More Than an Export Decision – How Export Induced Investments in R&D and Marketing Pay off

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ABSTRACT

Decisions on entering foreign markets are among the most challenging but also potentially rewarding strategy choices managers can make. However, existing literature is fragmented in explaining which investments are induced by export decisions and how they pay off. Based on a review of existing theory, we examine changes in R&D and marketing investment patterns that accompany export decisions and link these changes to performance in the post entry period. We distinguish between export-induced investments that occur ex-ante and ex-post to exporting. Our results show that both R&D and marketing investments are induced by export decisions. However, predominantly the marketing investments induced by export decisions increase firm performance.

Keywords: Exports and firm performance; learning-by-exporting; productivity

1. Introduction

The vast majority of firms interacts with foreign markets through exporting (Salomon and Shaver 2005). Exports enable firms to extend their product markets beyond national boundaries and often times lead to broader international engagements in the future. Therefore, export decisions and their consequences are of central importance to management theory and practice (Johanson and Vahlne 1977, Campa and Guillén 1999). However, our current understanding of strategic choices providing firms with the most performance potentials in export markets remains fragmented. Existing international economics literature has postulated that ex-ante more productive firms will self-select into exporting and uncovered some of the sources of these ex-ante productivity advantages, but merely speculated about ex-post performance benefits realized in the post-entry period (Bernard, Jensen et al. 2007). International strategy and business literature emphasizes benefits in terms of innovation performance when exporting (Salomon and Shaver 2005, Salomon and Jin 2008, Salomon and Jin 2010, Golovko and Valentini 2014), while marketing literature has almost exclusively focused on export marketing investments as a key to export success (Anderson 1960, Cavusgil, Zou et al. 1993, Wan, Luk et al. 2014).

The goal of our study is to overcome this fragmentation and provide a comparative framework of changes in the investment patterns of firms that are triggered by the decision to export. We focus on export-induced R&D and marketing investments and subsequently relate them to firm performance. Hence, we envision a broad choice set of firms who can accompany their export decisions with increased R&D and/or marketing investments. Within this broad choice set, we allow firms to make these changes in investments in preparation to exporting, i.e. ex-ante, or in reaction, i.e. ex-post to exporting.

To build our model, we synthesize arguments from international economics, international strategy and business, as well as international marketing literatures. From the international economics literature, we draw on the studies of the contribution of R&D activity and exports to firm productivity (e.g., (Lileeva and Trefler 2010)). From the international business literature we draw on explanations for patterns of internationalization of newly developed products (Vernon 1966, Vernon 1979) and on studies of the effect of exports on firm innovation performance (e.g. (Salomon and Shaver 2005)). Finally, we integrate theoretical mechanisms from international marketing studies to explain the necessity of product and strategy adaptation through marketing investments in the quest of internationalizing through exporting (Cavusgil, Zou et al. 1993). At the end of this process stands a structured comparison of mechanisms explaining ex-ante as well as ex-post export-induced R&D and/or marketing investments. We extend our review by explaining and contrasting mechanisms that link these investments to firm performance.

Based on our theoretical framework, we conduct an empirical study, which rests on the same idea of capturing a comprehensive choice set for firms when making export decisions. Our empirical setting is a panel of Spanish manufacturing firms during a period of 1990-2009. We focus on first-time export entrants and investigate their investment behavior in R&D and marketing around the moment of entry into exports. More specifically, we compare them to firms that never exported during 1990-2009 but had a similar propensity and identify the part of R&D as well as marketing investments induced by the export decision using a propensity score matching. This approach allows us to capture the counterfactual decision, i.e. the R&D and/or marketing decisions a firm would have undertaken anyways. By comparing investment decisions between exporting firms and their matched twins at different points in time, we can differentiate between preparatory (ex-ante) and reactive (ex-post) export-induced investments. We then relate these export-induced investments to performance in the post-entry period. Our findings show that new exporters increase both R&D and marketing investments, but timing patterns vary. Export-induced marketing investments occur both in preparation to exporting and in response after the firm has entered export markets. Export-induced R&D investments, though, occur only once a firm has entered export markets. Focusing on performance measured as labor productivity, we find that it is predominantly export-induced marketing investments that lead to increases in firm productivity. In such a way, we show that marketing investments conceptually associated with foreign market knowledge accumulation and dissemination are the essential part of performance gains from export decisions.

Our study advances existing research in three ways. First, we provide a structured review of mechanisms explaining export-induced R&D and marketing investments as well as their performance effects. Our comprehensive model provides comprehensive choice sets firms have when making export decisions. In particular, we show that the decision to export is not independent from the investments in R&D and marketing. Instead, at least parts of these investments would not occur in the counterfactual situation, i.e. without the export decision. Studies treating export decision as independent from R&D and marketing investments of a firm are therefore likely to suffer from biases. Besides, our theoretical distinction between ex-ante and ex-post export-induced R&D or marketing investments provides a platform for more precise theorizing about particular export strategies in the future, e.g. based on increased marketing, instead of general ones.

Second, we extend the stream of literature that has focused on "learning by exporting" and its effects on innovation performance (Salomon and Jin 2008, Salomon and Jin 2010). We go beyond the question of whether the technological learning from export markets directly translates into firm performance and find that it is not the case. We can only speculate that this is due to long time delays or export-induced innovations that are difficult for firms to exploit commercially. However, we can show that in relative terms the average firm is better off accompanying its export decision with increased marketing investments both ex-ante and ex-post to exporting.

Finally, we apply a methodological approach that has the potential to overcome many of the deficits of existing studies on the effects of exporting (Silva, Afonso et al. 2012). First, by using propensity score matching we reduce potential selection biases associated with export entry. Second, by combining a treatment model with a regression analysis, we can explicitly consider deviations from a counterfactual situation, i.e. we identify which part of the investments is directly associated with the export decision and assess whether these export-induced investments enhance productivity. The panel nature of our dataset makes it possible to distinguish between ex-ante and ex-post export-induced investments. In this way, we are able to provide a more precise explanation of the mechanisms behind the well-established export-performance relationship. Such an integrated empirical strategy is well-suited to our theoretical framework and will be useful for a variety of future empirical studies on this and related topics.

Our study has also direct implications for management practice. We show that the average firm would be ill-advised to neglect investments in marketing when exporting even when it invests heavily in the innovativeness of its products and production processes. Instead, both preparatory export-induced marketing investments as well as those made after exporting has commenced have the most potential for increasing firm performance. Budgets for firms with export intentions can be adjusted accordingly.

The rest of the paper is organized as follows. In the next section we conduct a structured review of existing theory on export-induced investments as well as their performance effects and build our theoretical framework. The third section describes the empirical approach, data and estimations. The fourth part presents the results of the empirical analysis. In the final section we provide conclusions, discuss contributions and directions for future research.

2. Export-induced investment decisions and performance links

The goal of the theoretical part of our study is to delineate and disentangle the mechanisms by which firms' decisions to export change investment patterns and relate these export-induced investments to subsequent firm performance. Within our model, the strategic choices of firms are not limited to the decision to export. Instead, we assume that firms have a broader choice set of investment decisions in R&D and marketing, arguably two of the most important strategic input decisions affecting firm performance (Song, Droge et al. 2005, Krasnikov and Jayachandran 2008). We review existing research for mechanisms explaining changes in both R&D and/or marketing investments, which are due to a firm's decision to export. Inherent in our modeling is the assumption that counterfactual levels of R&D and marketing investments exist, which firms would have undertaken anyway. Any deviation from these counterfactual levels, though, is due to the export decision and we will refer to it as export-induced R&D and marketing investments, respectively.

Additionally, our modeling of export-induced investment decisions allows for temporal differences. Our model distinguishes between investments that come ex-ante to exporting, i.e. in preparation, or ex-post, i.e. in reaction to exporting. In short, we conceptualize the export decision of firms to trigger ex-ante and/or ex-post export-induced R&D investments and ex-ante and/or ex-post export-induced marketing investments. We use this choice set to synthesize and disentangle theoretical mechanisms from existing research. Our goal is to establish a comparative framework of mechanisms, so that subsequent empirical findings on which export-induced investments are more likely to occur and increase performance can be traced back to theoretical mechanisms.

Export-induced investments in R&D

Firms invest in R&D to develop and introduce product and process innovations (Doraszelski and Jaumandreu 2013). At the same time innovation activity is an important factor determining a firm's decision to become an exporter. In his seminal papers, Vernon (1966, 1979) explained the internationalization process of firms introducing the product life cycle hypothesis. Firms, and in particular SMEs, start internationalizing through exports, and eventually move to foreign direct investment, building on their strengths in the home markets. The initial phase in the internationalization process is characterized by creation of new products using the home-based resources and opportunities. Once the demand for new products is developed elsewhere, the firm starts exporting its products to similar product markets abroad and eventually proceeds to foreign direct investment. Empirical studies find evidence consistent with the product life cycle hypothesis (Basile 2001, Roper and Love 2002, Bernard and Jensen 2004, Cassiman, Golovko et al. 2010, Becker and Egger 2013). Becker and Egger (2013) show the importance of product innovation (relative to process innovation) in determining a firm's export propensity for German firms. Cassiman et al. (2010) confirm the effect of product innovation on the probability of a firm to become an exporter for a sample of Spanish firms. Accordingly, firms have strong incentives to increase their investment in R&D while preparing for the export entry to assure future gains from export activity.

A related stream of literature provides mechanisms for increasing incentives for export-induced R&D investments ex-post, i.e. after the firm has started to export. First, an increase in demand for firms' products due to newly opened export markets increases the expected rate of return to a firm's R&D investments, further enhancing the incentives to invest in R&D. Aw et al. (2011) show that the expansion of the export market size has a positive effect on the R&D participation rates of Taiwanese exporting firms. Likewise, Bustos (2011) finds that during the trade liberalization period, new exporters are more likely to invest in R&D activities and technology upgrade compared to non-exporting firms. The underlying explanation is that the benefits of R&D investments (and in particular, technology adoption) are proportional to revenues, while their costs are fixed. Lileeva and Trefler (2010) argue that for lower-productivity firms incurring the fixed costs of R&D investments in technology is justifiable only if accompanied by larger sales that come with exporting. They show empirically that lower foreign tariffs induce Canadian firms with lower productivity levels ex-ante not only to export but also to simultaneously invest in product and process innovation. Essentially, these arguments suggest complementarity of export and R&D activities, as one activity reinforces the benefits of the other. Accordingly, such complementarity makes the adoption of one activity more likely in presence (or in expectation of adoption) of the other activity.

At the same time, existing literature on learning by exporting emphasizes the positive effects of exporting on the creation of new products and adoption of new processes and technologies (Salomon and Jin 2008, Golovko and Valentini 2014). Firms can acquire new information through exposure to more technologically sophisticated buyers, suppliers, or competitors in export markets. In order to absorb and use newly acquired knowledge, firms are likely to increase their R&D investments.

The rationales for export-induced R&D ex-ante and ex-post to exporting are not mutually exclusive and firms may well engage in both. Hence, we expect firms that start exporting to have higher investments in R&D compared to non-exporting firms both before and after they become exporters.

Export-induced investments in marketing

One of the major stumbling blocks for exporting firms identified in both international business and marketing literatures is the absence of knowledge about foreign markets. Due to existing differences across markets in terms of cultures, stages of economic/market development and customer values/life style, new entrants usually lack detailed information about foreign market characteristics, such as customer preferences or ways of competing. Marketing activities have often times been linked to how companies exploit the economic potential of existing products and competences (for recent reviews see (Krasnikov and Jayachandran 2008) or (Song, Droge et al. 2005)). Exporting involves substantial start-up sunk costs which firms have to bear prior to start the export operations (Campa 2004), and which also determine the expectations from the export entry. Export profits are often considered as the exporting firm's ultimate goal (Lisboa, Skarmeas et al. 2013), thus making the need for exploitation of the firms' strengths even higher.

To benefit from exporting, firms need to close the knowledge gaps related to business environment in the foreign markets (Petersen, Pedersen et al. 2008). Ex-ante marketing investments associated with the prospective export entry serve this exact purpose - to acquire knowledge about technical and legislative standards of the local markets, local competitors, product requirements, local customer needs and expectations, - and thereby help to decrease the perceived market uncertainty. Using acquired knowledge e.g. as a guide for adapting current products or promotion strategies to the export market conditions firms increase the competitiveness of their offers (Cavusgil, Zou et al. 1993) and thus can effectively enter to exploit the export market opportunities.

Additional marketing investments may also be required ex-post, i.e. to adapt products and promotion strategies and fit them better to the requirements of the market once exporting operations have started. Firms tend to lack knowledge held by local firms and organizations, which is useful for the development and commercialization of goods and technologies (Laursen, Masciarelli et al. 2012), and which is not easily fully codified or articulated. Customer demands are often times tied to economic, social or even religious conditions. Local competitors can tailor their products and practices to such needs over time while foreign competitors will only experience them once they have entered the market (Zaheer and Mosakowski 1997). This explains (a) why local competitors have better adapted products (Zaheer 1995) and (b) why local customers form perceptions about foreign products which are not exclusively built on product characteristics (Bilkey and Nes 1982). Such differences between local and foreign competitors make post-entry product adaptation and promotion strategies crucial for new exporters allowing firms to improve the interactions with foreign customers and increase consumers' willingness to pay.

In sum, firms have strong incentives for export-induced marketing investments both ex-ante and ex-post to exporting. The mechanisms are not mutually exclusive, so we expect exporting firms to have higher investments in marketing compared to non-exporters both before and after they start exporting.

Figure 1 summarizes the mechanisms underlying export-induced R&D as well as marketing investments both ex-ante and ex-post to exporting.

Insert Figure 1 about here

After establishing the incentives of firms for export-induced investments in R&D and marketing, we outline the mechanisms for how these investments turn into firm performance.

Performance effects of export-induced R&D investments

Ex-ante export-induced R&D investments can provide firms with unique products which competitors may only be able to imitate or substitute with significant delays (Mansfield, Schwartz et al. 1981, Amit and Schoemaker 1993). Innovative products raise performance or productivity due to at least temporary monopoly rents the firm can reap with new products. Empirical studies support the expected effect of R&D on innovations and subsequent performance improvements confirming that R&D investments indeed explain a large part of the observed productivity differences across firms (Griliches 1986, Crepon, Duguet et al. 1998, Griffith, Huergo et al. 2006, Doraszelski and Jaumandreu 2013). Export-induced R&D investments associated with preparation for export entry (e.g. (Lileeva and Trefler 2010)) can therefore lead to more competitive products on export markets with new and possibly strong competitors and directly contribute to subsequent firm performance.

Ex-post export-induced R&D investments associated with new information acquired abroad can lead to enhanced performance. Learning by exporting literature argues for increased innovation output due to exporting activity, such as more product innovations and patents (Salomon 2006, Criscuolo, Haskel et al. 2010, Filipescu, Prashantham et al. 2013, Golovko and Valentini 2014). In these models, exporting facilitates access to foreign knowledge pools, and predominantly new technological knowledge (Salomon and Jin 2010). Getting in touch with new knowledge allows firms to create novel combinations with existing knowledge stocks resulting in creation of new stocks of knowledge and innovation. R&D investments, which accompany foreign knowledge assimilation and utilization, therefore are likely to result in higher performance in the post entry period.

Finally, both ex-ante and ex-post export-induced R&D investments can become the sources of economies of scale and scope due to enlarged product markets and future increase in scope of international operations where firms can leverage their R&D investments. Moreover, both types of export-induced R&D investments can lead to additional positive performance effects originating from the fact that firms differ in terms of their abilities to innovate because they are heterogeneous in terms of reaching for technological opportunities (Capasso, Treibich et al. 2015). Then, the role of R&D is not only the direct input in the innovation process, but also a way to develop absorptive capacity needed to effectively exploit external knowledge (Cohen and Levinthal 1990). R&D investments triggered by exports can therefore indirectly lead to better performance by influencing the ability of a firm to recognize, select, and use valuable information.

Performance effects of export-induced marketing investments

Research on the performance effects of export-induced marketing investments stresses the foregone sales opportunities from products, which are not sufficiently adapted to the export markets. Ex-ante marketing activities are often times associated with learning about foreign market conditions and adapting the products and services accordingly (Anderson 1960). Such ex-ante marketing investments allow firms to collect information about tastes and preferences of foreign buyers and thereby facilitate necessary product adaptations. Although product adaptation increases the costs of export entry, the modified products may better fit the needs of foreign consumers and therefore generate higher sales due to increased foreign demand (Calantone, Cavusgil et al. 2004). Similarly, investments in promotion adaptation strategies, such as positioning, packaging/labeling, or advertising approach, associated with the export entry and adapted to foreign market conditions enhance the product's appeal to export customers (Cavusgil, Zou et al. 1993) and thereby contribute to building and increasing the demand for the firm's products and, therefore, performance. In line with these arguments, Foster, Haltiwanger, and Syverson (2008) find that firm-specific demand shocks account for a substantial part of the differences in measured firm productivity.

Ex-post export-induced marketing investments for the adaptation of the marketing mix to tastes and requirements of export markets should also have positive effects on firm. An important aspect of ex-post export-induced marketing investments is information dissemination and thus increasing customer awareness. Such investments have been linked to firm performance as firms build long-term assets through brand equity and customer loyalty in the export market which can prevent customers from switching to competing products (Suarez and Lanzolla 2007). A separate stream of literature has emphasized the opportunities for firms to learn from customers and competitors on export markets and transfer insights to other markets. In this regard, certain geographical markets have been identified as lead markets with anticipatory demand conditions for other international markets (for a review see (Beise and Cleff 2004)). Hence, the transfer of successful design, pricing, distribution or promotion strategies to the home country (and other export markets afterwards) can strengthen the exporting company as a whole.

In sum, export-induced R&D and marketing investments can both positively contribute to firm performance. Moreover, the mechanisms for the performance effects of export-induced R&D and marketing investments are not mutually exclusive. Additional performance benefits may stem from their interaction, for instance, by investing in marketing activities firms can improve the value creating and in particular, value capturing processes for their innovative products coming from R&D investments. In other words, both types of investments may be complementary in their effect on performance. We will explore potential interaction effects empirically. Figure 2 summarizes the mechanisms underlying the performance effects of export-induced R&D and marketing investments.

Insert Figure 2 about here

3. Empirical study

Data

The data come from a survey of Spanish manufacturing firms "Encuesta sobre Estrategias Empresariales (ESEE)" or Survey on Business Strategies during 1990-2009. The project was conducted by the Fundación Empresa Pública with financial support of the Spanish Ministry of Science and Technology. The survey is administered to the population of Spanish manufacturing firms with 200 or more employees and to a stratified sample of small and medium sized firms, representative of the population of manufacturing firms with more than 10 but less than 200 employees. The sample aims to maintain the representativeness of the manufacturing sector over time. Additional firms are included in the sample from the population of newly founded firms every year. Firms that exited the original sample during the sampling period are replaced by firms with similar characteristics drawn from the population. The initial sample is an unbalanced panel originating from twenty distinct industries.[1] The ESEE dataset has been used by prior research on learning by exporting (e.g. (Salomon and Shaver 2005, Salomon and Jin 2010, Golovko and Valentini 2014)), which allows us comparing the results to prior studies.

Since we are interested in estimating the impact of switching from exclusively local market activity into exporting, we only use firms that have started exporting during our sample period, i.e. for which we

[1] The ESEE data cover the whole manufacturing sector of Spanish economy and includes 20 industries defined at the 2-digit level. The industry breakdown with the number of firms in each sector is provided in Appendix 1.

can observe this switch with certainty. As a counterfactual group we use firms that never exported during the whole sample period. After adaptation of the sample and after dropping missing values and outliers, our final sample contains 9,232 firm-year observations, out of which 6% (or 549 firms) switched to exporting activities.

Dependent variables

Our analysis includes two steps. For the first part of our analysis, the dependent variables are R&D (*RD*) and marketing (*Mktg*) expenditures respectively. The former is measured by the ratio of R&D expenditures to total sales and the latter by the ratio of marketing expenditures to total sales[2]. For the second part of the analysis the dependent variable is firm performance. To measure performance, we use productivity calculated as the log of the focal firms' annual value added. This value is calculated by subtracting expenditures for raw materials, consumables and services from the firms' sales. We use productivity to evaluate performance to be consistent with prior literature (Bernard, Jensen et al. 2012). In addition, productivity measures have the advantage that they capture all forms of potential learning (e.g. increased sales due to improved products or marketing strategies as well as lower costs through improved manufacturing processes).

Independent variables

To estimate the propensity of firms to start exporting, we use a number of relevant covariates typically employed in the literature to model a firm's choice to start exporting. Firm size (*Size*) is calculated as the logarithm of the number of employees and accounts for the fact that larger firms are more likely to export (Bernard and Jensen 1999). We include the percentage of foreign ownership (*Foreign ownership*) as firms

[2] The ESEE questionnaire asks whether a firm invested in R&D activities in a given year and if so, how much it invested. We use the answer to this question to measure R&D expenditures related to technological activities of firms. For the marketing expenditures, we use the information on expenditures on advertising, publicity and public relations from the balance sheet of the firms (account 627 (Plan General Contable)), which they have to report in the ESEE questionnaire.

with a high foreign-owned capital might be more likely to export to the countries that hold their shares (Basile 2001). We use a dummy variable, which reflects the evolution of the firm's product market (*Market growth*). The ratio of debt to value added (*Financial constraints)* controls for the possible financial constraints that firms may experience, which can have an effect on the decision to export. We also include a control for the geographical location of a firm within Spain (*Location)*, as firms that are in proximity of a harbor or a border might have more options to export than firms that are located in more remote areas. Finally, twenty industry dummies control for unobserved heterogeneity and technological opportunity across sectors and time dummies, one for each year, are included to capture macroeconomic shocks.

Based on the predicted propensity scores we perform the matching analysis, which allows us to separate R&D and marketing investments of an exporting firm into a part that was induced by the export decision and a counterfactual part, which the firm would have undertaken anyway (see next section for methodological explanation). These differentiated variables, namely export-induced R&D investments, counterfactual R&D investments, export-induced marketing investments and counterfactual marketing investments become the central independent variables in the second part of the analysis in which we estimate a production function. We introduce the temporal component by interpreting differences in an exporting firm's R&D investments with its matched control firm two years prior to exporting as ex-ante, and two years after exporting (including the export start year) as ex-post.

In the subsequent production function, in addition to the controls of the probit model, we use the focal firm's physical capital, calculated as the log of firms stock of tangible assets (*Capital*). Next, the log number of employees in a given year (*Size)* stands as a control for labor input as is customary for a production function. Since we estimate an augmented production function (i.e. a knowledge production function), we also control for the focal firm's knowledge stock by including the patent stock (*Patent stock*) measured as the number of patent applications per employee.

Estimation strategy

We proceed in two main steps. First, we estimate the average effect of exporting on R&D investment and on marketing investment (Treatment model). Secondly, we estimate how these effects translate into overall firm productivity (Productivity model).

Treatment model

We start by estimating the average effect of exporting (the treatment) on firms' R&D investments and marketing investments, respectively. Using a treatment effects analysis allows us to estimate how much an exporting firm would have spent on R&D or marketing if it would not have exported. This counterfactual situation, i.e. expenditures of an exporting firm if it would be in a situation of not having exported, is never directly observable and has to be estimated. In order for our estimates to be unbiased, we have to account for the fact that the decision to enter international markets by a firm is not random. A firm that decides to start exporting may differ in important characteristics from a firm that decides to stay local. As a consequence, such selection has to be taken into account. In this study, we account for selection by using a non-parametric econometric matching estimator. More precisely, we employ a nearest neighbor propensity score matching that balances the samples of treated and untreated firms according to the probability of choosing to enter the export market. This probability is obtained from a probit estimation on the probability of switching export status. The matched pairs are then chosen based on the similarity in the estimated probability of starting to export. The construction of the control group depends on the algorithm chosen to conduct the matching. In our analysis, we conduct a variant of the nearest neighbor propensity score matching, namely caliper matching.[3]

Furthermore, on top of matching on the propensity score, we also require matched observations to be from the same year, industry and region, as those criteria seem essential to build comparable groups.

[3] Caliper matching aims at reducing the bias by avoiding to match treated firms with control firms above a certain "distance", i.e. those firms for which the value of the matching argument Zj is far from Zi. It does so by imposing a predefined threshold ε, above which an observation is deleted from the potential control group. More precisely, $||Zj - Zi|| < \varepsilon$ for a match to be chosen (see (Smith and Todd 2005)).

This allows us to assign each exporting firm with a matched twin, which had the same propensity to start exporting in the same year, industry and region but chose to remain local. The R&D and marketing investments of this matched twin serve as the counterfactual R&D and marketing investments of the focal firm, i.e. as the amount the focal firm would have invested if it had not started to export. Differences in investments can therefore be interpreted as induced by exporting.

The fundamental evaluation question is as follows:

$$\alpha^{TT} = \frac{1}{N^T}\sum_{i=1}^{N^T}\left(R\&D_i^T - \widehat{R\&D}_i^c\right) \qquad (1)$$

where $R\&D_i^T$ indicates the expenditure of treated firms and $\widehat{R\&D}_i^c$ the counterfactual situation, i.e. the potential outcome which a treated firm ($S=1$) would have realized if it would be in a counterfactual situation of not having received a treatment. In other words, for the untreated firms, $\widehat{R\&D}_i^c$ corresponds to their R&D expenditures. $S \in \{0,1\}$ indicates the switch from being a non-exporter to being an exporter and N^T corresponds to the number of treated firms. Marketing expenditures are evaluated analogously.

Productivity model

In a second step, we analyze how export-induced R&D and marketing investments contribute to firm productivity. We separate R&D and marketing expenditures into two components: expenditures which would have taken place even if a firm would have remained active exclusively on the local market ($\widehat{R\&D}^C$ in the case of R&D expenditures and $\widehat{Mktg}^C$ for marketing expenditures) and those expenditures that were induced by the fact that the firm went international ($\alpha^{R\&D_{TT}}$ and $\alpha^{Mktg_{TT}}$ respectively). To obtain these effects at the individual firm level, we calculate the difference between the overall R&D (marketing) investment and the counterfactual R&D (marketing) investment as follows:

$$\alpha_i^{RDTT} = R\&D_i - \widehat{R\&D}_i^c \quad \text{and} \qquad (2)$$

$$\alpha_i^{MktgTT} = Mktg_i - \widehat{Mktg}_i^c \qquad (3)$$

For firms that remained domestic, $\widehat{R\&D}_i^c$ ($\widehat{Mktg}_i^c$) is equal to their R&D (marketing) expenditures, as $\alpha_i^{R\&D\_TT}$ ($\alpha_i^{Mktg\_TT}$) equals to 0.

To estimate the impact of these variables on firms' value-added, we use a Cobb-Douglas production function. We augment the classical production function introduced by Griliches (1986) by adding two types of knowledge inputs, namely technological (R&D investment) and market knowledge (marketing investment). Our production function can thus be presented as follows:

$$Y_{it+2} = A^{\alpha t} K_{it}^{\gamma} L_{it}^{\lambda} RD_{it}^{\delta} Mktg_{it}^{\beta} \tag{4}$$

with *Y* representing the firm's output, forwarded by two periods in order to avoid direct simultaneity. *A* is a constant, measuring total factor productivity (TPF) with α*t* being the time trend in the rate of technical change. *K* is a firm's physical capital, calculated as the log of firms stock of tangible assets (*Capital*); *L* represents labor, measured by the log number of employees in a given year (*Size*). *RD* captures R&D expenditures and *Mktg* - marketing expenditures. The parameters γ, λ, δ and β denote the unknown output elasticities of inputs.[4] As mentioned previously, we further add a control for the firm's existing knowledge stock (*Patent stock*). This characteristic should be held constant in our augmented production function in order for the knowledge input not to be confounded with other effects. In order to obtain a linear form of the above production function, we take natural logarithms.

We induce a two-year time lag between the year of the export decision and the observed productivity outcome to account for potential simultaneity effects. The choice of two-year time lag is in line with prior empirical studies (e.g., (Bernard and Jensen 1999, Salomon and Shaver 2005)). Yet, even though our outcome variable is forwarded by two periods, therefore ruling out direct simultaneity, we account for the fact that our setting may suffer from autocorrelation. More precisely, we estimate our model by Generalized Estimating Equations (GEE), pioneered by Liang and Zeger (1986), which allow to account for autocorrelation. We use an autocorrelation structure of order one, specifying that the output variable

[4] We note that by defining *Y* as the firm's value-added, raw material input is taken into account in *Y* and we do not have to include it as an additional variable on the right-hand side of the equation.

may depend linearly on its own previous value and on a stochastic term. This approach has been used in a broad range of innovation performance models (see e.g. (Ahuja and Katila 2001, Somaya, Williamson et al. 2007)). After having forwarded the sample by two periods and having dropped missing values and outliers for the additional variables needed for the performance estimation, the sample for the second step equals to a total of 6326 firm-year observations.

Before turning to the empirical results, Table 1 presents the descriptive statistics of the firms composing our sample. On average, a firm in the sample has a marketing intensity of roughly 0.7% and an R&D intensity of 0.26%. Furthermore, the average firm has a size of 58 employees (23 at the median), a foreign ownership of 3%, 24% of the firms estimate that their most important market is growing and roughly 6% of the firms switched from non-exporting to exporting status during our observation period. The cross-correlations between these variables can be found in Appendix 2.

Insert Table 1 about here

When comparing firms that switched to exporting to firms that remained domestic, we see that on average exporting firms are significantly larger (with an average of 120 employees compared to 54 for non-exporting firms), have a significantly higher foreign ownership and indicated that their most important market is expanding more often. We further see that switching firms have significantly higher marketing as well as R&D expenditures when compared to non-switching firms. At this stage however, we cannot say how much of these additional expenditures can be attributed to the fact that they switched to exporting and how much is due to other firm characteristics.

4. Results

Treatment model

We begin by estimating a propensity to start exporting (i.e. the exporting decision). Table 2 displays the results of the estimation on the likelihood of entering the export market. In line with previous findings, foreign ownership, growth potential of the main market as well as location and industry have a significant and positive impact on the export decision. The coefficient of size is positive but not significant, indicating that for our sample size does not make a significant difference in terms of the probability to entering into exports. The financial constraints variable although negative, is insignificant in its effect on the export decision.

Insert Table 2 about here

The probit estimation allows us to predict a firm specific propensity score for each firm in our sample on the likelihood to start exporting, needed in the subsequent matching estimation.

Table 3 shows the results of the matching estimation. As can be seen from the t-test on mean differences between the treated (exporting) firms and the control group, all covariates are well balanced after the matching, pointing to the fact that our matching was successful and that we found a close neighbor for all of our treated firms. The only remaining significant differences are in the outcome variables.

Insert Table 3 about here

On average, we observe no significant difference in R&D expenditures between treated and control groups in the pre-entry period (time (t-1)). Switching firms start to invest significantly more in R&D at the year of entry and one year after entry into exports. New exporters have R&D expenditures that are 0.19% and 0.23% points higher at times (t) and (t+1) respectively. The results thus suggest that firms invest in R&D simultaneously or in response to the export entry, rather than in preparation. As for marketing investments, we do see a significant difference in the investment patterns between switching and non-exporting firms already one year before export entry. Switching firms invest significantly more in marketing (0.27% points) when compared to non-exporters already one year before actual export entry. The significant difference in marketing investments persists in the year of entry into exports (time (t)) and one year after the entry (time (t+1)) – new entrants have an additional 0.47% points and 0.32% points investment in marketing respectively.

Productivity model

We next turn to the estimation on how export-induced marketing and R&D investment contribute to firm productivity (Table 4). Models 1-3 in Table 4 test different specifications for time (t-1), (t), (t+1) making a distinction between export-induced and counterfactual parts of R&D and marketing investments. We exclude export-induced investments from (t-2) since they were not significantly different between exporting firms and matched control firms.[5] Models 4-6 explore multiplicative interaction effects between export-induced R&D and marketing expenditures.

Insert Table 4 about here

We find no significant effects of export-induced R&D investments on firm productivity neither ex-ante nor ex-post. Only, the counterfactual part of R&D investments made before export entry is positive and significant at the 10% significance level. In contrast, marketing investments do contribute positively and significantly to firm productivity after exporting. We observe positive and significant coefficients at export-induced and counterfactual parts of marketing expenditures for all time periods (t-1), (t), and (t+1). Therefore, export-induced marketing investments are on average more important for productivity improvements than R&D investments.

We find that as of (t-1), i.e. in preparation of the exporting activity, the additional marketing investment translates positively into firm performance. As we can see by the magnitude of the point estimate, this effect is slightly larger than the effect of the additional investment in period (t) or (t+1). In other words, a 10% increase in export-induced marketing intensity in (t-1) leads roughly to a 0.9% increase in productivity. In (t+1), the impact of export-induced marketing investment is very similar, while it is slightly smaller in (t) with a 0.8% change in productivity. Models 4-6 (Table 4) show the results with the interaction between R&D and marketing. We observe no additional contribution to productivity coming

[5] There are no additional significant effects from these export-induced investments in the production function. The estimation results are available from the authors upon request.

from the combined effect of R&D and marketing investments. The coefficients of the interaction terms are negative but insignificant.

Overall, the results suggest that although new exporters increase both R&D and marketing investments with export entry, it is mainly marketing investments induced by exporting that lead to increase in productivity.

5. Robustness checks

We test the robustness of our findings against critical features of our econometric specification as well as on the definition of our main outcome variable. First, the reliability of our results hinges upon the correct specification of the matching analysis. Thus a first robustness check consists in testing whether using an alternative econometric technique that takes the selection on unobservables into account comes to the same conclusion in terms of additional marketing and R&D investment (see e.g. (Czarnitzki and Lopes-Bento 2013)). Instrument variable (IV) regression approaches allow contrasting our findings with an alternative approach to model selection. To conduct our IV regression, we employ an instrument impacting the decision to start exporting without impacting R&D or marketing investments, namely the exchange rate[6]. The international trade literature shows that exchange rate fluctuations can significantly affect the export behavior of firms (Basile 2001, Campa 2004). Home currency devaluation is expected to result in more firms entering the export market. This variable has been used as an instrument for similar purposes in previous literature (see (Campa 2004, Golovko and Valentini 2014)). In our case, for both regressions the

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[6] Following Campa (2004), we calculate exchange rate index that reflects the changes in the Peseta (the Spanish national currency before Euro introduction) with respect to other foreign currencies during 1990-2009, with higher values of index corresponding to Peseta depreciation periods. With an introduction of Euro in 1999, we fix the Peseta/Euro ratio but allow the ratio of Peseta to vary with respect to other currencies. The exchange rate index is based on industry average, i.e. it accounts for the fact that different industries may export to different markets and thus be differently affected by the exchange rate changes. It is calculated as a weighted average of the bilateral exchange rates of each of the potential export markets. We use the percentage of export sales that goes to a particular market destination as weights. For exporting firms, the information on the export market shares is provided in the ESEE survey. The survey data distinguish among three broad export markets – EU (European Union) countries, other OECD countries, and the rest of the world. The computation of the exchange rate index is complicated as the survey reports the information on the markets once in four years, i.e. we have these data for 1990, 1994, 1998, 2002, and 2006. We calculate industry average export shares to different destinations for 1990, 1994, 1998, 2002, and 2006. For the years 1991-1993, we use the data on 1990, for 1995-1997 we use the information available in 1994, for 1999-2001 we use market destinations in 1998, and so on.

[6] We limit ourselves to the presentation of the results of the contemporaneous period. Results on other time periods are similar.

instrument fulfils the statistical tests for being valid instruments. In the first stage, the IV is highly significant and the F-test is above 10. Hence, both from a statistical as well as from an economic point of view, our instrument is valid. As displayed in Appendix 3, the results of the IV estimation are in line with what we find in our matching estimation. As IV is a linear specification and the matching estimator is a non-parametric estimator, the magnitude of point estimates are not directly comparable. Nonetheless, the significance levels and signs indicate that the results on R&D and marketing additionality hold when controlling for characteristics that are unobservable to the researcher, thereby confirming the findings from our matching estimation.

Second, we use an alternative measure of performance to test whether the results of productivity regression are driven by the choice of our outcome variable. More specifically, we re-estimate the performance regression using firm sales as a dependent variable (Appendix 4). The results confirm the importance of export-induced marketing investments both ex-ante (t-1) and ex-post (t+1) for firm performance, i.e. sales, without additional effects from export-induced R&D investments.

6. Discussion and conclusions

In this study, we delineate changes in R&D and marketing investments due to export decisions and compare their effects on firm performance. Many mechanisms have been suggested, which can potentially explain investment changes and performance effects but few, if any, comparative studies exist. We pay particular attention to separating export-induced investments from counterfactual investments that an exporting firm may have undertaken anyway. Our results indicate that increases in both marketing and R&D investments are triggered by exporting with one important difference. Firms start investing in marketing in preparation for exports and continue doing so when the actual entry takes place, while export-induced R&D investments occur simultaneously to exporting and after entry.

Moreover, we find a positive and significant effect of export-induced investments in marketing (ex-ante and ex-post) on firm productivity. While export decisions lead the average firm to invest more in R&D,

such export-induced R&D investments do not make firms more productive. An observed increase in R&D investments after export entry might indicate that some technological learning takes place, in line with learning by exporting literature (Girma, Görg et al. 2008). These particular R&D investments are either less successful or take substantial time to translate into higher productivity, while marketing investments pay off consistently. Our main models allow for a two-year time lag between export-induced investments and productivity effects. We experimented with longer time lags of up to four years before the sample size becomes too small for meaningful interpretation. The pattern of results does not change. Based on our empirical setting, the learning by exporting phenomenon might therefore be more properly characterized as "learning about and exploiting new markets" rather than "learning about new technologies" as prior studies have often implied.

Our study adds to the strategy and internationalization literatures in a number of ways. First, we bring together and structure theoretical mechanisms from three distinct streams of literature (international economics, international business and strategy and international marketing), which have been largely disconnected. In doing so, we build a comprehensive model of the export-induced investment decisions and performance links. We model a choice set for firms making export decisions with different investment options (R&D, marketing) as well as temporal dimensions (ex-ante, ex-post). Our findings indicate that both R&D and marketing investments are not exogenous to export decisions. Hence, studies exploring performance effects from exporting assuming independence of R&D and marketing investments (or not covering them) are likely to suffer from biased results. What is more, our model provides a structure and increasingly fine-grained set of export choices for firms. The model provides a basis for dedicated theorizing in future studies on which particular export choices will pay off for particular types of firms or export markets, building on our insights for the average firm.

Second, we extend a recent stream of research in international business and strategy on learning by exporting (Salomon and Jin 2008, Salomon and Jin 2010). These studies have found that technological learning occurs for some exporting firms resulting in higher innovation performance. We extend this research by asking whether these effects translate from innovation performance into firm performance. Our findings indicate that this cannot be readily assumed. We find that firms increase their R&D investments when entering export markets, which is in line with increased patent activity found in earlier studies; yet these investments do not translate into higher productivity. We can only speculate that effects would occur with a long time delay or that the firm has learned something by exporting that is particularly difficult to exploit commercially. Our study also indicates that export-induced marketing investments are the strategic choice increasing firm performance for the average firm. The empirical results suggest that market learning and adaptation of products and procedures prior to exporting as well as afterwards are a significant determinant of performance improvements. To this end, we embed the literature stream on learning by exporting in a broader context of strategic outcomes of exporting which compares technological learning effects with alternative choices, i.e. export-induced marketing investments.

Finally, extant learning by exporting research has used a variety of methodological approaches which made it difficult to arrive at a unified understanding of effects and to minimize potential biases (Silva, Afonso et al. 2012). We combine and integrate two methods for achieving the latter. First, by considering R&D and marketing investments simultaneously we eradicate potential omitted variable biases as both components may impact firm output. Second, we apply a treatment model to disentangle the investment decisions linked to export decisions from the investments that a firm would have undertaken anyway, i.e. the counterfactual investments in R&D and marketing. In other words, we reduce the potential selection biases of choosing to enter international markets. Third, we relate these differentiated investments to firm performance, more specifically to productivity. This approach is superior to just comparing firm performance before and after exporting because it provides a direct link between performance outcomes and changes in firm investment patterns due to export entry, thus providing a more precise explanation for the observed performance effects of exports. In sum, we lay out an integrated, multi-layered empirical strategy for testing learning by exporting effects and demonstrate its application. This strategy should be useful for a variety of future empirical studies on this and related topics.

In terms of relevance for practice, we provide impulses for both management and policy-making. Entering foreign markets is a risky decision for firms, in particular because they face new customers and competitors. Our findings provide managers with a more precise understanding of the kind of benefits they can expect from an export decision and where these benefits originate from. We find that an average firm increases both R&D and marketing investments when entering export markets. However, export-induced marketing investments are the primary source of positive performance effects. Accordingly, managers relying exclusively on the technological superiority of their export products are likely to see disappointing results. Firms are better off devoting resources to export marketing irrespective of their technological level and investments. Similarly, many governments, such as in the United States, have started high profile policy initiatives to encourage domestic firms to become exporters (e.g. export.gov). The US has currently only slightly more than 300,000 exporting firms (U.S. Department of Commerce 2014). Our study provides new insights into the changes that similar export policy initiatives will bring to firms investment decisions and productivity outcomes. Based on our findings, support schemes for creating marketing expertise for potential exporters in a country are more likely to pay-off after exporting as does support for export marketing during the initial stages of export market entry. Hence, policies can be reevaluated.

While conducting our study we have also learned about potentials for future research. First, our model implies information flows throughout the exporting company, i.e. from export sales to R&D and marketing departments. Dedicated studies may be able to disentangle how these information flows are organized and whether different organizational designs are particularly akin to result in productivity increases. Second, we focus on export-induced changes in firms' marketing. Future studies may be able to disentangle what part of the marketing mix or function (especially market research) is especially likely to benefit from export experience. Third, our empirical results suggest that the productivity increases due to export-induced marketing investments are particularly persistent over time. Put differently, we find that exporting firms continue to benefit from their export experience. Such timing effects have a large potential to inform managers since they hint at a sustainable source of competitive advantage. Explaining these timing effects of exploitative learning by exporting deserves dedicated theoretical explanations and empirical designs. We consider them as particularly fruitful paths for future investigations. Finally, we would urge future research to investigate if our findings are generalizable across heterogeneous firms or whether one can identify a systematic pattern of differences in the impact according to firm size, maturity or industry.

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8. Figures

Figure 1: Dominant mechanisms explaining export-induced investments

	Export-induced R&D investments	*Export-induced marketing investments*
Ex-ante to exporting	- Product life cycle - Creation of internationally competitive products	- Market research and ex-ante adaptation to demands, rules and competition in export markets
Ex-post to exporting	- Absorption and exploitation of knowledge obtained on export markets - Fixed costs from R&D investments provide opportunities for economies of scale and scope in multiple international markets	- Adaptation of product designs or promotion strategies

Figure 2: Dominant mechanisms linking export-induced investments to firm performance

	Export-induced R&D investments	*Export-induced marketing investments*	*Interaction of export-induced R&D and marketing investments*
Ex-ante to exporting	- Introduction of increasingly competitive products on export markets	- Additional sales from products and promotions adapted to export markets	- Additional sales from complementary relationship between R&D and marketing activities
Ex-post to exporting	- Exploitation of knowledge obtained on export markets - Fixed costs from R&D investments provide opportunities for economies of scale and scope in multiple international markets	- Additional sales from products and promotions adapted to export markets - Fixed costs from marketing investments provide opportunities for economies of scope through brand awareness and equity in international markets	

9. Tables

Table 1: Descriptive statistics, N=9,232

	Overall sample				By group of interest				
					Non-exporting firms N=8651		Switching firms, N=541		t-test on mean difference
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Mean	Std. Dev.	
Mktg	0.727	1.840	0	41.416	0.701	1.779	1.261	2.571	***
RD	0.256	1.544	0	63.730	0.239	2.165	0.524	0.010	***
Size	3.44	0.910	2.485	7.458	3.412	0.010	3.891	1.200	***
Foreign capital	2.902	15.542	0	100	2.470	14.310	9.750	27.840	***
Market growth	0.235	0.424	0	1	0.232	0.005	0.280	0.020	**
Financial constraints	1.243	21.254	-588.025	1741.796	1.316	20.853	0.100	26.810	

Table 2: Probit estimation on the likelihood of switching from non-exporting to exporting, N=9,232

Variables	**Coeff.**		**Std err.**
Size	0.217		(0.155)
Size^2	-0.002		(0.018)
Foreign capital	0.005	***	(0.001)
Market growth	0.089	*	(0.051)
Financial constraints	-0.003		(0.002)
Constant	-5.246		(130.552)
Log-likelihood			-1933.44
Joint significance of sector dummies		χ^2 (19) = 58.11***	
Joint significance of region dummies		χ^2 (7) = 13.11*	
Joint significance of time dummies		χ^2 (17) =53.84***	

Notes: *** (**, *) indicate a significance level of 1% (5%,10%). The model contains a constant, industry and year dummies (not presented).

Table 3: Matching results

	Treated firms N = 446		Selected control group N = 446		t-test on diff. in means
Variables	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	
Control variables					
Size	3.634	1.060	3.617	1.008	p=0.809
Size^2	14.334	9.439	14.097	8.814	p=0.701
Foreign capital	2.544	15.495	2.544	15.495	p=1.000
Market growth	0.271	0.445	0.262	0.440	p=0.770
Financial constraints	0.925	9.596	0.708	5.173	p=0.679
Outcome variable					
$Mktg_{t-2}$ (N^T=306;N^{UT}=300)	0.981	2.037	0.728	2.157	p=0.206
RD_{t-2} (N^T=308;N^{UT}=297)	0.361	1.506	0.279	1.632	p=0.570
$Mktg_{t-1}$ (N^T=430;N^{UT}=389)	0.921	1.733	0.648	1.157	p=0.011
RD_{t-1} (N^T=432;N^{UT}=394)	0.535	3.114	0.419	3.395	p=0.635
$Mktg_t$	1.126	2.199	0.655	1.286	p<0.000
RD_t	0.405	1.816	0.215	0.890	p=0.051
$Mktg_{t+1}$ (N^T=401;N^{UT}=389)	1.000	1.984	0.645	1.197	p=0.007
RD_{t+1} (N^T=400;N^{UT}=388)	0.474	1.826	0.240	0.927	p=0.027
$Mktg_{t+2}$ (N^T=345;N^{UT}=336)	0.930	1.661	0.768	1.493	p=0.228
RD_{t+2} (N^T=346;N^{UT}=332)	0.525	2.721	0.260	1.040	p=0.102

Notes: T-statistics are based on Lechner's (2001) asymptotic approximation of the standard errors that accounts for sampling with replacement in the selected control group. N^T refers to the number of observations for the treated firms and N^{UT} to the number of observations for the untreated firms for outcome variables where we lose observations because of time lags. Since we use sampling with replacement, the control group can be smaller than the treated group.

Table 4. Production function estimation accounting for autocorrelation of order 1 (AR1); dependent variable: ln(value_added)$_{t+2}$

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
α_i^{RDTT} *(t-1)*	0.040 (0.046)			0.047 (0.048)		
α_i^{MktgTT} *(t-1)*	0.101* (0.053)			0.102* (0.059)		
$\widehat{R\&D}_i^c$ *(t-1)*	0.046* (0.025)			0.046* (0.025)		
$\widehat{Mktg}_i^c$ *(t-1)*	0.053*** (0.021)			0.053*** (0.020)		
α_i^{RDTT} *(t)*		0.018 (0.031)			0.020 (0.032)	
α_i^{MktgTT} *(t)*		0.088** (0.044)			0.088** (0.044)	
$\widehat{R\&D}_i^c$ *(t)*		0.017 (0.026)			0.017 (0.026)	
$\widehat{Mktg}_i^c$ *(t)*		0.066*** (0.023)			0.066*** (0.023)	
α_i^{RDTT} *(t+1)*			0.056 (0.039)			0.057 (0.040)
α_i^{MktgTT} *(t+1)*			0.087* (0.048)			0.089* (0.053)
$\widehat{R\&D}_i^c$ *(t+1)*			0.042 (0.031)			0.042 (0.031)
$\widehat{Mktg}_i^c$ *(t+1)*			0.070*** (0.027)			0.071*** (0.027)
α_i^{RDTT}*(t-1)* * α_i^{MktgTT}*(t-1)*				-0.049 (0.063)		
α_i^{RDTT}*(t)* * α_i^{MktgTT}*(t)*					-0.009 (0.033)	

α_i^{RDTT}*(t+1)* * α_i^{MktgTT}*(t+1)*						-0.012 (0.034)
Foreign capital	0.085*** (0.017)	0.085*** (0.016)	0.077*** (0.015)	0.085*** (0.017)	0.085*** (0.016)	0.080*** (0.015)
Patent stock	-0.195 (0.555)	0.055 (0.376)	0.001 (0.374)	-0.200 (0.556)	0.055 (0.376)	0.083 (0.371)
Capital	0.008*** (0.002)	0.009*** (0.002)	0.009*** (0.002)	0.008*** (0.002)	0.009*** (0.002)	0.009*** (0.002)
Size	1.027*** (0.025)	1.039*** (0.022)	1.042*** (0.021)	1.030*** (0.025)	1.039*** (0.022)	1.043*** (0.022)
Constant	9.964*** (0.130)	9.833*** (0.101)	9.814*** (0.101)	9.964*** (0.130)	9.833*** (0.101)	9.839*** (0.100)
N of obs.	5373	6326	6228	5373	6326	6228
Overall model significance (Wald chi2)	4319,75***	5334,05***	5289,43***	4321,38***	5339,13***	5304,11***
Joint signif. of year dummies (chi2(16))	310,18***	382,69***	374,46***	310,18***	382,58***	374,29***
Joint signif. of industry dummies (chi2(19))	199,58***	227,26***	223,98***	199,65***	227,24***	224,04***

Notes: *** (**, *) indicate a significance level of 1% (5%, 10%). Standard deviations in parentheses are robust. All models contain industry and year dummies (not presented). α_i^{RDTT} and α_i^{MktgTT} stand for export-induced parts of R&D and marketing investments respectively. $\widehat{R\&D}_i^c$ and $\widehat{Mktg}_i^c$ stand for the counterfactual parts of R&D and marketing investments respectively, i.e. investments which would have taken place even if a firm would have sold its products only in the domestic market.

Appendices

Appendix 1: Industry distribution

Industry	Number of firms
Meat products	300
Food and tobacco	1,267
Beverages	182
Textiles	1,044
Leather and footwear	213
Wood and wood products	376
Paper	202
Publishing and printing	711
Chemical products	272
Plastic and rubber products	400
Non-metal mineral products	916
Metallurgy	106
Metallic products	1,254
Machinery and equipment	341
Office machinery and computing	164
Electronics and electronic equipment	486
Autos and motor vehicles industry	181
Other transport equipment	137
Furniture	589
Miscellaneous manufacturing	141
Total	9,232

Appendix 2: Cross-correlations (N=9,232)

		1	**2**	**3**	**4**	**5**	**6**
1	*Mkgt*$_t$	1.000					
2	*RD*$_t$	0.065*	1.000				
3	*Size*	0.223*	0.109*	1.000			
4	*Foreign capital*	0.118*	0.012	0.325*	1.000		
5	*Market growth*	0.045*	0.049*	0.101*	0.016	1.000	
6	*Financial constraints*	-0.011	-0.001	-0.005	-0.017	0.005	1.000

Appendix 3: IV regression instrumenting for the decision to export on marketing and R&D intensity

	Mktg		*R&D*	
	Coeff.	**Std. err.**	**Coeff.**	**Std. err.**
Export	4.194 ***	(1.246)	3.576 *	(1.947)
Size	-0.653	(0.437)	-0.378	(0.324)
Size2	0.107*	(0.057)	0.060	(0.045)
Foreign Capital	0.000	(0.004)	-0.010 ***	(0.004)
Market growth	0.123 **	(0.063)	0.090	(0.061)
Financial constraints	-0.001	(0.001)	0.000	(0.001)
Constant	-2.612 *	(1.458)	-3.182 *	(1.845)
F(50, 1940)	125.10 ***		127.01 ***	
Joint significance of sector dummies	90.60 ***		45.46 ***	
Joint significance of region dummies	7.01		20.59 ***	
Joint significance of time dummies	24		19.98	
F-test of excl. instr. (1st stage: marketing investment)	109.93 ***			
F-test of excl. instr. (1st stage: R&D investment)			108.7 ***	

Note: Standard errors are clustered at the firm level. *** (**, *) indicate a significance level of 1% (5%, 10%). The first stage regressions can be obtained from the authors upon request

Appendix 4: Production function estimation accounting for autocorrelation of order 1 (AR1); dependent variable: ln(sales)t+2

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
α_i^{RDTT} *(t-1)*	0.009 (0.047)			0.014 (0.046)		
α_i^{MktgTT} *(t-1)*	0.049** (0.025)			0.053** (0.027)		
$\widehat{R\&D}_i^c$ *(t-1)*	0.011 (0.013)			0.011 (0.013)		
$\widehat{Mktg}_i^c$ *(t-1)*	0.031*** (0.012)			0.030*** (0.012)		
α_i^{RDTT} *(t)*		-0.006 (0.017)			-0.016 (0.021)	
α_i^{MktgTT} *(t)*		0.007 (0.025)			0.005 (0.025)	
$\widehat{R\&D}_i^c$ *(t)*		0.009 (0.016)			0.009 (0.016)	
$\widehat{Mktg}_i^c$ *(t)*		0.023* (0.014)			0.023 (0.014)	
α_i^{RDTT} *(t+1)*			-0.016 (0.023)			-0.018 (0.022)
α_i^{MktgTT} *(t+1)*			0.080*** (0.023)			0.075*** (0.025)
$\widehat{R\&D}_i^c$ *(t+1)*			0.041** (0.017)			0.040** (0.016)
$\widehat{Mktg}_i^c$ *(t+1)*			0.061*** (0.020)			0.061*** (0.022)
α_i^{RDTT}*(t-1)* * α_i^{MktgTT}*(t-1)*				-0.030 (0.034)		
α_i^{RDTT}*(t)* * α_i^{MktgTT}*(t)*					0.032* (0.019)	

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
α_i^{RDTT}*(t+1)* * α_i^{MktgTT}*(t+1)*						0.018 (0.018)
Foreign capital	0.042*** (0.014)	0.059*** (0.015)	0.055*** (0.015)	0.042*** (0.014)	0.059*** (0.015)	0.055*** (0.015)
Patent stock	0.231 (0.491)	0.131 (0.390)	0.214 (0.356)	0.228 (0.492)	0.131 (0.390)	0.251 (0.356)
Capital	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
Size	0.090*** (0.042)	0.581*** (0.038)	0.606*** (0.035)	0.490*** (0.042)	0.581*** (0.038)	0.606*** (0.035)
Constant	12.601*** (0.224)	12.14*** (0.170)	12.05*** (0.178)	12.60*** (0.224)	12.08*** (0.168)	12.049*** (0.178)
N of obs.	5346	6297	6203	5346	6297	6203
Overall model significance (Wald chi2)	1117,61***	1498,31***	1591,93***	1118,27***	1498,45***	1592,63***
Joint signif. of year dummies (chi2(16))	518.91***	603,97***	602,07***	518,55***	604,21***	602,81***
Joint signif. of industry dummies (chi2(19))	159,53***	195,02***	205,38***	159,50***	194,94***	205,31***

Notes: *** (**, *) indicate a significance level of 1% (5%, 10%). Standard deviations in parentheses are robust. All models contain industry and year dummies (not presented). α_i^{RDTT} and α_i^{MktgTT} stand for export-induced parts of R&D and marketing investments respectively. $\widehat{R\&D}_i^c$ and $\widehat{Mktg}_i^c$ stand for the counterfactual parts of R&D and marketing investments respectively, i.e. investments which would have taken place even if a firm would have sold its products only in the domestic market.