AN ESSAY ON THE APPROPRIATE INDICATORS TO MEASURE INNOVATION IN THE PORTUGUESE FIRMS: AN APPROACH FOR THE LESS ADVANCED REGIONS FACING KNOWLEDGE ECONOMIES

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ABSTRACT

The Portuguese firms are mostly small or medium sized and do not have an R&D department and lack qualified personnel to develop it inside the enterprise. The business goals are often linked to what the owners desire for their firms and they usually consider innovation a very expensive and risky activity. The level of trust between economic actors is lower than most of the OECD countries which is responsible for many institutional, cultural and financial constraints that limit the entrepreneurial capacity to diversify. This helps to understand the small levels of international transfer of technologies and required patents to world Offices. Some studies show that the R&D efforts are not always directly related with economic performance, specially in less advanced regions. This work tries to investigate new indicators for the modes of learning in innovative firms of less advanced regions like Portugal and proposes a methodology to address a different approach from those that have been used for more advanced regions. The aspects related with behaviour, absorption of local sources of innovation and collaboration are some of the factors to have in mind when evaluating innovation in this new approach. The overall implication of the results is that no one existing index dominates in explaining how firms attempt to innovate. Instead, we require a richer conceptual perspective that combines diverse issues. Firms face strong obstacles that limit their abilities and propensity to innovate. At the same time, though, firms face strong competitive pressures to undertake innovating actions. Entrepreneurs need to develop new theories and methods concerning the intersection between these pressures.

INTRODUCTION

The knowledge-based economy is a concept often used to describe trends in the most advanced economies towards the potential of knowledge, information and qualified people. The European commission places great attention on the importance of these resources as regions that manage effectively their knowledge assets achieve higher levels of performance. The innovative activities, through R&D and knowledge creation, foster technological change which creates opportunities for further investments in productive capacity. This strategic role of knowledge underlies increasing investments in R&D, education and training, among other intangible assets, which have grown more rapidly than physical investments in most countries as the policy agenda has put emphasis on the innovation and knowledge-creating capacity. Technological knowledge is being understood to display other characteristics such as accumulation, influencing the dynamics of markets so that they are pushed away from equilibrium, which have resulted in the more recent developments of evolutionary economics and new growth theories. The evolutionary approach emphasises the importance of technological diversity and the ways in which it is translated into technological opportunities what influences the ability of firms to innovate and thus the trajectories they follow for innovation. A corollary is that statistical data need to be desegregated upon the firm-level to seek for competencies, skills, interactions and technology transfer. The systemic view of innovation emphasises the importance of the diffusion of ideas, skills, knowledge, information and signals of many kinds. The channels and networks through which these items of knowledge circulate are

embedded in a social, political and cultural background, and are strongly guided and constrained by the institutional setting. System approaches to innovation shift the focus of policy towards an emphasis on the interplay between institutions, looking at interactive processes in the creation of knowledge and in its diffusion and application. The analysis that will be carried out in this paper is about the innovative behaviour of the Portuguese firms which may bring interesting insights to the discussion of the factors affecting innovation performance in the less developed regions. Such analysis may also be a contribution to the policy discussion, in terms of what are the best approaches to be designed and implemented in the context of these regions.

Background Studies

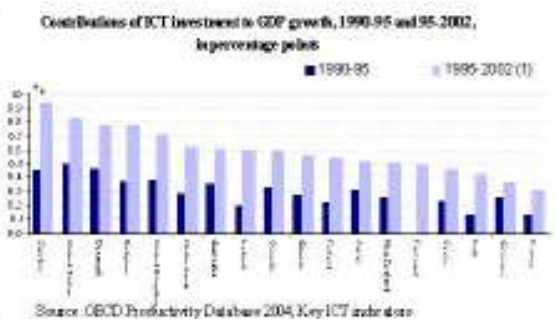
Innovation and technology play a central role in this knowledge-based view although the complex process behind innovation has been insufficiently measured (OECD, 1996a). This is why many recent studies in the literature have analysed innovative activities in different firms and sectors and state innovation as an enhancing process of the firm's capacity to learn and create new knowledge. Some of them put evidence on the difficulties of evaluating several important intangible factors that are involved in the innovation dynamics such as the attitudes, behaviours, skills and their transmission within organisations and between them. There is a lack of indicators and methods appropriate to determine most of immaterial aspects involved in innovative interactions like trust and receptivity to the adoption of improved practices. Technological progress used to be assumed as a simple linear process starting with basic scientific research and evolving, through more applied research, to scientific and technological applications. The new perspective about innovation has brought out the importance of linkages and led to a more integrated approach which gave birth to the innovation systems. To understand better this evolution it is convenient to recall briefly what have been the main steps towards the evolutionary theories. The root is on the Schumpeter's view that considered innovation as a relevant practice of business firms making part of their economic activities, against the neoclassical view that treated firms as passive users of exogenous technological advances. Schumpeter assumed the entrepreneur as the main actor of the innovation process and recognised the positive effects of organisational capacity, in terms of internal R&D specialisation, on the innovations' development. By the early 1980s, the linear models gave place to the dynamic vision of the innovation process in which S&T opportunities, combined with the economic needs, were the driving forces behind innovation (Freeman 1979). Then the studies covering innovative activities in a wide range of sectors also made possible to compare the different ways in which firms behave concerning their sources of innovation and patterns of technological diffusion (Scherer 1982, Pavitt 1984). By the end of the 1980s, a new approach has evolved from the observation of innovative firms in the Northern European countries where innovation only had succeeded within a long-term interactive environment with a multiplicity of agents. In contrast of US, where the emphasis of innovation is on the codified knowledge produced by science-intensive industries, the Northern European economies seem to get more advantage from the tacit component for innovating (Lundvall 1999). The fact is that, in these small successful regions, development might be associated mostly with processes of localised learning based on strong local interactions and the sharing of "sticky" knowledge (Asheim and Isaksen 1999, who have studied cases in Norway). This has led to the innovation systems framework which enriched the analysis by integrating the institutional setting, the culture and the history of the regions or countries where innovation activities take place (Lundvall 1992, Nelson 1993, Edquist 1997). The works of Lundvall (1988, 1992) and Freeman (1987) had also contributed to sustain these trends as knowledge can be tacit, resulting from informal interactions or interactive learning, and not only from scientific and technological activities, either in more developed or less developed regions.

In this paper, we will examine some of these aspects by focusing first on the levels of technology transfer, ICT investments and registered patents as appropriate indicators to explain innovation performance differences (between advanced and less developed regions) though insufficient in measuring innovation capacity, then on the relevance of other indicators in predicting innovation behaviour and performance, such as the level of external collaboration with different involving actors. We will then present empirical results from the Portuguese firms, in trade and service sectors, that support the validity of these arguments. The results suggest that collaborations do have a role in firms' innovation performance, but also highlight the potential complexity of it.

Research Hypotheses

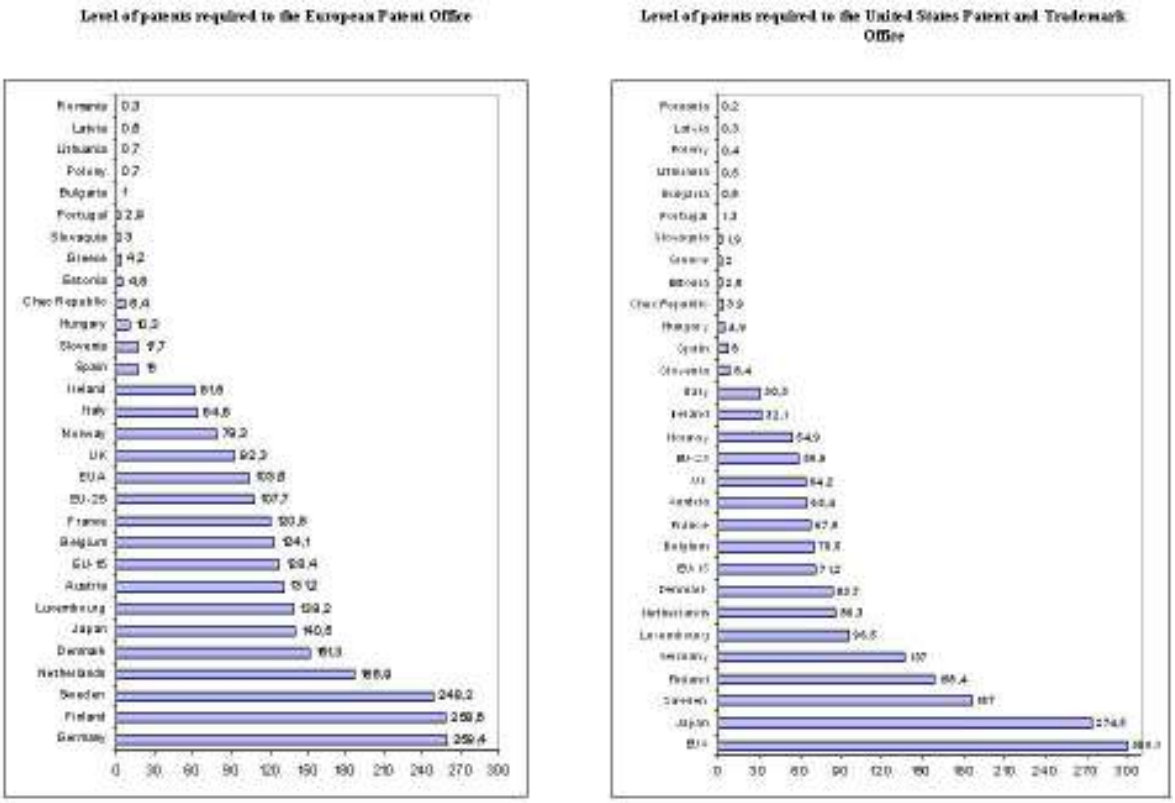
Hypothesis 1: As the levels of international transfer of technology and registered patents are very weak, these are not the appropriate indicators to measure the innovative potential of the Portuguese firms

The innovation is not only R&D but also knowledge and learning and, besides being radical, it can also be incremental through advances in the quality of products, process efficiency, marketing and design. According to Kleinknecht and Bain (1993) there are other important indicators to consider besides R&D and patents, as for example the number of innovations or the impact of the innovative products on sales. These can be collected through surveys or evaluations and the results can be quite different depending on the sector, size of the enterprises, business goals and institutional setting. The studies about the technological gap among European regions suggest a positive relation between the economic performance and the innovation activity based upon most common indicators: patents, R&D expenditures and R&D employment (Rosenberg and Fristack 1985). However, more specific works about convergence trends, such as the analysis of Cappelen et al. (1999) shows that R&D expenditures are only positively correlated with the GDP growth for a group of 29 European regions, while they are negatively correlated for a group of 76 regions (which includes Portugal). In the smaller group, with the more advanced regions, the R&D investments appear to be more efficient than in the other group. The results give no evidence suggesting that the less advanced regions which do more R&D efforts also do better in terms of growth. In the case of Portugal, the level of international transfer of technology including licenses, patents, R&D and technical services, is 0.31 which is lower than most European countries:



And the contribution of ICT investments (in information and communication technologies) to GDP growth is only 0.5% (period from 1995 to 2002), a percentage much lower than most European countries:

And both levels of required patents to the two main world Patent Offices are very weak in Portugal: 2.9 patents, per million of inhabitants, to the European Patent Office and 1.3 patents to the United States Patent and Trademark Office. These values are deeply below the averages in Europe of 107.7 and 59.9 patents per million of inhabitants, respectively.



Source: Eurostat, OECD, Key Figures 2003-2004

These findings allow us to think that the modes of learning within innovative firms in less favoured regions need to be addressed in a different way from the approaches that have been used for more advanced regions. This led to some studies about the behavioural aspects of the innovating performance, specially in the context of less developed regions and of small and medium enterprises (Fernandes et al. 2004, Vaz et al. 2005). The Portuguese firms have limited resources to invest strongly in innovation, mainly because the majority is small or medium sized and lack several financial and human competences (Godinho and Mamede 2000a, Conceição and Heitor 2003). This reality keeps being observed mostly in traditional sectors (Mytelka and Farinelli 2000, Fernandes 2003) and in lagging regions (Landabaso 1997). Some of the behavioural key-factors are related with external collaborations and the potential of embeddedness and linkages with different agents that can be of institutional, research, learning and economic nature (Koschatzky and Zenker 1999, Sengenberger and Pyke 1992). These last authors observed that the influence of the involving environment varies with the capacity of linking and absorbing the quality of these knowledge and informational sources/agents, what led them to raise the organisational/institutional context, above the firm's size, as a more explicit criterion of its innovative performance. Therefore we tried to test some of these arguments empirically, using a sample of Portuguese small and medium-sized firms, in order to support the next hypothesis.

Hypothesis 2: The levels of external collaboration with different involving actors are significant factors to consider in the measurement of the innovative performance of the Portuguese firms

Generally the Portuguese regions do not show a formal pattern of research and development as the majority of their firms are small and medium sized, which neither have the high-qualified labour nor the financial capacity to sustain it (Vaz and Nicolas 2000). Another obstacle is the strong weight of traditional sectors in the economic structure of the country which often blocks the emergence of new enterprises with new businesses and technologies (Nicolas and Vaz 1998). It is why the "paradox" persists: although there is an increasing rate of R&D expenses in the Portuguese firms, the executable innovation intensity is not attained (OECD 1996b). The small and medium enterprises have more difficulties to expand due to their limited capacity to enlarge external linkages (Rothwell and Dodgson 1991) what leaves them far behind the internationalisation

levels of the bigger ones. Even their capacity to develop special competencies like logistics, strategic planning, marketing and human resources (Hankinson et al. 1997) is weakened by the strong influence of the owners' experience and goals when they fail to delegate those key functions to specialised personnel. The inter-firm cooperation in a mutual basis of trust could thus bring them some anchors by sharing assets and knowledge to generate new resources. Other important agents with which Portuguese firms should sustain their cooperation, beyond the temporary linkages within European innovation projects, are the universities, research centres, technological poles and networks (Laranja and Fontes 1998).

Empirical Analysis Framework

In order to test this hypothesis, a sample was drawn from the trade and service sectors in Portugal. These sectors were chosen for two reasons: first, they present the highest GAV (Gross Added Value) in the Portuguese economic structure, as we can see in Table 1 (except the manufacturing industries which were not included in this study) and second, because over the last years these sectors have been increasing more than industry in Portugal (Godinho and Mamede 2000b). The sample used consists of 346 small and medium enterprises, with sizes between 20 and 250 workers, resulting in 20 groups of 17 or 18 firms for representative cross sector-region samples. These were obtained by the application of a statistic formula to get significant samples: $ni=[1.96^2*pi(1-pi)]/e^2$ at the 0.05 level, covering the five main regions at the NUT II level (Algarve, Alentejo, Center, Lisbon/TagusValley and North). In the formula, "*pi*" is the probability of having innovating firms in the sample and "*e*" is the error level. We have considered a "*pi*" of 15% and an "*e*" of 12%: the value chosen for *p* is based on a study about innovation in Portugal (Barata 2000) which had obtained a *pi* of approximately 30% for big enterprises and estimated half of this percentage for the small and medium ones; and the error level became 12% on getting the number of firms (346 SMEs) otherwise it should become higher than we could manage, within the available schedule for the Ph.D. thesis on which this study is based (Fernandes 2005). The formula has derived 17 or 18 firms per sector in each NUT II region (this relative number varies as it has to be reduced whenever the "*ni*" becomes greater than 5% of the population $Ni=pi*$total number of SMEs in each sector-NUTII).

Then we applied a simple survey to the selected firms, whose questions correspond to the variables resumed in Table 2. We considered four main groups of internal/external factors of performance (independent variables), particularly associated with innovation aspects. We have compared several innovation surveys (Avermaete 2004) which helped to select these domains and avoided a long and complex survey, as it should deal with a big sample of small and medium enterprises. The Table 2 also shows the two main statistic indicators used - the communality criterion from the principal component analysis and the spearman correlation coefficients from the bivariate correlation analysis - in order to confront the relative importance of the variables. While the principal component analysis uses the independent variables, the correlation analysis has to relate these independent factors with the dependent ones. It is why we used an innovation index (a), which was operationalized as a factor of the innovation outputs. These data were also drawn from companies' answers to the questioning. This index can be a proxy of the innovation capacity as it integrates the dependent variables that correspond to the survey's questions related with the introduction of new products and processes, or improved ones, and the registered patents. As the firms are from trade and service sectors, when we personally inquired them about the processes these included organisational, commercial and distribution issues.

Table 1: Gross added value and total employment of the main economic activities in Portugal

Main Economic Activities	Gross added value millions of euros		Total employment thousands of people	
	2000	2001	2000	2001
-Agriculture, forestry and cattle breeding	3203	3663	460,6	460,4
-Fishing	399	424	19,6	19,5
-Extractive industries	353	368	16	16,1
-Manufacturing industries	18649	19368	990,9	994
-Distribution of electricity, gas and water	2773	2850	30	28,9
-Construction	**8106**	**8684**	**505**	**499,9**
-Wholesale, retailing and automobile (trade)	**14847**	**16253**	**751,6**	**782,6**
-Accommodation and restaurants	**2980**	**3184**	**242,5**	**251**
-Transports, storage and communications	6897	7339	162,3	164,9
-Financial activities	**6517**	**7054**	**112,6**	**114,8**
- Real estate activities, renting and specialised business services	**13314**	**14088**	**326,5**	**341,4**
-Public administration, defence and social security	9754	10250	396,3	401,6
-Education	7178	7802	309,7	319,2
-Health and social assistance	5857	6504	261,2	274,8
-Other collective services	3245	3451	200,8	200
Totals	104072	111282	4785,6	4869,1

Source: INE – National Institute of Statistics, Gross added value and total employment per sector (CAE), 2000-2001

Table 2: Relationship between innovating capacity and internal/external factors of performance

Factors of performance (internal/external)	Principal Component Analysis Communality criterion	**Innovation index** (a) Spearman correlation coefficients
1.Innovation sources		
R&D services (RRDEX)	**0,842**	0,133*
R&D expenditures (RRDEXX)	**0,846**	0,195**
Acquisition of equipment (RMAC)	0,531	0,022
Specialised personnel (RDPER)	0,576	0,161**
Patent/bibliometric data (SPAT)	0,537	0,098
Participation in conferences (SPRO)	0,665	0,184**
Visits to expositions (SEXB)	0,628	0,019
2.Innovation domains		
Replacement of products (OREP)	0,537	0,144**
Quality improvement (OIMP)	**0,695**	0,052
Product enlargement (OEXT)	0,626	0,026
New Markets (OOPN)	0,626	0,162**
Process flexibility (OPDT)	**0,784**	**0,293****
Reduce manpower costs (OLBR)	**0,738**	-0,108*
Reduce materials' costs (OMAT)	0,611	0,010
Environment concerns (OENV)	**0,735**	0,076
3.Collaborations		
Collaborate with national enterprises of the same group (CO11)	**0,671**	**0,263****
Collaborate with foreign enterprises of the same group (CO12-15)	**0,745**	**0,239****
Collaborate with other national enterprises (CO21)	**0,702**	0,181**
Collaborate with other foreign enterprises (CO22-25)	0,569	0,156**
Collaborate with Clients (CO31)	**0,723**	**0,361****
Collaborate with Suppliers (CO51)	**0,671**	**0,310****
Collaborate with universities/R&D institutions (CO61)	0,519	**0,243****
4.Barriers to innovation		
Commercial risks (H11)	0,634	-0,038
Innovation costs (H21)	0,651	0,148**
Financial difficulties (H31)	**0,713**	0,057
Lack of skilled personnel (H51)	0,648	-0,061
Lack of information on technology (H61)	**0,789**	-0,118*
Lack of information on markets (H71)	0,565	-0,032
Institutional factors (H81)	0,612	0,191**
Demand response (H91)	0,656	-0,086
Market dimension (P15)	**0,713**	0,180**

Source: Based on own data.

** correlation is significant at the 0.01 level. * correlation is significant at the 0.05 level.

(a)**Innovation index** (dependent variables): new products or improved ones (INPDT) and, new processes or improved ones (INPCS) and patents registered (PAT).

If we consider those two statistic indicators together, they are more significant for the "collaborations" group of variables than for the others. In the trade and service sectors under study, the proximity with involving

agents seems to play a more emphatic role in their firms' innovation capacity, as the local collaboration results more efficient than R&D investments/services (based on both communality criterion and spearman correlation coefficient). This is partially due to their limited assets for developing R&D internally. The main cooperative agents are clients, suppliers and other firms of the same group. Since the interactions with external, either national or foreign, enterprises and with universities/R&D institutions are less explainable, the conjugation of these results suggests that the proximity factor is specially relevant for the firms in these sectors (another empirical work has affirmed the same argument - Matuschewski 2002). The innovation in these firms is usually incremental, focusing on processes and quality, which is typical of a direction toward the market and local clients/niches.

Discussion and Implications

Nevertheless the values obtained are not highly significant as the sample is only composed by small and medium enterprises and it is quite small, comparing with the number of SMEs that exist in the country. Therefore we used the statistic formula to get the significant samples (ni=[1.96^2*pi(1-pi)]/e^2) at the 0.05 level of significance. Other factors that can be responsible for these values are some cultural "stigmas" of our enterprises such as the fear of venture capital and the lack of trust between them. For example, the trust measure which is being used to capture the level of social capital in a country, as several studies identified it as a proxy for social capital, like the level of qualification is a proxy for human capital (Conceição et al. 2000), is weaker than the majority of OECD countries. Knack and Keefer (1997) used the responses to a question involving trust posed to thousands of respondents from 29 countries with market economies in the 1990-1991 World Values Survey (WVS 1992). The question was "Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?" and Knack and Keefer took the percentage of respondents from each country who answered that people could be trusted as a measure of how "trusting" that country's populace was. Then they conducted regression analyses examining the impact of this measure of trust on average annual growth in per capita income from 1980 to 1992. They found that trust contributes significantly to economic growth, particularly in poorer countries without developed legal enforcement systems. Table 3 shows this measure of trust in all OECD countries and we can see that Portugal has one of the lowest values (21.4%):

Table 3: A Measure of Trust - OECD countries

Norway	61.2	Ireland	40.2
Finland	57.2	Korea	38.0
Sweden	57.1	Spain	34.5
Denmark	56.0	Austria	31.8
Canada	49.6	Belgium	30.2
Australia	47.8	Germany	29.8
Netherlands	46.2	Italy	26.3
United States	45.4	France	24.8
United Kingdom	44.4	**Portugal**	**21.4**
Switzerland	43.2	Mexico	17.7
Iceland	41.6	Turkey	10.0

Source: Knack and Keefer (1997)

If the hypothesis under study is affirmed, it must be concluded that the indicator considered does have a predictive validity for innovation capacity measuring. Given the limited success of the R&D expenditures, patents and other comparable indicators as valid predictors of innovation capacity, a successful integration with other indicators either objective or immaterial, would have theoretical as well practical relevance. A joint "index" of innovation performance could explain more complex patterns of behaviour observed in firms and industries than either of the several indicators can accomplish alone. Firm performance can differ as much within industries as it does across them. The practical implications are also straightforward: innovation performance would have to be based on a new and integrated tool for measuring it.

CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

The empirical results confirm the conjecture that a combined index of innovation capacity measuring provides an important and valid explanation for innovation behaviour. An important corollary is that innovation measuring may often be more complex than one expects. Failure to uncover all relevant dimensions can invalidate results. Neither patents nor R&D expenditures are found to provide statiscally significant explanations for innovation performance. Therefore, while patents and R&D intensity are valid measures of innovation efforts, they are at the same time only partial measures. While the conceptual implication of this paper rests in the call for a re-conceptualisation of innovation measuring, there is also an important practical implication. In order to help managers to analyse their innovation capacity appropriately, there is a need of developing an integrated tool that will allow for a reliable clustering of firms and industries into different patterns of innovation behaviour.

Our study has a number of limitations. First, it is confined to a few sectors and indicators, therefore future research must consider either less "visible" indicators, or more sectors, or more lagging countries/regions and assess whether the indicators under study have a significant importance in measuring innovation performance. Second, the number of firms is still small because it was restricted to the available schedule, resulting in an overall sample size of 346 observations. This limits the extent to which generalizations can be made from these results. Third, additional impacts or efficiencies gained from collaboration initiatives, that might come about later, could not be observed or measured from the available data. Therefore, longitudinal data sets might help to assess whether those effects are sustainable in time. Also, there is evidence of high innovation performance in firms even in the absence of cooperation. We did not have at our disposal data on changes that took place in companies that did not experience any interactive movement. Finally, there is no reason to believe that any of these indicators will measure innovation performance exhaustively. There may be additional potential measures that we are unaware of at present. Therefore, the introduction of collaborations has not only helped to disentangle the indicators of patents and R&D expenses, it has also created an opportunity for researchers to consider alternative indexes or indicators, within industries and regions, that might have been dismissed before.

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