LEARNING FROM EXPORTING: THE MODERATING EFFECT OF TECHNOLOGICAL CAPABILITIES

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Abstract

There is evidence that exporters are more productive than non-exporters. Scholars argue that exporters may have access to knowledge spillovers in foreign markets and use this knowledge to become more efficient. However, we know little about whether learning from exporting is affected by firms' heterogeneous resource endowments and, particularly, about the specific firm characteristics that matter the most in this respect. Utilizing a sample of 1,534 Spanish manufacturing firms from 1990 to 2002, we empirically analyze whether a firm's technological capabilities (proxied by its relative R&D expenditures) affect its ability to learn from the interaction with foreign agents. We find that firm productivity increases after exporting for all firms. However, *ex post* productivity improvements are larger for the more technologically advanced firms than they are for their less technologically advanced counterparts. Our results show that some firms stand to benefit more from exporting than others and hint at the importance of absorptive capacity for knowledge acquisition overseas.

Keywords

Learning from exporting, technological capabilities, absorptive capacity, productivity, exports

1. Introduction

Firm internationalization has been a prominent phenomenon for a long time now, and this situation has increasingly attracted attention from the academic community. Scholars have extensively studied several aspects of international business strategy, such as the impact of multinational activity on firm performance or the motivations for firm internationalization.

Aside from arguments about internalization, scholars have argued that asset-seeking motivations may be at the core of international expansion (Kogut & Chang, 1991; Shan & Song, 1997; Wesson, 1999). Thus, firms may expand abroad with the intention to source new knowledge from foreign markets (Almeida, 1996; Penner-Hahn & Shaver, 2005). In this vein, a growing literature (mainly in economics) has examined whether exporters benefit from knowledge spillovers in international markets (e.g., Delgado, Fariñas, & Ruano, 2002; Salomon & Shaver, 2005). Scholars in this stream of literature argue that through interaction with foreign agents (e.g., customers, competitors, and/or intermediaries) exporters may gain access to state-of-the-art technologies and cutting-edge knowledge that are not available to non-internationalized firms (Afuah, 1998). The outcome is that exporters will benefit from learning from those agents and, as a consequence, from increased productivity after exporting (Álvarez & López, 2005; Aw, Roberts, & Winston, 2007; Castellani, 2002; Wei & Liu, 2006; World Bank, 1997).

Despite this extensive scrutiny of the learning outcomes of international expansion, we know little about whether some firms are better suited than others to learn from their foreign sales and, more interestingly, about the specific firm characteristics that contribute to knowledge sourcing abroad. Few studies so far (Aw *et al.*, 2007; Salomon & Jin, 2010) have addressed firm heterogeneity in learning from exporting.

Accordingly, the aim of this paper is to analyze whether the endowment of technological capabilities bears an influence on the ability of firms to learn by exporting. Our study extends prior literature by examining the moderating effect of firms' technological capabilities on the relationship between exports and firm-level productivity while controlling for firm-specific unobservable factors and endogeneity in firms' export decisions. We argue that firm-specific capabilities may affect the ability to recognize valuable knowledge, integrate it with existing prior knowledge and use it to improve the firm's operations. Thus, a firm with greater absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002) should obtain greater benefits from international sales. Following previous research (Salomon & Jin, 2008, 2010), we use relative R&D investments as a proxy for a firm's absorptive capacity. However, we depart from these previous studies in that we rely on two productivity measures (namely, labor productivity and total factor productivity), instead of innovative outcomes, to capture learning by exporting. On the one hand, innovation may not always manifest as increased productivity. On the other hand, the use of productivity may allow us to adequately capture the success of the firm in applying knowledge sourced overseas to productive ends. Given the relevance of productivity, in addition to innovation, for firm competitiveness our results may serve as a complement to those of Salomon & Jin's (2010) in explaining the several benefits accruing to firms from international sales, as well as in more deeply understanding the importance of absorptive capacity in knowledge sourcing abroad.

Using a sample of Spanish manufacturing firms for the period from 1990 to 2002, we empirically investigate these relationships. Our findings offer statistically significant support for our arguments, showing that learning by exporting takes place and that more technologically advanced firms benefit more from exporting than do less technologically advanced firms.

The remainder of the paper is structured as follows. Section 2 reviews the literature on learning by exporting, develops arguments and generates hypotheses. Section 3 describes the data, variables and methods. Section 4 presents empirical results. Section 5 discusses the results and offers conclusions.

2. Theory and hypothesis

There is abundant (macro)economic literature that has looked at the relationship between exports and home-country economic development. To some extent, there is a consensus that exports can be associated with high levels of growth in production and productivity (Aw & Hwang, 1995). For example, scholars argue that exports have a multiplying effect on investment and production.

From a microeconomic point of view, a literature on these issues has begun to emerge only relatively recently. Scholars have empirically studied how exports and productivity relate at the plant or firm level. Evidence shows that exporters perform better than non-exporters not only in terms of productivity but also in terms of size, survival, salaries, capital intensity and technological sophistication (Aw & Hwang, 1995; Aw, Chung, & Roberts, 2000; Bernard & Jensen, 1999; Bernard & Wagner, 1997; Delgado *et al.*, 2002). However, these findings may reflect either self-selection of the best firms in export markets or learning by exporting.

Self-selection implies that it is the most productive firms that become exporters. On the one hand, it is assumed that rivalry and competition in foreign markets are significantly greater than in the domestic market (Root, 1987). On the other hand, to overcome the liability of foreignness, exporters must face sunk costs, i.e., those associated with market research and adaptation of products to the preferences, tastes and/or legislation of the foreign market and the establishment of distribution channels (Roberts & Tybout, 1997), to sell their products abroad. Empirical evidence supports self-selection arguments (Aw & Hwang, 1995; Aw *et al.*, 2000; Bernard & Jensen, 1999; Bernard & Wagner, 1997; Clerides, Lach, & Tybout, 1998; Delgado *et al.*, 2002; Kox & Rojas-Ramagosa, 2010; Love & Mansury, 2009), reflecting that proprietary ownership advantages are necessary to be able to face competition in foreign markets (Dunning, 1977; Hymer, 1976).

More interesting from a strategy perspective is learning by exporting. Scholars have argued that exporters may benefit from knowledge spillovers in overseas markets, and thus they may learn from foreign operations (Root, 1987). Learning in international markets comes from repeated interaction and information exchange with foreign agents, i.e., competitors, distributors, intermediaries, customers and even customers' networks (Lafley & Charan, 2008; Lindstrand, Eriksson, & Sharma, 2009). By this interaction, exporters may be exposed to best practices (World Bank, 1997) and/or valuable knowledge not available to firms that operate only in their home market (Root, 1987; Denis & Depelteau, 1985). More specifically, firms may have access to two types of information in foreign markets: commercial and/or technological.

On the one hand, exporters may gain access to market information concerning customer preferences and/or substitutes for their products (Cooper & Edgett, 2009). For example, Prahalad (2005) shows how multinational firms often collaborate in product development with their customers in low-income countries (such as India or Mexico). By these close connections and frequent interactions firms are able to learn what customers in those countries expect from their products, which in turn allows multinationals to better meet those customers' needs. Moreover, products developed in this manner in low-income markets may afterwards be commercialized in high-income markets.

On the other hand, firms may obtain technological information abroad (Zahra, Ireland, & Hitt, 2000), including new or improved product designs and methods of production. For example, exporters may benefit from production advice embedded in product specifications (Kraay, 1999). Similarly, foreign buyers, in order to obtain cheaper, higher quality products, often provide their suppliers with product designs and technical assistance to help them upgrade their technology. Moreover, they might sometimes even transfer proprietary knowledge from some of their other national or international suppliers (World Bank, 1993).

The relevance of this information collected in foreign markets, particularly of technological nature, lies in the fact that firms may then incorporate it into its production process (Salomon & Shaver, 2005). In this vein, firms may apply this new knowledge to improve or upgrade their current production processes, or may even decide to adopt completely different new ones. For instance, firms may introduce more efficient technologies. Accordingly, increased productivity becomes an outcome of learning from exporting.

Consistent with these arguments, most studies so far have measured learning by exporting in terms of productivity improvements, a few of them having found consistent empirical evidence that learning by exporting takes place and that firms become more productive after exporting (Aw *et al.*, 2007, in Taiwan; Castellani, 2002, in Italy; Girma, Greenaway, & Kneller, 2004, in the United Kingdom; Kraay, 1999, in China). Some others have also found statistically significant support for the learning by exporting hypothesis, though using firm innovation indicators to capture learning (Salomon & Shaver, 2005; Salomon & Jin, 2008; 2010).

We depart from the latter studies in that we rely on productivity measures (specifically, labor productivity and total factor productivity) to proxy for learning from foreign agents. We argue that productivity may be an appropriate indicator of learning from exporting. First, learning in foreign markets may lead to technological development (Aw *et al.*, 2007; Hejazi & Safarian, 1999), which may in turn impact firm efficiency. Second, productivity improvements may reflect the success of the firm in the application of new knowledge to productive ends, i.e. they may be indicative of the ability of the firm to use knowledge in a meaningful way to improve its operations. And third, although one may expect innovation to ultimately manifest as increased productivity, improved labor productivity and/or total factor productivity are not necessarily indicative of innovation; there may be other drivers of firm efficiency. Thus, using productivity to proxy for learning by exporting may help us to more deeply understand the various benefits that firms may obtain from international sales and, therefore, may offer a complement to the findings of those studies that have used innovation outcomes in this respect.

Despite the growing scrutiny of firms' potential to learn from exporting, with a few notable exceptions (Aw *et al.*, 2007; Salomon & Jin, 2010), the impact of firm-specific characteristics in learning by exporting has been understudied in both the strategy and economics literatures. Although firms may learn from their foreign sales, we still know little about whether some firms stand to benefit more from exporting than others, and more importantly, we still do not understand much about the kinds of firm assets that matter the most when it comes to learning in foreign markets. Specifically, in this study we are interested in the role that the endowment of firm resources and capabilities play in shaping the relationship between exporting and productivity. This is a relevant issue; as Aw *et al.* (2007: 84) point out, "to understand […] the transmission of technology from abroad, it is necessary to understand the heterogeneity of firms' in-house capabilities to assimilate new information".

Our expectation is that not all exporters are equally suited to learn from their interactions with customers, competitors or intermediaries abroad, and that firms' technological capabilities may underlie these differences. Firms are heterogeneous in their resources and capabilities (Barney, 1991; Peteraf, 1993; Wernerfelt, 1984). Capability accumulation and development is a process that is subject to path dependence and mass efficiency (Dierickx & Cool, 1989). Mass efficiency affects the ability of the firm to generate new knowledge through the combination of old knowledge (Itami & Roehl, 1987). Thus, the generation and accumulation of new capabilities within the firm rests on the existence of a broad knowledge base. Moreover, absorptive capacity (Cohen & Levinthal, 1990) influences the development of capabilities, given that related knowledge is required to assimilate, integrate and use new knowledge.

Considering these arguments, we may expect knowledge spillovers to be contingent on a firm's ability to recognize the value of external knowledge (Cohen & Levinthal, 1990). Thus, firm-level investments in absorptive capacity will be positively related to knowledge spillovers in foreign markets because those investments are necessary to acquire external knowledge (Basant & Fikker, 1996; Cohen & Levinthal, 1990; Griffith, Redding, & Reenan, 2004). Therefore, firms with greater absorptive capacity will be better suited to learn from foreign agents and to integrate the obtained knowledge into their operations (Lafley & Charan, 2008).

Research and development (R&D) investments have been used to proxy for firms' technological and intangible capabilities (Caves, 1996; Chung & Alcácer, 2002). In fact, Cohen & Levinthal (1990: 129) contend that "absorptive capacity may be created as a by-product of R&D investments". In the same vein, Griffith *et al.* (2004) highlight the role of R&D on promoting absorptive capacity. In fact, some knowledge may only be acquired by engaging in active research in that specific field (Freeman, 1982). Thus, one's own R&D investments facilitate the understanding of others' discoveries and play a key role in the assimilation and absorption of new technologies. Jaffe (1986) provides empirical support for this idea, by showing that the impact of other firm's R&D investments on the focal firm's innovation and profits (that is, R&D spillovers) is greater for those firms that make larger investments in their own R&D. Similarly, Klette (1996) finds evidence of higher productivity growth in those Norwegian manufacturing plants that invested in R&D in the past.

In other words, R&D investments improve a firm's ability to assimilate, combine and use existing and new knowledge (Cohen & Levinthal, 1989). As Castellani & Zanfei (2007: 161) point out, "[t]he international generation of knowledge requires extensive R&D efforts to be carried out internally, but also contacts and collaborations with external parties possessing localized knowledge. Ex-ante advantages, resulting from a firm's history of technological accumulation, will provide […] abilities to absorb external complementary knowledge, wherever this may be available."

As already discussed, much of the knowledge that firms may obtain in foreign markets is technology-related -for instance, concerning new or improved product designs and/or production methods (Aw *et al.*, 2007). The existence of a broad knowledge base within the firm, particularly of related knowledge, certainly influences its ability to identify, assimilate, integrate and use new knowledge (Cohen & Levinthal, 1990). Thus, when confronted with new technological knowledge, a firm that invests heavily in R&D may be better able to discern its potential usefulness, to combine it with its current knowledge and to apply it in its own operations.

Additionally, according to Cohen & Levinthal (1990: 140), "a more difficult learning environment increases the marginal effect of R&D on absorptive capacity". It is reasonable to think that foreign markets represent more difficult competitive environments for firms than their domestic markets. Linguistic, cultural and/or institutional differences are substantially greater in foreign countries than within the firm's home country, imposing an important barrier for exporters' operations and their possibilities for learning overseas. Thus, R&D investments may play an even more important role in knowledge sourcing in an international context.

Therefore, we argue that learning by exporting may be contingent on a firm's previous R&D investments (Aw *et al.*, 2007). We expect firms that are investing intensively in R&D to benefit more from exporting than other firms that are investing less intensively in R&D. Accordingly, we propose the following hypothesis:

H1: Firms investing in R&D at a rate above their industry average will learn more from exporting than will firms investing in R&D at a rate below their industry average.

3. Data and methods

3.1. Sample

To test our hypothesis, we use the Encuesta sobre Estrategias Empresariales (Survey on Business Strategies; ESEE) data. The ESEE contains primary data from a yearly survey conducted by the Fundación SEPI (National Bureau of Industrial Activity Foundation) with the support of the Spanish Ministry of Industry. The survey was designed to gather data from a representative sample (by size and industry) of the population of manufacturing firms in Spain.

In the initial survey year (1990), the ESEE included information on 2,188 firms. We were able to gather data from 1990 to 2002. Throughout these 13 years some firms have quitted participating in the survey for various reasons. However, a representative sample of newly created firms in Spain from 1991 onwards has been included in the ESEE on a yearly basis. Therefore, due to these dynamics, our initial sample consists of an unbalanced panel of 3,462 firms from 1990 to 2002.

We complemented the ESEE data with data from the OECD Foreign Direct Investment Statistics (FDIS) database. The FDIS gathers annual, industry-level data on the FDI inflows for 30 OECD member states. These data is not available in the ESEE and it is important in our estimations given that we include inward FDI flows received in Spain as a control variable in our regressions. In order to combine both datasets (ESEE and FDIS) consistently, we had to remove all firms in the sample that belong to industries for which we could not find an exact match between the ESEE and the FDIS data (i.e., firms in the "non-metallic products" and "miscellaneous manufacturing" industries).

Additionally, from our initial sample we removed all firms that reported engaging in FDI, either in production plants or in non-industrial facilities (e.g., design centers). These firms may have access to foreign knowledge and information exchange directly through their subsidiaries abroad, and we do not want to erroneously attribute to learning by exporting results pertaining to learning by FDI.[1]

Finally, we lose additional data for several firms given the restrictions imposed by our statistical method (described in more detail below) and due to missing data for some variables. Therefore, our final usable sample is reduced to 1,534 firms and 6,597 firm-year observations.

Table 1 presents the industry breakdown and some descriptive statistics for the firms in our final sample.

*** Insert Table 1 about here ***

The highest proportion of firms in our final sample is in the food and tobacco, textiles and metallic products industries. According to Salomon & Jin (2008), Spain is not a relative technological leader in any of these industries. In terms of size distribution, our final usable sample is primarily comprised of medium-sized firms. Only in the beverages, chemical products, metallurgy, automobiles and motors and other transport material industries do firms employ, on average, 250 employees or more. This is the threshold commonly used to separate large from small and medium-sized firms (SMEs). As recent official statistics show, SMEs represent more than 99 % of firms not only in Spain, but also in the EU (European Union, 2011a).

In respect to some of the variables of interest in this study, Table 1 also shows that the firms in our sample dedicate a relatively low percentage of their total sales to export markets, with an average export intensity of roughly 17 %. Similarly, with a few exceptions, these

[1] Because the number of firms from the sample engaging in FDI was rather small, our results did not change when we included these firms in our analysis.

firms do not invest heavily in R&D, which is consistent with the fact that R&D expenditures in Spain are way below the EU-average (European Union, 2011b). Relatedly, the number of employees fully dedicated to R&D activities in these firms is rather small. Nevertheless, it must be noted that those firms investing in R&D above their industry average employ a much larger number of people in their R&D departments than those firms investing in R&D below their industry average (an average of 15.35 employees in the former vs. an average of 2.51 employees in the later).

3.2. Dependent variables

In this study we look at the impact of exports on firm productivity. We use two measures of productivity: Value added per employee and total factor productivity (TFP). These two measures have been extensively used in the literature (Bernard & Jensen, 1999; Caves, Christensen, & Diewert, 1982; Castellani & Zanfei, 2007; Girma *et al.*, 2004).

Value added per employee in a given year, which is a proxy of labor productivity, is defined as a firm's gross margins divided by the number of employees.

To estimate total factor productivity, we used a modified Cobb-Douglas production function. Following Hall (1993), we estimated a firm fixed-effects regression of labor, physical capital, and intermediate inputs on production output, including year dummies. Production output, physical capital and intermediate inputs were deflated by the Spanish consumer price index. We capture each firm's residual as a proxy for TFP (Chung, Mitchell, & Yeung, 2003; Fariñas & Martín-Marcos, 2007).

3.3. Independent variable

Our independent variable is labeled export status. As commonly defined in the literature, this is a dummy variable taking the value of 1 if the firm exports in a given year and 0 otherwise.

Because it may take time for learning to filter back to and be applied by the focal firm in its operations, we lag our export variable. Based on the size of our panel and previous studies, we use lags of one, two, and three years for our independent variable (Bernard & Jensen, 1999; Salomon & Jin, 2008, 2010; Salomon & Shaver, 2005).

3.4. Control variables

In addition to our independent variable, we control for other factors that could systematically affect labor and total factor productivity.

First, empirical evidence has shown substantial and persistent productivity differences between small and large enterprises (Taymaz, 2005). Researchers have long suggested that larger firms tend to perform better and to be more efficient than smaller companies (Caves & Barton, 1990; Álvarez & Crespí, 2003). Among other reasons, economies of scale in production favor large over small companies. Therefore, we may expect firm size to be positively related to our two measures of productivity. Thus, we control for any potential size effect, defining the variable firm size as the natural log of total employees of a focal firm in a given year.

Second, we control for the potential impact of a firm's intangible capabilities, such as marketing, on its productivity. Advertisement investments help a firm to differentiate its products and build a strong reputation, which will increase a firm's bargaining power with customers and intermediaries, thus improving its efficiency (Levitt, 1983). We therefore include advertising intensity (advertising expenditures divided by total sales) in our specifications.

Third, there is a body of literature (predominantly in economics) that has looked at the impact of inward foreign direct investment on local firms (e.g., Buckley, Wang, & Clegg, 2007). Some scholars argue (and find evidence) that inward FDI may generate positive externalities in host economies, either through knowledge spillovers or through a competition effect (e.g., Alcácer & Chung, 2007; Blomström & Kokko, 1998; Caves, 1974; Chung *et al.*, 2003, Dunning, 1958). However, competition from (better-endowed) foreign entrants may also result in detrimental consequences for local players (Haddad & Harrison, 1993; Konings, 2001; Spencer, 2008). Regardless of whether this influence is positive or negative, we control for inward FDI using two complementary measures: industry-level inward FDI and firm-level inward FDI. We define the variable FDI into industry as the total amount of FDI inflows to a given industry in a given year, expressed in millions of Euros. The variable FDI into firm captures the percentage of capital owned by foreign investors in the focal Spanish firm in a given year.

Fourth, industry structure may have an impact on the pressure firms face to be more productive. However, it remains unclear whether it is oligopolistic/monopolistic or competitive market structures that exert a greater pressure for firms to be more competitive. Regardless, we control for industry concentration. Following prior literature, we define industry concentration as the four-firm concentration ratio in the focal firm's primary market.

Fifth, it is plausible that firms that export more regularly will have more chances to interact frequently and repeatedly with foreign agents. Thus, we expect regular exporters to learn more from exporting than occasional exporters. Accordingly, we include an additional control variable labeled regular exporter that indicates a firm's turnover from export sales for the past four years (the current year and the three previous years).

Finally, for reasons unobserved by the authors, productivity might vary from industry to industry, with macro-level changes in the economic environment, and over time. We therefore include fixed-year and industry effects (year and industry dummies) in each specification.

3.5. Moderation effects

In this paper we are interested in determining whether firm's technological capabilities moderate the relationship between export status and firm productivity. We argue that technologically more advanced firms stand to learn more from exporting than their technologically less advanced counterparts.

Similarly to Salomon & Jin (2008, 2010), we rely on relative R&D intensity to identify more and less technologically endowed firms. That is, we compare the focal firm's R&D intensity to the average R&D intensity of all firms in its industry. As is common practice in the literature, we define R&D intensity as the R&D expenditures of firm *i* at time *t,* divided by its sales at time *t.* We then calculate the average R&D intensity for all firms in industry *j*. Finally, we build a new variable to compare a given firm's R&D intensity to its industry average; we subtract the average R&D intensity for industry *j* at time *t* from the R&D intensity of firm *i* from industry *j* at time *t.*

This relative R&D measure serves as an indicator of the firm's technological standing compared to the average firm within the same industry in Spain[2]. Considering that most of the interactions overseas in which knowledge may be sourced take place with firms, customers, intermediaries, etc. within the firm's industry, what is relevant in this respect is how the firm's technological capabilities compare to those of the other firms in its industry. According to our arguments on the role of absorptive capacity, a firm would need to have a comparable or even superior knowledge base than its counterparts in the same industry to be able to identify relevant knowledge, integrate it with its current knowledge base and apply it to its operations.

To assess moderation effects, we split our sample in two, based on our relative R&D intensity variable. Consistent with our arguments above, positive (or zero) values of this

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[2] Kox & Rojas-Ramagosa (2010) follow a similar approach to assess the potential impact of destination country in learning by exporting. They build an industry-level labor productivity international frontier and then calculate the relative gap of several Dutch industries compared to the respective frontier country.

variable indicate that the firm is a technological leader in its industry, whereas negative values indicate that the firm is a technological laggard in its industry. We then run separate regressions for the two sub-samples. To compare coefficients of our variable of interest (export status) across samples, we run t-tests after regressions.

Aside from its moderation effect, we assess the direct impact of R&D intensity on productivity. As already argued, R&D investments may allow a firm to improve its manufacturing processes, thus achieving efficiency in its operations (Hitt, Hoskisson, & Ireland, 1994). Accordingly, scholars have recognized that the accumulation of technological capabilities is an important source of productivity advantages (Castellani & Zanfei, 2007). Therefore, we include R&D intensity (R&D expenditures divided by total sales) in our specifications.

3.6. Statistical method

Our two dependent variables, i.e., value added per employee and total factor productivity, are continuous measures. Thus, we run linear OLS models.

Given the panel structure of our data with several observations per firm, we are concerned with serial correlation. If residuals (ε_{it}) across observations within firms are not independent, our regression results may be spurious.

We may also find spurious correlations between past exports and current productivity in the presence of unobserved firm characteristics (e. g. managerial capability) that simultaneously determine both productivity and exporting. For example, some firms may have proactive, talented, energetic and/or skilled managers that not only actively pursue opportunities in foreign markets, but are also active in running efficient operations; however, some other firms may have more conservative and less skilled managers that prefer to focus on the domestic market and are reluctant to introduce new technologies that might result in efficiency gains. If this should be the case, a positive correlation between past export activity and current productivity may not be attributed to learning by exporting.

Finally, endogeneity may also affect regression results. Given evidence in the literature showing that the most productive firms self-select into the export markets, it is necessary to account for the possibility that previous values of our dependent variables (labor and total factor productivity) are associated with export propensity.

We therefore use a dynamic longitudinal model. Following Salomon & Jin (2008, 2010), we incorporate an AR autoregressive process that includes lagged values of the dependent variable as regressors (see Alzaid & Al-Osh, 1990).[3] The inclusion of firm dynamics (1) reduces the potential for serial correlation of the errors; (2) allows for a dynamic firm-specific component; and (3) controls for the possible endogeneity of exporting (Cameron & Trivedi, 1998; Greene, 2003). To remain consistent with the 3-year lag structure we use for our independent variable (export status), we incorporate three lags of the dependent variable into every specification. We estimate the model expressed in equation (1):

$$Y_{it} = \alpha + \lambda \cdot Y_{it-n} + \beta_1 \cdot X_{it-n} + \beta_2 \cdot W_{it} + \beta_3 \cdot T_t + \beta_4 \cdot I_t + \varepsilon_{it}\text{, n = 1, 2, 3} \qquad (1),$$

where Y_{it-n} represents our productivity measures (value added or TFP) for firm *i* at time *t-n*, $X_{i,t-n}$ captures export status for firm *i* at time *t-n*, W_{it} is a vector of control variables, T_t is a set of time dummies, I_t is a set of industry dummies and ε_{it} is the individual unobserved error term.

[3] For continuous dependent variables, researchers have proposed the autoregressive model that includes exogenous regressors and lagged dependent variables as a method of controlling for firm-specific effects (see Greene, 2003). Instead of the traditional AR(1) model, we apply a *p*th-order autoregressive structure (AR(p)) process. We apply the AR(3) process to our linear regression model.

4. Results

4.1. Correlations and descriptives

Table 2 presents descriptive statistics for, and correlations among, the variables used in this study.

*** Insert Table 2 about here ***

Regarding our dependent and independent variables, we find that export status is positively correlated with our two productivity dependent variables: value added per employee and total factor productivity. Although this correlation may be indicative of positive externalities from exporting, correlations neither consider the temporal relationships among the variables nor control for other intervening effects. Thus, we turn to multivariate regression analysis, where we can control for these effects and better capture the relationships among the variables.

4. 2. Regression results

Table 3 presents the results of the linear regression with value added per employee as the dependent variable.

*** Insert Table 3 about here ***

Columns 1 through 4 present results for the subsample of firms that spend more in R&D than the average firm in their industry, whereas columns 5 through 8 present results for the subsample of firms investing less in R&D than the average firm in their industry. Columns 1 and 5 present the base model, including control variables only. The independent variable lagged one, two and three periods is respectively introduced in columns 2 and 6, 3 and 7, and 4 and 8.

For both sets of firms, all three lags of value added per employee have a positive and significant effect on contemporaneous value added per employee, suggesting persistence in labor productivity; that is, the most productive firms remain more productive in the following years. For the control variables, we find that inward FDI into a firm's industry does not significantly impact value added per employee, whereas FDI into the firm positively and significantly influences labor productivity.

For the rest of the control variables, the effects are mixed for the two sets of firms. Industry concentration is positive and significantly related to value added per employee, but only for low R&D investors. A similar effect is noted for the regular exporter variable, suggesting that regular exporters learn more from exporting than do occasional exporters. However, the influence of advertising intensity is negative and significant, but in this case only for the group of high R&D investors. The same happens for the direct effect of R&D intensity on productivity. Given the theoretical arguments in the literature, the negative sign of these coefficients is somewhat surprising. The lag structure that we use may underlie these effects. Although we measure the contemporaneous effect on firm productivity of both R&D and advertising intensity, it may take longer for firms to realize efficiency gains derived from their investments in intangibles. If this should be the case, we will not observe a positive effect of R&D and advertising expenditures in the short term[4].

Regarding our hypothesis, for both sets of firms we find that export status is positive and significantly related to subsequent firm labor productivity in all specifications ($p<.05$ in all specifications for the group of high R&D investors and $p<.01$ in all specifications for the group of low R&D investors). These results are consistent with learning by exporting arguments, suggesting that firms may stand to benefit from knowledge spillovers in foreign markets. If we look at the coefficients for the export variable in the two subsamples, we see that these coefficients are much larger for the group of technologically leading firms than for

[4] We have rerun our models including one-year lags of R&D and advertising intensities instead of the contemporaneous values. As of advertising intensity, results do not vary much when value added per employee is used as the dependent variable. However, they do change for TFP. For the group of high R&D investors, the negative coefficients of lagged advertising intensity now turn non-significant; for the group of low R&D investors coefficients remain positive, but they now become significant ($p<.01$). In the case of R&D intensity, substituting the contemporaneous value for the one-year lag notably alters the sign of the coefficients. The effect of lagged R&D intensity on productivity is positive for both groups, albeit non-significant. These results are available from the authors upon request.

the group of technologically lagging firms. We run t-tests to compare those coefficients and find that the differences are significant ($p<.01$), which indicates that the firms that invest more heavily in R&D benefit more from exporting than do the firms that invest less in R&D than the average firm in their industry.

Table 4 presents the results of the linear regression with total factor productivity as the dependent variable.

*** Insert Table 4 about here ***

Similarly to labor productivity, the results show persistence in TFP. For the control variables, the results are consistent with those presented for labor productivity with the exception of firm size, which is positive and significantly related to TFP, although now these results apply to both the technologically leading and lagging firms.

Regarding our hypothesis, we find that export status is positively related to subsequent firm total factor productivity, although now this is true only for the technological leaders and when a one-year lag of the independent variable is considered. Aside from the potential for learning by exporting, these results also suggest that more recent knowledge obtained abroad will be more valuable for firm current operations. Again, t-tests confirm that coefficients for the export variable are also significantly larger for the technological leaders than for the technological laggards.

Taken together, the results from Tables 3 and 4 suggest that selling in foreign markets may be beneficial for firm productivity. These findings hint at the potential for learning by exporting. Additionally, our results also suggest that firms' R&D investments play an important role in knowledge sourcing in foreign markets. It seems that technologically advanced firms will stand to benefit more from knowledge spillovers abroad than will technologically weak firms. Thus, our results hint at the relevance that the firm's absorptive capacity may have to source knowledge abroad; also, our results suggest that a critical mass of technological expertise will lead to greater learning outcomes. This evidence is consistent with previous findings in the literature. For example, Aw *et al.* (2007) found that Taiwanese firms that simultaneously export and invest in R&D and/or worker training show higher productivity than firms that only export or only invest in R&D/worker training.

In sum, our findings offer statistically significant support for our arguments and hypothesis.

5. Discussion and conclusions

In this study we have assessed whether firms' capabilities endowment is relevant in learning from exporting and have analyzed whether some firms are better suited than others to source knowledge from their interactions with foreign agents. Specifically, we have focused on how a firm's technological capabilities (proxied by its relative R&D expenditures) moderate the relationship between exporting and the firm's labor and total factor productivity.

In general, we find that export status is positively related to firm productivity, particularly labor productivity, which we interpret as evidence of learning by exporting. This is consistent with recent findings in the literature (e.g., Aw *et al.*, 2007; Castellani, 2002). Additionally, and more interestingly, our results suggest that not all firms benefit equally from foreign sales and that firms' technological capabilities play an important role in explaining these differences. Firms that invest in R&D more than the average firm in their industry tend to experience higher increments in productivity after exporting than those others that invest less in R&D than the average firm in their industry. Thus, it seems that the technological leaders in a given industry are better suited to benefit more from exporting than are the technological laggards in that industry. This evidence is consistent with arguments that hint at the importance of absorptive capacity for a firm to acquire advanced knowledge (Cohen & Levinthal, 1990). Although firms may gain access to knowledge from several agents (e.g., competitors, customers, intermediaries) in foreign markets, our findings support the idea that firms need a critical mass of previous technological knowledge and expertise to recognize the value of external knowledge, integrate it into their current operations and fully realize its potential benefits. Our findings complement those of Salomon & Jin (2010), showing that R&D investments may not only improve the ability of exporters to apply foreign knowledge to innovative purposes but may also provide those firms with productivity advantages derived from learning by exporting. Understanding the influence of firm-specific characteristics in the impact of exporting on productivity, and not only on innovation, aids our understanding on the diversity of benefits derived from international sales and on the importance of the firms' R&D investments to fully realize those potential benefits.

The findings from this study hold important implications for policymakers and managers. For policymakers, our findings indicate that exporting may positively impact firm productivity. Governments have extensively implemented programs to help domestic firms expand abroad under the assumption that exporting will help national firms to enhance their competitiveness (see World Bank, 1993; 1997). Our results support the implementation of these kinds of policies. However, policymakers should also take into consideration that firm heterogeneity in the endowment of resources and capabilities matter; as a consequence, not all firms stand to benefit equally from foreign sales.

For managers, the implications from our findings are twofold. On the one hand, our results suggest that knowledge spillovers take place in foreign markets and that this knowledge may help firms to improve their efficiency. Thus, firms may consider exporting as a way to increase their competitiveness. On the other hand, our findings indicate that not all firms are equally prepared to fully realize the benefits of these spillovers. Firm technological capabilities may underlie these differences, as the more technologically advanced firms benefit the most from exporting. Thus, if a firm wants to learn from exporting, it is important that firm managers be aware of their own capabilities and that, when needed, they plan their investments in R&D accordingly.

We acknowledge that our study is not free of limitations. Our findings are limited to the Spanish manufacturing context. It would be interesting to examine these relationships in different contexts to be able to account for industry- and/or country-specific heterogeneity.

We also acknowledge that the potential for learning by exporting may vary across countries. Given that Spain is a developed but middle-income country (Campa & Guillén, 1999), Spanish firms may learn more from exporting to more developed foreign markets than from exporting to less developed countries. However, we cannot control for host country heterogeneity due to data unavailability.

For these reasons, we are cautious about generalizing our findings. However, limitations notwithstanding, this study stands to contribute to the fields of international business and strategy.

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Table 1. Industry breakdown of the sample (1990-2002)

Industry	Percentage of Firms	Avg. Employees	Avg. R&D Intensity (%)	Avg. Export Intensity (%)
1. Meat products	2.95	112.69	0.07	5.31
2. Food and tobacco	11.13	147.65	0.22	9.94
3. Beverages	2.29	271.11	0.12	4.95
4. Textiles	12.45	122.68	0.40	12.60
5. Leather and footwear	3.91	32.12	0.36	18.62
6. Wood	2.77	57.47	0.04	5.32
7. Paper	2.41	153.43	0.39	16.28
8. Editing and graphic arts	5.42	84.98	0.09	3.76
9. Chemical products	7.64	252.47	1.92	17.94
10. Rubber and plastic products	5.54	172	0.40	15.59
11. Metallurgy	3.01	255.27	0.49	26.86
12. Metallic products	10.29	103.95	0.31	14.27
13. Machinery and mechanical	8.30	171.32	0.99	22.33
14. Office products, data, and optical	2.23	214.08	2.20	27.95
15. Electronic and electrical machinery	6.80	237.59	1.93	23.46
16. Automobiles and motors	4.81	588.34	1.21	34.95
17. Other transport material	2.23	576.04	1.64	31.78
18. Furniture	5.84	81.35	0.20	9.67
Full sample	100.00	172	0.72	16.75

Table 2. Descriptive statistics and correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. TFP $_{(t)}$	1																	
2. TFP $_{(t-1)}$	0.88	1																
3. TFP $_{(t-2)}$	0.84	0.86	1															
4. TFP $_{(t-3)}$	0.80	0.82	0.84	1														
5. Value added $_{(t)}$	0.70	0.60	0.57	0.55	1													
6. Value added $_{(t-1)}$	0.21	0.28	0.20	0.19	0.25	1												
7. Value added $_{(t-2)}$	0.58	0.60	0.71	0.59	0.70	0.24	1											
8. Value added $_{(t-3)}$	0.54	0.55	0.56	0.70	0.63	0.21	0.72	1										
9. Export status $_{(t-1)}$	0.43	0.42	0.41	0.40	0.28	0.10	0.28	0.26	1									
10. Export status $_{(t-2)}$	0.42	0.42	0.41	0.40	0.28	0.10	0.28	0.26	0.87	1								
11. Export status $_{(t-3)}$	0.42	0.42	0.41	0.40	0.27	0.10	0.27	0.26	0.80	0.86	1							
12. FDI into industry $_{(t)}$	0.11	0.10	0.09	0.09	0.09	0.02	0.08	0.07	0.03	0.04	0.03	1						
13. FDI into firm $_{(t)}$	0.46	0.45	0.44	0.43	0.33	0.10	0.32	0.29	0.35	0.35	0.36	0.09	1					
14. Industry concentration $_{(t)}$	0.33	0.33	0.32	0.31	0.26	0.09	0.26	0.25	0.21	0.21	0.21	0.04	0.26	1				
15. R&D intensity $_{(t)}$	0.15	0.17	0.16	0.17	0.09	0.03	0.11	0.11	0.18	0.19	0.18	0.08	0.08	0.08	1			
16. Advertising intensity $_{(t)}$	0.21	0.22	0.23	0.22	0.20	0.07	0.23	0.22	0.17	0.17	0.17	0.16	0.11	0.10	0.11	1		
17. Firm size $_{(t)}$	0.73	0.73	0.71	0.70	0.35	0.14	0.37	0.35	0.53	0.53	0.54	0.09	0.50	0.33	0.22	0.22	1	
18. Regular exporter $_{(t)}$	0.28	0.28	0.27	0.26	0.18	0.06	0.19	0.17	0.15	0.16	0.16	0.00	0.23	0.08	0.06	-0.01	0.33	1
Mean	0.01	0.00	0.00	0.00	5.78	5.68	5.27	5.04	0.58	0.56	0.54	146.80	17.95	0.32	0.01	0.01	4.11	5,237,682
s.d.	0.33	0.33	0.33	0.33	4.48	12.72	3.82	3.76	0.49	0.50	0.50	268.68	36.79	0.36	0.02	0.03	1.48	28,700,000
Min.	-1.17	-2.37	-2.37	-1.56	0.00	0.02	0.01	0.01	0	0	0	-1176	0	0	0	0	0	0
Max.	1.65	1.65	1.65	1.65	122.26	984.28	48.22	48.22	1	1	1	1176	100	1	0.40	0.47	9.01	714,000,000

Table 3. OLS regressions [Dependent variable: Value added per employee $_{(t)}$]

Variable	High R&D investors				Low R&D investors			
	1	2	3	4	5	6	7	8
Export status $_{(t-1)}$		0.627336** (2.55)				0.342784*** (3.79) [41.36***]		
Export status $_{(t-2)}$			0.576384** (2.38)				0.328362*** (3.63) [36.63***]	
Export status $_{(t-3)}$				0.507693** (2.19)				0.298826*** (3.27) [32.21***]
Value added $_{(t-1)}$	0.006173** (2.16)	0.006085** (2.13)	0.006071** (2.12)	0.006109** (2.14)	0.559938*** (35.63)	0.558230*** (35.55)	0.558955*** (35.60)	0.558893*** (35.59)
Value added $_{(t-2)}$	0.412752*** (16.56)	0.411171*** (16.53)	0.412518*** (16.58)	0.411375*** (16.52)	0.242970*** (13.33)	0.240606*** (13.21)	0.239959*** (13.17)	0.241273*** (13.25)
Value added $_{(t-3)}$	0.244845*** (10.08)	0.242237*** (9.99)	0.242389*** (9.99)	0.244729*** (10.09)	0.128459*** (7.87)	0.127976*** (7.85)	0.128136 (7.86)	0.127619*** (7.83)
FDI into industry $_{(t)}$	0.000223 (0.62)	0.000223 (0.62)	0.000208 (0.58)	0.000210 (0.59)	-0.000022 (-0.10)	-0.000030 (-0.14)	-0.000031 (-0.15)	-0.000027 (-0.13)
FDI into firm $_{(t)}$	0.010440*** (5.08)	0.010032*** (4.87)	0.010002*** (4.85)	0.010073*** (4.89)	0.005399*** (3.95)	0.004890*** (3.56)	0.004876*** (3.55)	0.004886*** (3.55)
Industry concentration $_{(t)}$	0.233722 (0.93)	0.212681 (0.85)	0.226205 (0.90)	0.211951 (0.85)	0.261544** (2.25)	0.252802** (2.18)	0.253918** (2.19)	0.255588** (2.20)
R&D intensity $_{(t)}$	-4.176243* (-1.71)	-4.331005* (-1.78)	-4.302164* (-1.77)	-4.017104* (-1.65)	-1.459499 (-0.15)	-2.928598 (-0.30)	-2.759807 (-0.28)	-2.639417 (-0.27)
Advertising intensity $_{(t)}$	-8.977878*** (-3.63)	-9.407738*** (-3.80)	-9.435430*** (-3.81)	-9.489152*** (-3.83)	0.668945 (0.45)	0.318108 (0.21)	0.307908 (0.21)	0.346217 (0.23)
Firm size (ln) $_{(t)}$	0.244614*** (3.28)	0.196708** (2.57)	0.197879** (2.57)	0.204734*** (2.67)	-0.016079 (-0.45)	-0.065663* (-1.73)	-0.063151* (-1.66)	-0.059655 (-1.56)
Regular exporter $_{(t)}$	0.00000000122 (0.62)	0.00000000134 (0.69)	0.00000000132 (0.67)	0.00000000131 (0.67)	0.00000000276 (1.55)	0.00000000305* (1.71)	0.00000000299* (1.68)	0.00000000296* (1.66)
Year effects	Included	Included	Included	Included	Included	Included	Included	Included
Industry effects	Included	Included	Included	Included	Included	Included	Included	Included
Constant	1.275019** (2.42)	1.071862** (2.02)	1.104935** (2.09)	1.138759** (2.15)	0.458454** (2.25)	0.501180** (2.46)	0.503216** (2.47)	0.506836** (2.49)
N	1,323	1,323	1,323	1,323	5,274	5,274	5,274	5,274
F-test	52.18***	51.05***	51.00**	50.94***	269.61***	262.77***	262.68***	262.48***
R squared	0.5719	0.5741	0.5738	0.5735	0.6293	0.6304	0.6303	0.6301

*: p<.10; **: p<.05; ***: p<.01 (Two-tailed tests)

t-statistics appear in (parentheses); t-tests from model 2 to model 6, model 3 to model 7, and model 4 to model 8 appear in [brackets]

Table 4. OLS regressions [Dependent variable: Total factor productivity $_{(t)}$]

Variable	High R&D investors				Low R&D investors			
	1	2	3	4	5	6	7	8
Export status $_{(t-1)}$		0.019404* (1.80)				0.007943 (1.63) [37.80***]		
Export status $_{(t-2)}$			0.009930 (0.94)				0.004975 (1.02) [16.57***]	
Export status $_{(t-3)}$				0.007209 (0.71)				0.003031 (0.62) [14.58***]
TFP $_{(t-1)}$	0.407251*** (15.80)	0.405226*** (15.72)	0.405778*** (15.72)	0.406333*** (15.75)	0.484040*** (36.87)	0.483646*** (36.84)	0.483903*** (36.86)	0.484030*** (36.86)
TFP $_{(t-2)}$	0.202893*** (7.37)	0.202734*** (7.37)	0.203448*** (7.39)	0.203227*** (7.38)	0.206182*** (15.31)	0.205776*** (15.28)	0.205966*** (15.29)	0.206098*** (15.30)
TFP $_{(t-3)}$	0.125200*** (5.55)	0.124834*** (5.54)	0.125084*** (5.55)	0.125353*** (5.56)	0.131504*** (10.69)	0.131584*** (10.70)	0.131452*** (10.68)	0.131420*** (10.68)
FDI into industry $_{(t)}$	0.000002 (0.14)	0.000002 (0.15)	0.000002 (0.13)	0.000002 (0.13)	0.000010 (0.95)	0.000010 (0.93)	0.000011 (0.93)	0.000011 (0.94)
FDI into firm $_{(t)}$	0.000341*** (3.77)	0.000328*** (3.63)	0.000333*** (3.68)	0.000335*** (3.70)	0.000206*** (2.83)	0.000193*** (2.63)	0.000198*** (2.69)	0.000201*** (2.73)
Industry concentration $_{(t)}$	0.004719 (0.43)	0.004054 (0.37)	0.004586 (0.42)	0.004397 (0.40)	0.017334*** (2.78)	0.017044*** (2.74)	0.017164*** (2.76)	0.017239*** (2.77)
R&D intensity $_{(t)}$	-0.598757*** (-5.61)	-0.604069*** (-5.67)	-0.601056*** (-5.63)	-0.596521*** (-5.59)	-0.079383 (-0.15)	-0.113970 (-0.22)	-0.099402 (-0.19)	-0.091507 (-0.76)
Advertising intensity $_{(t)}$	-0.243920** (-2.26)	-0.257409** (-2.38)	-0.251957** (-2.32)	-0.251307** (-2.31)	0.026591 (0.34)	0.017080 (0.22)	0.020230 (0.25)	0.022783 (0.29)
Firm size (ln) $_{(t)}$	0.040704*** (9.43)	0.039496*** (9.05)	0.040012*** (9.14)	0.040188*** (9.18)	0.024723*** (10.63)	0.023623*** (9.75)	0.024035*** (9.92)	0.024289*** (9.99)
Regular exporter $_{(t)}$	0.0000000000507 (0.59)	0.0000000000547 (0.64)	0.0000000000527 (0.62)	0.0000000000519 (0.61)	0.000000000194** (2.02)	0.0000000002** (2.09)	0.000000000197** (2.05)	0.000000000196** (2.04)
Year effects	Included	Included	Included	Included	Included	Included	Included	Included
Industry effects	Included	Included	Included	Included	Included	Included	Included	Included
Constant	-0.182708*** (-7.19)	-0.190912*** (-7.41)	-0.186399*** (-7.25)	-0.184984*** (-7.22)	-0.121866*** (-9.82)	-0.121596*** (-9.80)	-0.121604*** (-9.80)	-0.121579*** (-9.79)
N	1,323	1,323	1,323	1,323	5,274	5,274	5,274	5,274
F-test	170.14***	165.52***	165.14***	165.09***	634.64***	616.25***	616.01***	615.91***
R squared	0.8133	0.8138	0.8134	0.8134	0.7999	0.8000	0.7999	0.7999

*: p<.10; **: p<.05; ***: p<.01 (Two-tailed tests)
t-statistics appear in (parentheses); t-tests from model 2 to model 6, model 3 to model 7, and model 4 to model 8 appear in [brackets]