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ADDING VALUE TO RESEARCH INSTITUTES' KNOWLEDGE

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CONTENTS

I. INTRODUCTION

The process of adding value to the achievements of the public research sector for developing innovative technologies in industry, so that it can increase its international competitiveness, is often referred to as Technology Transfer. Really this label is rather misleading as it may seem to imply just the process of "transferring" the knowledge, shaped as technology, from public research institutes (mainly universities) to firms, so that they can apply them in their operations, and that the main problem lies in establishing an effective interaction communication channel between these two entities.

On the contrary, the problem is much more complex, as the knowledge produced by universities (and public research institutes) is often far from being an industrial technology; it is only the scientific basis for developing a technology and it requires a deep transformation of the scientific results provided by the research institutes.

The traditional approach to the valorisation of scientific results as Technology Transfer, stems from a "linear" model of the technology innovation process, according to which knowledge generated by fundamental and applied research, carried out by public institutes, is transformed into industrial technologies by firms. In this way the technology innovation process requires the "transfer" of the new knowledge, produced by the public research sector, to the industry, that can transfer into some innovative applications.

The linear model of technology innovation has been made more realistic by the Triple Helix concept, which points out that this process involves not only public research and industry, but also government and that these players interact and cooperate with specialized, but often overlapping, roles and strategies. So government often intervenes upon the interaction between public research and industry in order to foster and to support the transfer of potential technology (knowledge) from the former to the latter.

But even this revised linear model of technology innovation is unable to grasps and to describe properly the complexity of today's innovation process. In fact this process requires a strong interaction and cooperation between public research institutes and firms in all the phases of the path along which new scientific knowledge is generated and used to develop new industrial technologies.

More than this, the innovation process involves simultaneously more players (large firms, SMEs, research institutes, each providing specialized knowledge which has to be integrated into a system (the innovative technology).

It's quite apparent that this non-linear cooperative model of technology innovation requires appropriate strategies and tools for exploiting the research results of scientific institutes through applications and so to add economic value to them, quite different from the ones implemented in the past, which have become rather ineffective.

It's worth reminding that the interaction between universities and firms takes place through many mechanisms, that range from the recruitment of university graduates to personnel exchanges, cooperative joint research projects, contract research, consulting, licensing of patents, publications, spin-off companies, industry funded laboratories and other physical facilities; also there are informal contacts such as meetings and conferences.

In order to formulate suggestions regarding strategies and tools, for fostering the interaction and cooperation between research institutes and firms, finalized to technology innovation it's necessary to clearly understand the difficulties and barriers to these processes.

II. THE MAIN CRITICALITIES OF THE INTERACTION BETWEEN PUBLIC RESEARCH AND INDUSTRY TOWARDS TECHNOLOGY INNOVATION

The difficulties and barriers to the exploitation of the scientific results and competences of universities and research institutes by firms in order to develop new technologies that can be applied with success in the market, stem from some behavioral features of researchers on one side, and business people, on the other side, and from some institutional and organizational issues concerning the interaction between universities and research institutes and firms.

II. 1 Behavioral issues

II. 1.1 Different propensity of firms towards innovation

Not all firms require the same outside support for technology innovation. Really, different firms adopt different strategies and approaches towards innovation and reveal a different capability (and aptitude) of defining their needs, selecting potential partners, managing relationships, etc. On the basis of such considerations and of empirical investigations it is possible to make the following distinction:

- **Innovative firms**: they use innovation as a strategic tool for winning the competition in the market and they implement innovation at every organizational level as an everyday task. These firms are leaders that make state of the art innovations;
- **Aspiring firms**: they are aware of the value of innovation and, despite they did not make innovation previously, they want to make changes and are investing resources;

  Aspiring firms have a positive attitude toward innovation, but they struggle to grasp the required complementariness between technical and managerial innovation, and this may prevent the development of innovating capabilities.
- **Inactive firms**: they do not place innovation at the heart of their strategy and they tend to adopt a re-active or passive attitude towards changes in their environment. One can distinguish two kinds of inactive firms. The first ones are **persistent**, as they did not make any relevant innovation in the past and they do not intend to carry out any innovation in the future; the second ones are

extinguished, as they previously made some relevant innovations, but presently, for different reasons, they have extinguished their innovative efforts.

So, according to their strategy towards technology innovation, firms have varying needs of interacting with outside sources of technical knowledge, first of all universities and research institutes.

Apart from the innovation strategy of the firms, another factor explaining the rare use of the competences of research institutes by SMES for developing innovation is that the cost associated with it is perceived too high. The research institutes often consider their direct cost (for consultancy and research services) as the only cost for the firm. On the contrary it is necessary to take into account the whole cost that a firm has to sustain for taking benefits of the knowledge acquired from a research institute. The whole cost is made up by different components: the cost of access, the cost of interface and the cost of content. Institutes providing the needed innovation knowledge are usually difficult to find and it is difficult, as well, to identify reliable and valuable providers (access cost). More than this, there is a cost for the interaction between the research institute and the firm that is very high (cost of interface); and the knowledge provider may be not specialized (cost of content).

Empirical research confirms this hypothesis and highlights an issue that is very relevant for improving the interaction between research institutes and SMEs. It is necessary to think about the whole cost of the interaction and, contrary to common belief, the main limits are due not to the difficulties to provide some adequate answers and solutions to the needs of the firms, but to the manners these solutions are provided, that is to access and interface activities.

II. 1.2 Cognitive distance between business and research (university) people

Empirical research points out relevant socio-cognitive differences between the providers of scientific and technological knowledge (universities and public research institutes) and the users of such knowledge (firms), as the final target of the technology transfer process.

The first difference lies in the time horizon. Public researchers usually have a long term time horizon, while entrepreneurs and business managers have a much shorter one. Business people are very focused on the problem they have to solve, so they need to have the (technical) solution they require in a short time. On the contrary, public researchers and academics follow research paths and carry out research projects that may provide radical innovations, because of the necessity to make publications on scientific journals and therefore they aim at innovative results that are not simply an incremental evolution of existing knowledge.

Another strong difference is due to the procedures of problem-solving, that is the fact the same problem is conceptualized in different ways. In particular, in the academia one can find a strong inclination to tackle problems by means of a discipline-oriented approach. Such an approach may contrast with the prevailing attitude of entrepreneurs and business people as their problems are tackled in a more concrete and multi disciplinary way. In such a context, the failure to reach a solution in a short time may give birth to managerial constraints, as the results are translated into profits or losses in the balance sheet. On the contrary, in the university community most problems have a conceptual nature and the failure of finding a solution does not represent a major threat (and barrier) to the future career.

II. 1.3 Low entrepreneurship of public researchers

A relevant barrier to the entrepreneurship of academic researchers is their lack of business and managerial competences. Indeed the availability of managerial (first of all, marketing) skills, together with scientific and technical skills, in the researchers represents a crucial element for the birth and success of start-ups and spin-offs. In this context, the main risk is that academic spin-offs turn out to be a "craftsman" of technology, by focusing on the development of technologies without verifying the real market demand for them. The high technology focus, on one hand, and the scarce commitment to managerial functions, on the other hand, may lead academic spin-offs to operate in a technology-push perspective, without a sound grasp of the real market potential. As a consequence, these firms struggle to find some market niche for their products, and therefore they have little opportunity to grow either in terms of sales and employees.

Parallel to the lack of managerial skills, a further barrier to the success and growth of academic spin-offs lies in the lack of willingness to grow by the charter members of these firms.

Usually the main reason why academic spin-offs are established is the wish to apply the results of academic research that otherwise could be dismissed, the passion for technology, the willingness to work with people. In all these cases, the spin-off has objectives that are socially relevant, but it has no propensity to take risks. Such an approach has negative consequences on the future of the firm, in relation to both its economic performances and its growth.

II. 2 Institutional and organizational issues

II. 2.1 The role of the "3rd mission" in the strategy of universities

Universities, just like firms, vary enormously in the extent to which they engage in and experiment new mechanisms to promote the commercialization of academic research, and in the extent to which they succeed in generating additional income from this stream of activities. Many questions have been raised about the underlying reasons for this cross-institutional variety, and it is imperative from a Science & Technology policy perspective to be better acquainted with them. Some of this variance can be explained by a specific country effect, the UK being the country that has developed before and more intensively policies that create incentives for universities to carry out a systematic interaction with business and society, while, for example, Italy has tried to introduce new policies only in recent years (at least with respect at the national level). However, within the same country universities take very different approaches to their interaction with business and society as a whole.

Individual characteristics of researchers have a stronger impact than the characteristics of their departments or universities in explaining the variety and frequency of interaction with industry. Researchers' previous experience of collaborative research and high academic status have a significant and positive impact on the variety of interactions with industry. On the other hand, the quality of departmental research has no impact on the probability of engaging in a variety of interactions. Scholars provide evidence that academic reputation also impacts on the likelihood of signing license agreements, but they find no evidence that the inventor's academic reputation affects potential licensees' inferences about the technology's value.

Finally, funding is important for the purpose of knowledge transfer. Academic researchers, who receive grants and contracts, work more extensively with industry than those without grants or contracts. Industry contracts push even further university-industry collaboration as the involved scientists interact with industry to a greater degree than those who are exclusively funded by governments.

At the bottom of these factors it's quite apparent that the governance and management of university-industry interaction influence both their success and frequency. The many cases of success and failure in this field show that it is quite difficult to design and to implement a successful organizational set-up for the transfer of knowledge (and technology) from the university to business and society.

The partially tacit character of knowledge and the difficulty of pricing it (although some minor forms of market for technologies, based on licensing university patents, has developed in the most recent years in the US and in Europe) had made problematic the design of a governance structure that create the right incentives for academics to improve knowledge transfer without damaging the traditional role of the university as a knowledge producer and its focus on higher education (increasingly more times in a worker career).

While the university goals of 'creating knowledge for its own sake' and 'disseminating knowledge' mainly through teaching are the policy rationale for publicly funded (basic) research, a disregard for applied work (and its potentially successful commercial outcomes) may make some university departments redundant, in the sense that they may lose touch with practical problems, so leading them to fall behind the leading university departments in their field.

II. 2.2 Management of IPR in cooperative R&D projects

In the (potential) relationship between a research institute and a firm the confidentiality of information plays a crucial role. On this regard, usually a strong barrier consists of the lack of protection of innovations that are not patented and of other "secrets" (information), giving the owners the right of preventing their use by third parties. Contracts which ratify partnerships between research (academic) institutes and industrial players usually entail specific clauses which rule the use of confidential information. Anyway, information that was already common knowledge before it was received or which was already known by a partner before the partnership started, are not considered confidential. Every kind of information that was considered confidential in the contact agreement ceases being reserved at the time the information: a) becomes common knowledge without the violation of the contract rules by one of the partners; b) it is acquired by one of the partners from a third party without the obligation of confidentiality; c) it is developed autonomously by one of the partners.

The issue of confidentiality is clearly critical because the different attitude (and goal) of industrial and public research partners: while the former tend to keep the new knowledge confidential in order to maximize their profit, the latter aim at disseminating this knowledge through publications in order to improve their career.

II. 2.3 Governance pitfalls: localized approach to technology transfer by regional governments and lack of financial resources

On one hand, territorial proximity represents a strength, because it allows local players to spur new (technological) opportunities thanks to the identification and exploitation of local synergies. On the other hand, the local dimension represents a weakness as it often prevents to reach the critical mass required for tackling global competition.

Empirical investigations point out that bottom-up initiatives and actions usually are consistent because they are closer to the needs of the territory and of local stakeholders, first of all, industrial players. Anyway, from an overall (national) point of view these actions lack coordination and, most of all, the (financial) resources required to bring an effective contribution to industrial competitiveness. As a result, notwithstanding the growing attention and relevance of the technology transfer issue, often the support to practical initiatives is not organic and sufficient. A crucial element is therefore the amount of overall funds devoted to R&D policies and technology transfer (at national level), and the coordination and distribution of these resources (at regional level). In fact, most financial resources are managed by national governmental bodies. More than this, in relation to the targets of funds, usually those sectors that are less risky (e.g., traditional manufacturing sectors) tend to be privileged, with respect to high-tech sectors and new knowledge based firms (start-ups).

The coordination between the central (national) and local (regional) governmental bodies, in this context, represent a key issue for R&D and technology transfer policies, most of all of in all countries where regions show strong differences between advanced and less developed ones.

III. THE SITUATION OF THE INTERACTION BETWEEN PUBLIC RESEARCH AND INDUSTRY

III. 1 The case of Italy

III.1.1 Introduction

Since the early ‘90s the Italian Ministry of S&T paid growing attention to the cooperation between universities (and research institutes) and firms in carrying out applied research and technology innovation projects and provided some incentives for fostering it (mainly, increased financial contributions for such cooperative projects).

Later on the Ministry promoted and supported financially the creation of Science & Technology Parks in the less developed regions of the country only. This initiative wasn’t very successful wing to the non favorable context in which the Parks had to operate: universities focusing on purely academic research, on one side, firms of traditional industries, little interested of technology innovation. So, most Park could hardly survive after the public funding ended.

Only at the beginning of 2000's the Ministry provided some financial support to the creation of university Technology Transfer Offices after some universities had pioneered this instrument for a wider interaction with industry.

A few years ago the Ministry experienced a new organizational model, the Technological District, for promoting the cooperation of universities with the firms of the territory surrounding the university, with the aim of generating new technologies that could increase the competitiveness of the local economic system.

III. 1.2 The university Technology Transfer Offices (TTOs)

Recently most universities have established a Technology Transfer office, following the long-standing experience of US and UK universities.

The three key processes at the heart of TTOs operations are:

- the patenting process, which has the main goal of protecting the results of research;
- the licensing process, which allows the commercialization of patents through the bargaining of partnership agreement with potential users (firms).
- the process of creation and management of new firms (spin-off).

The following tables provide an overview of the evolution of Italian TTOs: Table 1 shows the cumulative number of Italian TTOs (1997 – 2006); Table 2 shows the size distribution of TTOs (number of employees); Table 3 indicates the number of licenses and/or options executed per year by Italian universities; Table 4 illustrates the number of licenses and/or options yielding revenues; Table 5 shows the license income generated by Italian universities.

Overall, data illustrate that the number of TTOs increased significantly after 2002, that they are quite small in size (4.1. average number of employees), and that the number of licenses (and related incomes) was still relatively low in the mid 2000's.

Table 1 - Cumulative number of Italian TTOs (1997 – 2006)

Year	**Number of Universities**									
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
	1	2	3	4	9	14	17	25	37	39

Table 2 – Size distribution of TTOs (number of employees)

Nr. of employees	Number of universities (2005)
0-1	4
1-2	12
2-3	11
3-4	4
4-5	2
5-6	1
6-7	1
7-10	1
>10	3
Mean	4.1

Table 3- Number of licenses and/or options executed per year by Italian universities

Number of licenses and/or options executed	Year			
	2002	**2003**	**2004**	**2005**
Total	30	39	33	55
Mean	1,4	2,3	0,9	1,7

Table 4- Number of licenses and/or options yielding revenues

Number of licenses and/or options yielding revenues	Year			
	2002	**2003**	**2004**	**2005**
Total	16	17	31	40
Mean	0,9	1,1	0,8	1,3

Table 5- License income generated by Italian universities

License income generated	Year		
	2003	**2004**	**2005**
Total	1,923.3	1,480.5	4,571.0
Mean	113.1	51.1	175.8

One of the main criticalities of TTOs regard their mission and how this should be pursued, in particular the source of funding of their activities; revenues from licensing are growing, but still they are not enough to cover the costs of TTOs. It is worth noting that the share of external funds, besides the ones coming from the university, is increasing, most of all in the case of mature TTOs. Unfortunately, national and regional funds do not support adequately the growth of TTOs both in terms of professional capabilities of human resources and of provision of the resources (instrumental assets) that are required.

Every phase of the three fundamental processes which have been listed above, requires a high level of specialized competences and multidisciplinary capabilities, in order to make the employers of TTOs capable to manage the legal, business and technological issues of the technology transfer process.

On this regard, the long established TTOs have a high professional qualification of technical and administrative human resources. Anyway this process has still to be completed because most of personnel and managers have basically an economic or legal background. There is still a strong need to integrate in TTOs human resources with some that are able to grasp the economic value of innovations, on one hand, and to select and to protect the innovation and to transfer the benefits of the patents to firms in the licensing process, on the other hand.

It is worth pointing out that the awareness of such a need has not brought to the growth of human resources neither in qualitative or quantitative terms. It seems impossible that universities are able in the short term to increase the activities of licensing following the increase of the number of patents, most of all for TTOs that are still in a stage of consolidation. Currently the number of patents that have been licensed is still a small share of the overall number of patents. At the same time, it would be fruitless to increase the number of patents without a corresponding increase in the licensing activities.

III. 1.3 Science & Technology Parks and Technological Districts

In the mid '90s the Italian Ministry of Science & Technology started a program, partially funded by EC, for promoting and supporting with financial incentives the creation of S&T Parks in the less developed regions of the Country (Centre and Southern Italy).

So, 14 Parks were established, as a public-private partnership which usually included governments, universities, research organizations, firms and their associations, of a region.

These entities were included in the governing body of each Park, which had an operational structure, in some cases very small (for coordination activities only) and in other cases quite large (as a unit of an already existing laboratory or research centre).

The general mission of a Park was to contribute to the development of the technological competitiveness of the local production system by means of R&I

projects, that involved firms and research institutes, and transfer of technologies form the local research sector to firms.

The S&T Park program was not very successful in achieving its main goals: most S&T Parks ended up in financing some R&I projects only, no structural activity was carried out and when the public funds were over, they tried to survive by focusing on the provision of some services to SMEs as a support to their innovation processes.

Given this rather disappointing experience, the Ministry of S&T in 2005 tried a new approach to fostering the cooperation “research-industry” at the regional scale, by designing and experimenting a somewhat different instrument: the Technological District.

Based on the consideration that the industrial districts, which are an important component of the Italian industry, have been very competitive and innovative by means of a widespread network of cooperative (and competitive at the same time) relationships of local technology providers and industrial users, it was envisaged that by establishing a structured network of local research institutes and local firms it would be possible to foster the transfer of knowledge from the former to the latter ones.

So in each region an organizational structure, involving key players of the government, R&I systems, banks of the region, has been established with the mission of carrying out R&I projects and Technology Transfer activities, focused on some technology area/industrial sector, that have been evaluated as priority for the regional economic development.

These activities are co-financed by the Ministry on the basis of a 5 year program, positively assessed by it.

Up to now 29 Technology Districts have been created, but not all of them are operational due to the delays in receiving funds from the Ministry. The outcomes of this instrument are not quite definite and clear due to the rather short time they have been active.

III. 1.4 The creation of university start-ups

A very relevant barrier to the birth and growth of academic start-ups and to the industrial and commercial exploitation of the capabilities of academic researchers is the complex set of rules that govern universities. First of all, the “cultural” environment of the university affects the choices of researchers and professors regarding entrepreneurial activities and the possibility itself to be involved in the setting up a spin-off. More than this, the rules that govern the universities may influence the initial structure and the business model of an academic spin-off and thus its long term success.

In many occasions, still at the end of 1990s and the early 2000s, the establishment of spin-offs or the commercialization of the capabilities of academic researchers were uneasy because the behavior and the attitude of the “colleagues”. There was no official definition of “spin-off firms of academic research” or of “structural partnership with firms”, and academic regulations did not provide any direct mention of these processes. This gave birth to uncertainty and confusion, that in 1999 were partially solved by the Ministry of S&T that defined spin-off firms as "new economic initiatives with high technological content aimed at the industrial exploitation of the results of research". In the following years there was an increasing acceptance of the phenomenon of spin-off firms within the academic community, that promoted ad-hoc rules and even provided some funds.

On one hand, the lack of clear rules regarding the establishment of academic spin-offs may raise confusion and ambiguity, thus discouraging researchers at setting up entrepreneurial initiatives. On the other hand, a negative behavior (i.e. disappointment, unwillingness or not acceptance) may be a relevant barrier to the establishment of academic spin-offs, and more generally to the cooperation between academic researchers and industrial partners. Similarly, the lack of advanced services (such as market analysis) required for the industrial exploitation of academic research, may have a negative impact on the creation of new firms and on the relationships between universities and industrial firms. A great problem lies more generally in the conflict of interest between the spin-offs initiatives and the cooperation with industrial partners, on one hand, and the traditional activities of the university, on the other hand universities spur researchers and administrative personnel to carry out entrepreneurship initiatives, by guaranteeing their job position; at the same, time, each university sets ad-hoc rules in order to limit the role and activities of researchers within a firm. In this way the academic institution aims at defending its own interests, as these may be disregarded by the researcher- entrepreneur, so raising a conflict of interest.

III. 1.5 The financial incentives

In order to foster the cooperation between firms, mostly SMEs, and universities in the area of innovation, the Italian government usually requires that R&I projects, if to be cofinanced with public funds, have to make use of the contribution of public R&D performers, first of all universities.

This contribution usually accounts for 15-25% of the total cost of the project.

The regional governments follow a similar approach when giving financial support to R&I projects.

Even if the aim of this structure of financial incentives is good in principle, its outcomes are not very satisfactory, due to the procedure for paying the incentives to firms. In fact, the firms have to pay in advance all participating universities and public research institutes, so these have their costs fully covered. But firms have to make some relevant payments in advance with their other financial resources, which in the case of SMEs are limited and are not enough supported by banks.

More than this, often firms get funds from governments long after, and with high uncertainty, they have completed the R&I project and have presented the accounts of expenditures, so the financial cost of the project is increased.

Some time ago the Italian government experimented a different way of supporting research-industry cooperation: tax credit as a percentage of the sum paid by a firm to a university for its research contribution to an R&I project.

This tool was well appreciated by the firms, as it meant definite and timely financial benefits (within tax declaration). But after a successful experience, this tool has not replicated due to organizational problems: how to accept the requests of the firms and, in the same time, to keep the total amount of financial contributions within the budgeted fund.

Moreover the Ministry of Education, University, Research (formerly Ministry of S&T) in 2005 set up a program for funding the creation or reinforcement of university TTOs, following some guidelines such as pooling some universities in one TTO only in order to reach an appropriate amount of patents to be commercialized and to exploit economies of scale in personal and operations.

Total distributed funds amounted to 12 millions € and no more money has provided afterwards.

III. 2 The case of Spain

III. 2.1 Introduction

Last two decades have involved an important effort in Spain to create programs and structures focused on favoring knowledge and technology appreciation and transfer to the enterprise sector, though these actions have not always been successful. Among a variety of activities and programs towards these objectives, the ones directly related to provide with funds to enhance knowledge transfer from the public R&D system (Universities and public R&D centers) have been summarized in point 3.5. A summary concerning the creation of spin-offs as an step further in this purpose corresponds to point 3.4.

About the institutions oriented to promote and improve Spanish knowledge transfer efficiency, a variety of them have slowly been created and the most relevant types with a potentially major contribution to the appreciation and transfer of knowledge from the public R&D system are Technology Transfer Offices (TTOs) treated in point 3.2, and Scientific Parks very briefly reviewed in point 3.3.[1]

III. 2.2 University TTOs

Technology transfer activities of Spanish universities and public R&D centres are also and mainly carried out by the *Oficinas de Transferencia de los Resultados de la Investigación* (OTRI, in English Offices for the Transfer of Research findings), which initially started more than two decades ago. The OTRI has traditionally carried out its technology transfer mission by conveying the institutional supply of technology to the market, and there are OTRIs currently doing this work for different types of institutions in Spain, as it is shown in table 1.

[1] Technology transfer. Issues common to the national innovation systems in Italy, Portugal and Spain (Cotec, 2005)

Table 1. Spanish *OTRIs* classified by Institution type

Institution	Number of OTRI
Universities	71
Technological Centres	70
Public R&D Centres	10
University-Enterprise Foundations	13
Health Care Institutions	15
Others	47
Total	**226**

Among all these 226 different *OTRIs*, a bit more than one hundred correspond to institutions of the public R&D system, being most of them part of the universities. A majority of these *OTRIs* have joined together in what is usually known in the country as *RedOTRI*, the network organization in charge of their activities coordination directed to make them more efficient. In fact, an evaluation of the success of the university *OTRIs* has been performed annually in the last few years through an enquiry made public as a report. This report offers a good overview of the *OTRIs* activities through the number of patent applications and patents achieved, of licence agreements and of spin-off created, in addition to other parameters such as income derived from rights licensed or the number of products successfully released to the market. The following paragraphs based on the results of the latest report available corresponding to 2008[2].

Technology transfer drawn by the *OTRIS* is solely based on the knowledge and expertise about what their own university is doing, which represents 32% of its economic activity as a whole. If only those universities which had obtained better results in technology transfer were considered, this percentage would increase over 40% of their total expenditure, being only 17 % of it due to private source funding.

RedOTRI members continue to be in 2010 the university core units providing technology transfer, thus safeguarding their legal status within them. Thus, intellectual and industrial property rights management as well as R&D recruitment remains their core responsibility.

A positive trend in recruitment, R&D cooperation and knowledge protection could be detected in Spanish universities. This positive trend appears to be mainly due to a stronger public effort in funding the partnership of R&D business-university cooperation, but the private sector unfortunately shows quite little support. In addition, despite having observed a right trend in licenses and spin-off creation, it was also observed that the overall results remain quite low, although a positive increase is nevertheless expected for the following years.

From that report it can be deduced that technology transfer from Spanish universities is highly balanced towards a development of their interaction with enterprises in order

[2] Informe de la encuesta RedOTRI 2008 (October, 2009)

to appreciate their R&D capacities, but it is highly unbalanced for the facts of appreciation and transfer of their research results. A trend towards rebalancing this undesired imbalanced status can be detected from the *RedOTRI* report results, but considerable efforts still need to be done as the problem has not been adequately approached until now.

Protection of intellectual property rights (IPR) show on the one side a positive global growth, with a sound increase in the number of invention communications. The latter ascertains that protection practices are becoming more efficient and specialized. Nonetheless a decrease in international PCT extensions has clearly been observed as well as a decline in the concession of international patents despite an increase in protection operating expenses. On the other side and comparing with previous past years, licensing results show a clear increase in revenues despite a decrease in software licenses. Indubitably, university patents are now geared towards the SME market.

Technology transfer through the creation of spin-offs is inducing an improvement in the regulations and the organization at institutional levels, but a more legislative development in general terms as well as an important increase in proximity funds are required for their adequate development.

III. 2.3 Scientific Parks

Technological and Scientific Parks initiated their existence in Spain around two decades ago. From that time, more and different parks were slowly developed until when in year 2000 a “burst” in parks creation happened quite likely stimulated by the financial support (subsidies, credits, etc.) from the Spanish Administration. Public accumulated investment in the last 10 years was approximately 1,600 million euro. Today there are more than 70 parks of two types, technological parks and scientific parks being each other close to the half.

The 34 Scientific Parks existing in Spain are the ones of interest in this document since there appears to exist a typically and very strong relationship with Universities, as quite frequently they have been their promoters and in addition could be their main owners. This makes Scientific Parks a good instrument to stimulate enterprise-university interaction to facilitate knowledge transfer, and if these parks had incubatory space they could also intensively facilitate the creation and the stabilization of spin-offs. In some cases the *OTRI* and its activities are included in Scientific Parks.

There is great degree of variation in the way Scientific Parks are organized, how they plan their objectives and the manner they manage their resources. It appears that how all that happens could be highly related to the particular type of University involved in their creation, as well as the political strategy followed by the universities top management team. As examples, it could be said that the main objective of the Park sometimes is the appreciation of scientific research through interaction with enterprises, but some other times objectives could be to just sustain scientific research, or to support local entrepreneurial activities. Therefore a more decided trend towards knowledge appreciation and technological transfer in many Scientific Parks objectives should be promoted and expected in the future.

III. 2.4 Creation of university start-ups

It could be said that the well established Northern European and Anglo Saxon tradition of spin-off enterprises creation from their universities and research centers has been quite recently implemented in Spain. From this fact two effects are derived which are highly interconnected. The first is a great absence of eagerness as well as of experience to develop new companies based on the knowledge and technology generated by scientists at the public R&D institutions, though it has to be said that enthusiasm and interest have been slightly growing for the last few years. The second is the highly important barrier caused by R&D institutions which becomes evident through cultural, financial and legal difficulties to initiate and consolidate entrepreneurial projects.

As the experience has already and repeatedly shown, cultural barriers are the most difficult to overcome as it is usually needed a long time to reach significant changes on society culture and habits. Financial and legal barriers could be more rapidly modified through the establishment of new or improved policies and laws, although it is not easy too. Until last few years scientists and professors had to face enormous difficulties to have a stockholding or to work full or part-time in technology based enterprises, or to own them. In 2007 some of these obstacles present in the Spanish law which was in force at that time (*Ley Orgánica 6/2001*) were either softened or removed through a modification with the *Ley Orgánica 4/2007, 12 de abril*, in May 3rd 2007.

In order to strengthen knowledge transfer through favoring the creation of technology based enterprises (TBE), modifications to the law mainly affected to the participation of university staff in these companies, to encourage them to be more open to perform knowledge transfer through different ways including the spin-offs, and to improve the general frame in which public R&D institutions and private sector interact between each other. Some examples are provided below.

Professors or scientists who went to work on a TBE some time ago and for whatever reason would like to be back at the R&D institution where they used to work before initiating the venture in the private sector, they currently have many fewer restrictions they used to have in the past and can do it in a much more easy way. As an example, their position is maintained for a period of up to 5 years.

Universities and R&D public centers members used to have completely banned sharing their activities at the public institution they belonged with their membership to top management boards of private companies. This prohibition has already been removed from the law, and professors and scientists are currently fully allowed to share their time with private activities in TBEs. The same has been done with the past limitation for this staff to own stock shares of TBEs which should never exceed 10%, and right now there is no limitation for that type of property.

Evaluation of the staff of public R&D centers used to completely exclude any potential valuable credit when coming from those activities related knowledge transfer, and right now and for the last three years this type of credits must be fully considered in any evaluation. In addition, the current law specifically includes technological development and knowledge transfer as activities to be included when crediting for additional payback, since in the past this was absolutely excluded too. Many more examples of modifications in the general law thought to stimulate knowledge transfer and spin-off creation could be described, but it would be too long to go through all of them and they follow the same trend as previously shown.

In addition to all that, public financial support to the creation of spin-offs has significantly been increasing for the last 10 years, and in a particularly intensive way between 2005 and 2008 until current economical and financial crisis evolved. Private financing for that purpose, such as seed capital or real venture capital, has however never been really strong in Spain, as what is named as venture capital has always been more dedicated to medium to big enterprise development and growth support. Anyway public financial incentives will be treated in more depth in the next point.

Data reported in the 2008 report from *RedOTRI*[2], show that a significant increase in spin-off creation was observed in 2006, one year before having performed the previously mentioned modifications in the Law. Subsequent years 2007 and 2008 data show a clear decline in the creation of this type of enterprises, when these modifications in the Law where in force. This could be showing that in addition to private financial support, cultural aspects could possibly be much more important than it could initially be thought, and that a lot of work in this area should be done.

III. 2.5 Financial incentives

Both the Administration of the Spanish Government and that of the Autonomous Communities have created policy tools to promote technology. They are directed to encourage technology transfer between universities, as well as other R&D public institutions, and the productive system. The great variety of programs available in Spain requires a screening ability quite often highly difficult to be performed by many SMEs. A barrier like this one together with the frequent request of bank guarantees to access to the support, can be considered as the main causes of criticisms under a general environment of acceptance of the system in force which is directed to stimulate cooperation between public university and enterprises, relationship still quite poor in Spain.

The Instrumental Line for Knowledge use and Technological Transfer of the National R&D Plan, the instrument used by the Spanish Government to establish its scientific, technological and innovation policy, brings together all tools whose strategic objectives are technology transfer from universities and public research institutions to firms or even transfer among the firms, as well as those directed to the appreciation of the knowledge generated at the public R&D system and the creation of knowledge based companies. This financing line includes all public funds directed to the institutions previously mentioned, and therefore only the instruments specifically oriented to stimulate technology transfer process will be described here.

Basic Research TRACE Program for transfer of knowledge to enterprises (acronym from Spanish *Programa de Proyectos de Investigación Fundamental Orientada a la Transmisión de Conocimientos a la Empresa*) is funding the cooperation of scientists from the public sector with firms in order to get knowledge transferred. Incentives are given to these scientists in the form of subsidies for basic research projects in which enterprises have shown their interest as they also contribute with funds.

Collaborative Applied Research Program (in Spanish, *Programa de Investigación Aplicada Colaborativa*) provides support in the form of subsidies, credits and advance reimbursable payments to perform applied research projects, previous viability studies and other complementary activities, with the requirement of the participation of at least one public R&D centre with the company or companies interested.

Simultaneously, Spanish innovation policy includes a quite particular fiscal incentive program. There exist tax credits as a percentage of the R&D and technological innovation activities costs which are deducted from the amount of money the firm has to pay to the Spanish Taxation Agency. These percentages are variable depending on the type of activity, their increase with time or the particular items involved. The current regulation indicates that for R&D activities, a 25% of the average of the expenses of the last two years can be deducted plus 42% on the excess over that average. Expenses derived from scientific personnel under exclusive dedication to R&D activities can deduct a 17%, and an 8% from investments on fixed and intangible assets involved in R&D activities, excluding building and property land. Concerning technological innovation activities, deduction rate is always 8% on the expenses in industrial design and process engineering, in acquisition of advanced technology with a maximum limit on one million euro, in obtaining quality assurance certificates such as ISO 9000 or GMPs, and in the preparation of technological viability studies requested to universities and R&D centres. All of these expenses not used for deduction in one year's tax report could be added to the next year report or the following ones up to 15 years.

It is obvious that these deduction benefits are only useful for companies which are getting benefits during fiscal year which they have to report to the Taxation Agency. There is however a number of small and technological firms without benefits which consequently can not get any benefit from tax deduction. Thinking on these companies another instrument was created by which a bonus reduction of 40% can be applied to the contribution the firm pays to the Social Security for the hired research personnel who are dedicated to R&D projects100% of their time.

In addition, a new program has quite recently been created by the Ministry of Science and Innovation named Innocash whose objective is to identify, appreciate and adapt to the market the results from research. This program starts by an offering of the results of an investigation to the program managers, which they evaluate and, if their opinion is positive, they include it in a technological showcase to allow private investors to check their interest on it. If any particular project would get private funds, then public funds would complement them, and if the project was successful the technology which was developed would be commercialized, either by an already existing enterprise or by a new created one. Added value obtained through this commercialization would be used to compensate both public and private investment.

In order to help in the creation of new technologically based enterprises, an important and possibly the most efficient way to stimulate technology transfer, the Spanish Government has created the program NEOTEC. This program provides public economical support to small firms, which are less than six year old, in the frame of the so called "Grants to young and innovative enterprises in the European Community frame which regulates state aids for R&D and innovation"

This program contains two categories depending on how old is the firm. Neotec I directed to enterprises younger than two years, and Neotec II for those whose age is between two and six years.

Participation in Neotec I demands from the company to get approved a five years business plan, although only the first two would be supported. A minimum budget of 240.000€ is required, and as eligible costs the fixed assets investment, staff costs, materials, external collaborations, costs derived from adhesion to Alternative Stock Exchange, among others, could be included. Grants neither cover expenses previous to the application date, neither building investment.

Public funds are offered in the form of seed or Neotec credits which could grow up to 70% of the approved business budget plan, with a maximum amount in absolute terms of 350,000 euro. This maximum could reach up to 400,000 euro when the project involves a technological break, and up to 600,000 euro when dedicated to biotechnology. Credits are given at a zero interest rate without any additional guarantee required. Forty to sixty percent of the approved amount is delivered at the time of signing the contract regulating the grant. The remaining amount will be returned at the end together with a technical and economical report of the approved project/business plan.

Credit refund will be done as the company will generate a positive cash-flow, and as a consequence the firm will be committed to provide the annual closed accounts every year. Return annual payments could involve up to 20% of generated positive cash-flow, until credit repayment is completed.

Neotec II credits were designed to support firms which are older than two years old, and as required by the European Community Regulation (CE nº 800/2008), these innovative and young enterprises could only receive this financial support if no older than six years. Similarly to Neotec I, companies will also have to present a business plan for five years with the possibility of just receiving funds for a maximum of two years. They shall have a minimum budget of 240,000 euro too, which will be managed under similar conditions. In this case of Neotec II, funds could reach up to 70% of the approved budget with a limit of one million euro. Credit conditions are also at zero interest rate and no additional guarantee is required.

As both Neotec I and II funds are restricted to a limit of one million euro, those enterprises which had already received a Neotec I credit, quite likely will suffer a reduction under a Neotec II application in order to not exceed that limit. An advance of 25% of total fund credited will be given when awarded, and the remaining amount will be made effective at finalization, when project-plan technical and economic reports of the company have been approved. Refund conditions are similar to those at Neotec I.

Every Spanish Autonomous Community has set up policies for science, technology and innovation promotion, which are directed to influence the economic development in their field. It is evident that they are particularly concerned about technology transfer both from the R&D centres located in their Region and from those located outside. They have a wide variety of supporting programs and grants which range from cooperation projects between public scientists and firms, to the creation of technology enterprises. Quite generally the form in which this support is provided is subsidies given to companies or institutions operating in the Region. Autonomous Governments have sometimes created new support instruments with better or poorer success, which should be considered anyway. Some examples are *trampolines tecnológicos* (Technological Springboards) in *Cataluña* Community, the support provided by the *Galicia* Government to Uniemprende from University of Santiago, the sometime ago Gesta initiative from *Comunidad Valenciana*, or Technological Corporation from the Government in *Andalucia*.

III. 3 The case of Portugal

III.3.1 Introduction

From the public policy perspective, we can state that the story of the evolution of science and technology in Portugal has led to a late and weak emergence of an innovation policy in the 90's decade. Until then attitudes both from the science and the technology/economy side had revealed weak inter-department coordination and little inter-institutional cooperation. Even the creation of the Ministry for Science and Technology in 1995 (S&T assuming for the first time the honors of a Ministry) could not fill the policy gap between university research and industrial research.

Actually, two ministries define and coordinate technology transfer and innovation policies in Portugal: MCTES – Ministry for Science, Technology and Higher Education in articulation with MEID – Ministry for Economic Innovation and Development. These ministries policies are managed by four public agencies: IAPMEI – Instituto de Apoio às Pequenas e Médias Empresas e ao Investimento (Institute for Supporting SMEs and Investment), FCT – Fundação para a Ciência e Tecnologia (Foundation for Science and Technology), AdI – Agência de Inovação (Innovation Agency) and INPI – Instituto Nacional da Propriedade Industrial (National Patent and Trademark Office).

To cope with the traditional difficulty of cooperation between the scientific community and the industry, several instruments have been set in place as we will describe below.

III.3.2 The University TTOs

The majority of the Technology Transfer Offices (TTOs) in Western Europe were created recently, approximately 60% of them between 1998 and 2007. Portuguese

TTOs are among the most recent in Europe, having almost all been created between 2003 and 2007.

Most of the currently active TTOs in Portugal evolved from two different initiatives: (I) OTICs: Oficinas de Transferência de Inovação e Conhecimento (Knowledge and Innovation Transfer Offices), an initiative launched by AdI – Agência de Inovação – (Innovation Agency) in 2006 which created 22 OTICs with the mission of transferring the technologies developed within their organizations (not all of the OTICs were based in Universities) and (ii) GAPIs – Gabinetes de Apoio à Propriedade Industrial (Industrial Property Support Offices), an initiative promoted by INPI – Instituto Nacional da Propriedade Industrial (the Portuguese Patent Office). Currently there are 20 GAPIs, split into three different types: (1) GAPI Conhecimento based on the Universities, (2) GAPI Tecnologia based on Technology Centers and (3) GAPI Inovação based at COTEC.

In 2007, the average TTO in Portugal (including both OTICs and GAPIs staff) was employing approximately 6 FTEs, a value almost half of the average in Europe, around 11 FTEs. Considering the dimension of the universities, Portugal has a ratio of FTEs to thousand academic publications in science and engineering of approximately 6, close to the European average of near 7.5.

The number of national patents applied from citizens residing in Portugal increased from 107 in 2001 to 248 in 2007, while the number of international patents increased from 18 in 2001 to 42 in 2007.

The average results in 2007, for European TTOs were 7.8 licenses/options, 100 industry sponsored research contracts, and 4.1 startups. For Portuguese TTOs, the analogous average results were approximately 5, 25 and 4.

III.3.3 Science Parks and Business incubators

In 2006, there were in Portugal 12 Science Parks and 13 Business Incubators. Except for two cases, they are generalist organizations.

All Portuguese Science Parks and Business Incubators were created by local/regional stakeholders, and are publicly funded. This is in contrast with European Commission 2002 data, according to which only 39.7% of Business Incubators in the EU would reduce activities significantly in the absence of public funding, and 21.8% would stop activities.

Although most have some kind of linkage to Universities, either through co-location, or through institutional relationships, the number of academic spin-offs that they house, as a proportion of the total of companies, is small – 8% in total – but in line with this proportion for BIs in the EU in 2001/2002 – 11.2% (European Commission 2002).

III.3.4 The Creation of University Start-ups

Spinning off ventures from university research is a quite recent phenomenon in Portugal. Most of the companies that spun-off have less than 10 years old and are micro-enterprises. As expected, they are much more R&D oriented and have more qualified human capital than typical non-university ones. In the early days most spin-offs were launched as a result of different initiatives led by Adi, but recently the number of initiatives aimed at promoting entrepreneurship exploded.

In 2004 COTEC launched the COHiTEC program aimed at supporting the creation of high-tech / high-growth startups originated from knowledge produced by researchers within the National Innovation System. COHiTEC started as a training program aimed at researchers and MBA students that used an active learning approach based on a methodology developed by the HiTEC center of North Carolina State University (which is still a strategic partner of COTEC for the initiative). The end result of this Program is an assessment of the commercial viability of the products that can be obtained from the technologies proposed by the researchers. Since its creation, 243 researchers and 180 management students have already participated in COHiTEC and 76 business proposals were developed, of which at least 12 turned into startups. In 2006 COTEC launched another stage of the Program that aimed at supporting a limited number of teams in the development of investment ready business plans. These teams are supported by executives from COTEC associates and from this effort two startups were created (that managed to attract funding on the amount of €14.9 million with impressive pre-money valuations) and two more concluding the deal stage of the commercialization process. More recently the Program evolved into a new initiative called Act (the Portuguese acronym for Technology Commercialization Accelerator) that adds a further layer of support to the technology commercialization process through a proof-of-concept venture fund. The Program received in 2006 the Price Foundation Innovative Entrepreneurship Educators Award from Stanford University (COTEC being the first non-US institution to receive such an award).

III.3.5 The Financial incentives

The Portuguese Government has created several financial incentives to support technology transfer between universities and companies. The program COMPETE, managed by IAPMEI and FCT, promotes different approaches to encourage companies to contract services from universities and other R&D institutions, in particular the "Vale ID&T", that is a grant to stimulate companies to buy services from universities and R&D institutes. Moreover, in COMPETE there is a special application called "Estratégias de Eficiência Colectiva" (Collective Efficiency Strategies), that will finance Clusters of Innovation for 3 years. So far, 19 clusters are being settled, in a partnership between companies, universities and R&D institutions, with the mission of promoting joint R&D projects and creating a network of knowledge. These Clusters are managed by the industrial sector and have a legal existence.

Also, to promote the link between R&D institutions and companies, the Portuguese Government has set up a tax credit incentive system for R&D expenses, named SIFIDE (Sistema de Incentivos Fiscais à Investigação e Desenvolvimento Empresarial), that exempt some requirements if the project is done with a Portuguese R&D institution. These credits can be carryforward until the 6th year after the credit is granted, in case the company did not have positive results and therefore could not use it.

Regarding Private Equity (PE) investment, there is still a limited presence of these entities in Portugal. In 2008, the investments made by the Portuguese PE industry were 0.73% of the total investment in Europe, with venture investments totaling 1.36% of the European total. As a percentage of GDP, Portugal had PE investments of 0.10% in 2007 and 0.24% in 2008, well below European total values of 0.6% in 2007 and 0.4% in 2008 (EVCA 2009).

Yet, whereas the number of PE funds and companies in Portugal has grown only moderately in recent years, the value managed by these funds and companies has grown considerably, with an increase of approximately 25% in 2006, and 48% in 2007. Resident companies have received a large majority of these investments, with only approximately 17% of the investment flowing to nonresident companies by the end of 2007 (CMVM 2008).

In 2008, the amount of seed investment in Portugal was practically none, versus 0.57% for Europe as a whole. However, start-up and later stage venture investments totaled 24.46% of the investment, almost doubling that proportion for Europe.

PE investment in high-tech industries is also below European totals. In 2008, all high-tech investment in Portugal (1.16% of the total) was venture investment, whereas in Europe high-tech investment was 8.77% of the total, split between venture investment, with 4.03%, and buyout and growth investment, with 4.74% of the total investment (EVCA 2009).

In 2008 COTEC associates promoted the F-HiTEC venture fund (managed by Espírito Santo Ventures) that is exclusively focused on the financing of startups and early-stage technological ventures with high-growth potential through the acquisition of minority participations. With a capital of €3.4 million, this fund supports high-tech / high-growth projects previously scrutinized by COTEC (through the COHiTEC Program), So far, F-HiTEC has two companies in its portfolio: CEV – Plant Biotechnology, an agro-biotech company, and ACS – Advanced Cyclone Systems, a Clean Tech company that develops and commercializes highly efficient industrial cyclones.

Furthermore, on September 2009 a new pre-seed venture fund was created in order to fill the gap for this type of funding in Portugal. ACTec venture fund will finance the proof-of-concept stage of tech-based high or medium growth projects. With a capital of €7.5 million, this fund is managed by InovCapital.

IV GUIDELINES OF ACTION

IV.1 Introduction

It's possible to summarize the most relevant criticalities of the interaction and cooperation between research institutes (universities) and firms in Italy, Spain and Portugal in the following way:

- <u>on the side of universities and research institutes</u>
    - The focus of TTOs on codified knowledge (patents) either to be marketed to industry or to be the basis of a start-up, while the most relevant stock of

knowledge that can be used by firms is largely tacit and resides in the competences and capabilities for problem solving of the researchers.

- The undervaluation of the remarkable "distance" of the scientific results produced through research from the state of industrial technology that can be developed by means of them. This process, which carries out the "engineering" of the scientific knowledge, requires more research efforts and more resources (mostly financial) and it's difficult to find adequate sources for them and really interested partners.
  So many scientific achievements, potentially able go generate technologies and economic value, end up in the "death valley".
- The governance system of universities, in which there aren't differentiated organizational structures for governing and managing the different main activities (education, research, economic valorisation), so that the first two are prevailing and the third one is given not enough (little) strategic attention and (few) financial and human resources.

- on the side of firms (specially SMEs)
  - The low propensity of SMEs in general to develop radical technology innovations based on the exploitation of scientific knowledge, and their widespread attitude to generate incremental innovations
  - The lack of adequate technical and financial resources for SMEs carrying out the development of advanced technologies
- regarding the overall socio-economic context
  - The lack of appropriate sources of funds, specially in the private sector, for supporting either the "engineering" of scientific results and their transformation into industrial technologies or the creation of academic start-ups.

IV.2 Some proposals

It's apparent that some of the criticalities of the interaction between research institutes (universities) and firms, such the behavioural issues, are rather difficult to overcome with actions from outside, at least in the short and medium term. Anyway some actions can be performed in this area also, specially for promoting among university researchers a positive attitude towards the cooperation with industry and among SMEs a strategic awareness of the role of technology innovation, based on scientific knowledge, for their medium-long term competitiveness.
For the other critical issues it's possible to make some actions in order to fill some gaps in the strategy and the tools that have been up to now designed and implemented for promoting and supporting the transfer of knowledge from research to industry.
The main lines of action regard the organizations that can be established for realising the "engineering" of scientific results and their transformation into industrial technologies, and the financial incentives for supporting all the phases of the process of technology innovation, including the creation of new knowledge-based firms.
Here follows a short description of the main lines of action that are envisaged most effective:

- Establishment/Reinforcement of RTOs (Research and Technology Organisation) that, have links with a university or a research institute, but are operationally independent from it, have their own technical personnel and laboratories and provide technical services for technology innovation to a variety of clients (mainly firms) in a competitive environment.

These RTOS can really perform the "engineering" of scientific knowledge, which they acquire, first of all, from the parent organization or outside sources, and transform it into applications.

Even if the RTOs get their revenues from the market, they need some kind of public financial support for some of the activities they carry out for SMEs (e.g. setting the technology innovation problem, which at the beginning is often quite vague and uncertain) and for R&D autonomously defined projects which are necessary for developing new technical knowledge that can be afterwards transformed into industrial applications.

- Provision of public financial incentives to technology innovation projects, that support the critical phase of "engineering" the scientific results, for which neither the research institution nor the interested firm are willing to make some investment due to the uncertainly and risk of developing a successful technological application.
- Provision of public financial "incentives" for supporting the creation of new knowledge based firms, so overcoming the criticalities of the private venture capital sector in Italy, Portugal and Spain (low propensity to take risk, small amount of available resources).

  The situation of this sector in these countries is quite different from the one in the US, where there is a lot of private money that can be invested in new risky business ventures. Therefore the process of creating new knowledge based firms (first of all, academic spin-offs and start-ups) must be supported by the public intervention with incentives that can promote and complement private investments.
- Provision of services for raising the level of awareness of SMEs regarding the strategic role of technology innovation for their competitiveness and for promoting their access to the competences of universities and research institutes: e.g. forum, technical workshops and informal meetings (through which information about the new scientific and technical knowledge is disseminated among SMEs and it's possible to set the basis for a future cooperation and for building a social network of researchers and business people), consultancy for problem setting, grant search and R&I project management (with the aim of lowering access and interface costs) and so on.
- Design of a system of rules regarding the interaction of a university with firms, rather flexible and able to cope with the needs of the firms, mainly in terms of secrecy, ownership of the results, ways of exploitation, timing and so on. This system of rules should avoid maximization of royalties as this is likely to prevent future cooperation.
- Design of a system of rewards to researchers for their participation in knowledge transfer activities, including the consideration of patents and licences in career and tenure development and a larger share (relative to the one retained by the university/institute) of licence or equity revenues.

  Given the not fully satisfactory outcome in terms of volume of commercialized knowledge achieved by the types of rewards implemented so far, there is the need of finding a new incentive structure that can be effective in stimulating researchers' involvement in knowledge transfer activities and increasing the volume of commercialization outputs from research.

- Provision of support to SMEs for the "internationalization" of their interaction with research institutes and universities. Usually SMEs, when searching for the advanced technical knowledge they need for solving their innovation problems, apply as a first step, to the local universitiy (ies), as the cost of access is minimal. But not always the local source of knowledge is competent enough, while the best competences can be found outside the territory, even abroad.
  As SMEs aren't usually equipped for such a search and unable to cover its cost, the provision of outside specialized support in this field could allow SMEs to have access to the most appropriate knowledge for their needs.
  The COTEC of Italy, Portugal and Spain have made some successful experiences of setting up R&I projects which involve universities, research institutes, large firms and SMEs of these countries, so that complementarities of competences and synergies among resources are exploited and outputs and outcomes are optimised.