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The effects of Innovation capacity on Innovation Performance in Spanish fast-growing firms: A DEA-based Malmquist productivity approach

Effets des capacités d'innovation sur la performance d'innovation au sein des entreprises à forte croissance espagnoles : Une approche Malmquist-DEA de la productivité

Nawfal ACHA, *(Enseignant-Chercheur)*
Équipe de recherche en Économie et Management des Télécommunications et des Technologies de l'Information (EM2TI)
Institut National des Postes et Télécommunications (INPT), Maroc

Correspondence address :	Tél : +212 5 38 00 27 00 Adresse : l'Institut National des Postes et Télécommunications (INPT), avenue Allal Al Fassi – Madinat Al Irfane - Rabat.
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Abstract

Innovation performance depends on a number of factors, including the innovation capabilities themselves. The efficiency analysis proposed by the article attempts to understand the effectiveness of Spanish high-growth firms from their innovation performance. Using the Pitec database, the current causal-comparative research focuses on innovative Gazelles to explain their sales growth across 2014 and 2016 through employees' number, R&D capacities, and technological development as inputs. Malmquist productivity index was combined with a panel data regression to test the hypotheses related to the model. Findings support the moderating effect of employee's number on the relationship between innovation (technical progress) and sales growth. The same moderating effect was proven of "Technology development". However, the Panel data regression gives a non-statically significant correlation between R&D capacities and sales growth presenting an indirect effect of R&D through innovation capacities.

Keywords : Innovation capabilities, Innovation performance, High-growth firms (Gazelles), DEA Malmquist Index, Pitec database.
Classification JEL : M15
Paper type : Empirical Research

Résumé

La performance de l'innovation fait appel à un certain nombre de facteurs dont les capacités elles-mêmes de l'innovation. L'analyse de l'efficience proposée par l'article tente effectivement de comprendre l'efficacité des firmes à fortes croissance espagnoles. En utilisant la base de données Pitec, la présente recherche comparent les Gazelles innovantes pour expliquer la croissance de leurs ventes entre 2014 et 2016 à travers le nombre d'employés, les capacités de R&D et le développement technologique en tant qu'inputs. L'indice de productivité de Malmquist a été combiné à une régression en panel afin de tester les hypothèses liées au modèle. Les résultats confirment l'effet modérateur du nombre d'employés sur la relation entre l'innovation (progrès technique) et la croissance des ventes. Le même effet modérateur a été prouvé pour le "développement technologique". Cependant, la régression en panel présente une corrélation non statiquement significative entre les capacités de R&D et la croissance des ventes, ce qui indique un effet indirect de la R&D par le biais des capacités d'innovation.

Mots clés : Capacités d'innovation, Performance d'innovation, Hyper-croissance, Index DEA Malmquist, Pitec database.
JEL Classification : M15
Type du papier : Recherche empirique

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1. Introduction

The study of innovation has evolved considerably over time. The main focus has been on detecting the intensity or causes of innovation. Its scope is still poorly understood. This incomprehension is more important when we analyze the relationship between innovation and company growth. Growth or fast-growth as gazelles is unquestionably fueled by innovation.
The fundamental question consists to know how the different facets of innovations technically support growth over years. Hence, distinguishing between innovation capacities and innovation performance can be initially a crucial element in understanding the relationship between innovation and growth. This article attempts to analyze the effects of innovation capabilities and innovation performance on growth from an efficiency angle. Efficiency analysis especsially the Data envelopment analysis (DEA) is a widely used methodology to evaluate and compare the performance and productivity of different organizational systems. It is a nonparametric technique used in this case to evaluate the relative efficiencies of a set of fast-growing Spanish firms.
In an increasingly uncertain environment, innovation capacity seems to be a major asset to support growth of companies over time. Firms able to exploit innovation realize higher profits and market share (Narver and Slater, 1990; Cooper, 1993; Christensen, 2000). Innovation Management responds to an articulation of capabilities between different actors that fit with novelty in product and processes within the organization (Pertuz et al. 2018). Despite several definitions and perspectives on innovation overtime, the concept still needs precisions to understand whether it constitute capabilities or performance. Capabilities refer to competitors especially how firms manage innovation to develop competitive advantages (Prajogo and Ahmed, 2006). Innovation performance facilitates continuously to bring new products and services. Innovation capabilities combines managerial and human dimensions as well as managing technological resources and R&D Management. People and organizational context conceive that technology and R&D are the 'front-edges' of innovative firms (Wiklund and Shepherd 2003). Researchers investigating innovative firms argue that innovation performance competences, including dynamic capabilities, are crucial in the process of growth and enhancing firm performance (Harms and Walsh 2015; Floyd 2012).
Competency-based view is also one of the perspectives explaining growth as an approach to achieve competitive advantage (Prahalad and Hamel 1990). Knowing that high-growth firms, the so-called gazelle, are growing considerably faster than the average and contribute to job creation and economic wealth (Birch, 1979; Anyadike-Danes et al., 2014), we attempt to explain How innovation capacities explain innovation performance in the case of innovative Hight-growth Spanish firms. To do so, we propose first to analyze innovation using R&D expenditures, Innovation expenditures and Technology development as inputs. Innovation performance is measured by new products and process (Technological innovation) as outputs. A DEA based Malmquist productivity index assess the productivity change over time (2014-2016) in gazelles' Spanish firms by analyzing the change in efficiency and the technical change using the Pitec Database. A panel data regression is also proposed to test the hypothesis of the model.
The remainder of this paper is structured as follows. First, the article presents a theoretical framework on innovation capacities, innovation performance and firm growth leading to the model and the hypothesis. The methodology is then presented along with the nature and structure of the data. The results are described in such a way as to revisit the assumptions made in order to test them. Afterwards, the paper undertakes the discussion of the findings followed by the major conclusions and implications drawn from the study.

2. Literature review and hypothesis development.

Innovation capacity is a multi-faceted concept that usually adopts a certain nature/type of innovation, or different intensities (radical, incremental, etc.). Moreover, we assume human aspect preexisting in innovative gazelles and supporting as good as R&D activities and technological development. The latter being essential to understand innovation performance and by extension fast growth. This perspective is useful in order to test some innovation metrics allowing to explain how innovate and what drives this performance. The following theoretical framework develop a central state of the art of innovation capacities and performance in high-growth firms before ending by presenting the conceptual model and its hypotheses.

2.1. Theoretical Background

- **Fast-growing firms**

According to the Schumpeterian theory of creative destruction, High-growth firms are created by entrepreneurs who can cope with market opportunities, develop their ideas, and transform them into innovations that will result in the rapid growth. Their capacity to generate new jobs and exploit their competitive advantages represents a real issue in the market structure. Firms' innovative effort is a key factor analyzed in the literature on firm growth (Audretsch et al, 2014). Fast-growth firms, the so-called gazelle, growing considerably faster than the average and make valuable contributions to job creation and economic wealth in society (Cho and Pucik, 2005). The "growth–innovation" relationship for gazelle firms has been an essential part of management research for decades. Innovation Management is the function through which growth is achieved (Davidsson et al, 2006; Wright and Stigliani, 2013) and has been seen as an approach to achieve competitive advantage and a way of increasing profitability (Newbert, 2007). Firms' innovative performance promotes the development of their internal capabilities and this is a key factor in consolidating their market position. In a similar vein, Brown and Mawson (2016) highlight the importance of promoting dynamic capabilities rather than resource acquisition to develop innovative behavior in Gazelles. Smallbone et al, (1995) found a positive relationship between innovating firms and fast growth rates and demonstrate that innovation capacities are the factors that most consistently distinguish Gazelles from other firms.

- **Innovation capacity**

Innovation capacity refers to produce and exploit new products, services or processes over long periods of time. Several studies identified some determinants of innovation capacity like organizational culture, leadership, process of radical product innovation, characteristics of the organization and the strategy of product launch (Slater et al, 2014). Another line of research put emphasis on strategic intention to innovate, strategic management of technology, organic structure and project management (Forsman, 2011). The current research stream conceives that technology development and R&D capacities are the 'front-edges' of innovative firms.

The "Technology development" refers to the effort to have the most appropriate and adapting technologies to suit the specific production conditions. Technological capacities act as the "planning, directing, control and coordination of the development and implementation of technological capabilities" (Cetindamar et al, 2016). As a result, a firm with superior technological capability can achieve higher growth because it is difficult for its competitors to accomplish similar tasks without similar technological capability. Some researchers have differentiated technological capability as either "routine" or "innovative." "Routine" technological capability is the capability to perform innovation activities with the given requirements, and "innovative" technological capability consists of possessing the technology-changing skills needed to create (Audretsch et al, 2014). Another stream of research has argued

that firms in the high technological capability stage attempt to expand R&D investment based on their accumulated capability, while firms in the low technological capability show lower growth.
R&D also plays an integral role in innovation since it functions as the growth driver in the organization (Jankowski, 1998). Numerous studies indicate only a significant relationship between innovation and R&D activities and high-growth (Baldwin and Johnson, 1996). For instance, innovative companies are often characterized by their excellent R&D activities (Harryson, 1997; Peters et al., 2017; Chauvin and Hirschey, 1993). At a more specific level, we propose that R&D can be deployed by a firm to drive many growth paths.

- **Innovation performance**

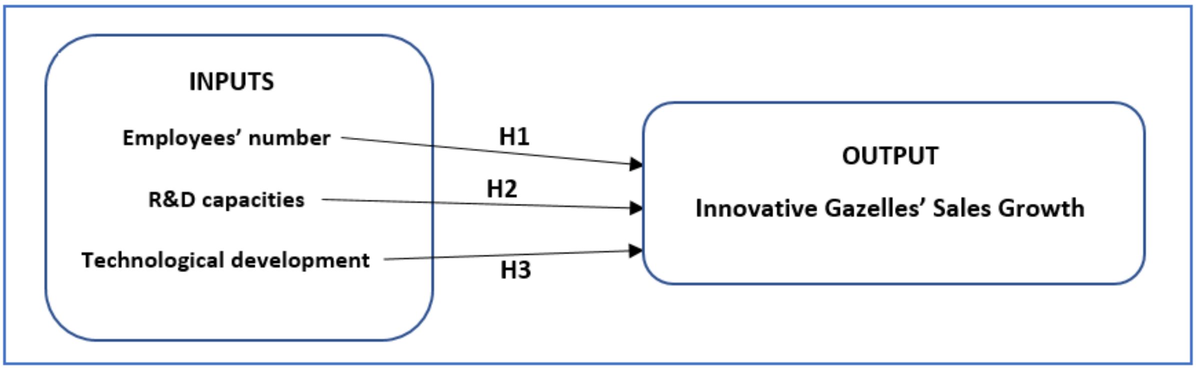
Innovation performance refers to the use of an ideas or creativity to improve the products, processes, procedures that increase the significance, usefulness and performance of the products and services. Innovation, at an aggregate level, represents the successful exploitation of ideas that are new and profitable products, processes, and/or services (Hammed et al. 2021).
Product innovation helps firms continuously to bring new products, which may, in turn, provide firms to earn profits and high growth. The current research assumes that technology management, especially its practices, have an impact on product innovation. Technology management comprises various practices that help firms implement product innovation at the strategic and operational levels (Gök and Peker, 2016). According to the resource-based view, technological capability is a set of resources that offers know-how to change existing products or create new products. As indicated by previous research, each technological innovation is associated with a certain level of technological capability (Liu et al, 2020).
Process innovation focuses on gain of efficiency by cost reductions and increased production volumes. In addition, process innovation can contribute to reducing development times for products. Process innovation may also add value directly to customers through improved product quality and reliability. Process innovation, process modelling or process optimization know an increasing importance regarding its role in the transfer business strategy into execution. Managing processes appropriately gives an organization the capability to successfully deal with a volatile business environment (Zhao-quan et al. 2017). Furthermore, from the RBV, to maintain a competitive advantage, it is imperative for firms to possess rare and valuable processes (Barney, 1991). Technological capability is also a critical factor that facilitates process innovation. The capability to develop process innovation depends on the firm's ability to acquire, assimilate, transform, and exploit technically related technologies and knowledge such as engineering know how. Frishammar et al. (2012) assume process innovation can allow both efficiency and effectiveness gains and is a key source of long-term competitive advantage ang high-growth rate. According to the capability-based view, firms therefore need to develop innovation capabilities for managing new product and process.

2.2. Hypotheses development

Innovation capacity as technology features represents nowadays an integral driver of innovation. Technology not only plays a key role in creating new products or processes, but at key points of redefinition to the rules of competition (Zhao-quan et al. 2017). Having separately discussed the innovation capacities and innovation performance, we now examine the inter-connection between these two factors inside Gazelles. Analyzing innovative Gazelles' Sales Growth as output encourages us to assume that increase in employees' number support innovation performance and sales growth. The organization's workforce determines performance in the area of productivity and sales leading to the first hypothesis:
H1: Number of employees moderate the relationship among technical progress and sales growth.

More recently, Cucculelli and Emini (2012) found product innovation had a positive impact on sales growth. Colombelli et al. (2013) show a positive association between product/process and organizational innovations and sales growth. R&D and technological Management are potentially positive factors that boost firm's productivity and growth by reinforcing the market position (Hammed et al. 2021). Consequently, increasing sales and expanding the labor force required for new production. Innovative performance potentially has an impact when new products or processes substitute the previous ones with more sophisticated witch led to firm growth. Innovation capacities allow an increase in productivity and a fall in price, which results in an increase in demand (Liu et al, 2020). Hence, we propose R&D capacities and technological development as inputs highlighting the hypotheses 2 and 3:
H2: R&D capacities moderate the relationship among technical progress and sales growth.
H3: Technology development moderate the relationship among technical progress and sales growth.

Figure 1 explores the conceptual model and the hypotheses related as follows:



Source: Author

In order to predict Gazelle's sales growth, we propose Employees' number, R&D capacities and technological development as inputs. To do so, we select high-growth firms developing innovation performance in Pitec database. For instance, only firms which are constantly focus on product and process innovations over time are studied. Regarding the DEA-based Malmquist index, this innovation performance is captured by the technical change coefficient. To give coherence to our sample and to exploit the database in the most optimal way, this paper has selected the companies in activity to date, i.e., not dormant (CP variable). The sample is only made up of private companies (CLASEN variable) located in Catalonia (SEDE variable) and with no known incidences (INCINE variable).

3. Methodology

3.1. Research model

Data envelopment analysis (DEA) is a widely used methodology to evaluate the performance of different organizational systems. It is a nonparametric technique used to evaluate the relative efficiencies of a set of DMUs (decision making units). DEA was created by Charnes et al. (1978) and the methodology compares DMUs with a frontier of efficiency. The first contribution to DEA change over time is the Malmquist index. The index represented by the following equation evaluates the productivity change of a DMU between two periods and is an example in comparative statistics analysis. It is defined as the product of "Catch-up" and "Technical-change" terms.

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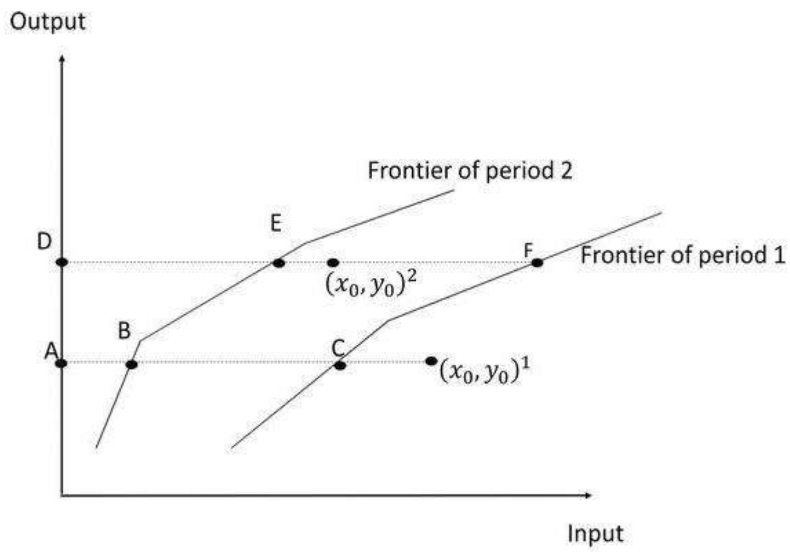
$$m_o(\mathbf{q}_s, \mathbf{q}_t, \mathbf{x}_s, \mathbf{x}_s) = \frac{d_o^t(\mathbf{x}_t, \mathbf{q}_t)}{d_o^s(\mathbf{x}_s, \mathbf{q}_s)} \left[\frac{d_o^s(\mathbf{x}_t, \mathbf{q}_t)}{d_o^t(\mathbf{x}_t, \mathbf{q}_t)} \times \frac{d_o^s(\mathbf{x}_s, \mathbf{q}_s)}{d_o^t(\mathbf{x}_s, \mathbf{q}_s)} \right]^{0.5}$$

Efficiency change Technical change

The catching up (or recovery) is the term that is calculated to study the effect of growth or deterioration in a DMU. The Technical change (or innovation) term is used to verify the change in the efficient frontiers between the two time periods. Figure 2 shows the difference in efficiency between two periods.

Figure 2: Malmquist index frontiers.



Source : Charnes et al. (1978) "Measuring the Efficiency of Decision-Making Units."

3.2. Dataset

This approach was adopted to explore the Pitec database which represents the Spanish Technological Innovation Panel. PITEC is the result of the collaboration between the Spanish National Statistics Institute and the COTEC foundation with the aim of providing data from the CIS. The PITEC database includes firms which have been making some kind of technological effort. The database has two main advantages. First, it contains detailed information of innovation behavior at firm level. Second, it is a panel data set that facilitates detailed analysis of firms' innovation behavior over time. The objective of the Pitec survey is to quantify the innovative activities of companies, among which, of particular note is the performance of R&D, and to evaluate the results (innovations) and effects of such activities. The purpose of the PITEC project (Technological Innovation Panel) is to create a representation of the situation and evolution of innovative companies in Spain in addition to detecting opportunities and necessities in the field of innovation. The PITEC Project started in 2004 as a result of collaboration efforts between FECYT and the COTEC Foundation along with advice from a group of researchers representing different universities.

Table 1: Dataset

Ident/ DMU	Years 1 &3	Turnover/ Sales	Employees Numbers	R&D capacities	Technology Development
748	1	21560851	163	10000	331664
748	3	32864693	160	11000	473109
866	1	3585840	46	7000	314679
866	3	5705516	42	11000	457278
929	1	289694240	1021	44000	17944297
929	3	459359684	1294	47000	24883333
1300	1	53136842	162	93000	3058167
1300	3	82943974	266	109000	5469361
2858	1	4920946	43	38000	1984633
2858	3	7410086	78	54000	1863500
3497	1	25992937	626	4000	522718
3497	3	25992937	644	4000	859163
3517	1	533228	6	1000	22104
3517	3	812712	10	2000	23598
5935	1	2344665	16	1000	40420
5935	3	3683018	20	1000	54001
5945	1	10542737	105	6000	326173
5945	3	16453348	125	7050	1539582
6148	1	4267795	58	20000	398145
6148	3	6452515	74	10000	993378
7560	1	2323332	17	1000	9841
7560	3	3651266	24	1050	25332
9077	1	4954173	13	5000	121480
9077	3	7838107	20	5000	156081
10011	1	2093227	15	12000	143435
10011	3	3158231	21	12000	430344
10021	1	2117896	36	21000	422517
10021	3	3271303	45	26000	537834
10495	1	40079210	128	50	1530671
10495	3	62180639	125	50	2175575
10532	1	11736157	45	8000	118146
10532	3	18139160	58	7000	240288
10553	1	3948327	19	2000	144223
10553	3	6139246	23	2000	163899
10832	1	35649355	95	3000	261830
10832	3	56881596	154	4000	289346
11048	1	7634846	60	37000	468626
11048	3	11561705	96	62000	568736
12279	1	2638271	31	19000	854606
12279	3	4031248	31	23000	1966325

Source : Author

The purpose of PITEC is to become a statistical reference tool for the analysis of R&D&I activity development in businesses at the national level. This will allow for the study of important aspects such as the impact that innovation has on productivity, the distribution of internal and external R&D&I or costs. Our model analyzes the gazelle's sales as output regarding three inputs Employee's number, R&D capacities and Technology development. Our sample select firms having an innovation performance captured by new products and process (Technological innovation) in the database. The DEA based Malmquist productivity index assess the change in efficiency and the technical change across 2014 and 2016 (last available Pitec data so far). To do so, the database was subjected to a process of filtering. First, we selected innovators firms having a high growth across 2014 and 2016. These companies seem developed an innovative culture enabling them to develop a mid-term innovation capacity. This segmentation reduces the sample at 20 firms and allows a Malmquist index analysis based on a

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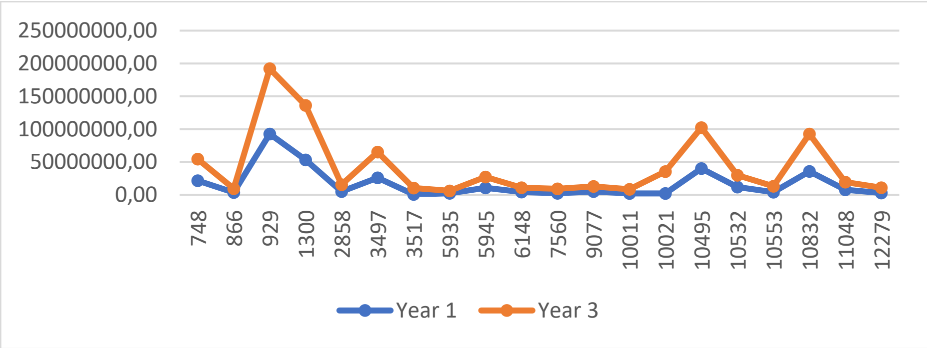
homogenous high-growth firms. As Table 1 shows, regarding the Banker's rule, we have tried to handle this issue and suggest that there should be a sufficient number of observations in comparison with the numbers of inputs and outputs. Banker et al. (1989) and Cooper et al. (2007) propose that the number of DMUs should be greater than the maximum of 3 × (m + s). Following the dataset, the variable "Sales" represents the output of our model and the others variables, Employees numbers, R&D capacities and Technology Development, the inputs. All the variables were analyzed in the panel-based view. The following graphs show the evolution of "Sales" and "Employees" between 2014 and 2016.

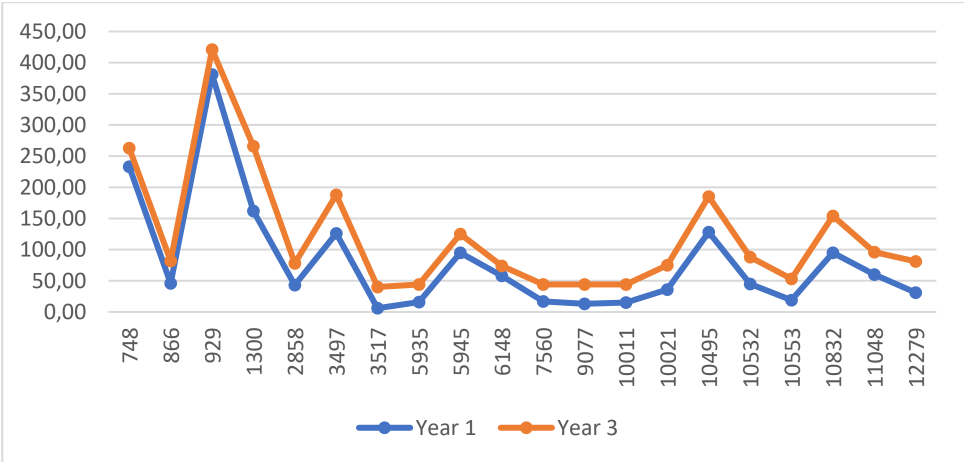
Figure 3: Sales growth.



Source: R Software

Sales growth is an essential parameter that measures the ability to increase revenue over time. A good sales growth can always be used for the benefits of the employees and company in terms of providing salary raise, acquiring new assets, an expansion of the company or the product line.

Figure 4: Number of employees' growth.



Source: R Software

For every company, the number of employees reflects it size. Hence, this variable shows how many products can the firm develop and maintain and how many big contracts can be landed. The number of employees' growth is a good predictor of the products or services sales.

4. Results

4.1. Malmquist Productivity indexes

The Malmquist indexes using Stata computes between two periods the Total factor productivity (TFPCH), the technical efficiency change (TECH) and technical change (TECCH) for each

DMUs in Constant return to scale (CRS) technology. Unit operates under constant returns to scale if an increase in inputs results in a proportionate increase in the output levels. If the inputs values for a unit are all doubled, then the unit must produce twice as much outputs. In a single input and output case, the efficiency frontier reduces to a straight line. The following table shows these three parameters respectively to the input orientation comparing years 2014 (1) and 2016 (3). For our purpose, we focus on the input orientation to analyze the changes in inputs over time.

Table 2: Malmquist Productivity indexes input oriented.

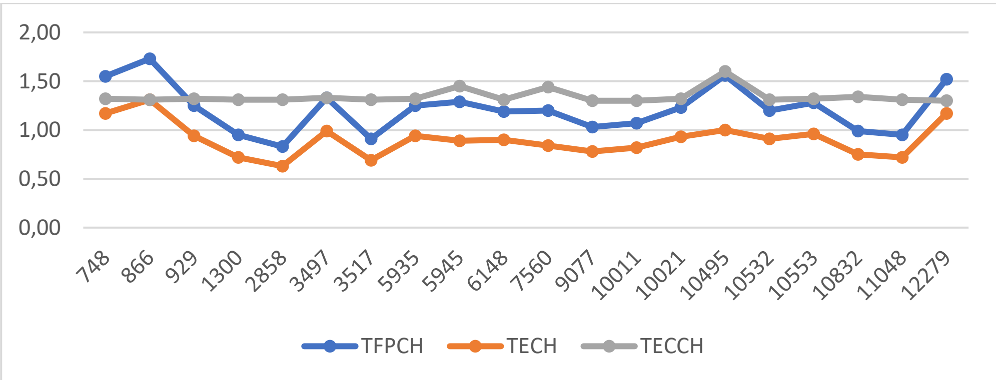
Malmquist Productivity Index Results:
(Row: Row # in the original data; Pdwise: periodwise)

	Row	Ident	Pdwise	TFPCH	TECH	TECCH
1.	2	748	1~3	1.5526	1.1730	1.3237
2.	4	866	1~3	1.7342	1.3175	1.3163
3.	6	929	1~3	1.2513	0.9443	1.3251
4.	8	1300	1~3	0.9518	0.7216	1.3190
5.	10	2858	1~3	0.8339	0.6360	1.3112
6.	12	3497	1~3	1.3311	0.9939	1.3392
7.	14	3517	1~3	0.9158	0.6940	1.3197
8.	16	5935	1~3	1.2570	0.9493	1.3242
9.	18	5945	1~3	1.2993	0.8960	1.4501
10.	20	6148	1~3	1.1904	0.9063	1.3136
11.	22	7560	1~3	1.2129	0.8408	1.4426
12.	24	9077	1~3	1.0314	0.7878	1.3091
13.	26	10011	1~3	1.0777	0.8256	1.3053
14.	28	10021	1~3	1.2357	0.9322	1.3256
15.	30	10495	1~3	1.5699	1.0000	1.5699
16.	32	10532	1~3	1.2016	0.9104	1.3198
17.	34	10553	1~3	1.2829	0.9690	1.3240
18.	36	10832	1~3	0.9993	0.7425	1.3458
19.	38	11048	1~3	0.9525	0.7237	1.3161
20.	40	12279	1~3	1.5280	1.1706	1.3053

Source: R Software

The previous table shows the average values of Malmquist indexes for twenty Gazelles from 2014 to 2016. In the non-parametric framework, it is measured as the product of catch-up (or recovery) and frontier-shift (or innovation) terms, both coming from the DEA technologies. The comparison between productivity, efficiency change and technical change among the DMUs can be represented by the following graph.

Figure 5: Productivity indexes trend



Source: R Software

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The Malmquist productivity (TFPCH) is positive for almost all the DMUs except firms 1300, 2858, 10832 and 11048. These results are due to the fact that this index is the product of efficiency change (TECH) and technological change (TECCH), especially due to the significance for the latter. When TFPCH >1, Productivity increases rather than TFPCH <1 when the Productivity decreases or remains unchanged if the index is equal to 1. As we can see, the DMUs 748, 866, 10495 and 12279 have a high productivity index greater than 1.5.

The efficiency change index has in the other hand three different cases. A TECH > 1 means efficiency at t+1 time period was more, comparing t time period. So, DMUs at t+1 time period is closer to t+1boundary, comparing t time period to its own boundary. Only three firms are in this case, DMUs 748, 866, 12279. TECH < 1 means the efficiency at time period t is bigger than the efficiency in time period t+1. So, DMUs at time period t is closer to t boundary, comparing t+1 time period to t+1 boundary. The rest of the firms are in this case except firm 10495 with a TECH = 1, their two efficiencies are equal.

Regarding the technical change or innovation, the index (TECCH) > 1 refers to a positive boundary movement which define a technical progress. All the DMUs present a technical progress following the findings. Note that the case of TECCH < 1, the boundary movement is negative and lead to a technical regress and no boundary change or no innovation when TECCH = 1. The results show the progression and regression of the firms with the Malmquist productivity indexes. The inputs on the basis of these parameters are the employee's numbers inside each firm, the research and development expenditures and the technology development. The next section analyzes the evolution of these indexes over time regarding the pervious inputs.

4.2. Panel regression results

Regarding our hypothesis, we conduct then a Panel-data regression with Stata to analyze two-dimensional (typically cross sectional and longitudinal) data. The data are usually collected over time and over the same DMUs and then a regression is run over these two dimensions. The analysis starts by generating a new variable grouping the firms over time. The following table shows the statistics:

Table 3: Panel data regression

```
Random-effects GLS regression                   Number of obs     =         40
Group variable: GrIdent                         Number of groups  =         20

R-sq:                                           Obs per group:
     within  = 0.9504                                         min =          2
     between = 0.9888                                         avg =        2.0
     overall = 0.9813                                         max =          2

                                                Wald chi2(3)      =     960.25
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000
```

Salesgr	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Emplgr	195144.2	21947.07	8.89	0.000	152128.7	238159.6
RDexp	-221.2685	125.0741	-1.77	0.077	-466.4092	23.87224
Innovexp	8.417185	1.291231	6.52	0.000	5.886418	10.94795
_cons	-1460297	3944936	-0.37	0.711	-9192229	6271635
sigma_u	7965615.1					
sigma_e	6442254.9					
rho	.60456221	(fraction of variance due to u_i)				

Source: R Software

The p-value for each term tests the null hypothesis that the coefficient is equal to zero (no effect). A low p-value (< 0.05) indicates that you can reject the null hypothesis. In other words, a predictor that has a low p-value is likely to be a meaningful addition to your model because changes in the predictor's value are related to changes in the response variable. This is the case only for number of employee’s growth and Technology development. R&D capacities is not significant.

5. Discussion

The Malmquist DEA-based analysis starts showing all firms with higher technical change due to the fact we focus on innovative firms and shows firms 748, 866, 10495 and 12279 having a high productivity index greater than 1.5. All these firms have known a significant sales growth and surprisingly, across 2014 and 2016, a diminution of their employees on average by 3 persons.

It seems that innovation capacities and sales growth depend more on the competencies and the development of employees rather than the number. Firms with a productivity lower than 1 have known an increase higher than 50% of their employees. This finding lead to the fact that facilitating the productivity, the quality of the staff is a predictor of innovation performance (with a technical change index higher than 1). Simultaneously, the panel data regression gives a significant coefficient indicates that for every additional employee, firm can expect sales to increase by an average of 169079 euros. However, this correlation does not apply for the high productivity firms with a technical progress. The number of employees may tend to drop the frontier over time. This result reachs the DEA classic assumption according to which in the tehnical progress, the firm is poditionned in final year in the frontier position whitch canno’t achieve in initial year (Charnes et al, 1978), the knowledge aquired in 2016 did not exist in 2014. Hence, the number of employees moderate, but negatively, the relationship among technical progress and sales growth. Hypothesis 1 remains supported.

The Panel data regression gives a non-statically significance between R&D capacities and sales growth. As many studies found, R&D capacities need time to transform investment in sales of products or services (Peters et al, 2017; Harryson, 1997). For instance, the observation period across 2014 and 2016 cannot capture any effect of R&D on sales growth. The R&D expenditures in 2014 may produce effects on sales over a longer period of time. The passage through successful innovations could be the reason for this fact. The R&D output is more associated to ICT investment to explain innovation-related spending (Audretsch et al, 2014). R&D capacities depend also whether the DMU is an ICT or non-ICT firm. Peters et al. (2017) propose a size perspective giving different results for R&D capacities among small and big firms. Small but mature ICT firms are likely to dominate market niches because their flexible and adaptable posture helps them respond to technological opportunities to develop innovative products and services. As has been found elsewhere in the literature, R&D output decline with firm growth. Consistent with findings reported by Chauvin and Hirschey (1993), valuation effects of R&D remain greater for larger as opposed to smaller firms. Hence, we cannot argue that R&D capacities moderate the relationship among technical progress and sales growth. Hypothesis 2 is not supported.

The Panel data regression shows a significant relationship between technology development and sales. For every additional euro in technology development, firm can expect sales to increase by an average of 8.41 euros. In almost all DMUs, the "Technology development" is relatively advanced and measures the company's effort to have the most appropriate and adapting technologies to suit the specific production conditions. Technological capacities are used when innovation occurs and hence can be measured as the distribution of returns to R&D (Slater et al, 2014). New or improved products and services expand sales through enhanced demand, whereas new or improved processes allow firms to compete more effectively and thereby gain market share. Technological development enables to identify opportunities and

establish technical progress over time (Cetindamar et al, 2016). Technological opportunities are viewed as an input into knowledge creation that might eventually lead to new products and increase in sales (Martínez et al, 2011). The relationship among "Technological development and "sales growth" confirm the idea of the indirect effect of R&D input on sales. Early studies found an effect of R&D on firm output, evident both directly via total factor productivity and innovation performance (Audretsch et al, 2014). Hence, hypothesis 3 is supported.
Calculating the Malmquist Productivity Indexes seems very useful and applicable system for determining the progress and regress of a unit. The approach used helps managers in innovation decisions regarding the productivity of the firm. The Global Malmquist Productivity Index represents an indication to sustain high-growth over two time periods and improve decision-making.

6. Conclusion

Using Pitec database, we select innovative Gazelles to explain sales growth across 2014 and 2016 through employees' number, R&D capacities and technological development as inputs. Malmquist productivity index was combining with a panel data regression to test the hypothesis. Findings support the moderating effect of employee's number on the relationship among technical progress and sales growth. The same moderating effect was proofed of "Technology development". However, the Panel data regression gives a non-statically significance between R&D capacities and sales growth. An indirect effect of R&D activities on firm output appears the total factor productivity and innovation performance. Combining Malmquist Productivity Indexes and panel data regression seems very useful analyze innovation capacities and performance inside Gazelles.
We recommend to analyze R&D capacities during a longer period to capture its effects on high-growth firms. A wide panel data may bring different results. The findings suggest also a size perspective to analyze the relationship among innovative capacities and performance in innovative high-growth firms. The focus on either manufacturing or service sector seems also advisable. Finally, a VRS assumption could provide interesting understandings since we consider firms operate with a production scale lower than the optimal.

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