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TECHNOLOGY TRANSFER IN ACADEMIA: THE CASE OF *NATIONAL TECHNICAL UNIVERSITY OF ATHENS*, GREECE (A BRIEF SKETCH)

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Abstract

The global economy changes rapidly and makes cooperation between researchers indispensable for the successful completion of the projects. In Greece, universities account for the majority of absorption of the research funds, at a time when industrial participation remains low. Hence, the analysis of Technology Transfer in Academia is of paramount importance. This paper describes the perspectives of the Industrial Liaison and Technology Transfer Office (ILTTO) of NTUA based on data from internal sources. The paper concludes that the ILTTO should focus on encouraging young researchers and improving the linkages with the users of the research results.

Keywords: Technology Transfer, Universities, S&T policy, NTUA, Greece

1. Introduction

Nowadays, universities, engineering schools and research centers are perceived as more than academic institutions of higher education and research. In fact, they are increasingly viewed as contributors to technology transfer and economic development. In this framework, in the course of the past three decades, university research has become a "hot" issue. Research conducted in universities is regarded as being of high intrinsic value, and several economic agents (e.g. the universities themselves, private companies, governments, etc) are interested in sharing this value. The relevant literature on the subject abounds and the United States, followed by Europe and Japan, are the main drivers of this phenomenon (see, among others, Mansfield, 1995; Etzkowitz and Leydesdorff, 1999; Rosenberg, 2000; Mowery et al., 2001).

There is no doubt that the creation, transfer and exploitation of science and technology are playing an important role in modern economic analysis. Numerous surveys have indicated the multiple sources of innovation, whereas collaboration between creators and users of knowledge is one of them. Of course, the process of technology transfer has a significant social dimension as well. For instance, the university spin-outs from the development of research products offer job vacancies. However, despite the fact that Research & Development (R&D) leads to increases in productivity and economic growth, E.U. invests fewer funds in R&D compared to its competitors. The R&D industry hires people of higher qualifications and pays better. Analytically, the employment increase was equal to 16.2 % for the knowledge-intensive services (KIS) and 12% for the high-tech field in the time period 1997-2002, compared to an 8% increase of the total employment (E.C., 2006).

Greece, despite having stabilized, to a great extent, its macroeconomic environment, is still in the process of implementing an effective strategy for the promotion of technology transfer. Meanwhile, several characteristics of the Science and Technology (S&T) system seem to constitute a burden to the dissemination of technology in the country, namely the small size of the research community, the dispersion of the research effort to multiple themes and the weak communication among research units.

The effort for the implementation of an efficient S&T policy is shared by several authorities in the country while it has been primarily supported by European Union (E.U.) funds. In this context, international co-operation and E.U. programs constitute an important channel of technology transfer for Greece. However, the global economic environment changes rapidly and makes cooperation between research units indispensable for the successful completion of the projects. In this context, academic institutions account for the great majority of absorption of the program funding, at a time when industrial participation remains relatively low in the country. Hence, the analysis of the process of technology transfer in Academia is of great importance.

The aim of this paper is to describe the various perspectives of Technology Transfer and Industrial Liaison (ILTTO) at the National Technical University of Athens (NTUA). The analysis is based on data that come from internal sources covering the time period 2000-2006 and proceeds on the assumption that the process of technology and knowledge transfer relies on the interaction with societal factors.

The paper is structured as follows: in the second part we present a brief account of the research process at NTUA; in the third part, we describe the relation between university and technology transfer; in the fourth part we set out the goals of the NTUA ILTTO; subsequently, in the fifth part, for reasons of comparison in terms of profitability, we refer to Massachusetts Institute of Technology (MIT) and two other major research centers in Germany, namely the Max Planck Institute and the Fraunhofer Gesellschaft; finally, the sixth part concludes the paper.

2. University Research and Technology Transfer

In advanced economies the knowledge-intensive sectors have replaced exploitation of natural resources as the primary source of economic growth. In this context, universities play a major role in social and economic life (Feller, 1990). Mansfield (1991) estimated that around 10% of products and processes could not have been developed in the absence of systematic academic research. These estimations were higher from the respective ones from a previous study (Gellman, 1976). A German study using Mansfield's approach concluded that in the 1993–1996 period, 40% of German firms produced an innovation that could not have been developed without the support of recent university research (Beise and Stahl, 1999). Also, Rosenberg and Nelson (1994) argued that American universities were closely related to the needs of industry through their growing engineering schools.

In general, research conducted in universities has direct impacts on commercial organizations; meanwhile, the rise of venture capital brought funds for the conversion of academic knowledge and research into new firms (the so-called academic spin-offs), the number of which has increased significantly over the last two decades.[1] In the last ten years, thus, the attention has been focused on the channels of technology transfer between university and industry and tries to measure the most effective mechanisms for their transfer to industry.[2]

The development of university research is often done by private firms, since university researchers typically lack appropriate resources for the development and the commercialization of the research results. But, the early stage of many university inventions ask for inventors to remain involved during development given that the inventor's role is one of transferring years or even decades of knowledge and experience to the firm (Jensen and Thursby, 2001).

In the meantime, the institutions of intellectual property rights (IPR) have supported the contribution of university research to economic development. For instance, in the U.S. the magnitude of this institutional change is illustrated by a variety of indicators, including the number of patents, the related income received by universities, and the diffusion of technology transfer offices across universities (Mowery and Sampat, 2001).

Also, the partnership agreements between universities and industrial firms have increased significantly and more funds are being funnelled from industry to universities. In many countries, governments and universities themselves provide the majority of funds for university research, but the contribution of the private sector has doubled since 1980. In 1997, about 12% of the funds allocated to university research came from the private sector, compared to about 6% in 1980 (OCDE, 1998).

Several authors studied the motivations of each party's willingness to establish a partnership (see e.g. Lee, 2000; OCDE, 1998). What motivates most universities to collaborate with the industry is obtaining funds for equipment and researchers, the possibility to test practical applications of their theories, and the opportunity to obtain funds for their own research. In this spirit, Cohen et *al.* (1998) argued that Universities are primarily motivated by the need to find funding (OCDE, 1998), for pursuing their objectives. In contrast, firms are mainly approaching Universities looking for knowledge and expertise, inherently driven by profit motives. The type of partnership and interactions between industry and universities depends on the contribution of both parties (Poyago-Theotoky et *al.,* 2002). The academic party often participates as a shareholder, a co-proprietor of a new company or as a recipient of license royalties (Jensen and Thursby, 2001). In fact, most universities and companies would undoubtedly

[1] Also, in the last twenty years, the great majority of patents, transfers and spin-offs came from biology and the human sciences (Mowery et al., 2001).

[2] Libaers et al. (2006) studied university spin-outs and concluded that university spin-offs play an important role in the development of this new technology, but they compete with large companies as well as corporate spin-outs and new technology based firms.

agree that university–industry collaboration should grow or, at least, maintain its present level.

Mansfield and Lee (1996) estimated that the probability for a business to invest in R&D activities in a university increases with the quality of the department involved. Berman (1990) found that the level of private funding in universities is positively related to the scope of research. For instance, following Beise and Stahl (1999), German universities prefer collaborating with large firms because of their financial robustness. Meanwhile, in Canada, large firms are also more inclined to get involved in partnerships with universities, when compared to small firms (Baldwin and Hanel, 2003).

Also, firms facing competition are more likely to collaborate with universities compared to firms facing limited or local competition. According to Berman (1990) and Beise and Stahl (1999) collaboration with universities is a motive for R&D spending within collaborating firms. In order to be able to benefit, firms must be able to incorporate this knowledge in their innovation process (Cohen and Levinthal, 1989).[3] The tendency of firms to collaborate with universities in their regions was also recorded (see Jaffe et al., 1993). Also according to the aforementioned studies, university research partners are geographically clustered (e.g. Silicon Valley in California, etc) and, thus, not accessible to all. Undoubtedly, more research is needed to precisely understand the value of academic technology transfer to industry. Hence, the analysis of the process of technology transfer in Academia is of great importance.

3. Research at NTUA: A Brief Outlook[4]

The National Technical University of Athens (NTUA) is the oldest and most prestigious educational institute in Greece in the field of technology which has contributed to the country's scientific, technical, economic and social development since its foundation in 1836. In Greek it is named "Metsovion" after its benefactors from a small town in the region of Epirus, who made generous donations.

NTUA is divided into nine (9) Schools, eight (8) being for the engineering sciences (including architecture), and one (1) for the theoretical and applied sciences. The total number of NTUA employees is about 1350. The personnel of the nine (9) Faculties include more than 700 people as academic staff, 140 scientific assistants and 260 administrative and technical staff. The total number of undergraduate students is about 8500 and the graduate students 1500.

The scientific staff in the Schools, together with post-graduate researchers, apart from teaching, conduct research work assisted by post-graduate students and a considerable number of external collaborators; the high standards of this research are proved by the numerous publications in International Scientific Journals and International Conferences as well as by the prominent place of NTUA among all European Universities, due to the increasing number of research projects financed by the E.U. and other Greek and foreign organizations. NTUA operates many of its Laboratories also as "service laboratories", which provide expert advice, tests and measurements and all specialized services in general, within the framework of its technological competence, which can be useful for the development of the country.

As it has been already mentioned NTUA undertakes scientific research projects financed by (a) the Directorates of the European Commission, (b) the General Secretariat of Research and Technology, (c) Ministries, (d) Public Corporations, (e) Prefectures, (f) Municipalities and (g) the private sector from Greece and abroad.

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[3] Anselin et al. (2000) found that no significant effect of university research was felt in the areas of chemicals, pharmaceuticals and machinery, while a highly significant effect was found in the areas of electronics and instrumentation.

[4] Most of the information provided in this section is drawn from the official NTUA site (http://www.ntua.gr).

A recent survey on the number of research projects sponsored by the European Commission classifies NTUA in the second place among all European Universities and in the fourth place among all European organizations, including private enterprises. The management and the accounting of the sponsored research is undertaken, according to the Greek law, by an administrative body, the Special Account for Research, which is regulated by the Research Committee, consisting of 9 representatives from each one of the 9 Schools, and chaired by the Vice Rector for Financial Planning and Development.

NTUA benefits from a very good technical infrastructure, experienced staff and is regarded as a "generator" for the production of technological applications. The Research Committee manages and controls the budget of research activities, withholding a 15% percentage from the budget of each research program. This percentage is allocated to a variety of activities, among which the support of undergraduate and postgraduate studies or the award of scholarships to both graduate and postgraduate students.

In addition to sponsored research, academic research at NTUA is carried out using the means which the University, through state funding, provides to its academic staff free of charge, on topics which are freely chosen by the faculty members, within the scientific areas of their Schools. Such means include use of the laboratories, the computing facilities, the modern library system and the technologically advanced integrated voice and data communication network, assistance by technicians, secretaries and other auxiliary personnel, consumables and printing facilities.

NTUA has been gradually transformed into a distinguished "Research Technical University" and is on the way of establishing itself as a "Technology Resources Center". The variety of topics of the research projects is wide and expresses its ability to not only conduct basic research but to also get directly involved with the problems of society, which can be treated by applied and/or technological research and/or provision of specialized technological services.

4. The NTUA Industrial Liaison and Technology Transfer Office (ILTTO)

In most European Universities and Research Centers, researchers are oriented towards the production of commercially exploitable ideas and applications. This is practically "imposed" by the specifications of the programs funded by the E.U. such as the Frame Programs (F.P.); these specifications ask for the "commercial exploitation" of the results. Similarly, the same holds for most of the projects funded by the General Secretariat of Research and Technology (GSRT) of the Greek Ministry of Development. This provision about the "commerciality" of research products constitutes a fundamental prerequisite.

In February 1996, the NTUA Industrial Liaison and Technology Transfer Office (ILTTO) was founded. From its first phase of operation the ILTTO developed the necessary Institutional Infrastructure and know-how concerning its operation within the framework of a Public Higher or Technical Education Institute and Public Research Organization.

The basic aim of the ILTTO is to facilitate the commercial exploitation of the research results, produced at NTUA. The development of the research projects at NTUA can be accomplished through:

- The direct commercialization from the part of NTUA; all relevant actions can be undertaken by the "NTUA Company of Development and Management of Property" SA.
- Granting the licence for the development of a scientific product to another organization or enterprise by means of a contract and a relevant fee.
- The creation of an affiliated company, in order to commercially develop the research products as is common practice in the EU.
- Participation of the NTUA into joint-ventures with other organizations.

Meanwhile, the NTUA ILTTO provides services on the protection of Intellectual Property to the Institution's Administration, to the Teaching Staff Members and to the researchers working for NTUA, provided that NTUA is the patentee or co-patentee of the respective IPR.

The services provided by the NTUA ILTTO concern:

- The patenting process of the patentees IP Rights
- The counselling about the Institute and its inventors rights according to the current legislation
- The contracting of licenses concerning the development of these rights or their transfer to third parties
- The contracting on the resulting IPR products with researchers working in the Institute.

Normally, the NTUA ILTTO could also provide instructions concerning the development of IPR from spin-off companies, organize seminars and publish manuals in reference with the significance of the Industrial and IPR protection. However, the NTUA ILTTO's Business Plan, despite the fact that it provides for patenting and establishing spin-off companies, still focuses on the provision of services. This is due to the fact that spin-outs and patents are fields not adequately developed at NTUA.

Of course, the NTUA ILTTO constitutes an essential developmental catalyst because it (re)establishes the communication channels with the productive/social operators enriching their information about the results and the products of research, as well as the possibilities for acquiring specialized services. It also develops new mechanisms for Technology (Knowledge) Transfer, for the management of the research results and the protection of industrial intellectual property.[5]

More precisely, the strategic goals of the NTUA ILTTO refer to:

- The formation of a successful model of technology transfer within the operational framework of a Greek University.
- The development and introduction of new activities and mechanisms concerning the technology transfer process, the research support, the exploitation of the research results and the management of intellectual property.
- The catalytic fermentation of its action in order to change the mentality and the structures of the Greek S&T system.
- The patent licensing system.
- The support of marketing and public relations activities.
- The management of research contracts and projects survey.
- The management and enlargement of the data base including specializations and skills.
- The development of new projects and initiatives in all the aforementioned fields.

5. The NTUA ILTTO Profitability: An International Comparison

Indicator development is still in its infancy in this field (e.g. Molas-Gallart et al., 2002). One indicator of great importance is to measure the net profit generated for universities in relation to these institutions' budgeted income. For reasons of comparison we calculate net profit ratio (% of the budget) for the following organizations: the ILTTO at NTUA, the Technology License Transfer Office (TLO) of the Massachusetts Institute of Technology (MIT) in the USA, the Garching Innovation (which is practically the TTO of Max Planck Gesellschaft) in Ge-

[5] The NTUA ILTTO was a founding member of the ProToN Europe thematic network, participating in its relevant working group.

rmany and the Patentstelle für die Deutsche Forschung (PST) in Fraunhofer Gesellschaft, also in Germany as described in Loukakis et al. (2006).

- *The ILTTO in NTUA*

The NTUA ILTTO operation period 2000-2003 coincides with an overall income increase from provision of services and one can claim that the external marketing activities positively contributed to this increase. The services interestingly refer to high scientific and technological specialization of services and display an increasing tendency (1995-2003). Meanwhile, the income generated by R&D activities at NTUA remained relatively stable in the 1997-2006 time span (see Fig. 1, below), while the provision of services experiences a significant decrease in ministry financing but a considerable increase in public funds in the time period 1997-2005 (see Fig. 2, below). According to the financial results of the year 2003, the annual income was equal to about 7.5 billions € and the net profit ratio was, roughly speaking, equal to about:

$$\frac{net\ profit}{annual\ budget} = \frac{0.15 \cdot 7.5 \cdot 10^6}{100 \cdot 10^6} = 1.1\% \quad (1)$$

The (operational) net profit is merely estimated as being equal to the 15% percentage withholded from the budget of each research program on behalf of the NTUA Research Committee. The NTUA annual budget is, approximately, 100 millions €.

- *The Garching Innovation in Max Planck*

The annual budget of *Garching Innovation in Max Planck* sums up to 1,25 billion €. This research organization consists of 80 research Institutes, occupies 21000 scientists and proudly displays 30 Nobel awards. Since 1970, it has established a special company, the Garching Innovation GmbH, aiming at commercially developing its research products. The Garching Innovation contracts about 70 cooperation agreements on an annual basis. However, its net profit to the parent company in 2002 was a mere 10 million €. The net profit ratio for Max Planck was approximately equal to:

$$\frac{net\ income}{annual\ budget} = \frac{10 \cdot 10^6}{1.25 \cdot 10^9} = 0.8\% \quad (2)$$

- *The Technology Licence Office in MIT*

The MIT Technology Licence Office in its annual report for 2003 presented a budget equal to 1,2 billion $. 134 IPR patents had been contracted and 42 software licenses had been granted. MIT disposes 81 active trademarks and 650 technological patents. MIT researchers submitted 452 new proposals for patenting products and in 2003, 17 new spin-off companies had been established compared to the 24 spin-off companies in 2002. The net profit of 12 million USD had been distributed in General Funding (5,3 M $), in Departments and Laboratories (5,6 M $) and in Health Sciences Institutes (1,1 M $). The expenses for patenting and extending the inventions summed up to 6,5 M $ for 2003. According to the MIT Technology Licence Office (TLO) the net profit of TLO is outlined in the following formulation (in $):

$$\frac{net\ profit}{annual\ budget} = \frac{12 \cdot 10^6}{1.2 \cdot 10^9} = 1\% \quad (3)$$

- *The Fraunhofer Gesellschaft PST*

This organization is specialized in Health Sciences, keeps 80 research units and 57 Institutes. The annual budget sums up to 1 billion € and occupies 13.000 scientists. One of its Institutes, the Fraunhofer Patentstelle für die Deutsche Forschung (PST) is dedicated to the development of Intellectual Property products. However, no net profit is recorded in its annual report. Hence:

$$\frac{net\ profit}{annual\ budget} = \frac{0}{1 \cdot 10^{9}} = 0\% \quad (4)$$

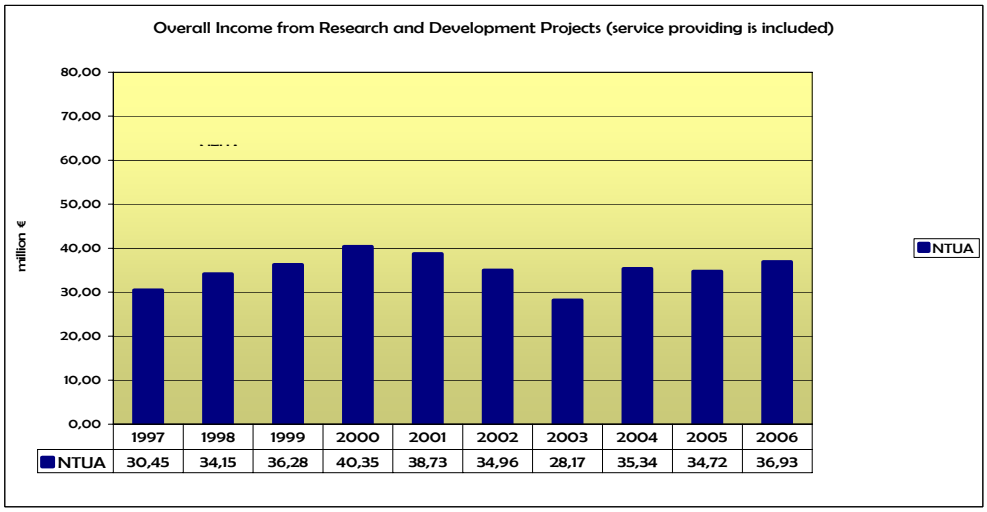

Figure 1: Income from R&D activities at NTUA (1997-2006)

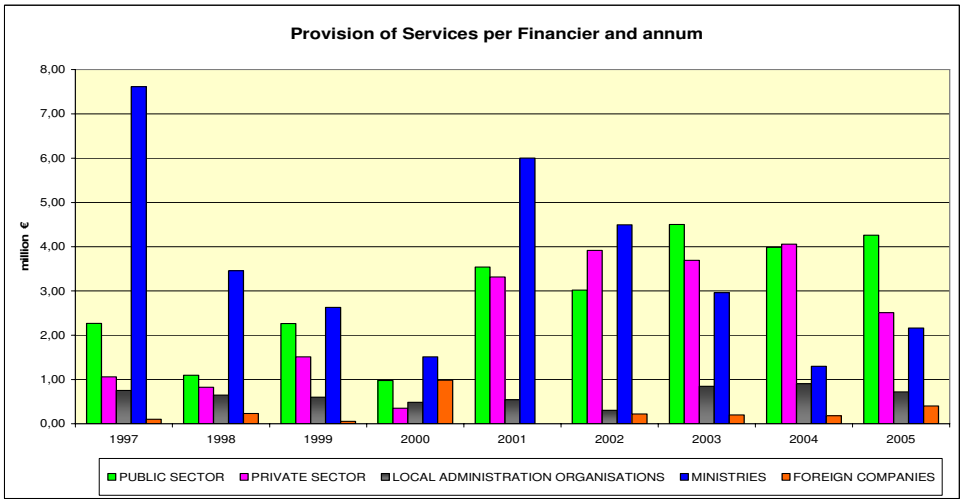

Figure 2: Provision of Services at NTUA (1997-2005)

6. Discussion and Conclusions

NTUA has been a pioneer in Greece in cooperative research, in providing technological services and in applied research (Loukakis et al. 2004). Lately, NTUA has experienced a decrease in EU funding because of the strict guidelines for proposals submission and the limited Greek participation; this may turn the research funding problematical. The insufficient support by national funds for research is also followed by the hypotonic funding from the private sector.

The NTUA ILTTO meets its operational and other needs (buildings, salaries, networking, fax/telephone lines, etc) and could be more actively oriented towards the patenting/licensing field. Meanwhile, the research activity should be continued and the status of public funding of the Research Organizations must be preserved, a thing that will prove to be extremely beneficial for the Greek social formation.

Innovation and new technologies act as drivers of social and economic development: this is one of the key elements in the growth of the knowledge society. However, to ensure the sustainability of such impetus, new links must be created between knowledge production, and the diffusion of knowledge. Through the osmosis of the scientific and research staff, respectively, in the technology transfer process the potential for improvement of everyday life increases significantly.

We believe that the research programs should focus on upgrading their research equipment, encouraging young graduates to integrate research teams, and on improving the linkages of the universities with other elements of the S&T system, especially the users of research results. Specifically, the new programs should contribute to new technological activities generating competitive advantage, and assist research teams to communicate the results. It should also raise awareness of the public in the use of new technologies, improve skills and increase the number of qualified personnel employed in universities and other research organizations. Opportunities should be provided for the transfer of technology in terms of integration of skilled researchers into the S&T system. The restructuring and the expansion of the existing infrastructure should be carried out on the basis of expert studies based on scientific and social criteria. We hope that the analysis in this paper will be helpful in the policy formulation procedure at NTUA and elsewhere.

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