CESIS

Electronic Working Paper Series

Paper No. 30

The trade-off between agglomeration forces and relative costs: EU versus the "world"

Evidence from firm-level location data 1974-1998[1]

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April 2005

The Royal Institute of technology
Centre of Excellence for Science and Innovation Studies
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[1] Status of the paper:

The trade-off between agglomeration forces and relative costs: EU versus the "world"

Evidence from firm-level location data 1974-1998[♣]

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Abstract

The theoretical prediction of a trade-off between production costs and agglomeration economies advanced in recent "new economic" geography models has – despite its important policy implications – not been exposed to empirical testing. Based on a standard model where labor mobility is assumed to differ between two regions - the "European Union" (EU) and the "world" - the empirical analysis shows that a ten percent increase in relative wages decreases entry by MNCs by approximately nine percent in EU, but only by three percent in the "world." Or, put differently, a ten percent increase in relative wages in EU requires an increase by 26 percent in agglomeration to keep production levels unaltered. To our knowledge, this is the first attempt to empirically estimate this trade-off.

JEL classification: F15, F20, F23

Keywords: FDI, agglomeration, relative costs

[♣] Financial support is gratefully acknowledged from the Marianne and Marcus Wallenberg Foundation.
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1. Introduction

The deregulation created by the European integration process – within as well as between nations – has turned the issue of firm location into a highly topical point on the political agenda in Europe. Integration makes firms more exposed to inter-country differences with respect to production costs, market size, knowledge spillovers, etc., thereby stiffening the competitive pressure under which firms operate. Moreover, firms will also be exposed to differences in macro-economic regimes and the institutional setting across countries, i.e., the "business climate".

According to mainstream "new economic geography" models, firms' locations are determined by trade and production costs, together with the degree of scale and agglomeration economies [Krugman (1991); Fujita et al. (1999)].[2] Despite a seemingly transparent structure, these models are analytically complex and the outcome hinges critically on the underlying assumptions. For instance, theory tends to provide different answers as regards the pattern of location depending on the particular assumptions imposed on mobility of labor in different sectors and trade costs [Davis (1998); Puga (1999)].

This brings up a number of questions concerning the current restructuring of the European industry, and its spatial implication. The spectacular growth in foreign direct investment (FDI), and the European Union's (EU's) increasing involvement in this process since the 1980s and 1990s, leaves little doubt that regional integration do influence the location of firms. Using country- and industry level data numerous studies have addressed how FDI influence home country employment and production, sensitiveness to wage differences, the

[2] See also Brainard (1993), Krugman and Venables (1995; 1996), Markusen (1995), Markusen and Venables (1995) and Venables (1996). For a survey, see Braunerhjelm et al. (2000).

impact of existing agglomerations on FDI, etc.[3] However, to our knowledge, no empirical analysis has examined whether the alleged lack of labor mobility in Europe tends to generate a more "fragmented" distribution of production and agglomeration sites as compared to other regions, particularly the U.S. That is, is there a trade-off between agglomeration and wage costs, and if so, can it be expected to promote more dispersed production?

To examine these issues we will pool a unique data set on the location of foreign production by Swedish multinational corporations (MNCs), spanning the period 1974 to 1998, with host-country data (38 countries) for the same period classified on cost-, agglomeration- and policy variables. We believe Swedish firms to serve as a particularly useful example. Swedish industry has been dominated by large MNCs with extensive – and geographically dispersed – international activities for a long time. Their strategies can be expected to pertain also to firms originating in other countries.

The remaining part of the paper is organized as follows. We begin by presenting some stylized facts concerning the distribution of FDI across regions and industries (section 2). In the following section 3, the theoretical framework is presented and relevant previous findings are reviewed. The econometric method, the data and the hypotheses are discussed in section 4, while section 5 present the hypotheses on the explanatory variables. Section 6 contains the results from the empirical analysis, and, finally, section 7 concludes.

[3] For a broad survey, see Caves (1996). Note that we do not address the issue of wage elasticities [see for instance Slaughter (1995); Brainard and Riker (1997a, 1997b); Braconier and Ekholm (2000)] in this paper, rather our focus is on the trade-off between relative wage costs and agglomeration as firms chose where to locate production.

2. Some stylized facts: FDI, location and wage costs

On a global level, the geographical distribution of location of MNCs is heavily oriented towards developed, high-wage, countries. In 2001, the share of inward FDI going to developed countries was about 68 percent and the share of outward FDI exceeded 93 percent. The region at focus in the present analysis, the European Union (EU), accounted alone for 44 percent of global inward FDI, and about 59 percent of the outward flows [UN (2003)]. These shares have remained more or less unchanged during the last decade, even though inward FDI to the EU peaked in the late 1980s and 1990s.[4] However, a shift towards other regions, such as North America and China, can be discerned during the 1990s. With regard to the distribution on industries, previous studies conclude that FDI predominantly occurs in industries either characterized by high R&D-outlays or by high marketing expenditures.

As shown in Figure 1, Figure 2a and Figure 2b, Swedish FDI seems to match the international trends relatively closely in terms of industries and regions, suggesting that it serves well as "role model" and that the results can be generated to FDI undertaken by firms originating in other countries.[5]

FIGURES 1, 2a, 2b HERE

[4] Moreover, concentration is also apparent within the EU where the so called core countries (Benelux, France, Germany, Italy) have received the major brunt of inward FDI [Dunning (1997)].

[5] For an analysis and description of Swedish FDI in last decades, see Braunerhjelm and Ekholm (1998).

It is obvious that FDI by Swedish firms to the EU increased considerably in the latter part of the 1980s, and that most of it was destined for high-wage, core EU-countries.[6]

In the mid-1990s, the U.S. reappeared as the most attractive market, while regions outside the U.S. and the EU have received a quite modest share of Swedish FDI. The major share of FDI originates in more knowledge-intensive industries, i.e., chemicals (ISIC 35) and the engineering industry (ISIC 38). But also the less R&D-intensive paper and pulp-industry (ISIC 34) has been involved in extensive FDI, reflecting Sweden's comparative advantage in that type of production.

Since our focus is the trade-off between agglomeration and wages, we end this brief presentation of stylized facts with a simple correlation between relative wage costs between production in the Swedish units and the host country units (distributed on eight industries) and the level of agglomeration of the corresponding industries in these host countries.

FIGURE 3 HERE

As can be seen in Figure 3, there seems to be a weak positive correlation between higher relative wage costs and higher agglomeration, implying that agglomeration economies compensate for higher costs. We will now in some detail examine whether such a relationship exists, and its implication for location of production.

[6] Please note the different scale as regards FDI in figure 2b.

3. Modeling the interregional location of firms

Krugman's initial contribution has been followed by an impressive output of articles that have refined and modified modeling of economic geography.[7] In the first generation of models, location was determined in an endogenous process based on production and trade costs, economies of scale and externalities originating in linkages to other firms and enlarged markets (pecuniary linkages), as well as knowledge spillovers (non-pecuniary linkages). Even small differences in size among regions and countries could generate a complete outward shift of the industrial sector in the smaller region/country. More sizeable market allows economies of scale to be exploited to a larger extent, which in turn enables firms to pay higher wages, leading to an inflow of labor, yielding a process of cumulative causation [Myrdal (1957); Venables (1996)].

More recently the basic structure and mechanism of some of the mainstream economic geography models has been questioned. In particular, attention has been drawn to the underlying assumptions as regards the substitutability of factors of production and the cross-sectional distribution of trade costs. First, it is assumed that labor in the agricultural sector cannot take up work in the manufacturing sector. That clearly contradicts the massive influx of labor from the agricultural sector into the manufacturing sector that has been observed in most countries. Second, trade in agricultural goods is assumed to be costless, which also stands in sharp contrast with empirical observations. As shown by Davis, dropping the latter assumption implies that the large market effect may be reverted.

[7] Still, issues concerning the location of economic activities have been addressed since at least the 19th century [Marshall (1890); Weber (1909)]. Weber was followed by "the German school", dominated by Christaller (1933, the central-place theory), and Lösch (1940, the hexagonal location structures). Recent work in that vein includes Fujita and Krugman (1995) and Fuijita and Mori (1997). Early contributions on location also entail work by Hotelling (1929), Perroux (1955), Isard (1956), Myrdal (1957), Hirschman (1958), Hoover (1963) and Pred (1966).

Moreover, relocation is visualized as a process driven by labor migration, which may, to some extent, reflect the situation in the U.S, but does not conform to the European case.[8] Rather, firms lead the way in altering the location of industrial activity. Puga argues that precisely the lack of international labor mobility can create convergence in terms of real wages, and a more even spatial distribution of production.[9] Given medium range trade costs, agglomeration will take place to exploit linkages to suppliers and customers. However, if firms' relocation of production is not paralleled by labor flows, then one can expect persistent and increasing wage differentials, which ultimately should induce geographical dispersion of production.[10]

3.1 The model

Following Puga, we assume the world to consist of two regions/countries (the "domestic" region d, and the "foreign" region f), which is endowed with L quantities of homogenous labor, as well as K_d and K_f sector specific, immobile production factors. Two different goods can be produced in the respective region; an industrial, differentiated product X and a homogenous good A (e.g. agriculture output).[11]

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[8] Blanchard and Katz (1992) show that the labor migration adjustment process works in the U.S. However, in Europe only about 1 percent of the EU workers are employed in a member state different from their home country. Even within the respective country, labor mobility is often limited.

[9] Income disparities across regions are wider in Europe than in the U.S. In Europe, about 25 percent live in so-called support areas (incomes are below 75 percent of the European average) which are entitled to support from the European Union, while only 2 percent live in corresponding areas in the U.S [Quah (1996)]. At the same time, production is much more concentrated in the U.S [Krugman (1991)].

[10] Puga's result also differs from those derived by Krugman and Venables (1995). They present a model with two sectors characterized by increasing returns to scale, where labor is assumed to be inter-regionally mobile but internationally immobile. It is shown how low trade costs lead to a regional specialization similar to the U.S, while high trade costs will refute such specialization. The "racetrack" model presented in Fuijita et al., ends up in similar conclusions.

[11] For a full description of the model we refer to Puga (1999, p. 306 and onward). Here we will present the main structure and mechanisms of the model. We will disregard the homogenous good sector and focus on the modeling of the industrial sector. See also Braunerhjelm, chapter four (1994).

The industrial good is produced under increasing returns to scale by a set of H firms in the two regions. Markets are exposed to monopolistic competition, where firms employ the same quantities α of fixed inputs and β quantities of variable inputs in order to a produce a given amount x of variety h of the industrial good. Thus, firms produce the same quantity x of h and no firm in the respective country/region produces identical goods. Hence, numbers of firms equal the numbers of varieties produced.

Firms implement a Cobb-Douglas technology where labor is combined with a composite of intermediate industrial products, with a constant elasticity of substitution across varieties, $\sigma > 1$. The price index of aggregated industrial goods that firms use as an intermediate products, is composed of goods produced within the region where the firm is located, and imports,

$$q_j \equiv \left[\int_{h \in N_d} (p_d(h))^{1-\sigma} dh_d + \int_{h \in N_f} (\tau \ p_f(h))^{1-\sigma} dh_f \right]^{\frac{1}{1-\sigma}}, \quad j = d, f \qquad (1)$$

where d and f refer to the domestic and foreign region, respectively. Producer price is denoted p, while τ is "iceberg" trade costs ($\tau > 1$) associated with imports of foreign produced varieties. The first expression on the right-hand side in equation (1) refers to prices of varieties produced within the respective region, whereas the second expression alludes to imported manufactured varieties. Firms facing wage cost w then strive to minimize the following cost function,

$$C(h) = q_j^{\mu} w_j^{1-\mu} \left(\alpha + \beta \ x(h)\right) , \qquad (0 < \mu \ \leq 1), \quad j = d, f. \tag{2}$$

On the demand side, individual utility-functions is characterized by standard Cobb-Douglas preferences over the homogenous good A and a CES aggregate of industrial x goods, where the income share devoted to expenditure on industrial goods is γ ($0 < \gamma < 1$). To simplify, utility functions are assumed to display constant elasticity of substitution of industrial varieties, i.e., similar to firms' production technology. Hence, the indirect utility function, *V*, of the consumer in region j is

$$V_j = q_j^{-\gamma} 1^{-(1-\gamma)} w_j, \quad j = d, f. \tag{3}$$

Total demand for a firm's production of x quantities of h in region j can then be expressed as,

$$x(h)_j = \left(p_d(h)\right)^{-\sigma} e_d q_d^{\sigma-1} + \left(p_d(h)\right)^{-\sigma} e_f q_f^{\sigma-1} \tau^{1-\sigma} \tag{4}$$

where the first part of the expression in (4) alludes to demand within a region, whereas the latter part relates to exports. Total expenditure (e) in region j on industrial goods consists of wages, return to the immobile factor (r) and entrepreneurial profits (π),

$$e_j = \gamma \left(L_j w_j + K_j r(w_j)\right) + \int_{h \in H_j} \pi(h) dh + \mu \int_{h \in H_j} C(h) dh \qquad (5)$$

all spent in accordance with the preference function in equation (3). The fractions spent on consumption and firms' demand for intermediates inputs is determined by γ and μ, respectively.

General equilibrium is obtained by substituting equations (1), (2) and (5) into (4). Differentiating with respect to the firm's own price yields a constant demand-elasticity of σ (>1) in all regions. Hence, irrespective of location, the same profit maximization producer price condition apply for all firms,

$$p_j = \left(\frac{\sigma\beta}{\sigma - 1}\right) q_j^{\mu} w_j^{1-\mu} \qquad (6)$$

but consumer prices – because of trade costs – will be τ times higher for imported goods. On the firm level (from equations (2) – (6)), profits in each region equals

$$\pi_j = \left(\frac{p_j}{\sigma}\right)(x_j - x) \qquad (7)$$

where zero profit requires a level of production equal to

$$x = \left(\frac{\alpha}{\beta}\right)(\sigma - 1) \tag{8}$$

implying that firm size is increasing fixed costs (α) and higher demand elasticities (σ). Considering that we assume a monopolistic competition market in the industrial sector, profits will be exhausted by entry,

$$\pi_j h_j = 0 \qquad \pi_j \leq 0, \;\; h_j \geq 0 \tag{9}$$

where – as mentioned above - h_j (varieties produced) is synonymous to the number of firms in region j.

Turning to the labor market, total demand for labor in the manufacturing and the homogenous goods sector is at any point in time given by,

$$L_j = (1 - \mu)\; h_j \left(\frac{C_j}{w_j}\right) - K_j r_w(w_j) \tag{10}$$

where the first part on the right-hand side in the above expression relate to demand for labor in the industrial sector (derived from equation 2) and the remaining share can be attributed the homogenous goods sector. If labor is inter-regionally mobile, migration will eliminate differences in real wage between the two sectors (in terms of manufactured goods) such that,

$$q_d^{-\gamma} w_d = q_f^{-\gamma} w_f \qquad (11)$$

In a two-region world setting, regional entry and exit by firms reflect changing profit opportunities. The cross-regional distribution of firms (h_d, h_f) can be assumed given in the short-run, corresponding to short-run equilibrium levels of wages and price-indexes, (w_d, w_f ,q_d ,q_f). By substituting equation (6) into (1), the equilibrium price indexes in the respective region are derived. Similarly, wages associated with labor market equilibrium can be found by substituting equation (2) and equations (4-8) into equation (10). If migration across sectors is allowed, then the short-run equilibrium distribution of labor ($L_d = L – L_f$) can be obtained from equation 11. Hence, short-run profits can then be expressed in terms of number of firms by substituting equations (2), (4-6) and (8) into equation (7). In short, the profit function for firm i in region j can be written as,

$$\pi_{ij} = \left(q_j, h_j, w_j, L\right) \qquad (12)$$

Consider a situation where equilibrium (zero profit) is gradually approached as firms move in and out of regions due to shifts in the argument of the profit-function. As a result, the number of firms (h) in region j changes over time,

$$\dot{h}_j = \lambda \pi_j \left(q_{j,} h_j, w_j, L\right) \qquad (13)$$

where $\dot{h}$ denotes the time derivative of the number of firms, λ is a constant exceeding zero (capturing all other elements that influence location), and π is the profit function.

The arguments in the short-run profit function – and location – in each region is affected by four forces: degree of competition at the production market and labor market together with cost- and demand-linkages. What is noteworthy is that these forces may push location in opposite directions.[12]

First, if the number of firms increase in a region, which is not accompanied by a corresponding flow of labor, the increase in demand for labor is likely to put an upward pressure on wages (expressions 2 and 10). Moreover, an inflow of firms also implies that the number of locally produced varieties will increase at the expense of imports. Consequently, as firms can procure more indigenous produced intermediate products, prices (and costs) will be lower due to a fall in trade costs as less goods are imported (expression 1). Assuming that the expenditure level remains unchanged (labor is assumed immobile), "love for variety" preferences implies that each variety will face lower demand (expression 3). In this scenario product- and labor market competition will result in lower profit, thereby inducing firms to exit or to relocate to other regions, prompting a dispersion of industrial production.

However, a different path may be taken if cost- and demand linkages are strong enough. Lower production costs could occur if such linkages yield a lower price on intermediate products, and if there is an inflow of labor to the region hosting an increasing number of firms. In addition, an inflow of workers and firms increase regional expenditure on the respective variety

[12] For the complete derivation of the general equilibrium solutions, given different assumptions concerning labor mobility, see Puga.

produced locally, thus mitigating the effect described above when each variety produced encounter lower demand. Hence, in this case cost- and demand linkages will mutually reinforce the attractiveness of a region, i.e., generating a positive impact on profits and propel entry. These effects may overturn the negative impact described in the first case and thus trigger agglomeration.

Assuming that an agglomeration process is set into motion (for instance due to an integration process), and that prices are held constant, we can formulate two alternative hypotheses. First, in an economy characterized by labor immobility – which could be called the "European case" - we would expect the following for firm i locating in region j:

$$H_1 : \text{If } \dot{L}_j \leq 0 \text{, then } \pi_{i,j,w} < 0 \text{ and } \pi_{i,j,h} \leq 0 \ .$$

Hence, if agglomeration through entry by new firms is not accompanied by labor inflows, labor competition drives up wages and reduce profits. This tends to deter further inflows by firms, unless the cost disadvantage is offset by exceptionally strong linkage effects related to the co-location of other firms. The absence of such agglomeration economies will induce a more spatially dispersed production structure.

Alternatively, if labor is mobile – which we may denote the "world case" - the hypothesis can be specified as,

$$H_2 : \text{If } \dot{L}_j > 0 \text{, then } \pi_{i,j,w} \geq 0 \text{ and } \pi_{i,j,h} \geq 0 \ .$$

As location of firms is paralleled by labor flows there is less pressure on wages and profits. Linkages associated with expanding markets and higher expenditure levels are also likely to increase profits, thereby attracting more firms and strengthening agglomeration.

4. Empirical analysis: Wages versus agglomeration

4.1. Econometric method

When firms decide where to locate production, the decision is taken in a step-wise fashion: First, choosing between all countries, firms decide in which country production should be located. Second, once that decision has been taken, the level of production at the respective location site is chosen. The Tobit method is then one conceivable statistical technique, applying maximum likelihood procedures. The estimates of the Tobit parameters reflect both changes in the probability of being above the limit, and changes in the value of the dependent variable if already above the limit. A decomposition of the effects is possible [McDonald and Moffitt (1980)], but the problem is that the two separate effects will always have the same sign and significance. If we have reason to believe that the probability effects and the marginal effects differ, the appropriate estimation technique is a Heckman's two-step procedure [Fomby et al. (1986)]. For instance, the probability that a firm chooses a particular host country may be associated with the degree of openness rather than relative labor cost. However, once the host country has been chosen, openness may have a negligible effect on the marginal effect on production, whereas the influence of relative labor costs may be substantial. We will therefore apply the Heckman estimation technique in the following regressions.[13]

[13] The location choice of firms is multinomial by nature and one way of accounting for this would be to estimate a multinomial logit or probit. However, the multinomial logit relies on a very strong assumption, the independence of irrelative alternatives, and the multinomial probit involves the evaluation of multiple integrals, something that is not feasible if the choice alternatives exceed three or four. Given these limitations, we believe that the best model to use is Heckman's two-stage estimation technique. An alternative would have been to estimate a structural model. However, our model differs from other recent empirical analyses on geographical structures and driving forces [see e.g. Hanson (1998) and Redding and Venables (2000)] since we use firm level data regarding the location of production. From the firm's point of view all variables used in the estimations are exogenous (except the firm's own R&D), implying that a reduced form estimation is appropriate.

The dependent variable is defined as affiliate employment of firm *i* in industry *b*, located in country *j* at time *t* (AL_{ibjt}), divided by the firm's total employment (TL_{it}).[14] The variable (AL/TL) is characterized by a large number of zeroes, since both the countries where the firms have production, as well as those countries where they do not, are included in the database. The model to estimate is specified as:

$$\frac{AL_{ibjt}}{TL_{it}}^{*} = \beta_0 + Z'\beta_1 + \varepsilon_{ijt} \tag{14}$$

$$\frac{AL_{ibjt}}{TL_{it}} = \begin{cases} \dfrac{AL_{ibjt}}{TL_{it}}^{*} & if \quad \dfrac{AL_{ibjt}}{TL_{it}}^{*} > 0 \\ 0 & if \quad \dfrac{AL_{ibjt}}{TL_{it}}^{*} \leq 0 \end{cases} \tag{15}$$

The residuals are assumed to have the properties $\varepsilon \sim N(0, \sigma_\varepsilon^2)$, $E(\varepsilon_{hjt}\ \varepsilon_{ijt})=0$ for $h \neq i$, $E(\varepsilon_{ijt}\ \varepsilon_{ikt})=0$ for $j \neq k$ but $E(\varepsilon_{ijs}\ \varepsilon_{ijt})\neq 0$ for $s \neq t$. If we had only included countries where affiliate production actually takes place, observations for which AL/TL=0 would be omitted, which is equivalent to omitting all observations for which $\varepsilon_{ijt} \leq -(\beta_0+Z'\beta_1)$. This implies that if ε_{ijt} in the population has a zero mean and a constant variance, the sample error μ_{ijt} will not have these properties because observations have been systematically rather than randomly excluded.

The Heckman method implies that first, a probit function is estimated for all observations, i.e., both AL/TL>0 and AL/TL=0 are included in the regressions in order to obtain the probability effects,

[14] The division by total labor of the firm, TL_{it}, is a way of controlling for historical factors as well as economies of scale on the firm level. Moreover, problems of heteroscedasticity are then reduced. We prefer employment data, since production data are influenced by exchange rate movements, price differences, etc., which could distort the variables.

$$F^{-1}(Pr(Y)_{ijt}) = J_{ijt} = \alpha_0 + Z'\alpha_1 \qquad (16)$$

where F^{-1} is the inverse of the cumulative standard normal distribution and Y takes the value of one if AL/TL>0, and zero if AL/TL=0. In expression 16, $Pr(Y)_{ijt}$ represents the probability that firm *i* has production in country *j* at time *t*, given the values of the explanatory variables. The α's are parameters showing the influence of the independent variables on the probability that the firm locates production in a certain country. From these estimates, a sample selection correction variable λ, called Heckman's lambda, is computed for all observations,

$$\lambda_{ijt} = \frac{f(-J_{ijt})}{1 - F(-J_{ijt})} \qquad (17)$$

where f and F are the density and the cumulative standard normal distribution function, respectively. Then, the sample is restricted to observations for which AL/TL>0, and a standard OLS regression is run, in which the estimated correction variable, λ, is included:

$$\frac{AL_{ibjt}}{TL_{it}} = \gamma_0 + Z'\gamma_1 + \gamma_2 \tilde{\lambda}_{ijt} + v_{ijt} \qquad (18)$$

The residuals are assumed to have the properties $\nu \sim N(0, \sigma_v^2)$, $E(v_{hjt}\, v_{ijt})=0$ for $h \neq i$, $E(v_{ijt}\, v_{ikt})=0$ for $j \neq k$ but $E(v_{ijs}\, v_{ijt})\neq 0$ for $s \neq t$.[15] The estimated γ's are here the marginal effects of the explanatory variables on overseas production.[16]

Since Heckman's lambda is included, the OLS equation will yield consistent parameter estimates. The estimated standard errors will, however, be inefficient since we use the estimated, rather than the actual, value of λ. A White (1980) correction for heteroscedasticity is therefore required in order to obtain efficient standard errors of the estimated parameters.

4.2. Data

A database has been compiled consisting of detailed information on all Swedish MNCs in the manufacturing sector, including data for each foreign affiliate on six different occasions (1974, 1978, 1986, 1990, 1994 and 1998).[17]

TABLE 1 HERE

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[15] This will not yield inconsistent parameter estimates. However, the efficiency of the parameter estimates will be reduced by this possible autocorrelation. In the model, we use unbalanced panel data and thus, a combination of a specific firm and a specific country is far from always included for all periods in the sample. This will partly reduce the autocorrelation problem. To further reduce the autocorrelation, we could specify fixed effects for each combination of firm and country in the form of additive dummies, but we would then suffer from a large loss of degrees of freedom and the estimation procedures would be complex.

[16] It should be noted that the probit and corrected OLS equations include the same explanatory variables in vector Z. A possible practical problem is then multicollinearity between Z and λ. There is no theoretical basis that such problems must arise, however, since the latter variable is a *non-linear* combination of Z, while OLS is a *linear* estimation technique. By excluding the firm variable in the OLS equation, it was verified that the results for the remaining parameter estimates were robust.

[17] According to the IMF (1999), a FDI arises when a firm "acquires a lasting interest in an enterprise operating in an economy other than that of the investor, the investor's purpose being to have an effective voice in the management of the enterprise". The criterion to have an effective voice means a 10 percent minimum ownership in the invested object. In the current data set, the definitions are somewhat stricter; to qualify as an MNC, the firm must have at least one consolidated (50 percent ownership) production unit abroad.

Table 1 illustrates the number of parent companies, the country coverage, and the number of observations of affiliates aggregated to firm-group level in the respective host country. All parent companies with at least one producing foreign affiliate are included in the data set for each of the years. Altogether, this yields almost 22 000 observations. The number of firms varies over time; hence, we have an unbalanced panel.[18]

These data will be pooled with country-level data for 38 host countries.[19] A fairly aggregated industry classification is used due to restrictions in the availability of data, and we have thus classified manufacturing production on eight industries in the respective host country.[20] These data allow a crude calculation of measures of relative agglomeration of manufacturing production and R&D, within the respective host country. Similarly, Hoover-Balassa indexes of absolute concentration of production in Europe have also been constructed (for the exact definition of these indexes, see the appendix).

The database also covers cost data, where the most important refer to relative wage per employee, distributed on industries for the respective host country. Furthermore, we have used data on distance, market size, factor endowments, and policy variables, such as corporate taxes, public expenditure shares, trade policies, etc. Even though considerable efforts have been made to collect data on all variables for the respective year, and to make data comparable across

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[18] It is of course always possible to create a balanced panel from an unbalanced by excluding cross-section units that are not present in all time periods. However, if the cross-section units that enter or exit the panel differ in a systematic way from those who are present in all periods, this will give rise to biased estimates. In this study, the cross-section unit is the firm, and it is more than likely that firms that enter and/or exit the panel differ from those that remain in the panel throughout the whole period.

[19] These data are compiled from various sources, see references.

[20] Industry 1: Food products (311), Beverages (313); Industry 2: Industrial chemicals (351), Other chemicals (352), Petroleum refineries (353), Miscellaneous petroleum and coal products (354), Rubber products (355), Plastic products (356); Industry 3: Iron and steel (371), Non-ferrous metals (372), Fabricated metal products (381); Industry 4: Machinery, except electrical (382); Industry 5: Machinery, electric (383); Industry 6: Transport equipment (384); Industry 7: Paper and products (341), Printing and publishing (342); Industry 8: Tobacco (314), Textiles (321), Wearing apparel except footwear (322), Leather products (323), Footwear, except rubber or plastic (324), Wood products, except furniture (331), Furniture, except metal (332), Pottery, china, earthenware (361), Glass and products (362), Other non-metallic mineral products (369), Professional and scientific equipment (385).

countries, industries and time, there are a few “holes” in the data set. Hence, the number of observations will differ in the regressions.

5. Hypotheses on the explanatory variables

As shown in section 3, forces promoting the dispersion of production involve differences in relative production costs, to which extent factors of production are inter-regionally mobile, and the level of trade costs. Profit-maximizing firms will co-locate with other firms if they can exploit agglomeration economies due to linkages to suppliers of intermediate products and customers, i.e., pecuniary linkages. Agglomeration may also take place because of less tangible linkages stemming from R&D and other knowledge-intensive activities, i.e. non-pecuniary linkages. Moreover, to fully reap the benefits of economies of scale, firms may chose to locate in regions with the most sizeable market.

The explanatory variables chosen are summarized in Table 2.

TABLE 2 HERE

Referring to our theoretical framework (equation 13), they can be categorized on production costs (*w* and *q*), agglomeration (*h*), policy (e.g. □and control variables (□. All variables are in logarithmic form and expressed in the same deflated currency, except when an alternative specification is explicitly stated. In the empirical model, we will focus on the relation between agglomeration and relative production costs (while controlling for other factors), and whether the impact of these factors differs between EU and the rest of the world, indicating higher labor mobility (or/and productivity).

5.1. Cost variables

Relative wage (RW) costs are defined as the industry wage level per employee in the respective host country, divided by the corresponding industry wage in the home country, i.e., relative wage costs for industry *b* in country *j* at time *t*:

$$RW_{bjt} = \frac{w_{bjt} / empl_{bjt}}{w_{bst} / empl_{bst}} \tag{19}$$

where subscript *s* stands for Sweden and *w* and *empl* represent the total wage sum and employment respectively. Previous empirical findings are quite ambiguous when it comes to firms' "cost" elasticity of location.[21] Yet, recent studies confer a negative impact of higher relative wages [Frost and Stein (1989); Yamawaki (1990); Braunerhjelm (1994); Slaughter (1995); Brainard and Riker (1997a, 1997b); Hanson (1998); Hatzius (1998); Braconier and Ekholm (2000)].[22]

[21] In particular, the study by Kravis and Lipsey (1982) claims that a pattern of "opposite attract" prevails. See also Swedenborg (1979), and Dunning (1993) for a survey. The interpretation is that higher relative wages mirror higher productivity. However, all of these studies suffer from a selection bias, since only countries where firms have located production are included in the analyses. Note also that our focus is on the trade-off between agglomeration and wage costs, not wage elasticities per se.
[22] We have also used relative unit labor cost as an explanatory variable, in order to control for productivity effects. Unfortunately, distributed on industries this variable is not available to the same extent. In the runs undertaken, it appears with the expected positive sign and is also weakly significant.

We expect increasing relative wage costs to have a negative effect on the location of affiliate production. Furthermore, we interact relative wages with a dummy denoting whether a host country belonged to the EU in the periods 1986–1990 (RW * EU * 8690), 1990-1994 (RW * EU * 9094) and 1994-1998 (RW * EU * 9498), respectively. Presumably, differences in relative costs should become more important over time as integration proceeds and firms' exposure to such differences is intensified.

5.2. Agglomeration variables

The degree of agglomeration of production (AGGL) is measured as an industry's share of a host country's total manufacturing, in relation to the industry's share of manufacturing production for all countries. According to theory [Fujita et al. (1999)], and supported by empirical evidence [Wheeler and Mody (1992); Head et al. (1995); Braunerhjelm and Svensson (1996)], agglomerated production structures should have a positive impact on location.[23] Likewise, agglomerated R&D-structures (HOSTR&D) are expected to exert a positive impact on production, though in this case because of non-pecuniary linkages (knowledge spillovers).[24]

As noted in section 2, production is quite concentrated also at the European level. To separate between the effect of agglomeration and concentration, we include a Hoover-Balassa index on absolute concentration of industrial production (CONC), which is expected to have a positive impact on FDI.

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[23] We also have data on input/output matrices for a limited number of countries, and price indexes for investment goods. However, none of these perform well in the regressions and are therefore not further discussed.
[24] For a theoretical modeling of these effects, see Martin and Ottaviano (1999). Fujita and Thisse (1996) allot agglomeration to the presence of Marshallian externalities, i.e., information spillovers in general, as well as specialized labor markets and other specialized non-tradable inputs.

Finally, among the agglomeration variables, we also include size of the respective host country's market (GDP), assumed to partly capture linkages in general, not least for downstream customers, partly being a proxy for economies of scale. Hence, this variable could be categorized as both an agglomeration variable and a cost variable.

5.3. Policy variables

We have also elaborated with a number of policy variables, stressing those related to trade costs and the level of taxes. Among the former, openness (OPEN) is defined as the share of exports and imports in relation to GDP, or host countries' import duties in relation to the total value of imports (IMPDUT). The trade costs variables are associated with some specific features: In particular, theory predicts a nonlinear relationship between trade costs and location of production. Either very low or very high trade costs generate geographically dispersed production structures, but in the medium range agglomeration will occur (Figure 4).

FIGURE 4 HERE

What can be said about the level of trade costs before the deepening of European integration was introduced in the mid-1980s?

First, as noted in section 2, the flows of FDI have increased markedly since the mid-1980s. Second, as shown by Dunning (1997), FDI into the European Union displays a distinct pattern of concentration to the more sizeable core countries. The increase in intra-EU FDI suggests that trade costs have shifted from high to more medium range levels. Hence, we would expect an increased openness to be positively related to FDI, while increased import duties are likely to deter FDI.[25]

The expected impact of openness on FDI is corroborated by the empirical observations in Braunerhjelm and Lipsey (1998). However, it was also evident that production by Swedish firms in developing countries (e.g. in Latin America), occurred where markets have been sheltered by considerable tariff and non-tariff barriers. We therefore believe that tariff jumping could be a reason for FDI in more remote markets where knowledge about market conditions is limited. Thus, the sign of openness may alter for remote markets. To account for this effect, we interact openness with distance, defined as the distance between Stockholm and the respective host country's capitol. This interaction variable should negatively affect FDI. We thus retain the old tariff-jumping argument for FDI in more distant markets.

Our next policy variable concerns taxes. There are relatively few studies applying European data on taxes, but the issue has been carefully examined in numerous studies on location in the U.S.[26] For instance, Hines (1996) contends that a 1-percent increase in corporate taxes is associated with a difference in the share of manufacturing in the order of 10 percent between low- and high-tax U.S. states. Prior to that, Bartik (1985), Coughlin et al. (1991), and Hill and Munday (1992), provided evidence that investments – national as well as international – were affected by corporate taxes. Brainard also examines the effects of corporate taxes, but she finds that location is increasing in higher corporate taxes.

[25] Brainard (1997) finds no influence of openness on FDI, whereas she reports a significant positive effect of trade barriers on FDI.
[26] See Graham and Krugman (1993) for a review of this literature. Note also, as pointed out by Kind et al. (1999), that the presence of agglomeration economies implies that tax revenue may increase or at least that a firm's sensitivity to differences in corporate taxes is diminished. Baldwin and Krugman (2000) forward similar arguments.

Two tax variables are implemented in the analysis. We commence by looking at the share of corporate taxes in relation to GDP (TAXCORP). In addition, since the quality on corporate tax data varies, we also use a proxy for the implicit overall taxation in a country defined as the size of public expenditure in relation to GDP (EXPEND). A non-linear relationship can also be expected here, i.e., some taxes are required to ensure that property rights are respected and enforced. However, in the current study, this is less likely to influence the estimations, at least when the EU-area is considered, since none of the EU-countries can be expected to have a public sector too small to guarantee basic functions such as a legal system, defense, etc. We expect both these variables to be negatively related to affiliate location by Swedish firms.

Also the level of education is likely to influence location. For efficiency and productivity reasons we believe that more educated individuals, measured as public spending on education in relation to GDP (EXPEDU), should attract entry by foreign firms.

Finally, we control for membership in the EU. A positive impact implies that the uncertainty of being an outsider in an integration process, taking place among a country's most important trading partners, may fuel FDI into that area. To control for this effect, an interaction dummy has been designed that captures whether a host country belonged to the EU in the periods 1986-1990 (EU * 8690), 1990-1994 (EU * 9094) and 1994-1998 (EU * 9498). Since Sweden applied for membership in 1991 and became full member 1995, we expect this effect be positive for FDI by Swedish MNCs in the 1986 to 1990 period.

5.4. Control variables

To isolate the effects referring to relative wage costs and agglomeration we also have to control for the impact of several additional variables. On the country level, capital per labor may influence wage level. Since we only have capital data for all the countries up to the beginning of the 1990s, we use GDP per capita (GDPC) which is highly correlated with the capital/labor ratio.[27] We expect a higher GDP per capita to positively influence location by MNCs.

Among the explanatory variables, only one relates to firm level data; the firms' R&D-intensity defined as total R&D-expenditure divided by total turnover (R&D). The reason is that theory predicts R&D-intensive firms to be most prone to internationalize production and there is also strong empirical support for this allegation [Horst (1972); Lall (1980); Mansfield and Romeo (1980); Davidson and McFetridge (1984); Kogut and Chang (1991)]. In addition, we have also included dummies to capture time- and region-specific effects in the regressions.[28]

6. Regression results

The results are reported in Tables 3–5.[29] Several variables failed to attain significance, irrespective of the specification of the estimations, and will henceforth be disregarded.[30] We

[27] Correlation coefficient >.80.

[28] Region 1 consists of countries in North America; region 2 of countries in Central- and South America; region 3 of countries in Europe; region 4 of countries in Eastern Europe; region 5 of Australia, New Zealand and Japan and region 6 of countries in Asia.

[29] To control for potential simultaneity problems, we also estimated a recursive system. It is conceivable that agglomeration is a function of relative wage costs, policy variables, etc. Therefore, we first regressed all variables on agglomeration to obtain a predicted variable of agglomeration. In the subsequent step, the predicted value was used as an explanatory variable in a Tobit estimation. The drawback in applying this method is that we lose degrees of freedom, since our dependent variable is now defined by industry and country, not by firm and country. Hence, we have only implemented this technique to control for the robustness of the results obtained in the other regressions. The estimation of the recursive system will not be reported, but is naturally available upon request. The results indicated no simultaneity problems.

[30] These variables – with the exception of corporate taxes – have not been described above: input-output matrixes (available for a limited number of European countries), prices on intermediate products, prices on investment goods,

present the results for EU, Non-EU and the "World", where all 38 countries are included in the regressions.[31] The reasons are that we would like to separate between the effects accruing to the EU and other regions, since we expect that differences in labor-mobility should vary between regions. Moreover, as soon as we extend the analysis to countries outside EU, the restrictions on data availability become much more severe (for instance, data for HOSTR&D and EXPEND is lacking).

TABLES 3-5 HERE

6.1. Is there a trade-off between wages and agglomeration?

As shown in Tables 3–5 the agglomeration variable (AGGL) has the expected positive sign and is highly significant in most regressions, irrespective of region. Both the probability that a country will be chosen as a host for affiliate production and the level of production are positively affected by the degree of agglomeration. For EU, this is also the case for agglomerated R&D (HOSTR&D) in the eight industries of the host countries.[32] Furthermore, both the size of the market (GDP supposed to capture linkages and scale effects), and the variables measuring industrial concentration within EU (CONC) comply with the expectations, being positive and highly significant.

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corporate taxes and population density as a proxy for congestion. They did not influence the results in any other ways.

[31] We have extended EU somewhat to comprise also Norway and Turkey, due to these countries close links with EU.

[32] We also interacted high-tech (R&D-intensive) firms with R&D-agglomeration in the host countries. We failed to detect any relationship between these variables. The inclusion of this variable did also insert strong multicollinearity.

Interestingly enough, the impact of relative wages seems to differ between EU and other regions.[33] In EU the marginal effects are negative and significant at the one-percent level as regards the level of MNC activity (Table 3), whereas both the choice of location and the levels are positive and significant (weakly) for non-EU (Table 4). In the estimations where all countries are included (Table 5), no clear-cut results are obtained, the estimated effect varying from being weakly positive to weakly negative. As indicated by the interaction between the relative wage variable and the EU-dummy (RW*EU*YEAR), the negative effect of higher relative wages in EU on foreign location seems to be particularly pronounced in the period 1986 to 1990. Thereafter the effect and significance vanishes.

Thus, there seem to be inherent differences between EU and the rest of the world. Regression 1 in Table 3, indicates that a 10 percent increase in relative wages decreases foreign production by 9.1 percent and that a 10 percent increase in agglomeration increases production by approximately 3.5 percent. Thus, a 10 percent increase in relative wages in EU calls for a 26 percent increase in agglomeration to keep the level of affiliate production unaltered. Or, put differently, a 10 percent increase in agglomeration enables a country within EU to increase its relative wages by 3.8 percent without loosing any affiliate production.

6.2. Policy and control variables

The policy variables refer to trade costs, tax policies, education and EU membership. As regards expansionary fiscal policies (EXPEND, implicit tax pressure), it is shown in Table 3 to have a strong significant and highly negative effect on foreign entry by Swedish MNCs in EU (data is

[33] We also used relative unit labor costs as an alternative variable, which did not alter the overall results. Since data on relative unit labor costs is much more restricted, we prefer to use the relative wage cost variable.

not available for other regions). Similarly, education (EXPEDU) exerts a strong positive effect on foreign location in all estimations, irrespective of whether the probability of choosing a country or the level of production is considered.

As regards trade costs, this variable seems quite sensitive to the way it is inserted into the regressions. If we only apply openness (OPEN), a negative and clearly significant effect is obtained, which suggests that FDI occurs in order to jump tariff barriers (Table 3). A similar result is obtained if we add the share of import duties (IMPDUT) in relation to the import value, albeit this variable attains a much higher significance (Table 4).

Next, we introduce an interaction variable, which supposedly captures the different effect of trade policy (costs) for neighboring countries as compared to more distant markets. This variable is defined as the interaction between openness and distance (OPEN*DIST), where we argue that foreign affiliate production in remote places is negatively affected by openness. This modification influences the parameter values in the following ways. When we consider non-EU (Table 4), this seems to have little impact on the variables OPEN and IMPDUT. However, when all countries are considered (Table 5), the probability that open host countries will attract FDI now turns positive, while the effect of high import duties becomes negative; i.e., openness promotes entry by MNCs. This conforms to expectations and the observed pattern of foreign production by Swedish MNCs. Moreover, the interaction between openness and distance becomes negative and significant, implying that tariff jumper may positively influence entry in more remote markets.[34]

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[34] We also tried with the interaction between import duties and distance, which yielded the expected positive and significant estimates. A high degree of multicollinearity was also inserted into the regressions, however. The correlation between the variables openness and import duties is -.35.

Our final policy variable, which is a dummy reflecting whether a host country belongs to the EU, did not fare particularly well. Even though it appears with the expected positive sign in the period 1986-1990, it is not significant. Furthermore, in the subsequent period 1990-1994, it turns negative, an effect which remains and becomes significant in the period 1994-1998 in terms of the level of FDI. This probably reflects the general shift in FDI towards the U.S. in the latter part of the 1990s.

7. Conclusions

Recent advances in economic theory predict that differences in production costs and agglomeration economies will influence the spatial distribution of economic activities. The extent to which these factors influence location, depend on the degree of integration across regions and countries, that is, trade costs are of importance. Throughout the post-war period, the dismantling of tariff and non-tariff barriers, paired with deregulation on the national level, have made formerly protected markets more exposed to international competition. This process gained momentum in the mid 1980s through global rounds of tariff reductions and the internal market program in Europe.

Through regression analysis, we have analyzed the relation between variables promoting agglomeration and dispersion of production by pooling unique firm level data on Swedish MNCs with country level data for the period 1974 to 1998. Several country level data are distributed on industries. We also included countries where the firms have no production. If omitting these observations, we are bound to introduce biasedness into the estimations, since the firm makes a step-wise decision when deciding to establish a foreign production subsidiary.

One clear result is that agglomeration factors strongly influence the location of production. At the same time, differences in relative wage costs are reported to have a negative effect on the location and production of MNCs in EU. We found that an increase in the relative wage level with ten percent would decrease affiliate production by nine percent. To compensate for such differences in wage levels, a 26 percent increase in agglomeration is required.

Considering the relatively modest mobility of the European labor force, this suggests that concentration to a limited number of regions within Europe is less likely, since an inflow of MNCs would tend to increase wages which would then deter further inflows of production. Alternatively, in countries outside the more homogenous Europe, differences in relative wage costs may also reflect differences in productivity.

In addition, economic policy variables were found to influence the outcome of the location of firms. First, an expansionary fiscal policy (high taxes) resulting in large public expenditures relative to GDP seems to be negatively associated with firms' locational decisions. Since this is not entirely due to the size of public expenditures, but more likely their composition, we control for education. The average spending on education is found to strongly increase the probability of inflows of FDI and also has a positive impact on the level of production. Finally, the effect of openness on location is more ambiguous even though there are indications that the effect is positive, except for more distant markets. We also controlled for market size and the relative abundance of capital, both of which were shown to exert a strong positive influence on MNC entry.

Table 1. Coverage of the data set on MNCs and number of observations

Year	Number of parent companies	Numbers of countries	Observations
1974	93	34	3 162
1978	101	34	3 434
1986	97	34	3 298
1990	112	34	3 808
1994	125	38	4 750
1998	85	38	3 230
Total	–	–	21 682

Source: IUI databases, see Braunerhjelm and Ekholm (1998).

Table 2. Definitions of explanatory variables used in the regressions

Cost variables (influencing w and q)	Agglomeration variables (influencing h)	Policy variables (influencing q and τ)	Other(control) variables (λ)
RW: Relative wage, measured as dollar per employed in a certain country and industry, compared to the same quota for Sweden. Industry level.	AGGL: Relative agglomeration index based on production value. Industry level.	EXPEND: Total public expenditure, percent of GDP. Country level.	GDPC: GDP per capita expressed in current purchasing power adjusted dollars. Country level.
	CONC: Absolute Hoover–Balassa index based on production value. Industry level.*	EXPEDU: Public spending on education, percent of GNP. Country level.	R&D: R&D expenditures, percent of total turnover. Firm level.
	GDP: GDP expressed in 1995 year dollars. Country level.	TAXCORP: Corporate taxes, percent of GDP. Country level.	DIST: Distance between Stockholm and the other countries' capitals.
	HOSTR&D: Number of scientists and engineers in the private business sector, percent of the total number of employed. Industry level.	OPEN: The sum of imports and exports, percent of GDP. Country level.	8698: Time dummy for 1986–1998.
		IMPDUT: Import duties, percent of import value. Country level.	8690: Time dummy for 1986–1990.
		EU: Dummy for the countries in the European Union.	9094: Time dummy for 1990–1994.
			9498: Time dummy for 1994–1998.

Sources: Data for the period 1974 to 1998 are collected from Barro and Lee (1996), IUI databases, various editions of OECD publications (1982 to 2000), Penn World Tables (1994), UNIDO (1997), and World Bank (2000).

* This variable could either be classified as belonging cost-variables, or to agglomeration variables.

Table 3. Regression results, EU

	(1)		
Independent variables	*Probit Pr(Y)*	*OLS AL/TL*	*OLS* AL/TL*
Intercept	8.18** (3.41)	37.65*** (7.45)	7.21 (7.58)
RW	-.16 (.11)	-.91*** (.22)	-.36 (.24)
AGGL	.07 (.07)	.35** (.14)	.21 (.15)
CONC	2.03 (1.45)	12.05*** (3.08)	2.56 (3.23)
GDP	.18*** (.03)	.96*** (.10)	.22*** (.07)
HOSTR&D	.05 (.04)	.18** (.08)	-.0006 (.09)
EXPEDU	.81*** (.17)	3.94*** (.46)	.91** (.39)
EXPEND	-.87*** (.27)	-3.97*** (.63)	-.65 (.59)
OPEN	-.30*** (.11)	-1.37*** (.26)	-.31 (.25)
GDPC	.87*** (.22)	4.10*** (.63)	.62 (.55)
R&D	.04*** (.01)	-	-
Λ	-	5.10*** (.49)	-
F	-	13.40	6.66
Adj. R^2	-	.19	.12
No of obs.	4 858	854	854
Left cens. obs.	4 004	-	-

Note: Standard errors in parentheses. *, ** and *** denote significance at the 10, 5 and 1 percent level respectively. Dummies for time and industries not shown but available on request. OLS* is a simple OLS regression, i.e., without taking into account the Heckman correction.

Table 4. Regression results, Non-EU

	(2)			(3)		
Independent variables	*Probit Pr(Y)*	*OLS AL/TL*	*OLS* AL/TL*	*Probit Pr(Y)*	*OLS AL/TL*	*OLS* AL/TL*
Intercept	1.03** (.48)	.44 (1.22)	1.12 (1.25)	-4.95*** (1.76)	-5.08 (4.71)	1.54 (4.57)
RW	.18** (.08)	.35 (.21)	.21 (.20)	.29*** (.08)	.45** (.23)	.21 (.22)
AGGL	.12** (.05)	.29* (.16)	.20 (.13)	.11** (.05)	.28* (.16)	.20 (.13)
GDP	.14*** (.05)	.47*** (.12)	.36*** (.13)	.22*** (.05)	.54*** (.14)	.36*** (.14)
EXPEDU	.16** (.08)	.59*** (.21)	.41* (.21)	.19** (.08)	.62*** (.21)	.41* (.21)
OPEN	-.15 (.11)	-.34 (.29)	-.14 (.29)	-1.37*** (.36)	-1.45 (.93)	-.05 (.90)
IMPDUT	.22*** (.06)	.87*** (.15)	.63*** (.15)	.25*** (.06)	.90*** (.15)	.63*** (.15)
*OPEN * DIST*	-	-	-	.14*** (.04)	.13 (.11)	-.01 (.10)
GDPC	.20* (.11)	.57* (.32)	.29 (.31)	.04 (.12)	.43 (.33)	.30 (.34)
R&D	.16*** (.02)	-	-	.16*** (.02)	-	-
Λ	-	1.18*** (.30)	-	-	1.20*** (.30)	-
F	-	21.41	16.60	-	20.60	15.88
Adj. R^2	-	.41	.37	-	.41	.37
No of obs.	9 929	612	612	9 929	612	612
Left cens. obs.	9 317	-	-	9 317	-	-

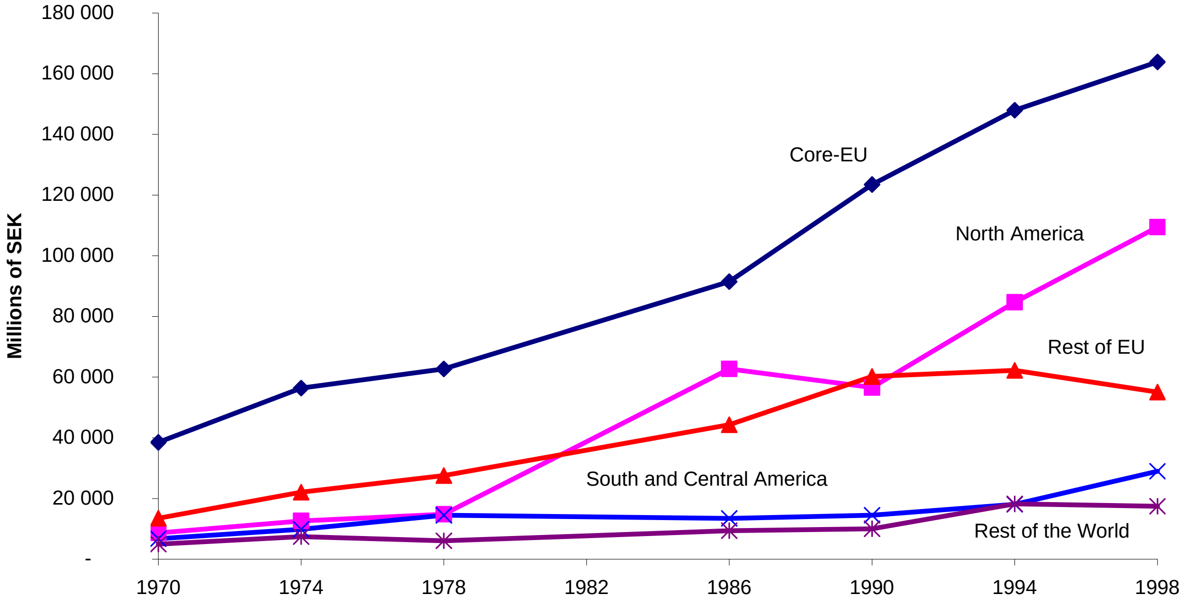
Note: Standard errors in parentheses. *, ** and *** denote significance at the 10, 5 and 1 percent level respectively. Dummies for time and industries not shown but available on request. OLS* is a simple OLS regression, i.e., without taking into account the Heckman correction.

Table 5. Regression results, the "World"

	(4)			(5)		
Independent variables	*Probit Pr(Y)*	*OLS AL/TL*	*OLS* AL/TL*	*Probit Pr(Y)*	*OLS AL/TL*	*OLS* AL/TL*
Intercept	.90*** (.27)	-1.74** (.67)	-.50 (.68)	2.91*** (.38)	3.58*** (.93)	.77 (.96)
RW	.01 (.06)	-.20 (.15)	-.23 (.15)	-.03 (.06)	-.34** (.15)	-.28* (.15)
AGGL	.13*** (.04)	.51*** (.10)	.28*** (.09)	.13*** (.04)	.49*** (.10)	.29*** (.09)
GDP	.04* (.03)	.19*** (.06)	.04 (.06)	.11*** (.03)	.39*** (.07)	.10 (.07)
EXPEDU	.40*** (.06)	1.38*** (.15)	.49*** (.15)	.21*** (.06)	.87*** (.16)	.37** (.16)
OPEN	-.41*** (.06)	-1.74*** (.17)	-.87*** (.16)	.31** (.12)	.20 (.30)	-.39 (.30)
IMPDUT	-.03** (.01)	-.15*** (.03)	-.07** (.03)	-.03** (.01)	-.13*** (.03)	-.06* (.03)
*OPEN * DIST*	-	-	-	-.07*** (.01)	-.18*** (.02)	-.04* (.02)
*RW * EU * 8690*	-.07 (.12)	-.48* (.29)	-.35 (.27)	-.18 (.12)	-.76** (.29)	-.41 (.27)
*RW * EU * 9094*	.003 (.16)	.22 (.40)	.39 (.38)	-.01 (.16)	.19 (.40)	.40 (.38)
*RW * EU * 9498*	.12 (.22)	.22 (.56)	-.22 (.52)	.06 (.22)	.07 (.56)	-.26 (.52)
*EU * 8690*	-.02 (.07)	.02 (.16)	.07 (.16)	.05 (.07)	.21 (.16)	.11 (.17)
*EU * 9094*	-.10 (.08)	-.26 (.19)	-.07 (.18)	-.02 (.08)	-.04 (.19)	-.01 (.19)
*EU * 9498*	-.25** (.10)	-1.18*** (.25)	-.65*** (.24)	-.16 (.11)	-.93*** (.25)	-.58** (.25)
GDPC	.46*** (.09)	1.74*** (.23)	.71*** (.23)	.33*** (.09)	1.38*** (.23)	.63*** (.23)
R&D	.08*** (.01)	-	-	.08*** (.01)	-	-
Λ	-	2.90*** (.22)	-	-	2.87*** (.22)	-
F	-	29.09	18.11	-	28.30	17.67
Adj. R^2	-	.30	.24	-	.30	.24
No of obs.	16 208	1 599	1 599	16 208	1 599	1 599
Left cens. obs.	14 609	-	-	14 609	-	-

Note: Standard errors in parentheses. *, ** and *** denote significance at the 10, 5 and 1 percent level respectively. Dummies for time, regions and industries not shown but available on request. OLS* is a simple OLS regression, i.e., without taking into account the Heckman correction.

Figure 1. Foreign production by Swedish manufacturing affiliates 1970-1998, distributed on

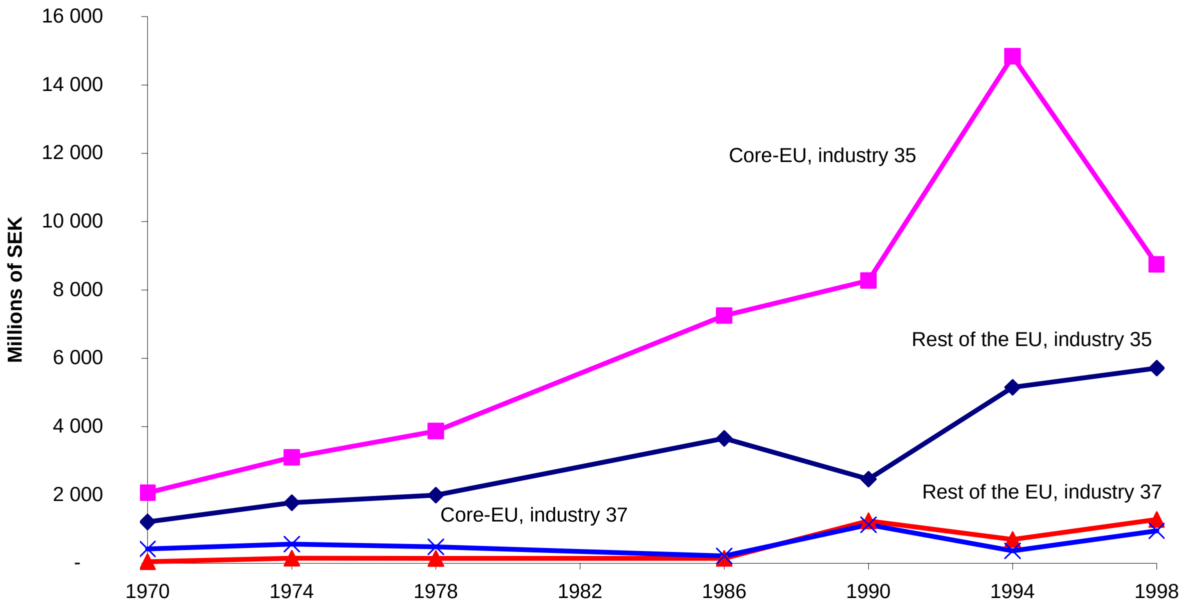


Sources: IUI's databases (see Braunerhjelm and Ekholm, 1998) and Statistics Sweden.

Note: Core-EU consists of Belgium, France, Germany, Italy, Luxembourg and the Netherlands.
The number of MNCs in the database in 1998 are considerably lower than in previous years. This will make comparisons between 1998 and earlier years difficult. Because of this, 1998 year's figures have been calculated using growth rates based on a balanced panel of MNCs for 1994 and 1998.

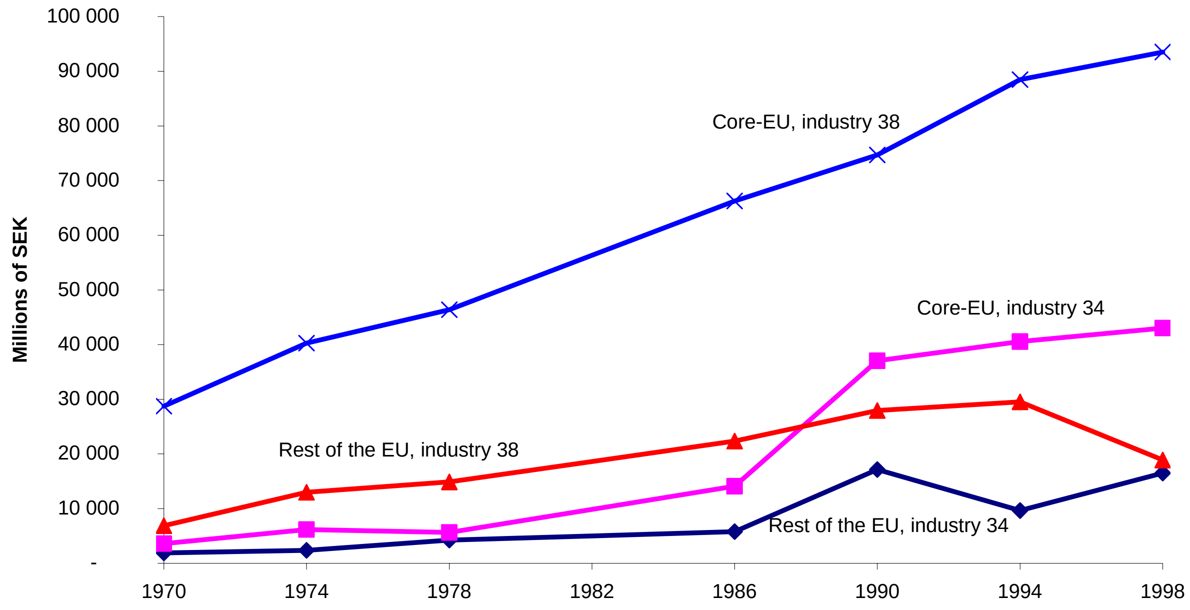
regions (millions of SEK, 1991 year's prices)

Figure 2a. Foreign production by Swedish manufacturing affiliates in the EU 1970-1998, distributed on industries and regions (millions of SEK, 1991 year's prices)



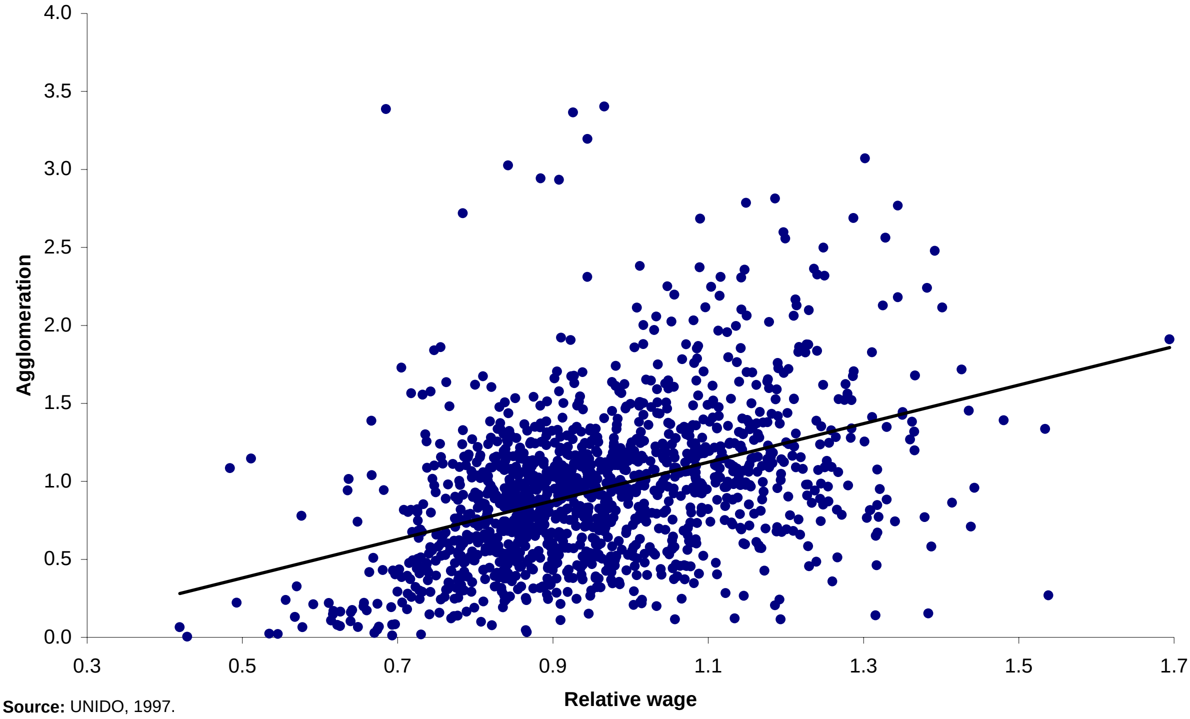
Sources: IUI's databases (see Braunerhjelm and Ekholm, 1998) and Statistics Sweden.
Note: Core-EU consists of Belgium, France, Germany, Italy, Luxembourg and the Netherlands.
The number of MNCs in the database in 1998 are considerably lower than in previous years. This will make comparisons between 1998 and earlier years difficult. Because of this, 1998 year's figures have been calculated using growth rates based on a balanced panel of MNCs for 1994 and 1998.
Industry 35: Chemicals and chemical, petroleum, coal, rubber and plastic products; Industry 37: Basic metal industries.

Figure 2b. Foreign production by Swedish manufacturing affiliates in the EU 1970-1998, distributed on industries and regions (millions of SEK, 1991 year's prices)



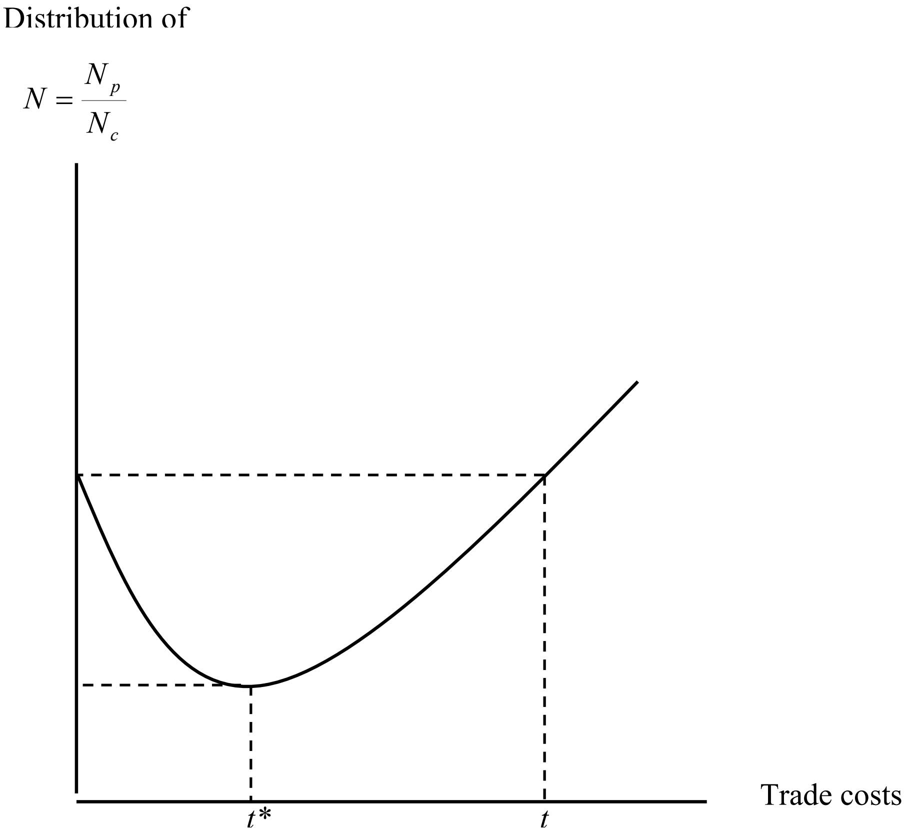
Sources: IUI's databases (see Braunerhjelm and Ekholm, 1998) and Statistics Sweden.
Note: Core-EU consists of Belgium, France, Germany, Italy, Luxembourg and the Netherlands.
The number of MNCs in the database in 1998 are considerably lower than in previous years. This will make comparisons between 1998 and earlier years difficult. Because of this, 1998 year's figures have been calculated using growth rates based on a balanced panel of MNCs for 1994 and 1998.
Industry 34: Paper and paper products; Industry 38: Fabricated metal products, machinery and equipment.

Figure 3. A simple plot between relative wage and agglomeration



Source: UNIDO, 1997.

Figure 4. Location, production cost and trade cost



Note: P equals more peripheral countries and C represents the core. Assume that $N=N_p/N_c$ represents the dispersion of production across two regions, where N_c refers to the number of firms in core countries and N_p equals the firms in peripheral countries. N=1 implies an even distribution of production (normalized by the size of the countries). Furthermore, countries share the same technology and have identical cost functions. Before a process of reducing trade costs is initiated, e.g. through regional integration (as in EU), we postulate that trade costs are initially at the level *t* in Figure 3. As trade costs move towards zero (from the right to left), the location of production (or FDI) first becomes more concentrated to the larger core countries, but below *t**, this pattern is reversed and once more, production becomes more dispersed [Fujita et al. (1999)].

Appendix

Definitions of the agglomeration variable AGGL and the concentration variable measured as a Hoover-Balassa index (CONC):

$$AGGL_{jb}^{t} = \frac{PROD_{jb}^{t} \Big/ \sum_{b} PROD_{jb}^{t}}{\sum_{j} PROD_{jb}^{t} \Big/ \sum_{j} \sum_{b} PROD_{jb}^{t}}$$

$$CONC_{b}^{t} = \sqrt{\frac{1}{c} \sum_{j} \left(\frac{PROD_{jb}}{\sum_{j} PROD_{jb}} \right)^{2}}$$

PROD refers to output in U.S. dollar. The subscripts refer to industry (b), country (j), and time (t). A small c denotes the number of countries. In AGGL, the country subscript refers to all countries, maximum 38. In CONC, the countries are Belgium, Denmark, Finland, France, Ireland, Italy, Netherlands, Norway, Portugal, Spain, UK, Turkey, Germany and Austria.

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