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Abstract:

This study examines how firms' internal and external knowledge sources affect the introduction of new export products with regard to value, number, average unit price and average quantity. Previous studies of this kind suggest that firms' export performance is influenced by internal knowledge, and the knowledge potential in the local and regional environment. In the present study the knowledge milieu of the exporting firm is the local and regional knowledge potential that is represented by the presence of Knowledge-Intensive Manufacturing Industries (KIMI). The empirical analysis demonstrates that a firm's internal knowledge has a positive effect on the value, number, average unit price, and average quantity of new export products. The knowledge milieu of the exporting firm, represented by the access to local and intra-regional KIMI-employment, has: i) a negative effect on the value and the average quantity, and ii) a positive effect on the number and the average unit price, of new export products, respectively.

Keywords: New export products, accessibility, manufacturing, knowledge, human capital.

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

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1 Introduction

We examine how a firm's internal knowledge and its proximity to high-technology industries affect the firm's introduction of new product ideas intended for exports. A firm's proximity to high-technology production environments may induce several important externalities that the firm can benefit from. The firm can for example benefit from interacting in a high-technology environment (Tilton 1971), or grow larger as it gains efficiency in specific activities (Chandler 1977). 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 the efficiency of already existing activities. Furthermore, Cohen and Levinthal (1990) extend their arguments to claim that the internal knowledge of the firm improves the capacity to absorb external knowledge that can later be used to create and adopt new innovations.

We study the innovative act of introducing an export product that is new to the firm. Previous research on how internal and external knowledge affect exports of new products is to our knowledge limited, yet there is a stream of empirical papers that analyze the effect of internal and external knowledge on exports in general. For example, Chevassus-Lozza and Galliano (2003) find that learning effects and informational spillovers in the French food industry play an important role in stimulating firms' exports to grow. Malmberg et al (2000) observe that firms' export performance in Swedish manufacturing is positively affected by agglomeration effects. The findings in Johansson et al (2013) show that firms' internal knowledge and access to employment in Knowledge-Intensive Business Services (KIBS) have a neutral effect on the total export value in local industries.

The purpose of this paper is to examine how firms' internal and external knowledge sources affect the introduction of new export products with regard to value, number, average unit price and average quantity. Unlike previous studies that for example measure the accessibility to employment in the KIBS sector (see e.g. Johansson et al 2013)), or the accessibility to human capital and R&D (cf. Gråsjö 2006), our study focuses on the accessibility to employment in Knowledge-Intensive Manufacturing Industries, referred to as KIMI. This focus allows us to empirically observe the effect that proximity to high-technology industries might have on firms that export new export products. By using a unique database we document that a firm's internal knowledge has a positive effect on the value, number, average unit price, and average quantity of new export products. We also observe that local and intra-regional KIMI-employment, has: i) a negative effect on the value and the average quantity, and ii) a positive effect on the number and the average unit price, of new export products, respectively.

2 Background and Motivation

This section presents the background and motivation of the hypotheses we state and empirically test in this paper. The focus is on how individual firms are influenced by knowledge sources when introducing new export products.

2.1 The Internal Knowledge of the Firm

Various framework conditions suggest that firms' human capital fosters the development of new products. For example, Schumpeter (1934) emphasizes technological innovations as a means to establish temporary monopolies, such that profits will gradually shrink as rival firms catch up. Moreover, Romer (1990) notes that new and reserved products are more likely to be developed in firms with greater amount of internal knowledge than in the average firm.

The picture is enriched when we recognize that a firm's internal knowledge affects its absorptive capacity. Cohen and Levinthal (1990) argue that the absorptive capacity of a firm, i.e. the firm's ability to recognize external knowledge and to exploit the new information, is to a larger extent determined by its internal knowledge. Griffith et al (2003) provide a microeconomic foundation to analyze how firms' internal knowledge affects their absorptive capacity. They find that the internal knowledge of firms, measured in terms of R&D investment, positively affects their absorptive capacity. However, when analyzing the effect of absorptive capacity on new product development, Stock et al (2001) find a nonlinear relationship, which suggests diminishing returns to absorptive capacity.

Firms' internal knowledge has also been examined in terms of human capital (e.g. number of schooling years, workers with tertiary education, or in 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. The finding by Robson et al (2012) can be motivated by theories related to Vernon (1966), who based his analysis on developments in the life cycle of a product.

The early stage in Vernon's (1966) model is characterized by innovative firms that create new products and processes in their home markets. At this stage, an important role is played by firms' internal knowledge, reflected design and R&D staff, prototype developers and technicians. The new products would in a later stage of the model be adapted in foreign countries.

A firm's internal knowledge assets are inputs to innovation activities that generate new products that are introduced in the domestic and foreign markets. Thus, we can state our first hypothesis segmented into four parts:

H_1: The larger the human capital in a firm, the more likely the firm is to increase the:
a) value, b) number, c) unit price, and d) quantity, of its new export products

2.2 The External Knowledge of the Firm

The phenomenon of external knowledge has been associated with localized industries, knowledge flows, and new ideas in theoretical elaborations for more than a century. As early as Marshall (1890), clustering groups of skilled workers in English manufacturing towns were used to explain the advantages of localized industries. According to Marshall (1890: p.225), the neighborhood effect from clustering groups of skilled workers acts as a catalyzer for how ideas are invented and new products are introduced. Marshall's theory on how knowledge spills over was further developed by Arrow (1962), and later by Romer (1986), and finally put together into the Marshall-Arrow-Romer (MAR) externalities framework by Glaeser et al (1992). The MAR externalities framework highlights the importance of a firm's proximity to other firms within the same industry, which positively affects how knowledge travels from one firm to another. For example, the spillover effect might involve information exchange of ideas that can improve the production technique in firms, and thus facilitates product innovations.

By analyzing the industries in Detroit and its vicinity, Jacobs (1969) developed a framework condition for explaining knowledge externalities. Similar to the MAR externalities framework, the Jacobian externalities were dependent on firms being close to other firms. However, Jacobs (1969) believed that positive knowledge externalities were due to having a diverse industry structure in close proximity to the local firm. The industrial diversity inspired the emergence of new ideas, product and process innovations, as it enabled persons with different backgrounds to interact with each other.

The nature of the agglomeration, i.e. whether there are MAR or Jacobian externalities, is not the focus in this paper. The focus is on agglomeration externalities in general (for a detailed modeling of different sources of agglomeration economies, see e.g. Duranton and Puga (2004)). Our interest is to empirically examine how firms' proximity to high-technological industries affect their new export products. Johansson (1993) suggests that the probability for product renewal increases the more resources a region has for development, such as educational attainment of labor and established R&D institutions in form of organizations and universities. According to Johansson and Lööf (2014), firms can influence their knowledge environment by establishing formal and informal networks with input suppliers, customers, and knowledge institutions. Moreover, Simmie (2003) argues that network development of this kind is less costly to carry out inside an urban region, where contacts are many and more diversified than elsewhere. Thus, knowledge externalities in networks within an urban region's high-technological industries can be partly linked to Jacobs (1969).

Nevertheless, there already exists a theoretical framework that highlights the importance of Knowledge-Intensive Business Services (KIBS) as an external knowledge source of firms (see e.g. Johansson and Klaesson (2011)). We adapt this framework by incorporating the ideas of Johansson and Lööf (2014) and Simmie (2003): that a larger region (e.g. a local labor market) can include high-technological industries, which form a customer base for KIBS suppliers. Figure 1 depicts this scenario, where the local labor market encompasses the networks connecting firms in the Knowledge-Intensive Manufacturing Industries (KIMI) and firms in the KIBS sector. Over time KIMI firms attract KIBS firms and KIBS employment, where the latter cause input diversity to increase and thereby stimulates productivity to improve (see e.g. Rivera-Batiz (1988), Matsuyama (1995), and Fujita and Thisse (2002)). According to this model formulation, the increased productivity reflects an increase of ideas and/or innovations that can enhance firms' export [1]

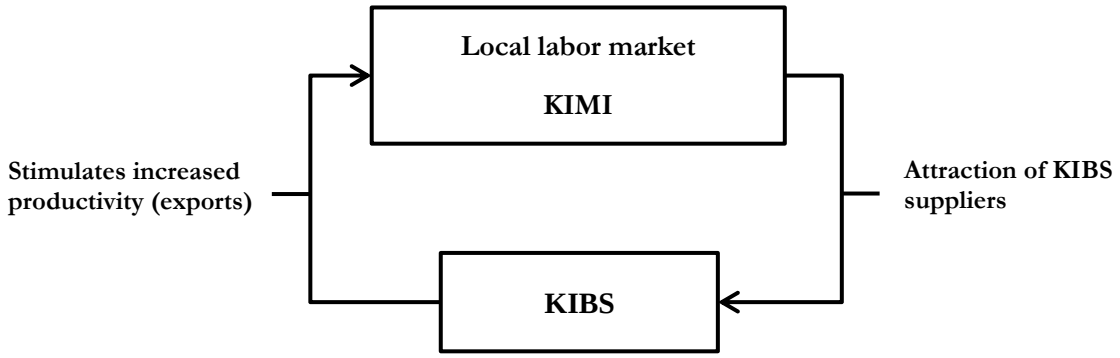

Figure 1 External knowledge sources of manufacturing firms
Source: Adapted from Johansson and Klaesson (2011)

With this outline we can state our second hypothesis segmented into four parts:

H_2: The better a firm absorbs the external knowledge, the more likely the firm is to increase the: a) value, b) number, c) unit price, and d) quantity, of new export products

The following section deals with export varieties that are new to individual manufacturing firms in Sweden. First, we describe how we measure the new export products, and second we depict their distribution across time and across space in Sweden.

[1] We have correlated the KIMI employment with the KIBS employment in Sweden's 290 municipalities and found that there is a high correlation between the two. The correlation between KIMI and KIBS employment inside municipalities is about 0.8, whereas the correlation between the two within Sweden's 72 local labor markets is close to unity. Hence, a cumulative effect obtains when the knowledge diversity functions as a public good to the firms.

3 Export Products that are New to the Firm

In the empirical part of this paper, a new product is considered to be introduced by a firm in the export market the first time its product code appears over the years analyzed. Product codes in our data are reported at the eight-digit nomenclature of the Standard International Trade Classification (SITC).

Suppose that new export products can be put on a timeline so that new products that are introduced at time t, can either be produced by an existing firm, or by a new firm. Let i denote an eight-digit product code that is contained in the set $I(k,t)$, and let k denote an individual firm contained in the set $K(v)$, where v is a firm location. When i is a new code to firm k at time t we say that $i \in I(k,t)$, where the latter denotes firm k's set of new export products at time t.

The number of new export products of firm k at time t is then given by $N_{I(k,t)}$, and the number of firms in location v which at time t export new products with code i is $N_{i,K(v,t)}$. Moreover, the number of new export products by firms located in v at time t is given by $N_{I,K(v,t)}$. In the empirical analysis, locations (i.e. v) refer to municipalities, which are also called local economies. In the sequel, we will use these measurements to map the dynamics of new export products across firms and regions in Sweden.

3.1 Mapping New Export Products in Swedish Manufacturing

Figure 2 displays firms' export products and new export products in the Swedish manufacturing sector for the period 2000-08 (SNI 15-36).[2] One may observe that the peak in export products occurred in 2002, whereas 2005 represents the lowest number of exported products over the period analyzed. These two points in time also represent the peak and trough for new export products. The total number of firms is rather constant for the first five-year period, and falls slightly in later years.

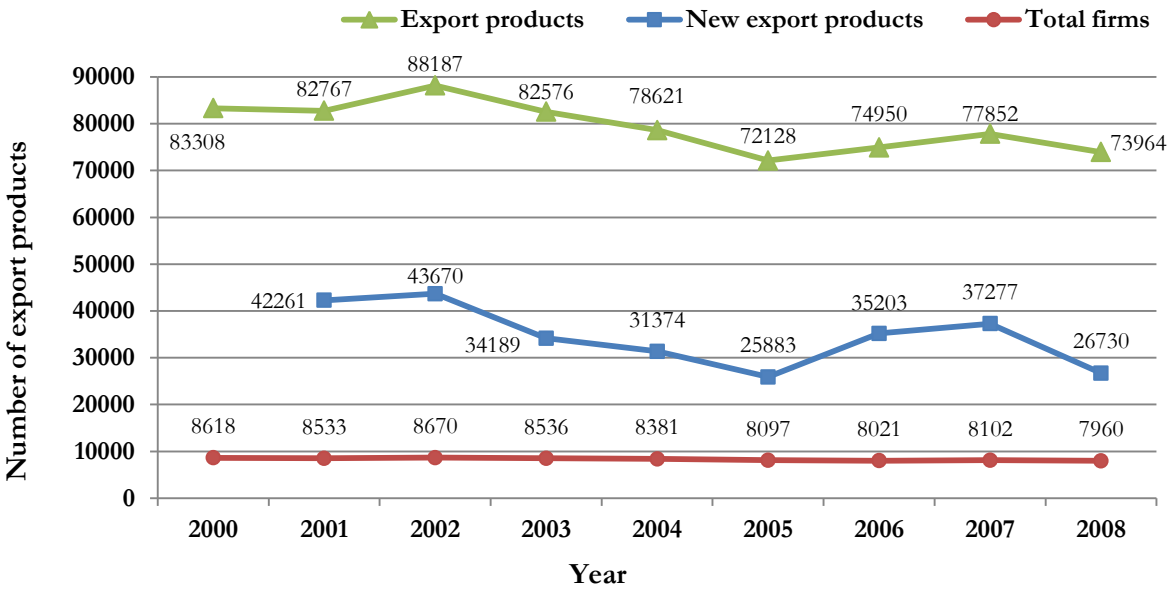

Figure 2 Export products and new export products, all exporting manufacturing firms in Sweden 2000-08 (SNI 15-36)

Source: SCB (2013)

[2] All products are seen as new in the starting year, i.e. in 2000. When firms introduce additional unique export products in subsequent years to 2000, i.e. in the period 2001-08, these will count as new export products. SNI is based on the Swedish standard industrial classification.

Figure 3 presents the average number of new export products in Swedish municipalities for the period 2001-08 (SNI 15-36). The average number of new export products is very high for Göteborg, followed by the municipalities of Stockholm, Borås and Malmö. Hence, the three metropolitan regions in Sweden, together with Borås, constitute the top four. Moreover, Helsingborg, accompanied by Jönköping, also export fairly large numbers of new export products. In the north of Sweden, new export products are strongly linked to the municipalities of Skellefteå, Örnsköldsvik, and Sundsvall. Municipalities that are located on the coast line have larger flows of new export products. It also tends to be advantageous for municipalities to lie between the three metropolitan regions in Sweden, as in the case of Jönköping and Borås. Figure 3 shows that there are some clear regional differences in firms' behavior with regard to new export products, and why internal and external knowledge sources might be important to firms.

This setting focuses on export products that are new to the firm. The next section presents the empirical strategy followed in this paper, along with a detailed description of the data and variables.

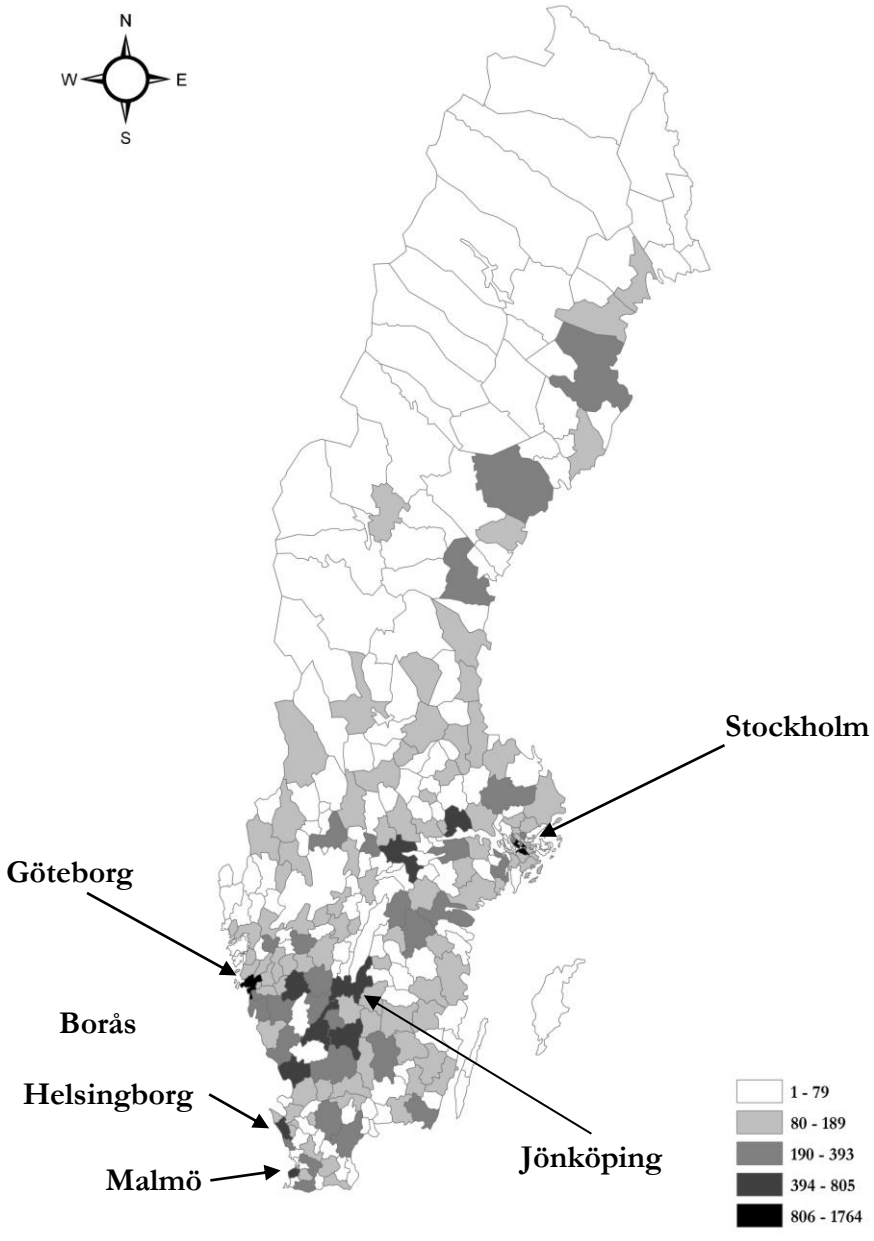

Figure 3 Average number of new export products in Swedish municipalities 2001-08 (SNI 15-36)

4 Data, Empirical Application, Variables and Descriptive Statistics

4.1 Data

The data used in this paper have been collected by Statistics Sweden and consist of publicly audited micro level data. They include information on employees (e.g. educational attainment), firms (e.g. trade data and number of employees) and establishments (i.e. information on how many establishments each unique firm has).

A strength of this dataset is that we can extract three-tiered data (i.e. employees-firms-establishments) on all exporting manufacturing firms in Sweden that belong to industries classified as SNI 15-36. The period examined is 2000-08. However, since all exported products are seen as new in 2000, we exclude year 2000 from the panel. In this way, we have constructed a panel for 2001-08 of 631045 exported products, where 424540 (67.3%) of the exported products are tied to firms with a single establishment at a unique location. Aggregating exported products and new exported products over firms and time gives a sample of 66300 observations, of which 53705 (81%) observations are tied to firms with new export products.[3]

Since firms can locate in several municipalities, it infers a limitation that needs to be carefully considered. For example, if a firm has establishments in several municipalities, this causes a problem in assigning the export data (which is a firm aggregate) to a certain establishment. In order to account for this problem of multi-location we do the following:

1) The establishment with most labor is assigned firm k's exports,

2) We construct two panels: the first panel includes all firms (i.e. single firm establishments and firms with establishments across many municipalities, where exports are assigned to the location with most labor), whereas the second panel includes only single-establishment firms (the second panel will be estimated for robustness control),

3) Additional robustness checks include controlling for export persistency and access to KIBS employment.

4.2 Empirical Application

We want to analyze how new export products are affected in manufacturing firms across space in Sweden. We do this by highlighting the role of firms' internal knowledge, and their access to external knowledge sources.

Firm k's value of new export products, V_k, can consist of three separable components:

$$V_k = N_{I(k)} P_k Q_k \,, \qquad (1)$$

where $N_{I(k)}$ is the number, P_k is the average unit price, and Q_k is the average quantity in kilograms, of new exported products of firm k, respectively. Equation (1) can be transformed to the summation of i) logged number of new export products, ii) logged average export unit price, and iii) logged average export quantity:

$$\ln V_k = \ln N_{I,k} + \ln P_k + \ln Q_k \,. \qquad (2)$$

Equation (2) implies that each component i), ii), and iii), along with $\ln V_k$, can be analyzed separately as a dependent variable.

[3] The sample consisting only of firms with a single municipality establishment has 59549 observations, of which 47489 (79.7%) observations are tied to firms with new export products.

Adding a location specification, represented by municipalities (v) to the firm structure, gives a reduced form regression model to analyze firms' value of exported new products:

$$\ln(V)_k = \alpha + \beta_1 \ln(X)_k + \beta_2 \ln(X)_{k,v} + u_k \,. \quad (3)$$

α is an intercept, whereas β_1 and β_2 are two vectors of parameters to be estimated. X_k and $X_{k,v}$ are vectors containing firm-specific and region-specific explanatory variables, respectively. u_k is an error term that by assumption is normally distributed with zero mean.

Moreover, we can define three measures of municipality v's knowledge accessibility building upon the works of Johansson et al (2003) and Andersson and Klaesson (2009):

$$A_v = S_v exp\{-\delta_v d_{vv}\}\,, \quad (4)$$

$$A_{\tilde{v}} = \sum_{j \in F(v)} S_j exp\{-\delta_{\tilde{v}} d_{vj}\}\,, \quad (5)$$

$$A_{\tilde{\tilde{v}}} = \sum_{j \in E(v)} S_j exp\{-\delta_{\tilde{\tilde{v}}} d_{vj}\}\,, \quad (6)$$

where A_v denotes the local, $A_{\tilde{v}}$ the intra-regional, and $A_{\tilde{\tilde{v}}}$ the extra-regional market access to the size of activities (S_j) in KIMI for municipality v.[4] $F(v)$ consists of all the neighboring municipalities that belong to the same functional economic region as v, and $E(v)$ is the set of all Swedish municipalities outside $F(v)$. The coefficient d_{vv} is the travel time distance inside municipality v, whereas the coefficient d_{vj} denotes the travel time distance between municipality v and municipality j. The δ's are measures of time-distance sensitivity. Equations (4), (5), and (6) indicate how accessible the surrounding knowledge sources associated with KIMI activities are for firms in the local municipality.

By expanding the X_k and the $X_{k,v}$ vectors in Equation (3) and adding a dynamic structure gives:

$$\ln(V)_{kt} = \alpha + \beta_1 \ln(H)_{kt} + \beta_2 \ln(L)_{kt} + \beta_3 \ln(A)_{kt,v} + \beta_4 \ln(A)_{kt,\tilde{v}} + \beta_5 \ln(A)_{kt,\tilde{\tilde{v}}} + u_{kt} \,. \quad (7)$$

Equation (7) is a logarithmic form model where the independent variables can be analyzed in form of elasticities. H_k is human capital, and L_k is a size variable (in terms of number of employees), of firm k at time t, respectively. $A_{k,v}$, $A_{k,\tilde{v}}$, and $A_{k,\tilde{\tilde{v}}}$ denote firm k's local, intra-regional, and extra-regional access to the size of KIMI activities proxied by the number of KIMI employment. V_k and u_k are defined as above.

A problem in our empirical strategy is that we want to regress the value of new export products on firm characteristics drawn from exporters. If this is the way, we are not observing the equation for the population as a whole. Hence, if firms with new export products would differ from firms with no new export products, then we would encounter a selection bias.

To account for this problem we estimate a Heckman Selection Model (HSM), which includes all exporting firms, and then selects from this population the firms with new export products (cf. Heckman 1979). As a result, we can approach the selection bias as an omitted variable problem. The coefficient of the omitted variable (known as the inverse Mill's ratio) might solve the problem of the selection bias as it takes into account the restrictions and correlations of the population and the sample selection error terms.

[4] KIMI in this context refers to manufacturing industries 24, 29, and 30-35 and is based upon the classification published in Eurostat (2009). See Appendix for an industry description.

4.3 Variables and Descriptive Statistics

Table 1 presents the descriptive statistics for exporting firms in the Swedish manufacturing sector. It also includes a brief description of the variables, and the expectation on the sign of each explanatory variable, respectively. The variances are large across variables and observations, however, with the logarithmic functional form (also presented in Table 1), the variances are mitigated and the distribution of each variable is tending towards normal.[5]

The mean of the value generated from new export products (V) is SEK 1116 million, and the average amount of new export products (N) is 4. The mean of the average unit price of new export products (P) is SEK 1157, whereas the mean average quantity (Q) is 0.301 million kilograms. In terms of human capital (H), the average amount of labor with a higher education degree (i.e. tertiary training programs shorter than three years, bachelor's degree, master's degree, or a PhD) is 16. The municipal accessibility of the local firm to the size of surrounding KIMI activities, (A_v), has a mean of 3408 labors, whereas the mean for intra-regional accessibility ($A_{\tilde{v}}$) has approximately the same size, 3630. The extra-regional accessibility ($A_{\tilde{\tilde{v}}}$) has a lower average of 636 labors, which is reasonable as the local firm's accessibility diminishes with an increased distance. The mean value of labor (L) in exporting firms is 68, indicating that the average exporting firm is a medium-sized firm.

Table 1 Descriptive statistics for exporting firms and expected signs (V and Q are denoted in units of SEK million, whereas N, P, H, A, and L are presented in number of units): 66300 firm observations

Dependent variable							
Variable	**Mean**	**Median**	**Standard deviation**	**Min**	**Max**	**Description**	**Model**
V	1116	0.360	55187	0	12097481	Value of the firm from new export products in SEK million.	1
$\ln(V)$	14.053	14.037	3.728	0	30.120		
N	4	2	8.717	0	453	Number of new export products by the firm.	2
$\ln(N)$	1.046	0.693	0.986	0	6.120		
P	1157	145	9614	0.001	1055615	Average unit price of new export products of the firm in SEK.	3
$\ln(P)$	5.501	5.521	1.870	-6.908	13.870		
Q	0.301	0.001	4.361	0	434	Average quantity of new export products by the firm in million kilograms.	4
$\ln(Q)$	7.507	7.534	3.345	0	19.890		
Explanatory variable							
Variable	**Mean**	**Median**	**Standard deviation**	**Min**	**Max**	**Description**	**Expected sign**
Firm-specific variables							
H	16	2	176	0	14509	Labor with higher education in the firm: tertiary training programs less than 3 years, BSc, MSc, or higher.	+
$\ln(H)$	-1.849	0.693	5.785	-11.51	9.581		
L	68	13	442	1	23321	Total amount of labor in the firm.	+
$\ln(L)$	2.691	2.565	1.501	0	10.060		
Region-specific variables							
A_v	3408	771	7166	0	35052	The firm's local access to KIMI.	+
$\ln(A)_v$	6.743	6.648	1.685	-11.51	10.460		
$A_{\tilde{v}}$	3630	1324	6166	0	46529	The firm's intra-regional access to KIMI.	+
$\ln(A)_{\tilde{v}}$	6.237	7.188	4.418	-11.51	10.751		
$A_{\tilde{\tilde{v}}}$	636	465	593	0.053	3044	The firm's extra-regional access to KIMI.	+
$\ln(A)_{\tilde{\tilde{v}}}$	5.929	6.142	1.244	-2.940	8.020		

[5] The variance inflation factor is below 5 for all the variables (including the year and industry dummies) that enter Models 1-4. In addition, Models 2, 3 and 4 suffer from heteroskedasticity, thereof we find it necessary to use robust standard errors.

5 Empirical Results and Analysis

In this section we estimate and analyze the effects of firms' internal knowledge and their access to external knowledge sources reflected by intra-regional, and extra-regional access to high-technology manufacturing industries. Localized high-technology manufacturing is assumed to have a catalytic effect on local and regional knowledge flows by stimulating suppliers of knowledge-intensive inputs to high-technology manufacturing firms.

The examined effects comprise: a) the value of new export products denoted by $\ln(V)$ in Model 1, b) the number of new export products denoted by $\ln(N)$ in Model 2, c) the average unit price of new export products denoted by $\ln(P)$ in Model 3, and d) the average quantity of new export products denoted by $\ln(Q)$ in Model 4.

For robustness and comparison matters, we estimate an additional panel containing only firms with a single establishment (see Table A3 in the Appendix). All models are estimated with robust standard errors, industry and year dummies. We use a Heckman Selection Model (HSM) to control for a possible selection bias. Since we observe a selection bias in all four models, the HSM will correct for the omitted variables problem by considering the inverse Mill's ratio (λ).[6]

5.1 Empirical Results and Analysis

Table 2 presents the empirical results from estimating the four models using the HSM. The empirical results are first discussed based upon Model 1. Thereafter we analyze how Models 2, 3, and 4 contribute to the total value of new export products.

The parameter for firms' internal human capital (H) is found to have a positive effect on the value of new export products. All else equal, if the human capital in a firm doubles, on average, the value of new export products in that firm increases by 6.3%. By looking at the separate components of a firm's value of new export products, we observe rather similar elasticities and that the effect on the number, average unit price, and average quantity is significant and positive. Hence, these empirical results are in line with Hypothesis 1a), 1b), 1c), and 1d). The positive correlation between a firm's human capital and its new export products (in value and number), average unit price and average quantity support the assumption that knowledge-intensive firms have greater opportunities to generate and turn new ideas into new products (see e.g. Romer (1987) and (1990)). These new products can either complement, or replace old products in the foreign markets. Previous studies observe a similar pattern when analyzing exports in general. For example, Munch and Skaksen (2008) find that there is a strong positive link between firms' export performance and human capital. Robson et al (2012) observe that human capital profiles of entrepreneurs act as key drivers of firms' export performance. A positive effect of human capital and the generation of new product ideas is also reported in Andersson and Johansson (2012).

Moreover, a positive and economically significant effect is observed for firm size as measured by the size of the labor force (L). Hence, if the amount of labor in a firm increases by 1%, on average, the value of new export products increases by 1.422%. In terms of separate components of the value of new export products it is obvious that the largest effect is captured by the average quantity of new export products. Moreover, firm size also has an economically significant effect on the number of new export products. If the number of employees in a firm doubles, on average, that will increase the number of new export products by 29.8%. The effect from labor on the average unit price of new export products is positive, however, of less importance compared to the average quantity and number of new export products.

[6] Our regression models have also been estimated by OLS. The empirical results are much similar, yet the results for the HSM are slightly upward biased on the fourth decimal point.

A firm's access to KIMI in the local environment (A_v) shows a negative effect on the value of new export products. The negative effect is also observed for a firm's intra-regional access to KIMI ($A_{\tilde{v}}$), but the effect has a lower magnitude than the former. For example, if a firm's local (or intra-regional) accessibility to KIMI doubles, on average, that decreases the value of its new export products by 8.1% (or by 1%). The results for A_v and $A_{\tilde{v}}$ are the opposite of what was expected from Hypothesis 2a). A somewhat similar result (yet for exports in general) is observed in Gråsjö (2006), who finds that intra-regional accessibility to human capital affects export values negatively. The effect of local accessibility to human capital on the export value is, however, observed as positive. The negative effect of the local and intra-regional access to KIMI on the value of new export products can, component-wise, be explained by the average quantity of new export products. The local and intra-regional accessibility to KIMI do, however, positively influence both the number and the average unit price of new export products, which support Hypothesis 2b) and 2c). Moreover, the further out in the periphery the KIMI location is, the more a firm can benefit from its value of new export products. This finding confirms Hypothesis 2a) for extra-regional access of a firm to KIMI ($A_{\tilde{\tilde{v}}}$). A possible explanation can be that larger quantities of new export products are preferred in the periphery, which is indicated by the $A_{\tilde{\tilde{v}}}$ coefficient for average quantity of new export products (i.e. 0.156). The local and the intra-regional environments are more intended for firms that export small quantities of new export products with high unit prices and high technological content. For example, components production for the aeronautics and the automotive industry are located in metropolitan regions, whereas heavy production such as rubber, metal, pulp and paper products is located further away from the metropolitan region. On these turns, the average unit price of new export products is affected positively in the local and intra-regional environment, which suggests that firms can benefit from charging a higher price for their new export products. Finally, a firm's access to KIMI in the local and intra-regional environment is important for the number of new export products to grow in the foreign market.

The overall outcome of the regression analysis is that the internal knowledge of an individual exporter increases its capacity to introduce new export products. According to our theoretical framework, the size of the internal knowledge reflects the firm's knowledge development and accession capacity. For the individual firm, its access to KIMI-activities helps it to develop many product variants which are sold at above average prices, but below average quantities. The firm's KIMI-environment stimulates the introduction of novel and high-priced products, however, this effect is not strong enough to match the scale effect of large export flows which is observed in less KIMI-rich environments.

Table 2 Regression results for firms' new export products in Swedish manufacturing: Dependent variables in logged form are $\ln(V)$, $\ln(N)$, $\ln(P)$, and $\ln(Q)$, where $\ln(V) \approx \ln(N) + \ln(P) + \ln(Q)$

Explanatory variable	Dependent variable			
	Value of new export products, $\ln(V)$	Number of new export products, $\ln(N)$	Average price of new export products, $\ln(P)$	Average quantity of new export products, $\ln(Q)$
Firm-specific variable				
Human capital, $\ln(H)$	0.063*** (0.003)	0.019*** (0.000)	0.023*** (0.002)	0.028*** (0.003)
Labor, $\ln(L)$	1.422*** (0.010)	0.298*** (0.004)	0.027*** (0.006)	1.104*** (0.009)
Region-specific variable				
Local accessibility, $\ln(A)_v$	-0.081*** (0.007)	0.021*** (0.003)	0.093*** (0.004)	-0.186*** (0.007)
Intra-regional accessibility, $\ln(A)_{\tilde{v}}$	-0.010*** (0.003)	0.005*** (0.000)	0.016*** (0.001)	-0.025*** (0.003)
Extra-regional accessibility, $\ln(A)_{\tilde{\tilde{v}}}$	0.066*** (0.010)	0.001 (0.003)	-0.087*** (0.006)	0.156*** (0.009)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Probability χ^2	0.000	no max	0.000	0.000
λ = selectivity effect	0.370*** (0.014)	1.002*** (0.003)	0.196*** (0.004)	0.089*** (0.023)
R^2_{OLS}	0.51	0.30	0.30	0.47
Observations	66300	66300	66300	66300
Censored: non-new export products	12595	12595	12595	12595
Uncensored: new export products	53705	53705	53705	53705

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Estimated by Heckman Selection Model (maximum likelihood).

5.2 Robustness

For robustness and comparison matters we estimate a sample that only consists of firms with a single establishment. This procedure reduces the sample from 66300 to 59549 observations, of which 47489 observations are tied to firms that introduce new export products. In doing so, we find that the effect of a firm's internal human capital on its value, number, average unit price, and average quantity of new export products is quite robust. There are, however, two differences in the results that are worthwhile to discuss (see Table A3 in the Appendix for the regression results).

When we account only for firms with a single establishment, we observe that the coefficient for extra-regional access to KIMI becomes significant and has a positive effect on the number of new export products. This result is in line with Hypothesis 2b). Another difference we find is that our firm size variable (i.e. labor) goes from positive and significant, to negative and significant for the model explaining the average unit price of new export products. A possible reason for the differing sign of the firm size variable is that in the reduced sample the majority of the excluded observations belong to large firms with many establishments. The negative effect of firm size on

the average unit price of new export products can then be related to the fact that single establishment firms are more of price takers.

To further test the robustness of Models 1, 2, 3 and 4, we also control for export persistency. Export persistency is a dummy variable that equals 1 if a firm introduces new export products in all the years in the period examined, or equals 0 if otherwise. Once we control for export persistency, we observe that the results presented in Table 2 remain the same. Moreover, the coefficient for export persistency is economically significant and positive for the value, number, average unit price, and average quantity, of new export products. This finding indicates the importance of being frequently innovative in order to increase the value and number of new export products, as well as the price and quantity of new export products.

Finally, in a last robustness check we estimate Models 1, 2, 3 and 4 by using the access to KIBS employment as our measure of external knowledge. By doing this, we find that all estimates are almost identical in terms of size, significance and sign. The only exception is the extra-regional access to KIBS employment, where the sign and significance are the same, yet the size of the coefficients is half that of KIMI employment. In addition, the goodness of fit measure obtained via simple least squares regression is identical to the fitted models with access to KIMI employment. Hence, these findings show how the access to KIBS employment is connected to the framework condition presented in Figure 1.

6 Concluding Remarks

The purpose of this study has been to examine how firms' internal and external knowledge sources affect the introduction of new export products with regard to value, number, average unit price and average quantity

Our results show that there is a strong positive correlation between a firm's internal knowledge and: i) the value, ii), the number, iii) the average unit price, and iv) the average quantity, of new export products, respectively. Hence, a firm with a higher human capital stock improves its competitiveness, as well as its ability to obtain higher levels of value added through new export products.

On the one hand, the number of new export products of a firm thrives mostly in environments that are close to KIMI employment. In addition, the closer a firm's proximity to KIMI employment, the higher is the likelihood that it can charge a high average unit price of its new export products. On the other hand, the firm's local and intra-regional access to KIMI employment generates a lower value of new export products. Hence, the positive effects induced by the firm's number and average unit price of new export products are completely washed out by a mass phenomenon. This mass phenomenon, in terms of the average quantity of new export products, indicates that small quantities of new export products are more important in local and intra-regional areas, while the benefits from large quantities of new export products are more obvious in the extra-regional area.

References

Andersson, M. and B. Johansson (2012). "Heterogeneous Distributions of Firms Sustained by Innovation Dynamics - A Model with Empirical Illustrations and Analysis." Journal of Industry, Competition and Trade **12**(2): 239-263.

Andersson, M. and J. Klaesson (2009). "Regional Interaction and Economic Diversity: Exploring the Role of Geographically Overlapping Markets for a Municipality's Diversity in Retail and Durables," in Karlsson, C., Johansson, B., and R. R. Stough (eds). Innovation, Agglomeration and Regional Competition. Cheltenham, Edward Elgar.

Arrow, K. J. (1962). "The Economic Implications of Learning by Doing." The Review of Economic Studies **29**(3): 155-173.

Chandler, A. D. (1977). The Visible Hand: the Managerial Revolution of American Business. Cambridge MA, Harvard University Press.

Chevassus-Lozza, E. and D. Galliano (2003). "Local Spillovers, Firm Organizations and Export Behaviour: Evidence from the French Food Industry." Regional Studies **37**(2): 147-158.

Cohen, W. M. and D. A. Levinthal (1989). "Innovation and Learning: The Two Faces of R&D." The Economic Journal **99**(397): 569-596.

Cohen, W. M. and D. A. Levinthal (1990). "Absorptive Capacity: A New Perspective on Learning and Innovation." Administrative Science Quarterly **35**(1): 128-152.

Duranton, G. and D. Puga (2004). "Micro-Foundations of Urban Agglomeration Economies." Handbook of Regional and Urban Economics **4**: 2063-2117.

Eurostat (2009). "High-Technology" and "Knowledge Based Services" Aggregations Based on NACE Rev.2. Luxembourg, The EU Commission.

Fujita, M. and J.-F. Thisse. (2002). Economics of Agglomeration - Cities, Industrial Location, and Regional Growth Cambridge, Cambridge University Press.

Ganotakis, P. (2010). "Founders' Human Capital and the Performance of UK New Technology Based Firms." Small Business Economics **39**(2): 495-515.

Glaeser, E. L., Kallal, H. D., Sheinkman, J. A., and A. Schleifer (1992). "Growth in Cities." Journal of Political Economy **100**(6): 1126-1152.

Griffith, R., Redding, S., and J. Van Reenen (2003). "R&D and Absorptive Capacity: Theory and Empirical Evidence." Scandinavian Journal of Economics **105**(1): 99-118.

Gråsjö, U. (2006). "Human Capital, R&D and Regional Exports", in Johansson I. (ed.). Uddevalla Symposium 2005: Innovations and Entrepreneurship in Functional Regions. Uddevalla, University West.

Heckman, J. J. (1979). "Sample Selection Bias as a Specification Error." Econometrica **47**(1): 153-161.

Jacobs, J. (1969). The Economies of Cities. New York, Random House.

Johansson, B. (1993). Ekonomisk dynamik i Europa: Nätverk för handel, kunskapsimport och innovationer. Malmö, Liber-Hermods.

Johansson, B., Johansson, S., and T. Wallin (2013). Internal and External Knowledge - Innovation of Export Varieties. CESIS Working Paper No. 297. Stockholm.

Johansson, B. and J. Klaesson (2011). "Agglomeration Dynamics of Business Services." The Annals of Regional Science **47**(2): 373-391.

Johansson, B., Klaesson, J., and M. Olsson (2003). "Commuters' Non-linear Response to Time Distances." Journal of Geographical Systems **5**(3): 315-329.

Johansson, B. and H. Lööf (2014). Innovation Strategies Combining Internal and External Knowledge. CESIS Working Paper. Stockholm. **Forthcoming**.

Malmberg, A., Malmberg, B., and P. Lundequist (2000). "Agglomeration and Firm Performance: Economies of Scale, Localisation, and Urbanisation among Swedish Export Firms." Environment and Planning **32**(2): 305-321.

Marshall, A. (1890). Principles of Economics. New York, Prometheus Books.

Matsuyama, K. (1995). "Complementaries and Cumulative Processes in Models of Monopolistic Competition." Journal of Economic Literature **33**(2): 701-729.

Mowery, D. C. (1983). "The Relationship between Intrafirm and Contractual Forms of Industrial Research in American Manufacturing." Explorations in Economic History **20**(4): 351-374.

Munch, J. R. and J. R. Skaksen (2008). "Human Capital and Wages in Exporting Firms." Journal of International Economics **75**(2): 363-372.

Rivera-Batiz, F. L. (1988). "Increasing Returns, Monopolistic Competition, and Agglomeration Economies in Consumption and Production." Regional Science and Urban Economics **18**(1): 125-153.

Robson, P. J. A., Akuetteh, C. H., Westhead, P., and M. Wright (2012). "Exporting Intensity, Human capital and Business Ownership Experience." International Small Business Journal **30**(4): 367-387.

Romer, P. M. (1986). "Increasing Returns and Long-Run Growth." The Journal of Political Economy **94**(5): 1002-1037.

Romer, P. M. (1987). "Growth Based on Increasing Returns Due to Specialization." The American Economic Review **77**(2): 56-62.

Romer, P. M. (1990). "Endogenous Technological Change." The Journal of Political Economy **98**(5): 71-102.

SCB (2013). Statistical Database MONA. Statistics Sweden. Örebro.

Schumpeter, J. A. (1934). Theory of Economic Development. Cambridge MA, Harvard University Press.

Simmie, J. (2003). "Innovation and Urban Regions as National and International Nodes for Transfer and Sharing of Knowledge." Regional Studies **37**(6-7): 607-620.

Stock, G. N., Greis, N. P., and W. A. Fischer (2001). "Absorptive Capacity and New Product Development." Journal of High Technology Management Research **12**(1): 77-91.

Tilton, J. H. (1971). International Diffusion of Technology: The Case of Semiconductors. Washington D.C., Brookings Institution.

Vernon, R. (1966). "International Investment and International Trade in the Product Cycle." The Quarterly Journal of Economics **80**(2): 190-207.

Appendix

Table A1 presents the industries within the Swedish manufacturing sector. The classification is according to the Swedish standard industrial classification (SNI), where the description of each industry is based upon SNI2002 published by Statistics Sweden.

Table A1 The Swedish manufacturing sector: SNI description of industries

SNI	Industry description in the Swedish manufacturing sector
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	Manufacture of pulp, paper and paper products
22	Publishing, printing and reproduction of recorded media
23	Manufacture of coke, refined petroleum products and nuclear fuel
24	Manufacture of chemicals and chemical products, including manufacture of basic pharmaceutical products and pharmaceutical preparations
25	Manufacture of rubber and plastic products
26	Manufacture of other non-metallic mineral products
27	Manufacture of basic metals
28	Manufacture of fabricated metal products, except machinery and equipment
29	Manufacture of machinery and equipment not elsewhere classified
30	Manufacture of office machinery and computers
31	Manufacture of electrical machinery and apparatus not elsewhere classified
32	Manufacture of radio, television and communication equipment and apparatus
33	Manufacture of medical, precision and optical instruments, watches and clocks
34	Manufacture of motor vehicles, trailers and semi-trailers
35	Manufacture of other transport equipment
36	Manufacture of furniture; manufacturing not elsewhere classified

A correlation matrix for the variables that enter Models 1, 2, and 3 is presented in Table A2. The correlation is fairly low among the majority of variables, however, is high between labor and new export products in terms of value and number. The correlation is also high between value and number of new export products, as well as between labor and human capital.

Table A2 Correlation matrix for dependent and explanatory variables in Models 1, 2, 3, and 4

	$\ln V$	$\ln N$	$\ln P$	$\ln H$	$\ln A_v$	$\ln A_{\tilde{v}}$	$\ln A_{\tilde{\tilde{v}}}$	$\ln L$
$\ln V$	1.000							
$\ln N$	0.668	1.000						
$\ln P$	0.188	0.259	1.000					
$\ln H$	0.473	0.360	0.116	1.000				
$\ln A_v$	-0.042	0.047	0.158	0.096	1.000			
$\ln A_{\tilde{v}}$	-0.031	0.017	0.097	0.041	0.264	1.000		
$\ln A_{\tilde{\tilde{v}}}$	0.065	0.046	-0.020	0.026	0.177	0.287	1.000	
$\ln L$	0.665	0.483	0.015	0.625	0.016	-0.024	0.073	1.000

Table A3 Regression results for single firm establishments' new export products in Swedish manufacturing: Dependent variables in logged form are $\ln(V)$, $\ln(N)$, $\ln(P)$, and $\ln(Q)$, where $\ln(V) \approx \ln(N) + \ln(P) + \ln(Q)$

Explanatory variable	**Dependent variable**			
	Value of new export products, $\ln(V)$	Number of new export products, $\ln(N)$	Average price of new export products, $\ln(P)$	Average quantity of new export products, $\ln(Q)$
Firm-specific variable				
Human capital, $\ln(H)$	0.062*** (0.003)	0.019*** (0.001)	0.025*** (0.002)	0.024*** (0.002)
Labor, $\ln(L)$	1.391*** (0.012)	0.251*** (0.004)	-0.019*** (0.007)	1.172*** (0.011)
Region-specific variable				
Local accessibility, $\ln(A)_v$	-0.066*** (0.008)	0.021*** (0.002)	0.090*** (0.005)	-0.163*** (0.007)
Intra-regional accessibility, $\ln(A)_{\tilde{v}}$	-0.006** (0.003)	0.005*** (0.001)	0.016*** (0.002)	-0.023*** (0.003)
Extra-regional accessibility, $\ln(A)_{\tilde{\tilde{v}}}$	0.078*** (0.011)	0.010*** (0.003)	-0.087*** (0.006)	0.165*** (0.010)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Probability χ^2	0.000	no max	0.000	0.000
λ = selectivity effect	0.330*** (0.013)	0.998*** (0.005)	0.097*** (0.011)	0.222** (0.012)
R^2_{OLS}	0.45	0.22	0.30	0.44
Observations	59549	59549	59549	59549
Censored: non-new export products	12060	12060	12060	12060
Uncensored: new export products	47489	47489	47489	47489

*** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Estimated by Heckman Selection Model (maximum likelihood).