionary learning through innovation and competence development.

Bank Boston (1996) has tried to figure out the development contribution (jobs, sales, value-added) of firms started up by MIT alumni. The study showed that up to 1994, graduates founded about 4,000 firms, created 1,1 million jobs and had a yearly turnover of $232bn with a value added of $ 116bn.

8. The regional dimension

Why it is that with all the information, knowledge and high-quality expertise available, so many university communities have remained economic backwaters, innovative wastelands? There are exceptions to this. The well-known US-cases, as Stanford and MIT. In the UK, Cambridge and Oxford have transformed beyond recognition. If we look at Germany, there is few we can show for, and the input logic dominates.

- **Tacit knowledge and competence**

Much of the knowledge that underlies innovative capabilities is tacit knowledge. It is difficult to understand and to communicate in symbolic form. Modern means of information and data storage and processing (computer, inter/intranet) remain deaf to tacit knowledge. First: Individual skills have large tacit components, second, knowledge is fragmented and inaccessible to others, third, knowledge, especially of a frontier type, may be uncertain and sticky, only available to the creator as hints and via intuition. This kind of knowledge is best transmitted via face-to-face interaction and through frequent and repeated coupling (von Hipple, 1994). This has long been known to scholars as F.A. von Hayek and Michael Polanyi, only to be recently discovered again to account for some surprising and even paradoxical facts in connection with regional concentration of knowledge skills.

A study on the transfer of university knowledge in the US technology comes to the conclusion: „ ...the cases studied here provide no evidence that technologies transferred from a university create - over a period of years- anything but the most minimal levels of job creation or economic impact.“ In addition the authors observed, that when transfer happened, it were the inventors/researchers themselves that made use of the knowledge by establishing their own firm (Harmon et al., 1995, p.6). From empirical research like this (and other not reported by us), we may conclude: (1) transfer does not work, (2) when there is transfer, the knowledge producers were heavily involved, (3) the economic impact remains negligible, if the entrepreneurial competence of the agents remains meagre.
The theoretical foundation of this empirical observation we call the (tacit) knowledge thesis and the competence thesis.

The difficulties with knowledge transfer leads to several questions:

1.“ How can [scientific agents] with a given endowment of new knowledge [and competences] best appropriate the returns of that knowledge [and competences]?“ (Audretsch, 1998, p. 21).
2. If the producer and owner of knowledge and competence has, for whatever reason, weak incentives to exploit his knowledge/competence commercially, how that knowledge/competence can be made available to others?
3. On what competences does the use and diffusion of univerisity produced knowledge, depend?
4. What role does location play in the economic application of new knowledge with substantial tacit content?

Concerning the regional dimension of knowledge application and spillover, the answer is straightforward: the marginal cost to transmit and apply new knowlodge, especially tacit knowledge, rises with distance. The application of new knowledge, including the financing of ventures based on new knowledge, requires frequent and intensive interaction between producer/owner, other members of the entrepreneurial team and suppliers and buyers and regulatory authorities[13]. This conclusion has recently been empirically validated at least for the US. Substantial spillover was reported was reported from university research & development to the regional economy in form higher wages and employment creation. As the main for this „significant and robust spillover“, the authors mention „the importance of personal contacts and face-to-face communication in transferring scientific progress into jobs and products“ (Acs et al., 1995, p. 4).

The higher the degree of newness of scientific knowledge, and the higher the degree of tacitness in new knowledge, the more localized innovative activity will tend to be.

Now, the marginal costs of pioneer innovation are not given. They have a regional or distance component, but they also depend critically on the competences of the entrepreneurial agents. With low competences, marginal costs of innovation are high. The advances of nearness are overcompensated by competence failure. Knowledge with high tacit content is not used locally (because of high competence costs), but also not outside the region. It turns into „dead“ knowledge. In other words: *localization advantages for science-based regions remain potential, hope - if they are not backed up by entrepreneurial competences within the science system itself.*
This explains, while only few knowledge/science-based communities/regions have transformed into high-growth, high-value added growth poles.
To unlock a science-based region’s development potential, evolutionary entrepreneurship must enter the university. If this does not happen, university-produced knowledge does not trickle down into the region. If the university remains entrepreneurial stale, reproduces itself as a competence blocking system, the region similarly will do the same - or has to look for comparative advantages outside university-knowledge-based endowments.

- **Science regions**

What it is about an entrepreneurial community/region that matters most to entrepreneurs?
Research has not unlocked any secret that allows us to answer this question unequivocally. There are however best kinds of places for engaging in entrepreneurship (Kotlin, 1997). Four types of places emerge as more attractive than others. They are the boomtown, the reinvented district, the networked neighborhood - and the science city/region.

Typical science cities/regions are Austin, Tex., Princeton, N.J., the Boston region, Silicon Valley area, Cal., Oxford and Cambrige, in the UK, to name the success stories. In some emerging economies in East Asia, we observe interesting experiments in university-business cooperation. In some instances, universities become directly involved in establishing companies on their own, staffed with researchers, for marketing scientific insights.[14] In Germany, we see the beginnings of similar developments, usually fostered by government

[13] The product cycle theory of Vernon and others has come up with very similar arguments. The requirements of intensive structural couplings between agents and high marginal costs of interaction in new ventures provide knowledge-based economies with a comparative advantage in innovation goods. Empirical research for German universities shows, how critical personal interactions between scientists and users of reseach and knowledge are for successful transfer (see Schröter, 1990, p. 163).

[14] An illustration: Peking university establishes companies to make commercial use of the scientific contributions of its staff. Listing the firms on a stock exchange, is part of the strategy. For a case see Hilborn, 1998.

assistance and promotion. Biotechnolgy for instance was pushed by a competition („Bio-Regio"), organized by the federal ministry of research[15].

The experience of these regions demonstrates several things:

- These regions can be classified as science regions, housing at least one reputed university or research institution.
- These regions are locations of new firms and product cylces; regional growth is based on innovative activity.
- New firm activity has been crucial in linking the science and economic subsystems.
- The regions have prospered and increased employment despite high wages. For example, employment has increased by 15 percent in Sillicon Valley between 1992 and 1996. But the mean income is 50 per cent higher than in the rest of the country (The Economist, March 29, 1997, special section, p. 1). In other words: these regions have maintained high wage rates, increased employment and remained (or succeeded in becoming) internationally competitive.
- The regions have attracted financial capital (venture and angel capital), often like a magnet. A case in point is Cambridge/UK where venture capitalist are falling over themselves to provide emergent science-based firms with financial capital and other services (Groom, 1998b).
- The universities in these regions have been actively engaged in building commercial links with the business community - they are strategic elements of the regional system of innovation. The universities foster entrepreneurship among its students and staff in various ways. They are transforming themselves into entrepreneurial universities.

Because of their different traditions and entrepreneurial cultures, US universities face few difficulties in interacting operationally with their economic environment. In Europe, a US style of entrepreneurial university can be ruled out for the time being. So the British experience may be more illuminating.

- **The UK experience: Cambridge/Oxford**

The impact of the structural coupling between university science and economic growth can be studied at Cambridgeshire, the region around Cambridge, UK[16]. The total number of high-tech jobs is growing exponentially, even so fast, that the District Council rejected a planning application by Wellcome Trust, the world's biggest charity, to build a science park south of Cambridge, for fear of putting increased pressure on housing, transport, public services and the countryside. High-technology jobs in the region have grown to 37,000, increase by more than 1,000 a year (accidently the same number as those academics registered as unemployed in the unviversity town Marburg). High-tech industries account for 11 per cent of Cambridgeshire jobs, rising to 15 per cent in Cambridge, and 24 per cent in south Cambridgeshire, the district around it. This compares with an UK average of 3 per cent (Groom, 1998a).
How the British did it? For an answer, we can make use of the conjectures of an old Oxford don, Prof. Toynbee, and his theory of challenge and response.
British universities were and are confronted with a formidable challenge. When Margaret Thatcher was the Prime Minister, she tried to reform the British university system on libertarian lines. State money was reduced, universities told: swim on your own, or sink. This challenge played into the hands of those scientists, who had no serious ethical problems in cooperating with industry, if not entering the world of business on their own. The political change also attracted entrepreneurs from outside, including venture capitalists, to enter the formerly closed world of academia to promote their commercial wares. These external entrepreneurs have been critical in forging links with entrepreneurial minded scientists to reform university live from *within*, to gradually mutate universities into entrepreneurial entities. This did not happen without conflict, still going on until today. But this is part of the „difficulties", any entrepreneur faces, if we believe Schumpeter in his classical account on implementing new recombinations of resources.
Interestingly, a divergence of responses between British and continental universities is to be observed. The continentals prefer to respond „adaptively"[17] to similar challenges (lack of financial resources, failure of

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15 As an illustration, see the report by Scharrenbroch, 1998 on the development of biotechnology in the Rhineland region, where 25 firms were founded in recent years, one (Quiagen) with a quote at the American Nasdaq.

16 For the historical development of the „Cambridge Phenomenon" and a case study of the rise of the telecommunication industry in the Cambridge region see Ablett (1996); see also Sternberg, 1995, pp. 181-196.

17 „Whenever an economy or a sector of an economy adapts itself to a change in its data ... by expansion within its existing practice ... or... by a contraction within its existing practice, we shall speak of an adaptive response. .. whenever an economy ... or some firms do something ... that is outside of the range of existing practice, we shall speak of creative response" (Schumpeter, 1991, p. 411).

knowledge transfer, regulation, academic unemployment) . If the state cuts their budgets, they downsize, under protest; if budgets increase, they expand, without producing new variety from within. They act rationally within the input logic. At best, they cut out some bureaucratic fat and reduce x-inefficiency. In the UK, the response in general was more creative, or had to be, since the challenge posed by the government was much more serious, even deadly. They acted in a way, Ross Ashby predicted any system needs to act in order to survive, by producing variety: Only variety can destroy variety.

9. Conclusion

There is only a one letter difference between a non-entrepreneurial and an entrepreneurial university:

The movement from block - university to bloc - university. A university, to become entrepreneurial, to energize regional development, must develop entrepreneurial **c**ompetences, turn into a competence bloc for regional development.

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