ILKKA SUSILUOTO

AGGLOMERATION FACTORS IN FINNISH URBAN REGIONS

3

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FOREWORD

A number of international studies indicate that urbanisation development is continuing, and Finland is no exception to this rule. The concentration of population does not occur without the concentration of jobs, and consequently the industrial structure of our national economy has undergone a rapid process of change in recent years. How to understand the changes in the industrial structure and the development and potential specialisation of the economic structure of the urban areas?

From the perspective of economics, the concentration of business activity can be explained with so-called agglomeration benefits. In addition to the scale of production, i.e. economies of scale, the issue addresses how the efficiency and productivity of a firm is affected by the vicinity of other firms. The economic science offers alternative models for explaining the clustering of firms. In his Principles of Economics (1890), one of the classics of the field, Alfred Marshall explains the concentration of industrial firms with horizontal and vertical specialisation. According to this theory, firms in the same field of industry benefit from each other due to, for instance, the development of the intermediate product market. This is referred to as the benefits of concentration brought by specialisation. An alternative method of understanding the concentration of firms is based on the benefits of concentration created by urbanisation. In this scheme, innovations surpassing the borders of different industries enhance productivity and act as the stimuli for concentration. The question on the significance of different types of benefits gained from concentration is primarily empirical.

In this study, Ilkka Susiluoto, a senior researcher at The City of Helsinki Urban Facts, will analyse the effects of different types of agglomeration benefits on the productivity of labour in five industries. The industries included are manufacture of food and beverages, manufacture of metal products, machinery and equipment, construction, hotels and restaurants, and business services. The research data, compiled by Statistics Finland, covers the years 1975–2008. The subject has not been widely researched in Finland despite a number of international studies.

Helsinki, March 2016

Timo Cantell
Director

1 INTRODUCTION

Economic activity and population are globally agglomerating to large urban centers. The economic benefits behind this development have been extensively studied, and a large body of evidence on their existence has been found. Big cities offer good possibilities for various types of communication between individuals and communities. Lively exchange of information enhances diffusion of new ideas and adopting innovations. The diversified and well-educated labor of cities increases productivity, raising the local income level and further increasing the attraction of these regions.

Similar development has also taken place in the sparsely populated country of Finland: population and economy concentrate increasingly to its relatively small urban regions, while the rural regions depopulate. The Helsinki region has increased its share of the economy, and alone produces today more than a third of the Finnish GDP. Actually in Finland relatively few urban regions have increased their share of the economy, and in this millennium university regions have generally fared best, a fact which illustrates the increasing role of knowledge in the economy.

What makes economic actors agglomerate and what are the benefits of this agglomeration is a central question in economics, and a vast literature on the topic exists. It has been stated that agglomeration benefits are due to localization: concentration of an industry into a region brings benefits internal to this industry, causing a productivity increase. Another suggested factor is diversification of the regional economic structure, which would promote the spreading of new ideas and knowledge. In addition, size of the urban agglomeration may in itself create benefits, giving large urban regions the upper hand in growth. Regardless of the extensive empirical literature on the subject, the last word on the relative importance of the various factors has not yet been said.

In this paper we study the role of different agglomeration factors in Finnish urban regions and in selected industries, including both goods production and service sectors. The data consists of 35 largest urban regions in Finland, with a large size variation from the Helsinki region with over a million inhabitants to towns of only 30 000 to 40 000 people. The time period covers the years 1975–2008 and most of the data is from the Regional accounts of Statistics Finland.

The methodology follows closely a study by Kluge and Lehmann (2013) which includes the additional perspective of nonlinearity and mutual dependence of the explanatory factors. To our knowledge no such study has to date been made in Finland.

Chapter 2 includes a short review on the nature of the agglomeration factors and presents selected research examples. Chapter 3 gives some general points on definition of the variables, in addition to which the regions and industries are described. Chapter 4 presents the regression model and the estimation method and Chapter 5 reports the results. Chapter 6 is a brief conclusion of the study.

2 AGGLOMERATION AND REGIONAL GROWTH: A SHORT REVIEW

Which agglomeration factors are most important for regional growth? In this chapter we give some examples of the empirical research that has been made on the subject. During the last decades a vast literature has accumulated, but unanimous results are still to be found. For extensive surveys on the topic see Duranton and Puga (2004) or Rosenthal and Strange (2004).

Alfred Marshall discussed the principles of agglomeration already in his classical early work Principles of Economics (1890). According to him, concentration of an industry into a specified place leads to agglomeration benefits for the industry. Concentration promotes the spreading of ideas and knowledge in different ways, for example with skilled labor moving from one firm to another or through informal discussions between professional workers. A larger local labor market as well as a larger market for production inputs lead to agglomeration benefits. As the industry grows the number of skilled and specialized workers increases, raising the level of local knowledge. The regionally concentrated industry also attracts suppliers of specialized services, for example transport firms, which leads to cost reductions. Altogether it was assumed that the accruing benefits are mostly realized within the industry, not between the different branches of the economy. Marshall's theory was further developed by Kenneth Arrow (1962) and Paul Romer (1986), consequently the term Marshall-Arrow-Romer (MAR) theory is often used.

Contrary to Marshall, Arrow and Romer, Jane Jacobs (1969) assumed that the spreading of information and knowledge is mainly realized between different industries, not within them. A diversified economic structure fosters innovations: "the greater the sheer number of and variety of division of labour, the greater the economy's inherent capacity for adding still more kinds goods and services" (Jacobs 1969, p. 59). A diversified production structure increases the possibilities to copy and combine ideas and methods from one industry to another.

The study by Glaeser (1992) consisted of 170 United States regions in 1956 and 1987, and was related to the earlier studies by Romer (1986) and Porter (1990) as well as to the book by Jane Jacobs (1969). Employment growth of largest regional manufacturing sectors was explained, and while Jacobs-type positive urbanization effects were detected, MAR-type specialization rather seemed to hold back growth. Benefits from transferring knowledge seemed to realize mostly between industries, not within them.

Also Henderson et al. (1995) studied the U.S. metropolitan regions. Eight manufacturing sectors were represented, including both traditional, declining industries and new technology sectors. According to the results, new growth industries need the diversity typical of large urban regions, while benefits of specialization are more important for the traditional industry groups.

Henderson's results are in line with the idea of the regional product cycle: new products are developed in large urban regions with a diversified economic structure, and as the production reaches a mature phase it moves to more specialized and cheaper locations. Duranton and Puga (2004) gave this idea a theoretical background leaning on a general equilibrium model, while Neffke et al. (2011) obtained results that were consistent with it, using data from Sweden. Greunz (2004) found that the effect of localization factors on innovation is highest in industries with low or medium-level technology, while high level technology industries benefit mostly from urbanization factors.

Using a disaggregated data Combes (2000) studied the effects of employment density, specialization, diversity, competition and firm size on the growth of French regions. Differing and somewhat unexpected results were obtained for manufacturing and services. The explanatory variables had mostly a negative effect on manufacturing growth, while in service sectors diversity had a positive and specialization a negative effect. Further results were obtained by Combes, Magnac and Robin (2004), and Fuchs (2011) has applied Combes' approach to Germany.

In Finland Kirsi Mukkala (2004) studied agglomeration benefits in Finnish regional manufacturing in 1995 and 1999. According to the results, localization benefits were larger than urbanization benefits, the former being particularly notable in pulp and paper industry. According to Capello (2002) localization benefits are primarily realized in the smaller enterprises, while the bigger firms take advantage of urbanization factors.

In addition to diversity, urbanization benefits may also result from size of the region or its density. The World Bank (2009) uses "the three D's", density, distance and division to explain regional economic development. Abel, Dey and Gabe (2012) found that doubling the density of population brings a productivity increase of 2–4 per cent in US urban regions, and that the increase is bigger in regions with a large base of human capital. According to Carlino et al. (2007) the patent density of US urban regions increases 20 per cent with the doubling of employment density.

Most of the studies assume linearity of the agglomeration effects and rule out the possibility of interaction between these factors. However, in his study of German regions Illy et al. (2011) includes second-order terms of the localization and size variables and detects a U-shaped relationship between localization and growth. De Lucio's (2002) study on the productivity of labor in Spanish regional manufacturing included two localization variables and their squares, and the effects on productivity were found to be nonlinear. Farhauer and Kröll (2012) introduced the concept of diversified specialization. They assumed that many urban regions have specialized relatively strongly into several industries, while these regions also have a diversified production structure. According to the authors such regions are able to benefit both from specialization and urbanization, and the simultaneous presence of both factors would strengthen the effects.

A recent study by Kluge and Lehmann (2013) examines further the mutual dependence and nonlinearities of urbanization and specialization in their effect on growth. It can for example be assumed that the more diversified the regional production structure is, the higher is the effect of specialization on productivity. Technological expertise coming from other industries could increase the benefit of specialization. As we do not yet know enough about these mechanisms and effects, we cannot predict their direction. We could also expect that for example a firm is able to benefit more from increasing specialization if the industry is already relatively strongly represented in the region. On the other hand very high specialization could result to disadvantage caused by congestion effects.

Our study follows closely the ideas and methods of Kluge and Lehmann. The methodology has partly been simplified, for example we have not applied instrument methods as Kluge and Lehmann did. On the other hand, our study includes a size or density variable as an additional agglomeration factor.

3 DATA AND THE REGIONS OF THE STUDY

3.1 Some considerations about defining the variables

In regressions attempting to detect regional agglomeration benefits the variable to be explained is usually a measure of production, employment, productivity or innovations. An indicator of the number of employed have often been used, however labor is not a homogenous factor, nor is it completely mobile or always freely available (Almeida 2007). Real growth of value added would be a natural choice, but availability of data is often a problem. In addition the number of new firms, wage sum or an indicator based on plant sizes or numbers has been used, each of these having its own problems.

An alternative choice would be a simple productivity indicator, the most usual being productivity of labor, measured either as value added per hours of labor or per employed person. In this study the latter alternative is used. In the ideal but rare case reliable time series of regional capital stock would be available by industry. When a measure of productivity has been explained, Marshallian benefits of specialization have been detected more often than Jacobs-type urbanization effects, according to Beaudry and Schiffauerova (2009). On the other hand the choice of explanatory variables affects this result (Gao 2004).

A third alternative for the endogenous variable would be to use a measure of innovative activity, most often the number of patents. While this is an unambiguous indicator it also has some defects, as some innovations are not patentable or they do not result in patents. In addition the importance and quality of patents varies considerably (Beaudry and Schiffauerova 2009).

As for a measure of specialization, the relative location quotient of the industry has been the most popular choice. It is typically calculated by dividing the industry's share of total regional employment or value added by the corresponding national figure. The location quotient correlates strongly with the intensity of connections between firms (Glaeser 1992) but it may be sensitive to the size of the region, in addition to which benefits of specialization may rather result from the absolute rather than relative size of the industry (Ejermo 2005). Some alternatives for measuring specialization would be total industry employment, the number of firms or indicators of technological distance between the regional industries.

Urbanization benefits can be viewed either from the perspective of diversity of regional economic structure or alternatively resulting from regional size. Very often urbanization is combined in a regression model with specialization, in which case diversity of structure and some formulation of Hirschman-Herfindahl index are typically used. In the basic Hirschman-Herfindahl formulation the shares of the different industries in the total regional employment are squared and the squares are added together. A Gini index would be an alternative measure.

It has been common to include only a specialization and a diversification variable as explanatory agglomeration factors, but it can be stated that part of the urbanization benefits is created independently of regional production structure, as implied by Jacobs (1969). A natural alternative would then be an indicator of regional size or density, for example population, total employment, population density or employment density. In our study both a modification of the Hirschman-Herfindahl index and total population are used[1].

The level of regional and industrial aggregation may also effect the results. While data is usually collected by administrative regions, it would be better to use functional economic or labor market regions. When the regions are small it is more common to detect both specialization and urbanization effects and they are also more likely to appear simultaneously in the results. As for industrial aggregation levels, a large industry groups may contain a heterogeneous group of subindustries. Detailed industrial classifications tend to find urbanization effects more often than specialization effects, while the latter are most easily detected when a medium level (about three-digit) classification is used (Beaudry and Schiffauerova 2009). Data availability unfortunately limits our study to a fairly aggregated industrial classification.

3.2 Regions and industries of the study

The main data source is Statistics Finland Regional accounts, including annual production, value added, gross fixed capital formation and employment for 1975–2008. Economic activity is classified by main functional sector (private – public) and by 20 industries. Geographically Finland is divided into 78 regions according to the former NUTS 4-level ("seutukunta"), of which the 35 largest were included in the regressions[2]. In addition, several other data sources of Statistics Finland were used for the explanatory variables.

The Finnish NUTS 4 regions vary greatly by size, from the 1.3 million people of the Helsinki region (2008) to barely over 2000 in the Åland archipelago, while the smallest ones included in the regressions had about 30 000 inhabitants. The largest 35 regions cover 85–88 per cent of Finnish private value added, gross investment and employment, the Helsinki region alone producing 35 per cent of the Finnish GDP.

We wanted to include both material production and service industries, in addition to which the chosen industries should be well represented also in the smaller regions.

1 In the alternative regressions of the Appendix, population density and a modified formulation presented by Krugman (1991) are used. The results for these alternatives were very similar.

2 Some additional estimations were made with the 55 largest regions, see the Appendix.

The following five were selected:

- Manufacture of food, beverages and tobacco (below food industry)
- Manufacture of metal products, machinery and instruments (below metal industry)
- Construction
- Hotels and restaurants
- Business services

Table 1. Value added, employment and gross fixed capital formation in 2008. The largest 35 Finnish regions and five industries.

	Value added, M€	Gross investment, M€	Employ-ment, 1 000	Value added growth rate, %		
				1975-90	1990-98	1998-2008
Food industry	2 200	370	30	1,6	1,4	3,7
Metal industry	18 300	1 550	190	4,5	7,3	12,0
Construction	9 900	730	160	2,1	-3,0	1,5
Hotels and restaurants	2 400	150	70	2,4	0,7	3,3
Business services	16 600	7 420	260	4,2	3,8	5,0
Private sector total	116 200	*19 920	1 630	3,1	2,0	4,3
Finland, private sector total	**132 700**	***23 000**	**1 910**	**3,2**	**1,9**	**4,1**

*Excluding housing investment.

In each of the above industries the 35 largest regions produced at least 85 percent of national value added. The metal industry and business services are the largest ones in the group and construction is important in terms of employment. The rapidly growing metal industry (including the electronics industry and instruments) reached two-digit growth rates in the late 1990's as well as in 2004–2007. Also the business services sector has shown rapid long run growth.

The production share of the food industry has declined in the long run, being now only about half of its share in the 1970's. Construction produces 7 to 10 per cent of all private value added, and hotels and restaurants about 4 per cent. Altogether the five industries produce about two fifths of private Finnish value added and 30 per cent of total GDP.

Table 2. Value added per employed in 2008 and its growth in 1975–2008. Five industries and 35 largest regions.

	€/employed, 2008	Real growth rate/year, %			
		1975–1990	1990–1998	1998–2008	1975–2008
Food industry	70 100	2,8	5,0	5,6	4,1
Metal industry	95 500	4,7	7,1	10,3	7,0
Construction	62 500	1,7	1,5	-1,8	0,6
Hotels and restaurants	33 700	1,3	2,3	1,3	1,6
Business services	63 500	-0,9	2,0	-0,6	-0,1
Private sector total	71 400	3,2	3,9	2,4	3,1
Finland, private sector total	**69 500**	**3,4**	**3,9**	**2,4**	**3,2**

4 THE MODEL AND THE ESTIMATION METHOD

A fixed effects model was used for the estimation. In addition to the agglomeration variables, two controlling explanatory variables and the usual dummies were used. The Beck and Katz (1995) method was employed to obtain a realistic picture of the statistical variability of the estimates, as well as to take autocorrelation and spatial correlation into account

4.1 The regression model

The following model was estimated

(1)

$$\ln(y_{z,s,t}) = \alpha + \beta \cdot \ln(SPEC_{z,s,t-1}) + \gamma \cdot \ln(DIV_{z,s,t-1}) + \phi \cdot (\ln(SPECI_{z,s,t-1}) \cdot \ln(DIV_{z,s,t-1})) + \theta \cdot (\ln(SPEC_{z,s,t-1}))^2 + \vartheta \cdot (\ln(DIV_{z,s,t-1}))^2 + \varphi \cdot \ln(POP_{z,s,t-1}) + \chi \cdot \ln(DIST_{z,s,t-1}) + \psi \cdot \ln(PRIM_{z,s,t-1}) + a_{z,s} + v_t + \varepsilon_{z,s,t}$$

where $y_{z,s,t}$ is value added per employed in fixed prices in region z, industry s and year t. The variables $a_{z,s}$ are regional dummies and correspondingly v_t stands for time dummies. $\varepsilon_{z,s,t}$ is the ordinary error term.

The explanatory factors are as follows:

Degree of specialization into industry s is measured with its value added divided by total value added of the region, relative to the corresponding national figure:

(2)

$$SPEC_{z,s,t} = \frac{(VA_{z,s,t} \;/\; VA_{z,t})}{(VA_{s,t} \;/\; VA_t)}$$

where VA stands for value added in current prices and $VA = \sum_z VA_z$. Positive coefficients for SPEC are taken as a sign for Marshallian localization effects in industry s.

For a measure of diversity of industrial structure, a modified Hirschman-Herfindahl index is used:

$$(3) \qquad DIV_{z,s,t} = \frac{1 / \sum_{s'} (VA_{z,s',t} / (VA_{z,t} - VA_{z,s',t}))^2}{1 / \sum_{s'} (VA_{s',t} / (VA_{t} - VA_{s',t}))^2}$$

The index DIV is calculated at the disaggregation level of 16 private industries, and it takes the greater value the more even the regional industrial structure is. Positive coefficients of DIV indicate Jacobs' urbanization effects resulting from the industrial structure.

Equation (1) also includes the squares and products of the explanatory factors SPEC and DIV. Therefore the corresponding marginal effects depend on several factors:

$$(4) \qquad \frac{\delta y}{\delta \ln(SPEC_{z,s,t})} = \beta + 2\,\theta \cdot \ln(SPEC_{z,s,t}) + \phi \cdot \ln(DIV_{z,s,t})$$

$$(5) \qquad \frac{\delta y}{\delta \ln(DIV_{z,s,t})} = \gamma + 2\,\vartheta \cdot \ln(DIV_{z,s,t}) + \phi \cdot \ln(SPEC_{z,s,t})$$

As the variables SPEC and DIV were calculated by dividing the regional figure by the corresponding national one, they have the value of unity when the rate of regional specialization or diversification equals the national average. The logarithm of the variable is then zero, and the term in question disappears from (4) or (5). In this case only one explanatory factor will remain and a simple graphical representation for the result is possible. When presenting the results, the zero case is actually not a good point of reference, because only the bigger regions are included in the data. If both SPEC=1 and DIV=1 both logarithms disappear from the right side of (4) and (5), and only the constant terms β and γ remain, which is the basic linear case.

The size variable POP is the total regional population and is added to measure Jacobs urbanization effects following from the size of the region. A positive coefficient would be expected.

Two controlling factors were included. The reverse accessibility variable DIST gives weighted average distances from the other Finnish NUTS 4 regions, with regional gross value added as weights. Higher average distance means weaker accessibility. The other controlling factor PRIM gives the share of primary production in total value added, and it measures the degree of region's stage of economic development. Negative coefficients were normally expected for both DIST and PRIM.

An alternative random effects estimation was also made with 55 biggest regions and the time span of eleven three-year periods. The results are presented in the Appendix. In addition to the variables mentioned above, the following were used in the random effects models:

In addition to DIV, the diversification variable suggested by Krugman (1991) was applied (Blien, Suedekum and Wolf 2006). It gets only positive values and measures the structural difference between the region and the whole country. Negative coefficients would be obtained in the case of Jacobs' urbanization benefits:

$$\textbf{(6)} \qquad KRUGMAN_{z,s,t} = \sum_{s'} \left| \frac{VA_{z,s',t}}{VA_{z,t}} - \frac{VA_{s',t}}{VA_{t}} \right|$$

Average population density DENS was used as an alternative to POP, and instead of DIST the variable UDIST was used, the latter measuring weighted distance from regions with a university. Total numbers of students in technical, natural science and commercial faculties were used as weights.

4.2 Estimation

The estimation was made using the PCSE (panel-corrected standard errors) method suggested by Beck and Katz (1995). The main purpose of using this method is to give a realistic picture of the standard error of the estimates, in addition to which it helps to remove autocorrelation and take spatial correlation into account. The ordinary fixed effects model can be applied. The covariance matrix for the parameters is:

$$\textbf{(7)} \qquad Cov(\hat{B}) = (X'X)^{-1} \cdot (X'\Omega X) \cdot (X'X)^{-1}$$

where Ω consists of block diagonal matrices ∑:

$$\textbf{(8)} \qquad \hat{\Sigma}_{i,j} = \left(\sum_t e_{i,t} \cdot e_{j,t}\right) / T$$

The reliability of Cov($\hat{B}$) increases with T.

The PCSE method works well in panels if (N/T) is not large and when the primary purpose is to estimate confidence intervals, particularly when autoregression of the residuals is fairly low (Reed and Haichun 2011). However the method is not designated to detect the statistical processes behind the problems in the data. Attempts have been made to assess its relative reliability by the Monte Carlo method, and it has been noted that using PCSE together with a lagged endogenous variable in a fixed effect model results in biased estimates. On the other hand it has been stated that results obtained with PCSE are often equally good as those obtained with more complicated methods whose optimality properties are only asymptotic. In the latter case large standard errors of the estimates may result (Beck and Katz 2004). As a consequence PCSE has become popular in handling panel data in a simple manner.

In principle random effects is more efficient than fixed effects and should be used whenever it is applicable. As usual, the Hausman test was applied in choosing between these two. Random effects proved to be possible for four industries, provided the data was enlarged to contain 55 largest regions.

In all estimations the explanatory variables were lagged one period, in order to take possible endogeneity into account.

5 RESULTS

5.1 Basic results

In this section the most important estimation results are presented. We proceed from the basic regression results to presenting the combined marginal effects (equations 4 and 5 above) in a graphical manner. Detailed marginal effects are shown below for the manufacture of food, beverages and tobacco, construction, and business services.

Table 3. Explaining productivity of labor in five industries, 35 Finnish NUTS 4-regions 1976–2008, fixed effects.

	Manufacture of food, beveragesand tobacco	Manufacture of metal products, machinery and instruments	Construction	Hotels and restaurants	Business services
Specialization (SPEC)	0,179	0,015	0,087	0,063	0,149
	*** (5,20)	(0,25)	*** (4,01)	(1,15)	** (2,50)
Diversity (DIV)	0,142	-0,024	-0,146	-0,074	0,005
	1,01	(-0,15)	*** (-2,62)	(-1,35)	(0,05)
Interaction and squared variables:					
$SPEC^2$	-0,005	0,024	0,150	-0,022	-0,012
	(-0,37)	(1,21)	*** (3,31)	(-0,33)	(-0,41)
DIV^2	0,145	-0,148	-0,137	-0,023	0,026
	(1,05)	(-1,17)	*** (-3,19)	(-0,41)	(0,28)
SPEC x DIV	-0,050	0,164	0,079	-0,017	0,031
	(-0,78)	* (1,85)	* (1,77)	(-0,17)	(0,31)
Population (POP)	0,438	0,228	0,083	0,163	0,218
	** (2,57)	(1,37)	(1,28)	*** (3,00)	** (2,48)
Distance (DIST)	-0,797	-0,873	-0,351	0,036	0,259
	** (-1,99)	*** (-2,64)	*** (-2,90)	(0,29)	(1,04)
Primary production (PRIM)	-0,306	-0,138	0,130	0,023	0,166
	*** (-3,21)	(-1,42)	*** (3,46)	(0,64)	** (2,56)
Constant	6,701	5,075	6,960	3,704	4,069
	*** (2,61)	*** (3,68)	*** (9,40)	*** (6,77)	*** (3,28)
R^2	0,769	0,916	0,983	0,984	0,938
N	*1 155*	*1 155*	*1 155*	*1 155*	*1 155*

Table 3 contains the estimated coefficients for the five industries. Due to the interaction and squared variables, the total marginal effects of specialization and diversity on the productivity of labor are not directly seen from the coefficients of table 3. However, the coefficient of SPEC (β in equation 4) is positive and significant in three cases out of five, which is what we would expect. On the other hand the diversity factor DIV does not give expected results, and in construction the coefficient is actually negative and statistically significant. Construction is the only sector with clear nonlinearities and the coefficients for the other sectors are mostly close to zero.

The population variable has the expected positive sign in every industry and the coefficient is significant in three industries, including both service sectors. Population does not interact with other variables and its coefficients in table 3 give the total marginal effect on the productivity of labor in each industry. As for the controlling factors, the distance factor gives expected and significant results in manufacturing and construction, but the results for service industries are not significant. The coefficients for the share of primary production vary and are partly unexpected

5.2 Total marginal effects

Figures 1a to 3b give the total marginal effects of SPEC and DIV on labor productivity in three of the five industries, namely manufacture of food, beverages and tobacco, construction, and business services. The figures are similar for each industry. The results for the two remaining industries are reported briefly below.

In each of the figures 1a to 3a the horizontal axis shows the degree of specialization and the vertical axis gives the total marginal effect on productivity. Likewise, the figures 1b to 3b give the effect of diversity of production structure on productivity. The value of the y-axis gives the relative change in productivity caused by a relative change in SPEC (or DIV) when SPEC (DIV) is originally at the point given by the x-axis. When y is positive, productivity increases with increasing x. When the slope of the line is positive, higher starting values of x will give higher productivity gains. Similarly a negative slope means smaller gains with higher starting values of x. If the slope is zero the productivity gain is independent from the starting value of x.

In addition to the variable described by the x-axis (SPEC or DIV), the estimated effect on y depends also on the other explanatory variable (DIV or SPEC). The latter fact is described by the four parallel lines in figures 1 to 3. Each of these lines represents a situation where the background variable has a different fixed value. Altogether 95 per cent of the values of the background variable lie between the lines "high 0.975" and "low 0.025", where 97.5 per cent of all observations of the background variable lie below the "high 0.975" line, and correspondingly for "low 0.025". The median line divides the observations into two groups of equal size. Finally there is the line showing the national average, or the situation where ln(DIV) or ln(SPEC) equals zero.

The line "high 0.975" lies above the line "low 0.025" when the coefficient ϕ of $\ln(SPEC) \cdot \ln(DIV)$ is positive in equation (1). In this case, the productivity gain from increasing the value of the x-axis variable (for example, starting from a certain value of SPEC) is higher, the larger the value of the background variable depicted by the four parallel lines (for example DIV). Conversely ϕ is negative, when the "low 0.025" line lies above the "high 0.975" line.

Considering the many problems in the estimation, we are more interested in the statistical significance of the results rather that the exact numerical value of the coefficients. We apply the 0.05 significance level in figures 1-3, depicting statistical significance with the help of the four parallel lines. A line is solid when the coefficient of the x-axis variable is significant at the 0.05 level (at a fixed value of the background variable), while a dotted line indicates a non-significant result. The dots in the figures depict the 35 regions, and their position is based on applying the regression model to the most recent data years 2005-2008. In addition, the six largest Finnish regions (Helsinki, Turku, Tampere, Oulu, Jyväskylä and Lahti regions) are depicted separately.

The results for manufacture of food, beverages and tobacco are presented in figure 1. Figure 1a gives the effects of specialization on the productivity of labor. All the four lines of figure 1a are well above the zero level. Increasing specialization seems to raise productivity of labor in this industry independently of the initial level of specialization. The result is statistically significant at all levels of specialization and diversification (solid lines throughout), as half of the 0.95 confidence interval is only around 0.12. This is also in line with the positive and significant coefficient (0.179) of SPEC in table 3. Loosely speaking, higher specialization brings higher competitiveness in the manufacture of food, beverages and tobacco, according to our result. Applying the numerical range of this estimated total marginal effect, we could expect that an increase of one per cent in the specialization index SPEC would raise the productivity of labor for something like 0.2 per cent. The amount of productivity increase from increasing specialization seems to be independent of the initial level of specialization, as the parallel lines are only slowly declining.

The effect of increasing production structure diversity on labor productivity is depicted in figure 1b. The index of production structure diversity lies between -0.5 and +0.1 in about 90 per cent of all observations. As to the role of specialization in determining the effect of diversity on productivity, the median line represents a typical case in the data, and this line takes positive values between -0.5 and +0.1. The lowest line depicting the upper 97.5 per cent of the values of SPEC takes positive values when DIV is greater than -0.35, which is typically the case. However these results are statistically not significant, which is also seen from the dotted lines in figure 1b.

The coefficient of population (0.438) in table 3 is significant, which means that increasing size of the region means higher productivity of labor. However the confidence interval is large, and not much can be said of the size of this coefficient.

The conclusion for the manufacture of food, beverages and tobacco is that both Marshall-Romer-Arrow type localization benefits and Jacobs-type general urbanization benefits working through the size of the region exist. No support was found for Jacobs-type effects working through diversity of the production structure.

Figure 1. Manufacture of food, beverages and tobacco. The effects of specialization and diversification on the productivity of labor 1976–2008.

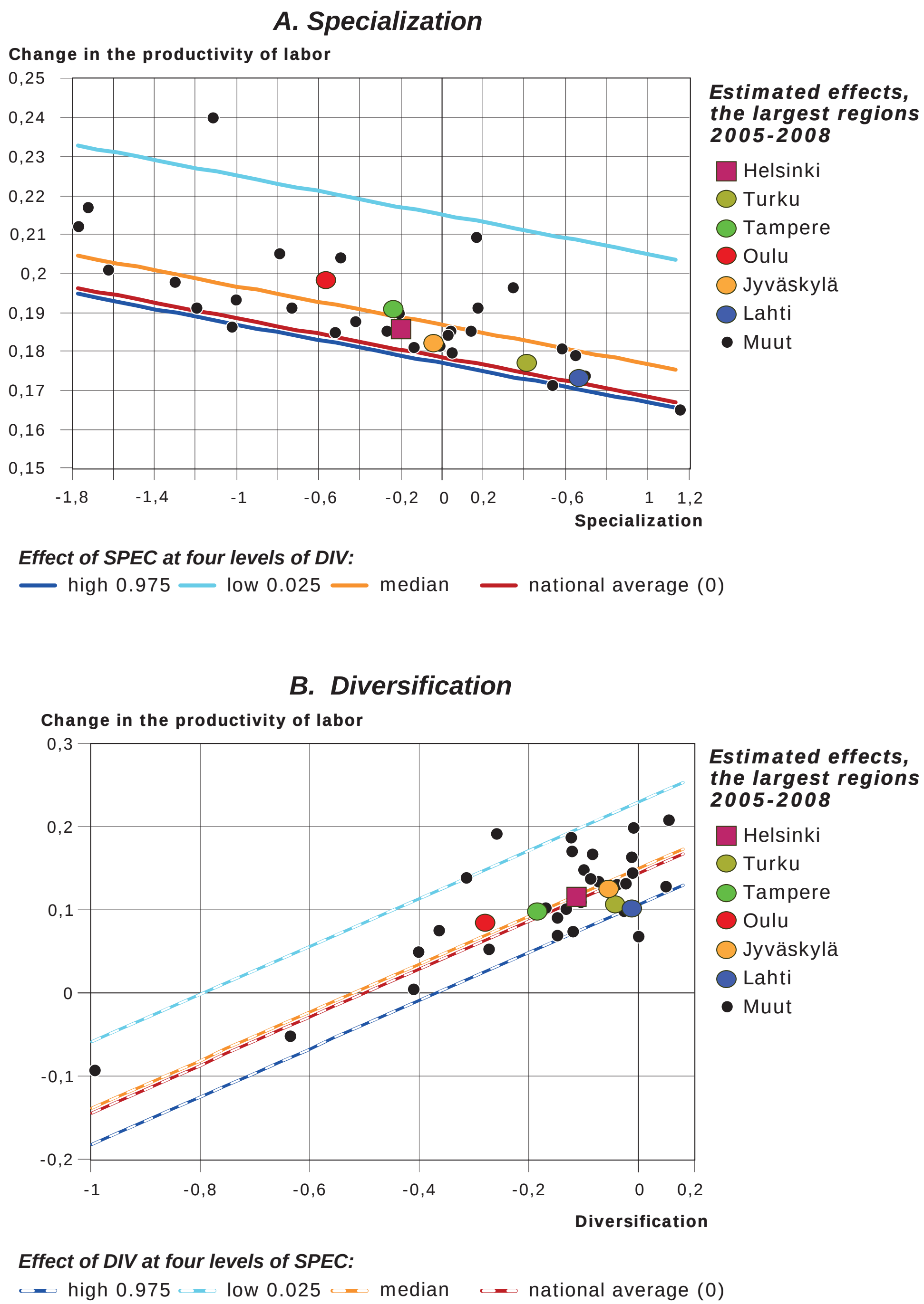
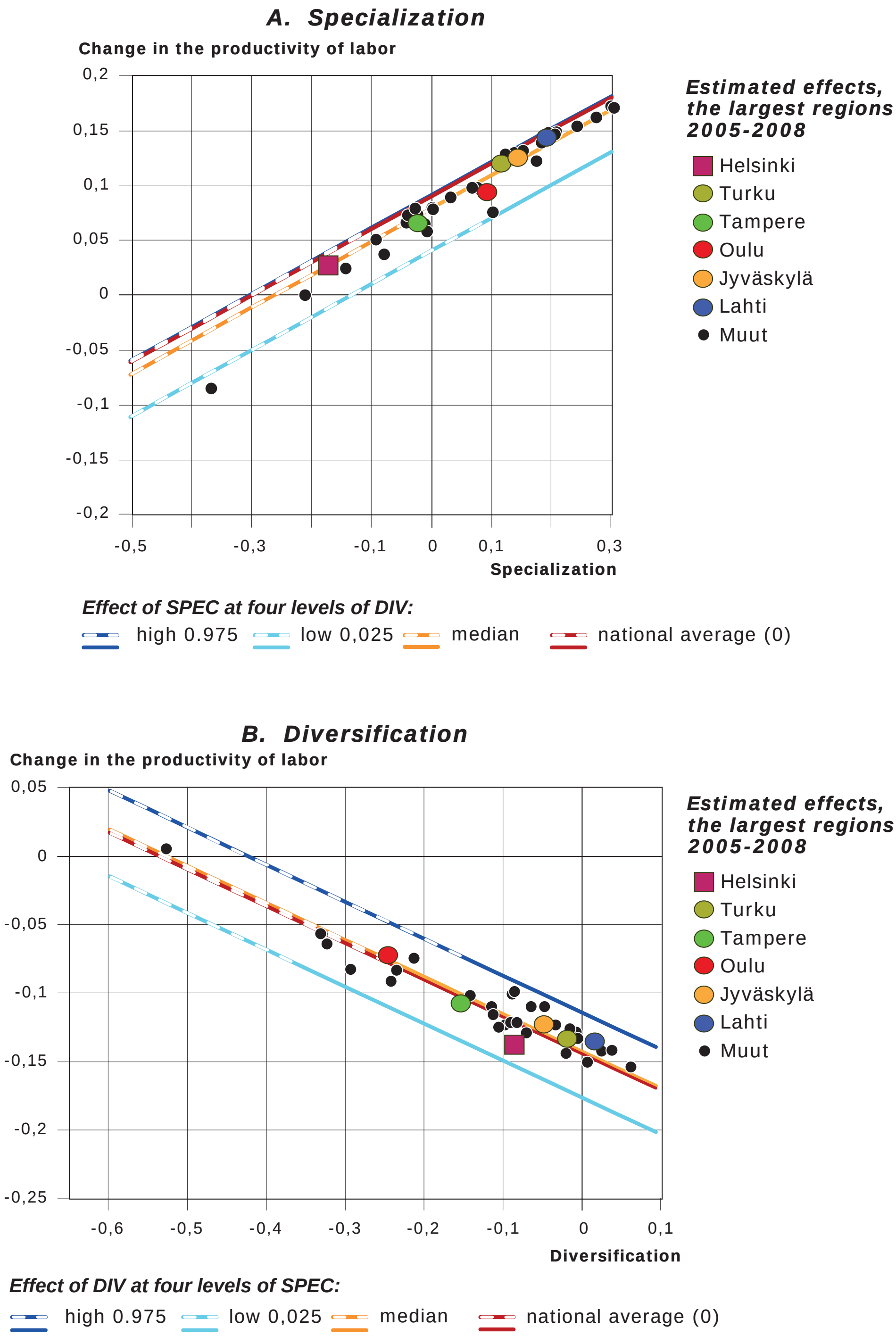


Figure 2. Construction. The effects of specialization and diversification on the productivity of labor 1976–2008.



The results for **construction** (figure 2) are clearly different from both the food industry and the metal industry (see below). The median line of DIV in figure 2a cuts the horizontal axis at ln(SPEC) = -0.25. On the right side of this point (in about 85 % of the data) the estimated benefit from higher value of SPEC is positive. The result is statistically significant approximately when ln(SPEC) is greater than zero, or in about half of the data. The results are not significant at negative values of ln(SPEC).

The slope of the lines is positive, indicating that the benefit from increasing specialization is higher the higher the initial level of SPEC. The rising trend of the lines in figure 2a means that the coefficient of squared specialization is positive and statistically significant for construction (table 3). From the relative order of the lines we can see that the total marginal benefit from specialization is higher, the higher the diversity of the economic structure. The coefficient of the product ln(SPEC) x ln(DIV) is positive albeit its significance level is low. Consequently there is some indication that specialization and diversification may strengthen each other's productivity effect.

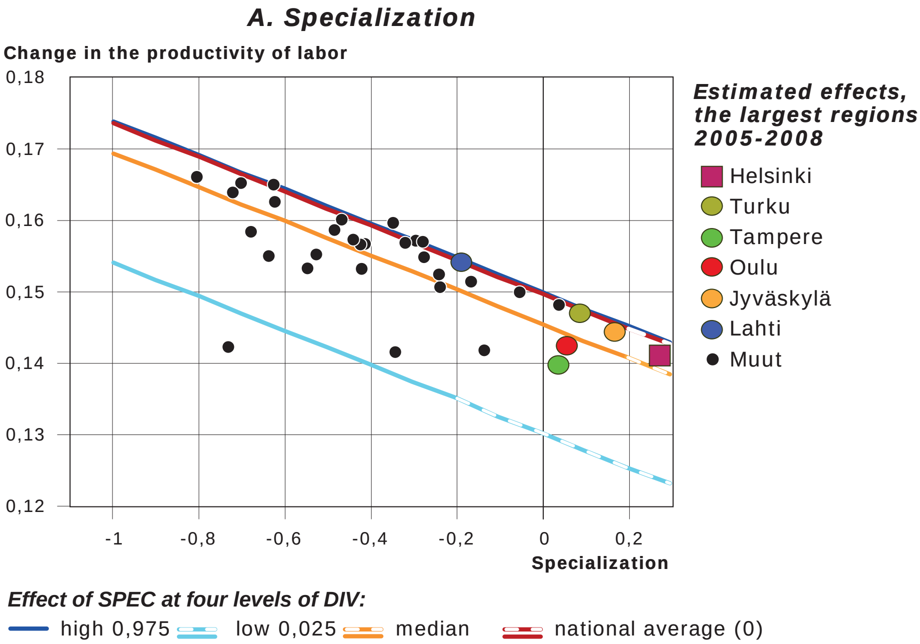
The slope of the lines in figure 2b are declining and the effects of increasing diversity are negative almost everywhere. In addition, the coefficients of DIV and DIV*2 are negative and significant. The median line for SPEC gives negative productivity effects when ln(DIV) is -0.5 or larger, which is generally the case. The 0.95 significance level is achieved when ln(DIV) is at least -0.25. Consequently in about three fourths of the data higher diversity would be detrimental to productivity, and the effect of increasing DIV would become more negative the higher the value of DIV.

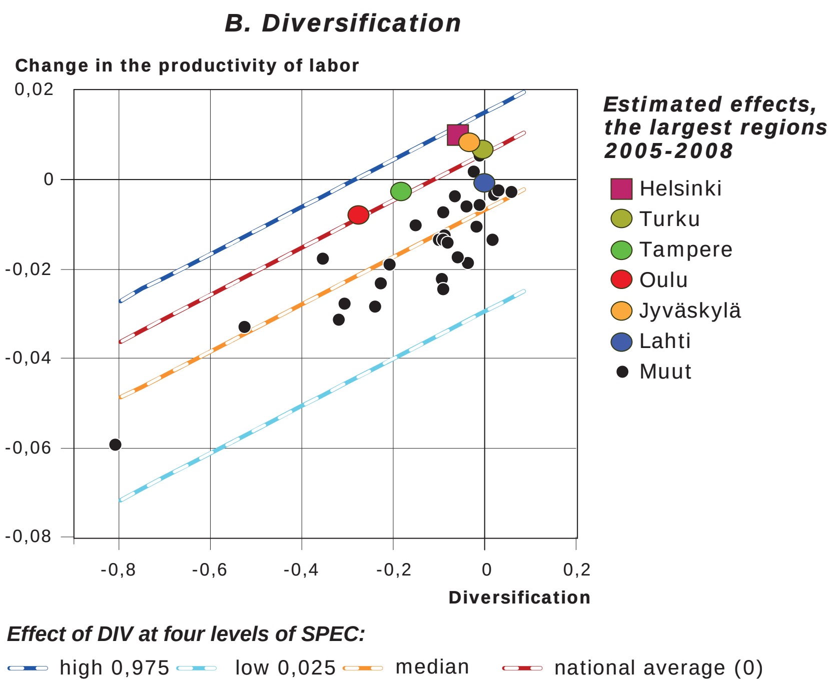
We conclude that our regressions give support to the Marshall-Arrow-Romer localization effect also in construction, but the results for the Jacobs diversity effect are contrary to general expectations, a finding not new in the literature. The results also indicate that nonlinear factors connected with these two variables would be more important in construction than in the other industries studied. The coefficient of population is positive and its size plausible (+0.083), but the result is not significant, and no conclusions can be made concerning urbanization effects caused by the size of region.

In Finland the **business services** sector is strongly concentrated to the Helsinki region, and although the region's share of the sector has declined somewhat in the 2000's, the region still produced half of its value added in 2012, and 75 % of its value added is created in the six largest regions.

According to figure 3a the estimated effect of increasing specialization on productivity of labor is positive with a coefficient of around 0.15 which is significant at 0.05 level in almost all of the data. The declining trends of the lines is not significant, nor is the coefficient of ln(SPEC) x ln(DIV). Figure 3b shows the effect of diversity on productivity. The estimates are mostly below zero and the lines have a positive slope, but the estimates are significant nowhere. On the other hand the coefficient for population is positive and significant, indicating a higher productivity of labor for the most populous regions.

Figure 3. Business services. The effects of specialization and diversification on the productivity of labor 1976–2008.





As for the two remaining industries, the estimated effect of increasing specialization on productivity of labor was close to zero and insignificant in **manufacture of metal products, machinery and instruments**. The estimated effect of increase in diversity decreases with the increasing value of initial diversity, but neither are the results for diversity significant. However the coefficient of the product ln(SPEC) x ln(DIV) was positive (+0.164) and significant at 0.10 level (t=1.85). This refers to the possibility that specialization and diversification might reinforce each other's effect on productivity. The coefficient of the population variable was positive but not significant.

No significant results were found for SPEC or DIV in the **hotels and restaurants** sector. The estimation gave a coefficient of +0.163 for the population variable, which is significant at 0.01 level, but as the 95 % confidence interval is as wide as (+0.06– +0.27) much cannot be said about the size of the coefficient.

6 CONCLUSION

Population and economy agglomerate increasingly to large cities, both globally and in the sparsely populated country of Finland. Cities offer good possibilities for various types of communication between individuals and communities. Lively exchange of information enhances diffusion of new ideas and adopting innovations. The diversified and well-educated labor of cities increases productivity, raising the local income level and further increasing the attraction of these regions.

What makes economic actors agglomerate and what are the benefits of this agglomeration is a central question in economics. It has been stated that agglomeration benefits are due to localization: concentration of an industry into a region brings benefits internal to this industry. Another suggested factor is diversification of the regional economic structure, which would promote the spreading of new ideas and knowledge. Also size of the urban agglomeration may independently create benefits, giving large urban regions the upper hand in growth.

As the largest agglomeration in the country, the Helsinki region has in the long run increased its share of the economy and produces today more than a third of the Finnish GDP. University cities have during the last couple of decades fared generally better than other regions, while the countryside is losing its population.

This study addresses the effect of the various agglomeration factors on productivity of labor in the 35 largest economic regions in Finland during the period 1976-2008. Five industries are included, namely manufacture of food, beverages and tobacco, manufacture of metal products, machinery and instruments, construction, hotels and restaurants and business services. Fixed effects estimation was applied together with the Beck-Katz-method, to get a realistic picture of the reliability of the estimates. The explanatory variables measured the localization effect, diversity of the local economy and size of the region. Additionally, possible nonlinearities as well as interaction between the explanatory variables were estimated for localization and diversity. The methodology follows closely the article by Jan Kluge and Robert Lehmann (2013).

The main results are in the table below. The findings differ by industry, but in each industry at least one kind of effect was detected.

Table 4. Effects of the three agglomerative factors on labor productivity in Finland. Five industries and 35 regions 1976–1988, fixed effects.

	Localization	Diversity	Population	Cross effect	Nonlinearity
Food, beverages, tobacco	Positive	No effect	Positive	No effect	No effect
Metal products, machinery, instruments	No effect	No effect	No effect	Probably Positive	No effect
Construction	Often positive	Mostly negative	No effect	Probably positive	Varying nonlinearity
Hotels and restaurants	No effect	No effect	Positive	No effect	No effect
Business services	Positive	No effect	Positive	No effect	No effect

Specialization into the industry (localization) as well as large population had positive agglomeration effects in three out of five industries, whereas no positive effects were found for diversity of the local economy. On the contrary, in construction even negative effects were detected. Both service sectors seemed to benefit of a large population. Cross effects and nonlinearities were only found in a couple of cases.

The two control variables accessibility and share of primary production had in most cases expected and statistically significant coefficients. The alternative random effects estimation gave results similar to the above.

The results of this preliminary study should be taken with care and no regional policy recommendations should be drawn from them. A possible further study should tackle at least the problem of endogeneity, in addition to which a more detailed industrial classification could be useful. It would also be interesting to repeat the analysis including the last few years, during which the country has faced new economic problems.

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APPENDIX

Explaining productivity of labor in four Finnish industries. The largest 55 NUTS 4-regions 1976–2008, two random effects models.[3]

Table 1. Food industry[4] construction, Hotels and restaurants and Business services

	Food industry		Construction		Hotels and restaurants		Business services	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Constant	8.671	11.651	10.713	11.214	7.121	8.533	10.63	10.55
	*** (7.40)	*** (17.99)	*** (13.36)	*** (37.2)	*** (8.08)	*** (25.04)	*** (9.08)	*** (21.08)
SPEC	0.315	0.382	0.1236	0.137	0.306	0.230	0.472	0.349
	*** (10.56)	*** (6.49)	*** (5.32)	*** (4.12)	*** (9.43)	*** (4.02)	*** (8.64)	*** (3.30)
DIV	-0.206		-0.2136		-0.154		-0.055	
	(-1.60)		*** (-4.31)		*** (-2.75)		(-0.55)	
KRUGMAN		0.423		0.141		0.070		0.123
		*** (2.57)		*** (2.70)		(0.92)		(0.72)
SPEC^2	0.0242	0.0242	0.0094	0.0088	-0.014	-0.005	-0.011	-0.024
	** (2.42)	** (2.33)	(0.38)	(0.35)	(-0.39)	(-0.14)	(-0.43)	(-0.84)
DIV^2	-0.0710		-0.1046		-0.029		-0.0251	
	(-0.64)		*** (-2.72)		(-0.56)		(-0.30)	
KRUGMAN^2		0.105		0.0470		-0.003		0.053
		(1.39)		* (1.83)		(-0.07)		(0.82)
SPEC x DIV	-0.0563		0.0132		0.048		0.050	
	(-0.94)		(0.33)		(0.69)		(0.69)	
SPEC x KRUGMAN		0.0672		0.0098		-0.090		-0.110
		(1.13)		(0.25)		(-1.28)		(-1.51)
POP	0.158		0.153		0.074		-0.050	
	* (1.94)		*** (3.25)		(1.40)		(-0.65)	
DENS		0.293		0.186		0.155		0.180
		** (2.60)		*** (3.49)		** (2.53)		** (2.21)
DIST	0.0779		-0.309		0.368		-0.0689	
	(0.54)		*** (-2.80)		*** (3.12)		(-0.46)	
UDIST		-0.205		-0.164		0.181		-0.038
		** (-2.05)		***(-4.41)		*** (4.07)		(-0.53)
PRIM	0.0094	-0.0811	0.136	0.0962	-0.0903	-0.083	0.0602	0.089
	(0.13)	(-0.89)	*** (4.27)	*** (2.88)	** (-2.38)	** (-2.09)	(0.99)	(1.37)
N	605	605	605	605				
Hausman	0.787	0.832	0.968	1.00	0.056	0.657	0.617	0.909
R^2	0.791	0.791	0.608	0.605	0.793	0.792	0.462	0.468

3 Data is averaged to eleven three-year periods. t-values in parentheses.

4 Manufacture of food, beverages and tobacco.

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Abstract

Economic activity and population are agglomerating to cities both in Finland and globally. The question of the drivers that explain why economic actors decide to locate near each other, as well as the benefits accruing to firms, has received much attention in economic research. It is customary to divide the factors causing agglomeration economies into three groups. The first type are the so-called localisation benefits that occur when a particular industry agglomerates in a certain geographic area. A diverse economic structure is also considered to be beneficial. Thirdly, the size of a region or the density of its economic activity has been seen as a source of agglomeration economies.

The present report assessed the impact of the different agglomeration factors on the productivity of labour in the large and medium-sized regions of Finland in 1976–2008. The analysis was focused on five branches of industry: food industry, metal industry, construction, hotels and restaurants, and business services. The analysis focused especially on the potential interdependence of the agglomeration factors as well as their nonlinearity.

According to the results, the industries differed from each other as regards the agglomeration effects, but each industry showed at least one type of agglomeration benefits. However, none of the industries produced a result where all of the three factors explaining productivity of labour would have had an effect. A high degree of specialisation as well as a large population increased the productivity of labour in three out of five industries, while the diversity of the economic structure had no effect. There was not much evidence of nonlinearity and interdependence of variables. The essential data for this analysis is based on Statistics Finland's Regional Accounts.

Keywords
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AGGLOMERATION FACTORS IN FINNISH URBAN REGIONS

Economic activity and population are globally agglomerating to urban centers, and similar development has also taken place in Finland. Today the Helsinki region produces alone more than a third of the Finnish GDP. What makes economic actors agglomerate and what are the benefits accruing from this development?

This study addresses the role of three agglomeration factors in Finnish urban regions and in selected industries during the period 1975–2008. The agglomeration factors are concentration of the industry into the region or localization, diversity of regional economic structure and size of the region. In addition to the ordinary linear effects, also nonlinearities and interdependence between localization and diversity are addressed. According to the results both localization and size effects could be detected, while diversity of regional economy was unimportant. The results varied widely between the industries.

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