CESIS Electronic Working Paper Series

Paper No. 368

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August, 2014

The Royal Institute of technology
Centre of Excellence for Science and Innovation Studies (CESIS)
http://www.cesis.se

Knowledge Absorption in the Development of Export Products

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Abstract: In this paper we analyze how firms' knowledge absorption capacity – given the knowledge environment – affects the development, adoption and introduction of new export products among Swedish manufacturing firms. Our model formulation builds on theoretical arguments which imply that firms can influence the usefulness of their knowledge environment by establishing formal and informal networks with input suppliers (especially suppliers of knowledge-intensive business services) and by exploiting their absorptive capacity. The model suggests that the higher the knowledge absorption in firms, the higher the introduction frequency of new export products. In particular, it is the conjunction of a high absorptive capacity and a high external knowledge potential that makes certain firms successful introducers of new export products.

Keywords: Absorptive capacity, innovation, exports, manufacturing, knowledge, Sweden

JEL classification: D21, D24, F23, L60, R30

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1 Introduction

This paper investigates how a firm's knowledge intensity and its proximity to the local and regional supply of Knowledge-Intensive Business Services (KIBS) affect the firm's introduction of new product ideas intended for exports. As such, the innovative act of the firm is reflected in its ability to introduce an export product that is completely new to itself. A firm's proximity to external knowledge supply of KIBS is assumed to induce several important externalities that the firm can benefit from in order to speed up its frequency of export innovations. In this case, a firm's access to the KIBS supply is modelled as its external knowledge potential, where the firm can draw upon knowledge flows associated with its interaction in a high-technology environment (Tilton 1971). Moreover, Mowery (1983) suggest that a firm invests in its own internal knowledge in order to acquire information that is externally available. Griffith et al. (2003) find that a firm's internal knowledge positively affects both its innovations and its assimilation of others' discoveries. Cohen and Levinthal (1989) argue that a firm's internal knowledge enhances both its efficiency of basic operations and its renewal activities. Cohen and Levinthal (1990) extend their arguments to claim that the internal knowledge of the firm improves its capacity to absorb and exploit the external knowledge that can help the firm to create and adopt new innovations.

Previous research on how internal and external knowledge affect exports of new products is to our knowledge limited, however, some empirical papers analyze the effect of internal and external knowledge on exports in general. For example, Chevassus-Lozza and Galliano (2003) find that learning effects in the French food industry stimulate firms' exports to grow. From another angle Malmberg et al. (2000) observe that the export performance of firms in the Swedish manufacturing industry is positively affected by agglomeration advantages. The findings in Johansson et al. (2014) show that firms' internal knowledge and their access to the supply of KIBS influence the export prices and number of export product varieties, while having a neutral effect on the total export value in local industries.

The purpose of this paper is to analyze how firms' knowledge absorption capacity affects the development, adoption and introduction of new export products among Swedish manufacturing firms. We do this with regard to the value, number, average unit price and average quantity per new export product. In concordance with previous studies such as Johansson et al. (2014) and Johansson and Lööf (2014), we measure the external knowledge potential by the accessibility to the employment in KIBS activities. Moreover, we introduce a model that quantitatively examines the role of a firm's absorptive capacity on its new export products. Our main contribution is that this focus allows us to empirically observe how a firm's knowledge intensity in conjunction with its external knowledge potential affects the frequency of its introduction of new export products.

By using a unique database with detailed data on more than 50000 observations we document the impact a firm's internal and external knowledge has on (i) the total value of new export product varieties, on (ii) the number of new export varieties, on (iii) the unit price of new export products, and on (iv) the average quantity exported of each new variety. We recognize that a firm's total export value is its number of varieties times its average unit price times its avgerage quantity. Because of this, we may appreciate (ii)-(iv) as value components.

In a sequence of regression equations each of these value components are regressed against first the internal knowledge, second the combination of internal and external knowledge. For the conjunction case (i.e. absorptive capacity) we test a multiplicative conjuction variable. The overall hypothesis is that the multiplicative conjunction variable has the stongest association with the three value components. The results show that the internal knowledge of a firm is associated with a higher value, number, and average price per unit of new export products. Being close to a knowledge environment allows a firm with a higher than average conjunction variable to use its internal knowledge to better access the external knowledge that later can be integrated in its innovation and adoption processes. As an additional exercise, a firm's probability of introducing new export products is regressed against the knowledge intensity and conjunction variables. The empirical analysis also examines the role of knowledge for firms that do not introduce new export products, to verify that those firms are less knowledge dependent.

2 Knowledge Mechanisms and New Export Products

Secion 2 outlines a theoretical framework for understanding firms' introduction of new export products. The latter are identified at a detailed level of differentiated product varieties, such that each variety has some market power.

2.1 Developing and Exploiting the Internal Knowledge

Developing new export products comprises activities such as monitoring novelties in the market, imitating and adopting new technical solutions, R&D efforts and innovation. All these activities are assumed to benefit from internal knowledge that the firm has accumulated by recruiting employees who embody knowledge and know-how and by accumulation of experiences from R&D efforts. In the context of the present paper the relevant knowledge comprises know-how both about product development activities and procedures for penetrating new customer markets.

Adopting and innovating new product varieties are obviously different types of processes, but they share the feature of relying on internal knowledge that is based on past efforts as well as

purchase of ready-made technical solutions and critical knowledge components. One special phenomenon in our data set is firms that are newly established and immediately start to export products that evidently are new to the firm which is new itself. In such cases we may observe a mother company that starts a new subsidiary and that equips its daughter company with novel export products. Also for events of this type we assume that the internal knowledge of the exporting firm increases the number and price of the new products.

The importance of internal knowledge is suggested by Lucas (1988) who argues that positive externalities in a firm arise from both the individual's human capital, by increasing its own productivity, as well as from the average level of human capital in the firm, by increasing the efficiency of all the production factors. Other frameworks suggest that firms' human capital fosters the development of new products. For example, Schumpeter (1934) emphasizes technological and organizational innovations as means to establish temporary monopolies. Romer (1990) notes that new and reserved products are more likely to be developed in firms with greater amount of internal knowledge.

The picture is enriched when we recognize that a firm's internal knowledge affects its absorptive capacity. Cohen and Levinthal (1990) argue that the firm's ability to recognize external knowledge and to exploit the new information, is to a large extent determined by its internal knowledge. Moreover, Griffith et al. (2003) find that the internal knowledge of firms positively affects their absorptive capacity. In research on absorptive capacity and new product development, Stock et al. (2001) observe that there are diminishing returns to absorptive capacity. On the other hand, Expósito-Langa et al. (2011) find that greater absorptive capacity positively influences product development in industrial districts.

Firms' internal knowledge has also been examined in terms of human capital (e.g. number of schooling years, workers with tertiary education, or in the form of worker experience) and how it affects the innovative behavior in firms. For example, Ganotakis (2010), finds that the relationship between human capital and innovative performance in firms is positive. Robson et al. (2012) observe that entrepreneurs with large human capital values have a greater tendency to introduce new products and process innovations, which induce firms to export more. Although these observations associate with our findings, this paper distinguishes between knowledge effects on number, average unit price and quantity of each firm's new export products.

A firm's internal knowledge assets are inputs to adoption and innovation activities that generate new product varieties that are introduced in the domestic and foreign markets. Thus, we can state our first hypothesis about a firm's internal knowledge fund:

Hypothesis 1

> The internal knowledge fund of a firm, measured by the knowledge intensity of employees, has a positive association with its number of new export products and the average price of these products. Moreover, increased internal knowledge is associated with increased total export value (sales) and decreased average export quantity per product variety.

Hypothesis 1 indicates that the knowledge intensity augments the value of new export products in firms, and augments the frequency at which new export products are being introduced. If such new products are sold in small quantities, the total export value of new varieties may eventually display a negative correlation with the knowledge intensity. However, Hypothesis 1 assumes otherwise.

2.2 The External Knowledge of the Firm

A firm can access external knowledge in different ways. The knowledge may be purchased or transferred according to a license contract, it can move into the firm through new employees who carry with them know-how and knowledge about technical solutions acquired in places where they have been employed in their previous career. Moreover, knowledge can spill over from collaboration with other firms and knowledge sources associated with universities and other organizations.

Krugman (1991) suggests that spillovers cannot easily be tracked because knowledge flows are at least partly invisible. However, more recent research has made important progress in the attempt to observe flows in indirect ways. The current presentation argues that empirical research in this area should focus on potentials for knowledge interaction and accession, by measuring these potentials and then use them as explanatory variables. In this context we also stress that knowledge flows diminish in volume and intensity as the distance between origin and destination grows.

In case studies one may find out actual channels for knowledge flows as implied by Krugman's argument and investigate the influence of distance on patent-citation frequencies, on establishment of cooperation links between innovation actors, and on attracting new employees who embody attractive knowledge. An alternative way, suggested here is to employ a potential measure that defines a field of influence which affects knowledge flows and knowledge creation in a relevant geography. Such an approach can be found among scholars like Jaffe et al. (1993), and Feldman and Audretsch (1999) who specify measures of aggregate knowledge sources and R&D activities inside an urban region. They assume that these measures affect innovation

activities of firms located in the region. Different studies of this type conclude that knowledge flows and spillovers are spatially bounded.

Calculating a Location's Knowledge Potential

In the subsequent analysis we develop the approach above, by applying a finer spatial resolution for which we collect information about firm location and location of knowledge sources. Following Johansson et al. (2003) we can then introduce a model that identifies locations *i* and *j*, and the time distance, t_{ij}, between each such pair of locations. The next step is to collect information about the size for each selected type of knowledge source, G_j, in location *j*. For any firm in location *i* we define the firm's distance-discounted knowledge potential with regard to G_j as

$$M_{ij} = \exp\{-\lambda t_{ij}\} G_j \qquad (1)$$

where λ is an estimated time-sensitivity parameter reflecting the friction for making face-to-face contacts between two locations, observing that contacts inside a location also have a time distance, signified by t_{ii}. On the basis of Equation (1) it is possible to calculate the entire external knowledge potential that firms in location *i* have as $M_i = \sum_j \exp\{-\lambda t_{ij}\} G_j$. Moreover, the knowledge of a firm's local milieu is given by $M_{ii} = \exp\{-\lambda t_{ii}\} G_i$. In this study the *G*-variable represents a location's supply of KIBS activities as these suppliers get their revenues from delivering innovation ideas and technical solutions. This means that for a firm with location in *i*, M_i measures the firm's access to the total supply of KIBS in the local and regional area, and thus represents the external knowledge potential of the firm. We use this information to present a second hypothesis:

Hypothesis 2

> The external knowledge potential of a firm, represented by its accessibility of KIBS employment, has a positive relationship with its number of new export products and the average unit price of these products. Moreover, increased access to the external knowledge potential is associated with increased total export value (sales) of new export products and decreased average export quantity per product variety.

It is also interesting to observe that measures of the knowledge-potential (i.e. the *M*-values) can be given a probability interpretation so that Equation (1) provides a measure of expected knowledge contacts between actors in location *i* and knowledge sources in location *j*, based on random-choice behavior or accessibility calculations (see e.g. Johansson and Klaesson (2011) and Weibull (1976)). Individual firms have different innovation capacities that affect each firm's

capacity to make use of its external knowledge potential, and this motivates our interest in conjunction of the firms' internal and external knowledge sources.

2.3 Conjunction of Internal and External Knowledge for the Introduction of New Export Products

The interdependence between a firm's internal and external knowledge can be depicted as a conjunction phenomenon, as suggested by Almeida and Phene (2012) and Cantwell and Zhang (2012). The two contributions emphasize that knowledge management of firms comprises the task of combining internal and external knowledge components, and the capacity to access external knowledge in order to integrate it in the in-house renewal efforts. In this presentation we suggest that this conjunction idea is relevant for firms of different sizes and with different ownership structures.

In the previous analysis we have introduced $M_i = \sum_j \exp\{-\lambda t_{ij}\} G_j$ to represent the external knowledge potential of a firm located in *i*. The conjunction hypothesis, to be discussed further, implies that (i) a firm with small internal knowledge funds cannot make use of a large external knowledge potential, and (ii) a firm with a large innovation capacity can remain innovative also in locations with a small external knowledge potential, although its innovation output improves as the external knowledge potential is increased.

The conjunction phenomenon that is discussed above informs about how and in what proportions a firm's internal innovation capacity and external knowledge potential are combined. We consider the knowledge conjunction phenomenon to be represented by the multiplicative interaction between the firm's knowledge intensity and external knowledge potential.

With a multiplicative interaction form a conjunction variable is given by the following specification of the pertinent regressor, where C_k denotes firm *k's* conjunction variable in linear regressions

$$C_k = \Lambda_k \ln M_{k,i} \qquad (2)$$

where Λ_k denotes firm *k*'s internal knowledge intensity and $M_{k,i}$ denotes the external knowledge potential for firm *k* associated with location *i*. By taking formula (2) into account we hypothesize on a third empirical regularity that stems from the combination of the firm's internal knowledge intensity and its external knowledge potential. Thus, Hypothesis 3 is as follows:

Hypothesis 3

> The conjunction variable is positively associated with a firm's number of new export products and the average unit price of a firm's new export products. In addition, the conjunction variable positively influences the total export sales of new export products, whereas it is negatively related to the average export quantity of each new product variety.

The following section presents some descriptive data on how the knowledge intensity of Swedish manufacturing firms with new export products is concentrated across municipalities. The section also outlines the characteristics of firms in the Swedish manufacturing industry that in some way are involved in exporting new product varieties.

3 Knowledge Intensity and New Export Products in Swedish Manufacturing

The descriptive data in the following section is based on manufacturing firms with new export products that belong to industries 15-36 based on the Swedish Industrial Classification (SNI).

The knowledge intensity refers to the internal knowledge of the manufacturing firms with new export products. The knowledge intensity in this context refers to a firm's employees with a specialized training degree from a university and/or college where the program duration is less than three years, a bachelor's degree, a master's degree, a PhD or higher.

Export products are distinguished by product codes according to the Combined Nomenclature (CN) for the period 2000-08. In this sense, all export products are counted as new in year 2000. If a firm introduces a new product code in any of the subsequent years to 2000, these are counted as new export products. As such, we lose the observations that belong to year 2000, which limits our analysis to the period 2001-08. The code of each export product has been recoded so that it follows the same CN throughout the period under analysis (i.e. 2001-08), which in this case is CN2008.

3.1 Knowledge Intensity of Firms with New Export Products in Swedish Manufacturing

To analyze the knowledge intensity of the manufacturing firms with new export products we use quantile maps of which the unit of analysis is Swedish municipalities. The left panel in Figure 1 depicts the average share of knowledge intensity in manufacturing firms (both multi-location firms and single establishments) with new export products over the period 2001-08. The right panel shows the average share of knowledge intensity in single establishments only.

It is obvious from the left panel in Figure 1 that firms with new export products in the metropolitan regions Stockholm, Gothenburg and Malmö typically have higher average shares of knowledge intensity. There is also a tendency that manufacturing firms with new export products have a higher average knowledge intensity if they are located in municipalities with universities.[1] However, if the focus is on single establishments only (the right panel in Figure 1), the high average shares of knowledge intensity are mostly observed in the metropolitan regions in Sweden.

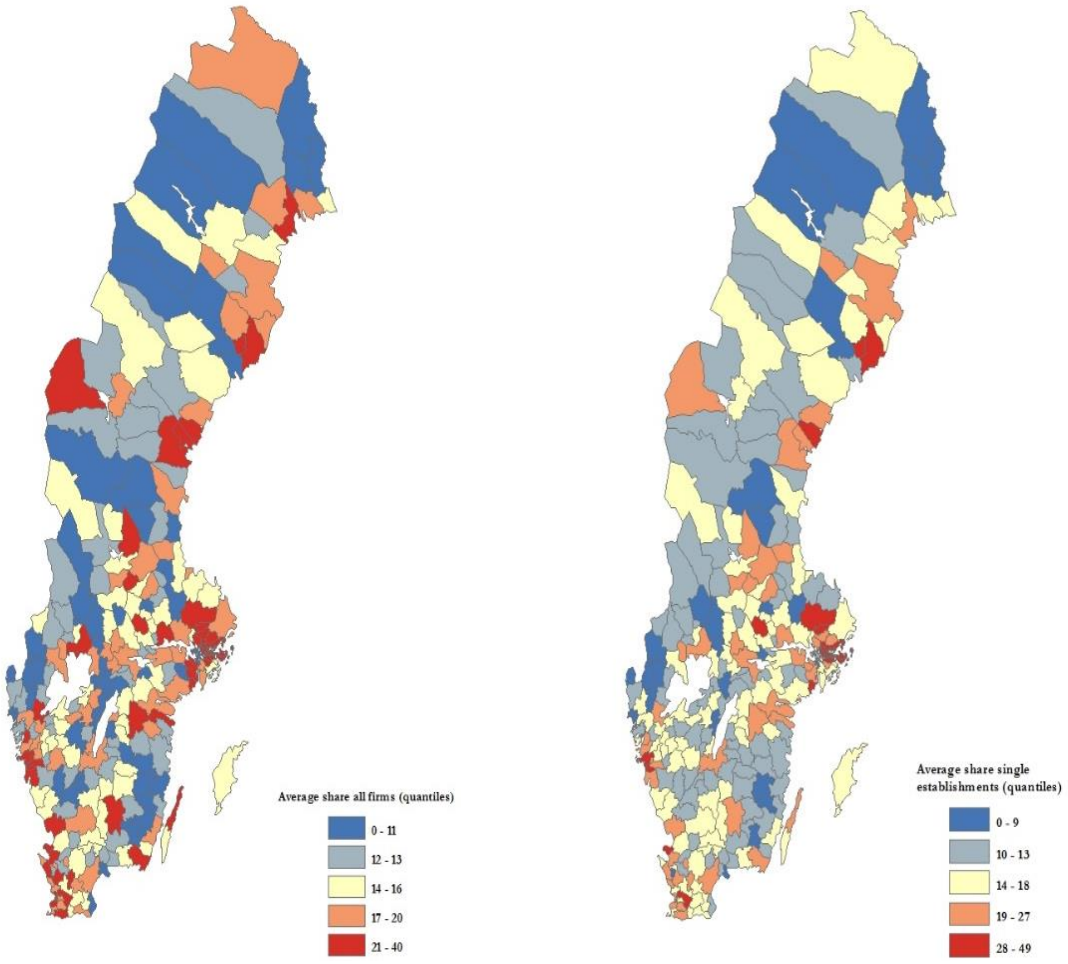

Figure 1 Average share of knowledge intensity in municipalities for firms with new export products in Swedish manufacturing, 2001-08 (SNI 15-36)

The following sub-section gives a yearly outline on the firms with new export products. Specifically, we outline how many firms of the total number of firms in Swedish manufacturing have new export products. We also consider the total number of new export products introduced and if firms with new export products are newly established.

[1] In this case, municipalities such as Luleå, Härnösand, Sundsvall, Umeå, Karlstad, Halmstad, Växjö and Karlskrona display a high average share of employees with higher education.

3.2 New Export Products in Swedish Manufacturing

The number of firms in Swedish manufacturing averages around 22000 firms per year over the period. Out of these firms, about 37 percent of the firms have engaged in exporting activity over the period 2000-08. If the focus is only on manufacturing firms with new export products, then approximately one third of the firms with exports have at some point in time over the period 2001-08 introduced a new export product. Table 1 summarizes the yearly information on firms with new export products in Swedish manufacturing.

Table 1 Firms with new export products in Swedish manufacturing, 2000-08 (SNI 15-36)

Year	Total manufacturing firms	Manufacturing firms with exports	Manufacturing firms with new export products
2000	22970	8618	-
2001	22810	8533	7295
2002	22445	8670	7268
2003	22175	8536	6891
2004	22288	8381	6609
2005	22418	8097	6251
2006	22454	8021	6487
2007	22340	8102	6722
2008	21370	7960	6208
Average	**22363**	**8324 (37% of total)**	**6716 (30% of total)**

To learn more about the population used in the empirical analysis we also consider that newly established manufacturing firms can be different from firms that have some experience of exporting new export products. As such, we separate out from our population (which corresponds to the fourth column in Table 1) the manufacturing firms that are newly established and that introduce new export products.

Table 2 presents the number of manufacturing firms that introduce new export products, the number and percentage of the newly established firms over the period 2001-08. On average, 458 firms, or about 7 percent of the firms, with new export products are newly established firms.

Table 2 Newly established firms with new export products in Swedish manufacturing, 2001-08 (SNI 15-36)

Year	Manufacturing firms with new export product	New firms with new export products	Percent of new firms with new export products
2001	7295	606	8.31
2002	7268	495	6.81
2003	6891	459	6.66
2004	6609	467	7.07
2005	6251	431	6.89
2006	6487	446	6.88
2007	6722	461	6.86
2008	6208	296	4.77
Average	**6716**	**458**	**6.81**

Turning to the exported products by the Swedish manufacturing firms we see that a large share of these exports are in the form of new export products. However, the total number of export products and new export products have varied greatly over the period. It is also obvious that during the crisis period post-2007, the number of firms in Swedish manufacturing decreased and so have the number of new export products (the annual fall between 2007 and 2008 is about 12 percent). A possible reason is that the 2007 crisis has negatively impacted the innovation pace in large firms (such as technological innovation), which is also confirmed for a number of OECD countries in OECD (2009).

Table 3 Export products and new export products in Swedish manufacturing, 2001-08 SNI 15-36

Year	Total export products	New export products of total export products	Percentage share of new export products
2001	82767	42261	51.06
2002	88187	43877	49.75
2003	82576	34292	41.53
2004	78621	31384	39.92
2005	72128	25892	35.90
2006	74950	35207	46.97
2007	77852	37460	48.12
2008	73964	26764	36.19
Average	**78881**	**34642**	**43.68**

Note: All export products are counted as new in year 2000. If a firm introduces a new product code in any of the subsequent years to 2000, these are counted as new export products. In addition, all export products have been recoded to follow the same combined nomenclature (CN), which in this case is CN2008.

4 Data, Variables and Descriptive Statistics

4.1 Data

This paper uses publicly audited data collected by Statistics Sweden. The data is available in three databases including firms, employees and international trade. The databases are linked together by a key identification number that makes it possible to link a firm to its employees and to link the firm to its exported and imported products. The period under analysis is 2000-08, where the focus is on manufacturing firms that belong to SNI 15-36. During this period, the branch classification 'SNI1992' and 'SNI2002' are fully comparable at the two-digit branch level for the manufacturing sector.

Since we count all exported products as new in year 2000, our period reduces to 2001-08 in the regression modelling in Section 5. For 2001-08, we have a total of 66300 observations on firms with export activity. Of these, 12569 firms do not have any new export products. This leaves us with a sample consisting of 53731 observations.

One limitation with linking the international trade data to a firm is that the international trade data is reported as a firm aggregate. In this sense, it is difficult to distinguish where the exporting activity takes place in a firm with multi-locations. To handle this problem we follow two procedures in i) assigning the export aggregate and ii) suggest a possible robustness check for our main model.

i) In case of a multi-location firm we assign the export aggregate to the location with most employees and run our model for the full panel.
ii) As a follow up robustness check we reduce the size of our panel to include only single establishments and then estimate our model in order to compare the result with those obtained using the full panel in i). This latter act reduces the number of observations from 53731 to 47513, as 6218 firms are multi-located.

4.2 Variables

Dependent variables

The dependent variable in this paper is each exporting firm's value of new export products (V). A firm's value of new export products is composed by the three components specified in Equation (3)

$$V = NPQ \tag{3}$$

where N is the number of new export products, P is the average unit price of new export products and Q is the average quantity per new export product. By taking the logarithm of Equation (3) we obtain a decomposed linear value function as expressed in Equation (4)

$$\ln V = \ln N + \ln P + \ln Q \tag{4}$$

where the three components on the right-hand side, including the value component on the left-hand side can be analyzed in terms of four different models. Note that the three right-hand side variables add up to the left-hand side value component, such that each right-hand side component's effect can analyzed individually as a dependent variable.

Explanatory variables

The firm's knowledge intensity, Λ, is proxied by the share of employees with short and long higher education. As such, the knowledge intensity share includes the firm's employees with a degree from a short tertiary learning program with duration less than three years, a bachelor's degree, a master's degree, a PhD degree or higher.

Moreover, the firms external knowledge potential, M, is represented by its distance-discounted access to KIBS employment according to Equation (1) above. In this sense, KIBS include SNI

industry classifcations 72 (computers and related activities), 73 (research and development) and 74 (other business activities and services).

The firm's knowledge intensity in conjunction with its external knowledge potential, C, is constructed based on Equation (2) above. The conjunction variable shows the effect from combining the firm's knowledge intensity with its external knowledge potential at location i.

Additional controls include firm size, F, which consists of the firm's total number of employees. The firm size variable controls for possible effects on the dependent variable that are influenced by exporting market power. Another control is represented by the firm's physical capital holdings, K. Physical capital in this context refers to a firm's holdings of automated machines and other capital goods inventories, buildings and land. We include this control in the model to account for effects that are due to capacity expansion by augmenting the factory space and through new machinery inputs in the production.

Finally, if the firm is newly established and introduces a new export product in the same year, it is assigned a dummy variable, D_1, that equals 1. Otherwise the dummy equals 0. The new firm dummy might capture possible differences in the behavioral mechanism between new firms with new export products and firms with new export products that have some experience. We also control for being a persistent exporter of new export products throughout the period 2001-08 (in this case D_2 equals 1, otherwise 0) and for belonging to a Swedish multinational group (if so D_3 equals 1, otherwise 0) or a foreign multinational group (then D_4 equals 1, otherwise 0).

4.3 Descriptive Statistics

Table 4 reports the descriptive statistics for the firms with new export products in terms of mean, median, standard deviation, minimum and maximum values (Table A.1 in the Appendix presents a correlations matrix for the variables). The mean is rather close to the median for most of the variables, so in this context we interpret the mean value for the population average.

By taking the antilog of the value ($\ln V$), number ($\ln N$), average price per unit ($\ln P$) and the average quantity ($\ln Q$) of new export products we can interpret the average values. The average value of new export products is about SEK50000, whereas the mean for the number of new export products per firm is around 3. The average price per unit of new export products is close to SEK130 and the average quantity of new export products is about 136 kilograms.

The mean for the knowledge intensity (Λ) shows that about one fifth of the employees in firms with new export products has some form of degree from a shorter or longer higher education program. Moreover, the accessibility to the external knowledge potential represented by the

surrounding KIBS activities (ln$M$) has a mean of 3611 units of labor. The mean value for firm size (ln$F$) is 17 employees, which indicates that the average firm that introduces new export products is a small-sized firm. A typical firm with new export products holds a physical capital stock (ln$K$) of SEK149 million.[2]

Newly established firms (D_1) with new export products represent on average approximately 7 percent (this mean value corresponds to the average reported in Table 2). According to the export persistency mean (D_2), almost one fourth of the firms have new export products in every year during the period 2001-08. In terms of ownership and group belonging (i.e. dummies D_3 and D_4), about 18 percent of the firms belong to a Swedish group, whereas approximately 14 percent of the firms belong to a foreign group.

Table 4 Descriptive statistics, dependent variables are ln$V$, ln$N$, ln$P$ and ln$Q$: Total number of observations = 53731

Variable	Mean	Median	Standard deviation	Min	Max
Value of new export products, ln$V$	10.808	10.716	3.381	-4.159	29.133
Number of new export products, ln$N$	1.047	0.693	0.987	0	6.116
Price per unit of new export product, ln$P$	4.845	4.894	2.055	-10.319	13.869
Quantity per new export product, ln$Q$	4.916	4.817	2.933	-3.045	19.888
Knowledge intensity, Λ	0.190	0.133	0.213	0	1
External knowledge potential, ln$M$	8.192	7.978	1.756	2.437	11.554
Knowledge intensity in conjunction with its external knowledge potential, C	1.659	1.008	2.051	0	11.554
Firm size, ln$F$	2.846	2.773	1.559	0	10.062
Physical capital, ln$K$	14.214	14.678	3.989	-11.510	23.760
Newly established firm, D_1	0.068	0	0.252	0	1
Export persistency, D_2	0.245	0	0.430	0	1
Firm is part of Swedish group, D_3	0.175	0	0.380	0	1
Firm is part of foreign group, D_4	0.144	0	0.351	0	1

[2] Note that physical capital is measured in units of hundreds SEK.

5 Empirical Strategy, Results and Analysis

The following section is split into two parts where the first subsection presents the empirical strategy and the models of use. In the second subsection we estimate our models to arrive at the regression results to be discussed and analyzed.

5.1 Empirical Strategy

We want to analyze how a firm's knowledge absorption capacity affects its development, adoption and introduction of new export products. In this sense, we study two knowledge sources represented by the firm's knowledge intensity and the firm's external knowledge potential. We are also interested in analyzing the effect from the conjunction of these two knowledge sources (i.e. the firm's absorptive capacity) on new export products.

First, we adapt Equation (4) as our dependent variable to arrive at the following reduced form regression for the firm's knowledge intensity

$$Y = \alpha_0 + \alpha_1 \Lambda + \alpha_2 X + \varepsilon \quad (5)$$

where Y is the dependent variable representing one of the components in Equation (4) that is under analysis. α_0 is a constant and α_1 and α_2 are parameters. Λ represents the firm's internal knowledge. X is a vector of additional firm characteristics, such as firm size, physical capital holdings, being a newly established firm, history of new export products and ownership and group belonging. ε is a stochastic error term that by assumption is normally distributed with a zero mean.

Equation (5) can be expanded to also incorporate Equation (1), i.e. the firm's external knowledge potential

$$Y = \beta_0 + \beta_1 \Lambda + \beta_2 \ln M + \beta_3 X + \varepsilon \quad (6)$$

where M denotes the external knowledge potential represented by surrounding KIBS activities. Equation (6) allows us to analyze the effect of the firm's external knowledge potential on its new export products, while holding its knowledge intensity constant.

Finally, we model the firm's knowledge intensity multiplied by its external knowledge potential (C) as specified in Equation (2)

$$Y = \gamma_0 + \gamma_1 C + \gamma_2 X + \varepsilon \quad (7)$$

Since we are estimating Y as a mathematical system, Equation (4) must hold, which implies that $\ln N$, $\ln P$ and $\ln Q$ must sum up to $\ln V$. The mathematical system tends to work most efficiently

when the models are estimated by least squares.[3] We also make use of firm clustered robust standard errors in our regressions to adjust for inflated t-values due to possible heteroskedasticity in our data.

5.2 Regression Results and Analysis

The regression results are presented first in terms of the value of new export products and then followed by each of the value components number, average price per unit and average quantity.

Table 5 shows the regression results from estimating Equation (5) when we expand the vector of additional firm characteristics with firm size, physical capital holdings, if the firm is a newly established firm with new export products, the firm's history of introducing new export products, and if the firm belongs to a Swedish or a foreign owned multinational group.

If a firm increases its knowledge intensity, then, on average, its value of new export products increases. By analyzing the different value components, the largest effect of a firm's knowledge intensity is an increase in average unit prices of the new export products. Hence, a higher internal knowledge intensity allows the firm to charge a higher average unit price of the new export products. A similar effect is found for the number of new export products, yet at a lower magnitude than for the average unit price. Moreover, a larger internal knowledge intensity is on average associated with a smaller quantity of a typical new export product. Thus, the more knowledge in a firm, the smaller the average quantity and the higher the firm's frequency and average price of new export products. These results are in line with Hypothesis 1.

If the firm size increases, on average, the value, number and the average quantity of new export products increases. However, larger firms typically charge lower than average unit prices for their new export products, suggesting that firm size reflects the degree of price competition, whereas smaller firms with new products rather engage in monopolistic competition. More physical capital holdings, on average, lowers the average unit price of new export products. The opposite case applies to the average quantity of new export products. This may be a scale-economies effect where more automated processes push the optimal choice towards increased quantity and reduced price of the new export products.

[3] As an experiment we have estimated the models using a Heckman Selection Model (HSM) to control for a possible selection bias when we select the firms with new export products from firms that export. The regression results show the similar significance and signs, however, the size of the coefficients cannot hold the system $\ln V = \ln N + \ln P + \ln Q$ intact as the sum of the right-hand side coefficients of this system is either under-estimated or over-estimated, i.e. $\ln V \neq \ln N + \ln P + \ln Q$.

Newly established firms is a variable that elevates all three value components of the export sales of new export products. Moreover, firms that are persistent exporters of new export products enjoy a higher value, number and average unit price of new export products. In this sense, experience seems to matter. Finally, firms that belong to a foreign multinational group, on average, tend to perform better than firms that belong to a Swedish multinational group.

Table 5 Regression results for the effect of a firm's knowledge intensity (Λ) on new export products ($\ln V = \ln N + \ln P + \ln Q$)

Explanatory variable	Dependent variable			
	$\ln V$	$\ln N$	$\ln P$	$\ln Q$
Firm's knowledge intensity, Λ	0.942***	0.393***	1.249***	-0.700***
	(0.083)	(0.026)	(0.062)	(0.079)
Firm size, $\ln F$	0.507***	0.211***	-0.029**	0.325***
	(0.018)	(0.006)	(0.012)	(0.015)
Physical Capital, $\ln K$	0.009*	-0.000	-0.023***	0.032***
	(0.005)	(0.001)	(0.003)	(0.005)
Newly established firm, D_1	1.126***	0.149***	0.070**	0.907***
	(0.057)	(0.015)	(0.034)	(0.052)
Export persistency, D_2	0.269***	0.483***	0.140***	-0.354***
	(0.051)	(0.017)	(0.035)	(0.045)
Firm is part of Swedish owned group, D_3	0.523***	0.273***	-0.057	0.307***
	(0.058)	(0.018)	(0.037)	(0.049)
Firm is part of foreign owned group, D_4	0.835***	0.321***	0.064	0.450***
	(0.065)	(0.020)	(0.042)	(0.058)
Constant	8.285***	0.049	3.460***	4.776***
	(0.125)	(0.036)	(0.075)	(0.113)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
R^2	0.16	0.36	0.26	0.19
Observations	53731	53731	53731	53731

Least squares estimation where ***, **, *, indicate significance level at 1 percent, 5 percent and 10 percent, respectively. Firm clustered robust standard errors in parentheses.

Table 6 presents the regression results for the model which analyzes the firm's knowledge intensity and its external knowledge potential in Equation (6). In this model, we observe a somewhat similar effect for the firm's knowledge intensity on the value and the different value components, yet at a lower magnitude compared to the case with only the firm's knowledge intensity. However, in this model the external knowledge potential has a neutral effect on the value of new export products. The parameter estimates imply that if the firm's external knowledge potential represented by the access to KIBS employment increases then, on average, the number and the average unit price of new export products increases. The average quantity, on the other hand, is negatively influenced by an increase in a firm's external knowledge potential. These regression results are partly in line with Hypotheses 2.

Similar to the previous model that focuses on the firm's knowledge intensity, if a firm becomes larger, then the value, number and the average quantity of new export products increases, whereas the average price per unit of new export product decreases. The physical capital holdings and the export persistency of firms also show a somewhat similar pattern to the previous case where we modeled the firm's knowledge intensity alone. This similarity is also observed when we interpret the estimates for the dummies representing type of company group belonging.

Table 6 Regression results for the effect of a firm's knowledge intensity (Λ) and its external knowledge potential ($\ln M$) on new export products ($\ln V = \ln N + \ln P + \ln Q$)

Explanatory variable	Dependent variable			
	$\ln V$	$\ln N$	$\ln P$	$\ln Q$
Firm's knowledge intensity, Λ	0.921***	0.359***	1.036***	-0.474***
	(0.083)	(0.026)	(0.062)	(0.079)
Firm's external knowledge potential, $\ln M$	0.013	0.021***	0.134***	-0.142***
	(0.011)	(0.004)	(0.008)	(0.010)
Firm size, $\ln F$	0.508***	0.213***	-0.020*	0.315***
	(0.018)	(0.006)	(0.011)	(0.015)
Physical Capital, $\ln K$	0.009**	0.001	-0.018***	0.026***
	(0.005)	(0.001)	(0.003)	(0.004)
Newly established firm, D_1	1.127***	0.151***	0.078**	0.898***
	(0.057)	(0.015)	(0.033)	(0.051)
Export persistency, D_2	0.270***	0.484***	0.146***	-0.360***
	(0.051)	(0.017)	(0.035)	(0.045)
Firm is part of Swedish owned group, D_3	0.523***	0.273***	-0.058	0.308***
	(0.057)	(0.018)	(0.036)	(0.049)
Firm is part of foreign owned group, D_4	0.833***	0.317***	0.040	0.476***
	(0.065)	(0.020)	(0.042)	(0.057)
Constant	8.166***	-0.142***	2.255***	6.053***
	(0.159)	(0.049)	(0.102)	(0.146)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
R^2	0.16	0.36	0.27	0.20
Observations	53731	53731	53731	53731

Least squares estimation where ***, **, *, indicate significance level at 1 percent, 5 percent and 10 percent, respectively. Firm clustered robust standard errors in parentheses.

Finally, Table 7 shows the regression results when the conjunction variable is introduced as an explanatory variable. The conjunction variable takes on high values when both the knowledge intensity and the external knowledge potential simultaneously are large. In Table 7 all the estimated conjunction parameters are significant, although the differences between Tables 5, 6 and 7 are small. Table 6 seems to indicate that the external knowledge potential has no significant separate effect on the value, whereas it has a conjunction effect according to Table 7. The model with the conjunction variable is consistent with the relationships stated in Hypothesis 3.

Although the majority of the results seem similar to the previous two tables, there is some weak evidence that suggests that a firm that belongs to a Swedish group has lower average unit prices of new export products.

Table 7 Regression results for the effect of a firm's knowledge intensity in conjunction with its external knowledge potential ($C = \Lambda \ln M$) on new export products ($\ln V = \ln N + \ln P + \ln Q$)

Explanatory variable	Dependent variable			
	$\ln V$	$\ln N$	$\ln P$	$\ln Q$
Firm's knowledge intensity in conjunction with its external knowledge potential, C	0.091***	0.041***	0.143***	-0.093***
	(0.009)	(0.003)	(0.007)	(0.008)
Firm size, $\ln F$	0.506***	0.212***	-0.028**	0.322***
	(0.018)	(0.006)	(0.012)	(0.015)
Physical Capital, $\ln K$	0.010**	0.001	-0.021***	0.030***
	(0.005)	(0.001)	(0.003)	(0.004)
Newly established firm, D_1	1.130***	0.150***	0.066**	0.914***
	(0.057)	(0.015)	(0.034)	(0.052)
Export persistency, D_2	0.275***	0.485***	0.146***	-0.356***
	(0.051)	(0.017)	(0.035)	(0.045)
Firm is part of Swedish owned group, D_3	0.530***	0.274***	-0.062*	0.318***
	(0.058)	(0.018)	(0.037)	(0.049)
Firm is part of foreign owned group, D_4	0.838***	0.321***	0.051	0.466***
	(0.065)	(0.020)	(0.042)	(0.058)
Constant	8.296***	0.049	3.436***	4.811***
	(0.125)	(0.036)	(0.075)	(0.113)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
R^2	0.16	0.36	0.26	0.19
Observations	53731	53731	53731	53731

Least squares estimation where ***, **, *, indicate significance level at 1 percent, 5 percent and 10 percent, respectively. Firm clustered robust standard errors in parentheses.

6 Robustness and Causality Checks

Firms with new export products are drawn from all firms that export, including those which do not introduce new export products. There is a possible selection bias in the characteristics of the two types of firms. Our concern is the difference between firms with no new export products and firms with new export products. In view of this, we examine the selection effect in the full population of exporting firms. To do this we use a logit model, where the dependent variable is a dummy variable where firms with new export products are given a value of 1, and other firms a zero value. Table 8 summarizes the regression results for the logit model.[4] We find that the probability for introduction of new export products depends on the same explanatory variables

[4] Note that we exclude the export persistency dummy from the logit estimations since it predicts success perfectly. By including this dummy all the three specifications in Table 5 report augmented estimates.

that are included in the models estimated in Section 5. This means that the variables that predict the performance of firms with new export products also influence a firm's probability of being an exporter of new products.

Table 8 Logit model results where the dependent variable is firms with new export products

Explanatory variable	Firms' knowledge intensity (Λ)	Firms' knowledge intensity (Λ) and external knowledge potential ($\ln M$)	Firms' knowledge intensity multiplied by its external knowledge potential (C)
Knowledge intensity, Λ	0.369*** (0.066)	0.303*** (0.066)	
External knowledge potential, $\ln M$		0.052*** (0.009)	
Firm's knowledge intensity in conjunction with its external knowledge potential, C			0.039*** (0.007)
Firm size, $\ln F$	0.243*** (0.012)	0.247*** (0.012)	0.243*** (0.012)
Physical capital, $\ln K$	0.005 (0.004)	0.007** (0.003)	0.005 (0.004)
Newly established firm, D_1	0.581*** (0.048)	0.586*** (0.048)	0.581*** (0.048)
Export persistency, D_2	Not included (see footnote 4)		
Firm is part of Swedish owned group, D_3	0.434*** (0.050)	0.434*** (0.050)	0.435*** (0.050)
Firm is part of foreign owned group, D_4	0.605*** (0.060)	0.596*** (0.060)	0.603*** (0.060)
Constant	0.414*** (0.088)	-0.056 (0.108)	0.412*** (0.089)
Observations	66300	66300	66300
Pseudo R^2	0.064	0.065	0.064

Logit estimation where ***, **, *, indicate significance level at 1 percent, 5 percent and 10 percent, respectively. Firm clustered robust standard errors in parentheses.

Since exports are a firm aggregate, we perform the regression analysis only on single establishments in order check the robustness of our results. In this case, we reduce the panel size from 53731 observations to include only the observations of single establishments, which is 47513. This implies that we lose the 6218 observations we allocated the export aggregate to the establishment with most employees. The regression results for the estimations on single establishments are presented in the Appendix (Tables A.2, A.3 and A.4).

By comparing the panel estimations for all firms with new export products (Tables 5 through 7) with the estimations that includes only single establishments (Tables A.2 through A.4), we note

that most of the results are the same in terms of significance and sign. However, the size of the coefficients are somewhat different.

For the model with knowledge intensity (see Table A.2) we note that the size of the coefficients for single establishments with new export products is smaller for the knowledge intensity, firm size, physical capital, being a newly established firm and being part of a foreign group. Furthermore, if firms are persistent exporters of new export products and are part of a Swedish group then the size of the coefficients is larger. In addition, we also note that the dummy variable for being a newly established firm goes from positive and significant to insignificant. The explanatory power indicated by the goodness of fit (R^2) reduces for all the four components of new export products.

For the model including both knowledge intensity and external knowledge potential (see Table A.3) we observe that the regression results are following the same pattern as for the model with knowledge intensity only. The magnitude for the external knowledge potential of firms, represented by the access to KIBS employment, is smaller in size of the coefficient, yet has same sign and significance level. The goodness of fit worsens for the model in where the dependent variable is value, number and average quantity, whereas the fit remains constant for the model with average unit price of new export products.

Finally, the model with the conjunction variable (see Table A.4) shows the same results as the previous two models. However, the weak evidence on that firms being part of a Swedish group have lower average unit price of new export products is no longer significant.

As a final exercise we will examine how non-new (established) export products relate to the explanatory variables in Equations (5)-(7). Total export sales of new export products have been shown to be positively associated with a firm's knowledge variables. Now we ask another question: how are total export sales of non-new export products impacted by internal and external knowledge, by size, physical capital and ownership structure? The result of this exercise is reported in Table A.5, where we can see that the total value of established export products is negatively associated with the knowledge variables, and with being a member of a multinational company group.

Thus, comparing the results in Table A.5 with our previous results, indicate that established export products follow another logic than new export products. In the latter case, the value of export revenues is knowledge dependent, in the former case it is not. Moreover, the knowledge advantages of being a member of a multinational company is present for new export products, but it is absent for established export products. These observations are consistent with a dynamic

process where new export products are associated with small quantities and high price levels, whereas established export products are characterized by larger quantities and less elevated prices. We may emphasize that our data contain observations where a product first is new to a firm, while becoming established at subsequent years.

7 Conclusions

The purpose of this paper has been to examine the role that an exporting firm's knowledge funds play in the process of the firm's introduction of new export products. The basic population is the set of firms which introduce such products. The analysis makes a distinction between a firm's internal knowledge and the firm's access to external knowledge sources (external knowledge potential), where the former reflects the capacity to absorb external knowledge including new product ideas. The opportunities to access and absorb external knowledge are represented by a conjunction variable which takes on high values when a firm simultaneously has a large internal knowledge intensity and a large external knowledge potential.

First, the analysis shows that the relative size of the internal knowledge affects the character of new export products by, (i) making export sales larger, (ii) making the number of new export products larger, and (iii) augmenting the export price of the new export products. In addition, the greater price level is combined with a larger number of products sold in smaller quantities.

Second, the conjunction variable predicts a similar pattern of consequences for the new export products – as does the internal knowledge. Thus, an augmented price, a larger set of new varieties, and smaller quantities combine into an increased value of total sales of new export products.

Third, explanatory variables that reflect scale, such as size of labor and physical capital, impact the price downwards and the quantity per variety sold upwards. This means that the effect of the internal knowledge intensity and the knowledge conjunction variable is more pronounced for smaller firms.

Amongst exporting firms, the probability of introducing new export products increases with the size of internal and conjunction knowledge, and with the size of the firm. Moreover, the probability is significantly higher for firms belonging to a multinational company group, which may reflect access to global knowledge sources. We suggest that a firm which decides to introduce a new export product either already has the necessary internal and conjunction knowledge or it adds new knowledge as an integral part of the introduction decision.

The internal knowledge of a firm is based on straightforward decisions of the firm. To influence its external knowledge potential a firm has to contemplate its location, and that may include sunk cost conditions. This would make us classify the external knowledge potential as a slowly changing variable, determined by past decisions.

Applying our regression model for total export sales of exporters that abstain from introducing new export products, reveals that this group of exporters follow a different logic. In this case the total export sales of established export products are negatively influenced by the exporters internal and conjunction knowledge. Thus, enlarged knowledge funds contribute to reduced export sales of established export products. Introduction of innovative novelties is a knowledge-dependent activity in a sense that the maintenance of established export products is not.

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Appendix

Table A.1 Correlations matrix for dependent and explanatory variables: The total number of observations is 53731

	ln$V$	ln$N$	ln$P$	ln$Q$	Λ	ln$M$	C	ln$F$	ln$K$	D_1	D_2	D_3	D_4
ln$V$	1.000												
ln$N$	0.659	1.000											
ln$P$	0.336	0,256	1.000										
ln$Q$	0,696	0,245	-0,399	1.000									
Λ	0,076	0,129	0,234	-0,120	1.000								
ln$M$	-0,023	0,019	0,218	-0,186	0,273	1.000							
C	0,063	0,118	0,249	-0,142	0,971	0,413	1.000						
ln$F$	0,300	0,479	-0,078	0,239	-0,031	-0,109	-0,044	1.000					
ln$K$	0.161	0.242	-0.123	0.191	-0.075	-0.151	-0.094	0.542	1.000				
D_1	0,334	-0,045	0,015	0,044	0,058	0,027	0,060	-0,162	-0.106	1.000			
D_2	0.180	0.408	0.057	0.029	0.047	-0.041	0.030	0.396	0.223	-0.116	1.000		
D_3	0.148	0.260	0.009	0.077	0.076	-0.027	0.065	0.351	0.168	-0.040	0.207	1.000	
D_4	0.181	0.268	0.003	0.116	0.090	0.028	0.089	0.367	0.188	-0.035	0.192	-0.189	1.000

Table A.2 Regression results for the effect of a firm's knowledge intensity (Λ) on new export products ($\ln V = \ln N + \ln P + \ln Q$) for single establishments

Explanatory variable	Dependent variable			
	$\ln V$	$\ln N$	$\ln P$	$\ln Q$
Firm's knowledge intensity, Λ	0.789***	0.339***	1.095***	-0.645***
	(0.082)	(0.025)	(0.064)	(0.081)
Firm size, $\ln F$	0.398***	0.170***	-0.080***	0.308***
	(0.018)	(0.006)	(0.013)	(0.017)
Physical Capital, $\ln K$	0.009*	0.001	-0.021***	0.029***
	(0.005)	(0.001)	(0.003)	(0.005)
Newly established firm, D_1	0.992***	0.111***	0.038	0.843***
	(0.057)	(0.015)	(0.035)	(0.054)
Export persistency, D_2	0.326***	0.516***	0.151***	-0.341***
	(0.054)	(0.018)	(0.039)	(0.049)
Firm is part of Swedish owned group, D_3	0.556***	0.285***	-0.037	0.308***
	(0.061)	(0.019)	(0.040)	(0.053)
Firm is part of foreign owned group, D_4	0.771***	0.287***	0.060	0.424***
	(0.070)	(0.021)	(0.046)	(0.063)
Constant	8.611***	0.176***	3.494***	4.941***
	(0.131)	(0.035)	(0.080)	(0.123)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
R^2	0.13	0.29	0.25	0.18
Observations	47513	47513	47513	47513

Least squares estimation where ***, **, *, indicate significance level at 1 percent, 5 percent and 10 percent, respectively. Firm clustered robust standard errors in parentheses.

Table A.3 Regression results for the effect of a firm's knowledge intensity (Λ) and its external knowledge potential ($\ln M$) on new export products ($\ln V = \ln N + \ln P + \ln Q$) for single establishments

Explanatory variable	Dependent variable			
	$\ln V$	$\ln N$	$\ln P$	$\ln Q$
Firm's knowledge intensity, Λ	0.781***	0.313***	0.897***	-0.429***
	(0.082)	(0.025)	(0.062)	(0.080)
Firm's external knowledge potential, $\ln M$	0.005	0.018***	0.138***	-0.151***
	(0.011)	(0.004)	(0.008)	(0.011)
Firm size, $\ln F$	0.398***	0.172***	-0.065***	0.291***
	(0.018)	(0.006)	(0.013)	(0.017)
Physical Capital, $\ln K$	0.009*	0.002	-0.016***	0.023***
	(0.005)	(0.002)	(0.003)	(0.005)
Newly established firm, D_1	0.993***	0.112***	0.051	0.830***
	(0.057)	(0.015)	(0.035)	(0.053)
Export persistency, D_2	0.326***	0.517***	0.152***	-0.343***
	(0.054)	(0.018)	(0.038)	(0.048)
Firm is part of Swedish owned group, D_3	0.556***	0.285***	-0.038	0.309***
	(0.061)	(0.019)	(0.040)	(0.053)
Firm is part of foreign owned group, D_4	0.770***	0.283***	0.029	0.458***
	(0.070)	(0.021)	(0.046)	(0.063)
Constant	8.562***	0.010	2.253***	6.299***
	(0.165)	(0.048)	(0.110)	(0.157)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
R^2	0.13	0.29	0.27	0.18
Observations	47513	47513	47513	47513

Least squares estimation where ***, **, *, indicate significance level at 1 percent, 5 percent and 10 percent, respectively. Firm clustered robust standard errors in parentheses.

Table A.4 Regression results for the effect of a firm's knowledge intensity in conjunction with its external knowledge potential ($C = \Lambda \ln M$) on new export products ($\ln V = \ln N + \ln P + \ln Q$) for single establishments

Explanatory variable	Dependent variable			
	$\ln V$	$\ln N$	$\ln P$	$\ln Q$
Firm's knowledge intensity in conjunction with its external knowledge potential, C	0.077***	0.036***	0.128***	-0.087***
	(0.009)	(0.003)	(0.007)	(0.009)
Firm size, $\ln F$	0.396***	0.170***	-0.078***	0.304***
	(0.018)	(0.006)	(0.013)	(0.017)
Physical Capital, $\ln K$	0.009*	0.001	-0.020***	0.028***
	(0.005)	(0.001)	(0.003)	(0.005)
Newly established firm, D_1	0.995***	0.111***	0.035	0.849***
	(0.057)	(0.015)	(0.035)	(0.054)
Export persistency, D_2	0.330***	0.518***	0.154***	-0.342***
	(0.054)	(0.018)	(0.039)	(0.049)
Firm is part of Swedish owned group, D_3	0.563***	0.286***	-0.042	0.319***
	(0.061)	(0.019)	(0.040)	(0.053)
Firm is part of foreign owned group, D_4	0.772***	0.285***	0.045	0.442***
	(0.070)	(0.021)	(0.046)	(0.063)
Constant	8.619***	0.174***	3.468***	4.977***
	(0.131)	(0.035)	(0.080)	(0.123)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
R^2	0.13	0.29	0.26	0.18
Observations	47513	47513	47513	47513

Least squares estimation where ***, **, *, indicate significance level at 1 percent, 5 percent and 10 percent, respectively. Firm clustered robust standard errors in parentheses.

Table A.5 Regression results for the effect of knowledge intensity (Λ), external knowledge potential ($\ln M$) and knowledge intensity in conjunction with its external knowledge potential ($C = \Lambda \ln M$) on firms export value from non-new export products ($\ln V_{\text{non-new}}$)

Explanatory variable	Firms' knowledge intensity (Λ)	Firms' knowledge intensity (Λ) and external knowledge potential ($\ln M$)	Firms' knowledge intensity multiplied by its external knowledge potential (C)
Knowledge intensity, Λ	-0.344 (0.221)	-0.344 (0.221)	
External knowledge potential, $\ln M$		-0.004 (0.071)	
Firm's knowledge intensity in conjunction with its external knowledge potential, C			-0.041* (0.024)
Firm size, $\ln F$	0.493*** (0.065)	0.493*** (0.066)	0.493*** (0.066)
Physical capital, $\ln K$	0.013 (0.008)	0.013 (0.008)	0.013* (0.007)
Firm is part of Swedish owned group, D_3	-0.287* (0.166)	-0.288* (0.166)	-0.287* (0.166)
Firm is part of foreign owned group, D_4	-0.078 (0.196)	-0.078 (0.195)	-0.079 (0.195)
Constant	11.526*** (1.026)	11.554*** (1.169)	11.524*** (1.028)
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
R^2 (within) R^2 (between) R^2 (overall)	0.03 0.08 0.08	0.03 0.08 0.08	0.03 0.08 0.08
Unique firms (groups)	6097	6097	6097
Observations	12569	12569	12569

Fixed effects estimation where ***, **, *, indicate significance level at 1 percent, 5 percent and 10 percent, respectively. Firm clustered robust standard errors in parentheses.