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The micro-level dynamics of regional productivity growth: The source of divergence in Finland / Petri Böckerman* & Mika Maliranta**

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ABSTRACT

Productivity growth of the Finnish regions in 13 manufacturing industries is decomposed into micro-level sources by using plant-level data from 1975 to 1999. There are substantial regional differences in the intensity of productivity-enhancing restructuring. Dynamic competition is more intensive in Southern Finland, where the productivity level is also high. In contrast, plants located in Eastern Finland are equipped with low-productivity technologies owing to persistently sluggish micro-level dynamics. Productivity dispersion between plants within industries is greatest in Southern Finland. We argue that intensive experimentation is a more reasonable interpretation of this finding than large static X-inefficiency in this high productivity region.

1 Introduction

Productivity certainly matters. As Paul Krugman (1994) has put it: “Productivity isn’t everything, but in the long run it is almost everything”. The same view holds from the regional perspective, because a region’s ability to improve its living standards in the long run without transfers of economic resources from other regions depends on its ability to raise its output per available labour and other factors of production. Regional disparities in Finland are sharp by their nature. As the European Union average is standardized as 100, the level of GDP per capita is 141 in the province of Uusimaa, which is located in the southern part of the country and characterized by a high density of economic activity. This means that Uusimaa belongs to the club of the richest regions in the whole of the European Union. In contrast, by using the same measure, the level of GDP per capita is 75 in Eastern Finland (Behrens 2003). This study shows in detail that the pattern repeats itself in productivity. The aggregate picture of regional productivity has emerged from its plant-level roots. Indeed, the underlying regional disparities are helpful in learning about the micro-level dynamics of productivity growth emphasized by Boone (2000), Melitz (2002) and Aghion et al. (2002).

Plant-level data is rarely available for the regional analysis of economic performance. However, the regional approach provides tempting prospects for the analysis of the micro-level dynamics of economic growth at least for two reasons. Firstly, the role of labour market regulations and other institutional aspects has gained a lot of attention in the cross-country comparisons of productivity dynamics (see e.g., Barnes et al. 2001; Scarpetta et al. 2002; Nicoletti et al. 2003). In contrast, this study shows that there are large differences in the micro-level dynamics of productivity growth across regions within the same country that share the same institutions and similar regulations. Secondly, the differences in the data characteristics make it hard to conduct a reliable comparison of productivity dynamics across countries (see e.g., Baily and Solow 2001). While using the same plant-level data in the analysis of regions within the same country, data comparability problems can be largely bypassed.

The aim of this study is to characterize the evolution of productivity growth in the Finnish regions. More precisely, the regional productivity growth rates in the period from 1975 to 1999 are decomposed into micro-level sources. By doing this, the following empirical investigation fills an important gap in the earlier literature on regional dynamics. In particular, the study contributes to the very small body of literature on regional productivity that is based on micro-level evidence. In addition, the study makes use of matched employer-employee data to document the underlying regional productivity differences.

This study provides evidence for the perspective that regional disparities in restructuring have fundamentally shaped the evolution of regional productivity in Finland during the past few decades. This means that the framework of the representative firm is not an appropriate tool for understanding the regional productivity disparities. The elaboration of underlying plant-level dynamics starts by analysing productivity performance in the Finnish regions. In certain regions of Finland, the level of productivity is quite low and it cannot be explained by such factors as the industry structure or characteristics of the labour force. This study then advocates the perspective that there have been sustained regional differences in the magnitude of productivity-enhancing micro-level restructuring. This is the reason why, in certain regions, plants are equipped with low productivity technologies whereas, in some regions, plants have adopted high productivity technologies successfully. The empirical findings point out that there are deeply underlying differences in the competitive environment that are reflected in the renewal of technologies at the micro-level.

The study appears in eight sections. The second section outlines theoretical underpinnings. The third section surveys the earlier empirical literature. The fourth section introduces the applied productivity growth decomposition method. The fifth section contains a description of the plant-level data. The sixth section documents and characterizes the regional productivity disparities of the Finnish regions. The seventh section shows that the underlying differences in the reshuffling of the input shares among incumbent plants provide a coherent explanation for the regional disparities in productivity performance. The last section concludes.

2 Theoretical considerations

Competition is believed to be important for efficiency and productivity (see e.g., Caves 1992). However, it is essential to make a sharp distinction between two types of efficiency, and between two views on the nature of competition. The traditional view is that productivity is low because of X-inefficiency, i.e. production potentials determined by technology are utilized incompletely (see e.g., Leibenstein 1966; Caves 1992). This study advocates an alternative view, i.e. “Schumpeterian efficiency” or dynamic efficiency, that focus on the process of technological renewal instead of static efficiency in the use of current technology.

Quite analogously, Baldwin (1993) distinguishes two different conceptual approaches to the nature of competition. The static view is traditional and therefore more widely adopted. It focuses on the market structures. The intensity of competition is typically evaluated with indicators such as the number of firms, concentration, advertising ratios, etc. As a result, intensive static competition leads to a narrow dispersion of productivity across plants within industries. The alternative approach sees competition as a dynamic process. When one adopts the dynamic approach, measures of mobility of plants and workers provide a potentially useful indicator for the intensity of competitive pressure. Simultaneous occurrences of declines and rises within an industry suggest that there is a competitive struggle taking place. However, mobility is not an end in itself. It is of our interest only to the extent that it is beneficial to aggregate productivity performance, i.e. restructuring is productivity-enhancing.

The insight emphasised by Boone (2000) and advocated by Aghion et al. (2002) is that the intensity of dynamic competition can be assessed from the point of view as to how strict the relationship is between technical efficiency and profit level. According to this view, an increase in the competitive pressure will improve the competitive position of high productivity firms relative to low productivity ones. Similarly, we would expect that in a competitive environment, high productivity plants and firms have high labour demand in relative terms, i.e. there is a strict relationship between the productivity level and net job creation. This means that high productivity plants increase their share of labour usage. As a result, competitive pressure is positively associated with the productivity-enhancing restructuring.

Decomposition of productivity growth into its micro-level sources makes it possible to evaluate the underlying nature of adjustment in market economies in detail. Marshall’s framework of the representative firm is implicitly advocated in a number of textbooks that provide a discussion on regional growth (see e.g., McCann 2001). This perspective assumes that the rate of growth in productivity is identical across firms. Firms experience productivity growth owing to disembodied technological change, retooling or a decrease in X-inefficiency. Improvement in productivity is therefore achieved within firms (and their plants). Productivity growth therefore involves internal restructuring. The total absence of heterogeneity among firms implied by the framework of the representative firm means that this internal restructuring of firms captures the dynamics of productivity growth entirely.

The alternative approach stresses the underlying heterogeneity of adjustment at the micro-level. This feature implies that there is an important role for creative destruction à la Schumpeter (1942). In particular, Boone (2000) and Aghion et al. (2002) state that an increase in competitive pressure may encourage innovation. Firms improve their productivity by adapting new technologies. A more frequent emergence of new technologies, stimulated by increased dynamic competition, can be expected to lead to greater experimentation. However, there are a number of reasons why some firms cannot, fail or do not want to implement new technologies (see e.g., Greenwood and Jovanovic 2001). For this reason, intensive dynamic competition is consistent with the presence of wide dispersion of productivity and underlying heterogeneity across plants within industries.

Dynamic competition immediately stimulates the innovation and implementation of new technologies. However, it takes time before the fruits of these actions can be observed in productivity. In particular, this type of competition involves selection and resource reallocation, which is time-consuming as well. Thus, the consequences of increased dynamic competition can be expected to be more gradual and longer-lasting than increased competition in the static sense. These points mean that the productivity growth of a whole industry often involves an important external adjustment that is realized via productivity-enhancing restructuring between plants.

3 Previous related studies

There are a great number of non-Finnish empirical studies that have investigated the plant-level components of the aggregate productivity growth rate (see e.g., Bartelsman and Doms 2000, and Foster et al., 2001). These studies tend to underline the enormous heterogeneity among plants. For instance, Haltiwanger (1997) reports that 4-digit industry effects can explain less than 10 per cent of the overall variation in productivity across establishments in the U.S. from 1977 to 1987. In addition to the underlying heterogeneity among plants, there is a well-documented stylized feature according to which the reallocation of resources plays an important role in the movement of aggregate productivity growth. However, these notions of the literature have not been extended to take into account the regional dimension of economic growth.[1]

The earlier Finnish research into the determination of regional productivity can be summarized in a nutshell as follows. Maliranta (1997a) observes selected fundamental patterns of regional productivity for manufacturing. Maliranta (1998) shows that plants' productivity is positively associated with the productivity performance of the rest of the plants in the same region within the same industry when a number of other factors are taken into account. The finding can be interpreted as evidence of local spillover and agglomeration effects. These effects are particularly important for young plants. Lehto (2000) discovers that investments in R&D have large regional impacts on productivity in the Finnish regions. Böckerman (2002) documents that ICT manufacturing yields an increase in regional labour productivity in Finland. Kangasharju and Pekkala (2001) report that there was an increase in regional disparities in labour productivity across the Finnish regions during the 1990s. In addition, they discover that the manufacturing industries have been the most important segment of the Finnish economy in the increase of regional disparities. In particular, this pattern provides the motivation to focus on manufacturing in decompositions of productivity growth.

4 Empirical strategy

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

$$P_t = \frac{Y_t}{X_t} = \frac{\sum_i Y_{it}}{\sum_i X_{it}}, \qquad (1)$$

where Y is output, X is input and i 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. We use the simple Cobb-Douglas formula:

$$X = \prod_j X_j^{\alpha_j} , \qquad (2)$$

where j denotes input type and α is a parameter. We require that $\sum_j a_j = 1$. This means that constant returns to scale are imposed in the computation of TFP. Indeed, there is econometric evidence for the perspective that the assumption of constant returns to scale is not unreasonable at the plant level (see e.g., Baily et al., 1992; Dwyer 1998). Our input index includes labour (L) and capital (K). Thus, total input is a weighted geometric average of labour and capital. Parameter α_L is defined as 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. TFP can then be expressed as TFP=exp(α_L *ln(Y/L)+(1-α_L)*ln(Y/K)). In other words, TFP can be measured as a weighted geometric average of labour and capital productivity.

An advantage of the labour productivity measure is that it is closely related to the most commonly used measure of living standards, which is gross national product divided by the number of inhabitants. In addition, measurement of labour productivity does not require information about other factors of production. However, TFP provides a more comprehensive measure of economic performance than labour productivity, because TFP takes into account the efficiency of capital input usage that is evidently an important element of competitiveness. A problem with TFP is that it requires the measurement of capital input, a task which is plagued with various troubles.

In this study we focus on the sources of productivity growth. We calculate the annual aggregate productivity growth rate in year t by using the following formula:

$$\frac{\Delta P_t}{\overline{P}_t} = \frac{P_t - P_{t-1}}{\left(P_t + P_{t-1}\right)/2} . \qquad (3)$$

This provides a very close approximation to the log-difference of aggregate productivity that is commonly used in the analysis of aggregate productivity growth. We focus on the micro-level components of productivity growth among continuing plants (i.e. we use successive, pair-wise balanced panels).[2] Then our measure of aggregate productivity (AGG) change can be broken down into various additive components in the following way:

$$\frac{\Delta P_t^C}{\overline{P_t^C}} = \sum_{i \in C} \overline{w}_{it} \frac{\Delta P_{it}}{\overline{P}_{it}} + \sum_{i \in C} \Delta w_{it} \frac{\overline{P}_{it}}{\overline{P}_t^C} + \sum_{i \in C} \overline{w}_{it} \left(\frac{\overline{P}_{it}}{\overline{P}_t^C} - 1 \right) \frac{\Delta P_{it}}{\overline{P}_{it}}, \qquad (4)$$

where C (continuing plants) denotes that only those plants are included in the calculations that are observed both in year t and t-1. The weight of plant i (w_{it}) is the plant's input share, i.e. $w_{it} = X_{it}/\Sigma X_{it}$. In this decomposition formula the average share in the initial and final year is used (indicated by $\overline{w}_{it}$).

The first term in the right-hand side of the equation (4) indicates the productivity growth rate within plants (WH). The within component is simply the input-weighted average productivity growth rate of the continuing plants. As stressed earlier, the framework of the representative firm assumes that all productivity growth takes place within firms or plants.

The second term, the between component (BW), is the main focus of this study. 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. Fig. 1 provides an illustration of the between component in a region and in an industry which has three plants. The size of a ball indicates the amount of input usage. Here the level of productivity is assumed constant within each plant. The aggregate productivity level, which is an input-weighted average of the plant productivity levels, rises, as is indicated by an upward sloping dashed line. This is because weights (input shares) change, owing to reallocation of inputs from the low productivity plant to the high productivity plant.

The earlier empirical literature has discovered a strong correlation between firm (and plant) exit and low productivity (see e.g., Maliranta 1997a; Bartelsman and Doms 2000; Foster et al. 2001). Indeed, there are several arguments for the perspective that the between component is a more suitable indicator for the process of creative destruction à la Schumpeter (1942) than net entry. There is a limited role for the entry and exit of plants in the determination of productivity growth. Böckerman and Maliranta (2001) report that the entry and exit of plants covers about 2-3% of all employees in the Finnish regions each year. Entries and exits typically account for 10-20 percent of total job creation and job destruction in manufacturing (Davis et al. 1996). This means that micro-level restructuring is mainly driven by continuing plants.

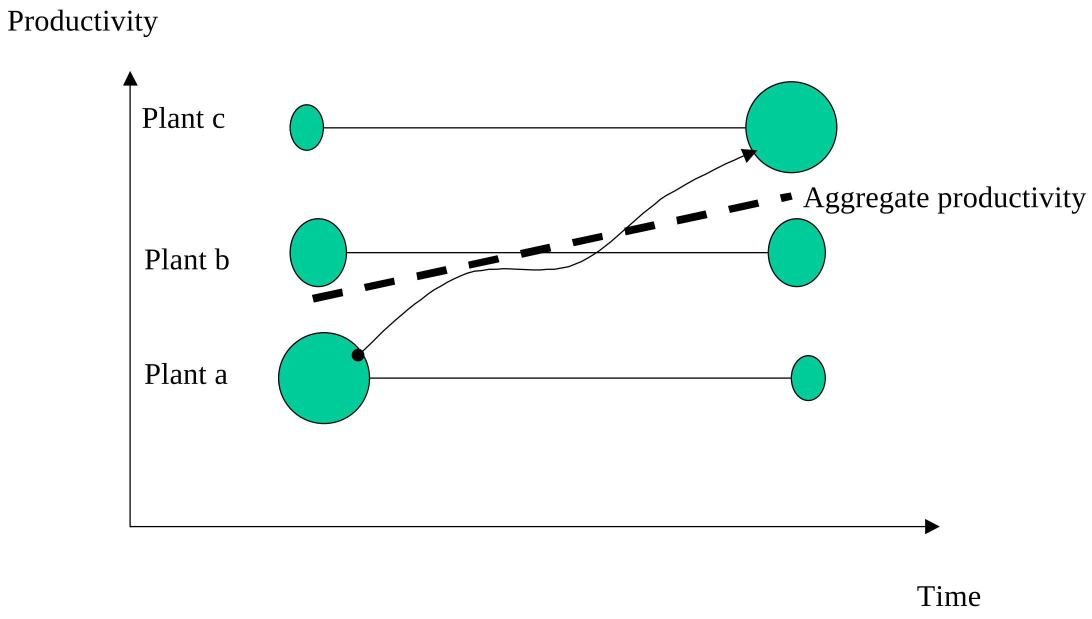
Decomposition methods of productivity assume that entries and exits of plants are one-time events by their nature. However, Maliranta (1997a) has shown that the labour productivity of new plants relative to existing ones in Finnish manufacturing increases over time and reaches its highest level in a decade (for additional non-Finnish evidence, see e.g., Jensen and McGuckin 1997; Dwyer 1998). The employment share of new plants also grows over time. An important feature is that among the existing plants there is a "shadow of death" effect, documented by Griliches and Regev (1995) in Israeli manufacturing and by Maliranta (1998) in Finnish manufacturing. This means that the relative productivity of plants starts falling as early as several years before exit while, at the same time, their employment share falls. Thus, it is not at all surprising that Maliranta (2001; 2003) has found a strong positive relationship in the patterns of the exit and the between component in Finnish manufacturing.[3]

Another reason for preferring the between component for the measure of productivity-enhancing restructuring instead of net entry is that there are always inaccuracies when identifying entries and exits of plants in the comprehensive data sets. Entries and exits observed in data include true as well as some artificial births and deaths, possibly in somewhat varying proportions. The series of the entry and exit components can therefore be argued to be subject to less reliability.[4]

It is worth noting that the between component may be linked to the changes in the productivity dispersion when the dispersion is measured with input weights. Input weighted productivity dispersion declines if there is a cleansing effect in operation at the left-hand tail of the productivity dispersion. Then the productivity dispersion narrows. As this type of reallocation of resource shares is reflected as a positive between component, we might expect a negative correlation between the change in the productivity dispersion and the between component.[5]

The last component in the equation (4) can be called the catching-up component (CH).[6] 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 catch up with the high productivity ones, thanks to the above-average productivity growth rate. Therefore, it can be used as an indicator of the productivity convergence. In particular, the catching-up component captures the convergence to the best practice in the group. (In this study the group consists of the plants operating in the same industry and in the same regions.) In other words, negative values should predict narrowing productivity dispersion (for Finnish manufacturing evidence, see Maliranta 2001). 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 catching-up component can be expected to be low when the productivity-improving adjustment among low-productivity plants is common.

Fig. 1. An illustration of the between component in a region of three plants. The dashed line indicates the evolution of the aggregate productivity of the region. The magnitude of the balls shows the amount of input usage in each of the plants.



5 The data

The measures for the productivity growth rates and micro-structural components of aggregate productivity growth are calculated by using plant-level panel data constructed especially for economic research purposes. The data is based on the Annual Industrial Statistics surveys that basically cover all Finnish manufacturing plants employing at least five persons up to 1994. Since 1995 it includes all plants owned by firms that have no fewer than 20 persons. As for robustness checks, Maliranta (2001; 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.

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 2- or 3-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 (for Finnish manufacturing evidence, see Maliranta 2001).

Labour input is measured by total hours worked. For TFP indicator we use capital stock estimates, which are constructed from each plant's past investments by using the perpetual inventory method (PIM).[7] The assumed depreciation rate is 10%.[8] 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 as 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.[9]

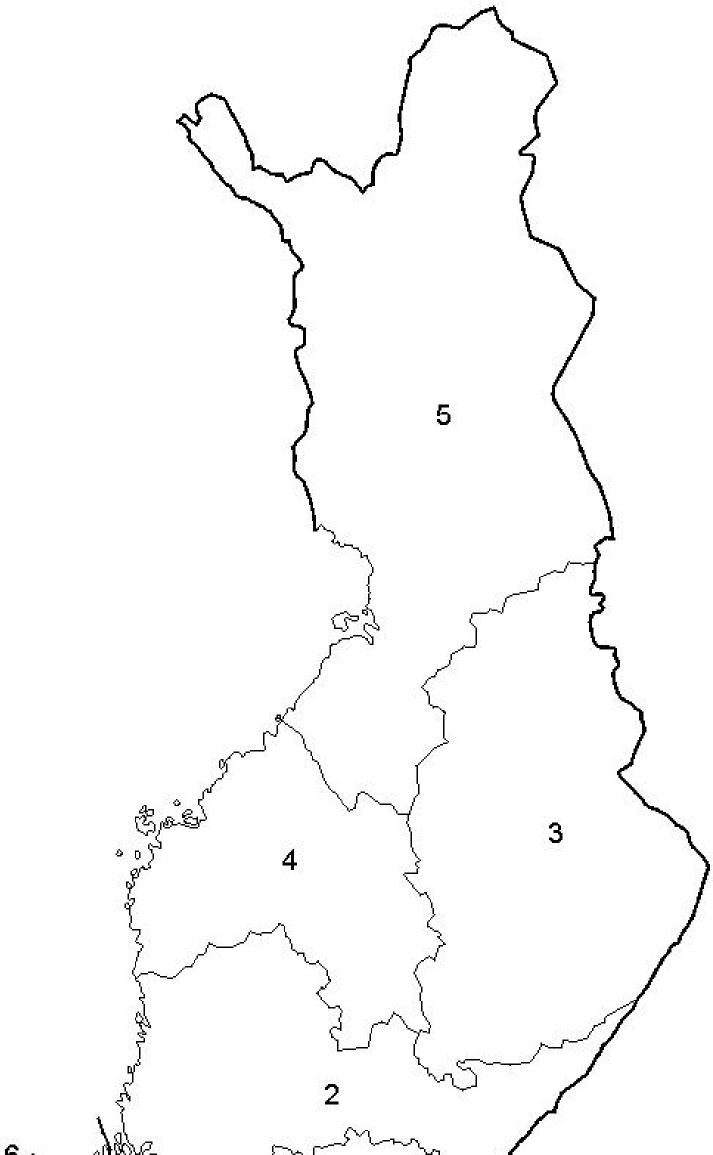
The study provides estimation results that control for the effects of labour characteristics on plant productivity. The data on employee characteristics for the population of plants in manufacturing is obtained from Employee Statistics, which in principle cover the whole working age population. The employees can be matched to plants based on information on their primary employer in the last week of the year (Ilmakunnas et al. 2001). We have calculated the following employees' characteristics for the population of plants: education and field of education (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 the plants (the share of females).

The estimated regression models include dummies for 2- or 3-digit industries that are interacted with year dummies. By doing 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 between 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 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. 2 shows the geographic location of the provinces. However, the province of Åland (region '6' in Fig. 2) is excluded from the analysis of regional productivity disparities, because the small number of plants on this island community means that the measures of micro-level productivity would be not reliable. In addition, one of the regions of NUTS2-level called "Väli-Suomi" (in Finnish), (region '2' in Fig. 2) is combined with the province of Western Finland (region '4'). Our investigations have revealed that the level of productivity in these provinces 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 alternating the picture of productivity of the Finnish regions. Thus, this study is based on the division of Finland into four regions. The province of Eastern Finland is chosen to be the reference group in the presentation of the estimation results.

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 on the differences between regions and patterns over time we have aggregated industry-specific results by using industry-input shares of 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 1975-99.[10]

Fig. 2. The location of the provinces in Finland. The provinces of Finland are as follows: 1=Uusimaa, 2+4=Western Finland, 3=Eastern Finland and 5=Northern Finland.



6 Regional productivity differences

Regional disparities in productivity are substantial, based on plant-level data. The Finnish regions can be classified into three groups in terms of the level of TFP. The regressions show that the level of TFP is definitely highest in the province of Uusimaa (Table 1). In particular, the level of TFP is about 11% higher in the province of Uusimaa compared with Eastern and Northern Finland. In this respect, the results are quite similar to those obtained by Maliranta (1998), who used somewhat different models. The second highest level of TFP is reached in Western Finland. The level of TFP is about 7% higher in Western Finland compared with Eastern and Northern Finland. This means that Eastern and Northern Finland belong to the third group of the regional productivity pattern.

The estimation results remain essentially the same after taking into account several additional controls with an application of matched plant-level data (Table 2). Thus, these results indicate that the level of TFP is roughly 13% higher in the province of Uusimaa compared with Eastern and Northern Finland. An application of matched plant-level data underlines the fact that the differences in labour characteristics fail to provide an explanation for regional productivity disparities. The high level of productivity in the province of Uusimaa is therefore not explained by the quality of the labour force in this region. After the plant vintage effect is controlled, the productivity gap diminishes to some extent. It can be inferred from the results that there are more young high-productivity plants in the province of Uusimaa.

According to these estimates, manufacturing plants that are located in Eastern and Northern Finland need more than ten per cent more labour and capital input in the production of a given amount of output compared with plants in the province of Uusimaa. This difference is substantial by its nature, because it converts into the difference of equal magnitude in living standards in the long run without transfers of economic resources from the province of Uusimaa to the rest of the regions.

7 Decomposition of regional productivity growth

The conventional explanations for productivity gaps between regions refer to local spillovers, X-inefficiency and agglomeration (see e.g., Gerking 1994; Ciccone and Hall 1996; Ciccone 2002). For instance, 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 to fat-trimming and decrease X-inefficiency. Both knowledge spillovers and X-inefficiency considerations yield a prediction that agglomeration yields compressed productivity dispersion between plants within industries. Further, increased agglomeration can be expected to lead to higher within firm productivity growth. Of course, agglomeration can be a consequence of the fact that certain regions are, for some reason or another, favourable for gaining high productivity. This study argues that agglomeration affects competitive environment in its dynamic meaning. This means that agglomeration is likely to lead to greater innovation, experimentation and selection. This particular perspective can be evaluated by analysing the micro-level dynamics of productivity growth by using the decomposition method.

The earlier empirical literature has discovered that improvements within plants or firms tend to be an important micro-level component of productivity growth (see e.g., Foster et al., 2001). The Finnish evidence reported in Table 3 (labour productivity) and Table 4 (TFP) is broadly in line with this perspective. It is worth noting, however, that the between component is about as influential as the within component in the TFP decompositions. This proves the importance of capturing capital input in addition to labour input.

Certain patterns are worth noting. Firstly, the within-plants component typically constitutes 50-80 per cent of aggregate productivity growth, which is a tremendous departure from the 100 per cent implied by the framework of the representative firm. Secondly, the cyclical variation of the within component is quite large, especially in TFP case. Instead, the between component exhibits a much smoother pattern over time. This means that comparisons are more reliable with the latter indicator. Thirdly, as stressed earlier, the between component is highly interesting in terms of regional growth dynamics, because it captures the Schumpeterian creative destruction that reallocates resources between heterogeneous plants. Fourthly, the negative values of the catching-up component of TFP growth are in line with the conjecture that there has been some convergence in performance through the above-average growth rates among low productivity plants.[11]

From the regional perspective, it is interesting to observe that the productivity evolution of Eastern and Northern Finland is not characterized by the low within plants productivity growth rates. In fact, the within component of Eastern Finland has been comparable to that of Uusimaa and Western Finland. Indeed, regression estimations fail to indicate any statistically significant differences in the within component across regions (Table 5). This feature means that the framework of the representative firm is, based on the plant-level evidence, entirely useless for understanding regional disparities of productivity in the Finnish regions.

In sharp contrast, regression estimations reveal that the between component of productivity growth decomposition has a clear regional dimension (Table 6). In particular, we obtain statistically significant support for the perspective that productivity-enhancing restructuring has been more intensive in the province of Uusimaa and Western Finland compared with Eastern Finland. 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 the large standard error means that the estimated coefficient is not statistically significant. All in all, micro-level restructuring has been proven to be intensive in those regions where the level of productivity is also high. Thus, there is empirical evidence for the perspective that differences in micro-level dynamics of productivity growth have been an important economic fundamental that is behind the regional productivity disparities of the Finnish regions.

Figs. 4 and 5 illustrate the cumulative effects of the Schumpeterian process in the Finnish regions since 1975.[12] We see that micro-level restructuring had little effect on labour productivity growth in all four regions up to the mid-’80s. The mid-’80 constituted a turning point in regional productivity dynamics. The 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. Fig. 4 shows that the between component contributed aggregate labour productivity by 20 per cent in the province of Uusimaa during the period 1975-1999, whereas the corresponding amount for Eastern and Northern Finland is 7 per cent. Fig. 5 reveals the cumulative effect was clearly higher for TFP: 31 per cent in Uusimaa and 15 per cent in Eastern Finland. In addition, Fig. 5 indicates that the effect has been substantial for Northern Finland. However, one third of the cumulative effect comes from two 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 6. The conclusion concerning the sluggishness of the micro-level dynamics in manufacturing plants located in Eastern Finland is very robust, however.

The dispersion of productivity levels (measured by the input-weighted standard deviation of logarithm of productivity across plants) by region reveals an important additional aspect of the dynamics of productivity growth. In particular, the magnitude of dispersion in productivity across plants within industries is higher in the province of Uusimaa (Table 7). Labour productivity and the TFP measure lead to the same conclusion. The observation is in disagreement with the conventional argumentation based on 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 (see e.g., Caves 1992). However, the high level of dispersion in productivity across plants within industries in the province of Uusimaa is consistent with the perspective that intensive dynamic competition stimulates innovation and experimentation among plants in this high productivity region (see e.g., Boone 2000; Aghion et al. 2002).

The cumulative effects of restructuring revealed that the latter part of the 1980s constituted a turning point in regional productivity dynamics. Productivity-enhancing restructuring started to sour in Uusimaa and the productivity gap between Uusimaa and Eastern Finland started to expand. At those times, the deregulation of capital markets begin and the exposure to Western markets by Finnish companies started to increase. Indeed, Caballero and Hammour (2000) emphasise the functioning of capital markets for creative destruction. Liberalization of international trade changed the competitive environment in a deep-going way. In particular, the theoretical model by Melitz (2002) indicates that an increase in industry’s exposure to trade will lead to inter-firm reallocations towards more productive firms. Moreover, the latter part of the 1980s was the beginning of an era of successive, centralized collective agreements in the Finnish labour markets, whose coverage and tenability was high (Marjanen 2002). Collective bargaining involved aims to wage compression. Hibbs and Locking (2000) stress that wage compression has stimulated the inter-firm reallocation of resources in Sweden. Maliranta (2003) argues that collective agreements have increased job destruction among low productivity plants in Finnish manufacturing and, at the same time, increased labour demand in high productivity plants yielding productivity-enhancing reallocation of labour input between heterogeneous plants.

However, it is worth noting that the institutional changes concerned all regions and, as such, fail to provide an explanation for the widening gap between Southern and Eastern Finland in the intensity of productivity-enhancing micro-level restructuring. On the other hand, of course, trade liberalization can be expected to have shaped the competitive environment differently across regions. Interestingly, the export share was highest in Eastern Finland in the 1980s (Appendix 1), which may reflect its particular industry structure. However, an increase in export exposure was clearly highest in Uusimaa from 1980 to 1994 and clearly lowest in Eastern Finland. These findings suggest that the province of Uusimaa has indeed experienced the most profound change in the competitive environment in the medium term. The change in the functioning of capital markets need not be similar in all regions, either. In particular, Hyytinen and Toivanen (2002) argue that there are still substantial differences in capital markets between regions. Extensive subsidies to Eastern Finland may have insulated those regions from productivity-stimulating selection, even though increased exposure to international competition in product markets, wage compression and market-orientated capital markets may be totally effective in itself. Thus, even though the available evidence seems somewhat more supportive for the explanations emphasizing product market competition, productivity-stimulating effects arising from capital markets cannot be totally ruled out, either.

Fig. 4. The cumulative effect of the between component on the labour productivity of the Finnish regions.

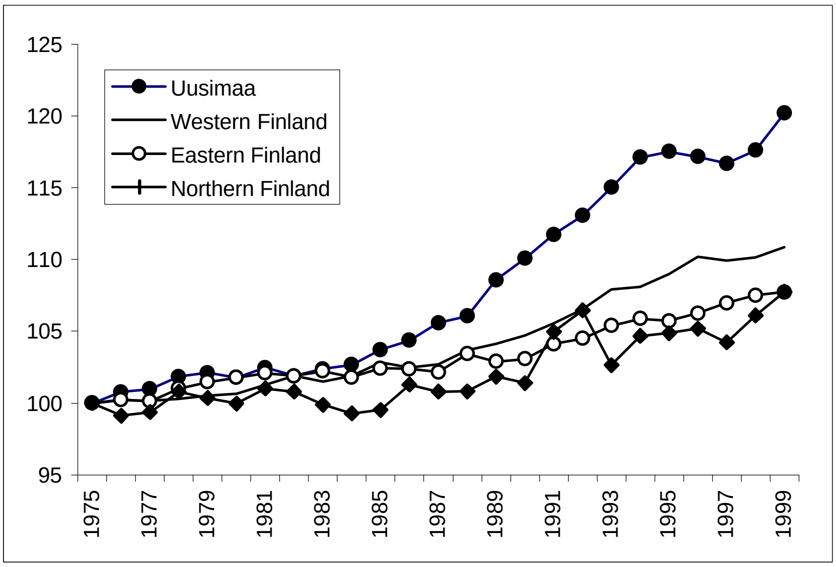
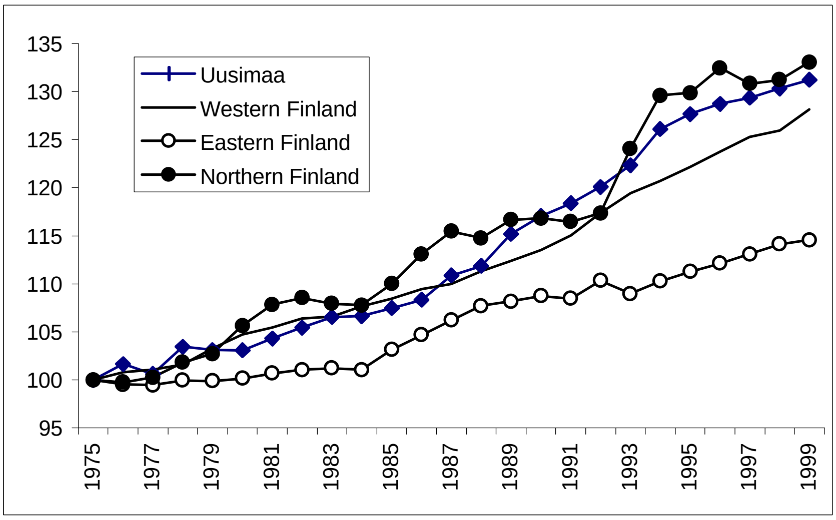


Fig. 5. The cumulative effect of the between component on the total factor productivity of the Finnish regions.



8 Conclusions

The evidence obtained by using plant-level data shows that there are large disparities in productivity performance in manufacturing in the Finnish regions. The level of total factor productivity is roughly 13% higher in the province of Uusimaa, which is located in Southern Finland, compared with Eastern and Northern Finland after taking into account several plant-level controls. In particular, an application of matched plant-level data shows that the differences in labour characteristics fail to provide an explanation for the regional productivity disparities of the Finnish regions.

This study has sought the source of these regional disparities from the micro-level dynamics of productivity growth. The productivity growth rates of manufacturing in the Finnish regions were decomposed into their micro-level sources. The within component of aggregate productivity growth fails to have a regional dimension. This feature implies that the framework of the representative firm is entirely useless for understanding regional disparities of productivity in Finland. In contrast, the productivity-enhancing reallocation of resources in manufacturing has been substantially stronger in Uusimaa and Western Finland, which outperform in terms of productivity level. This means that Schumpeterian creative destruction characterizes the micro-level dynamics of productivity growth in these high productivity regions.

A dynamic perspective on competition and efficiency appears to provide an explanation for the Finnish regional disparities. Dynamic competition involves aims to ‘escape the competition’ à la Aghion et al. (2002) by innovation as well as experimentation yielding wide productivity dispersion across plants within industries. The plant-level evidence indicates that there are indeed significant regional differences in dynamic competition. In particular, the fact 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 explains why plants use more productive equipment and methods in Southern Finland. In contrast, sluggishness in dynamic competition explains why plants are equipped with low productivity technologies in Eastern Finland.

Moreover, agglomeration of economic activity increases competition, as emphazised by Boone (2000), and accentuates the importance of a high productivity level for survival. Agglomeration can be expected to stimulate dynamic competition and improve aggregate productivity through selection (Melitz 2002). These effects fit nicely into the regional picture of productivity disparities, because the density of economic activity is substantially higher in Southern Finland compared with Eastern and Northern Finland.

The time pattern and the regional differences in the intensity of productivity-enhancing restructuring suggest that the liberalization of international trade and the increased exposure to global competition have affected the micro-level dynamics of regional productivity growth. However, there are reasons to believe that the functioning of capital markets is essential for technological renewal at the micro level as well. The role of different institutions in the process of creative destruction certainly deserves further empirical studies from the regional perspective.

References

Aghion P, Bloom N, Blundell R, Griffith R, Howitt P (2002) Competition and innovation: an inverted U relationship. Working Papers 04/02. The Institute for Fiscal Studies

Baily MN, Hulten C, Campbell D (1992) Productivity dynamics in manufacturing plants. *Brookings Papers on Economics Activity* Microeconomics: 187-267

Baily MN, Solow RM (2001) International productivity comparisons built from the firm level. *Journal of Economic Perspectives* 15: 151-172

Baldwin, JR (1993) *The Dynamics of Industrial Competition. A North American Perspective.* Cambridge University Press, Cambridge

Barnes M, Haskel J, Maliranta M (2001) The sources of productivity growth: micro-level evidence for the OECD. Unpublished. OECD

Bartelsmans EJ, Doms M (2000) Understanding productivity: lessons from longitudinal microdata. *Journal of Economic Literature* 38: 596-594

Behrens, A (2003) Regional gross domestic product in the European Union 2000. Statistics in Focus. Theme 1 – 1/2003. Eurostat

Bernard AB, Jones CI (1996) Productivity across industries and countries: time series theory and evidence. *The Review of Economics and Statistics* 78: 135-145

Boone J (2000) Competitive pressure: the effects on investments in product and process innovation. *RAND Journal of Economics* 31: 549-569

Böckerman P, Maliranta M (2001) Regional disparities in gross job and worker flows in Finland. *Finnish Economic Papers* 14: 83-104

Böckerman P (2002) Understanding regional productivity in a Nordic welfare state: does ICT matter? *Studies in Regional Science* 32: 57-73

Caballero RJ, Hammour ML (2000) Creative destruction and development: institutions, crises, and restructuring. Working Papers 7849. National Bureau of Economic Research

Ciccone A (2002) Agglomeration effects in Europe. *European Economic Review* 46: 213-227

Ciccone A, Hall RE (1996) Productivity and the density of economic activity. *The American Economic Review* 86: 54-70

Caves, RE (1992) *Industrial Efficiency in Six Nations.* The MIT Press, Cambridge MA

Davis SJ, Haltiwanger J, Schuh S (1996) *Job Creation and Destruction.* The MIT Press, Cambridge MA

Dwyer, DW (1998) Technology locks, creative destruction, and nonconvergence in productivity levels. *Review of Economic Dynamics* 1: 430-473

Foster L, Haltiwanger J, Krizan CJ (2001) Aggregate productivity growth: lessons from microeconomic evidence. In: Hulten CR, Dean ER, Harper MJ (eds) *New Developments in Productivity Analysis. Studies in Income and Wealth Volume 63.* The University of Chicago Press, Chicago

Gerking, S (1994) Measuring productivity growth in US regions: a survey. *International Regional Science Review* 16: 155-186

Greenwood J, Jovanovic B (2001) Accounting for growth. In: Hulten CR, Dean ER, Harper MJ (eds) *New Developments in Productivity Analysis. Studies in Income and Wealth Volume 63.* The University of Chicago Press, Chicago

Griliches Z, Regev H (1995) Productivity and firm turnover in Israeli industry: 1979-1988. *Journal of Econometrics* 65: 175-203

Haltiwanger, JC (1997) Measuring and analyzing aggregate fluctuations: the importance of building from microeconomic evidence. *Federal Reserve Bank of St. Louis:* May/June, 55-77

Hibbs DA Jr, Locking H (1996) Wage dispersion and productive efficiency: evidence for Sweden. *Labour Economics* 18: 755-782

Hyytinen A, Toivanen O (2002) Do financial constraints hold back innovation and growth? Evidence on the role of public policy. Discussion Papers 820. The Research Institute of the Finnish Economy

Ilmakunnas, P, Maliranta M, Vainiomäki J (2001) Linked employer-employee data on Finnish plants for the analysis of productivity, wages and turnover. In: Jensen TP, Holm A (eds) *Nordic Labour Market Research on Register Data.* Nordic Council of Ministers, Copenhagen

Jensen JB, McGuckin RH (1997) Firm performance and evolution: empirical regularities in the U.S. microdata. In: Laaksonen S (ed) *The Evolution of Firms and Industries.* Statistics Finland, Helsinki

Kangasharju A, Pekkala S (2001) Regional economic repercussions of an economic crisis: a sectoral analysis. Discussion Papers 248. Government Institute for Economic Research

Kiander J, Vartia P (1996) The great depression of the 1990s in Finland. *Finnish Economic Papers* 9: 72-88

Krugman P (1994) *The Age of Diminished Expectations.* The MIT Press, Cambridge, MA

Lehto E (2000) Regional impacts of R&D and public R&D funding. Studies 79. Labour Institute for Economic Research

Leibenstein, H (1966) Allocative efficiency and versus X-efficiency. *The American Economic Review* 56: 392-415

Mairesse J, Kremp E (1993) A look at productivity at the firm level in eight French service industries. *Journal of Productivity Analysis* 4: 211-234

Maliranta M (1997a) Plant productivity in the Finnish manufacturing. Characteristics of high productivity plants. Discussion Papers 612. The Research Institute of the Finnish Economy

Maliranta M (1997b) Plant level explanations for the catch up process in Finnish manufacturing: a decomposition of aggregate labour productivity growth. In: Laaksonen S (ed) *The Evolution of Firms and Industries. International Perspectives*. Statistics Finland, Helsinki

Maliranta M (1998) Factors of performance by plant generations. Some findings from Finland. In: Biffignandi S (ed) *Micro- and Macrodata of Firms. Statistical Analysis and International Comparison*. Physica-Verlag, Heidelberg

Maliranta M (2001) Productivity growth and micro-level restructuring. Finnish experiences during the turbulent decades. Discussion Papers 757. The Research Institute of the Finnish Economy

Maliranta M (2002) From R&D to productivity through micro-level restructuring. Discussion Papers 795. The Research Institute of the Finnish Economy

Maliranta M (2003) Micro-level dynamics of productivity growth. An empirical analysis of the great leap in the Finnish manufacturing productivity in 1975-2000. Forthcoming. The Research Institute of the Finnish Economy

Marjanen, R (2002) Palkkaratkaisujen sisältö ja toteutuminen tulopoliitikan aikakaudella (In Finnish). Series B 188. The Research Institute of the Finnish Economy

McCann, P (2001) *Urban and Regional Economics.* Oxford University Press, Oxford.

Melitz MJ (2002) The impact of trade on intra-industry reallocations and aggregate industry productivity. Working Papers 8881. National Bureau of Economic Research

Nicoletti G, Scarpetta S (2003) Regulation, productivity and growth: OECD evidence. Working Papers 347. OECD

Rigby DL, Essletzbichler J (2000) Impacts of industry mix, technological change, selection and plant entry/exit on regional productivity growth. *Regional Studies* 35: 333-342

Scarpetta S, Hemmings P, Tressel T, Woo J (2002) The role of policy and institutions for productivity and firm dynamics: evidence from micro and industry data. Working Papers 329. OECD

Schumpeter JA (1942) *Capitalism, Socialism, and Democracy.* Harper and Row, Harvard

Table 1. The OLS estimates of labour productivity (lnlp) and total factor productivity level (lntfp) for Finnish manufacturing by region from 1975 to 1999.

	Lnlp	Lnlp	Lntfp	Lntfp
Uusimaa	0.101	0.101	0.111	0.113
	(0.015)***	(0.015)***	(0.017)***	(0.016)***
Western Finland	0.026	0.027	0.069	0.071
	(0.013)**	(0.013)**	(0.014)***	(0.014)***
Northern Finland	0.061	0.057	-0.015	-0.016
	(0.023)***	(0.021)***	(0.024)	(0.023)
Eastern Finland (reference)				
Industry effects	Yes	Interacted	Yes	Interacted
Year effects	Yes	Interacted	Yes	Interacted
Observations	1248	1248	1248	1248
Adjusted R-squared	0.96	0.97	0.95	0.96

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

Table 2. The OLS estimates of total factor productivity level by using matched plant-level data for Finnish manufacturing by region from 1988 to 1999.

	Model 1	Model 2	Model 3
Uusimaa	0.103*** (0.012)	0.131*** (0.013)	0.128*** (0.012)
Western Finland	0.024** (0.011)	0.041** (0.001)	0.037** (0.010)
Northern Finland	0.017 (0.016)	0.014 (0.015)	0.004 (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	41299	41299	41299
R-squared	0.30	0.31	0.37

Notes: 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 Employee Statistics. Thus, the models include education and age of employees along with the share of females in the population of plants as control variables. The plants are classified into 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.

Table 3. The decomposition of labour productivity growth rates among incumbents for Finnish manufacturing, annual averages, %.

	1976-1980	1981-1985	1986-1990	1991-1994	1995-1999	1976-1999
Uusimaa						
AGG	2.5	3.3	6.0	0.9	4.3	3.4
WH	2.0	2.6	4.8	-0.3	3.7	2.5
BW	0.4	0.4	1.2	1.3	0.6	0.8
CH	0.2	0.3	0.0	-0.1	0.0	0.1
Western Finland						
AGG	3.9	3.8	5.3	1.0	4.3	3.6
WH	3.8	3.0	4.7	0.4	2.7	2.9
BW	0.1	0.4	0.4	0.8	0.4	0.4
CH	0.0	0.3	0.2	-0.2	1.1	0.3
Eastern Finland						
AGG	2.6	3.9	5.4	2.7	1.5	3.3
WH	2.7	3.3	5.2	1.3	1.1	2.8
BW	0.4	0.1	0.1	0.5	0.5	0.3
CH	-0.4	0.4	0.1	0.9	-0.1	0.2
Northern Finland						
AGG	3.2	2.0	6.8	4.3	4.6	4.2
WH	2.8	2.0	6.5	3.7	3.8	3.8
BW	0.0	-0.1	0.4	0.7	0.7	0.3
CH	0.4	0.1	-0.1	-0.1	0.1	0.1

Notes: Computations are made separately for 13 manufacturing industries. Industry-level results are aggregated for each region by using the industry structure of hours worked in Finnish manufacturing.

Table 4. The decomposition of TFP growth rates among incumbents for Finnish manufacturing, annual averages, %.

	1976-1980	1981-1985	1986-1990	1991-1994	1995-1999	1976-1999
Uusimaa						
AGG	-0.5	-0.1	2.7	-0.6	5.8	1.3
WH	0.1	-0.6	1.5	-1.0	5.8	1.0
BW	0.6	0.8	1.7	1.7	0.7	1.1
CH	-1.1	-0.4	-0.5	-1.3	-0.7	-0.8
Western Finland						
AGG	1.3	0.3	1.7	0.8	3.1	1.3
WH	1.5	-0.3	1.4	0.5	2.1	1.0
BW	0.9	0.7	0.9	1.5	1.2	1.0
CH	-1.1	-0.1	-0.6	-1.2	-0.2	-0.7
Eastern Finland						
AGG	-1.1	0.2	3.0	2.2	0.7	1.0
WH	-0.6	-0.1	2.9	2.6	0.4	1.1
BW	0.0	0.6	1.1	0.5	0.7	0.6
CH	-0.5	-0.2	-1.0	-0.9	-0.5	-0.6
Northern Finland						
AGG	0.9	-0.6	3.2	3.5	1.5	1.7
WH	0.3	-0.9	2.2	3.9	2.4	1.5
BW	1.1	0.8	1.2	2.1	0.6	1.2
CH	-0.5	-0.5	-0.2	-2.5	-1.4	-1.0

Notes: Computations are made separately for 13 manufacturing industries. Industry-level results are aggregated for each region by using the industry structure of input (labour and capital combined) in Finnish manufacturing.

Table 5. The OLS estimates for the determination of the within component for labour productivity (whlp) and total factor productivity (whtfp) of Finnish manufacturing by region from 1975 to 1999.

	Whlp	Whlp	Whtfp	Whtfp
Uusimaa	-0.009	-0.008	-0.009	-0.008
	(0.011)	(0.010)	(0.015)	(0.013)
Western Finland	-0.001	-0.001	-0.006	-0.005
	(0.009)	(0.007)	(0.012)	(0.010)
Northern Finland	0.005	0.006	0.005	0.006
	(0.015)	(0.014)	(0.022)	(0.019)
Eastern Finland (reference)				
Industry effects	Yes	Interacted	Yes	Interacted
Year effects	Yes	Interacted	Yes	Interacted
Observations	1248	1248	1248	1248
Adjusted R-squared	0.11	0.32	0.17	0.44

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

Table 6. The OLS estimates for the determination of the between component for labour productivity (bwlp) and total factor productivity (bwtfp) of Finnish manufacturing by region from 1975 to 1999.

	Bwlp	Bwlp	Bwtfp	Bwtfp
Uusimaa	0.004	0.004	0.006	0.006
	(0.002)**	(0.002)**	(0.002)***	(0.002)***
Western Finland	0.000	0.000	0.004	0.005
	(0.001)	(0.001)	(0.002)**	(0.002)**
Northern Finland	0.000	-0.001	0.004	0.004
	(0.003)	(0.003)	(0.003)	(0.003)
Eastern Finland (reference)				
Industry effects	Yes	Interacted	Yes	Interacted
Year effects	Yes	Interacted	Yes	Interacted
Observations	1248	1248	1248	1248
Adjusted R-squared	0.05	0.19	0.07	0.08

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

Table 7. The estimation results for the magnitude of dispersion of labour productivity (stdlnlp) and total factor productivity (stdlntfp) across plants of Finnish manufacturing by region from 1975 to 1999. Dispersion is measured by the input weighted standard deviation of logarithm of productivity across plants.

	Stdlnlp	Stdlnlp	Stdlntfp	Stdlntfp
Uusimaa	0.079	0.078	0.071	0.073
	(0.016)***	(0.015)***	(0.020)***	(0.019)***
Western Finland	0.007	0.007	0.015	0.014
	(0.011)	(0.012)	(0.016)	(0.016)
Northern Finland	0.030	0.024	0.002	-0.006
	(0.017)*	(0.017)	(0.024)	(0.025)
Eastern Finland (reference)				
Industry effects	Yes	Interacted	Yes	Interacted
Year effects	Yes	Interacted	Yes	Interacted
Observations	1248	1248	1248	1248
Adjusted R-squared	0.36	0.46	0.27	0.42

Notes: Robust standard errors are reported in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Panel-specific AR(1) and heteroscedastic errors are allowed. The models are estimated by using data from 13 manufacturing industries in four regions. Estimations are made with input weights.

Appendix 1. Background characteristics for manufacturing in the provinces of Finland.

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

Notes: 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.

[1] Rigby and Essletzbichler (2000) decompose the labour productivity growth rate of the US states over the period from 1963 to 1992. However, they apply a different decomposition method of productivity growth.

[2] The additional effects arising from entrants and exitors (net entry) can be measured by subtracting the aggregate productivity growth rate among incumbents from the total aggregate productivity growth rate. The total aggregate productivity growth rate is, therefore, net entry plus productivity growth components among incumbents. The net entry effect can be decomposed further into entry and exit effects by using a formula introduced by Maliranta (1997b). In this method entry has a positive contribution to productivity growth if new plants have a higher productivity level than older ones in the current year. In other words, the entry effect is positive if the aggregate productivity level were lower without the appearance of new plants. Exit has a positive contribution if the disappearing plants (i.e. those which do not exist in year t) have a lower productivity level than the continuing ones (i.e. those which appear both in t-1 and t).

[3] The conclusion on the entries and exits of plants is based on the successive, pair-wise comparisions of productivity from year to year. The role of entries and exits of plants for the growth rate of productivity naturally increases as the time-horizon of the comparisons extends.

[4] We have analyzed in detail the entry and exit components by region. The unreported results led to quite similar conclusions about the pattern of restructuring over time and differences across regions.

[5] Regarding the evidence, see Maliranta (2002). The unreported regression results with our industry-region panel data confirm the predicted relationship between productivity dispersion and productivity-enhancing restructuring. High productivity dispersion is positively associated with the subsequent productivity-enhancing restructuring, which is no surprise because productivity dispersion is a necessary condition for the non-zero between component. On the other hand, we found empirical evidence that productivity-enhancing restructuring simultaneously compresses productivity dispersion, while the restructuring process seems to involve job destruction, especially in the left-hand tail of productivity distribution.

[6] The catching-up component (CH) is a term that is obtained by reformulating the decomposition formula presented by Bernard and Jones (1996) (Maliranta 2001).

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

[8] 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 1975-84 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 per cent.)

[9] 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 catching up terms of equation (4) are quite large and have opposite signs.

[10] For aggregating regional TFP results to the level of total manufacturing we have constructed appropriate input measures X for each industry j. Input measure of industry j is computed as $X_j = K^{0.408}L^{0.592}$, where K is capital stock in 1995 prices and L is worked hours. 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 Finnish regions.

[11] The assumption that the size and productivity level are uncorrelated among plants is more realistic in the case of TFP than labour productivity so that our catching-up component can be expected to capture better the negative correlation between the productivity level and the growth rate (with a negative value).

[12] The cumulative effect is measured by the index $INDt=IND_{t-1}\times(1+0.5\times at)\times(1-0.5\times at)^{-1}$, 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 component and the catching-up component of productivity growth.