The Four Key Factors for Commercialising Research

The Case of a Young University in a Region in Crisis

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ABSTRACT

In France, as in all industrial countries, the government is seeking to promote more extensive ties between universities and enterprises in order to stimulate creativity and growth. But can this be achieved through legislation alone? The various cases studied herein show that the successful commercialisation of public research is the result of the application of an "organic paradigm" consisting of the four closely interacting factors of legislation, the economic environment and entrepreneurship, technical progress and university strategy. We have applied this method to the specific case of a young French university (Université du Littoral Côte d'Opale) and have shown that what is lacking is the close interaction between academic research and a wealthy local economy, which hinders transfers of the scientific resources of public research to the business world.

INTRODUCTION[1]

The 1999 Innovation and Research Act opened up new perspectives for French universities. The commercialisation of research, which can be defined as the process of transforming basic knowledge into marketable new products, is becoming an integral mission of universities alongside their traditional functions of teaching and research. The university, whose role is to produce, transmit and renew scientific knowledge, must now become a place where new and innovative projects are created and brought onto the market (enterprises, technological inventions).

This paper will seek to answer the following question: is legislation alone a sufficient factor to launch the process of forging closer ties between scientific

research and enterprises, which is now seen as being indispensable to technological innovation and economic growth? This question is prompted by the poor results achieved (in terms of enterprise creation in particular) since this new legal framework has been implemented in France. To answer this question, this paper will also draw on the results of studies on other rich industrial countries that have long experience in commercialising public research (the United States in particular). This line of investigation will lead us to lay the foundations of a method for analysing the commercialisation of research that focuses on organically linked incentive factors. In addition to the legislative aspects, these factors comprise scientific and technological changes, university strategy and the economic and social environment in which the commercialisation activities are conducted (first part).

This method will then be used to analyse the results of a field study (a survey on the practices, advantages and disadvantages of commercialising research in a young university in a region in crisis, *i.e.* the U*niversité du* L*ittoral* C*ôte d'*O*pale* located in the Nord/Pas-de-Calais region of France). We shall then suggest some possible approaches for promoting the harmonious development of research, education and the commercialisation of research results in the light of this method and present some of the challenges as well as the risks involved in a "forced march" towards commercialisation (second part).

A LONGSTANDING PRACTICE, NEW CONDITIONS

The emergence of the current situation

T*he ways of commercialising public research*

The commercialisation of research can be defined as the transformation of basic knowledge into marketable new products and services. It is carried out through co-operation between public research institutions and enterprises and through mobility of researchers. It most often consists of making the results of research available to the private sector (whether on an exclusive basis or not). The main ways of commercialising public research are as follows:

- Signing of research contracts by universities and public research centres with companies.
- Commercial exploitation of the results of research (filing of patents by universities and licensing agreements that generate income for universities).
- Mobility of researchers: young doctoral students from a public research laboratory do graduate research in a company (which cofunds this research); a researcher or a team of researchers provide scientific assistance or advice to a company, etc.

- Creation of enterprises by the researchers themselves. The researcher acts as an entrepreneur.

Not all of these ways of commercialising research are new. There have long been research contracts between universities, public research centres and companies, but they have been difficult to implement in some countries because of the use of different accounting systems in the public and private sectors. Similarly, the cofinancing of postgraduate research is not a new practice, but mobility has now been extended to other categories of staff (such as researchers with civil servant status). Consequently, the two genuinely new ways of commercialising public research, in particular in France, are the ability to file and exploit industrial property rights and to create enterprises to capitalise on research. However, these are developments that are taking place in many industrial countries because of the changes that they have made changes in their legislative framework.

Since the 1980s, a number of industrialised countries have introduced public policies for commercialising research, under which the universities are assigned the role of initiating innovative projects. The main measures that have been taken as follows: *a*) to allow universities and public research centres to exploit the results of research commercially; *b*) to create scientific and technical networks between businesses and universities *c*) to redefine the status of researchers to make it easier for them to become entrepreneurs; *d*) to create institutions and various forms of assistance to promote the emergence of innovative projects (incubators, seed funding).

These developments have been analysed in recent case studies on the changes taking place in the university systems in many countries, such as the United States (Etzkowitz, 1998; Jaffe, 2000; Mowery *et al.*, 2001; Henrekson and Rosenberg, 2001), but also in Europe (see Vol. 13, No. 3 of the OECD's Journal *Higher Education Management*, 2001), Japan (Wen and Kobayahi, 2001), Latin America (Arocena and Sutz, 2001), Canada (Menzies, 2000), and the former socialist countries (Mayntz, 1998). These studies focus on the means used by governments to strengthen ties between universities and companies and analyse the results of these changes and the difficulties encountered.

In these countries, universities adopt entrepreneurial operating standards; they become, in the words of Clarke (1998), "entrepreneurial universities" by incorporating market requirements into their functioning (performance requirements, competition, emphasis on applied research) while endeavouring not to neglect their traditional functions of teaching and basic research. The current phase of opening up scientific work is the outcome of the series of economic, political and social factors described above, which make it possible to understand the process and challenges of the commercialisation of public research.

New conditions

In our view, the following four sets of factors can enable us to understand how the current situation of commercialisation has emerged: 1) the basic conditions and organisation of economic competition; 2) the transformation of innovation processes; 3) the nature of technological changes; 4) changes in the financing of R&D. Naturally, these factors are interconnected.

The basic conditions and organisation of economic competition

Technological innovation, which was defined by the economist J.A. Schumpeter (1947) as a new combination of productive resources by an entrepreneur, has now become the key to international economic competition.

This is explained by the changes in production systems that took place in the 1960s and 1970s (the decline in the mass production of undifferentiated goods and the globalisation of competition in the wake of public policies promoting privatisation, deregulation and market liberalisation implemented during the 1980s).

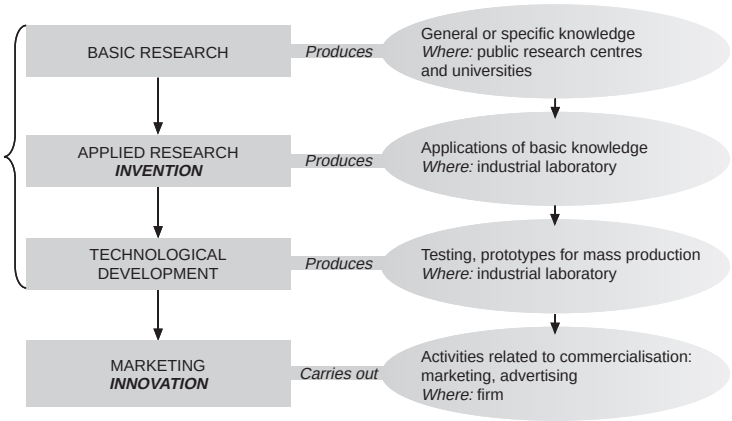
Companies began to reorganise in order to cope with these deep-seated changes in the basic conditions of competition and their new geographical horizon. During the period of relatively orderly competition based on mass production of undifferentiated goods, they had expanded in order to realise economies of scale, but in the 1980s they progressively began to focus on the core of their business (design), which they reinforced through buyouts and mergers. They also externalised many tasks and services that did not relate to their production strategy, but only to its implementation (spin-offs, intrapreneurship, hiving-off, subcontracting). Small units sprang up, linked to the firm's decision-making centre through flexible contracts (which replaced rigid legal ties). The strategic core of the company became the centre where innovation was fostered and where decisions were made regarding technological, scientific and financial strategies involving vast corporate interests with unclear legal boundaries.

The transformation of innovation processes

All of these developments led to radical changes in innovation processes and in economists' thinking about these processes (for a presentation of the various models, see Perrin, 2001). Traditionally (since World War II), the innovation process had been studied through a "linear model" in which each phase of R&D followed the other (see Figure 1).

In this model, each of the phases pursues a goal and is carried out in a different place (a university or public research laboratory for basic research, an industrial laboratory for applied research and technological development). The three phases mark the progression of scientific and technological discoveries, from the

Figure 1. **The "linear" innovation process**



Source: Author.

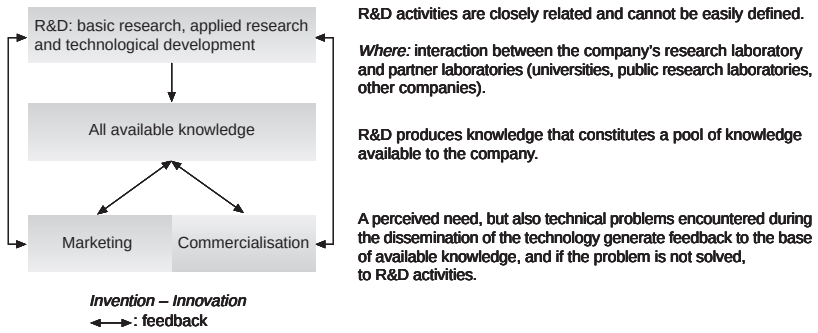
initial idea for a product or service through its design and commercialisation. This process entails the transition from a stock of knowledge produced by basic research to invention, derived from applied research, and finally to innovation.

This model, which was dominant from the 1950s until the 1970s, overlooked the fact that private companies were increasingly investing in R&D, and reflected neo-classical theoretical concepts of growth which considered that technological progress and scientific and technological discoveries lay outside the sphere of the economy. Today, the analysis of innovation processes takes better account of the interactions between all public and private institutions carrying out scientific and technological activities. These processes are viewed in terms of interactive models that stress the interaction between the phases of R&D and the importance of taking the market into account (*cf.* consumers' tastes, demand for quality) in the various phases of research. Consequently, in these models technology changes as it is disseminated, as the new theories of "endogenous" growth have shown (see Figure 2).

The nature of technological changes

The greater interaction between the phases of R&D (basic research-applied research-technological development) can be explained by the desire on the part of firms to accelerate the processes extending from the initial idea for a product to the marketing of the new goods and services. It is also explained by the nature of technological changes. In biotechnologies, for example, the boundaries between

Figure 2. **The "interactive" innovation process**



Source: Author.

R&D phases are becoming increasingly blurred. As a result, in research conducted in universities and public research centres, theoretical and practical aspects almost naturally go hand in hand, making the results potentially marketable. These fields of research in which theory is allied with practice are increasingly numerous today. For example, linguistics, which has traditionally been considered only as a field for basic research, is now making a very significant contribution to progress in the computer and software industry. Once researchers realised (initially in the United States) that they could combine both activities and that this could be justified by the fact that the money made by commercialising their research results could be reinvested in their basic research work, the trend towards the closer association between basic and applied research accelerated, ultimately giving rise to the figure of the "new scientific entrepreneur"[2] who unapologetically bridges the gap between basic research (the search for truth) and industry (making profit), without neglecting either aspect (Etzkowitz, 1998).

Changes in the financing of R&D

R&D expenditure has risen substantially in the OECD area over the past two decades. It accounted for 2.2% of the area's GDP in 1999, with wide disparities across countries (see OECD, 2001). The share of business in financing R&D (60% across the entire area) but also in performing R&D (70% across the entire area) shows its importance to the business sector, which is funding a growing (though still small) share of research in universities and public research centres. According to the OECD, 4.1% of government research and 6.1% of research performed by higher education is funded by business.

The budget deficits have led to reductions in public spending. This has chiefly affected the business and defence sectors, but there has not yet been a significant decline in public support for basic research. However – and this is important – the nature and the conditions of financing are changing, for the granting of funds is subject to output and performance requirements, which has the effect of concentrating resources on specific contracts in specific places (OECD, 1998). The interest shown by the business sector and the need for universities to develop their own sources of funding are further explanations for the development of practices of commercialising the results of scientific research and the ongoing debates in this regard.

However, there are considerable differences in the results obtained in commercialising research in different countries and university systems. Some countries, such as the United States, are often presented as examples of successful relations between universities and business. In other countries (such as European countries), efforts to build these relations are fraught with difficulties and public research often continues to be perceived as an "ivory tower". It is therefore necessary to examine the factors that act as incentives for commercialising public research.

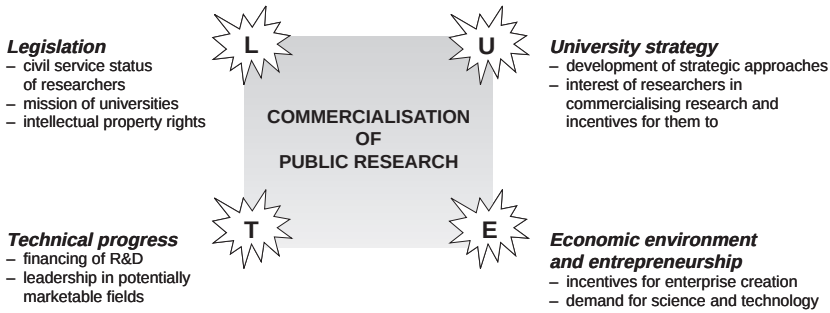
What are the incentives for commercialising research?

The "organic paradigm" of commercialisation

Innovation policies alone cannot explain the results obtained by given countries in commercialising public research. The existing case studies, and those that we have cited above in particular, make it possible to identify what we have called the "organic paradigm" of commercialisation, which presents the key factors of commercialisation in schematic form (Figure 3).

Why have we used the expression "organic paradigm" of commercialisation and how do we justify the choice of the incentive factors presented here? To answer these questions, we must refer back to the definition of commercialisation, according to which new objectives and evaluation criteria are assigned to scientific work which is no longer aimed solely at disseminating basic knowledge (*i.e.* publications) but at generating returns (measured by the number of inventions patented, the number of enterprises created, contracts signed and, further down the line, profits generated, jobs created, etc.). This process requires the decompartmentalising of scientific work and the forging of interactive, systemic and cumulative links between science (the original purpose of which is to increase knowledge of natural and social phenomena), technology (creation of artefacts, fields of invention) and the economy (the market rewards, punishes and evaluates). Consequently, the existence and/or nature of the links between these factors (science: university strategy; technology: technological progress; the economy: the economic environment and entrepreneurship) make it possible to explain the results obtained in commercialising public research. These relations

Figure 3. **The organic paradigm of commercialisation of research**



Source: Author.

are regulated by government intervention (legislation, incentives), which can either promote basic research or focus on reinforcing the operational, economic and technological side of science.

This organic paradigm thus provides a method for analysing commercialisation within an economy or an institution and facilitates comparisons at the national (between universities) and international level.

This analytical framework is supported not only by the history of economic development, which since the beginning of industrial capitalism has been characterised by the increasingly close relationship between science, technology and the economy, regulated by government (on this topic see Bernal, 1954; Gille, 1978), but also, as we shall see later, by the current case studies presented in the literature.

We were prompted to propose this analysis of commercialisation after examining the case of the United States and after comparing this case study with the situation prevailing in other countries. Let us explain this more fully. The debate on the use of the results of scientific research that has now reached Europe began in the United States in the 1970s. It was against a background of a growing budget deficit in the United States that the Stevenson Act and the Bayh-Dole Act were passed in the early 1980s. The former introduced commercialisation as a new mission of public research, while the latter gave universities conducting research jointly financed by federal funds intellectual property rights over their discoveries and the right to commercialise them through exclusive licences. This legislation is now often seen as a key factor explaining the strong patenting and licensing results achieved by US universities since the 1980s.[3] However, some researchers

feel that this explanation is insufficient, and focus on other incentive factors that support our analytical framework.

Legislation. The legislative aspect comprises a number of factors. Firstly, there is the legislation on the missions of a university, *i.e.* what it can and cannot do to commercialise research. For example, until 1999 it was illegal for a civil servant in France to hold ownership rights, exercise supervisory duties or accept employment of any kind in a private company, subject to severe punishment under the law. This seriously restricted the possibility of commercialising research.

Legislation also concerns intellectual property rights. For example, in the case of the United States, economists (Mowery *et al.*, 2001; Jaffe, 2000) stress the role that the legislation and decisions enacted in the 1970s have played with regard to the patentability of biotechnologies and software, and maintain that they facilitated the commercialisation of the results of research carried out in universities.

Technological progress. The trend of R&D expenditure (and especially public R&D spending) since the Second World War is also an important factor in explaining the robust results achieved in the United States in commercialising university research in biotechnologies and information technologies (Etzkowitz, 1998).

However, the study carried out by Henrekson and Rosenberg (2001) comparing Sweden with other countries shows that, despite strong public support for R&D activities and the commercialisation of university research in Sweden, the results obtained are significantly lower there (in proportion to expenditure) than in the United States. Consequently, technical progress and legislation are not sufficient to explain the favourable results achieved in commercialising research.

University strategy. According to the authors cited above, the reasons for Sweden's poor results in commercialising research are to be found within the university system: the Swedish system (like that in European countries, according to the authors) is hierarchical and compartmentalised and provides little incentive for mobility; it differs from the US system, which is open, competitive and more responsive to the needs of firms since its operating standards are closer those of the corporate world.

At the institutional level, other studies stress the importance of defining the specific strategy for the university. This can mean capitalising on its assets by specialising either in conducting high-quality research or in meeting the needs of firms by seeking to develop applied research and high-quality education (as in the case of Salford University in the United Kingdom, studied by Powell *et al.*, 2001).

The economic environment and entrepreneurship. This aspect is also emphasised in the comparison between Sweden and the United States by Henrekson

and Rosenberg (2001), but at the macroeconomic level (the factors listed are: incentives to invest in human capital; incentives to become an entrepreneur, *i.e.* industrial legislation and a framework conducive to the creation of innovative companies; incentives to develop existing companies, such as low taxes and availability of various means of financing such as venture capital; labour market flexibility).

Another aspect less frequently addressed in these case studies concerns the local environment. The results of commercialising pubic research will no doubt be very different in an "innovative environment" (in which all the resources necessary to support enterprise creation are available) than in a poor environment where innovation is the exception rather than the rule. We shall place strong emphasis on this aspect in the second part of this paper.

T*he situation in* F*rance*

What is the situation in France with respect to the organic paradigm of commercialisation presented above?

In France, the 1999 Innovation and Research Act put an end to the criminal sanctions to which researchers with civil servant status were liable that prevented them from becoming involved in creating enterprises (Richevaux, 2001). This legislation provided a complete system for enabling the commercialisation of research to be developed in France (see box).

However, the initial quantitative results obtained have proved relatively disappointing since they are far lower than originally anticipated. According to the Ministry for Research, 168 researchers have been authorised to create or participate in the creation of enterprises (as compared with the 400 anticipated for the 1999-2002 period) and the total number of enterprises created at the end of 2001 stood at 102.[4] According to our calculations, this means that fewer than 0.3% of French researchers covered by the Innovation Act participated in the creation of an innovative enterprise. The government has spent enormous sums to support the development of innovative enterprises (some 300 million Euros per year, not including tax relief),[5] but the results are long in coming, even though some universities and public research centres are capitalising on this legislation to broaden their longstanding relations with the business sector. An analysis of the incentive factors listed above can enable us to understand the French situation better.

Firstly, in the field of **legislation**, as we saw in the case of the United States, the strengthening of intellectual property rights and their extension to new fields at the cutting edge of science and technology such as biotechnology and software played an important role in promoting patenting by US universities. However, in

The four facets of the Innovation and Research Act (Act No. 99-587 of 12 July 1999)

Mobility of research staff to enterprises via:

Enterprise creation aimed at commercialising the work of the staff members concerned, who may keep their status for a maximum period of six years and return to their laboratory of origin if they wish to do so at the end of this period.

Employment in a scientific capacity in an innovative enterprise (for a maximum period of five years).

Equity investment in an enterprise, for an amount up to 15% of its capital.

Membership on an enterprise's board directors.

The provisions of the law concern civil servants, both permanent and probationary. However, certain employees without civil service status working under the authority of the ministers for higher education and research may, under certain conditions, be eligible for the first two forms of mobility, *i.e.* enterprise creation to commercialise research and private employment in a scientific capacity. There are no restrictions regarding the legal status of the enterprise created, but its activity must be devoted to the commercialisation of research. A contract must be signed between the public institution and the company commercialising the research.

Co-operation between public research and firms:

Creation of business incubators and provision of operating resources to enterprises. An incubator is defined as a support centre created by research bodies or universities in order to provide advice, financing and premises to prospective entrepreneurs with innovative projects.

Development of units responsible for the industrial and commercial activities of public institutions to manage their research contracts with firms or other public bodies and also to manage patents and provision of services.

Streamlining of the administrative formalities applicable to the creation of subsidiaries or associations in the public interest and the recruitment of contract staff.

Creation of a tax framework conducive to the development of innovative enterprises:

Liberalisation of stock option schemes.

Liberalisation of provisions on "innovation" mutual funds.

Extension of the research tax credit.

The creation of a legal framework conducive to the development of innovative enterprises:

Extension of the provisions governing simplified joint stock companies to venture companies with high growth potential.

France and Europe more generally, debates on the patentability of software or on "isolated elements of the human body" have either met with scepticism or not changed the status quo. In February 2002, the European Commission opted for the patentability of software, but there is still much resistance in France. In the field of biotechnology, the European Directive of 1998 is ambiguous and France is still firmly opposed to the patentability of human genes, which is seen as being contrary to French legislation on bioethics. This difficulty of patenting hinders the commercial exploitation of the results of public research.

In the field of **technological progress**, R&D expenditure in France relative to GDP (2.1%) was below the OECD average in 1999 (2.2%), but also below the average of the major industrial countries (OECD, 2001). Moreover, the scientific and technological fields in which basic research naturally goes hand in hand with applied research (*i.e.* biotechnology and information and communication technologies) are not ones in which France can claim to have a significant lead. According to the French Centre for the Monitoring of Science and Technology (OST, 2002), France's global share of scientific competence in key technologies (defined through 2005) stood at 5.5% in 1999. It is below average in electronics (3.8%), telecommunications (4.1%) and computers and biotechnologies (5.1% respectively). Similarly, France produces 6% of all European patents linked to key technologies. Although it is above this average in some fields (such as materials and metallurgy with 7.6%), it is lower in others, such as biotechnologies (4.2%), electronic components (4.8%) and computers (5.2%).

Regarding the **economic environment and entrepreneurship**, the liberal policies implemented in recent years are leading to a simplification of the rules governing enterprise creation, even though this often remains a long and difficult process.

Lastly, there are the existing incentives in **universities** and research bodies. These can be developed by raising staff awareness, but above all by increasing the flexibility, competitiveness and mobility of researchers. This too is an area where there seems to be progress towards a more open system. But the French education and research system has been built on the key ideas of public service, *i.e.* equal access for all to education and to the knowledge produced by research. Although this system is seen as being a source of bottlenecks, hierarchy and bureaucracy, a broad privatisation of university systems can also have negative consequences (more difficult access to education and research, greater job insecurity, a short-term outlook). In the second part of this paper, we shall study in greater depth the case of a young French university located in a region in crisis – Nord/Pas-de-Calais – in order to gain a better insight into the impact of the Innovation and Research Act.

PROSPECTS FOR A YOUNG UNIVERSITY IN A REGION IN CRISIS

A university to support local restructuring: the Université du Littoral Côte d'Opale (ULCO)

The origin and development of the Université du Littoral Côte d'Opale

The university that will be studied in this second part is the U*niversité du* L*ittoral* C*ôte d'*O*pale* (ULCO), located in the Nord/Pas-de-Calais region. It is a young university, founded in 1991 for the purpose of revitalising activity by developing human potential in a region in crisis. It has several campuses, with university facilities in four cities (Boulogne, Calais, Dunkerque and Saint Omer), three of which are characterised by intense port activities (specialised in fishing at Boulogne, transport at Calais and industry at Dunkerque).

The sharp rise in student enrolments since 1992 (from 4 278 in 1992-93 to 10 608 in 2001-02) has justified the decision to create an additional university in the Nord/Pas-de-Calais region (which has five other public universities: the three universities located in Lille, the U*niversité de* V*alenciennes* and the U*niversité d'*A*rtois*). The region's coastal areas lagged considerably behind in enrolment rates because of insufficient university facilities (the Lille universities ran some local branches), which hampered the development of new activities.

Students enrolled in the U*niversité du* L*ittoral* can pursue studies in all disciplines except medicine, which is not offered. Over 40% of the university's students are grant recipients (consisting of the annual financial aid provided to young people from disadvantaged families), since it has a larger than average number of students from a working-class background and this characteristic has increased over time (index 184 in 1992-93 and 246 in 1999-2000, R*epères* – ULCO, 2001).

Nearly 60% of the university's students are enrolled in purely vocationally oriented programmes, such as Business and Social Administration (AES), vocationally oriented university institutes (IUP), university institutes of technology (IUT), business schools, etc. General education programmes are not popular with young local residents and are numerically smaller, even though they include students preparing for vocationally oriented programmes. Most students are enrolled in undergraduate programmes. Only 7% of the degrees granted in 2001 were the graduate level DEA (Diplomas of Advanced Studies) and DESS (Diplomas of Specialised Higher Studies), although this proportion has been increasing over the years (R*epères* – ULCO, 2001).

The teaching staff has also grown considerably, rising from a total of 223 in 1992-93 to 492 in 2001-02. There were 316 teacher-researchers (full professors and senior lecturers) in 2001-02. Secondary teachers seconded to teach at the university represent a large category of staff, well above the average in other French uni-

versities (29% of teachers at the ULCO in 1999-2000, as compared with 20% in French universities at the same date, *Repères*, 2001). Moreover, the student-teacher ratio is too low (by 156 teaching positions according to French standards), and the university administration feels that the prospects for recruitment are a cause for concern (see 2002-06 four-year contract).

The university's research potential is developing gradually (17 laboratories are recognised nationally) and is organised around three poles: the "environment, man and coastal areas", mathematics and engineering sciences.

From these brief indications, it can be seen that the U*niversité du* L*ittoral* is a university which is predominantly vocationally oriented in its teaching, with a staff that is expanding but that is still too small for the number of students, and which is seeking to ensure that its research activity is adapted to the region in which it is located. Since the U*niversité du* L*ittoral* cannot compete nationally in all fields of research with older and more prestigious universities, one course of action might be to gear its research and teaching activities towards meeting the region's economic and social needs – but is this approach compatible with the economic and social context of the region?

T*he economic and social context*

The administrative centre of the university is located in Dunkerque. This campus houses the university's central services and nearly 38% of students were enrolled there in 2000/01 (compared with 31% in Boulogne, 27% in Calais and 4% in Saint Omer). The main socio-economic characteristics of this region are its geographic location (on the coast, as stated above) and the importance of heavy industry, particularly in Dunkerque.

The region of Dunkerque has been highly industrial since the end of the Second World War and the industrial firms that settled there in the mid-1970s were the driving force behind the post-war economic growth (steel production, metallurgy, petrochemicals, energy) (Boutillier and Uzunidis, 1998). These firms were primarily production units (the decision-making centres being located in other regions of France or abroad) and took advantage of the large local labour force, which was generally unskilled. As heavy industry developed in Dunkerque, workers accounted for an increasingly large segment of the labour force (Coppin, 1999).

The crisis in shipyards and heavy industry at the end of the 1970s led to a slowdown in Dunkerque's economic development. Unemployment rose sharply and there was growing competition between firms. In response to these economic difficulties, both the local and national government sought to develop a new restructuring strategy. As regards capital, this strategy sought to attract foreign firms. In the field of labour, it sought to create new training and research potential (U*niversité du* L*ittoral* C*ôte d'*O*pale*).

Once again, outside companies (from other regions of France and/or owned or controlled by foreign interests) established operations in Dunkerque in the form of production units for subsidiaries headquartered in various major European cities. Consequently, the decisions made reflect the strategy of the parent company. These production units also wished to capitalise on the region's structural advantages (industrial port, gateway to the European market) and economic factors (tax relief) (Ziel, 1998). All decisions regarding the recruitment of unskilled labour are made by the parent company. The senior managers working in companies in Dunkerque most often come from outside the region and are often assigned there only for a short period. Firms mainly recruit manual and office staff with low to average skills (Laperche and Loubert, 1998; Laperche, 2002). These firms' research laboratories are located in other regions with greater scientific and technological potential. Because of this situation, and despite the relative interest that the university's researchers have shown in commercialising research, there are few incentives for them to do so.

Enterprise creation is low in the Nord/Pas-de-Calais region compared with the national average (26 enterprises created each year per 10 000 inhabitants, compared to the national average of 44/10 000). It is even lower in the labour market area of Dunkerque (553 new enterprises created in 2000) according to the National Statistical Institute (INSEE), *i.e.* a rate of 25 enterprises created per 10 000 inhabitants, also well below the national average. The same is true of Boulogne and Calais, where activities are geared more towards the primary and service sectors. Unemployment rates are also high (13.5% in the Calais region, 13.6% in the Boulogne region and 11.6% in the Dunkerque region in September 2001), and although initiatives to create new activities have been launched, they involve many more traditional projects than high-tech ones (see Mudard Franssen, 2001, for the case of Dunkerque).

The problems encountered in implementing the Innovation Act in a university such as the U*niversité du* L*ittoral* prompt us to raise the question of the role played by the economic and social environment in the universities' ability to adapt to the new situation. Before attempting to provide some partial answers to this question, it is interesting to take a look at the practices and opinions of this university' researchers regarding the commercialisation of research.

The difficulties of commercialising research

A *survey*

The U*niversité du* L*ittoral* has made the commercialisation of research one of its priorities during its third institutional contract (2002-06), even though this has been a key aspect ever since the university was established in view of both its

location and its stated objective of contributing to the renewal of local economic activities.

The survey conducted between July 2001 and February 2002 concerned the commercialisation practices of laboratories. It also included a study on researchers' opinions regarding the advantages and disadvantages of commercialising research. The research laboratories were surveyed through direct interviews (using a questionnaire) and were selected on the basis of two criteria:

- Recognition received from the National Education Ministry and/or the CNRS (National Council for Scientific Research).[6]
- The fact that they were currently (or potentially) conducting work that might be commercialised in any of the forms identified, *i.e.* filing of industrial property rights, signing of contracts with firms, mobility of research staff or creation of enterprises to commercialise research results.

Sixteen laboratories were initially selected, the vast majority of which were in the fields of materials sciences and life sciences. A human sciences laboratory was also included, since it was already actively involved in commercialising its research. Fourteen laboratories responded to the survey, representing a total of 207 teacher-researchers and associate research-teaching staff members. The laboratories surveyed covered 43% of the university's teacher-researchers (full professors and senior lecturers employed by ULCO). This percentage may seem low, but in all, only half of the university's teacher-researchers in all disciplines are attached to laboratories recognised by the National Education Ministry and the CNRS, which explains this university's considerable research potential, but also the fact that this potential is underused because the university has not extensively developed its research facilities.

Main results

The questionnaire comprised two parts: a section identifying the laboratory (name of laboratory, discipline, name of director of laboratory, field of research) and a section devoted to the various practices of commercialising research.

The four forms of commercialising research identified and the type of questions asked were as follows:

- *Filing of industrial property rights*: has the laboratory filed industrial property rights? What types of property rights? Does the laboratory plan to file industrial property rights in coming years?, etc.
- *Contracts with firms and with partners outside the university*: has the laboratory signed contracts with partners outside the university and what are the types of partners: local authorities, ministries, the European Union, firms, associations or foundations, other? Number and duration of contracts? etc.

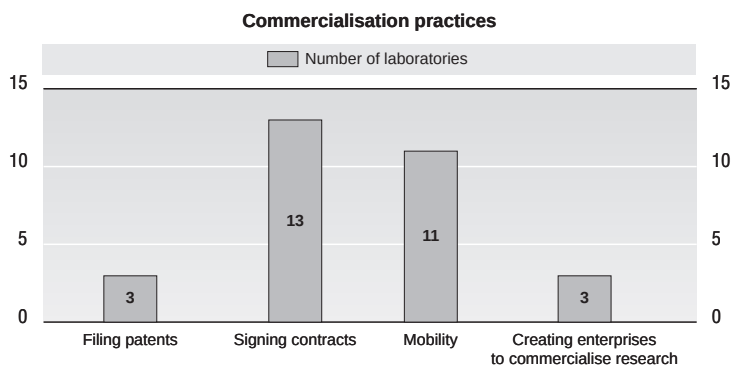
- *Staff mobility*: does the laboratory practice mobility of research staff? What types of mobility (graduate research grants, cofunded graduate research in companies, secondment of staff to private bodies, hiring of researchers, membership of researchers on boards of directors of private firms, other)? And for how long? etc.
- *Creation of enterprises to commercialise research findings*: the questions asked concern the legal form of the company, the date when it was established, the number of persons employed, its sector of activity, its equity capital and location. One question concerns any assistance received (subsidies, advice on commercial aspects, material assistance).

A qualitative study was also conducted on each of the forms of commercialising research using a non-exhaustive list of the benefits and difficulties of each form of commercialisation. These lists were drawn up by making an inventory of the advantages and disadvantages of commercialising research most frequently presented in the literature (examples of advantages: source of funding, enhancing the laboratory's reputation, creating scientific networks; example of disadvantages: legal problems, problems of confidentiality, lack of support staff).

The results showed that all these different practices of commercialising research are used by the laboratories of the *Université du Littoral Côte d'Opale* (see Figure 4).

The signing of outside contracts (particularly with private firms) was the most common form of commercialising research among laboratories (with 13 of the 14 laboratories surveyed stating that they had already signed one or more

Figure 4. **Practices of commercialising research by laboratories**



Source: Author.

contracts with private firms). Staff mobility came next and generally took the form of participating in national and international scientific networks, but less often involved genuine mobility to firms (graduate research cofunded by firms, *i.e.* "CIFRE" contracts for industrial agreements for training through research). The filing of industrial property rights (limited to patents only) and the creation of enterprises to commercialise research were tied for third place. In the latter case, the laboratories themselves created an enterprise (through one of their teacher-researchers) or else they supported the creation of an enterprise through their research (creation of an enterprise by a Ph.D holder). It should be pointed out that most of these initiatives by laboratories to support enterprise creation predated the Innovation and Research Act. Concerning future plans, ten laboratories envisage the possibility of filing industrial property rights and six laboratories are planning to create an enterprise or would like to do so. On the whole, the signing of contracts and the mobility of researchers are the most common forms of commercialising research, which can be explained by the fact that these practices are now a firmly established tradition in universities.

The results of the qualitative analysis are as follows:

- **"Filing of patents: "As many advantages as disadvantages"**

The main advantages of filing industrial property rights are the revenue generated by the patent and the enhanced reputation of the laboratory. The main disadvantages are the cost of filing industrial property rights (in this case a patent) and the problems that it generates for the future publication and use of the research findings.

Researchers are willing to practice this form of commercialisation, but are waiting until they can be more certain about its comparative cost-benefits and about the changing criteria for the evaluation of their careers.

- **Contracts and mobility: "the advantages outweigh the disadvantages"**

Contracts bring sources of financing, make it possible to create and consolidate scientific and technological networks and integrate researchers into the professional world. The main disadvantages of signing contracts are management problems and the confidentiality of research findings. As for mobility, it is hindered by the lack of staff (*cf.* the staff shortage mentioned above) and the risk of disseminating research results and methods without proper control.

These longstanding and widespread practices are forms of commercialising research that have more advantages than disadvantages. The disadvantages can largely be solved by hiring staff (research engineers, researchers). The analysis of the results shows that the problems of controlling research results and methods are an inherent concern of laboratory directors.

- **Creation of enterprises to commercialise research: "more disadvantages than advantages"**

The main advantages of this practice are that it promotes use of the laboratory's research and thereby enhances its reputation. The assistance provided by regional incubators is considered to be an important advantage that can facilitate this form of commercialisation.

The main difficulty resides in researchers' lack of interest in creating enterprises, followed by the legal and administrative problems involved and the lack of awareness of the assistance provided by regional incubators and by the university's commercialisation unit.

Issues and prospects

This case study makes it possible to address a quite specific aspect of the issue of commercialisation of research, *i.e.* the impact of the economic and social environment on relations between universities and firms. These relations involve both education and research. With regard to education, the applications submitted by universities to the Ministry for National Education and Research for approval of new programmes (whether in initial, continuing or vocational education) incorporate this dimension of relations with the economic and social environment. These programmes may include the participation of firms in education and training by taking in trainees and/or by having their staff collaborate with teaching teams in universities. The objective is to enable future graduates to enter the labour market, but there is debate over whether these initiatives may not limit the scope of the programmes offered and lead to specialisation in very specific fields that may soon be outdated.

It is in this regard that the level of development of a region and the diversity of its activities takes on great importance. A rich and diversified economic and social environment, in which activities with high scientific and technological content are found alongside more traditional activities, will play a positive role in enabling a university to develop a broad range of programmes that can easily be integrated into the local economy (*i.e.* enable graduates to find jobs) and promote the creation of new activities. Similarly, there is every reason to believe that in this type of environment partnerships between universities and firms will not only lead to the development of new subjects of research but also to the creation of new enterprises and jobs. However, it will be more difficult to trigger this virtuous relationship in industrial regions specialising in economic activities in highly specific traditional fields.

In regions hit by the crisis in large-scale industry, the development of educational programmes that are out of step with the needs of the economic environment (as in the case with the U*niversité du* L*ittoral* C*ôte d'*O*pale*) lead to a form of

"brain drain" of graduates from the region where they were educated to other regions or environments where it is easier for them to find jobs or create new activities. This occurs because one of the specific characteristics of "human capital" is that it is only effective in an environment in which it can develop and grow. This can be quite easily demonstrated in a micro-economic setting, for the fact that a highly skilled employee moves from an innovative start-up to a traditional company will not in itself enable the latter to become an innovative firm unless it also completely changes its organisation and development strategy. Similarly, the fact that an area offers a broad range of high-level education programmes will not in itself make it possible to restructure the economy of an area and diversify its activities. This requires a complex and complete strategy in which firms, universities and government work together (Coppin, 2001).

If we refer to the organic paradigm of the commercialisation of research presented in the first part, without returning to the aspects of legislation and technological progress that we have studied more broadly for the case of France, we can understand the difficulties that the U*niversité du* L*ittoral Côte d'*O*pale* has encountered in developing and commercialising its research. These difficulties originate in the aspects of the economic environment and entrepreneurship and the university's strategy.

Our presentation of the economic and social context showed that **entrepreneurship** is not highly developed in the region and that there is little incentive to establish new practices of commercialising research in the local area. Most of the university's partnerships (numerically speaking) are with small and medium-sized enterprises working as subcontractors for major industrial groups and consist of one-off projects that are more related to engineering than to research work. In the university's larger research programmes, its laboratories work with companies in other regions on highly specific subjects. This being the case, the economic impact of these projects on the area (creation of activities and jobs, diversification of activities) is very slight. Consequently, this case study shows that it is not sufficient to legislate a policy for making scientific and technological knowledge available in order to create a relationship of synergy between the development of universities and economic development. In the case in point, the problem is the lack of demand on the part of the main economic actors (industrial firms).

Regarding **university strategy**, the department responsible for the commercialisation of research is recent (the commercialisation unit was set up in 2001-02) and the commercialisation policy lacks a priority focus and targets the widest possible audience (there are plans for outreach to second-year students). We should mention that bodies with responsibilities in this field have existed since the university was established (in particular "the Centre for Research on the Industrial Environment of Dunkerque" responsible for creating bridges with firms) but they have gradually been neglected because of the plans to organise the new bodies

provided for by the Innovation Act. We have sensed that this lack of clarity regarding the responsible bodies generates some perplexity among researchers and reflects the lack of a common policy and goals. Moreover, the fact that the university is still relatively new exacerbates the general difficulties faced, *i.e.* the problems of reconciling the missions of teaching, performing research and commercialising research in a university in which the first two missions are only beginning to be developed, the lack of research and engineering staff, etc.

CONCLUSION

The commercialisation of research is not a new development, for although science and technology have long been thought of as being separate they have gradually drawn together during the history of capitalism, and especially industrial capitalism. The current period is marked by a growing involvement of scientific work with society and by the general extension of the corporate model to all branches of social activity. The commercial exploitation of the results of scientific research has taken on new importance now that global economic competition is based on technological power, which is broadly dependent on continual interaction of producers of knowledge, inventors and innovators. Furthermore, the budgetary constraints facing governments require public research bodies to diversify their sources of funding.

France, after other major industrial countries, has implemented a new legislative framework aimed precisely at facilitating the commercial exploitation of the results of public research. The relatively disappointing quantitative results achieved thus far can be explained by the fact that legislation alone is not sufficient to promote the creation of entrepreneurial universities. Empirical studies on the situation in the United States, for example, show that entrepreneurship (*i.e.* the economic and social context), leadership in scientific and technological fields that naturally combine theory and practice (such as biotechnologies and information technologies) and, lastly, the incentives existing in universities (the university strategy but also the operating standards of the university system) help to explain the United States' positive results in commercialising research. The organic paradigm showing all of these incentives makes it possible to understand the French situation better: the fact that it is less advanced in key scientific and technological fields, the patenting difficulties encountered in these fields and the low enterprise creation rates despite generous government subsidies, but also the few incentives existing within the university system, can explain why there have been problems in commercialising research in France. Nevertheless, the current trend is towards strengthening the incentives to commercialise research. These changes have prompted major debates, in particular concerning the future of the public education and research service, which is the foundation of long-term technological progress and growth.

The field study used as an example (U*niversité du* L*ittoral* C*ôte d'*O*pale*) shows the inequality of universities regarding the opportunities available but also the risks involved in implementing an ambitious programme to promote all forms of commercialising research. In particular, it stresses the importance of the economic environment in which the research is commercialised. While the forging of closer ties between research laboratories and firms in areas with scientifically, technologically and economically rich environments can trigger a virtuous circle in which a university's development goes hand in hand with economic development, in a region in crisis the same process can have a negative impact on education, university research and the local economy.

In conclusion, we think that it is interesting to mention the fact that there is widespread debate on the subject of the transformation of university systems in the various countries that are currently modifying their public and university research institutions. We shall simply mention here four major areas of discussion, some of which have been touched upon in this case study (for more details, see the contributions of Uzunidis, 2001; Foray, 2000; Cassier, 2001, and also the many articles on this subject in the journal R*esearch* P*olicy*, in particular the articles cited earlier).

The first area of discussion concerns the future of non-oriented basic research, which is the cornerstone of long-term technological progress. Private funding introduces time constraints and causes research to be geared to specific applications. The OECD (1998) reports in this regard that there is a downward trend in the funding available for research based on simple curiosity. This seems to jeopardise the necessary freedom of research. The orientation of funding towards specific areas may lead to increasing specialisation of research in key fields, which might favour certain disciplines strongly to the detriment of others.

The second area of discussion is the future organisation of universities, particularly in Europe and France, where the concept of public service is very important, as we mentioned earlier. Factors such as the major changes in the status of researchers, the introduction of competition and flexibility and the cost of implementing the new legislation (the need to increase technical staff, pay researchers who create enterprises, maintain incubators, etc.) could well lead to a cleavage between universities (those that manage to increase their self-financing and those that are unable to do so). "For the former, the entrepreneurial approach to research will create a virtuous circle of growth, while the latter will remain trapped in a vicious circle of education programmes increasingly divorced from the job market" (Uzunidis, 2001).

The third area of discussion concerns the issues raised by the private use of research results. The essential question concerns what is the best way to promote the wide dissemination of knowledge and make available the secrets hidden in

laboratory test tubes: is it to allow firms to have exclusive use of knowledge (by having universities grant them exclusive licences) or is it to make this knowledge available free of charge to society at large? The idea of allowing universities to exploit the results of research (filing patents, selling exclusive licences) is based on the desire to make them self-financing, but also to promote broader dissemination (and wider commercial use) of knowledge in society. The underlying idea is that firms will exploit this knowledge more easily if they are in a monopoly situation (via exclusive licences). But recent studies tend to show that the research results that are best exploited are not those that are commercialised through exclusive licences (Mowery *et al.*, 2001).

Lastly, the final area of discussion is whether or not there is a real demand for commercialising the results of scientific research. The legislation aimed at transforming university and research systems establishes policies of scientific and technological supply. But is there a corresponding demand? Are firms willing to invest large sums to create products when it is far from certain that these will ever be profitable (witness the problems of firms that invested massively in new information and telecommunications technologies in recent years)? This question is all the more relevant given that many scientific and technological advances do not concern individual consumers, but society as a whole (such as high-speed communications or therapeutic cloning). Moreover, the demand of firms is far from uniform and varies considerably depending on the characteristics of the environment studied. Consequently, there is reason to believe that the scientific and technological demand will be stronger in a region that is rich (in human and financial capital) than in more traditional regions. However, although not every economy can become a Silicon Valley or a Genome Platform, every human environment can, by establishing intrinsic relations of synergy, become an innovative environment.

Notes

1. This document was drafted on the basis of the results of a research programme entitled *Valorisation de l'offre technologique et incubation* (Commercialisation of technological supply and incubation) carried out on behalf of the Delegation for Territorial Development and Regional Action (DATAR) and the incubator of Nord/Pas-de-Calais (MITI) under the supervision of Dimitri Uzunidis, Director of the Laboratory for Industrial Redevelopment and Innovation of the Université du Littoral Côte d'Opale. Final Report, Laperche (2002), Valorisation de l'offre technologique et incubation, Datar/MITI/Lab.RII-ULCO.
2. The idea for a new scientific entrepreneurship is based on the fact that relations between science and industry have long existed but that they are currently taking new, more interactive forms that more closely involve scientific researchers, who more readily link (both in thought and in action) the production of knowledge to the realisation of profits through relations with industry (Etzkowitz, 1998).
3. Fewer than 200 patents per year were filed by US colleges and universities before 1981, and this figure had risen to nearly 2 500 in 1997 according to the US Patent Office [Mowery *et al.*, Research Policy (30), 2001, p. 104]. Viewed from Europe, this new legal framework linking academic research to the industrial world was rapidly seen as being the result of the strong US growth in the innovative technological fields (information and communication technologies and biotechnologies) during the late 1990s.
4. S*ource*: Ministry for Research, Legal Advisor, Directorate for Technology, December 2001 and January 2002 and compilation DT C2.
5. According to L*e* M*onde*, "L'État vole au secours des start-up", 19 December 2001.
6. In July 2001.

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From:
Higher Education Management and Policy

Access the journal at:
https://doi.org/10.1787/17269822

Please cite this article as:

Laperche, Blandine (2002), "The Four Key Factors for Commercialising Research: The Case of a Young University in a Region in Crisis", *Higher Education Management and Policy*, Vol. 14/3.

DOI: https://doi.org/10.1787/hemp-v14-art23-en