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The micro-level dynamics of regional productivity growth: The source of divergence in Finland

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Abstract

Despite a rapidly expanding theoretical and empirical literature emphasising the role of incessant intra-industry restructuring in productivity growth, few studies have gone beyond the framework of the representative firm in examining convergence or divergence in regional productivity. We use unique longitudinal plant-level data over a long period of time and apply a useful variant of productivity decomposition methods to study differences in productivity-enhancing restructuring within manufacturing industries among Finnish regions. Long-lasting differences in industry productivity growth between Southern and Eastern Finland can be attributed to the "creative destruction" components of productivity growth, mainly to the between and entry components.

JEL classification: O12; R11
Keywords: Productivity; Efficiency; Micro-level restructuring; Convergence; Divergence

1. Introduction

Regional convergence and divergence have gained more notice in Europe in recent years, because deepening economic integration has emphasised the role of regions. These issues have almost exclusively been analysed by means of focusing on overall productivity growth through the use of aggregate data on regions and industries (e.g., Ezcurra et al., 2005; Martin, 2005), and, as a consequence, the studies have been silent about what happens between firms or plants within

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industries. Only recently has the literature started to point to the role of firm heterogeneity, firm selection and resource reallocation between firms for economic development (e.g., Bartelsmans and Doms, 2000; Foster et al., 2001; Klette and Kortum, 2004). In this paper, we investigate the role that these factors may play for regional productivity convergence/divergence. The novelty of this study is the use of unique longitudinal plant-level data over a long period of time and an application of a useful variant of productivity decomposition methods to analyse differences in intra-industry restructuring between Finnish regions.[2]

The analysis of micro-level dynamics of productivity growth requires longitudinal data on firms, or more preferably plants. Such data, together with a suitable decomposition method, allow one to examine mechanisms of productivity growth beyond the so-called "representative firm model" which has dominated research of regional economic growth. We use a decomposition formula which decomposes industry productivity growth into several distinct sources. The within component indicates the productivity growth rate of the average incumbent plant. The between component gauges the productivity-enhancing effect of intra-industry reallocation of inputs between heterogeneous plants. Other components, closely related to the between component, include the entry and exit components that capture the effect of the turnover of plants on productivity growth. The between, entry and exit components together indicate the role of "creative destruction" in industry productivity growth. In this paper we provide robust empirical evidence that the differences in the intensity of creative destruction within industries explain long-lasting differences in industry productivity growth among regions.

Finland is an interesting case, because there has been large and increasing variation in regional performance. As the European Union average is standardised as 100, the level of GDP per inhabitant is 141 in the province of Uusimaa, which is located in the southern, more urbanised part of the country (Appendix: Table A1). Hence, the region of Uusimaa is among the richest regions in the whole of the European Union. In contrast, the same measure reveals that the level of GDP per inhabitant is 75 in Eastern Finland. It belongs to the club of the poorest regions in the EU 15 (Behrens, 2003).[3]

By using plant-level data we discover that there have been general and sustained differences in productivity growth among regions in 13 Finnish manufacturing industries over the period of 1975–1999. The richest region, Uusimaa, has had the fastest productivity growth. The growth rate of labour productivity (and, as happens to be the case, total factor productivity) for all plants has been 0.9 percentage points higher per year in Uusimaa than in Eastern Finland over the period. This gap does not derive from differences in the industry structures. We show that it has emerged from differences in micro-level dynamics within industries among regions, instead. Perhaps surprisingly, productivity growth of the average staying plant shows no advantage for Uusimaa, since the within component for annual labour productivity (TFP) growth has been even slightly larger in Eastern Finland than in

[2] To our knowledge, Rigby and Essletzbichler (2000) provide the only paper that has decomposed the productivity growth rates by using regional plant-level data. They study the labour productivity growth rate of US states and apply a decomposition method that differs from ours to some extent.

[3] To get a more intuitive flavour of the regions that we are using in the following analysis, two more details are worth mentioning. First, in terms of industry structure, the main difference is that the share of the private service sector is larger in Uusimaa compared with Eastern and Northern Finland. In contrast, the share of public services is higher in Eastern and Northern Finland. Importantly, the share of manufacturing of total employment does not differ much between Uusimaa and Eastern and Northern Finland. Second, in terms of natural barriers, Uusimaa, Western Finland and a part of Northern Finland are bordered by sea. In contrast, Eastern Finland is bordered by Russia, which constitutes a political barrier. Ottaviano and Pinelle (2004) use distance from the Russian border as one explanatory variable for the regional performance in their aggregate analysis. They report that closeness to the Russian border is associated with poor economic performance.

Uusimaa, 2.8%-points (1.1%-points) vs. 2.5%-points (1.0%-points), respectively. One important aspect is that differences in regional productivity growth emerge essentially from the entry and between components, both being roughly equally significant. Both the entry and between components of annual labour productivity growth have been 0.5%-points higher in Uusimaa than in Eastern Finland. The respective numbers for TFP growth are essentially the same. These components are economically significant. For instance, the between component has cumulatively contributed to total factor productivity by 31% in Uusimaa over the period, whereas the corresponding number has been 15% for Eastern Finland. Analyses of trends reveal that the mid-'80s constituted a turning point in regional productivity dynamics. The micro-level restructuring started to fuel aggregate productivity growth, especially in Uusimaa. To sum up, the between and entry components for both labour and total factor productivity uniformly point out that the creative destruction process has been strongest in Uusimaa and weakest in Eastern Finland, especially since the mid-'80s. Because Eastern Finland has always been poorer and has had a lower productivity level than Uusimaa in most industries, creative destruction has contributed to the widening productivity level gap between these two regions since the mid-'80s.

In addition to documenting differences in micro-level dynamics of regional productivity growth based on a decomposition method, we discuss at some length the relationship of our results to the theoretical and empirical literature on productivity dynamics that has emerged recently. It turns out that disparities in the level of agglomeration of economic activity and differences in exposure to international trade have most likely contributed to long-lasting regional differences in the between and entry components of industry productivity growth.

The paper is organised as follows. Section 2 summarises the literature on regional productivity gaps. Section 3 introduces the productivity growth decomposition method. Section 4 describes the data. Section 5 documents the basic facts about the regional differences in productivity levels and productivity dispersion. Section 6 reports the results from the decomposition of regional productivity growth. Section 7 explores additional explanations for differences in regional industry productivity growth. The last section concludes.

2. Relevant literature

The prominent explanations for regional productivity gaps that have been given in the literature refer to local spillovers, X-inefficiency (i.e. production potentials determined by technology are utilized incompletely) and agglomeration (e.g., Gerking, 1994; Ciccone and Hall, 1996; Ciccone, 2002).[4] Firms may experience extra productivity growth when they absorb more knowledge spilling over from new competitors or their partners. The large number of competitors in local markets may also coerce the plants into fat-trimming and decrease X-inefficiency. Both knowledge spillovers and X-inefficiency considerations predict that agglomeration produces compressed productivity dispersion between plants within industries (e.g., Baldwin, 1995). Importantly, this prediction can be evaluated by using plant-level data.

There are earlier Finnish studies on the regional aspects of productivity. Lehto (2000) argues that investments in R&D have large regional impacts on productivity. Böckerman (2002) finds that ICT manufacturing contributes to regional productivity growth. Mukkala (2004) discovers that there is more evidence for specialisation economies than for diversification economies by using aggregate data for manufacturing from 83 NUTS4 level regions. Piekkola (2005) puts forward the

[4] The research started by Glaeser et al. (1992) has produced many papers that look at productivity growth (or employment growth) in the context of externalities that arise in agglomerations.

argument that regional concentration of human capital has played a positive role in the divergence of productivity levels. Interestingly, Kangasharju and Pekkala (2001) report that manufacturing has made the greatest contribution to the increase of regional disparities in labour productivity in the 1990s. This provides one motivation for focusing on plant-level dynamics in manufacturing.

3. Methodology

3.1. Aggregate productivity level

Aggregate productivity level P in industry i in year t is defined as follows:

$$P_{it} = \frac{Y_{it}}{X_{it}} = \frac{\sum_{pi} Y_{pit}}{\sum_{pi} X_{pit}}, \tag{1}$$

where Y is output, X is input and p denotes the plant. In order to measure labour productivity, input X is measured here by hours worked and Y is value added. In the case of total factor productivity (TFP) input, X is an index of different types of inputs (labour and capital). We use the simple Cobb–Douglas formula:

$$X_{pit} = \Pi_j X_{jpit}^{\alpha_{ij}}, \tag{2}$$

where j denotes input type and α is a parameter. We require that $\sum_j \alpha_{ij} = 1$ for each industry i. Hence, constant returns to scale are imposed for the computation of TFP. According to econometric evidence obtained with plant level data, this does not seem to be an unreasonable assumption (e.g., Baily et al., 1992; Dwyer, 1998). Here, input index includes labour (L) and capital (K). Therefore, total input is a weighted geometric average of labour and capital. Parameter α_L is the proportion of labour compensation (wages plus supplements) to value added. The parameter for capital input (i.e. α_K) is one minus α_L. The adopted TFP measure is very common in the literature (e.g., Hulten, 2001; Carlaw and Lipsey, 2003). It can be expressed as $\text{TFP} = \exp(\alpha_L * \ln(Y/L) + (1-\alpha_L) * \ln(Y/K))$. Thus, TFP is measured as a weighted geometric average of labour and capital productivity.

3.2. Decomposing aggregate productivity change

In this paper we focus on the micro-level mechanisms of productivity growth. We calculate the annual aggregate productivity growth rate in industry i in year t by using the following formula:

$$\frac{\Delta P_{it}}{\overline{P}_{it}} = \frac{P_{it} - P_{i,t-1}}{(P_{it} + P_{i,t-1})/2}. \tag{3}$$

This provides a very close approximation to the log-difference of aggregate productivity that is commonly used in the analysis of aggregate productivity growth, i.e.[5]

$$\frac{\Delta P_{it}}{\overline{P}_{it}} \cong \ln\left(\frac{P_{it}}{P_{i,t-1}}\right). \tag{4}$$

[5] Consequently, this method provides us with a useful tool to shed light on the micro-level roots of the results obtained in various aggregate level analyses. In contrast, the aggregate productivity growth rates obtained with the popular decomposition methods by Griliches and Regev (1995), and Foster et al. (2001) may significantly differ from the traditional aggregate productivity growth rates. This is shown in detail in Maliranta (2003, p. 122).

The aggregate productivity growth rate can be decomposed into two main components: the aggregate productivity change rate among continuing plants and the impact of the turnover of plants through entries and exits (net entry effect), i.e.

$$\frac{\Delta P_{it}}{\overline{P}_{it}} = \frac{\Delta P_{it}^{C}}{\overline{P}_{it}^{C}} + \quad \text{Net entry effect,} \tag{5}$$

where C denotes continuing plants. In other words, the net entry component is obtained as a difference of two aggregate productivity growth rates: the growth rate among all plants and the growth rate among all those plants that are present both in the initial and final years (i.e. continuing plants). This approach defining the net entry effect was proposed by Maliranta (1997) and more recently advocated by Diewert and Fox (2005). According to this approach, the net entry effect is positive when the aggregate productivity growth rate would have been lower without entering and exiting plants.

As shown by Maliranta (1997), net entry can be further decomposed into the entry and exit component as follows:

$$\text{Net entry effect,} = \frac{\Delta P_{it}}{\overline{P}_{it}} - \frac{\Delta P_{it}^{C}}{\overline{P_{it}^{C}}} \cong \ln\left(\frac{P_{it}}{P_{i,t-1}}\right) - \ln\left(\frac{P_{it}^{C}}{P_{i,t-1}^{C}}\right)$$

$$\Leftrightarrow \underbrace{\ln\left(\frac{P_{it}}{P_{i,t-1}}\right) - \ln\left(\frac{P_{it}^{C}}{P_{i,t-1}^{C}}\right)}_{\text{Net Entry}} = \underbrace{\ln\left(1 + w_{it}^{N}\left(\frac{P_{it}^{N}}{P_{it}^{C}} - 1\right)\right)}_{\text{Entry}} \underbrace{-\ln\left(1 + w_{i,t-1}^{E}\left(\frac{P_{i,t-1}^{E}}{P_{i,t-1}^{C}} - 1\right)\right)}_{\text{Exit}} \tag{6}$$

where P^N refers to the aggregate productivity level of the entrants (those that appear in t but not in $t-1$), P^E that of the exiting plants (those that appear in $t-1$ but not in t), $w_{it}^{N} = 1 - \sum_{p \in C}(\prod_{j=1}^{J} X_{jpit}^{Sij}) / \sum_{p}(\prod_{j=1}^{J} X_{jpit}^{Sij})$ is the current input share of the new plants in year t, and $w_{i,t-1}^{E} = 1 - \sum_{p \in C}(\prod_{j=1}^{J} X_{jpi,t-1}^{Sij}) / \sum_{p}(\prod_{j=1}^{J} X_{jpi,t-1}^{Sij})$ is the current input share of those plants in the initial year s that do not exist in the final year t. The income share of input j, i.e. S_{ij}, is calculated by

$$S_{ij} = \frac{1}{2} \cdot \left(\frac{p_{jit} X_{jit}}{\sum_j p_{jit} X_{jit}} + \frac{p_{ji,t-1} X_{ji,t-1}}{\sum_j p_{ji,t-1} X_{ji,t-1}}\right) \tag{7}$$

where p_j denotes the unit price of input type j.

The first term on the right-hand side of Eq. (6) is the entry effect and the second term (minus included) is the exit effect. We see that the magnitude of the entry effect (exit effect) is dependent on the input share of those plants in the final year that have appeared after the initial year $t-1$ (of those plants in the initial year that will disappear before the final year t) and the average productivity level of the new plants (the disappearing plants) relative to the continuing plants. One great advantage of this decomposition method is that the productivity of the exiting and entering plants is compared with the other plants in the current year (the year $t-1$ in the case of exits and the year t in the case of entries).[6] So, the entry (exit) effect is roughly equal to the

[6] In the methods by Griliches and Regev (1995), and Foster et al. (2001), the productivity level of the entrants is compared with the productivity level of the continuing plants in the past. Therefore, those methods may yield positive entry components even when the entrants have a lower productivity level than the rest of the plants at that point of time.

product of the input share of entering (exiting) plants and the productivity gap in percentages between entering (exiting) plants and incumbent plants in the final (initial) year.

As pointed out, for example, by Baily et al. (2001) and Bernard and Jensen (2004), the contribution of entries and exits to the annual change in aggregate productivity is modest, owing to the simple fact that continuing plants usually account for more than 95% of input usage. This is to say that the main part of reallocation takes place between incumbent plants. Consequently, the continuing plants can be expected to play an important role in the micro-level dynamics of productivity growth.

The aggregate productivity rate of the continuing plants can be broken down into various additive components as follows (Maliranta, 2003, 2005):

$$\frac{\Delta P_{it}^{C}}{\overline{P}_{it}^{C}} = \underbrace{\sum\nolimits_{p\in C} \overline{w}_{pit}\frac{\Delta P_{pit}}{\overline{P}_{pit}}}_{\text{Within}} + \underbrace{\sum\nolimits_{p\in C} \Delta w_{pit}\frac{\overline{P}_{pit}}{\overline{P}_{it}^{C}}}_{\text{Between}} + \underbrace{\sum\nolimits_{p\in C} \overline{w}_{pit}\left(\frac{\overline{P}_{pit}}{\overline{P}_{it}^{C}}-1\right)\frac{\Delta P_{pit}}{\overline{P}_{pit}}}_{\text{Convergence}} \tag{8}$$

The weight of plant p (w_{pit}) is the plant's input share, i.e. $w_{pit}=X_{pit}/\Sigma_p X_{pit}$. In this decomposition formula the average share in the initial and final year is used (indicated by $\overline{w}_{pit}$).[7] The first term on the right-hand side of Eq. (8) is the within component, which indicates the productivity growth rate of the average establishment that has continued in business (weighted by input share).[8]

The second term is the between component. It specifies how much the plant-level restructuring among continuing plants contributes to aggregate productivity growth. It is positive when relatively high-productivity plants expand their share of input usage. The between component, along with the entry and exit components, is a suitable indicator for the process of creative destruction à la Schumpeter (1942).

The third term in Eq. (8) can be called the convergence component. If the size and the productivity level are mutually uncorrelated, a negative value of this component suggests that plants that have a relatively low productivity level are able to converge on the high productivity ones, thanks to the above-average productivity growth rate. Negative values should predict narrowing productivity dispersion. If the relative productivity levels across size groups are reasonably stable over time, short-term variation in this component may reveal something interesting about the changes in the economic environment. The component can be expected to be low when the productivity-improving adjustment among low-productivity plants is common.

4. The data

The productivity growth rates and micro-structural components of aggregate productivity growth are calculated through the use of plant-level panel data constructed especially for economic research purposes. The data is based on the Annual Industrial Statistics surveys that basically cover all manufacturing plants employing at least five persons up to 1994. Since 1995 it has included all the plants owned by firms that have no fewer than 20 persons. As for robustness

[7] Foster et al. (2001) point out that the type of decomposition methods that make use of the initial year input weights may render a distorted view of the micro-level sources of productivity growth. In particular, the input values of the plants may deviate from the true optimal values because of idiosyncratic shocks or measurement errors, for example.

[8] This is not the case in the methods by Griliches and Regev (1995) and Foster et al. (2001), in which the sum of the weights of the continuing plants is less than one if some plants have exited during the period.

checks, Maliranta (2003) has examined how sensitive the patterns of productivity components are to changes in the cut-off limit from 5 to 20 in the period 1975–1994. It seems the cut-off limit makes little difference. This is because the large plants account for a substantial share of the total input usage in manufacturing.

The classification into 13 industries used in this paper (which is close to the two-digit standard industry classification for manufacturing) is very much dictated by our aim to provide a reliable measurement of the productivity levels and decompositions of productivity growth by regions. Our experiments show that the three-digit industry classification is not feasible for our current purpose because the number of plants in some regions and in some industries is too small for reliable computations.

Output is measured by value added for the purpose of calculating labour and total factor productivity indicators. Nominal output measures are converted into the end-year (t) prices by using the producer's price index at the two- or three-digit industry level when computing productivity changes between pairs of successive years. In this way, we avoid a fixed base year bias that will arise if a certain fixed base year is used and different price indexes are used for plants in different industries.

Labour input is measured by total hours worked. For the TFP indicator we use capital stock estimates, which are constructed from each plant's past investments through the use of the perpetual inventory method (PIM).[9] The assumed depreciation rate is 10%.[10] This means that the TFP indicator captures the efficiency in the use of the past investments in the current production, giving more weight to more recent investments. For the purpose of measuring total factor productivity, we have also needed information on labour compensation (wages plus supplements). We have followed a similar procedure of Mairesse and Kremp (1993) when defining outliers. Those plants are dropped whose log productivity differs more than 4.4 standard deviations from the input-weighted industry average in the year in question.[11]

The regression models of productivity levels and productivity dispersions include dummies for industries that are interacted with year dummies. By the use of this, it is possible to control for industry effects and, moreover, eliminate the need for industry–year-specific price deflators. It should be noted that these regressions implicitly assume that plants in all regions share the same price level in each industry. This assumption can be challenged. If there are differences in the intensity of competition among regions we may expect to find differences in mark-ups and price levels as well. However, this means that the applied estimates of productivity differences can be expected to be underrated. This is because the lack of competition in Eastern and Northern

[9] In the PIM method capital stock (K) in year t is computed as follows: $K(t)=I(t)+(1-\delta)*I(t-1)+\ldots+(1-\delta)t*(0)$.

[10] Maliranta (2003) provides diagnostics about plant-specific perpetual inventory method (PIM) estimates. It is shown that at the aggregate level PIM estimates give a very similar picture of the changes in the capital stock in the period 1975–1984 as an alternative measure, using fire insurance estimates. Estimation of the so-called 'reliability ratios' with the two independent indicators of capital input reveals that the reliability of our PIM estimates is, at least, satisfactory. (The reliability ratio is about 90%.) The capital stock for the initial year of the analysis is constructed by the use of industry-specific proportions of the fire insurance value. The proportion for each 15 NA industry is estimated in such a way that the PIM estimate per fire insurance value is as stable as possible in the period from 1975 to 1984 for a balanced panel of plants at the industry level.

[11] In addition to this, for productivity decompositions we have dropped 9 influential observations from those plants, about 10 000 in number, that appear at least once in the period from 1975 to 1998 when one is calculating total factor productivity components (16 in labour productivity computations). They have clearly erroneous information that is reflected, for example, so that the absolute values of between and convergence terms of Eq. (8) are quite large and have opposite signs.

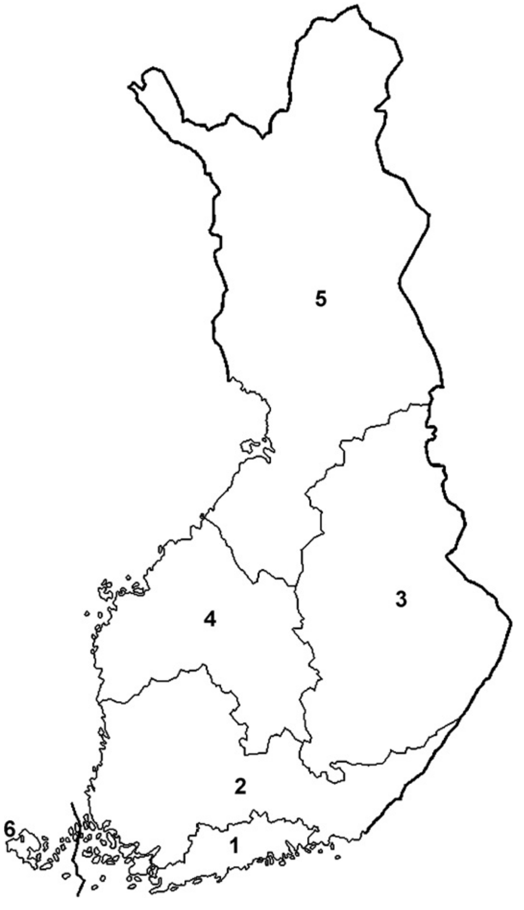

Fig. 1. The location of the provinces in Finland. (1 = Uusimaa, 2 + 4 = Western Finland, 3 = Eastern Finland and 5 = Northern Finland.)

Finland due to the low density of economic activity compared with Southern Finland can be expected to lead to low productivity and a high price level at the same time.

Finland is divided into six provinces (the so-called NUTS2 level in the European Union) (Fig. 1). However, the province of Åland (region '6' in Fig. 1) is excluded from the analysis of regional productivity disparities, because the small number of plants in this island community means that the measures of micro-level productivity dynamics are not reliable. In addition, one of the regions of the NUTS2 level called "Southern Finland" (region '2' in Fig. 1) is combined with the region called "Väli-Suomi" (in Finnish) (region '4') to construct the region of Western Finland. Our investigations have revealed that the level of productivity in these regions and its evolution have been quite similar over the period of investigation. This aggregation increases the accuracy of the computations and compresses the presentation of the results without altering the picture of productivity that emerges. Hence, this study is based on the division of Finland into four regions. Eastern Finland has been chosen to be the reference group, because it has the lowest level of GDP per inhabitant.

Table 1
The OLS estimates of labour productivity (Lnlp) and total factor productivity level (Lntfp) for manufacturing by region from 1975 to 1999 are reported in the first and second columns of the table

	Lnlp	Lntfp	Stdlnlp	Stdlntfp
Uusimaa	0.101***	0.113***	0.078***	0.073***
	(0.015)	(0.016)	(0.015)	(0.019)
Western Finland	0.027**	0.071***	0.007	0.014
	(0.013)	(0.014)	(0.012)	(0.016)
Northern Finland	0.057***	−0.016	0.024	−0.006
	(0.021)	(0.023)	(0.017)	(0.025)
Eastern Finland (reference)				
Industry effects	Interacted	Interacted	Interacted	Interacted
Year effects	Interacted	Interacted	Interacted	Interacted
Observations	1248	1248	1248	1248
Adjusted R-squared	0.97	0.96	0.46	0.42

The results for the magnitude of dispersion of labour productivity (Stdlnlp) and total factor productivity (Stdlntfp) across plants of manufacturing by region from 1975 to 1999 are reported in the third and fourth columns of the table.
Robust standard errors are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The models are estimated by the use of data from 13 manufacturing industries in four regions. Estimations are made with input weights. Panel-specific AR(1) and heteroscedastic errors are allowed for the models reported in the third and fourth columns. Dispersion is measured by the input weighted standard deviation of the logarithm of productivity across plants.

Productivity growth decompositions are made separately for 13 manufacturing industries, four regions and 24 years. Thus, the regional data contains 1248 observations. In order to give an overview of the differences between regions and patterns over time we have aggregated industry-specific results by using industry-input shares of total Finnish manufacturing as weights. In the case of labour productivity we have used hours worked as industry weights. In the TFP computations we have used industry-specific factor income shares that are determined by taking the average share in the period 1975–1999.[12]

5. Regional differences in productivity levels and productivity dispersion

Regional disparities in productivity levels are substantial, based on plant-level data (Table 1; columns 1–2). These notable differences emerge despite the fact that firm heterogeneity can be expected to be less important in manufacturing industries than in service industries. The regions can be classified into three groups in terms of the level of TFP. The level of TFP is about 11% higher in the region of Uusimaa compared with Eastern and Northern Finland. The second highest level of TFP is reached in Western Finland, where the level of TFP is about 7% higher than in Eastern and Northern Finland. This means that Eastern and Northern Finland belong to the third group of the regional productivity pattern.

The degree of uncertainty that is associated with the measurement of regional productivity disparities is illustrated by including 95% confidence intervals for estimates (Fig. 2). The ranking

[12] For aggregating regional TFP results to the level of total manufacturing we have constructed appropriate input measures X for each industry j. The input measure of industry j is computed as $X_j = K^{0.408} L^{0.592}$, where K is capital stock at 1995 prices and L is worked hours. The labour income share 0.592 is the average in the period 1975–1999. By this means, we obtain the manufacturing industry-structure that is used for 'standardizing' different industry structures of the regions. The value of around 0.4 for capital share is in line with the Finnish evidence. For instance, Jalava (2002) has documented that the value for capital share is 0.39 in Finnish non-residential market production for the period 1990–1995. In addition, the share of capital has been quite stable for most of the period.

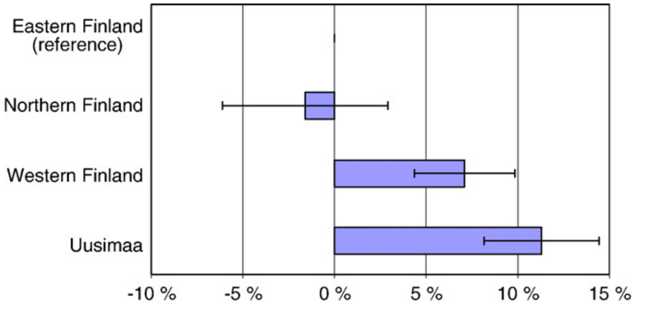

Fig. 2. Differences in regional productivity levels in manufacturing measured by total factor productivity with 95% confidence intervals.

of Uusimaa as the region with the highest productivity level is robust in terms of different productivity measures. The labour productivity level is lowest in Eastern Finland, which is consistent with the differences in regional GDP per inhabitant. Unlike labour productivity, the TFP measure does not indicate a statistically significant difference between Northern and Eastern Finland. This implies that plants in manufacturing industries are generally more capital-intensive in Northern Finland than in Eastern Finland. The labour productivity indicator therefore gives an excessively favourable picture of the performance level in Northern Finland.

The dispersion of productivity levels (measured by the input-weighted standard deviation of the logarithm of productivity across plants) between plants within industries is clearly higher in the province of Uusimaa (Table 1; columns 3–4). Labour productivity and the TFP measures lead to the same conclusion. Substantial productivity dispersions between plants that operate in the same industry and in the same region suggest that plant heterogeneity has an important role to play in productivity development and, consequently, there is a need to analyse the micro-level dynamics of productivity growth in the regions.

6. Decomposition of regional productivity growth

Table 2 reports the average annual productivity growth rates for the years 1976–1999 at the level of total manufacturing and their micro-level components in four regions. The within component appears to be the most important single source. It is, however, important to note that the other components are not negligible. Even more importantly, the proportion of the other components (i.e. the difference between aggregate productivity growth and the within component) varies between regions; it is 40% for labour productivity (57% for total factor productivity) in Uusimaa[13], 26% (50%) in Western Finland, 15% (21%) in Eastern Finland and 21% (40%) in Northern Finland. These regional differences are particularly interesting, because the effects of the different industry-structures are controlled.

Moreover, the regional productivity growth decompositions reveal that the within component of Eastern Finland has been comparable to that of Uusimaa and Western Finland. Accordingly, regression estimations fail to indicate any statistically significant differences in the within component across regions (Table 3; columns 1–2). In sharp contrast, the between component of productivity growth decomposition has a clear regional pattern (Table 3; columns 3–4). Its impact

[13] The proportion of the other components for labour productivity in Uusimaa is calculated from the numbers that are reported in the first column of Table 2 as follows: $(4.2-2.5)/4.2=0.4$.

Table 2
The decomposition of labour productivity and total factor productivity growth rates, annual averages for the period 1976–1999, %

Growth rates and components	Uusimaa	Western Finland	Eastern Finland	Northern Finland
Labour productivity				
Aggregate productivity growth for continuing plants (A–C)	3.4	3.6	3.3	4.2
Aggregate productivity growth for all plants (A–E)	4.2	3.9	3.3	4.8
A. Within component	2.5	2.9	2.8	3.8
B. Between component	0.8	0.4	0.3	0.3
C. Convergence component	0.1	0.3	0.2	0.1
D. Entry component	0.1	−0.2	−0.4	0.0
E. Exit component	0.7	0.5	0.4	0.6
Net entry effect (D–E)	0.8	0.3	0.0	0.5
Total factor productivity				
Aggregate productivity growth for continuing plants (A–C)	1.3	1.3	1.1	1.7
Aggregate productivity growth for all plants (A–E)	2.3	2	1.4	2.5
A. Within component	1.0	1.0	1.1	1.5
B. Between component	1.1	1.0	0.6	1.2
C. Convergence component	−0.8	−0.7	−0.6	−1.0
D. Entry component	0.7	0.6	0.3	0.7
E. Exit component	0.3	0.1	0.0	0.1
Net entry effect (D–E)	0.9	0.6	0.4	0.8

Computations are made separately for 13 manufacturing industries. Industry-level results are aggregated for each region by the use of the industry structure of hours worked for labour productivity (and combined labour and capital input for TFP) in manufacturing. Owing to rounding, components do not always add up.

on productivity growth has been stronger in high productivity regions. The coefficient estimate of the between component of TFP growth for Northern Finland is about the same size as that of Uusimaa and Western Finland, but its coefficient is too imprecise, reflected in the large standard error, for reliable conclusions.

Table 3
The OLS estimates for the within and between components of labour productivity and total factor productivity (TFP) growth by region in the years 1975–1999

	Within component		Between component	
	Labour productivity	TFP	Labour productivity	TFP
Uusimaa	−0.008	−0.008	0.004**	0.006***
	(0.010)	(0.013)	(0.002)	(0.002)
Western Finland	−0.001	−0.005	0.000	0.005**
	(0.007)	(0.010)	(0.001)	(0.002)
Northern Finland	0.006	0.006	−0.001	0.004
	(0.014)	(0.019)	(0.003)	(0.003)
Eastern Finland (reference)				
Industry effects	Interacted	Interacted	Interacted	Interacted
Year effects	Interacted	Interacted	Interacted	Interacted
Observations	1248	1248	1248	1248
Adjusted R-squared	0.32	0.44	0.19	0.08

Robust standard errors are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The models are estimated by the use of data from 13 manufacturing industries in four regions. Estimations are made with input weights.

Table 4
The OLS estimates for the entry and exit components of labour productivity and total factor productivity (TFP) growth by region in the years 1975–1999

	Entry component		Exit component	
	Labour productivity	TFP	Labour productivity	TFP
Uusimaa	0.005***	0.003**	−0.001	−0.001
	(0.001)	(0.002)	(0.002)	(0.002)
Western Finland	0.002**	0.003***	−0.000	0.000
	(0.001)	(0.001)	(0.002)	(0.002)
Northern Finland	−0.000	0.000	0.000	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Eastern Finland (reference)				
Industry effects	Interacted	Interacted	Interacted	Interacted
Year effects	Interacted	Interacted	Interacted	Interacted
Observations	1248	1248	1248	1248
Adjusted R-squared	0.06	0.08	0.17	0.06

Robust standard errors are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The models are estimated by the use of data from 13 manufacturing industries in four regions. Estimations are made with input weights.

As for other indicators of creative destruction, the exit component turns out to be another important factor of labour productivity growth in industries. The average over the period 1976–1999 is highest in Uusimaa (0.7% per year) and lowest in Eastern Finland (0.4% per year). Uusimaa is the only region where new plants are more productive than incumbents. The contribution of new plants to labour productivity is most negative in Eastern Finland (−0.4%). When both labour and capital are taken into account by the use of the TFP indicator, the entry component seems to have a positive impact. Again, the entry component is highest in Uusimaa (together with Northern Finland) and lowest in Eastern Finland. In addition, the exit component is highest in Uusimaa (0.3%) and lowest in Eastern Finland (0.0). To explore the statistical significance of these differences, we estimated similar regression models for the entry and exit components as for the within and between components earlier. The results confirm the pattern according to which the entry component has made a greater contribution to productivity growth in

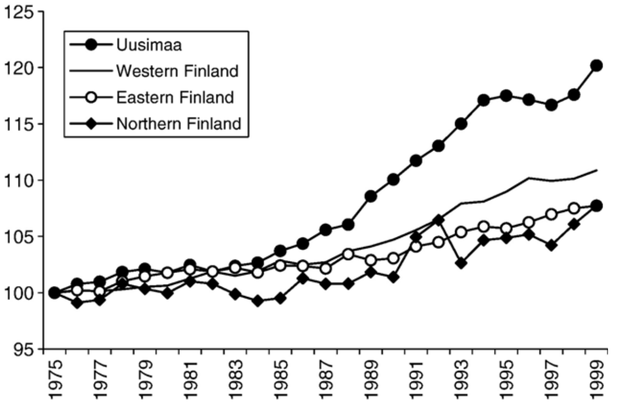

Fig. 3. The cumulative effect of the between component on the labour productivity growth of the regions.

Uusimaa compared with Eastern Finland (Table 4; columns 1–2). To sum up, the between and entry components for both labour and total factor productivity uniformly point out that the creative destruction process has been strongest in Uusimaa and weakest in Eastern Finland.

The convergence component is slightly positive for labour productivity and the regional differences are not very significant. The component is negative for all regions when TFP is used. This means that plants that have a relatively low TFP level have been able to have above-average TFP growth rates. This tendency seems to have been weakest in Eastern Finland, however. On the other hand, differences are quite insignificant in this respect.

Figs. 3 and 4 illustrate the trends and the cumulative effects of the Schumpeterian process for continuing plants since 1975.[14] The between component had little effect on labour productivity growth in all four regions up to the mid-'80s. The mid-'80s constituted a turning point in regional productivity dynamics. Micro-level restructuring started to fuel aggregate productivity growth, especially in Uusimaa. On the other hand, in Eastern and Northern Finland the micro-level dynamics remained essentially unaltered.[15] Accordingly, the productivity gap between Southern and Western Finland started to grow at the same time. Fig. 3 shows that the between component contributed to aggregate labour productivity by 20% in the province of Uusimaa during the period 1975–1999, whereas the corresponding amount for Eastern and Northern Finland is 7%. Fig. 4 reveals that the cumulative effect was clearly higher for TFP: 31% in Uusimaa and 15% in Eastern Finland. In addition, Fig. 4 indicates that the effect has been substantial for Northern Finland. However, one third of the cumulative effect comes from 2 years (1993 and 1994). Besides, it should be kept in mind that the difference between Eastern and Northern Finland was deemed statistically insignificant in Table 3. The conclusion concerning the sluggishness of the micro-level dynamics in manufacturing plants located in Eastern Finland is very robust, however.

7. Additional explanations

This section analyses some additional explanations for differences in regional industry productivity growth and discusses the relationship of our results to the literature on productivity dynamics. We can control for the effects of labour characteristics on plant productivity. This is important, because the quality of the labour force is a classic determinant of productivity and it might explain the productivity level gap between regions. The data on employee characteristics for the plants in manufacturing is obtained from Employment Statistics by Statistics Finland.[16] Interestingly, the results obtained through the use of the matched plant-level data reveal that the high level of productivity in Uusimaa cannot be explained by the quality of the labour force in this

[14] The cumulative effect is measured by the index $\mathrm{IND}t = \mathrm{IND}_{t-1} \times (1+0.5\times \mathrm{at}) \times (1-0.5\times \mathrm{at})^{-1}$, where at is the component of the annual growth rate in year *t*. IND1975 = 100. By focusing on the cumulative effect of the between component, we naturally ignore the effects of the within, convergence, entry and exit components. The combined effects of the between, convergence, entry and exit components, i.e. the differences of the aggregate productivity growth rate and the within component, yield quite similar pictures (not reported).

[15] Kangasharju (1999) and Ottaviano and Pinelle (2004), among others, investigate income convergence by using aggregate data in Finland. Divergence in productivity performance puts strains on the regional redistribution of income.

[16] The employees can be matched to plants based on information on their primary employer in the last week of the year. We have calculated the following employees' characteristics for the population of plants: education and field of study (shares of employees in the following groups: comprehensive school, upper secondary or vocational technical or non-technical education, polytechnic or lower university degree in a technical or non-technical field, higher university degree in a technical or non-technical field), age (shares of employees in groups: 15–24, 25–34, 35–44, 45–64), and the gender composition of plants (the share of females).

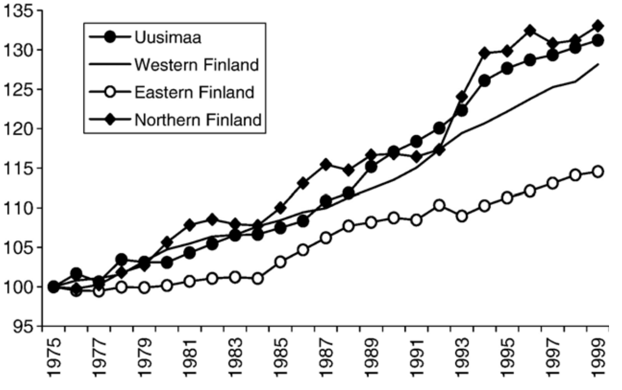

Fig. 4. The cumulative effect of the between component on the total factor productivity growth of the regions.

region (Table 5; column 2).[17] After the plant vintage effect is controlled, the productivity gap across regions is essentially at the same level (Table 5; column 3). Hence, the productivity gap remains unsolved in this kind of analysis.[18]

The evidence that the dispersion of productivity levels between plants within industries is greatest in Uusimaa is in disagreement with the static view of competition, according to which intensive competition is reflected in the small X-inefficiency, high aggregate productivity level and low productivity dispersion across plants within industries (e.g., Caves, 1992). In contrast, the high level of dispersion in productivity in Uusimaa is consistent with the view that intensive competition in its dynamic meaning stimulates innovation and experimentation of technologies, producing wide productivity dispersion across plants in this high productivity region (e.g., Boone, 2000; Aghion et al., 2005). Firms are keen to innovate and experiment with different technologies in the environment of intensive dynamic competition to 'escape the competition' à la Aghion et al. (2005). Hence, the magnitude of dynamic competition seems to be largely different in the Finnish regions.

The single most important difference in terms of economic geography between the four regions is that the density of economic activity is much higher in Uusimaa (Appendix: Tables A1 and A2). The level of productivity has been shown to be higher in agglomerations for several reasons (e.g., Ciccone and Hall, 1996; Ciccone, 2002; Rosenthal and Strange, 2004). Agglomeration can be expected to increase competitive pressure among firms and their plants. It accentuates the importance of a high productivity level for survival and growth (e.g., Vickers, 1995; Boone, 2000). Accordingly, our results suggest that agglomeration may contribute to industry productivity growth, along with other mechanisms that have been analysed in the literature, through intensified dynamic competition and micro-level restructuring.

Melitz (2003) argues that an increase in industry's exposure to international trade will lead to inter-firm reallocations towards more productive firms. Interestingly, an increase in export exposure has been highest in Uusimaa and lowest in Eastern Finland from 1980 to 1994

[17] The education structure of the workforce in manufacturing plants that are located in Uusimaa is more polarized than the education structures in other regions. Hence, the share of highly educated workers is high in Uusimaa, but the share of the lowest educated workers is also high. The education structure of the workforce in plants that are located in other regions seems to be more balanced.

[18] The differences in the data characteristics, which are stressed, for instance, by Baily and Solow (2001) and Bartelsmans et al. (2005) in the context of cross-country comparisons, are not able to explain the prevailing differences in micro-level dynamics, because we are using the same plant-level data source for all regions.

Table 5
The OLS estimates of total factor productivity level by using the matched plant-level data for manufacturing by region from 1988 to 1999

	Model 1	Model 2	Model 3
Uusimaa	0.103***	0.131***	0.128***
	(0.012)	(0.013)	(0.012)
Western Finland	0.024**	0.041**	0.037**
	(0.011)	(0.001)	(0.010)
Northern Finland	0.017	0.014	0.004
	(0.016)	(0.015)	(0.016)
Eastern Finland (reference)			
Employees' attributes	No	Yes	Yes
Plants' age (five groups)	No	No	Yes
Industry effects	Interacted	Interacted	Interacted
Year effects	Interacted	Interacted	Interacted
Observations	41 299	41 299	41 299
R-squared	0.30	0.31	0.37

Robust standard errors are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The models are estimated from 1988 to 1999 in order to obtain information about the employees' attributes from Employment Statistics that was created in 1988. The models include education and age of employees along with the share of females in the population of plants as control variables. The reference group is males in age group 15–24 with comprehensive school education. The plants are classified to five age groups for additional control variables. The models 1–3 include year dummies interacted with 2- or 3-digit industries. In addition, the intercept terms included are not reported.

(Appendix: Table A2). This suggests that Uusimaa has experienced the most profound change in the competitive environment in the medium term, during a critical episode of sharply increasing disparities in regional productivity levels. Increasing exposure to international trade adds directly to the amount of dynamic competition in the region. We cannot exclude the possibility that the high level of agglomeration has reinforced the positive effects of increasing international trade on productivity dynamics in Uusimaa, based on our evidence.

8. Conclusions

By using plant-level data, large regional differences in productivity levels in manufacturing industries were found. For instance, the level of total factor productivity is roughly 10% higher in the province of Uusimaa, which is located in Southern Finland, compared with Eastern and Northern Finland. In addition, productivity dispersion between plants was found to be larger in Uusimaa than in Eastern Finland. When evidence was found of differences in the heterogeneity of plants between regions, micro-level dynamics of industry productivity growth were analysed by means of a decomposition method. Importantly, there are no statistically significant regional disparities in the average rate of productivity growth for continuing plants. However, the productivity-enhancing reallocation of resources within industries has been substantially stronger in Uusimaa compared with Eastern Finland. The same finding is obtained, irrespective of alternative gauges, for creative destruction (the between or entry components) and alternative measures of productivity (labour productivity or TFP). Hence, Schumpeterian creative destruction characterizes the micro-level dynamics of productivity growth in Uusimaa, which is the richest region. This process has led to an overall and long-lasting regional productivity growth difference in Finland during the past few decades.

Broadly speaking, the dynamic perspective on competition and efficiency appears to provide a suitable theoretical framework for understanding the prevailing regional disparities in productivity growth. The finding that productivity dispersion across plants within industries is higher in Southern Finland is in keeping with the perspective that dynamic competition is more intensive in Southern Finland. This might explain why plants use more productive equipment and methods in this high productivity region. In contrast, sluggishness in dynamic competition explains why plants are equipped with low productivity technologies in Eastern Finland.

Arguably, the differences in regional restructuring and dynamic competition have been induced by more fundamental forces. By excluding some candidates for factors that could account for the substantial differences in regional performance, such as the differences in the quality of the labour force in the population of plants, we did come to the tentative conclusion that the high level of agglomeration and increasing exposure to international trade have most likely supported more intensive restructuring and dynamic competition in Southern Finland. The prevalence of these effects is in line with the theoretical literature on reallocation. An in-depth analysis of the factors underlying the mechanisms of incessant micro-structural change and hence the sources of regional productivity differences is an important avenue for future research. Comprehensive plant-level data will be an invaluable tool in such work.

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Appendix A

Table A1
Background characteristics for the NUTS2 regions in Finland

	The level of GDP	Population	Employees
Uusimaa	141	1401362	753174
Southern Finland	94	1818384	719952
Väli-Suomi	83	703628	291043
Eastern Finland	75	678725	257098
Northern Finland	88	556933	219826

Notes: For the level of GDP per inhabitant in the year 2000, the European Union average (for 15 member countries) is standardized as 100 (Behrens, 2003). The population and number of employees for the year 2000 is taken from regional accounts produced by Statistics Finland.

Table A2
Background characteristics for manufacturing

Levels	PLANTS	PER	VAL	VAL/PER	EXP (%)
Year 1980					
Uusimaa	1442	110287	22	200	21.8
Western Finland	3931	317373	58	184	30.4

Table A2 (*continued*)

Levels	PLANTS	PER	VAL	VAL/PER	EXP (%)
Year 1980					
Eastern Finland	710	46621	8	168	34.6
Northern Finland	477	30895	6	185	22.6
Year 1990					
Uusimaa	1216	87753	31	356	22.2
Western Finland	3484	242711	77	316	35.0
Eastern Finland	673	39891	11	287	31.6
Northern Finland	465	28734	9	300	20.1
Year 1994					
Uusimaa	1048	66775	27	403	41.5
Western Finland	3144	195581	76	390	45.0
Eastern Finland	601	30712	12	392	40.7
Northern Finland	394	23103	11	457	32.1
Changes (%)					
Years 1980/1994					
Uusimaa	73	61	122	202	191
Western Finland	80	62	131	212	148
Eastern Finland	85	66	153	233	118
Northern Finland	83	75	185	247	142
Years 1980/1990					
Uusimaa	84	80	142	178	102
Western Finland	89	76	131	172	115
Eastern Finland	95	86	146	171	91
Northern Finland	97	93	151	163	89
Years 1990/1994					
Uusimaa	86	76	86	113	187
Western Finland	90	81	100	124	129
Eastern Finland	89	77	105	137	129
Northern Finland	85	80	122	152	160

PLANTS denotes the number of plants, PER the number of persons, VAL value added (in billions FMK in 1995 prices), VAL/PER value added per person (in 000s FMK in 1995 prices) and EXP is export per total deliveries.

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