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Spillovers to foreign market participants: assessing the impact of export strategies on innovative productivity

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Abstract

Although a substantial body of research has investigated spillovers to FDI, we know very little about whether, and how, firms stand to benefit from spillovers without making such crossborder investments. In this study I investigate this issue by examining the *ex-post* innovative benefits that accrue to exporting firms. I argue that exporters access diverse knowledge inputs not available in the domestic market. This knowledge spills back to the focal firm and results in increased innovation. I explore how exporters derive such knowledge-based advantages by examining the relationship between export strategies and innovative productivity. Specifically, I contend that firms that export to developed countries will experience increased innovative productivity. Similarly, firms that reach the foreign market directly rather than relying on export brokers should innovate more, as they maintain closer ties with their information conduits. The empirical analysis is conducted using a stratified representative sample of Spanish manufacturing firms from 1990 to 1997. The dependent variable (innovation) is measured using several widely employed proxies including patent counts and innovation counts. I find that export strategies influence innovation in complex ways. I discuss the relevance of these findings for research in international business, strategy, and innovation.

Key words • exporting • innovation • international trade • learning from exporting • spillovers

Internalization theory asserts that in order to succeed internationally, a firm should possess advantageous assets and capabilities (Hymer, 1970, 1976; Buckley and Casson, 1976). These advantages are initially developed in the domestic market and then exploited abroad. Following this fundamental insight, researchers sought to identify firms that possess the 'right' characteristics for expansion. Results show that firms with distinctive technological, marketing and managerial capabilities are more prone to expand internationally and most likely to benefit from foreign direct investment (FDI) (see Caves, 1996; Morck and Yeung, 1991, 1992).

Recently, scholars have offered an alternative inducement to engaging in FDI. Researchers have argued that since firms can channel knowledge from the local host environment through its subsidiaries, firms may expand abroad in order to source, rather than exploit, knowledge (Cantwell, 1989; Ghoshal and Bartlett, 1990; Dicken, 2003a; Martin and Salomon, 2003). Empirical evidence suggests that firms do indeed enter, acquire, or joint venture in other countries for the purpose of sourcing knowledge (Kogut and Chang, 1991; Cantwell, 1995; Almeida, 1996). This stream of research has become labeled the reverse internalization (asset-seeking) view of FDI.

The fundamental assumption associated with this perspective is that firms need to establish a local presence to benefit from knowledge that resides abroad. So while we know that firms may acquire technologies and increase their innovative productivity by investing abroad, we know very little about whether firms can absorb knowledge outside their national boundaries without making such crossborder investments. I explore this question by examining how innovative benefits accrue to exporting firms.

In this study I assess the applicability of reverse internalization logic to export strategies. I contend that foreign market contact via exporting provides firms with exposure to diverse knowledge inputs located in foreign markets (and not available in the domestic market). Export strategies employed by the firm influence the flow of that knowledge, and thereby affect innovative productivity. Specifically, I argue that firms that export to developed countries, and export directly to the foreign market, should experience innovative boons.[1]

In order to test the hypotheses, I examine the exporting behavior of a sample of 1050 manufacturing firms from the Spanish economy between 1990 and 1997. These data provide a comprehensive and detailed view of exporting activity in one country. Moreover, the panel data allow me to better isolate how the hypothesized variables, versus other sources of firm heterogeneity, influence innovation over time.

In the next section, I briefly review the extant research on reverse internalization and discuss how these arguments have been extended to research on export strategy. I subsequently generate hypotheses about how export strategies influence innovation. The third and fourth sections describe the data and methods employed to test the hypotheses. The fifth section presents empirical results. The final section discusses the relevance of the findings for research in international business, strategy and innovation.

Theory and hypotheses

Geographical distance imposes constraints on a firm's ability to access information. This is because knowledge can be geographically bound, and subsequently unavailable to those who do not participate in that boundary (Kogut, 1991; Nelson, 1993; Almeida and Kogut, 1999). The prevailing logic therefore

advises that in order to overcome these constraints, firms should locate proximally. By agglomerating, firms can benefit from location externalities and take advantage of specialized labor and knowledge inputs (Marshall, 1920; Porter, 1990; Almeida, 1996). Extending this logic to foreign entry, firms can tap foreign knowledge bases to acquire knowledge not available in the domestic market via FDI.

There are several mechanisms through which firms can acquire such knowledge. First, firms can simply hire local employees. Entry affords them access to the local labor pool and the expertise possessed by those individuals (Almeida, 1996). Second, firms can gain knowledge through technology spillovers from competitors (Shaver and Flyer, 2000). Similarly, firms can access the knowledge and technology they lack from local joint-venture partners (Kogut and Chang, 1991). Third, firms have access to local knowledge via informal channels such as trade associations; local social engagements; and information exchanges between scientists, managers, and engineers. Finally, firms acquire knowledge through their customer base, as customers are likely to suggest specific improvements that stimulate innovation (von Hippel, 1988, 1989; Clerides et al., 1998). In short, entrants become connected in the domain and privy to ongoing research and technological developments.

Results consistent with these claims abound. For example, Kogut and Chang (1991) observed that Japanese firms entering the US invested in industries in which US firms were relatively strong. In addition, they found that Japanese firms preferred joint-venture entries when they lacked technological expertise in a particular industry. The authors concluded that Japanese entrants sought skills, particularly from joint-venture partners, when investing in the US. Corroborating, Cantwell (1993) showed that foreign parents established subsidiaries in Britain in geographical areas of technological expertise. Likewise, Mariotti and Piscitello (1995) found that the FDI location choice of firms investing in Italy was principally based on information availability. Finally, Shan and Song (1997) discovered that US firms with many patents were likely targets of foreign takeovers.

These results provide evidence that firms often seek to acquire knowledge when they enter foreign locations. Whether firms used the knowledge available to them in the host country was less clear. However, Almeida (1996) demonstrated that foreign semiconductor firms investing in the US were more prone to cite local firm patents when they innovated. Likewise, Cantwell and Piscitello (1999) showed that international growth led firms to develop competences in new technological fields. Penner-Hahn and Shaver (2005) found a similar effect for firms that invest in foreign R&D facilities. Specifically, firms benefited from increased patent output after investing in foreign R&D facilities. Thus, recent evidence suggests that not only do foreign entrants actively seek knowledge when investing abroad; they use this knowledge to innovate.

But the question remains whether firms that do not engage in crossborder investments can gain access to knowledge embedded in a foreign environment.

At first glance it appears as if the lack of a physical presence in the foreign environment might preclude exporting firms from accessing locally, regionally or nationally bound knowledge. Recent work in the international trade and strategy literatures suggests otherwise.

At the macro level, scholars have argued that trade helps facilitate the bi-directional exchange of knowledge across borders (Grossman and Helpman, 1991, 1993). As such, inward spillover benefits should not be confined to direct investment. By engaging in trade, lower-productivity countries may catch up with leaders (Ben-David and Loewy, 1998; Feeney, 1999). The argument runs as follows. Trade opens lower-productivity countries to knowledge from their well-endowed destination countries. As that knowledge filters back to the domestic country and is incorporated into the domestic production function through technology transfer, the low-productivity country experiences higher growth (for a review see Bernard and Jensen, 2004). Although there has been considerable debate in the literature about whether countries accrue spillovers from well-endowed destinations, poorly-endowed destinations, or both (Kozul-Wright and Rowthorn, 1998), this research goes a long way in identifying the *ex-post* impacts of exporting behavior for the exporting country.

Although exporting firms lack a direct presence in the host environment, they may still benefit from inward knowledge spillovers from customers, competitors and suppliers (Salomon and Shaver, 2005a). Exporters may receive valuable information about product preferences, competing products and the local environment from local customers. They also confront competitors in the host country that would have otherwise escaped their purview. Although perhaps not to the extent of their FDI counterparts, they can become connected in the domain by engaging in dialogue with host-country competitors and suppliers. Further, exporters can potentially hire host-country employees to bring expertise back to the home country.

Competing in the foreign market allows exporting firms to amass market and technological information (Clerides et al., 1998). Because consumers from different countries do not share identical tastes, the end products desired by consumers in the destination country may vary from those offered in the home country. Market information passed from the foreign customer to the focal firm may help firms tailor products to meet the specific needs of foreign customers (Vernon, 1966, 1979) or innovate in the domestic market as a direct result of the feedback they receive from those customers. Similarly, exporting firms encounter novel technological knowledge in the destination country. Through repeated interactions with various agents in the foreign environment, the focal firm becomes privy to technological discoveries made in the foreign location (Grossman and Helpman, 1991, 1993). The focal firm may gain technological insights and use this knowledge to improve existing products or invent new ones. In sum, theory suggests that exporters should be able to access diverse knowledge inputs not available in the domestic market, and use this knowledge to foster learning.

Although theory has highlighted the potential for learning from exporting, the firm-level strategy literature has just begun to examine these relationships. In economics, scholars generally look at firms to see if their productivity increases after they become exporters. While some authors fail to find support for expected productivity increases (Clerides et al., 1998; Delgado et al., 2002; Bernard and Jensen, 2004), others do find evidence consistent with learning (Aw et al., 1998; Ozler and Yilmaz, 2001; Blalock and Gertler, 2004). Departing from that literature, Salomon and Shaver (2005a) suggest that the mixed empirical findings might be a function of the dependent variable. They argue that in order to evaluate whether firms have learned, a better measure might assess how firms' innovation productivity responds to exporting. Those authors find a consistent increase in innovation for firms after they become exporters. Specifically, Salomon and Shaver (2005a) find that exporters tend to introduce more new product innovations very quickly after market entry and file for significantly more patents several years after entry into export markets.

In sum, theory suggests that knowledge creation and realization are affected by knowledge access. Moreover, empirical results provide preliminary evidence that exporting firms benefit from the access they gain to knowledge that resides abroad. However, we know less about how the export strategies that firms use to reach foreign markets influence innovative productivity. There exists substantial heterogeneity in export strategies; and expectedly, these strategies have performance implications. To my knowledge, no study has explicitly examined how particular export strategies influence innovative output. I turn to that issue in the next section where I explore how the strategies used by export firms affect knowledge flows, and thereby influence innovative productivity.

Spillover heterogeneity among exporters

Because information is imperfectly distributed (Hayek, 1945), the availability of information varies across national markets (Dicken, 2003b). Given the diversity of knowledge inputs available across geographic markets, the locations to which a firm exports can affect the type of knowledge that firms access and absorb. In this section I address the distinctive knowledge inputs available to firms in different locations, and consider the opportunity for firms to collect and use that knowledge to expand capabilities. Specifically, I consider differences in the knowledge inputs available to firms that export to developed (OECD) compared with developing (non-OECD) countries, and their likely impact on innovation.[2]

Marshall (1920) first observed that economic activity was drawn to certain regions. Proponents of the asset-seeking motivation for FDI draw on Marshall's observations to argue that firms invest in technologically advanced regions in order to tap locally embedded knowledge and increase innovative output (see Dunning, 1998 for a review). The exporting corollary suggests that if firms export to regions that are rich with knowledge, and knowledge spills back to

those firms that export, then firms that export to well-endowed regions should benefit disproportionately (Grossman and Helpman, 1991). Furthermore, it is more likely that the knowledge benefit derived in more advanced regions is technological in nature; that is, firms benefit from exposure to knowledge that is at the technological frontier. In developed countries, exporters can benefit from the technological expertise of their buyers, and gain technological insights about competing products and technological processes (von Hippel, 1988, 1989; Clerides et al., 1998; Salomon and Shaver, 2005a). For example, the 30 OECD countries account for about 80 percent of total worldwide R&D spending, and nearly 98 percent of all patenting activity (OECD, 2003). When a firm exports to developed (OECD-member) countries, it would likely be in a much better position to have access to, and absorb, technological knowledge residing in the environment than if it exported to developing countries.

In developing (non-OECD) countries, by contrast, firms are less likely to have access to technologically advanced knowledge. The knowledge that they gather is more likely to be market-based. Firms may learn more about consumer preferences via customer feedback, but are less likely to acquire technological expertise from their buyers and/or the competitive environment, as such technological sophistication is less likely present in those markets. And while market information passed from the foreign customer to the focal firm might help firms tailor products to meet the specific needs of foreign customers (Vernon, 1966, 1979), it will likely have a negligible impact on innovative productivity.

For these reasons, I assert that the knowledge rich in technological content in developed countries can be used to inform the innovative productivity of the focal firm. I therefore expect firms that export more to developed (OECD) countries to introduce more technological innovations *ex-post*, than similar firms that export to developing (non-OECD) countries. Otherwise stated:

> HYPOTHESIS 1 All else equal, firms that export more to developed (OECD) countries will introduce more *ex-post* technological innovations.

When bringing products to market, firms must choose between using captive agents (an internal salesforce) or independent intermediaries (outside sales agents) to reach end markets. In the marketing literature, these are referred to as distribution channel decisions, and they can be treated as analogous to vertical integration decisions from a transaction cost perspective (Anderson and Coughlan, 1987; Heide, 1994; Frazier, 1999). For exporters, distribution channel decisions generally manifest as a choice between exporting directly (managing exports from the home country using an existing, internal salesforce) or using an independent (export) broker.[3] An export broker is an independent commercial agent that acts as a market intermediary to link a seller in one country to prospective buyers in another. Firms that use export brokers often sell the product to a third-party commercial agent that takes ownership of the goods, assumes liability for the products and solicits buyers in the foreign market.

Using an export broker does not demand great financial or organizational commitment, and requires little managerial attention (Campa and Guillén, 1999). It saves on governance costs by reducing the need for layers of bureaucratic oversight, relying instead on the high-powered incentives of the market to align the interests of the broker with those of the firm (Anderson and Coughlan, 1987). In addition, brokers may represent a more efficient means of distribution to the extent that they can effectively pool products from many producers to achieve economies of scale in distribution (Heide, 1994). For these reasons, using an export broker often makes export market entry (and when necessary, exit) easier.

Although using a broker represents the less costly option, it cedes control over distribution and marketing to a third party, and potentially, puts proprietary knowledge at risk (Anderson and Coughlan, 1987; Heide, 1994; Campa and Guillén, 1999). By managing exports internally, firms more efficiently respond, and adapt, to uncertain market conditions (Heide, 1994). Firms are thereby better equipped to coordinate their own value chain in both sales and service, and as a result, achieve higher levels of customer satisfaction (Root, 1987; Terpstra, 1987). Moreover, managing exports directly allows firms to better protect proprietary, rent-generating assets from misappropriation on the part of the broker (Anderson and Coughlan, 1987; Caves, 1996; Campa and Guillén, 1999).

With respect to knowledge access and acquisition, the literature suggests that intermediaries (such as export brokers) that bridge two parties that otherwise do not communicate occupy a position of power in which they can control the flow of information between the two (Granovetter, 1973; Burt, 1992; Uzzi, 1996, 1997). Because information collected by broker intermediaries is not necessarily critical to their own operations, they are more prone to misunderstandings when transmitting information, forgetting message details and failing to convey important pieces of information because they do not recognize the relevance (Collins and Guetzkow, 1964; Miller, 1972; Huber and Daft, 1987; Gilovich, 1991; Medin et al., 2002). Moreover, if we assume that brokers act as self-interested agents maximizing their own private utility, in addition to the natural amount of information distortion, brokers may strategically fail to pass along relevant information, or intentionally pass on misinformation for their own gain (Williamson, 1985). For example, the broker may learn of a specific product improvement that could be made to better meet the need of foreign customers, yet fail to pass that information along because it may know of another supplier with a product that better meets those specifications. Rather than passing the information along to the manufacturer so that the product may be improved, the broker prefers to keep the information private and switch suppliers (rather than incur delays in product delivery and, potentially, decreased sales), depriving the focal firm of the opportunity to assimilate those technical improvements.

For the reasons identified above, indirect relationships (e.g. those characterized by the use of a broker) are not good conduits for information about technological opportunities. When information is passed indirectly, through an intermediary, it is more likely to become distorted (Bartlett, 1932; March and Simon, 1958), and this loss of integrity can prove costly to innovative search and discovery (Hansen, 2002). Although using a broker represents a less costly option to reach foreign markets than setting up an internal operation to maintain individual ties with numerous dispersed customers, Hansen (2002) finds that direct relations are especially beneficial when it comes to the exchange of technological knowledge. Campa and Guillén (1999) similarly suggest that reaching export markets directly results in better market feedback and the opportunity for enhanced learning.

By internalizing the export function and managing exports directly from the home country, firms maintain closer links with their potential information conduits (local customers, competitors, etc.). They receive information directly from the source in a manner that preserves its richness. Firms can then assimilate this information and use it to develop new products. By contrast, firms that rely on export brokers simply turn the product over to a commercial agent that orchestrates the trade. In this latter situation, the broker becomes the information conduit. As such, less pertinent or distorted information siphons back to the focal firm, and I expect firms that use export brokers to make fewer innovations than firms that export directly to the foreign market. Maintaining direct relations to both customers and competitors in the foreign environment assures the focal firm that more, and richer, technological and market knowledge will permeate firm boundaries. Stated formally:

HYPOTHESIS 2 All else equal, firms that export directly to the foreign market will introduce more ex post innovations than those that use export brokers.

Sample and method

The data I employ to test the hypotheses are from a yearly survey initiated in 1990 by the Fundación Empresa Pública with the financial support of the Spanish Ministry of Industry. The Fundación surveys a sample of Spanish manufacturing firms to get a representative picture of the country's manufacturing economy. The data cover the entire population of Spanish firms with 200 or more employees and include 4 percent of the population of firms with at least 10 but fewer than 200 employees. Although the Fundación continues administering the survey and anticipates doing so for some years, I was afforded access to data from the years 1990 through 1997.

The initial survey collected information on 2188 firms, representative of the Spanish manufacturing economy at large. When a firm drops from the sample in any given year, another with similar characteristics (of the same size, from the

same industry) replaces it. The base sample from this source then was an unbalanced panel of 3060 firms. Because I am interested in exploring the variance in strategy among export firms, and because there exists no variance in the export strategies of interest for purely domestic firms, the non-exporting firms were dropped from the analysis. From the resultant 1061 exporting firms, I removed all 11 that reported any FDI. For this set of firms there exist other, more direct, mechanisms to facilitate information exchange from outside the domestic market, and I do not want to spuriously attribute results from learning from foreign investment.[4] The final usable sample then consists of 1050 exporting firms with 8400 firm-year observations.

Data from this source offer a particularly good setting in which to study this phenomenon. The survey collects data on the innovative outcomes of a sample of firms from a single economy over time. Detailed information on export strategies, innovation, and other firm characteristics was collected for each firm year. Moreover, many of the sample firms (nearly 50%) engage in exporting. This provides rich variance among firms' exporting strategies.

Dependent variables

Since I am interested in the existence and extent of knowledge spillovers to exporting firms, my dependent variable is firm innovation. I adopt the standard definition of innovation to include combinations of existing resources and capabilities that result in new/improved products or services, new/improved organizational processes, new/improved organizational designs, and/or the opening of new markets (Schumpeter, 1942; Rosenberg, 1982; Damanpour, 1991; Afuah, 1998).

Using innovation as a manifestation of inward knowledge spillovers is consistent with other measures employed in the broader international business and innovation literatures (Penner-Hahn and Shaver, 2005; Salomon and Shaver, 2005a). To that end, I use product innovation counts and patent counts as alternative constructions of this variable. I do so for two reasons. First, each dependent variable does not impart mutually overlapping information. Incorporating both measures allows me to explore the variance unique to each construct. Further, interpreting the pattern of results across dependent variables adds to our understanding of what drives innovative productivity. For instance, Afuah (1998) suggests that market knowledge generally leads to product innovation while technological knowledge lends itself to invention (patents). Second, scholars have long argued both for and against the merits of each variable. Including both measures of innovation mitigates some of the deficiencies inherent in selecting one measure to the exclusion of the other.

Patents

The survey administered by the Fundación Empresa Pública collects information on the number of patents applied for by the focal firm in a given year. Those

seeking patent protection must file an application with the appropriate agency that governs patenting in the country or region in which it seeks protection. The European Patent Office (EPO), established as a result of the European Patent Convention (EPC) of Munich in October 1973, currently oversees and governs patent applications and grants in 19 European countries (EPO, 2000). Spain formally became a member of the EPC and aligned its national patent laws with prevailing European law on 20 March 1986 (Ulloa and Salas, 1993). However, it still maintains a national patent office. Thus, any firm choosing to patent its technology in Spain has two available options. The firm may submit its application to the EPO and designate Spain as one of the countries in which it seeks protection. Alternatively, it may apply directly to the Spanish Industrial Property Registry (SIPR). Both offices use identical criteria for granting patents and both methods offer the same protection to patent holders in Spain (Ulloa and Salas, 1993). While it costs more to file with the EPO and the grant process takes longer (an average of 18 months for the EPO as against 12 with the SIPR), if applying for protection in more than one EPC country, applying through the EPO saves on paperwork and administrative costs (EPO, 2000). The variable that I label *patent applications* captures the number of patent applications filed for protection in Spain, whether via the SIPR or the EPO.

The patent count variable that I employ departs somewhat from existing research in that it measures total patent applications (whether granted or not) rather than a count of patent applications that were later granted. As a result, these counts likely upwardly approximate the number of patents that a firm ultimately receives. For example, the EPO (2000) notes that European patent submissions have a 67 percent success rate. Unfortunately, these data do not identify the firms or patents by name; therefore, I am unable to assess which patent applications were successful and which failed. A potential problem in assessing patent applications compared with granted patents is that it may capture spurious applications filed by the focal firm. Nevertheless, because the patent application process is not costless, I expect that patent applications reflect a firm's belief that it has innovated. Therefore, a benefit of this measure is that it captures the number of innovations for which the firm believes it is worthwhile pursuing patent protection. In this sense then, patent counts of applications filed and later granted may underreport the number of innovations actually achieved by the firm.[5]

Patent data and patent counts have been used extensively in industrial economics research on technology and innovation (Scherer, 1965; Comanor and Scherer, 1969; Basberg, 1982, 1987; Henderson and Cockburn, 1994, 1996; Hall et al., 2001a). Furthermore, the strengths and weaknesses of the measure are well documented (Hall et al., 2001a).

Innovation counts

Not all innovations are patentable (Griliches, 1990). Further, firms may decline to patent certain innovations to preserve trade secrets (Levin et al., 1987).

Therefore, in order to complement the patent count measure, and to mitigate the concerns regarding patent counts as a measure of innovative output, I incorporate a second measure of knowledge spillovers, which is a count of product innovations. The survey administered by the Fundación Empresa Pública collects information on the innovations achieved by the focal firm. *Product innovations* captures the total number of new and modified products introduced by the focal firm in a given year.

Scholars have pointed out that innovation counts are less comprehensive than patents because they are more subjective (Archibugi and Pianta, 1996). Although patents are either granted or not according to some objective legislative criteria, the definition of when an innovation becomes an innovation, and when the firm identifies it as such, may be ambiguous. However, with the proper controls, both patent and innovation counts can serve as adequate proxies for innovative productivity in order to capture the flow of knowledge (Pavitt, 1984; Pavitt et al., 1987; Acs and Audretsch, 1989, 1990).

Independent variables

Export strategies

In order to test whether there are any innovative advantages to exporting to one region rather than another, I would like to have some measure of the knowledge content of the region to which a firm exports. Unfortunately, those data were unavailable from this source. Instead I use a broad measure as a proxy for the knowledge content of the destination region. In the Fundación survey, export destination markets were grouped into two broadly defined areas: developed countries and developing countries (specifically measured as OECD and non-OECD countries).[6] Firms then reported the percentage of export sales that they ship to either set of countries. Using this breakdown, I define *DC (developed-country) sales* as the percentage of export sales to developed countries (where 100 minus *DC sales* equals the percentage of export sales to developing countries). The inherent assumption in using this measure is that exporting to OECD countries provides the focal firm access to richer knowledge resources (skilled labor, more competitive firms, etc.) than exporting to lesser developing countries.[7]

The survey collects data on whether the focal firm exports directly, managing exports from the home country, or engages in some sort of commercial arrangement with an export broker or industry trade group.[8] The *export broker* measure is a dichotomous variable that captures whether or not the focal firm predominantly exports itself or via other sources. The variable takes the value of 1 if the focal firm uses a broker in any market, zero otherwise.

Because knowledge takes time to filter back to the focal firm (Cohen and Levin, 1989), the benefits of particular export strategies may not be realized until future periods. For that reason, I lag the export strategy variables. As Salomon and Shaver (2005a) show, feedback is generally direct for product

innovation. It takes one or two years for firms to collect, assimilate and translate knowledge inputs from export markets into product innovation. By contrast, it takes about three years to convert acquired knowledge into technological patents. After exploring the appropriate lag structure of the export strategy variables included in this study using distributed-lag models, I likewise found the one-year lag most explanatory for product innovations and the three-year lag most explanatory for patent applications. Based on these results and earlier research, I lag the independent variables of interest one year for the product innovation dependent variable, and three years for the patent dependent variable.

Control variables

Ever since Schumpeter (1942), researchers have sought to empirically verify whether large or small organizations were more prone to innovate. While the results have been inconclusive (Baldwin and Scott, 1987), I control for firm size to diminish the potential for a size effect in these data. Similarly, scholars have long explored the association between R&D (as an innovative input) and innovative productivity (for a review see Cohen and Levin, 1989). Although results of these studies have demonstrated wide variability in the ability to convert R&D inputs into innovative output, controlling for its potential influence seems well warranted. Likewise, theories of firm-specific advantage suggest a link between firm-level intangibles and international business activity (Hymer, 1976; Caves, 1996). Researchers typically proxy for this advantage using R&D and advertising expenditures (Caves, 1996; Morck and Yeung, 1991, 1992). Therefore, in addition to the R&D measure, I incorporate advertising intensity (*advertising intensity*) as a control.

Finally, research in international management points out that FDI parents make decisions in global networks (Prahalad and Doz, 1987; Kogut, 1983; Rangan, 1998; Salomon and Shaver, 2005b). That is, parents may allow subsidiaries to operate as freestanding units in order to respond to local market conditions. Alternatively, they can integrate the multinational corporation (MNC) under one roof for operating efficiency. For instance, an MNC may choose to conduct all R&D activities at the corporate headquarters and diffuse knowledge from one central point. In that case, we would expect headquarters to realize all innovative output. In order to control for the way in which foreign ownership of the focal firm affects innovative productivity, I incorporate a measure of foreign capital participation (*inward FDI*). The variable is defined as the percentage of ownership held in the focal firm by foreign companies in a given year. Again, because there are only 11 Spanish firms with any FDI, I do not define a similar (outward FDI) variable for Spanish-owned companies with foreign subsidiaries. Table 1 presents a list of all dependent, independent, and control variables with their definitions and expected signs.

In addition to the above control variables, I incorporate a combination of year fixed effects, and firm fixed and random effects, in order to control for other

Table 1 Variable names and definitions

Variable	Definition	Expected sign
1. Product innovations	Number of new and modified products realized by the focal firm in a given year	
2. Patent applications	Number of patents filed for in Spain by the focal firm in a given year	
3. DC sales	Percentage of total export sales that go to developed countries (compared with less developed countries)	+
4. Export broker	Categorical variable that captures whether or not the focal firm uses an export broker (0 = No, 1 = Yes)	–
Control variables		
5. R&D intensity	R&D expenditure divided by total sales for the focal firm in a given year	+
6. Advertising intensity	Advertising expenditure divided by total sales for the focal firm in a given year	+
7. Size	Natural log of total firm employees	?
8. Inward FDI	The percent of the focal firm owned by a foreign organization in a given year	?

unobservable characteristics that may systematically affect the dependent variable. The benefit is that fixed and random effects control for all stable unobserved covariates without precisely having to specify the source of the heterogeneity. The drawback is that all individual covariates (firm or industry) that influence innovative productivity cannot be identified. Because the goal is to control for rather than investigate these effects, I accept this tradeoff.[9]

Statistical method

In selecting an appropriate multivariate statistical method, I must take into account the nature of the data. Specifically, the dependent variable is a bounded count measure. It can only take non-negative integer values and many of the observations are bunched close to zero. Authors have suggested a Poisson regression model to deal with dependent count variables of the sort employed in this study (Maddala, 1993; Kennedy, 1998; Greene, 2000). In fact, many studies of innovation and patent output rely on this non-linear estimation technique (Hausman et al., 1984; Graves and Langowitz, 1993).

The Poisson regression, however, is quite sensitive to its distributional assumptions. For instance, both the mean and variance are assumed to be equal. Should the mean and variance for the observed sample not be equal (overdispersion), the likelihood function would be misspecified and the estimators would be biased. The common approach then is to turn to the negative binomial regression. The negative binomial allows for relaxation of the Poisson assumption that the mean and variance equal lambda (Hausman et al., 1984;

Henderson and Cockburn, 1996). Given that overdispersion was present in these data (Cameron and Trivedi, 1986), the results that follow are from negative binomial regressions. They were obtained using the LimDep 7.0 software package (Greene, 1998).

Results

Table 2 presents summary statistics and product moment correlations for the sample of exporting firms. The average firm in this sample has about 152 employees, exports nearly Ptas3.35 billion per year (approximately US$22 million calculated using 1997 exchange rates), and invests about 1 percent of sales in R&D and nearly 2 percent in advertising. The data indicate that Spanish manufacturing firms export about 73 percent of their output to developed countries. This result is not surprising given Spain's status as a developed country and the world's ninth-largest economy by total GDP. Foreign firms own nearly a 33 percent stake in the sample firms, and 42 percent of the firms used export brokers to reach destination markets.

With respect to the dependent variables, the average firm reported 4.32 product innovations and 0.48 patent applications per year. The maximum value reported by any one firm was 950 for product innovations and 300 for patent applications. Although at first glance the maximum values appear out of line with their respective means, it is consistent with the other values reported by this company throughout the panel. Moreover, when I excluded observations based on extreme values (two or more standard deviations away from the mean) of each of these variables in sensitivity analyses, results did not change.

Correlations among the variables are generally as expected. The results in Table 2 suggest that larger firms spend more on R&D and are less likely to use

Table 2 Descriptive statistics and product moment correlations

	1	2	3	4	5	6	7	8
1 Product innovations	1							
2 Patent applications	0.08	1						
3 DC sales	–0.00	0.01	1					
4 Export broker	–0.04	–0.04	0.05	1				
5 R&D intensity	0.05	0.04	–0.07	–0.05	1			
6 Advertising intensity	0.01	0.06	–0.08	–0.02	0.08	1		
7 Size	0.02	0.03	0.00	–0.17	0.15	0.11	1	
8 Inward FDI	–0.01	–0.02	0.12	0.11	0.03	0.03	0.35	1
Mean	4.32	0.48	73.18	0.42	1.03	1.89	5.02	32.65
Std. Error	28.50	5.78	36.78	0.49	2.40	3.60	1.50	44.27
Minimum	0	0	0	0	0	0	0	0
Maximum	950.00	300.00	100.00	1.00	35.80	44.90	10.14	100.00

an export broker. The latter result is consistent with small firms' internationalization strategies (Johanson and Vahlne, 1977; Campa and Guillén, 1999). Size is positively correlated with both measures of innovation, although only weakly so. As indicated by the correlation between inward FDI and innovation, foreign-owned subsidiaries introduce fewer innovations into the local market. Somewhat interestingly, they are more likely to use an export broker.

With regard to the hypotheses, the negative correlation of export broker on both product innovations and patent applications is consistent with H2. By contrast, the correlations between developed-country sales and the dependent variables of interest are more ambiguous. It is premature, however, to conclude that such relationships disconfirm or support the hypotheses, as correlations do not control for intervening factors that have the potential to influence both the independent and dependent variables. I turn to these issues in the regression analyses below.

The results for the product innovation dependent variable appear in Table 3. Because the independent variables of interest were lagged by one year, one year's worth of data was necessarily sacrificed from the analysis. Moreover, as a result of missing data, and performing lags using missing data, the final usable sample for this analysis is 5048 firm-year observations. All specifications include year and firm fixed effects.

Table 3 Regression results for product innovations

DV = Product innovations	1	2	3
Developed country sales$_{(t-1)}$	–0.002* (–1.50)		–0.002* (–1.63)
Broker$_{(t-1)}$		–0.210*** (–2.92)	–0.215*** (–2.99)
R&D intensity$_{(t)}$	0.078*** (7.34)	0.079*** (7.50)	0.076*** (7.17)
Advertising intensity$_{(t)}$	0.012 (1.20)	0.014* (1.36)	0.013 (1.21)
Size$_{(t)}$	0.011 (0.33)	–0.004 (–0.13)	–0.006 (–0.19)
Inward FDI$_{(t)}$	0.003*** (2.82)	0.003*** (3.06)	0.003*** (3.19)
Year effects	Yes	Yes	Yes
Firm effects	Fixed	Fixed	Fixed
n	5048	5048	5048
Log likelihood	–4467.70	–4464.50	–4463.18

* $p < .10$; *** $p < .01$

In each of the models R&D intensity and inward FDI are all positively related with product innovation. The results suggest that firms that invest more in R&D realize more product innovations. The positive results for inward FDI suggest that firms with foreign parents perform better at product innovation than those without FDI, contrary to what the correlations suggest. With regard to advertising, there does not appear to be a consistent effect on product innovation, although it appears positive and significant in column 2. There is no relationship between firm size and product innovation. Because these are contemporaneous effects, the findings should be interpreted with caution because causality could run in either direction. For example, the results on R&D could suggest that firms that experience more product innovations subsequently spend more to further develop and support those innovations. Regardless, the results on the control variables are fairly consistent across specifications.

Column 1 tests the effects of location preference on product innovation. Somewhat surprisingly, I find that firms that export predominantly to developed countries experience significantly fewer *ex-post* product innovations than those that prefer less developed countries. Not only is this result inconsistent with H1, the effect is significant in the opposite direction to that hypothesized. Although somewhat puzzling, because the product innovation dependent variable includes product improvements and modifications, this result may suggest that the information gathered by exporting firms results in the tailoring or modification of particular products to meet the needs of heterogeneous foreign consumers in less developed countries. Given Spain's status as a developed country (Guillén, 2001, 2005), Spanish consumers potentially share more in common with developed-country consumers. Spanish firms likely face greater consumer heterogeneity in developing countries than developed countries. As such, firms may tailor, change or modify their products more to meet the needs of the heterogeneous consumers they face in less developed countries. In addition, I cannot rule out the possibility that these product modifications take the form of product simplifications and quality reductions aimed at reducing cost and price. Such cost and price reductions may be necessary in order to sell to lower-income consumers in developing countries.

Column 2 presents the results for broker effects. This tests the effects of intermediaries on the knowledge acquisition process. It was argued that firms that use export brokers would experience fewer innovations as they keep less direct ties with their sources of information. Consistent with this hypothesis, I find that exporting firms that employed export brokers in the prior year experience significantly fewer product innovations in the current year than those firms that export on their own.

Results on the full specification appear in column 3 of Table 3. The directionality and significance levels are consistent with those presented earlier. The results are robust to this specification and thus lend added support to the previous findings.

Table 4 Regression results for patent applications

DV = Patent applications	1	2	3	4
DC Sales$_{(t-3)}$	0.004*		0.005*	0.005**
	(1.47)		(1.62)	(1.45)
Broker$_{(t-3)}$		–0.814***	–0.822***	–0.408**
		(–4.33)	(–4.39)	(–2.19)
R&D intensity$_{(t)}$	0.228***	0.213***	0.222***	0.224***
	(3.47)	(3.31)	(3.51)	(6.29)
Advertising intensity$_{(t)}$	0.120***	0.111***	0.107***	–0.003
	(4.12)	(3.91)	(3.77)	(–0.14)
Size$_{(t)}$	0.386***	0.339***	0.333***	0.513***
	(4.92)	(4.23)	(4.22)	(5.10)
Inward FDI$_{(t)}$	–0.010***	–0.009***	–0.009***	–0.002
	(–4.26)	(–3.60)	(–3.66)	(–0.94)
Year effects	Yes	Yes	Yes	Yes
Firm effects	No	No	No	Random
n	3128	3128	3128	3128
Log likelihood	–1504.48	–1496.47	–1495.21	–1509.79

* $p < .10$; ** $p < .05$; *** $p < .01$

The patent application results appear in Table 4. Again, because the independent variables of interest were analyzed using a three-year lag, and as a result of missing data, the final usable sample for this analysis is 3128 firm-year observations. Although all specifications include year dummy variables, the models do not include firm fixed effects.[10] Instead, the results are presented using the standard negative binomial model. In column 4 a random effect Poisson is presented to check the robustness of the results to unobserved firm heterogeneity. Although the firm fixed-effect model would be preferable, as Greene (2001) points out, the random-effect specification effectively controls for unobserved effects in similar fashion.

With regard to the control variables, results similar to those for product innovation prevail for R&D; namely, R&D is positively related to patent applications. However, in contrast to the product innovation results, there are consistent and significant advertising and size effects on patent applications. Likewise, the inward FDI measure turns negative and significant for patent applications. This latter result may point to an interesting difference between the locus of product innovation and the locus of invention. For patent applications, it may be that the parent firm manages the process with a greater multinational network in mind, and takes control of the process of both invention and patent application (Kogut, 1983; Rangan, 1998; Salomon and Shaver, 2005b). By

contrast, the positive effect of inward FDI for product innovations may hint at the localization of demand. In the case of product innovations, parents may allow subsidiaries greater autonomy to innovate and respond to local market conditions (Prahalad and Doz, 1987). But again, because these are contemporaneous effects, the findings should be interpreted with caution due to the potential for reverse causality.

Turning to the variables of interest, column 1 tests H1. An interesting contrast to the product innovation result presents itself with regard to the location of export sales. Specifically, the positive and significant coefficient for the developed country sales variable suggests that firms that export to developed countries subsequently experience more patent applications. This result is diametrically opposed to that attained with product innovation as the dependent variable. So while firms that export to developed countries introduce fewer *ex-post* product innovations, they submit more patent applications. This result may speak to the fundamental difference in the underlying knowledge that leads to product innovation versus patent application. Invention (patents) relies upon technological knowledge inputs. When firms export to developed countries, they likely gain access to knowledge that is rich in technological content. This encourages invention. By contrast, consumer feedback regarding product attributes likely drives the product innovation results. As mentioned earlier, Spanish exporting firms that reach developed countries need not tailor or modify their products as much for homogeneous consumers. Therefore, they experience fewer product innovations.

The export broker variable is added to the specification in column 2. Again, these results turn out negative and significant, suggesting that firms that used brokers to reach their export markets in period (t–3) experience fewer patent applications at time (t). This provides further support for H2. In columns 3 and 4, all variables are included into the specification. Column 4 adds the firm random effect. The results are generally consistent with those presented in earlier specifications and as such inferences do not change.

Sensitivity and robustness

At this point, several theoretical and methodological issues merit attention. In order to assess the robustness and sensitivity of the results to these considerations, I tested several variants of the models presented here.[11]

First, in this article I have introduced independent variables that have been dependent variables in past studies. Specifically, the decisions to export to particular destinations (developed as opposed to developing countries) and to use an export broker are endogenous to the focal firm. Scholars have pointed out that not controlling for endogeneity of this sort can lead to systematic biases in empirical results (Masten, 1993; Shaver, 1998; Hamilton and Nickerson, 2003). I take several steps to mitigate the possibility of such a self-selection bias.

Specifically, I introduce lags of the independent variables in order to ensure that the direction of causality runs from the independent variables to the dependent variables, and not vice versa. Moreover, if we assume that firms make consistent decisions over time with respect to the independent variables in question, firm effects can do a sufficient job of controlling for endogeneity caused by unobserved firm heterogeneity (Greene, 2001). Nevertheless, there is still a possibility that the results may be biased if within-firm variance on the choice variables is great. For this reason, I estimated two-stage Heckman (1979) models controlling for the endogeneity of export location and export broker using foreign GDP, exchange rates and exchange rate volatility as instruments. The results of the second-stage treatment models were largely consistent with those presented in the article with one exception: The *DC sales* variable did not significantly differ from zero in some models with product innovation as the dependent variable. Otherwise, inferences are unchanged. However, caution is warranted when interpreting coefficients from two-stage models in a panel setting because changes in strategy choice are necessarily treated as exogenously determined (Hamilton and Nickerson, 2003). These models pool within-firm data across time and treat same firm observations as independent, leading to violations of regression assumptions when firms switch their decisions. For these reasons, for panel data, models with firm effects are generally preferred to selection models (Greene, 2001).

Second, there is the possibility that these results are subject to a sample selection bias as a result of a dependent variable that is observed only for a restricted, non-random, sample. Specifically, by eliminating all non-exporting firms from the sample, some bias may be inhered in the results to the extent that firms entering export markets systematically favor some strategies over others. Bivariate tests of means across exporters and non-exporters indicated that exporting firms apply for significantly more patents, introduce more product innovations, are larger, spend more on R&D and advertising, and have a greater percentage of equity owned by foreign firms than non-exporting firms. Hence, firms are clearly not assigned randomly to the export and non-export conditions. For this reason I modeled a two-stage Heckman (1979) conditioned on the decision to export in the first stage. I used foreign GDP and exchange rates as instruments. The results of second-stage models were largely consistent with those presented in the article, and indicate that sample selection (arising from the exclusion of non-exporters from the sample) does not adversely impact on the results.

Third, if firms trade off domestic for foreign sales, the results presented may be biased to the extent that learning from foreign markets denies opportunities to learn in the domestic market. In order to account for this possibility, I examine model specifications including domestic sales as an additional control variable. The pattern of results with respect to the hypothesized variables, both in terms of magnitude and statistical significance, did not change. Moreover, consistent with prevailing literature (Salomon and Shaver, 2005b), I find a positive

association between export and domestic sales in these data (even after controlling for size), suggesting that domestic and export sales are complements rather than substitutes.

Finally, because I lag the export strategy variables while using contemporaneous control variables, there is the possibility the results will be biased if matched lag controls better account for variation in the independent and dependent variables of interest. That is, it may be statistically more appropriate to lag all independent variables to the same year, (t–3) for patent applications and (t–1) for product innovations. In order to explore this possibility, I ran models including matched control variables. The results were entirely consistent in both magnitude and effect with those presented. As such, inferences do not change.

Discussion and conclusions

Although the extant reverse internalization and international trade literatures demonstrate that firms can access knowledge and increase innovative productivity by conducting business in foreign markets, we understand far less about how international business strategies influence innovation. In this article I argue that firms access and acquire diverse knowledge inputs by strategically managing exports. In general, I find evidence consistent with that conjecture, as heterogeneity in export strategies significantly affected innovative productivity.

The findings from this study consistently supported H2, suggesting that employing an export broker negatively impacts on innovation. An intermediary inserted between the producer and consumer diminishes the quality and/or quantity of information that passes between the two. As a result, firms experience fewer *ex-post* innovations. I can make no such general conclusions regarding H1, which suggested that exporting to developed countries would aid in the realization of innovation (both product and patent). The results for this hypothesis were mixed. Although a preference for developed as opposed to developing countries positively affected patent applications, it negatively influenced product innovation. Taken together, these results imply that there may be a technological, knowledge-based advantage to be gained by exporting to developed countries. By contrast, exporting to developing countries encourages firms to modify, change or tailor products for dissimilar consumers with heterogeneous preferences.

Some caution in interpretation is warranted with respect to this latter result because I cannot rule out that the positive effect on product innovations of exporting to developing countries is driven by product simplifications and/or quality reductions. The finding begs the question of whether product simplifications and quality reductions are consistent with what we consider when we engender innovation. For example, it is unclear whether modifying a watch to remove the chronograph function in order to reduce the price to better serve

foreign consumers would meet the innovation criteria, as technological innovation is generally associated with advancing the technological frontier rather than retreating from it (OECD, 1997).

Vernon (1966, 1979), however, saw the value in collecting market information from foreign customers in order to tailor products to meet their specific needs. Moreover, Schumpeter (1942) explicitly recognized the opening of a foreign market as innovation. He writes, 'The opening up of new markets, foreign or domestic ... revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism' (1942: 82). Therefore, to the extent that product simplifications are undertaken in the endeavor of opening or reaching a new market that would otherwise be inaccessible, they can stand as an important form of innovation. There is certainly an ingenuity in recognizing that willingness to pay can be increased through product simplification.

At this point, I draw several caveats. First, this study treats brokers as homogeneous in their ability to deliver knowledge to the focal firm. However, it is likely that brokers vary both in technological competence and in their experience with local markets. As such, some brokers may be able to provide valuable information to its client firms, and in some cases, better information than might be attained by exporting directly. Moreover, firms are not randomly assigned to brokers, but rather, the process is likely characterized by one of endogenous matching in which firms select brokers, and brokers select firms. The result is that superior brokers likely match up with superior firms, and inferior brokers with inferior firms. To the extent that firms in this sample, for whatever reason, are systematically matched with inferior brokers, I may be spuriously attributing results on the broker variable to advantages of exporting directly rather than to the type of broker with which the firm is matched. Unfortunately, I have no specific information about the individual brokers used by the firms in this sample, and I cannot account for such heterogeneity or endogeneity. Some caution is therefore warranted with respect to the interpretation of broker effects.

Second, the effects examined in this article were tested solely in one particular environment, Spain. Given its status as a developed though middle-income country, some of the results are not altogether surprising. Future research would be well served to further explore whether similar results would be borne out in other contexts.

Finally, throughout the article I have treated innovation as an unambiguously positive and desirable firm outcome; one that it is tied to increased performance. However, scholars point out that the innovative process itself is fraught with uncertainty (March and Olsen, 1975; Nelson and Winter, 1982). Likewise, innovative search is costly and not always fruitful, that is, it does not always result in an implementable innovation (Dosi, 1988). If we take the standard profit maximization problem as our starting point, however, firms have the incentive to engage in innovative search in order to reduce cost, increase revenue,

or both (Tirole, 1997); and the preponderance of empirical literature supports this contention. Research indicates that innovation increases market share (Henderson and Clark, 1990; Henderson, 1993; Banbury and Mitchell, 1995), encourages sales growth (Tushman and Anderson, 1986; Anderson and Tushman, 1990), positively affects stockmarket value (Hall et al., 2001b), and enhances survival (Banbury and Mitchell, 1995; Carroll and Teo, 1996; Klepper and Simons, 2000). Although I cannot fully rule out the possibility that innovation realized as a result of exporting (or innovative search undertaken as a result of exporting) leads to sub-optimal results for the firms in this sample, the assumptions that firms have the incentive to engage in innovative search, and that innovation and performance are positively related, seem reasonable. A natural extension of this work could address the influence of export strategies on other firm outcomes such as financial performance.

The caveats notwithstanding, the results of this study have important implications for research on exporting and exporting strategy. While much of the research on export strategy addresses which firms we would expect to export and how much each firm optimally exports, few address the implications of being an exporter on other firm outcomes (Leonidou et al., 1998). This article attempts a step in that direction by arguing that export strategies affect the diversity of knowledge inputs available to the firm, the flow of knowledge received by the firm, and, thereby, innovation.

For the innovation literature, one of the most interesting implications can be gleaned by considering the results across the product innovation and patent application dependent variables. The findings suggest that exporting firms collect and use information available in both developing and developed countries, but in strikingly different ways. Specifically, knowledge acquired in developed countries stimulated technological innovation, while information gathered from less developed countries led to product modifications.

These results also inform how exporting impacts on firms' domestic innovative productivity. The findings suggest that exporting directly, and to developed countries, results in *ex-post* increases in patent applications. Because the patent measure captures applications filed for protection in Spain, the results suggest that the knowledge firms acquire abroad helps them innovate at home. The knowledge acquired in foreign markets makes firms' domestic product offerings better, and improves their competitive position at home.[12]

This study also extends theoretical and empirical work in the broader strategic management literature. Recent work on interorganizational interaction suggests that firms can acquire knowledge and gain innovative benefits from alliance or joint-venture partners (Mowery et al., 1996; Ahuja, 2000; Kotabe et al., 2003). However, we understand less than we should about how other forms of strategic interaction influence innovation (Drazin and Schoonhoven, 1996). This article helps fill this gap by examining how innovative outcomes accrue to more market-based forms of exchange such as exporting.

Finally, the outcomes of this scholarly exercise are relevant for managers. From a practitioner perspective, these results inform managers of the innovative benefits of particular exporting strategies. This research shows that export strategies can influence firm outcomes beyond simply providing a sales outlet for existing products. Exporting can be a strategic tool that has implications not only for a firm's sales, but also for its innovative productivity.

Rather than concluding, however, that all firms should consider exporting to developed countries or that all firms should export directly in order to enhance their innovation, I want to stress that combining these results with the existing literature highlights that the effect is likely contingent. Spillovers are predicated on the firm receiving information from certain types of customers and agents in the foreign environment. This, in turn, tends only to occur if the firm is able to sell its products in developed markets or bypass export intermediaries. Firms will often need enhanced productivity to reach developed markets. Likewise, they should be competitive enough to export without the aid of a broker. Should they lack this competitiveness, it is unlikely that they will be able to effectively implement such strategies, and this in turn will limit the flow of knowledge. Moreover, there are other strategic factors to consider when choosing where and how to export that are likely unrelated to innovation. As a result, exporting to developed countries or bypassing a broker for the sole purpose of enhancing innovation will likely not be optimal for all companies. All the same, because exporting is the most widely used firm strategy to tap foreign markets, it is important to understand these dynamics, and further research into these phenomena seems well warranted.

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Notes

1 The research question of interest is conditioned on exporting. That is, I am specifically interested in exploring whether export strategies impact innovation, given that a firm is an exporter. For non-exporting firms, there is de facto no variance in export strategies (at least for those strategies defined in this study).

2 It is important to recognize that not all non-OECD countries are necessarily developing countries. For example, Taiwan and Singapore are not members of the OECD, yet they are relatively advanced countries with high GDP per head, higher than those of Spain, Greece, Portugal, South Korea, Mexico, New Zealand, Turkey, the Czech Republic, Hungary, Slovakia and Poland (all OECD countries). Likewise, OECD countries are not, by affiliation alone, developed countries. Nevertheless, in this article I treat OECD countries as more

developed on average because they account for a greater share of the world's R&D spending and patenting activity. In this sense then, OECD countries are more technologically advanced than non-OECD countries.

3 There is a third option (a form of exporting directly) that includes opening a foreign sales office in order to manage exports. This option, however, represents a case of FDI, where reverse internalization arguments are likely more applicable. In order to better isolate the distinct effects of using an export broker as opposed to managing exports directly from the home market, I have not included any cases of direct investment (for the purposes of managing exports) in this analysis. I discuss the empirical implications of excluding such investments in the Sample and method section.

4 Although Spanish firms in some sectors aggressively invested abroad in the 1990s, most of this investment was in the service sector (Guillén, 2001). Spanish firms in the banking (notably BBV and Banco Santander), travel (e.g. Grupo Sol Melia) and telecommunications (Telefonica) industries were rather aggressive in investing abroad, especially in Latin America. However, Spanish firms are not nearly as strong globally in the manufacturing sector as in the service sector (Guillén, 2001, 2005). Because these data solely focus on manufacturing firms, much of this investment is not captured in my data. For that reason, and because these data come from reliable government sources, I believe the level of FDI represented in these data is accurate – although seemingly low. Nevertheless, when I include firms with foreign ownership in the analysis, I find results that are consistent with those presented.

5 Using a distributed lag model, the relationship between patent applications and R&D in these data follows a similar pattern to that between granted patent applications and R&D found by Hausman et al. (1984).

6 Ideally, I would like to have even more disaggregated data for the exact country that the firm exports to, but that information was likewise unavailable from this source. Thankfully, it does not invalidate the results. Although using a developed and developing country dichotomy is an admittedly blunt instrument, the noise inhered in the measure makes it a conservative test. That is, because not all OECD countries are developed countries, and vice versa, a significant coefficient found on this measure would suggest a true effect greater than that measured if I could precisely discriminate between all developed and developing countries, or if I performed the analyses using disaggregated, country-by-country data.

7 Using export destination (e.g. developed or developing country) as a measure of access to technological knowledge raises a potential concern. Specifically, exporting to developed as opposed to developing countries reveals varied information about a firm. The information imparted by export destination can be categorized as either selection or learning (Clerides et al., 1998). On the one hand, the fact that a firm exports to developed countries may reveal certain information about it or its environment (e.g. that it is a high-growth company, that it is more productive, that it comes from a relatively well endowed industry). On the other, exporting to developed countries should also correlate with access to intangible ideas available in the destination market that may lead to innovation. In order to separate the selection and learning effects, one must empirically control for the unwanted information that the choice to export conveys about a firm. Incorporating lags of the independent variables and firm-specific effects should effectively help mitigate some of these concerns.

8 Again, because there was little FDI in these data, firms in this sample did not open foreign sales offices as an alternative to using an export broker.

9 An alternative to firm effects would be to include industry-specific effects. As with firms, there is substantial heterogeneity across industries with respect to innovation. For instance, we can plausibly expect firms in more technical manufacturing industries such as semiconductors to innovate more than those in relatively mature industries such as grain milling. In order to control for industry heterogeneity of this sort, I opted for a combination of firm-level fixed and random effects, for as long as firms do not change industries over time

throughout the sample period, the firm effects will subsume such industry variance. Due to almost perfect collinearity between firm and industry effects, I was not able to include both effects in the same regression specifications; however, in models estimated with industry fixed effects in lieu of firm effects, the results were consistent with, and statistically stronger than, those presented.

10 Given the three-year lags and the nature of the patent application dependent variable (93% of the firm-year observations equal 0); the fixed-effect models would not converge.

11 All results discussed in this section are available from the author upon request.

12 I thank an anonymous reviewer for motivating this discussion.

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