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A Contribution for the Identification of Indicators for the Evaluation of the Impact on Regional Innovation and Development of an EU Program for University Research in the North of Portugal

Maria Estela Ferreira¹

FOREWORD

This article is the primary outcome of the need of a public officer involved in the process of financing a set of University research projects through European Funds to contribute to their evaluation, having in mind the quest for regional innovation and development.

A first version of the paper referred only methodological aspects, but final reports of were analyzed by last summer, and this made possible to gather some results of the accomplishment of the indicators suggested herewith, as presented in the ERSA Congress in Vienna.

An improved version of this paper must still be made, in order to include more recent references from the available literature.

ABSTRACT

Co-financed Programs by the European Union have been with no doubt relevant to contribute to some endeavours of Research and Development in the North of Portugal. This paper intends to provide an insight view on the way some available and/ or feasible indicators can illustrate the results and impact, specifically on Regional Innovation and Development, of the so called Integrated Programs, a large set of R&D projects by the Universities of the North of Portugal, sponsored by the EU.

After an introductory section summarizing some literature mining as relevant to be had in mind, the paper briefly describes the three main Universities at stake. That description is followed by a discussion of the relevance of each indicator for the undertaken purposes and their performance within the Integrated Programs. Finally, there is a brief section of conclusions.

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1 – INTRODUCTION

The literature² refers a wide set of policies that have been undertaken in the last decades, namely in the OECD countries, envisaging to foster regional development through the development of research in locally settled Universities, in connection with local enterprises.

In this context, research and Development (R&D) programs co-sponsored by the European Union are relevant³. Among them, we deal at the present moment with the so called Integrated Programs⁴ which took place in the Northern Region of Portugal⁵ between 2013 and 2015 and through which a relevant investment has been made in the Universities of the Region and related Laboratories, especially in human resources allocated to R&D.

This paper does not intend to focus on institutions like research institutes, technological parks, or departments for industrial connections, as those are not the scope of the EU Program which indicators are meant to be analyzed. Nor shall we discuss matters such as the possibility of engaging external agents to foster university relations with enterprises, material incentives for researchers, or such.

On the other hand, as some of the projects dealt with do indicate the objective of potentiating the creation of start-ups and patent registration, some aspects of such trends should be analyzed.

Section 2 is an introductory one, and intends to focus the main trends of the relation between Research in Universities and Regional Innovation and Development that should be looked at as a background for the objectives of this work.

In Section 3 there will be a brief characterization of the three main Public Universities in the Northern region of Portugal, which were the ones sponsored through the Integrated Programs.

² See for instance OECD (1982); Fagenberg et alii, Eds (2006);; Goddard and Vallenge (2011); Kantor and Whalley (2013)

³ See for instance RECITE (1994).

⁴ As full denomination, the SAESCTN-PIIC&DT/1/2011 is a bit complicated and of a difficult direct translation, we will designate it merely as the “Integrated Programs”, as they are usually referred to by technicians and researchers.

⁵ In Portugal there are no Regions in the political sense. Nevertheless, the Country comprises some regional divisions, for administrative practical reasons. The North is a NUTS 2 Region.

Section 4 will describe the available indicators which contribute to the characterization of the achievements of the Integrated Programs.

We will conclude with a brief 5th Section of conclusions.

2 – SOME REFLECTIONS RELATED TO THE WAY UNIVERSITY RESEARCH CAN FOSTER REGIONAL INNOVATION AND DEVELOPMENT

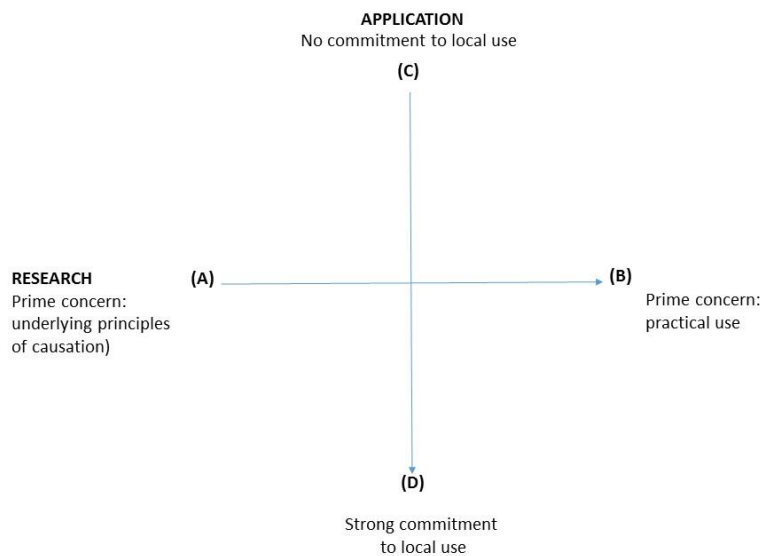
The Northern Region of Portugal has witnessed some encouraging progress on the promotion of an innovative environment with repercussions on its territory and inhabitants. The role of the Universities of the Region has been of an utmost importance in this process.

Universities contribute to the development of the regions they belong in some different aspects. Especially in what concerns Universities in lagging regions, it is often stressed the impact of the existing of a student population in the local economy. The university also functions as a provider of trained intellectual persons who can foster development and innovation once hired by enterprises. That is not the focus of the present work.

In the context of the aim of this paper, a previous reflexion should be made specifically on how University research can contribute for regional innovation and development.

It is consensual that University research plays an important role as a source of fundamental knowledge (Mowery and Sampat 2006; Link and Siegel, 2007; Theis, 1986). Through the evolution of times, especially since the 1970's, the recognition of the fact that Universities also have proved to provide, at least occasionally, industrially relevant technology, brought about governments throughout the industrialized world to launch numerous initiatives to link universities to industrial innovation more closely (Mowery and Sampat 2006), also trying to foster further development in the regions they belong. In varying degrees, universities throughout OECD now combine the functions of education and research.

G. C. Cameron (1986) provided a simple diagram that still may help to understand the important question of the different degrees of basic researching versus practical concern can combine with various degrees of local commitment, as presented in the next diagram:



While in the post-war period basic research was considered as a critical factor to the economic growth (Mowery and Sampat 2006:212), the present quest which is being addressed to Universities tends to be situated in the B/D quadrant. In this context, we shouldn't just speak of Research, but rather about Research and Development (R&D). Cunha⁶ (2015:30) adds to the perspectives of the pure quest of enlarging knowledge and the one of applied research, which gathers different knowledges and disciplines in search of a concrete response to a societal or commercial necessity, a third one: the translational perspective, which consists in the efforts to converse discovery research on applied research.

A word must be given about the University agents of R&D. First we should mention the Professors who, alongside with their teaching commitments, also dedicate themselves to research activities. They have a fundamental contribution to the research outcomes, as they gather knowledge information from an international context, being aware of the last novelties and discoveries in their particular field of study; they constitute the leaders of research projects since their beginning, defining the objectives to be reached at every stage of the process and identifying the needs in what concerns the number and background of the collaborators to be engaged.

⁶ Cunha, António M, is the Rector of the University of Minho, referred further in this paper.

Those collaborators are usually PHD students and post-Doctoral researchers, and it is most desirable that an affinity is reached between the purposes of the project they are engaged in and their specific researching interests. Otherwise, that should be one of the causes of high turnover of this particular kind of agents.

The literature points out that there can be a critical difference between the norms of academic research differ substantially from those observed within industry. (Paul David and colleagues, cit by Morey and Sampat: 2006; Cunha, 2015; Universidade de Aveiro,1998⁷; 62-3; Theis, 1986;28-9)). Morey and Sampat (2006:213) stress that:

For academic researchers, professional recognition and advancement depend crucially on being first to disclose and publish their result. Prompt disclosure of results and in most cases, the methods used to achieve them, therefore is central to academic research. Industrial Innovation, by contrast, relies more heavily on secrecy and limitations to the disclosure of research results. The significance of these “cultural differences” for the conduct and dissemination of research may assume greater significance in the face of closer links between university and industrial results.

Nowadays there have already been several examples of joint research with these two types of entities together, upon the establishment of contracts that satisfy either part. R&D by contract, in which solutions specified by the user are developed, is referred (Universidade de Aveiro, 1998; 58). Industrial co-financing should be interesting to speak about, but in the context of the Program to be observed it is not an inner trend, but rather can follow the undertaken R&D, in a subsequent phase, hopefully a consequent one.

The relations between University research and enterprises may take some other forms, either more or less formal. For instance, some teachers make themselves available for the elaboration of studies or consultancy for the enterprises, within the frame of their functions in the university. Other get involved in projects contracted by enterprises to the University. Other make available their competences through the exercise of a liberal profession and by the creation of their own enterprises, in a complementary way to their university commitments (Universidade de Aveiro, 1998; 60-1).

⁷ The University of Aveiro is located in the Center of Portugal and faces the same general institutional and entrepreneurial environment as Northern Universities.

Another important trend is the desirability of co-operation between universities, which has been stressed at least since the 1980's. Adolph Theis (1986) begins by stating that the medieval university was already designed to be international⁸. This Author stands that exchange of knowledge between universities has been primarily determined by the stiff competition among industrial nations world-wide in developing pure knowledge and its technical transfer into industrial production, and that pure research in physics, chemistry, biology and biochemistry prove to be the starting point for new branches of industry. This perspective has been even more emphasized for R&D, as world-wide results have to be taken into account for local and regional development purposes, otherwise they wouldn't provide competitive innovation.

Therefore, we shouldn't take dissemination of results as a mere egoistic trend from researchers. In fact, through the participation in Congresses and Seminars, researchers immerse in the top levels of knowledge in their specific fields. And while being recognized by means of their publications, not only in such gatherings but also in international reviews and specialized books, their word and opinion becomes valuable both in world and local contexts.

In what concerns the question of how to translate local and regional research, especially University research, to local and regional development, above referred need of an informed knowledge at the world level, by locally settled researchers, is a necessary condition for local innovation, but it is not a sufficient one: it surely brings to the region a set of advised persons who might contribute to foster local applicability of science findings, but such fostering will depend on the achievement of sound links with local and Regional entrepreneurial agents and organizations.

The Universidade de Aveiro (1998: 59) stresses that the capacity for the University to support the creation of new enterprises will be reinforced by its capacity of potentiating other general services to enterprises. Link and Siegel (2007: 115) add that university's previous success in technological transfer is a key explanatory factor of start-up formation. These Authors (2007: 121; 131) continue:

⁸ Day (1986: 61) stresses that, in this concept, European co-operation is at least 800 years old.

The best approach for universities that wish to lounge successful technology transfer start-ups is a combination of academic and surrogate entrepreneurship. Universities that generate the most start-ups have clear, well defined strategies regarding the formation and management of spinouts. [...] Universities that stress economic development outcomes are advised to focus on start-ups because these companies could potentially create jobs in the local region or state. Note that a startup strategy entails higher risks because the failure rate of new firms is quite high. [...]. It is also important to note that a start-up strategy entails additional resources, if the university chooses to assist the academic entrepreneur in launching and developing their start-up.

As for patent registration within University research, there may occur desirable achievements, but this does not tend to constitute an end in itself, neither shall necessarily be considered a decisive indicator, for R&D evaluation purposes. Nicolas and Vaz (1999: 839) stand that it should be desirable to be able to use the number of patents as an output indicator as related to the input expenses in research. Nevertheless, these Authors continue:

...but inventive endeavour is not precisely measured with this indicator. Even if patent registration rate is linked – at a universal scale – to the intensity of technologic activities, at local level this relation may be weak: such rate deeply varies from one industry to another, and from country to country.

New patents and spin-offs are not likely to occur with the same frequency in every field of knowledge and research. As a matter of fact, in the last decades innovation has taken place with more intensity within fields such as computers (hardware and software), biotechnology and health, the development of new materials and nanotechnology. This should be taken into account when evaluating the Program.

Furthermore, we should refer Couto (2002), who stresses the importance for researchers to protect their intellectual property. This Author discusses how patent registration can both contribute as an incentive to inventing and to the promotion for technological market conditions which may foster a greater dynamics for distribution, commercialization and use of knowledge.

A word should be mentioned about the links and perceived importance by industrial enterprises of the action of Universities for innovation. Costa and Teixeira (2005) conclude that, contrasting with CIS related evidence, a survey to a set of 425 Portuguese Technology Intensive Firms, university is critical to these firm innovative activities being likely to substantially and positively impact on regional knowledge network flows and density.

A quick look at the data provided by CIS (2012) suggests that, among other indicators:

- In the period 2005/2010, Portugal was the second country in EU27 with a greater increase in R&D expenditure (more than 15% average yearly growth rate).
- No Portuguese Region is among the 30 regions of EU27 with higher level of R&D expenditure per inhabitant (2009).
- The intensity of R&D expenditure on equipment is weaker than the one on human resources, as compared with EU27 average (2008). It should be interesting to have a look on some indicators of “research productivity”, as different as scholarly articles production or patent registration.
- In Portugal, R&D personnel as a percentage of persons employed surpassed the EU27 average, being of almost 2% (2009).
- In Portugal (2009), regional disparities (NUT2 level) in R&D personnel as a percentage of persons employed seem to be about average, in EU27 terms

A more in-depth look could lead to further conclusions. It should be undertaken in the context of a further version of this paper, to contribute for a background of the evaluation of the Program’s indicators.

3 – SOME CHARACTERISTICS OF NORTHERN UNIVERSITIES OF PORTUGAL

At the time Portugal joined the European Economic Community, this is, 30 years ago, in 1986, research in Portugal was still deeply centralized in Lisbon. A long way has been walked since then, and nowadays there has been the establishment of an important set of sound research institutions and laboratories in other regions, namely in the North, ranging from nanotechnology to biotechnology, the search of new materials, to mention some.

Most of these institutions are linked to the larger, most ancient (100 years old) and well-known university of the North of Portugal, the University of Porto (UP). The UP has now more than 30000 students, and provides courses on every field of knowledge, having reached sound international remarkability. Besides teaching and research, the UP develops important science dissemination actions directed to high school students during summer, with the general name of Junior University. The UP also develops an action of Museum management, especially in what concerns Biology. Another relevant activity has been the establishment of a unit for fostering start-ups among graduate students.

In 1974 there took place the creation of the University of Minho (UM), with departments in Braga and Guimarães, two medium cities which head an important industrial region in the Northwest, which main specializations are textiles, footwear and mechanics. From the beginning, it included courses like Production Engineering, and an Informatics Department, showing care for the management of industrial productive systems, their computerization, the integrated analysis of the production system of each enterprise, automation and training of intermediate managers. In this context, young graduates, while integrated in the enterprises, constitute a linking element between the University and industries (Braga da Cruz, 1986). Pereira and Freitas (1986) also stress the strong interaction of the UM with the community, especially at the local and regional levels, with protocols of association with the industrial association of Minho and joint ventures with National laboratories, “Industrial Development Contracts in the fields of textile technology, energy savings, Plastic industry, Weighing electronics, industrial water quality, among other. For instance the already long cooperation with local entrepreneurs also through the Tec Minho, the Association University- Enterprise created within the University of Minho has been working since before 2000 on the creation of spin-offs starting in a University context (see Tec Minho:2000).

In 1986, a Polytechnic school in the inner part of the North has been enlarged and reinforced, giving the place to the birth of the University of Trás-os-Montes e Alto Douro (UTAD). Professors in the UTAD understood the need to study the region they are inserted in and their work has been largely recognized, especially in the fields of agricultural systems and other traditional activities (Braga da Cruz, 1986), but without forgetting the fostering of new activities locally undertaken.

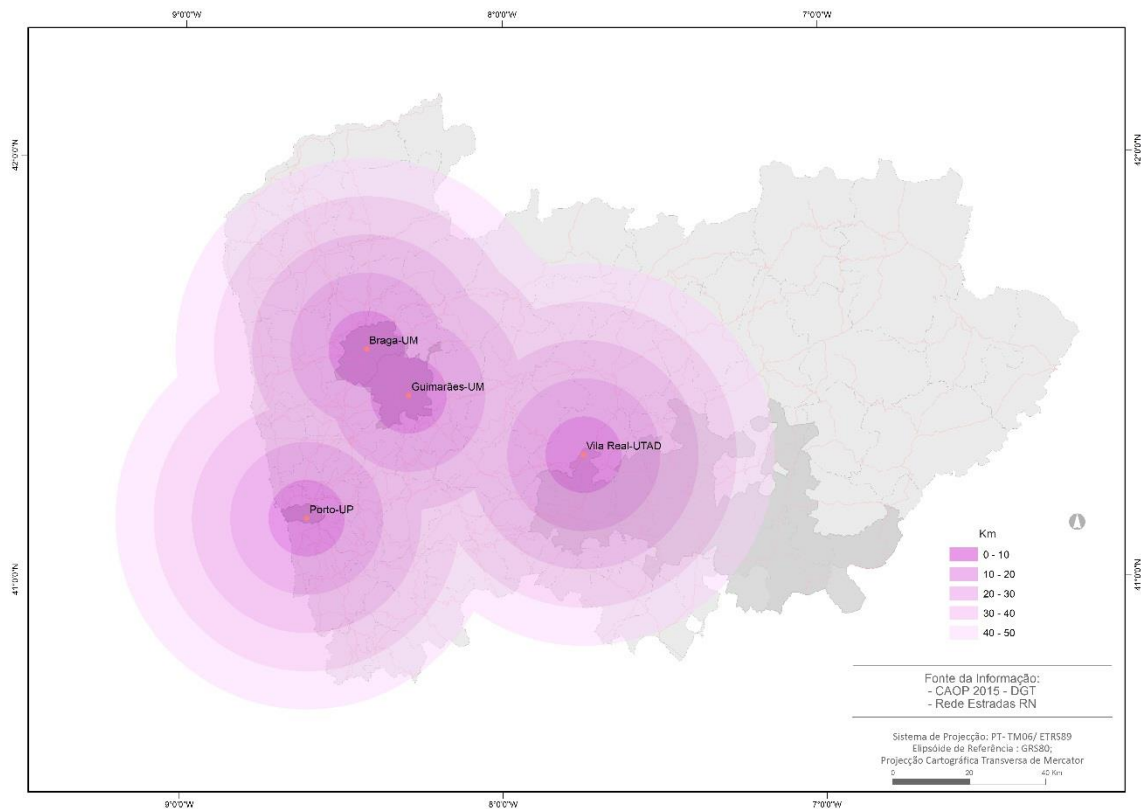
A particular word must be addressed in relation to the field of enology, as the Douro region is the location of vineyards that produce Port Wine and more recently, no doubt with the connection of UTAD graduates and researchers, gave the origin of also making premium table wines.

The Rector of UTAD recently (2015) stressed the need for a holistic view of the University, adding that the role of Universities in territorial cohesion to shouldn't be minimized, within a view of a high quality of such institutions. He also stressed the need to attract more Knowledge workers to low density regions, who can enhance added value to endogenous resources.

Woodward and alii (2003) developed a spatial econometric study with data from the United States in which they concluded that in that country which points out to a geographic association between local university R&D expenditure and the total number of newly created high technology plants by county. They also found that the spillover effects between funded academic research and plant increases are geographically limited and, depending on the sectors, they may extend to a maximum of approximately 230 miles.

In what concerns firm-university geographical proximity, Costa and Teixeira conclude that the point made in location related literature concerning the existence of knowledge externalities in regions surrounding research universities is indeed applicable to the Portuguese context. But in what concerns the geographical range of university research, we believe that it must be shorter than the one found for the States, due to the size of the country and the habits of distance- travelling that prevail in Portugal as compared to the USA. Though the exact measure has not been studied, we present in the Map in below a perceived idea of the influence of the 3 Universities we are dealing with⁹.

⁹ On the types and sectors of enterprises that have linkages with the different Portuguese Universities, see Teixeira and Costa (2006).



We must add that, as stated above, cooperation between Universities strengthens the reach of their action, especially in what concerns R&D. Having this in mind, Northern Region and University leaders fostered a contract of cooperation between the three Universities of the Northern Region, since 2015.

Some R&D Projects sponsored by the UE, particularly within the program we are dealing with, have been designed and implemented in joint ventures of departments from either Universities in the North.

4 - AN ANALYSIS ON THE MEANING, INTERPRETATION AND RESULTS OF SOME AVAILABLE INDICATORS

In this section, as referred, we will present some comments about the available indicators on the UE sponsored research through the Integrated Programs, in the North of Portugal.

As indicators of INPUTS we have, basically, R&D Expenditure and R&D Employment. For OUTPUTS we will mention DISSEMINATION INDICATORS such as scholarly articles, participation in Congresses and Seminars, and the organization of Workshops; and LINKS WITH ENTERPRENEURSHIP's INDICATORS, such as Start-up creation and Patents registration.

R&D Expenditure

R&D Expenditure should be referred to the GDP of the region where it is spent, as the percentage of R&D Expenditure in GDP is an indicator that corrects, in a way, the different levels of the cost of life between regions, especially when we compare regions from different countries. Moreover, R&D Expenditure in GDP is a most used indicator of the incidence of R&D expenditure/investment in countries and regions, may it be public or private expenditure, in universities, technological parks or similar, enterprises or other. *Caeteris paribus*, R&D expenditure by inhabitant only seems to be a good indicator if the compared regions have the same level of income and related wages, namely the wages of researchers.

A distinction should be made between spending in equipment or wages of researchers. Equipment for research needs to be continuously up to dated, and its life duration may be shorter than in other fields of investment. Investment on human capabilities in research should be considered as investment costs as well, due to the lasting character of the results of such activity. Research is a continuous process, where knowledge accumulates as sediments. Research of today is the starting point of research of tomorrow. Research results tend not to be volatile.

The Integrated Programs were almost solely directed to financing human resources. R&D Expenditure referred to the GDP should also consider equipment, and should require further information about other projects. That goes out of the scope of the present paper.

R&D Employment

It is consensual that Employment in R&D should be measured in Researcher Full Time Equivalent (RFTE). For each project of the Integrated Programs the respective financed RFTE has been calculated.

Such RFTE is a mix of relatively small time expenditures by University each professor on research, combined with full time junior (PHD students) and senior (PHD graduates) researchers. The former represent guidance, experience and leadership, and their link with the university is relatively stable. The latter are generally contracted for a the purpose of the respective project, and usually present a high level of turnover, due to such lack of job stability, adding to very low wages that cannot compete with jobs abroad they often end up to be engaged in.

Some projects lasted 30 months, others began later and lasted only 18 months. On the whole, the Integrated Programs have financed the equivalent to a thousand full time researchers during one year.

Complementarily, there is the possibility of calculating the turnover rate of nonteaching researchers, as dividing the respective RFTE for the number of contracts that took place under each project. In this context, it has been calculated that the average duration of permanence of research fellows was of only 14 months for the 30 month projects, that is to say, of less than half of their duration. Among them, Laboratories without teaching commitments presented a capacity of retention of research fellows of 17 months average. The University of Minho reached 15 months, but the University of Porto (the more famous, as referred) could only reach 11 months, as their research fellows tend to gain curricula and go abroad.

Projects of 18 months duration reached 10 month turnover for research fellows. The University of Trás-os-Montes (UTAD), only with 18 month projects, also presented a 10 month retaining capacity.

Participation in Congresses and Seminars and Scholarly articles

Innovation systems at regional and local level have to rely on innovation nets that surpass such territorial scale. In this context, the active participation of researchers, both Professors and contracted persons, in Congresses and Seminars should be measured. An indicator for such active participation is the number of presentations achieved by the sponsored researchers, which globally attained more than 1800, of which 500 took place in the Region, 350 in the remaining Portugal, 650 in remaining Europe and 350 in the rest of the World. The set of these indicators also constitute a qualitative view on the degree of

both the vigor of regional and national research community and the degree of international awareness of sponsored researchers, which is an essential requirement to allow that the use of such knowledge in the region can bring real innovation there.

Another indicator of such awareness is the number of published articles in scientific reviews or as book chapters or even books, which reached more than 2400.

It also becomes evident that the rest of Europe also receives the return of their investment in R&D in the North of Portugal, namely through the dissemination of results that has just been referred. And it is a cheap investment, as researchers fees are about half the ones on countries such as Germany, France or Denmark. Even if compared with Greece or Spain, these wages are cheaper in Portugal, as stated in official EU documents related, for instance, with ERASMUS' sponsorship.

The number of citations of scholarly articles, would also be an interesting indicator of the relevance of the works. But their availability occurs later than paper production. Thus, this indicator should be looked at in an ex-post evaluation.

- **PHD thesis within the Program**

The number of PHD and post- PHD thesis accomplished or developed by sponsored researchers within the Projects under evaluation is also an important indicator. More than 260 were accomplished. If weighted by the number of contracted researchers, it provides an idea of the personal interest these researchers devoted on the projects they are assigned to. In the Integrated Programs as a whole, such proportion was of about 1/3.

- **Organization of workshops and other dissemination actions**

The organization of workshops has been a way that many projects under the Integrated Programs have found both to disseminate their findings, questions and conclusions to a selected audience, specifically constituted by entrepreneurs with an interest in the area of the research items, as well as some researchers or other relevant persons related to the same fields.

Other dissemination actions took place under those Projects, as for instance mere informal meetings with agents like the ones mentioned for the workshops.

Nevertheless, differences on concepts and definitions about what is considered a workshop by the different projects made it impossible to account them as a whole to constitute a reliable indicator.

- **Patenting**

Patent registration may constitute an objective for an R&D project, but the randomness of such occurrence during the pre-defined time-lag of a project of the nature we are observing makes it a very volatile targeting issue.

The fields within which patents occurred, under the Integrated Programs, were exactly the ones referred in the literature: health, biotechnology, engineering, new materials. In a set of only 16 projects, 47 patents and 32 prototypes were generated. Each of these outputs required three years Researcher Full Time Equivalent (RFTE), which is considered a good performance. Only 26 percent of researchers and 28 percent of financing were assigned to the generation of patents or prototypes.

For instance, the UTAD didn't generate any patent. Nevertheless, this University performed a strong support to local enterprises and enterprise creation, besides the visibility of its contribution, for instance, for quality wine production in the Douro Valley and the development of new crops in Trás-os-Montes.

Therefore, there is the necessity of giving importance to other outputs such as spin-off generation, prizes, and links with enterprises and to international projects. Otherwise, about 70 percent of the work on R&D will simply be ignored.

- **Start-up creation**

Some projects of the UE Program we are dealing with stated the objective of originating start-up creation. Other did create some start-ups, although it hasn't been an initial purpose. Nevertheless, start-up creation hasn't been yet a stated objective of the Program as a whole, although such creation has been welcome both by program Managers and Researchers. So, in the end, the full number of start-ups directly born from the Program is not available, so it is not possible to be considered it as a main Program indicator. The same goes, as a consequence, to the rate of start-up creation. Also for start-ups, their field or sector should be identified in an evaluation context.

Anyway, it seems possible that further start-up creation might occur in a later period, still as a consequence of some Projects of the Integrated Programs. It will be interesting to consider this situation in the context of an ex-post evaluation.

5 - CONCLUSIONS

The character of use of research, whether the undertaking is of a basic, applied or development nature, entails a recurrent discussion which difficultly reaches an edging frontier between each of those three concepts in a consensual way. This awareness is important for designing R&D development projects.

In the same manner, there can not occur sound regional development based in innovation if such innovation is not valid in a world perspective.

On the other hand, Europe also receives an immediate return of their investment in R&D in the North of Portugal, namely through the dissemination of results. And it is a cheap investment, compared to the costs of R&D in other European countries.

We may also conclude that the development of regionally settled and directed R&D is of a vital importance for EU Cohesion Policy, especially if we take into account that the Northern region of Portugal has persistently shown development indices far below from the community average.

And what could be a more relevant kind of program to contribute for Europe 2020 objectives, stated as the desire of UE to perform an Intelligent, Sustainable and Inclusive growth, than one which has been designed to invest in human capacities devoted to contribute to innovation in a region which living standards need to be improved?

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