A PANEL DATA ANALYSIS OF THE RELATION BETWEEN TECHNOLOGICAL INNOVATIONS AND EXPORTS

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Abstract

Technological innovations and exports are vital for today's economic success, being extremely important to consider them simultaneously when analysing the dynamics of firms operating abroad. Focusing on a large sample of Spanish manufacturing firms during 1994-2005, this paper aims to analyse the relation between technological innovations and exports. Tobit and Logit regressions, as well as Granger test of causality are used in order to offer a complete image of this relation. Our findings reveal that not only different measures of technological innovations positively influence exports achievements and vice-versa, but both processes "Granger cause" each other, demonstrating therefore that there is a reciprocal relation between these two features. Moreover, this paper provides important implications, such as managerial, empirical and methodological ones, as well as for public policy.

Keywords: technological innovations; exports; experiential knowledge; panel data.

1. Introduction

The evolution of the international economy has revealed important changes regarding the structure of the relationships among economic agents and the variables determining the conditions of competitiveness (Fletcher, 2001). There are two main factors that stand out over many others: the first is the growing number of elements of economic organisation affected by internationalisation; the second refers to the increasing complexity of the innovative process (Molero, 1998; Rogers, 2004).

Internationalisation is an important issue for firms that often results in vital growth, useful learning outcomes and superior financial performance (Prashantham, 2005). The first important steps in firms' internationalisation process are generally assumed to be trade related, and although import activity is considered to play a role, it is export activity that is most often recognised as being the initial real step in the internationalisation process (Jones, 2001). However, this is not an easy process because international markets are characterised by a greater competitive pressure than national markets (Prashantham, 2005).

In order to survive in the competitive scene that companies have faced in recent years and which is characterised by a high level of dynamism (Teece, 1998; López and García, 2005; Diaz *et al.*, 2008), the continual renewal of competitive advantage through innovation (Cho and Pucik, 2005) and the development of new capabilities (Grant, 1996) has become necessary (Danneels, 2002; Branzei and Vertinsky, 2006). In this context, technology represents one of the most important factors in increasing the national and international competitiveness of the firms (Eusebio and Rialp, 2002), while successful technological innovation in new products and processes is increasingly more regarded as the central issue in economic development (Porter, 1998).

The purpose of this research is to analyse the existent relation between technological innovation and exports since they are vital for today's economic success, both for firms and countries (Vila and Kuster, 2007). These two features reinforce each other to the extent that today's economic analysis has to consider both of them simultaneously when trying to account for the new dynamic of the firms operating at the international level (Molero, 1998; Zahra and George, 2002). Hitt *et al.* (1997) emphasise that it is highly important to examine the complexity of these relations both theoretically and empirically. Similarly, Prashantham (2008), who carefully develops a wide theoretical background regarding the relationship between technological innovation and internationalisation process, strongly recommends it for future analysis. Therefore, a better perception of their results and interrelation could lead to better recommendations for managers in formulating the technology and internationalisation strategies, and for public authorities in designing supporting public policies.

In terms of data, our research employs a firm-level dataset on Spanish manufacturing firms during 1994-2005 and parts from the assumption that there is a mutual, reciprocal relation between the two processes mentioned above. We argue that technological innovations may lead to a wider international activity through the creation of important competitive advantages. Consequently, a more internationally active firm will acquire experience and, implicitly, knowledge, which would lead to a continuous search and development of competitive advantages, and therefore to an increment of technological innovations.

The remainder of the paper is as follows. The next two sections offer an overview of the state of the art of the field of technological innovation and internationalisation and provide the theoretical framework which fits the objective of this paper. Section 4 describes the data used in the analysis. The presentation of the results follows in Section 5 and finally, conclusions, implications, limitations and future lines of investigation are outlined in Section 6.

2. Related literature

Innovation is the effort to create purposeful, focused change in a firm's economic or social potential (Acs, Morck, and Yeung, 2001). Furthermore, an innovative firm is one that implements technologically new or significantly improved products (OECD, 1997). Following the Oslo Manual (OECD, 1997), technological innovation is defined as an iterative process initiated by the generation of new products and processes or of significant technological improvements in current products and processes. According to Damanpour (1991), product innovations are new products or services introduced to meet an external user or market need, and process innovations are new elements introduced into an organisation's production or service operations.

Regarding firms' internationalisation, it is understood as the process through which firms increase their exposure and response to international opportunities and threats through a variety of cross-border modes of operating (Johanson and Vahlne, 1990; Prashantham, 2005; Morgan and Jones, 2009). In this context, export activity is the initial real step and is defined as the sale of goods or services in country markets other than that of the exporting firm (Jones, 2001).

Although a lot of research is being focused on the internationalisation of the firm and the technological innovation process, up to the best of our knowledge there are few researchers who have somehow considered and found a relation between internationalisation and technological innovation with a longitudinal perspective (Barrios *et al.*, 2003; Mañez *et al.*, 2004; Lopez and García, 2005; Salomon and Shaver, 2005; Diaz *et al.*, 2008). However, there are several cross-section investigations which stand out and help us understand more about the relationship between these two processes (Zhao and Li, 1997; Molero, 1998; Wakelin, 1998; Basile, 2001; Cho and Pucik, 2005; Lachenmaier and Wößmann, 2006; Pla and Alegre, 2007; Vila and Kuster; 2007; Filipescu *et al.*, 2009; etc.).

Therefore, it seems that empirical literature has become increasingly aware of the need for disentangling the direction of causality between firms' internationalisation and the technological innovations they develop. According to Vila and Kuster (2007), firms start thinking about innovation because they want to offer different things in different markets. Some authors focus on the role of innovation regarding firms' internationalisation process, considering it as a sustainable competitive advantage necessary for successful international achievements (Wakelin, 1998; Basile, 2001; Mañez *et al.*, 2004; Lopez and García, 2005). Specifically, there is strong evidence that R&D intensity is an important determinant of whether the firm exports (Kumar and Siddharthan, 1994; Bleaney and Wakelin, 2002; Barrios *et al.*, 2003; Ozçelik and Taymaz, 2004).

Nevertheless, there are also controversial findings regarding this relation. For instance, Vila and Kuster (2007) find only partial support for the argument which establish that internationalisation is associated with some kinds of innovation, while Alonso and Donoso (1998) and Lefebvre *et al.* (1998) do not find a significant influence of R&D expenditures on export intensity.

Furthermore, there are opinions which suggest that the increment of international activities leads to innovation, many internationally diversified firms being also product diversified. Unfortunately, this has not been deeply addressed, or at least not so profoundly empirically demonstrated. Hitt *et al.* (1997) examine it, among other issues, and find that there is a linear relationship between international expansion and technological innovation, depending on the level of product differentiation. Kumar and Saqib (1996) and Buesa and Molero (1998) find that firms' international activity is one of the main determinants of regularity in innovation. In addition, Salomon and Shaver (2005) consider exports as activities which generate information, useful for a firm in order to innovate. Hence, it seems that firms' international diversification may have a positive effect on their innovation processes.

Regarding the reciprocity direction of the relation under discussion, Zou and Ozsomer (1999) proposed that companies with high levels of innovation reflected a high degree of dependence on export markets and vice versa. Zhao and Li (1997) reveal that R&D is a significant determinant of firms' propensity to export and level of export intensity and also they find a significant reciprocal dependence between R&D and exports. Likewise, Lachenmaier and

Wößmann (2006) also anticipate a mutual causation of technological innovation and exports but their results can show only one part of the relationship, the one in which the fact of being innovative causes firms to have substantially larger export shares than non-innovative firms in the same sector. Based on case-study approach, Filipescu *et al.* (2009) state that firms become international due to their technological competitive advantages, and consequently, the fact of being international offers them the possibility to develop more technological innovations.

Therefore, it is obvious that more extensive research is needed in order to accomplish the objective of this paper which is to analyse the mutual relationship between technological innovation and export-based internationalisation processes of the firms.

3. Conceptual framework and hypotheses

As the model in Figure 1 suggests, we argue that it seems to be an interdependent, reciprocal relationship between technological innovation and internationalisation. Explicitly, the technology owned by a firm helps it innovate in order to create competitive advantages necessary to compete and succeed in international markets. Once the firm develops activities abroad, it gains knowledge about the environment and the competition that exists, being this very helpful in maintaining its competitive advantages and creating new ones. Improving and/or creating competitive advantages imply more innovation. Consequently, the relation between the two processes may be considered reciprocal and this is exactly the core of our investigation.

[Insert Figure 1 here]

In order to accomplish the objective of this paper, we will focus on the resource-based view (RBV), since it explains how, in the context of an innovative culture, knowledge and the resultant organisational capabilities are developed and leveraged by enterprising firms (Knight and Cavusgil, 2004). Its central focus is the exploitation of firm strategic resources to gain a sustainable competitive advantage that affords the acquirement of superior performance (Wernerfelt, 1984; Barney, 1991). Among these strategic resources the intangible ones stand out as they are the most likely to fulfil the requirements for resources to generate sustainable competitive advantages (Lopez and García, 2005): be valuable, unique, inimitable, and immobile, reflecting the distinctive pathways of each company (Grant, 1991). Intangible resources are usually divided into technological, human, commercial and organizational resources (Hall, 1992; Galbreath, 2005).

According to Lopez and García (2005) and Surroca and Santamaria (2007), technological activities are essential, providing firms with an innovative capacity and developing competitive advantages based on differentiation which give firms superior competitiveness to act in international and global markets. Therefore, technological activities can generate a two-fold competitive advantage for a firm: in costs and in differentiation (López and García, 2005). Moreover, Itami (1987), Styles and Ambler (1987) and Eusebio and Rialp (2002) consider technological innovations as the key for firms' international success, being highly-knowledge intensive. These arguments lead us to pose the following hypothesis:

H1: Technological innovations have a positive and significant influence on the development of export-related activities.

According to Penrose (1959), Barney (1991) and Grant (1991), a firm should possess certain intangible assets that competitors can not copy or buy easily, thus gaining sustainable competitive advantage in the market. Firm's relations with foreign clients (Galende and Suárez, 1999), regularly measured by international achievements, are important intangible assets. International achievements are often considered useful for properly exploiting technological innovations (Teece, 1986). In addition, export-related activities increase the firm's need for technological inputs. As a result, a firm is induced to invest in R&D activity for continuous updating and product adaptation (Kumar and Saqib, 1996). From this we deduce the second hypothesis:

H2: Export-related activities have a positive and significant influence on the development of the innovative ones.

Hence, on one hand side there are investigations which deal with the impact that technological innovations have upon exports, being a source of competitive advantage that give firms the opportunity to gain more markets abroad and enlarge their horizon; the majority shows a positive effect. On other hand side, academicians focus on the other direction of the relation between technological innovations and internationalisation, explicitly on the influence that exports exert upon innovations, the results usually showing a positive and significant impact. So it seems somehow obvious that these two processes exist in an inter-dependent relation (Zhao and Li, 1997; Zou and Ozsomer, 1999; Lachenmaier and Wößmann, 2006; Vila and Kuster, 2007; Filipescu *et al.*, 2009). Therefore, we formulate the next hypothesis:

H3: There is a reciprocal relation between technological innovations and export-related activities.

Another argument of this paper is that once a firm is international, it acquires experiential knowledge useful for future development of innovations and, likewise, once a firm is innovative it acquires experiential knowledge for a wider international achievement. Theory considers firm's experience as an intangible asset which represents the basis for obtaining a sustainable competitive advantage (Nonaka *et al.*, 2000; Barney *et al.*, 2001). Firm's experience is also understood as attainment of knowledge. Consequently, achieving a differentiating level of profitability depends on the firm's capacity to acquire, generate and exploit knowledge assets, firms enjoying competitive advantage if they know how to manage knowledge (Diaz *et al.*, 2008). Drawn from all these, we pose the next two hypotheses:

H4: Firm's experiential knowledge has a positive and significant influence on export-related activities.

H5: Firm's experiential knowledge has a positive and significant influence on technological innovation.

4. Methods

4.1. Data sources, sample and time frame

In order to accomplish the purpose of this study, we use the ESEE (Spanish Business Strategy Survey, from now on referred to as SBS) which is a statistical investigation carried out by SEPI Foundation with the financial support of the Ministry of Industry, Tourism and Trade. The reference population of SBS is represented by the companies with ten and more employees, usually known as manufacturing industry, representativeness being one of the most outstanding characteristics of SBS.

Our sample constitutes an unbalanced panel since some firms cease to provide information while others continue to do so every year. Next table shows a brief description of the sample, in particular the overall percentage regarding exporters, innovators, firm size and activity sector[1].

[Insert Table 1 here]

For the current investigation, twelve years were considered, specifically firms that answered during the period 1994-2005. It is important to emphasize that all the firms which answered the survey are considered in this paper, nonchalantly if they are exporters or non

[1] SBS provides the binary variable EXPORT. Innovators' percentage is given by the junction between the two binary variables IP and IPR (product and process innovation). SBS also provides a six category variable regarding firm's size, based on the number of employees. We proceeded in joining the categories into three major ones. As for the activity sectors, we created a variable parting from OECD classification. Firstly, we formed a four-categories variable: low, medium-low, medium-high and high. After this, we combined the first two and last two, transforming the variable into a binary one (IN_TEC_HIGH=0/1).

exporters, innovative or non innovative. By doing this, we avoid possible bias generation (Surroca and Santamaría, 2007) which some previous investigations present due to their focus only on exporting or innovative firms. After deleting outliers (missing values; unusual values like, for example, percentage over 100%; considerably higher/smaller values), we remain with a final number of observations of 8,309 corresponding to a final sample of 696 firms. 95.11 % of the firms in the sample answered during the whole panel (twelve years), precisely 662 firms.

4.2. Variables

To what empirical part refers to, this investigation has three major focuses. Firstly, we aim to analyse the impact that technological innovations have on international activities. Secondly, we analyse the impact that the latter has upon the former. And thirdly, we seek to explain the inter-dependence of these two processes.

When foreign commercial activities are the dependent variable, firm's export-related achievements are considered to be a good proxy for measuring them (Surroca and Santamaría, 2007) since these activities also deal with firm's relationships with its foreign clients (Galende and Suárez, 1999). We will focus on three different variables that explain exports, considering previous investigations (see Table 2): number of main international markets (understanding by main international markets those representing at least 50% of firm's total sales – NMIM); propensity to export (ratio between the percentage of exports and total sales – PX); and the exports value (employed here as its logarithm due to the high value of the variable – logVE). We think about NMIM and PX as firm's presence abroad or its export propensity and about logVE as its export intensity (Gemunden, 1991), therefore they explain different things but not less important, all being valuable for our investigation.

Three variables regarding firm's technological activities represent the independent variables: innovative intensity (ratio between R&D expenses and total sales – RDS); number of product innovations (NPI); and process innovation (PRI)[2]. Therefore, these innovative activities provide firms with an innovative capacity and allow them to develop valuable competitive advantages (Lopez and García, 2005; Surroca and Santamaría, 2007). The forth independent variable will focus on firm's experiential knowledge, firm age properly defining its experience and knowledge as well as the absorptive capacity acquired over time (Molero and Buesa, 1996; Galende and de la Fuente, 2003). We define firm's age as the difference between year *t* of the firm and its foundation year – AGE).

For the second part of the analysis, we will focus on the impact that international achievements will have upon the technological activities. Thus, RDS, NPI and PRI will be the new dependent variables, while the independent ones will focus on export-related activities (NMIM, PX, logVE) and experiential knowledge (AGE). Summarizing, in each of the two analyses three models will be generated, which will allow us to determine more accurately the effect that technological innovations has upon exports and vice-versa, detecting in this way if there is any sensitivity depending on which variables are introduced in the estimations (López and García, 2005).

For both analyses we will control by firm size (number of employees) and technological intensity of sectors calculated according to OECD's (1997) classification. The same variables explaining technological and commercial activities of the firm will be maintained in order to proceed to the third part of the analysis, where we will be examining the inter-dependence between these two kinds of activities.

Moreover, lagged variables are going to be introduced in this investigation as we believe that exports in year *t* can be influenced by technological innovation in year *t-1* and, consequently,

[2] We follow Roper and Love (2002) and López and García (2005) argument, meaning that studies based solely on R&D intensity may be misleading, using a range of innovation indicators being thus more appropriate.

exports in year *t-1* would also explain the technological innovations in year *t*. Hence, only one year[3] lagged variables regarding technological innovations and exports will be introduced (without considering their values in year *t*), being this the case just for the independent variables. We base these arguments not only on logic but also on Bernard and Jensen (1999) and Salomon and Shaver (2000) who advise the introduction of lags into analyses in order to reduce possible simultaneity problems and on Baum (2006) who considers lags important in order to improve prospects of valid causal inference.

We present in Table 2 a summarised description of all the variables used in our analysis as well as the authors who have already supported them in empirical investigations.

[Insert Table 2 here]

4.3. Empirical analysis

With the aim of contrasting the hypotheses formulated in this paper, different statistical methods with panel data will be employed. When analysing the influence that technological innovation activities have upon exports, three Tobit regressions will be run. Explicitly, since all variables regarding export-related activities are truncated ones, having the lower limit 0 for non-exporters, Tobit analysis is the most appropriate one in order to obtain unbiased and consistent estimators, as well as inferential results (Ozçelik and Taymaz, 2004). In conclusion, the general specification of this first analysis is as follows:

$$Exports_t^{4} = \beta_1 Technological\ innovations_{t-1} + \beta_2 Experiantial\ knowledge + \beta_3 Control + \tau_t$$

[3] Estimations with two-year lags for the independent variables were also run and no significant results (regarding the relation under focus) were given.

[4] Only the value corresponding to year *t* is considered for the dependent variables (exports and technological innovations) because we do not focus in these analyses on dynamics. However, it represents a valuable future line of investigation which can be complemented with learning theories.

When analysing the influence that export activities have upon the innovation ones, we will estimate three regressions as well. Firstly, Tobit regression will be ran twice, since both RDS and NPI are truncated variables, assuming the value 0 for non-innovators and positive values for innovators. Secondly, since PRI is a binary variable (it takes the value 0 if the firm does not develop product innovations and the value 1 if it does), Logit regression[5] is considered to be an appropriate technique. So, the general specification of this second analysis is as follows:

$$Technological\ innovations_t = \gamma_1 Exports_{t-1} + \gamma_2 Experiential\ knowledge + \gamma_3 Control + \upsilon_t$$

Running the models above-mentioned represent a first insight of the causal relation between the two processes under analysis. In order to offer more accurate empirical support and since the main objective of this research is to find out if there is indeed a reciprocal relation between technological innovation and exports, we shall perform the Granger test of causality (Granger, 1969) since it remains the most popular methodology for evaluating the nature of the causal relation between two variables (Hood *et al.*, 2008).

Therefore, we aim to determine whether one process is useful in forecasting the other one. Explicitly, we will test whether technological innovations are "Granger caused" by exports and vice-versa. To incorporate dynamics, we will include lagged variables in this analysis as well. As a result, the model for testing Granger causality (Luo and Homburg, 2007) between technological innovations and exports will be specified as follows:

$$Technological\ innovations_t = \pi_1 Technological\ innovations_{t-1} + \chi_1 Exports_t + \chi_2 Exports_{t-1} + \upsilon_t$$

[5] Probit analysis could be also used since it is similar with Logit and both give similar conclusion in most applications (Nassimbeni, 2001). However, sometimes their results may differ substantially such as cases with an extremely large number of observations and a heavy concentration of the observation in the tails of the distribution. In this situation, Logit model is more appropriate (Liao, 1994).

$$Exports_t = \omega_1 Exports_{t-1} + \varphi_1 Technological\ innovations_t + \varphi_2 Technological\ innovations_{t-1} + \tau_t$$[6]

Furthermore, a Wald F test will determine the significance of the equations, considering this formula:

$$F = \frac{(SSR1 - SSR2)/q}{SSR2/(n-s)},$$

where SSR1 represents the sum of squared residuals in the restricted equation (in which χ_j and φ_j are restricted to zero) and SSR2 is the sum of squared residuals in the unrestricted equation. Additionally, q = the number of restrictions, n = the number of observations, and s = the number of independent variables in the unrestricted equation.

5. Results

5.1. Mean, standard deviations and correlations between variables

Below, Tables 3.1 and 3.2 show the means, standard deviations and correlations between the variables to be considered in both analyses, explicitly both the one where we focus on the influence that technological innovations have upon exports and vice-versa.

[Insert Table 3.1 and Table 3.2 here]

It can be observed that the majority of the correlation values is lower than 0.56 which is the maximum level a correlation is allowed to have for assessing multicolinearity analysis (Leiblein *et al.*, 2002). However, there are correlations slightly higher than the recommended level, being the case of PX_t with $NMIM_t$ (0.5929), $logVE_t$ with $NMIM_t$ (0.6093) and $logVE_t$ with PX_t (0.6994) on one hand and PX_{t-1} with $NMIM_{t-1}$ (0.5923), $logVE_{t-1}$ with $NMIM_{t-1}$ (0.6094) and $logVE_{t-1}$ with PX_{t-1} (0.7012) on the other hand.

[6] If all the coefficients of these equations are significant, technological innovations and exports mutually lead to "Granger cause" each other.

In order to evaluate their impact, the variation inflation factor (VIF) test is applied, running a regression for all the variables. The highest VIF levels are 2.23 and 2.47 respectively, being substantially lower than the allowed level of 10.0 (Baum, 2006) or even 5.0 (Studenmund, 1997; Pindado and de la Torre, 2006), indicating therefore that the results will not be biased due to multicollinearity (Nester *et al*., 1985).

5.2. Empirical results and discussion

As already mentioned, the first analysis is about the understanding of the impact that technological innovations have on exports. We observe in Table 4.1 that model *A)*, C) and *D)* show a similar result regarding the influence that technological innovation activities have on the commercial ones. Namely, both the innovative intensity (RDS_{t-1}) and the number of product innovations (NPI_{t-1}) present positive and significant values with respect to the number of the main international markets ($NMIM_t$) and the propensity to export (PX_t), respectively. In model *D)*, the dependent variable is a factor which contains all the three export measures. This was generated so to unify the three dimensions and look for a general result. Model *B)* focuses on firm's export intensity, explained here as the logarithm of the export value (logVE). We detect that process innovation in year *t-1* is the only statistically significant ($p < 0.1$) and positive innovation variable.

[Insert Table 4.1 here]

Therefore, our results show that only two technological innovation indicators are important if a firm looks for increasing its presence in different markets abroad (namely, RDS and PRI). It is worth to observe that the innovation developed the previous year affects firm's export activities in the current year[7].

[7] We also estimated models with two-year lags for the independent variables. It was only when the dependent variable was NMIM that IDV_{t-2} and NPI_{t-2} had a positive and significant coefficient. For the rest, no significant results were achieved.

Consequently, if a firm is interested in selling more abroad (logVE) or to have a higher propensity to export (PX), the process innovation realized a year before, and not the product one, seems to be more relevant. It is highlighted in the literature the difficulty to clearly differentiate these two types of technological innovations, but Becker and Egger (2007) underline that firms which develop process innovations, on one hand, are more interested in maintaining their international market position and firms which focus on product innovations, on the other hand, look for successful market entries.

Our data support therefore H1, meaning that technological innovations have a positive and significant influence on export-related activities. Considering our theoretical framework (RBV), H1 is in line with it since several authors classify technological innovation as the main source of firms' competitive advantage (Prahaled and Hamel, 1990; Bone and Saxon, 2000; Eusebio and Rialp, 2002; Rodriguez *et al.*, 2007). Cho and Pucik (2005) argue that innovation becomes critical in order to achieve a sustainable competitive advantage due to the rapid technological change, short product life-cycles, and increasing global competition. The effect that technological innovation has upon exports has been largely discussed, most of the academicians agreeing upon a positive and significant one (Bleaney and Wakelin, 2002; Barrios *et al.*, 2003; etc.). In this line, Basile *et al.* (2003) build an indicator of foreign expansion of Italian firms and find that firms' innovative activities are important determinants of the degree of involvement in international operations. Moreover, Castellani and Zanfei (2007)'s results show that increasing commitment to international operations is also associated with higher innovative effort, higher propensity to innovate, and a higher propensity to engage in technological collaboration within groups. On the opposite, even if Bloodgood *et al.* (1996) predict that internationalisation will be higher in new ventures in which innovation is high, they do not succeed in finding enough evidence, the relationship being marginally significant but negative.

Regarding firm's experiential knowledge, measured by firm age, results do not offer us an easy remark, since AGE, even significant for $\log VE_t$ and PX_t ($p < 0.01$), appears with different signs. Explicitly, firm age has no significant impact on firm's number of main international markets and neither does on $Factor\_Exp_t$, but it has a positive and significant one in regard to the volume of exports, whereas its impact is negative and significant in relation to the propensity to export. These results can be understood in the sense that the younger a firm is, more propensity to export it has, finding support in Oviatt and McDougall (2005)'s argument according to whom international new ventures begin with a proactive international strategy in contrast to organisations that evolve gradually from domestic firms to multinationals (Johanson and Vahlne, 1977; 1990). On the other hand, more experienced firms have a higher volume of exports. Considering these results, we can not generally accept H4. Our finding is in line with others, evidence being generally mixed. Barrios *et al.* (2003) and Mañez *et al.* (2004) find a positive and significant relation between firm's experience and its international activities, contrasting with the findings of Preece *et al.* (1999) who support the argument of McDougall *et al.* (1994) regarding that firms begin their international activity at an early stage.

As for the control variables, both firm size and sector show a positive and significant coefficient with respect to the three dependent variables. The relation between firm size and export behaviour has been extensively analysed in the literature, the first one being considered to be a useful and manageable approximation of firm assets which affect the latter one (Bonaccorsi, 1992). There is a wide evidence in the literature about the strong relation between firm size and export activity (Wagner, 1995; Roberts and Tybout, 1997; Barrios *et al.*, 2003; Bernard and Jensen, 2004; Mañez *et al.*, 2004), more precisely it is stated that the probability of a firm to be an exporter increases with its size. On the contrary, Pla and Alegre (2007) found that firm size is not a determinant for innovation or for export intensity. This goes in line with the findings of

Bonaccorsi (1992), Calof (1994) and Preece *et al.* (1999) who focus on early-stage technology-based firms and argue that these are by necessity international from the start. Regarding the sector where the firm operates, according to López and García (2005), belonging to a particular industry may condition a firm's strategy and performance in some way. In this regard, some empirical studies, at the sector level above all (Dosi *et al.*, 1990; Verspagen and Wakelin, 1993), have shown that technology-intensive sectors tend to export a higher proportion of their output than other sectors, as a result of technological spillovers within the industry, externalities and accumulated experience, allowing it to improve its technological capacity at the firm level and thus its competitiveness.

The second part of the analysis separates the dependent variable into firm's innovative intensity (RDS) and activity (NPI and PRI), as it can be seen in Table 4.2.

[Insert Table 4.2 here]

Our findings show that when firm's innovative intensity is a dependent variable (model *E*), both $logVE_{t-1}$ and PX_{t-1} influence it in a positive and significant way ($p < 0.01$ and $p < 0.05$ respectively), whereas $NMIM_{t-1}$ has no statistically significant impact. The following two models explain the innovative activity of the firm, $logVE_{t-1}$ being positive and significant for both. In the case of NPI as a dependent variable, NMIM appears also as an important explanatory variable, having a high (1.493) and significant ($p < 0.01$) coefficient. In order to unify the three dimensions and look for a general result, a factor which contains innovation variables was also generated (model *H*). After employing it in a random effects regression as a dependent variable, $NMIM_{t-1}$ and $logVE_{t-1}$ appear as significant ($p < 0.1$), as well as AGE and the control variables ($p < 0.05$ and $p < 0.01$ respectively), whereas $R^2 = 0.1136$.

Therefore, more markets a firm possesses, more product innovations it will achieve, since it gains access both to new market knowledge and to different patterns of consumer behaviour.

However, this does not have a direct effect on innovative intensity and neither on the process innovation advances. On the other hand, the only commercial resource that explains all technological ones is $logVE_{t-1}$. It seems extremely important how much a firm sold abroad one year[8] before in order to accomplish and develop more technological innovations in the current year. Therefore, when a firm is more consolidated abroad, having a high value of exports, it invests more in R&D, developing not only product innovations but also process ones, perhaps more sophisticated and radical rather than incremental. Considering all these, we accept H2.

These results are in line with some academicians who find that there are strong opinions to suggest that the increment of international activities actually leads to innovation (Hitt *et al.*, 1997; Barrios *et al.*, 2003; Cruz *et al.*, 2009). As already mentioned in the literature review section and also developed in Wakelin (1998), even if the influence that technological innovation has on export has not been so deeply addressed, there are a few studies which examined it, such as Willmore (1992) and Kumar and Siddharthan (1994) among others. Regarding the first one, no significant role for R&D expenditures as a determinant of exports was found (Willmore, 1992). In contrast, Bleaney and Wakelin (2002) consider innovation as the driving force behind exports, innovative firms having a significantly higher propensity to export than non-innovative ones. Therefore, studies have been successful in showing that there are international firms which relate their R&D activity more to exporting over time (Lall and Kumar, 1981), that the propensity to export of innovative firms tends to be higher than that of non-innovative ones (Hirsch and Bijaoui, 1985), and that the variation in export sales are well explained by the variations in innovative intensity (ratio between R&D expenditures and total sales) (Hirsch *et al.*, 1988).

As for the predicted relation between firm's experiential knowledge and technological innovations, we can not generally support H5 since AGE does not have the same effect on all the

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[8] We also estimated models with two-year lags for the independent variables. Results were extremely similar.

dependent variables, being positive and significant only for RDS_t and $Factor\_Inn_t$. Therefore, more experiential knowledge a firm has, the greater its R&D expenses over sales will be. Similarly, most of the academicians find a positive impact of age on innovative activity (Kumar and Saqib, 1996; Gumbau, 1997; Kuemmerle, 1998), except Molero and Buesa (1996), who show that younger companies rapidly acquire experiential knowledge and use it to develop more technological innovations.

With respect to the control variables (firm size and the sectors' technological intensity), they represent as well important factors which allow firms to improve their technological innovation activities, showing a highly significant and positive sign ($p < 0.01$) in almost all the three regressions employed to analyse the relation that exists between firm's technological innovation and its exports. The only exceptions are for the second and third model, precisely, medium firms show no significant influence upon technological innovations measured as the number of product innovations, and neither does sector for the binary variable IPR.

Next, with the purpose to provide a greater empirical support to the estimations obtained in the previous models, and in order to investigate the existence of a reciprocal, mutual relation between technological innovations and exports, we perform the Granger test of causality (1969), which is the subject of this investigation's third analysis. This test's computed Wald F results are presented in Table 4.3.

[Insert Table 4.3 here]

As it can be observed, the F statistics account for extremely significant *p*-values when referring both to the impact that technological innovations have on exports and also to the impact the latter has on the former. Therefore, we can affirm that innovation "Granger causes" internationalisation and that internationalisation "Granger causes" innovation, hence giving full support to H3.

However, there is not enough evidence in the literature regarding this finding, being few the authors who suggest but not research it, such as Zhao and Li (1997), Prashantham (2005), Lachenmaier and Wöβmann (2006), Pla and Alegre (2007), Vila and Kuster (2007) among others. Moreover, Castellani and Zanfei (2007) results suggest that a two-way link exists between innovation and internationalisation. Firms invest in R&D and innovation to gain advantages and compete in international markets. On the contrary, international production favours access to foreign knowledge sources, enhancing firms' advantages.

6. Conclusion

Academicians repeatedly report the need for disentangling the direction of causality between innovation and internationalisation (Hitt *et al.*, 1997; Lachenmaier and Wöβmann, 2006; Prashantham, 2008). In addition, Knight and Cavusgil (2004) highlight that innovation, knowledge and capabilities have been central themes of research on the international strategy and performance of the firm.

In this paper, we argued that both innovation and internationalisation may influence each other. The basis of this argument resides, firstly, in the fact that firms which participate in international markets must develop competitive advantages in order to survive, being these advantages potentially transferable further into technological innovations. In order to achieve the objective of this paper, we focused on RBV, analysing firms' technological and international achievements as well as their experience. Spanish Business Strategy Survey (SBS) was used, analysing an unbalanced panel formed by 696 firms which answered during the period 1994-2005. Around 65% of the firms involved in the analysis were exporters and almost 44% were innovators. Several statistical techniques were applied since we considered both innovation and export based-internationalisation as a dependent variable. The results of these analyses revealed a preliminary causality relation between the two processes under investigation.

On one hand, the findings of our first analysis suggest that the technological activities of the firm are a key factor in its international performance, providing it with greater capacity to enter and sell products in foreign markets. Consequently, if a firm is interested in selling more abroad (logVE) or in increasing its propensity to export (PX), it seems it takes into consideration the process innovations developed a year before, and not the product ones. Even if it is hard to make a clear distinction between these two types of technological innovations, especially when it comes of chronological issues, it stands out in our analysis that firms are more interested in maintaining their international market position and not in having successful market entries.

On the other hand, the findings of our second analysis suggest that the commercial activities of the firm are also a key factor in the advances achieved in technological innovations. Firstly, the higher the number of main international markets is, the more product innovations a firm will develop, since the firm gains access both to new market knowledge and to different patterns of consumer behaviour. However, this does not have a direct effect on innovative intensity and neither on the process innovation advances. This could be due to the type of ideas involved in the development of product innovations, perhaps being handier and not so in need of R&D investments. Secondly, it seems extremely important how much a firm sold abroad in previous years in order to accomplish and develop more technological innovations in the current year. Therefore, when a firm is consolidated abroad, having a relevant value of export-sales, it develops a complete picture of technological innovations, from high R&D investment to both product and process innovations.

Furthermore, the causal relation was statistically strengthen by the Granger test of causality (1969), developed exclusively to test the reciprocity between technological innovation and exports, and bringing therefore an add value to our investigation. Results were notable, since all combinations of variables showed a very significant ($p < 0.05$ and $p < 0.01$) and positive value.

With respect to the implication of this study, firstly it provides important insights to managers regarding the causal and reciprocal relation between technological innovation activities and internationalisation ones. So, if managers are interested in increasing their firms' export propensity and intensity, they must pay a special attention to the technological activities developed inside the firms. Specifically, in order to increase their presence in the main international markets and also their propensity to export, both innovative intensity and process innovation developed the previous year represent an important input. If, on the contrary, managers seek only to increase their firms' export intensity, by selling more abroad, they first must consider developing process innovations. In the case that managers desire to improve technological innovation issues in their firms, we outline the importance of commercial activities, precisely firms' export intensity measured by the value of their export-sales.

Secondly, this study has implications also for the literature, in both empirical and methodological issues. From an empirical point of view, the use of longitudinal data for a twelve-year period supposes an extension to the traditional focus on cross-sectional data analysis. By focusing on a panel data, historical behaviour can be observed since lagged variables are introduced in the analysis. Regarding the methodology used, we offer a complete image of the existent relation between technological innovation and exports since we apply different methods of analysis, culminating with the Granger test of causality (1969). And thirdly, our study presents implication also for public authorities in designing supporting public policies.

This study is not free from limitations. Some are especially regarding to the fact that we dealt with a longitudinal sample which, according to Baltagi (2007), includes problems in the design, data collection, and data management of panel surveys. It is also possible that panel data show bias due to sample selection problems and attrition (Wooldridge, 1995). Other limitations are related to the introduction and measurement of some other variables in the analyses, thus conferring a more complete image of both export and innovation activities. The inclusion of export experience and patent citation may also offer another path for future research. Moreover, the approach used to measure some of the factors may be less precise than desired.

Future research might examine whether the reciprocal relation observed in our investigation is also evidenced in alternative samples. In this way, it would reveal if institutional factors play a role in influencing the relation (Kogut *et al.*, 2002; Peng *et al.*, 2005; Kumar, 2009). Furthermore, dynamics might be introduced into the analysis, precisely single equation models could be developed, with autoregressive dynamics and explanatory variables that are not strictly exogenous, the Generalised Method of Moments estimators being widely used in this context (Bond, 2002). In order to do this, learning-by-doing literature represents a valuable academic evidence and extremely useful for developing new models. Finally, firms from specific sectors or of specific ownership could be also more in-depth analysed.

References:

Acs, Z.J.; Morck, R.K. and Yeung, B. (2001). Entrepreneurship, Globalisation, and Public Policy, *Journal of International Management*, 7/3, 235-251.

Alonso, J.A. and Donoso, V. (1998) *Competir en el exterior. La empresa española y los mercadosinternacionales*. Madrid: ICEX.

Baltagi, B. (2007). Comments on: Panel Data Analysis—Advantages and Challenges”, *Test*, 16/1, 28-30.

Barney, J.B. (1991). Firm Resources and Sustained Competitive Advantage, *Journal of Management*, 17/1, 99–120.

Barney, J.B.; Wright, M. and Ketchen jr, D.J. (2001). The Resource-Based View of the Firm: Ten Years After 1991, *Journal of Management*, 27/6, 625–641.

Barrios, S.; Görg, H. and Strobl, E. (2003). Explaining Firms’ Export Behaviour: R&D, Spillovers and the Destination Market, *Oxford Bulletin of Economics and Statistics*, 65/4, 475-496.

Basile, R. (2001). Export Behaviour of Italian Manufacturing Firms Over the Nineties: the Role of Innovation, *Research Policy*, 30/8, 1185–1201.

Basile, R.; Giunta, A. and Nugent, J. (2003). Foreign Expansion by Italian Manufacturing Firms in the Nineties: An Ordered Probit Analysis, *Review of Industrial Organization*, 23/1, 1–24.

Baum, C.F. (2006) *An introduction to modern econometrics using Stata*. Texas: Stata Press.

Becker, S.O. and Egger, P. (2007). Endogenous Product Versus Process Innovation and A Firm's Propensity to Export, *CESifo Working Paper Series*, 1906.

Bernard, A. and Jensen, J. (1999). Exceptional Exporter Performance: Cause, Effect or Both?, *Journal of International Economics*, 47/1, 1–25.

Bernard, A. and Jensen, J. (2004). Why Some Firms Export, *The Review of Economics and Statistics*, 86/2, 561–569.

Bleaney, M. and Wakelin, K. (2002). Efficiency, Innovation and Exports, *Oxford Bulletin of Economics and Statistics*, 64/3, 3-15.

Bloodgood, J.M.; Sapienza, H.J. and Almeida, J.G. (1996). The Internationalization of New High-Potential U.S. Ventures: Antecedents and Outcomes, *Entrepreneurship Theory and Practice*, 20/4, 61-76.

Bonaccorsi, A. (1992). On the Relationship Between Firm Size and Export Intensity, *Journal of International Business Studies*, 23/4, 605-635.

Bond, S.R. (2002). Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice, *Portuguese Economic Journal*, 1/2, 141-162.

Bone, S. and Saxon, T. (2000). Developing Effective Technology Strategies, *Research Technology Management*, 43/4, 50-58.

Branzei, O. and Vertinsky, I. (2006). Strategic Pathways to Product Innovation Capabilities in SMEs, *Journal of Business Venturing*, 21/1, 75–105.

Buesa, M. and Molero, J. (1998). La Regularidad Innovadora en Empresas Españolas, *Revista de Economía Aplicada*, 6/17, 111–134.

Calof, J.L. (1994). The Relationship Between Firm Size and Export Behaviour Revisited, *Journal of International Business Studies*, 25/2, 367-387.

Castellani, D. and Zanfei, A. (2007). Internationalisation, Innovation and Productivity: How Do Firms Differ in Italy, *The World Economy,* 30/1, 156-176.

Cho, H.J. and Pucik, V. (2005). Relationship Between Innovativeness, Quality, Growth, Profitability, and Market Value, *Strategic Management Journal*, 26/6, 555–575.

Cruz, C.; Bayona, C. and García, T. (2009). Innovation Strategy Selection: Make, Buy or Both?, *UPNA Documento de Trabajo,* 96.

Damanpour, F. (1991). Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators, *Academy of Management Journal*, 34/3, 555-590.

Danneels, E. (2002). The Dynamics of Product Innovation and Firm Competences, *Strategic Management Journal*, 23/12, 1095–1121.

Díaz, N.L.; Aguiar, I. and Saá, P.D. (2008). The Effect of Technological Knowledge Assets on Performance: The Innovative Choice in Spanish Firms, *Research Policy*, 37/9, 1515-1529.

Dosi, G.; Pavitt, K. and Soete, L. (1990) *The Economic of Technical Change and International Trade*. New York: Harvester.

Eusebio, R. and Rialp, A. (2002). Innovación Tecnológica y Resultado Exportador: Un Análisis Empírico Aplicado al Sector Textil-Confección Español, *UAB Document de treball*, 4.

Filipescu, D.A.; Rialp. A. and Rialp, J. (2009). Internationalisation and Technological Innovation: Empirical Evidence on Their Mutual Relationship, *Advances in International Marketing*, 20, 125-154.

Galbreath, J. (2005). Which Resources Matter the Most to Firm Success? An Exploratory Study of Resource-Based Theory, *Technovation*, 25/9, 979–987.

Galende, J. and de la Fuente, J.M. (2003). Internal Factors Determining a Firm's Innovative Behaviour, *Research Policy*, 32/5, 715-736.

Galende, J. and Suárez, I. (1999). A Resource-Based Analysis of the Factors Determining a Firm's R&D Activities, *Research Policy*, 28/8, 891-905.

Gemunden, H.G. (1991) Success factors of export marketing: A meta-analytic critique of the empirical studies. In S.J. Paliwoda (Ed.), *New Perspectives on International Marketing,* London: Routledge.

Granger, C.W.J. (1969). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods, *Econometrica*, 37/3, 424-438.

Grant, R.M. (1991). The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation, *California Management Review*, 33/3, 114–135.

Grant, R.M. (1996). Toward a Knowledge-Based Theory of the Firm, *Strategic Management Journal*, 17/Winter, 109-122.

Gumbau, M. (1997). Análisis Microeconómico de los Determinantes de la Innovación: Aplicación a las Empresas Industriales Españolas, *Revista Española de Economía*, 14/1, 41–66.

Hall, R. (1992). The Strategic Analysis of Intangible Resources, *Strategic Management Journal*, 13/2, 135-144.

Hirsch, S. and Bijaoui, I. (1985). R&D Intensity and Export Performance: A Micro View, *Weltwirtschaftliches Archiv*, 121/2, 238–251.

Hirsch, S.; Kalish, S. and Katznelson, S. (1988). Effects of Knowledge and Service Intensities on Domestic and Export Performance, *Weltwirtschaftliches Archiv*, 124/2, 230–241.

Hitt, M.A.; Hoskisson, R.E. and Kim, H. (1997). International Diversification: Effects on Innovation and Firm Performance in Product-Diversified Firms, *Academy of Management Journal*, 40/4, 767-798.

Hood, M.V.; Kidd, Q. and Morris, I.L. (2008). Two Sides of the Same Coin? Employing Granger Causality Tests in A Time Series Cross-section Framework, *Political Analysis Advance Access*, 16/3, 324-344.

Itami, H. (1987) *Mobilizing invisible assets.* Cambridge, MA: Harvard University Press.

Johanson, J. and Vahlne, J. (1977). The Internationalisation Process of the Firm: A Model of Knowledge Development and Increasing Foreign Commitments, *Journal of International Business Studies*, 8/1, 23-32.

Johanson, J. and Vahlne, J. (1990). The Mechanism of Internationalisation, *International Marketing Review*, 7/4, 11-24.

Jones, M.V. (2001). First Steps in Internationalisation: Concepts and Evidence from a Sample of Small High Technology Firms, *Journal of International Management*, **7/**3, 191–210.

Kogut, B.; Walker, G. and Anand, J. (2002). Agency and Institutions: National Divergences in Agency Behaviour, *Organization Science*, 13/2, 162–178.

Knight, G.A. and Cavusgil, S.T. (2004). Innovation, Organisational Capabilities, and the Born-Global Firm, *Journal of International Business Studies*, 35/2, 124-141.

Kuemmerle, W. (1998). Optimal Scale for Research and Development in Foreign Environments: An Investigation into Size and Performance of Research and Development Laboratories Abroad, *Research Policy*, 27/2, 111–126.

Kumar, M.V. (2009). The Relationship Between Product and International Diversification: The Effects of Short-run Constraints and Endogeneity, *Strategic Management Journal*, 30/1, 99-116.

Kumar, N. and Saqib, M. (1996). Firm Size, Opportunities for Adaptation and In-house R&D Activity in Developing Countries: The Case of Indian Manufacturing, *Research Policy*, 25/5, 713–722.

Kumar, N. and Siddharthan, N.S. (1994). Technology, Firm Size and Export Behaviour in Developing Countries: The Case of Indian Enterprise, *Journal of Development Studies*, 31/2, 288–309.

Lachenmaier, S. and Wöβmann, L. (2006). Does Innovation Cause Export? Evidence from Exogenous Innovation Impulses and Obstacles Using German Micro Data, *Oxford Economic Press*, 58/2, 317-350.

Lall, S. and Kumar, R. (1981). Firm-level Export Performance in An Inward-Looking Economy: The Indian Engineering Industry, *World Development*, 9/5, 453–463.

Lefebvre, E.; Lefebvre, L.A. and Bourgault, M. (1998). R&D-related Capabilities as Determinants of Export Performance, *Small Business Economics*, 10/4, 365–377.

Leiblein, M.J.; Reuer, J.J. and Dalsace, F. (2002). Do Make or Buy Decisions Matter? The Influence of Organizational Governance on Technological Performance, *Strategic Management Journal*, 23/10, 817-833.

Liao, T.F. (1994) *Interpreting probability models*. Sage Publication, Iowa.

López, J. and García, R.M. (2005). Technology and Export Behaviour: A Resource-Based View Approach, *International Business Review*, 14/5, 539-557.

Luo, X. and Homburg, C. (2007). Neglected Outcomes of Customer Satisfaction, *Journal of Marketing*, 71/2, 133–149.

Mañez, J.A.; Rochina, M.E. and Sanchis, J.A. (2004). The Decision to Export: A Panel Data Analysis for Spanish Manufacturing, *Applied Economics Letters*, 11/11, 669 – 673.

McDougall, P.; Shane, S. and Oviatt, B. (1994). Explaining the Formation of International New Ventures: The Limits of Theories from International Business Research, *Journal of Business Venturing*, 9/6, 469–487.

Molero, J. and Buesa, M. (1996). Patterns of Technological Change among Spanish Innovative Firms: The Case of the Madrid Region, *Research Policy*, 25/4, 647–663.

Molero, J. (1998). Patterns of Internationalisation of Spanish Innovatory Firms, *Research Policy*, 27/5, 541-558.

Morgan, A. and Jones, M.V. (2009). Post-entry Internationalisation Dynamics, *International Small Business Journal*, 27/1, 71-97.

Nassimbeni, G. (2001). Technology, Innovation Capacity, and the Export Attitude of Small Manufacturing Firms: A Logit/ Tobit Model, *Research Policy*, 30/2, 245–262.

Nester, J.; Wasserman, W. and Kutner, M.(1985) *Applied linear statistical models.* 2nd edition. Irwin: Homewood, IL.

Nonaka, I.; Toyama, R. and Nagata, A. (2000). A Firm as a Knowledge-creating Entity: A New Perspective on the Theory of the Firm, *Industrial and Corporate Change*, 9/1, 1–20.

OECD-EUROSTAT (1997) The Measurement of Scientific and Technological Activities. *Proposed guidelines for collecting and interpreting technological data*, Oslo Manual, Paris.

Oviatt, B.M. and McDougall, P.P. (2005). The Internationalisation of Entrepreneurship, *Journal of International Business Studies*, 36/1, 2-8.

Ozçelik, E. and Taymaz, E. (2004). Does Innovativeness Matter for International Competitiveness in Developing Countries? The Case of Turkish Manufacturing Industries, *Research Policy*, 33/3, 409–424.

Peng M.W.; Lee, S.H. and Wang, D. (2005). What Determines the Scope of the Firm Over Time? A Focus on Institutional Relatedness, *Academy of Management Review*, 30/3, 622–633.

Penrose, E.T. (1959) *The Theory of the Growth of the Firm*. Oxford: Blackwell.

Pindado, J. and de la Torre, C. (2006). The Role of Investment, Financing and Dividend Decisions in Explaining Corporate Ownership Structure: Empirical Evidence from Spain, *European Financial Management*, 12/5, 661–687.

Pla, J. and Alegre, J. (2007). Analysing the Link Between Export Intensity, Innovation and Firm Size in a Science-based Industry, *International Business Review*, 16/3, 275–293.

Porter, M.E. (1998) *On Competition.* Boston, MA: Harvard Business School.

Prahalad, C. and Hamel, G. (1990). The Core Competence of the Corporation, *Harvard Business Review*, 68/3, 79-91.

Prashantham, S. (2005). Toward a Knowledge-based Conceptualisation of Internationalisation, *Journal of International Entrepreneurship*, 3/1, 37-52.

Prashantham, S. (2008) *The Internationalisation of Small Firms – A Strategic Entrepreneurship Perspective*. Glasgow: Routledge Studies in Small Business.

Preece, S.B.; Miles, G. and Baetz, M.C. (1999). Explaining the International Intensity and Global Diversity of Early-stage Technology-based Firms, *Journal of Business Venturing*, 14/3, 259–281.

Roberts, M.J. and Tybout, J.R. (1997). The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs, *The American Economic Review*, 87/4, 545-564.

Rodriguez, A.; Sandulli, F.D.; Minguela, B. and López, J.I. (2007). The Endogenous Relationship Between Innovation and Diversification, and the Impact of Technological Resources on the Form of Diversification, *Research Policy*, 36/5, 652–664.

Roper, S. and Love, J.H. (2002). Innovation and Export Performance: Evidence from the UK and German Manufacturing Plants, *Research Policy*, 31/7, 1087–1102.

Salomon, R. and Shaver, J. (2005). Learning-by-exporting: New Insights from Examining Firm Innovation, *Journal of Economics and Management Strategy*, 14/2, 431-461.

Santamaría, L. and Rialp, J. (2007). Determinantes de la Elección del Socio Tecnológico: Especificidades Sectoriales y de Tamaño, *Cuadernos Económicos de ICE*, 73, 37-64.

Sterlacchini, A. (1999). Do Innovative Activities Matter to Small Firms in Non-R&D Intensive Industries? An Application to Export Performance, *Research Policy*, 28/8, 819–832.

Studenmund, A.H. (1997) *Using Econometrics. A Practical Guide*. Addison-Wesley.

Styles, C. and Ambler, T. (1994). Successful Export Practice: The UK Experience, *International Marketing Review*, 11/6, 23-47.

Surroca, J. and Santamaría, L. (2007). La Cooperación Tecnológica como Determinante para los Resultados Empresariales, *Cuadernos de Economía y Dirección de Empresa*, 33/Diciembre, 31-62.

Teece, D.J. (1986). Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy, *Research Policy*, 15/6, 285-305.

Verspagen, B. and Wakelin, K. (1993) *International Competitiveness and Its Determinants*. Maastricht: MERIT.

Vila, N. and Kuster, I. (2007). The Importance of Innovation in International Textile Firms, *European Journal of Marketing*, 41-1/2, 17-36.

Wagner, J. (1995). Exports, Firm Size, and Firm Dynamics, *Small Business Economics*, 7/1, 29-40.

Wakelin, K. (1998). Innovation and Export Behaviour at the Firm Level, *Research Policy*, 26/7-8, 829-841.

Wernerfelt, B. (1984). A Resource-based View of the Firm, *Strategic Management Journal*, 5/2, 171–180.

Willmore, L. (1992). Transnationals and Foreign Trade: Evidence from Brazil, *Journal of Development Studies*, 28/2, 314–335.

Wooldridge, J.M. (1995). Selection Corrections for Panel Data Models under Conditional Mean Independence Assumptions, *Journal of Econometrics*, 68/1, 115–132.

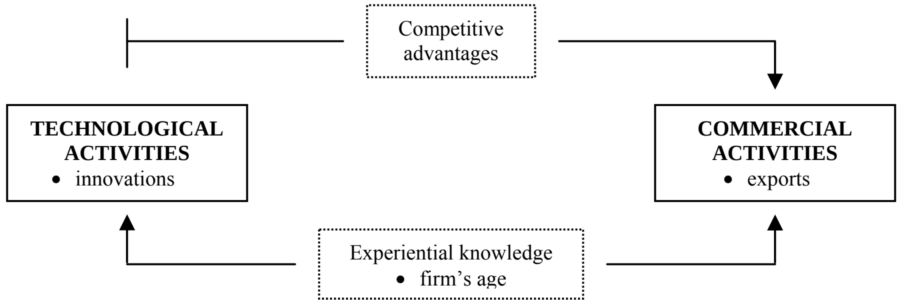
Zahra, S.; Ireland, R. and Hitt, M. (2000). International Expansion by New Venture Firms: International Diversity, Mode of Market Entry, Technological Learning, and Performance, *Academy of Management Journal*, 43/5, 925–950.

Zhao, H. and Li, H. (1997). R&D and Export: An Empirical Analysis of Chinese Manufacturing Firms, *Journal of High Technology Management Research*, 8/1, 89–106.

Zou, S. and Ozsomer, A. (1999). Global Product R&D and the Firm's Strategic Position, *Journal of International Marketing*, 7/1, 57-76.

Appendix. Tables and Figures

Figure 1. Conceptual framework



Source: Self-elaborated

Table 1. Sample description

Firms' characteristics	Categories	Overall percentage
Exporters	No	34,94
	Yes	65,06
Innovators	No	56,14
	Yes	43,86
Size (nº of employees)	<= 50	51,18
	> 50 & <= 200	17,37
	> 200	31,46
Activity sectors (technology intensity)	Low-Medium	71,07
	Medium -High	28,93

Source: Self-elaborated

Table 2. Description of variables

Variable	Definition	Calculation	Authors
Export	Number of main international markets Propensity to export Exports value	Continuous Percentage of exports on total sales Logarithm of exports value	Wakelin, 1998; Sterlacchini, 1999; Basile, 2001; Nassimbeni, 2001; Bleaney and Wakelin, 2002; Roper and Love, 2002; Barrios *et al*., 2003; Ozçelik and Taymaz, 2004; López and García, 2005; Santamaria and Rialp, 2007.
Innovation	Innovative intensity	R&D expenses divided into total sales	Bloodgood *et al.*, 1996; Zhao and Li, 1997; Basile, 2001; Nassimbeni, 2001; Bleaney and Wakelin, 2002; Roper and Love, 2002; Barrios *et al.*, 2003; Mañez *et al.*, 2004; Ozçelik and Taymaz, 2004; López and García, 2005; Salomon and Shaver, 2005; Diaz *et al.*, 2008.
	Number of product innovations Process innovation	Continuous Binary	Wakelin, 1998; Bleaney and Wakelin, 2002; Roper and Love, 2002; Ozçelik and Taymaz, 2004; López and García, 2005; Salomon and Shaver, 2005; Diaz *et al.*, 2008.
Knowledge (experience)	Firm age	Firm's foundation year rested from year *t*	Zahra *et al.*, 2000; Nassimbeni, 2001; Barrios *et al.*, 2003; Mañez *et al.*, 2004; Santamaria and Rialp, 2007; Diaz *et al.*, 2008.
Control	Firm size	Number of employees	Bloodgood *et al.*, 1996; Roberts and Tybout, 1997; Molero, 1998; Wakelin, 1998; Zahra *et al.*, 2000; Basile, 2001; Nassimbeni, 2001; Bleaney and Wakelin, 2002; Barrios *et al.*, 2003; Mañez *et al.*, 2004; Ozçelik and Taymaz, 2004; López and García, 2005.
	Technological intensity	OECD (1997) classification	Zahra *et al.*, 2000; Basile, 2001; Barrios *et al.*, 2003; López and García, 2005.

Source: Self-elaborated

Table 3.1: Means, standard deviations and correlations between variables

Variables	Mean	Std.Dev.	1	2	3	4	5	6	7
1. NMIM*t*	.8408926	1.151225	1.0000						
2. PX*t*	20.84577	27.1898	**0.5929***	1.0000					
3. logVE*t*	8.785601	6.831174	**0.6093***	**0.6994***	1.0000				
4. RDS*t-1*	.7601794	2.239202	0.1779*	0.1620*	0.2007*	1.0000			
5. PRI*t-1*	.3440832	.4750996	0.1752*	0.1780*	0.2419*	0.1606*	1.0000		
6. NPI*t-1*	2.837442	16.93018	0.0407*	0.0602*	0.0939*	0.1074*	0.0800*	1.0000	
7. AGE	26.9258	21.40507	0.1419*	0.0830*	0.2680*	0.0824*	0.0820*	0.0425*	1.0000

* Significance level at 0.05

Source: Self-elaborated

Table 3.2: Means, standard deviations and correlations between variables

Variables	Mean	Std.Dev.	1	2	3	4	5	6	7
1. RDS*t*	.7744621	2.47896	1.0000						
2. NPI*t*	2.736493	16.38968	0.0940*	1.0000					
3. PRI*t*	.3378608	.4730095	0.1393*	0.0814*	1.0000				
4. NMIM*t-1*	.8344083	1.152743	0.1527*	0.0397*	0.1719*	1.0000			
5. PX*t-1*	20.73183	27.11618	0.1433*	0.0646*	0.1627*	**0.5923***	1.0000		
6. logVE*t-1*	8.677452	6.779672	0.1826*	0.0865*	0.2291*	**0.6094***	**0.7012***	1.0000	
7. AGE	26.9258	21.40507	0.0959*	0.0403*	0.0819*	0.1447*	0.0792*	0.2687*	1.0000

* Significance level at 0.05

Source: Self-elaborated

Table 4.1: Results. Innovation as a cause of internationalisation

Variables		*Export* A) NMIM*t* (tobit)	*Export* B) logVE*t* (tobit)	*Export* C) PX*t* (tobit)	*Export* D) Factor_Exp*t* (random effects)
Technological activities	RDS*t-1*	.0289*** (.0070)	.0322 (.0271)	.2091** (.0875)	.0091*** (.0027)
	NPI*t-1*	.0010 (.0007)	.0009 (.0029)	-.0045 (.0097)	.0002 (.0002)
	PRI*t-1*	.0543* (.0295)	.2034* (.1052)	.6749* (.4094)	.0194** (.0098)
Organizational activities	AGE	-.0011 (.0010)	.0236*** (.0044)	-.0352*** (.0116)	.0004 (.0006)
Control	SIZE 2 (med)	.6233*** (.0583)	2.609*** (.2125)	5.131*** (.6863)	.2399*** (.0258)
	SIZE 3 (large)	.9304*** (.0562)	4.781*** (.2370)	10.42*** (.5906)	.5175*** (.0342)
	TEC_INTENS	.6706*** (.0615)	2.502*** (.2397)	10.15*** (.6816)	.4583*** (.0614)
Log-likelihood		-6185.7285	-14846.354	-21036.756	n.a.
Constant		-.5591*** (.0638)	4.966*** (.2160)	11.19*** (.7099)	-.5006*** (.0391)
R-square		0.2146	0.3939	0.2049	0.3264

** p < .1*

*** p < .05*

**** p < .01*

Standard errors into brackets

Source: Self-elaborated

Table 4.2: Results. Internationalisation as a cause of innovation

Variables		*Technological innovation*			
		E) **RDS*t*** **(tobit)**	***F)*** **NPI*t*** **(tobit)**	***G)*** **PRI*t*** **(logit)**	***H)*** **Factor_Inn*t*** **(random effects)**
Commercial activities	**NMIM*t-1***	.0746 (.0555)	1.493*** (.5650)	.0731 (.0490)	.0258* (.0150)
	logVE*t-1*	.0606*** (.0142)	.8868*** (.1621)	.0264** (.0117)	.0064* (.0034)
	PX*t-1*	.0063** (.0030)	-.0040 (.0302)	-.0000 (.0026)	.0007 (.0008)
Organizational activities	**AGE**	.0122*** (.0036)	-.0172 (.0348)	.0012 (.0030)	.0020*** (.0010)
Control	**SIZE 2 (med)**	.6588*** (.1736)	.5403 (1.851)	.8798*** (.1592)	.2092*** (.0476)
	SIZE 3 (large)	.8238*** (.1961)	5.222*** (1.889)	1.549*** (.1733)	.3362*** (.0559)
	TEC_INTENS	2.146*** (.1847)	4.562*** (1.434)	.2390 (.1586)	.3282*** (.0570)
Log-likelihood		-8753.5645	-10997.382	-3806.4602	n.a.
Constant		-2.859*** (.1889)	-20.77*** (2.138)	-1.964*** (.1555)	-.4876*** (.0544)
R-square		0.0872	0.0074	n.a.	0.1136

** p < .1*
*** p < .05*
**** p < .01*
Standard errors into brackets

Source: Self-elaborated

Table 4.3: Results. F statistics from Granger test

Indep. Var.	Dep. Var.					
	NMIM	**logVE**	**PX**	**RDS**	**NPI**	**PRI**
NMIM	n.a.	n.a.	n.a.	15.6***	5.759***	36.139***
logVE	n.a.	n.a.	n.a.	26.53***	6.186***	70.424***
PX	n.a.	n.a.	n.a.	14.51***	3.68**	31.25***
RDS	31.654***	11.855***	15.715***	n.a.	n.a.	n.a.
NPI	103.528***	77.385***	110.791***	n.a.	n.a.	n.a.
PRI	8.78***	15.50***	7.213***	n.a.	n.a.	n.a.

*** p < 0.05*
**** p < 0.01*

Source: Self-elaborated