CESIS Electronic Working Paper Series

Paper No. 195

Human Capital and the Structure of Regional Export Flows

Martin Andersson and Sara Johanson

(CESIS, JIBS)

September 2009

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

Scale and Scope

– Human capital and the structure of regional export flows

Martin Andersson & Sara Johansson

Abstract

This paper presents an empirical analysis of the relationship between human capital endowments and the structure of regional export flows. Since the development of each export product may be assumed to be associated with innovation activity, requiring human capital inputs, the core hypothesis tested in this paper is that cross-regional variations in endowments of human capital influence the extensive margin (number of export products) rather than the intensive margin (average export value per product). The hypothesis is tested in a cross-regional regression model, applied to aggregate and within-industry export flows from Swedish regions. The empirical results confirm the theoretical prediction that the response of regional export flows to cross-regional variations in human capital is an increase in the extensive margin. To the extent that the regional human capital endowment affects the intensive margin, the effect is a higher average price per export product.

JEL: F12, F14, R12, R32

Keywords: product differentiation, knowledge, human capital, accessibility, export diversity, extensive margin, economies of scale

1 Introduction

This paper analyzes the relationship between the structure of export flows from different regions and regional human capital endowments. The analysis considers how the internal geography of human capital in a country shapes the trade flows to foreign markets from its different regions. The approach of the study may be thought of as an analysis of a country's export, while taking regional heterogeneity into account. The national export flow is indeed the sum of firms' export activities and firms are located in different regions.

Knowledge is a core variable in many modern theories of international trade and its role for exports and comparative advantages has been emphasized at least since the 1960s by e.g. Posner (1961), Vernon (1966) and Hirsch (1967). According to this view, comparative advantages are dynamic and develop over time as knowledge accumulates, through e.g. purposeful investments and absorption of knowledge and information from different sources. It should be clear that the spatial distribution of human capital – i.e. the knowledge, competencies and skills embodied in people in different regions – influences the pattern of comparative advantages as well as the structure of specialization and trade across regions.

Traditional perspectives in the international trade literature tend to disregard the regional distribution of a country's export since human as well as investment capital are typically assumed to move freely between regions within a country. This free mobility wipes out factor price differentials and subsequent differences in specialization across regions. Unless for spatially 'trapped' factors – like natural resources – the composition of export flows to foreign countries from the different regions of a country should be similar.

Although human capital is essentially mobile, its spatial distribution is highly persistent and invariant over time. One reason is that the regional characteristics attracting human capital

(quality of life factors and local labor market attributes) are slowly changing. Another reason is that human capital tends to be attracted to places with already high levels of human capital (Berry and Glaeser 2005). Johansson and Wigren (1996) use the term 'production milieu' to denote slowly changing and regionally sticky features of a region which influences production and specialization opportunities. The human capital in a region is one such feature.

It may be obvious that the spatial distribution of human capital plays a fundamental role in shaping regional patterns with regard to comparative advantages, specialization and export market performance (cf. Grossman and Helpman 1991b). What is less clear, however, is in what way regional endowments of human capital influence regional export. What components of regional export flows reflect the fact that human capital endowments differ between regions?

This analysis focuses on supply-side influences on export flows and asks the question *how* export flows from regions that are well endowed with human capital differ from export flows from other regions. With the objective to analyze this question the study contributes to the literature in two respects. First, focusing on human capital, it presents empirical evidence of the role of regional supply-side characteristics for understanding the internal geography of a country's aggregate exports. Second, the paper contributes to the literature on how different margins in trade flows adjust to variations in supply-side factors.

This study follows Hummels and Klenow (2005) who inquire into how large countries export more than small countries by distinguishing between different margins of trade flows. Specifically, we make a distinction between the intensive margin (exports per product) and the extensive margin (number of products). The intensive margin is further divided into one price and one volume component.[1] The empirical analysis is designed to reveal the contribution of

[1] For aggregate exports, Hummels and Klenow (2005) find that the extensive margin accounts

each respective margin to the overall relationship between exports and human capital across regions.

Theoretical arguments from the literature of innovation and product life cycles stresses that the level of human capital in a region and the potential for knowledge flows should primarily be associated with the extensive margin of trade, i.e. the number of products, and average quality of the goods that are exported. The number of export products exported from a region reflects the number of product varieties developed by firms in the region. The development of each such variety can be assumed to be associated with innovation activity requiring human capital inputs. The basic conjecture is that environments with richness and density of human capital are conducive to the arrival of ideas for product varieties (eg. through knowledge flows). In this way, the stock of product varieties of a region in any point in time reflects the stock of realized 'innovation ideas' (cf. Andersson and Johansson 2008). Human-capital abundant regions also provide the necessary accessibility to human capital to realize such ideas. Moreover, high-quality products can readily be assumed to have a larger content of knowledge and human-capital than other products. Therefore, we expect that regions that are well endowed with human capital specialize and export high-quality products. For a given sector in a region, this is assumed to apply to the influence of the human capital employed in the sector and the influence of human capital employed in other sectors. Making use of detailed export data cross-tabulated on sectors and regions, our empirical results confirm both hypotheses.

The remainder of the paper is organized as follows: The next section presents the theoretical background to and discusses previous empirical results in related research. Section 3 presents the empirical strategy for analyzing how regional variations in human capital endowment affect

---

for about 60 percent of the larger exports of larger economies. Within product categories, they show that richer countries export larger volumes at somewhat higher prices.

the structure of regional export flows. The results of the econometric estimations are presented and discussed in Section 4, followed by a summary and conclusions in Section 5.

2 Human Capital and the Structure of Export Flows

An analysis of how the internal geography of human capital affects the structure of export flows basically relates to three veins in the economic literature, which are briefly reviewed in this section.

Human capital and export performance

A vast body of theoretical and empirical work that emphasises the role of human capital, R&D and innovation for international competitiveness and export performance at the level of nations, regions as well as firms. Fagerberg (1988), Greenlagh (1990) and Gustavsson et al. (1996) (among others) conclude that technological factors are important for countries' international competitiveness and trade specialization. Grossman and Helpman (1991b), Fagerberg (1996) and Braunerhjelm and Thulin (2008) show that investments in R&D create comparative advantages in high-tech sectors, which increase the share of high-tech goods in a country's aggregate export. Regional studies on R&D and export performance have shown that regional R&D activities amplify diversity of export sectors in regions (Johansson and Karlsson 2007), stimulates regional export specialization in technologically advanced goods (Breschi et. al 1999, Gråsjö, 2006) and increases firms' export market participation (Andersson and Johansson, 2008). At the firm-level, several studies have shown that R&D investments stimulate export market participation and export intensity (Wakelin 1998, Sterlacchini 1999 and 200, Bleaney et al. 2002, Barrios et al. 2003 among others). Taken together these empirical findings indicate that knowledge and R&D investments have a positive impact on firms' competitiveness in international markets, which stimulates export market performance in several dimensions. In more explicit terms, previous studies show that knowledge and R&D have a positive effect on

export volumes, export prices as well as the size of the export base. However, few studies have analyzed the importance of knowledge and R&D on these three components of export flows simultaneously.

Product Variety and Human Capital Inputs

Lancaster (1966, 1980) defines products having the same set of characteristics as varieties belonging to the same product group. If varieties in the same product group have different proportions of characteristics but none has a larger amount of every attribute, they are horizontally differentiated. Horizontally differentiated product varieties have similar but not identical attributes, implying that consumers and customers in general perceive varieties as imperfect substitutes. The existence of many product varieties reflects a demand for variety, either because consumers maximize utility by consuming many differentiated varieties ('love for variety') or due to heterogeneity in consumers' perceptions of which is the ideal composition of product characteristics (most preferred variety). Moreover, vertical product differentiation occurs when products differ in quality and, subsequently, also in price (e.g. Flam and Helpman 1987, Falvey and Kierzowski 1987). Vertical product differentiation is a response of suppliers to heterogeneity among customers as regards preferences for product quality.

Heterogeneous consumer preferences or preferences for variety allow firms to differentiate their products. Differentiation is achieved through investments in innovative activities that result in new combinations of product characteristics embodied in specific varieties. Product varieties may be physically similar but are economically differentiated by the fact that buyers perceive them as imperfect substitutes. As a result, each firm faces its own separate downward sloping demand curve. Such demand properties provide a possibility for firms to charge a price mark-up over marginal costs i.e. the firm enjoys monopolistic ascendancy on its market.

It is generally recognized that product differentiation induces a fixed investment or fixed production cost, which makes mark-up pricing a necessity to avoid negative profits. Provided that the number of suppliers and product varieties in the commodity group is sufficiently large, it is rational for each firm to take the behaviour of other firms as given. If in addition there is free entry and exit of firms, product differentiation is consistent with monopolistically competitive market equilibrium where net profits are squeezed to zero. A market structure characterized by monopolistic competition was first analyzed by Chamberlin (1933), who argued that the monopolistic feature of the market is deduced from the elements that distinguish product varieties from one another and give firms a limited market power. The large number of operating firms and the possibility of free entry and exit constitute, on the other hand, the competitive elements in this market structure.

The implications of demand structures reflecting preferences for variety and market structures characterized by monopolistic competition on trade patterns were formalized in a seminal paper by Krugman (1980). Based on assumptions of product differentiation, monopolistic competition and increasing returns to scale, Krugman's theoretical model is a natural point of departure in analysing the influences of human capital on regional export structures. This is because the production of differentiated goods can readily be assumed to require a fixed input of human capital associated with research and product development, development of brand profiles, marketing etc, which insulates the demand for the firm's output from actions undertaken by its competitors. That input of human capital is a prerequisite for both horizontal and vertical product differentiation has been showed in a number of empirical studies during the last decades (Chiarlone 2000, Martín and Orts, 2001, Ferragin and Pastore 2005, Faruq 2006, Johansson, 2008).

Regional Endowments of Human Capital and Knowledge Flows

It is well documented that knowledge in the form of human capital as well as R&D activities and other measures of knowledge tend to be strongly concentrated in space (Audretsch and Feldman 1996).[2] Density of firms and human capital is assumed to bring advantages pertaining to the spread of ideas, knowledge and innovation (Glaeser 1994, Feldman 1999). The localized nature of knowledge spillovers suggests that knowledge accumulation is faster in regional environments with high knowledge density. This reasoning also applies specifically to human capital. Following the arguments outlined in Lucas (1988), there is a large empirical literature focusing explicitly on so-called 'human capital externalities' in dense environments with concentrations of educated people (e.g. Rauch 1993, Moretti 2004). The regional perspective on human capital and exports should be appreciated in this context.

Johansson and Wigren (1996) suggest that the level of human capital in a region can be described as a property of its production milieu. The production milieu comprises slowly changing and regionally trapped features, which have an influence on the production and specialization possibilities of the firms in the region. Human capital can be thought of as the specific knowledge that each worker possesses. This specific knowledge can be of either technical or entrepreneurial nature and is characterized by the particular feature that it is non-rivalrous. Non-rivalry is a feature of a pure public good (Romer 1990). Nevertheless, for certain types of knowledge it is possible to exclude other economic agents from using it commercially by means of patents and trademarks. Thus, not all knowledge is a pure public good in the sense that anyone can freely use it for whatever purpose he wants. Still, even if excludability prevails as regards commercial use, the actual knowledge can be used in the

[2]It is frequently claimed that the continued spatial concentration and clustering of economic activities, despite lower transportation costs and ICT, should partly be understood as a response to an increased role of knowledge, innovation and technology in the economy. Many scholars argue that spatial transactions costs for routinized and standardized activities have fallen, whereas they have increased for knowledge-intensive and non-routine activities (McCann 2008,

generation of new knowledge applications. This implies that knowledge to some extent is a public good that can spill over between economic agents. An appropriate definition of regional human capital endowment must consequently include external knowledge flows in such a way that spatial knowledge spillovers augment the regional knowledge endowments.

As argued by Federici et al. (2008) the kind of knowledge crucial for entrepreneurship and innovation tends to be tacit or sticky in the sense that it is not codified. Such tacit knowledge is an individual asset, based on personal experiences and interactions. This tacit knowledge is mainly exchanged through interpersonal contacts, such as face-to-face business communications, business collaboration, seminars, fairs, etc. Because of travelling costs in terms of time and money, the frequency of these kinds of face-to-face communications decreases with the time distance between the agents involved (Pred 1966, Feldman 1994). Thus, the transmission and absorption of knowledge is facilitated by geographical proximity. Indeed, a large number of empirical studies in the last 15 years indicate that knowledge flows are bounded in geographical space.

3 Empirical Strategy

From the arguments presented in the previous section pertaining to (i) horizontal and vertical product differentiation, which require investments in knowledge and (ii) regional endowment of human capital as a source of external knowledge flows, we derive three hypotheses that we aim to test.

Glaeser and Kolhase 2004). Hence the tendency of ‘knowledge’ to cluster spatially.

- The predominant effect of regional variations in human capital endowment on regional export flows is regional variability in the extensive margin of these flows, i.e. the number of export products.
- The price component of the intensive margin is positively related to the regional endowment of human capital.
- Since the regional abundance of human capital provides a source for spatial knowledge spillovers, it is expected that such external knowledge flows have a positive effect on the extensive margin and the price component of the intensive margin.

We test these hypotheses with data on exports of manufactured goods from Swedish regions for the year 2003. The spatial unit of analysis is the municipality (local government area), which divides Sweden into 288 localities. In the empirical analysis, henceforth, a region refers to a municipality. The municipality data is aggregated from firm-level data, containing information about export value and export volume for each firm at the 8-digit level of product classification according to the combined nomenclature (CN). We regard each firm-level observation in each 8-digit product group as a unique product variety. Each firm is thus assumed to produce a distinct variety. We may think of an 8-digit code as a product group, and the number of firms with positive exports of that product group as the number of varieties. The number of varieties is thus given by the number of 'firm-product-group-specific' observation in each municipality. Firms, and their products, are also classified as a 2-digit industry, implying that the data set contains both an industry and a regional dimension. The data set used for the regression analysis contains 3788 industry-region specific observations. Skilled workers are employed persons with at least three years of university education.

To test the hypothesis that variations in the regional endowment of human capital mainly affect

the extensive margin in regional export flows we apply a cross-regional regression model of the form:

$$\ln V_s = \alpha + \lambda_1 \ln emp_s + \lambda_2 \ln H_s + \eta_s \qquad (1)$$

where V_s is the aggregate export value of municipality *s*, emp_s is the total employment in *s* which reflects the size of the region, and H_s is the endowment of human capital. η_s is the error term subject to the usual assumption of a zero mean and normal distribution.

How do we define a region's endowment of human capital? The approach taken here is to consider a region's total accessibility to employees with a long university education ($\geq$ 3 years). For a given region, such a measure accounts for the human capital in each and every region and discounts the human capital in other municipalities with a distance decay function. The total regional endowment of human capital is given by:

$$H_s = S_s f(c_{ss}) + S_1 f(c_{s1}) + S_2 f(c_{s2}) + ... + S_n f(c_{sn}) \qquad (2)$$

where S_s is the number of skilled workers employed in region *s* and *f(c)* is a distance decay function that determines how the accessibility value is related to the cost of spatial interaction. A common approximation of this distance decay function is an exponential function (Weibull 1976):

$$f(c_{sr}) = \exp\{-\sigma t_{sr}\} \qquad (3)$$

where t_{sr} is the travel-time distance by car between region s and *r* and σ is a pre-estimated time-sensitivity parameter, reflecting the sensitivity of the accessibility to changes in travel

time distances[3]. Combining Equations (2) and (3), the human capital endowment of region *s* is defined as:

$$H_s = \sum_{r=1}^{n} S_r \exp\{-\sigma t_{sr}\} \qquad (4)$$

Equation (4) expresses the accessible human capital endowment of region *s* as the sum of its internal and external skilled labour, weighted by a spatial discounting matrix[4]. As such the regional accessibility depicts the total amount of human capital that is potentially available to any firm in municipality *s*[5]. This human capital also reflects a source of external knowledge flows that may influence firms in a region. This way of measuring regional abundance of human capital implies that variations in human capital across regions can arise solely from regional differences in the internal and external geography of knowledge.

In order to disentangle which margins of regional trade flows that are affected by variations in regional human capital endowments, we note that the export flows of a region consist of three separable components:

i. the number of product varieties exported
ii. the average export price per product variety
iii. the average quantity exported per product variety

Variations in the size of regional export flows can be due to variations in any of these three components. We break down the aggregate export flow from a given industry and region into the three components:

[3] See Johansson, Klaesson and Olsson (2002) for a thorough analysis of time sensitivities in travels.

[4] For a formal definition of accessibility, see for example Gråsjö (2006) or Johansson and Karlsson (2007).

[5] A measure of accessibility should satisfy certain criteria of consistency and meaningfulness,

$$V = n\tilde{q}\tilde{p} \qquad (5)$$

where V denotes total export value, n is the number of product varieties exported and $\tilde{q}$ and $\tilde{p}$ denote the average export quantity and the average export price, respectively. In logarithmic form this relationship is written as:

$$\ln V = \ln n + \ln \tilde{p} + \ln \tilde{q} \qquad (6)$$

where $\ln n$ is the extensive margin of the aggregate export flow and $\ln \tilde{p} + \ln \tilde{q}$ constitutes the intensive margin, consisting of the average price per exported unit and the average quantity exported per product. With these notations, the model in Equation (1) can be regressed on each variable in Equation (6) at the purpose of analysing the influences of regional human capital endowments on the extensive respectively the intensive margin and the price respectively the quantity component.

While we estimate the described model for aggregate regional export flows, we recognize that there are large variations in knowledge intensity across sectors and this industry heterogeneity may generate an endogeneity problem since the actual employment of skilled labour in a region depends on the demand for human capital in that region's manufacturing sector. Furthermore, the possibility to differentiate products and the demand for product variety differ across industries and product groups. Consequently, the observed amount of skilled and unskilled labour in regional employment is likely to be a result of the industrial structure of the region.

In order to preclude empirical results generated by regional variations in industrial structure rather than by regional variations in human capital endowments, we also perform a regression

---

the measure used here satisfies those warranted criteria as shown by Weibull (1976).

analysis that includes an industry dimension. For this purpose, we formulate a regression model that allows us to analyze within-industry variation in the size and structure of export flows across regions. In this model, cross-regional variations within industries in terms of export value are explained by (i) the employment of skilled and unskilled labour in that sector and region, (ii) the accessibility to skilled labour in other sectors in their own region and the (iii) accessibility to skilled workers in all sectors in all other regions (Figure 1).

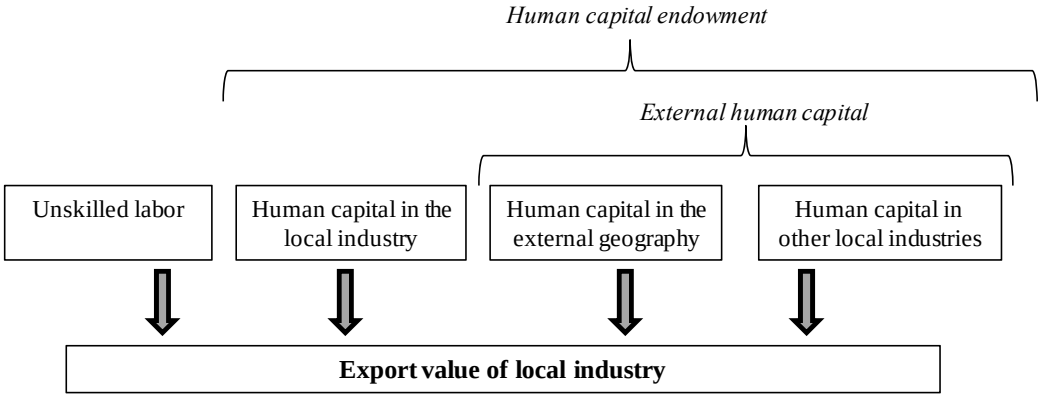

Figure 1. *Structure of the empirical model for within-industry differences in regional exports and human capital*

In the industry-model, we hence separate between internal human capital (skilled labour employed in the local industry) and external human capital (skilled labour employed in other industries and/or in other municipalities). A logarithmic form of this model, including industry specific dummy variables to control for unobserved industry heterogeneity, is formulated as:

$$\ln V_{j,s} = v + \gamma_1 \ln L_{j,s} + \gamma_2 \ln S_{j,s} + \gamma_3 \ln \left[f(c_{ss}) \sum_{i \neq j} S_{i,s} \right]_{j,s} + \ldots$$

$$\ldots + \gamma_4 \ln \left[\sum_{r \neq s} \left(f(c_{sr}) \sum\nolimits_{i=j} S_{i,s} \right) \right]_s + \gamma_5 D_j + \varepsilon_{j,s} \qquad (7)$$

where $L_{j,s}$ is the number of unskilled labour employed in industry *j* in region *s* and variations in

the human capital input across regions and sectors are reflected by the variable $S_{j,s}$. The influence of spatial knowledge flows within the region is captured by the term $\left[f(c_{ss}) \sum_{i \neq j} S_{i,s} \right]_{j,s}$, which is the intra-regional accessibility of industry *j* in regions *s* to skilled labour employed by other sectors in region *s*. The model also includes a variable reflecting inter-regional knowledge spillovers, $\left[\sum_{r \neq s} \left(f(c_{sr}) \sum_{i=j} S_{i,r} \right) \right]_s$, which is the accessibility of any industry in region *s* to skilled labour employed in all other regions. Unobserved industry heterogeneity, originating from differences in knowledge intensity, minimum efficient production scale, transport costs, trade costs and so on, is controlled for by a vector of industry-specific dummy variables, D_j. Finally, *v* is the intercept term and $\varepsilon_{j,s}$ is an error term assumed to have zero mean and to follow a normal distribution.

Due to large variations in the size of Swedish regions in terms of population and employment, all components of regional export flows tend to have a skewed distribution. Table 4 in the Appendix displays descriptive statistics for the dependent variables considered in the econometric estimations. Each of these variables has a mean value that by far exceeds the value of the median observation, which indicates a positively skewed distribution. The implication of this is that the residuals from OLS estimations of the regression model in Equation (3.1) and Equation 3.4 do not fulfil the assumption of homoscedasticity. To produce efficient estimates of the regression coefficients, the regressions are estimated by means of FGLS, using White's robust covariance matrix. The results of these estimations are presented in Section 4.

Another consequence of the skewed distributions of the dependent variables is that the marginal effects of the explanatory variables may vary along the distribution of the dependent variable. Since OLS and GLS estimate the conditional mean of the dependent variable as a

function of the explanatory variables, these estimation methods cannot account for the possibility that the estimated effects of the covariates differ between different points on the conditional distribution of the dependent variable. In this case, quantile regression techniques offer a solution as it enables the estimation of any conditional quantile of the dependent variable as a function of the independent variables. Koenker and Basset (1978) originally proposed quantile regressions as an alternative to OLS when residuals are not normally distributed. However, since marginal effects are the same across all quantiles of the dependent variable only in the special case where the errors are homoscedastic, is the quantile regression estimator also particularly useful in the presence of heteroscedasticity (Gråsjö, 2006).

With the intention to present a more complete picture of the influences of knowledge on the structure of regional export flows, the FGLS estimations of the regression model in Equation (7) is complemented with quantile regressions for the 25th quantile, the median quantile and the 75th quantile. Analogously to a standard OLS regression, which estimates the conditional mean of a random variable, the quantile regression model expresses the conditional quantile of the dependent variable as a linear function of some independent variables. For the θ^{th} quantile ($0 < \theta < 1$) the regression model is expressed as:

$$v_{j,s} = X_{j,s}'\beta_\theta + \mu_{\theta,j,s} \qquad (8)$$

where β_θ is the unknown vector of regression parameters associated with the θ^{th} quantile and $X_{j,s}$ is a vector containing the same independent variables as the regression model in Equation (1) and $\mu_{\theta,j,s}$ is the error term. The θ^{th} quantile of $v_{j,s}$ given $x_{j,s}$ is $Q_\theta\left(v_{j,s}\middle|x_{j,s}\right)$. The quantile regression estimate of β_θ is the value of β_θ that minimizes the sum of the absolute deviations residuals:

$$\min_{\beta} \frac{1}{n}\left(\sum_{v_{j,s} > x_{j,s}'\beta} \left| v_{j,s} - x_{j,s}'\beta \right| \theta + \sum_{v_{j,s} < x_{j,s}'\beta} \left| v_{j,s} - x_{j,s}'\beta \right| (1-\theta) \right) \qquad (9)$$

According to Equation (9) the regression coefficients of different quantiles are estimated with different weights given to the residuals. For the median regression, all residuals receive equal weight, whereas negative residuals are given a weight of 0.25 and positive residuals a weight of 0.75 when estimating the 75th percentile. Moreover, Gould (1992) and Gråsjö (2006) suggest a bootstrap re-sampling procedure for estimating standard errors in data sets with heteroscedastic error distributions. This procedure is preferable since it only affects the standard errors and associated significance levels while leaving the estimations of quantile regression coefficients unchanged. Accordingly, the standard errors in the quantile regressions are obtained by bootstrapping the entire vector of observations. The results of these estimations are presented in the next section.

4 Results

The theoretical argument that the process of horizontal product differentiation depends on the input of human capital implies that regional variations in human capital endowment are expected to affect the number of varieties produced and exported rather than the volume exported of each variety. Moreover, vertical product differentiation results in product varieties with different amount of knowledge content. Consequently, variations in the knowledge endowment of regions are expected to affect the unit price of export products rather than the quantity exported. These hypotheses are tested by FGLS estimations of the cross-regional regression model presented in Equation (1) and FGLS estimations of the two-dimensional regression model presented in Equation (7). These models are regressed on five different dependent variables: total export value, extensive margin (number of export products), the intensive margin, the average export price and average export quantity. Thereafter, the

robustness of the regression coefficients produced by FGLS estimations across different points on the conditional distribution of the dependent variables is examined by estimation of quantile regressions.

The results of the FGLS estimations of the cross-regional regression model, displayed in Table 1, show that the aggregate export flow from a region is increasing with both regional size (in terms of employment) and with the regional endowment of human capital (measured by accessibility to human capital). The values of the estimated coefficients for the extensive and intensive margins (column 2 and 3) additively sum to the regression coefficients for the aggregate export value (column 1). Accordingly, the coefficients in Table 1 indicate that 82 % (0.983/1.202) of the total effect of cross-regional variations in employment on regional export value falls on the extensive margin. In accordance with the findings presented by Hummels and Klenow (2005), these results show that the major explanation for the larger export flows from large regions is that the number of export products increases with the size of the region. Furthermore, the regional endowment of human capital affects the extensive margin only, whereas the effect of this variable on the intensive margin is negative, yet not significant.

The intensive margin can be divided into a price and a quantity component. Column 4 and 5 in Table 1 show that the regional size has a negative influence of the average price of the exported products, whereas there is a significant positive influence of regional size on the average quantity exported per product. The average export price is positively related to the regional endowment of human capital, whereas the average export quantity is decreasing with the regional endowment of human capital. In sum, these results indicate that the export flows from human capital abundant regions are more diversified and consists of goods with a relatively high unit value. These findings are consistent with the results from cross-country data presented by Hummels and Klenow (2005) and support theoretical trade models based on product

differentiation and monopolistic competition (Krugman 1980). Moreover, these results support the theoretical conjecture of a positive effect of human capital on the extensive margin and on the price component of the intensive margin in regional export flows.

Table 1. Results of cross-regional regression estimations

Dependent / Explanatory	Aggregate export value	Extensive Margin	Intensive Margin	Average export price	Average export quantity
Regional size (total employment)	1.202** (0.106)	0.983** (0.015)	0.219* (0.089)	-0.153* (0.078)	0.372** (0.138)
Regional human capital endowment (accessibility to human capital)	0.201* (0.100)	0.250** (0.005)	-0.044 (0.079)	0.253** (0.073)	-0.297* (0.132)
Constant	7.800** (0.881)	-5.213** (0.129)	13.036** (0.731)	2.337** (0.656)	10.677** (1.145)
R^2-value	0.52	0.78	0.03	0.07	0.04
Number of observations	288				

Robust standard errors within parenthesis. **Significant at the 1% level. *Significant at the 5% level

As discussed in the previous section, however, the results of the cross-regional regression model may be driven by regional differences in industry structures. To control for industry heterogeneity, we analyze within-industry variations in the structure of export flows across regions through FGLS estimation of the two-dimensional regression model in Equation 3.4. The results of these estimations are displayed in Table 2.

The figures in the first column of Table 2 show that the total export value is positively affected by all variables included in the model and the regression coefficients are strongly significant. Column 2 and 3 reveal that the input of unskilled labour has a positive effect both on the extensive and intensive margin, yet the size of the estimated coefficient for the intensive margin is about three times larger than the estimated coefficient for the extensive margin. The figures in the first row of table 2 reveal that regional variations in the size of industries (measured as

the input of unskilled workers) predominantly affect the intensive margin. In fact, 73 % (0.617 / 0.850) of the variations in aggregate export flows due to differences in the input of unskilled labour across industries and regions are explained by variations in the intensive margin. Only 27 % (0.233 / 0.850) of the effect of variations in employment of unskilled labour is attributed to variations in the extensive margin. Column 4 and 5 show that it is the quantity component of the intensive margin that is positively affected by the input of unskilled labour, whereas this variable has a significant negative effect on the price component. This outcome indicates that cross-regional differences in input of unskilled labour within industries results in an adjustment of the intensive margin of regional export flows.

The figures presented in the second row in Table 2 signify that cross-regional differences in employment of skilled workers within industries mainly influences the intensive margin and only about one third (35 %) of the marginal effect of human capital input falls on the extensive margin. The coefficients in column 4 and 5 indicate that the predominant effect of variations in human capital input on the intensive margin is an adjustment of the quantity component. The effect of the price component of the intensive margin is positive but smaller and not significant.

The results from the regression estimations presented in Table 2 indicate that when cross-industry heterogeneity, such as average knowledge intensity and average production scale, are controlled for by the inclusion of industry dummy variables, the predominant effect of cross-regional differences in sector size and human capital input is an adjustment of the intensive margin in export flows. Regional variations in input of skilled and unskilled labour have similar effects on the structure of regional export flows.

Table 2. Results of two-dimensional regression estimations

Dependent / Explanatory	Aggregate export value	Extensive Margin	Intensive Margin	Average export price	Average export quantity
Employment of unskilled labour in industry j in region s	0.850** (0.037)	0.233** (0.015)	0.617** (0.030)	-0.095** (0.021)	0.712** (0.038)
Employment of skilled workers in industry j in region s	0.052** (0.012)	0.018** (0.005)	0.034** (0.009)	0.010 (0.007)	0.024** (0.012)
Local accessibility to skilled workers in other sectors in region s	0.439** (0.030)	0.507** (0.012)	-0.067** (0.025)	0.019* (0.009)	-0.087** (0.032)
Inter-regional accessibility to skilled workers	0.210** (0.024)	0.111** (0.009)	0.099* (0.020)	0.001 (0.016)	0.098** (0.028)
Constant	7.211** (0.310)	-2.239** (0.129)	9.450** (0.248)	4.672** (0.175)	4.778** (0.317)
R^2-value	0.53	0.64	0.42	0.48	0.48
Number of observations	3788				

Robust standard errors within parenthesis. ** Significant at the 1% level. *Significant at the 5% level

However, the employment of skilled labour in each industry and region does not necessarily capture all the knowledge that is actually used in the development and production of differentiated varieties. Each sector may benefit from external human capital as skilled workers in other sectors and in other regions can be used in the development or production process, either through business transactions or through pure knowledge spillover effects. In either case, the geographical accessibility to skilled workers are likely to reflect the potential of a sector in a given region to benefit the human capital employed in other locations and other sectors. In accordance with theoretical predictions, the local accessibility to skilled workers in other sectors show a positive and strongly significant impact on the total export value of industry *j* in region *s*. Interestingly, more than 100 percent of this effect falls on the extensive margin, whereas the intensive margin is negatively influenced by knowledge flows from other sectors in the region. Furthermore, column 4 and 5 in Table 2 show that the intra-regional accessibility to skilled workers in other sectors has a positive effect on the average export price and a

negative effect on the average export quantity. This result suggests that industries located in human capital abundant regions specialize in commodities of higher values and operate on a smaller production scale. This is consistent with standard spatial product cycle models where innovation activities in early phases of the product cycle are located in regions rich in human capital and other 'innovation inputs', but the production of more standardized goods in later stages of the cycle exploit internal scale economies and locate in regions with low costs of labour and land.

In accordance with theoretical expectations, the intra-regional endowment of knowledge, measured as knowledge accessibility, enhances regional capacities of innovation and product differentiation in the export sector. This product differentiation results in smaller export volumes per product, whereas the average export price is higher than in regions that are poorly endowed with human capital.

The accessibility to human capital in other regions (inter-regional accessibility) has a positive effect on both the extensive and intensive margin in export flows. A closer examination of the intensive margin shows that regions with a high inter-regional accessibility to knowledge export goods at larger volumes. This result indicates that knowledge flows that are less spatially localized augment regional export production possibilities both in terms of number of export varieties and in terms of export volumes, but has no significant effect on average unit values. This finding signifies that municipalities with low internal accessibility to knowledge specialize in goods of low unit values exported in large volumes. This may be the only option when proximity to knowledge inputs is too small. Still, such locations benefit from knowledge flows from other regions in expanding their export bases.

In sum, the results presented in Table 2 reveal that the extensive margins in sectoral export flows are growing with the accessibility to human capital in other sectors and regions. This outcome suggests that a substantial fraction of the innovation and development activities that generate differentiated products takes place outside their own sector or outside their own municipality. As a consequence, industries in locations where proximity human capital is abundant, i.e. locations that are well endowed with human capital, have a more diversified export, consisting of product varieties of relatively high value.

The regression model applied on the region-industry data set performs fairly well in estimating variations in export flows across industries and regions. When regressing the model on the total export value, the model explains 53 % of the variations in the size of aggregate export flows across industries and regions. The R-square value is highest in the regression where the extensive margin is the dependent variable (65 %) and lowest in the regression where the intensive margin is the dependent variable (42 %). The regression model applied on the two-dimensional data set has a substantially higher power in explaining adjustments in the intensive margin than has the regression model that only includes a regional dimension.

Addressing the issue of variations in estimated marginal effects along the distribution of the dependent variable, Table 3 presents the results of quantile regressions estimated for the three components in aggregate export flows: the number of export products, average export price and average export quantity. For each one of these three dependent variables, regressions are estimated for the 25th quantile, the median quantile and the 75^{th} quantile.

Table 3 shows that the sign of the estimated coefficients of all explanatory variables are the same as in the FGLS estimations for the 25^{th} and median quantile in all regressions. For the 75^{th} quantile, the estimated effects have the same sign as in the FGLS estimations in all regressions except for the specification where average export price is the dependent variable. In contrast to

the FGLS estimations, the impact of local and inter-regional accessibility to skilled workers appear to have a negative effect on the average export price in the 75th conditional quantile of this dependent variable. However, these coefficients are not statistically significant.

Table 3. Results of quantile regressions

	Number of export products			Average export price			Average export quantity		
	Q25	*Q50*	*Q75*	*Q25*	*Q50*	*Q75*	*Q25*	**Q50**	*Q75*
Employment of unskilled workers in industry j in region s	0.237** (0.021)	0.235** (0.019)	0.222** (0.017)	-0.073** (0.024)	-0.124** (0.023)	-0.136** (0.028)	0.692** (0.052)	0.713** (0.043)	0.707** (0.040)
Employment of skilled workers in industry j in region s	0.019** (0.006)	0.018** (0.006)	0.013* (0.006)	0.015* (0.007)	0.014* (0.007)	0.011 (0.008)	0.047** (0.015)	0.032* (0.013)	0.009 (0.012)
Local accessibility to skilled workers in other sectors in region s	0.553** (0.018)	0.496** (0.015)	0.488** (0.017)	0.054** (0.019)	0.044* (0.018)	-0.006 (0.020)	-0.060 (0.045)	-0.181** (0.034)	-0.246** (0.035)
Inter-regional accessibility to skilled workers	0.134** (0.012)	0.134** (0.011)	0.118** (0.015)	0.004 (0.019)	-0.007 (0.017)	-0.011 (0.017)	0.169** (0.030)	0.097** (0.029)	0.055 (0.039)
Constant	-3.400** (0.201)	-2.370** (0.144)	-1.425** (0.165)	3.741** (0.211)	4.675** (0.204)	5.711** (0.209)	2.801** (0.399)	5.331** (0.336)	7.431** (0.382)
Pseudo R^2-value	0.40	0.42	0.42	0.33	0.32	0.30	0.28	0.30	0.34
Number of observations	3788								

Robust standard errors within parenthesis. ** Significant at the 1% level. * Significant at the 5% level

Another observation from Table 3 is that the size of the estimated coefficients for input of unskilled and skilled labour is fairly robust across different quantiles of the dependent variables, whereas the influence of local human capital accessibility seems to be significantly smaller for the upper quantiles of the distribution of *number of export products* and *average export price* respectively. In the regression where average export quantity is the dependent variable, the estimated negative effect of local human capital intensity is significantly larger in the 75th quantile.

Summarizing the outcomes of the quantile regressions, we find that the estimated coefficients are generally higher for observations in the median or bottom range of the conditional distribution of the dependent variables. This pattern is particularly distinct for the intra-regional accessibility variable, where the confidence intervals indicate a significant difference in the size of the marginal effects between the 25^{th} and 75^{th} conditional quantiles of each one of the dependent variables. These results signify that local knowledge flows across sectors are particularly important in stimulating growth in the extensive margin in regions where the within-industry regional export flows have relatively low product diversity. The same reasoning applies to the price component in the intensive margins; intra-regional knowledge flows across sectors have a larger influence on the average export price in regions where the within-industry regional export flow has a relatively low unit value.

5 Summary and Conclusions

Larger regions with higher endowments of human capital are expected to have larger exports. In this paper we have asked: *how do they trade more?* Previous research has analyzed this question for the exports of countries with different size. The analysis presented in this paper examines the contribution of the different components, i.e. the intensive and extensive margin, to exports across regions in Sweden. Instead of focusing on how the different components of export flows vary with sheer size, however, our analysis is focused on how they vary with regional endowments of human capital, including the potential for spatial knowledge flows. The basic hypothesis is that the extensive margin is driven by innovative efforts and those efforts require human capital. Regions rich in human capital are therefore better equipped for the production of differentiated products.

At the aggregate level our analysis yields the following results:

- Larger regions have larger exports. The elasticity of exports with respect to a plain size variable (total employment) can be attributed to both the intensive and the extensive margin. Exports prices are negatively related to regional size, whereas export quantities are positively related.

- In line with our expectations, the elasticity of exports with respect to accessibility to human capital is solely due to adjustments on the extensive margin. Also, export prices are higher from regions with higher accessibility to human capital.

These results at the aggregate level can reflect different industry structures in different regions, e.g. human capital intensive regions can be more specialized in sectors characterized by differentiated products as well as differences within industries across regions. Our within-industry analyses show that industries in regions that are well endowed with human capital have a more diversified export flows, consisting of goods of relatively high unit value. They also show that human capital employed in other sectors correlate significantly with the extensive margin and export prices in given sectors.

The paper contributes to the literature in two major respects. First, focusing on human capital, it presents empirical evidence of the role of regional supply-side characteristics for understanding the international geography of a country's aggregate exports. Second, the paper also contributes to the literature on how different margins of trade adjust to supply-side factors. Specifically, the paper addresses *how* endowments of human capital influence trade flows.

In relation to previous research this paper has shown that the relationship between exports and human capital at the regional level goes beyond specialization patterns, as indicated by e.g. RCA indices, and also comprise variations in the extensive and intensive margins, as well as prices and quantities. The results of this analysis provide support for the argument that human capital is important for product differentiation, both vertically and horizontally. They show that the structure of a region's export flows is highly related to its 'production milieu' in terms of accessibility to human capital. The ability of industries to differentiate their products and achieve the associated competitive advantages from such differentiation appears to be strongly related to the accessibility to human capital in other sectors in their own region. How the co-location of different economic activities stimulates the arrival of new products and the expansions of regional export bases is an important issue for further research.

References

Andersson, M. (2007) *Disentangling Trade Flows. Firms, Geography and Technology.* JIBS Dissertation Series No. 36, Jönköping

Andersson, M. and B. Johansson (2008) "Innovation Ideas and Regional Characteristics – product innovation and export entrepreneurship by firms in Swedish regions", *Growth and Change*, 39, 193-224

Audretsch, D. B. and M. P. Feldman (1996) R&D "Spillovers and the geography of innovation and production", *American Economic Review*, 86, pp 630 - 640

Barrios, S., H. Görg & E. Strobl (2003), Explaining Firms' Export Behaviour: R&D, Spillovers and the Destination Market, *Oxford Bulletin of Economics and Statistics 65*, 475-496

Berry, C and E. Glaeser (2005), "The Divergence of Human Capital Levels across Cities", Harvard Institute Economic Research Discussion Paper No. 2091

Bleaney, M. and K. Wakelin (2002) "Efficiency, Innovation and Exports" *Oxford Bulletin of Economics and Statistics 64*, 1-25

Brakman, S., Garretsen, H. and Marrewijk, C. (2001), *An Introduction to Geographical Economics*, Cambridge University Press, Cambridge

Braunerhjelm, P. and P. Thulin (2008) "Can Countries Create Comparative Advantages? –R&D expenditures, high-tech exports and country size in 19 OECD countries, 1981-1999", *International Economic Journal*, 22, 95-111

Breschi, S. and D. Palma (1999), "Localised Knowledge Spillovers and Trade Competitiveness: The Case of Italy", in Fischer, Suarez-Villa & Steiner (1999) (Eds.), *Innovation Networks and Localities*. Springer Verlag, Milano

Chamberlin E. H. (1933) *The Theory of Monopolistic Competition.* Harvard University Press; Cambridge, Massachusetts

Chiarlone, S. (2000) "Product Differentiation and Relative Quality in Italian Trade with European Union". CESPRI Working Paper No. 112

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

Dixit, A.K. & Stiglitz, J.E. (2004) "Monopolistic Competition and Optimum Product Variety", *American Economic Review*, Vol. 67 pp. 297 – 308

Ejermo, O. (2004) "*Perspectives on Regional and Industrial Dynamics of Innovation*" JIBS Dissertation Series; No. 024; Jönköping

Fagerberg, J. (1988) "International Competitiveness" *The Economic Journal,* 98, pp. 355 – 74

Fagerberg, J. (1996), "Technology and Competitiveness", *Oxford Review of Economic Policy*, 12, pp. 39 – 51

Falvey, R. and H. Kierzkowski, (1987) "Product Quality, Intra-Industry Trade and (Im)perfect Competition." in Kierzkowski, H. (1987) (Ed.) *Protection and Competition in International Trade. Essays in Honor of W.M. Corden.* Oxford, pp 143 – 161

Federici, D., F. Ferrante and D. Vistocco (2008) "On the Sources of Entrepreneurial Talent: Tacit vs. Codified Knowledge"*IFCAI Journal of Knowledge Management*, 4, pp. 7 – 28

Feldman, M (1999), "The New Economics of Innovation, Spillovers and Agglomeration – a review of empirical studies, *Economics of Innovation and New Technology*, 8, 5-25

Feldman, M. (1994), *The Geography of Innovation*, Kluwer Academic Publishers, Boston

Ferragin A. M, and F. Pastore (2005) "Factor Endowment and Market Size in EU-CEE Trade. Would human capital change actual quality trade patterns?" *Eastern European Economics*, 43, pp 5 – 33

Flam, H. and E. Helpman (1987) "Industrial Policy Under Monopolistic Competition", *Journal of International Economics*, 22, pp. 79 – 102

Glaeser, E. (1994) "Cities, Information and Economic Growth". *Cityscape: A Journal of Political Development and Research***,** 1, 9-47.

Glaeser, E. and Kohlhase, J. (2004) "Cities, regions and the decline of transport costs", *Papers*

in Regional Science, 83(1), pp. 197-228.
Gould, W.W. (1992) "Quantile regression with bootstrapped standard errors" *Stata Technical Bulletin*, 9, 19 – 21
Gråsjö, U. (2006) "*Knowledge Production and Spatial Spillovers. An Accessibility Approach"* JIBS Dissertation Series No. 34, Jönköping
Greenlagh, C. (1990), Innovation and Trade Performance in the UK, *Economic Journal 100*, pp. 105 – 118
Grossman, G.M. and E. Helpman (1991a) "Quality Ladders and Product Cycles" *The Quarterly Journal of Economics*, Vol. 106, No. 2, pp. 557 – 586
Grossman, G.M. and E. Helpman (1991b) *Innovation and Growth in the Global Economy*. MIT Press; Cambridge, Massachusetts
Helpman, E. (1981) "International Trade in Presence of Product Differentiation, Economies of Scale and Monopolistic Competition: A Chamberlinian-Heckscher-Ohlin Approach." *Journal of International Economics,* 11, pp. 305 – 340
Helpman, E. (1984) "A simple Theory of International Trade with Multinational Corporations", T*he Journal of Political Economy*, Vol. 92, No. 3, pp. 451-471.
Hirsch, S. (1967), *Location of Industry and International Competitiveness*, Clarendon Press, Oxford
Hummels, D. and P. J. Klenow (2005) "The Variety and Quality of a Nation's Export" *American Economic Review,* Vol. 95, pp. 704 – 734
Johansson, B. & Klaesson, J. (2001), Förhandsanalys av Förändringar i Transport- och Bebyggelsesystem, JIBS
Johansson, B. and Wigren, R. (1996), Production Milieu and Competitive Advantage, In: Batten, D. and Karlsson, C. (eds) *Infrastructure and the Complexity of Economic Development*. Berlin: Springer Verlag.
Johansson, B., Klaesson, J. & Olsson, M. (2002), "Time Distances and Labor Market Integration", *Papers in Regional Science,* pp. 305-327
Johansson, S. (2008) "R&D Accessibility and Comparative Advantages in Quality Differentiated Goods" *IFCAI Journal of Knowledge Management*, 4, pp. 29 – 50
Johansson, S. and Karlsson, C. (2007) "R&D Accessibility and Regional Export Diversity" *Annals of Regional Science,* 41, pp. 501 – 523.
Klette, T. and S. Kortum (2004) "Innovating Firms and Aggregate Innovation" *Journal of Political Economy*, volume 112 (2004), pp. 986–1018
Koenker, R and G. Basset (1978) "Regression Quantiles", *Econometrica,* 46, pp.33 – 50
Krugman, P. (1979) "Increasing Returns, Monopolistic Competition and International Trade" *Journal of International Economics 9*, pp.469 – 479
Krugman, P. (1980) "Scale Economies, Product Differentiation and the Pattern of Trade" *American Economic Review 70*, pp. 950 – 959
Lancaster, K. (1966) "A New Approach to Consumer Theory" *Journal of Political Economy*, 74, pp. 132 – 157
Lancaster, K. (1980) "Intra-Industry Trade under Perfect Monopolistic Competition" *Journal of International Economics 10*, pp. 151 – 175
Lucas, R.E. Jr, (1988), "On the Mechanics of Economic Development," *Journal of Monetary Economics*, Vol. 22(1), s. 3–42.
Martín, J.A. and V. Orts (2001) "Vertical Specialization and Intra-Industry Trade: The Role of Factor Endowments" *Weltwirtschaftliches Archiv* Vol. 138, No 2, 340 – 367
McCann, P (2008), "Globalization and Economic Geography: the world is curved, not flat", *Cambridge Journal of Regions, Economy and Society*, 1(3), 351-370
Moretti, E (2004), "Workers' Education, Spillovers, and Productivity: Evidence from Plant-Level Production Functions," *American Economic Review*, Vol. 94(3), s. 656–690.
Niebuhr, A. (2003) Spatial Interaction and Regional Unemployment in Europe, European Journal of Spatial Development, No. 5, 2003

Posner, M.V. (1961), “International Trade and Technical Change”, *Oxford Economic Papers*, 13, pp. 323 – 341

Pred, A. (1966), *The Spatial Dynamics of U.S. Urban-Industrial Growth, 1800-1914. Interpretative and Theoretical Essays*, The MIT Press, Cambridge, MA

Rauch, J.E., (1993), ”Productivity Gains from Geographic Concentration of Human Capital: Evidence from the Cities,” *Journal of Urban Economics*, Vol. 34(3), s. 380–400.

Sterlacchini, A. (1999), Do Innovative Activities Matter to Small Firms in Non-R&D-intensive Industries? An Application to Export Performance, *Research Policy 28*, 819-832

Sterlacchini, A. (2001), The Determinants of Export Performance: A Firm-Level Study of Italian Manufacturing, *Weltwirtschaftliches Archiv 137*

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

Wakelin, K. (1998), Innovation and Export Behaviour at the Firm Level, *Research Policy 26*, pp. 829 – 841

Weibull JW (1976), An Axiomatic Approach to the Measurement of Accessibility, Regional Science and Urban Economics, 6, pp. 357 – 379

Appendix

Table A1 Descriptive statistics of dependent variables

	Min	Max	Median	Mean	Std. Dev.	Skewness
Aggregate export value (thousands SEK)	10.00	65962590	7635	200151	1731725	28.38
Number of export products	1.00	3342	18	57	178	10.43
Average export price (SEK/kg)	0.10	30088	73	331	1178	11.88
Average exported quantity (tonnes)	1.00	121924	3885	409	3563	20.73

Table A2 Descriptive statistics of independent variables

	Minimum	Maximum	Median	Mean	Std. Deviation
Employment of **unskilled** labour in industry j in region s	1.00	17114.00	44.00	168.70	489.88
Employment of **skilled** workers in industry j in region s	0.00	5924.00	2.00	20.62	155.71
Intra-regional accessibility to skilled workers in other sectors in region s	24.86	123861.71	721.12	2834.84	10181.78
Inter-regional Accessibility to Skilled Workers	0.02	87766.03	4423.60	9485.18	14210.52

Table 1. Results of second regression on TFP (n = 31505)

	Expected sign	*TT1*	*TT2*	*TT3*	*GI1*	*GI2*
Intercept		1.32e-02***	2.31e-03*	1.77e-02***	2.43e-02***	2.37e-02**
CAPINT	(+/-)	-1.02e-03***	-3.08e-03***	-1.13E-04	-3.63e-03***	-3.70e-03**
MKTCOM	(+/-)	1.32e+00***	1.21E+00	3.09e+00***	-4.40e+00***	-3.98e+00**
HMNCAP	(+)	8.70e-05***	1.15e-03***	1.01e-03***	2.01e-03***	1.72e-03**
HMNGRT	(+)	-2.31E-05	1.02E-04	1.67E-04	7.50E-05	1.09E-0
CAPSTR	(+)	6.22E-08	4.61E-07	9.76E-07	6.54E-07	6.65E-0
WGGRTH	(+)	1.59e-04***	2.85e-04***	2.01e-04***	2.30e-04***	2.24e-04**
Size dummy included		Yes	Yes	Yes	Yes	Ye
Year dummy included		Yes	Yes	Yes	Yes	Ye
Industry dummy included		Yes	Yes	Yes	Yes	Ye
R2		0.645	0.341	0.273	0.695	0.67
Adjusted R2		0.645	0.34	0.273	0.695	0.67

Note: 1. The dependent variable of each regression model is the rate of TFP growth for each model specification.