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UNDERSTANDING REGIONAL PRODUCTIVITY IN A NORDIC WELFARE STATE: DOES ICT MATTER?**

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ABSTRACT: The study is about the determination of regional productivity in a Nordic welfare state, more particularly in Finland. Regional labour productivity is related to industry structure, demographic factors and the variables that capture the reorganization of labour markets. The data covers 85 Finnish regions over the period of 1989-1997. Industry structure is an important determinant of labour productivity in the Finnish regions. In particular, the emerging new economy in terms of ICT manufacturing yields an increase in labour productivity measured by the value-added divided by the total hours of work of the regions, but the positive impact of ICT manufacturing is tightly limited to its direct contribution. The share of ICT services has no impact on the level of labour productivity across the Finnish regions. In contrast to the U.S. and European stylized features, there is no evidence for the view that when the density of economic activity increases (measured by the number of employees divided by surface area), the labour productivity of the Finnish regions rises. In addition, restructuring at the plant level of the regions is not directly related to the evolution of labour productivity based on the evidence.

Keywords: Finland; regional labour markets; productivity

JEL classification: R23; J63

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TIIVISTELMÄ: Tutkimuksessa eritellään alueellisen tuottavuuden määräytymistä Suomessa. Alueellista tuottavuutta selitetään tuotantorakenteella, demografisilla tekijöillä sekä muuttujilla, jotka kuvaavat työmarkkinoiden rakennemuutosta toimipaikoilla. Aineisto perustuu 85 seutukunnan tietoihin vuosilta 1989-1997. Tuotantorakenne on keskeinen alueelliseen tuottavuuteen vaikuttava tekijä Suomessa. ICT-tavaratuotannon osuuden kasvu nostaa tuottavuutta (mitattuna seutukunnan arvonlisäyksellä jaettuna tehdyillä työtunneilla). ICT-tavaratuotannon positiivinen vaikutus seutukunnan tuottavuuteen rajoittuu sen suoraan osuusvaikutukseen. ICT-palvelutuotannon osuudella ei ole vaikutusta tuottavuuden tasoon. Aiemmin Yhdysvalloista ja Euroopasta saatujen tulosten vastaisesti taloudellisen aktiviteetin “tiheydellä” (ts. työntekijöiden määrällä suhteessa seutukunnan pinta-alaan) ei ole vaikutusta tuottavuuteen Suomen alueilla. Rakennemuutos toimipaikoilla ei ole suorassa yhteydessä tuottavuuteen.

Avainsanat: Suomi; alueelliset työmarkkinat; tuottavuus

JEL luokitus: R23; J63

1 Introduction

Regional disparities are definitely extremely sharp in Finland. By any standards, most of the economic activity is located in Southern Finland, where the unemployment rate has been low compared with the lagging regions of Eastern and Northern Finland during the past few decades. The Finnish regional labour markets have gained growing interest, because there has been a rapid rise in the regional disparities in unemployment rates as part of the export-led recovery from the great slump of the early 1990s (see, for example, Pehkonen and Tervo 1998; Tervo 1998).

As Paul Krugman (1994, p. 13) has famously put it: "Productivity isn't everything, but in the long run it is almost everything". The same view holds from a regional perspective in the Nordic welfare states, because a region's ability to improve its standard of living in the long run without large transfers of economic resources from other regions depends on its ability to raise its productivity with the available labour resources. The focus on the underlying productivity disparities across the regions within the same country means that the following investigation is not hampered by various measurement problems that are common in cross-country studies.[1]

Certain interesting regional patterns of productivity evolution can be found by employing data based on the European regions. In particular, Cuadrado-Rouda, Mancha-Navarro and Carrido-Yserte (2000) examine the differences in the behaviour of productivity across the European regions. They discover that despite the global trend towards convergence in productivity, significant regional differences persist. These overall patterns of productivity evolution mean that it is highly interesting to investigate in detail the determination of productivity within the same country that is characterized by large disparities in the regional measures of economic activity.

However, detailed empirical studies have not been available that aim to relate the enormous dispersion in productivity to the underlying economic fundamentals in the Finnish regions. This study therefore sheds some light on this issue by providing a coherent picture of the determination of regional labour productivity during the 1990s. In particular, the following empirical investigation provides an evaluation of the so-called new economy as defined recently by OECD (2000) on the level of productivity across the Finnish regions.

The study is indeed an important extension of the available empirical evidence concerning the economic fundamentals that are behind regional productivity in Finland, because the ICT sectors have definitely been the horsepower of the recovery from the great slump of the 1990s (see IMF 2001).[2] In other words, the volume index of the manufacturing of electronics by Statistics Finland grew from 100 in 1990 to 653 in 2000. By focusing on the ICT sectors, the study is able to deviate from the mainstream empirical studies that elaborate the determination of productivity from a regional perspective.[3]

Regional economies are in a state of continuous turbulence. However, the existing empirical studies on the issue exclude an evaluation of the impact of restructuring at the establishment level of the economy in terms of gross job and worker flows on regional labour productivity despite the fact that the Finnish economy experienced a deep structural change during the 1990s as an element of the great slump. In addition, the turnover of jobs and workers provides a mechanism of knowledge transfers and spillovers be-

tween the establishments within the same region.[4] The neglect of restructuring at establishment level of the economy seems to extend to the whole literature on regional labour market issues (see, for example, Elhorst 2000). The industry structure of the regions is obviously an important element in the determination of labour productivity from a regional perspective, but in the following study we further study how labour market flows (including a measure of simultaneous gross migration flows) are linked to the level of labour productivity across the Finnish regions.

The rest of the study is organized as follows. The second section of this study provides a brief discussion of the earlier empirical studies that have investigated the issue of regional productivity in the Finnish regions. The third section provides a description of a unique data set that is used to address the issue of regional productivity. The fourth section of this study includes the empirical evaluation by using panel data techniques. The last section concludes.

2. Previous related studies

The earlier empirical investigation into the determination of regional productivity in Finland can be summarized in a nutshell as follows. Maliranta (1997a) provides selected fundamental patterns of productivity within manufacturing industries across provinces in Finland. The level of labour productivity is at its highest in the province of Uusimaa and Northern Finland. In contrast, the total factor productivity is definitely at its highest level in the province of Uusimaa. Maliranta (1997b) provides an empirical evaluation for the factors in Finnish regional labour productivity within manufacturing industries. However, the study does not include the elaboration of restructuring at the establishment level of the economy.

Maliranta (2001) provides detailed empirical evidence about the structural change and productivity growth by using decompositions of labour and total factor productivity growth during the great slump of the 1990s. Böckerman and Maliranta (2002) provide similiar decompositions of productivity growth for the Finnish provinces over the period from 1974 to 1999.[5] The decompositions indicate that the growth rate of labour productivity was extremely rapid in the province of Oulu during the 1990s. The outstanding success of the province of Oulu in terms of labour productivity growth can most likely be explained by the cluster of information technology that has increased its share of the value-added within the manufacturing industries during the 1990s. In the providence of Oulu, in particular, there has been a strong positive contribution from the so-called "between component" of labour productivity growth decomposition to the measure of labour productivity growth. The so-called "between component" constitutes a coherent measure of restructuring between the plants of the region. The most striking finding is that this effect has had an accelerating impact on the growth rate of labour productivity in the province of Oulu during the 1990s.[6] In other words, there is preliminary evidence for the conjecture that the share of ICT sectors might be linked to the dispersion of productivity across regions.

However, there are indeed a rather limited number of empirical studies that actually evaluate the determination of productivity in Finland from a regional point of view. Lehto (2000) discovers by using detailed firm-level data that investments in R&D have large regional impacts on productivity in the Finnish regions. Kangasharju and Pekkala (2001) report that there has been 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 key driving force in the increase of regional disparities. In a related study, Susiluoto and Loikkanen (2001) provide an empirical investigation into the private sector inefficiency of 83 Finnish labour market areas from 1988 to 1999 by using Data Envelopment Analysis (DEA), which is a non-parametric linear programming method. The results indicate that the more efficient regions tend to be in the southern part of the country. On the other hand, the most inefficient regions are small, usually peripherally located, and their economic development has been weak during the 1990s. In contrast to the recent empirical study by Susiluoto and Loikkanen (2001), the following empirical investigation employs parametric techniques in order to evaluate the driving forces of regional productivity across the Finnish regions.

3. The data

The study exploits the fact that Finland is divided into 85 subregions (the so-called NUTS4-level in the European Union). The borders of the regions follow quite closely those of commuting districts. The yearly observations cover the period from 1989 to 1997. Table 1 contains a description of the applied variables.

Table 1. Description of the applied variables.

Variable	*Definition/measurement*
a. The measures of labour productivity:	
PROD1	A log of value added in region i divided by the number of employees in region i
PROD2	A log of value added in region i divided by the number of the total hours of work in region i
PROD3	A log of value added in region i (excluding ICT1 sectors of region i) divided by the number of the total hours of work in region i
b. The measures of industry structure:	
AGRI	Value added by agriculture in region i / GDP in region i (reference)
MANU	Value added by manufacturing industries in region i / GDP in region i
META	Value added by metal industries in region i (excluding ICT1-sectors of the region i) / GDP in region i
ICT1	Value added by the manufacture of office, accounting and computing machinery (TOL95: 30010 and TOL95: 30020)[7], the manufacture of insulated wire and cable (TOL95: 31300), the manufacture of television and radio transmitters and apparatus for line telephony (TOL95: 32200), the manufacture of electronic components and their parts (TOL95: 32100), the manufacture of television and radio receivers, sound or video recording or reproducting apparatus, and associated goods (TOL95: 32300), the manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process equipment (TOL95: 33200) and the manufacture of industrial process control equipment (TOL95: 33300) in region i / GDP in region i
ICT2	Value added by wholesaling of machinery, equipment and supplies (TOL95: 51432, 51641, 51652), renting of office machinery and equipment (TOL95: 71), telecommunication (TOL95: 642) and computer and related activities (TOL95: 72) in region i / GDP in region i
SERV	Value added by private services in region i / GDP in region i
PUBL	Value added by public sector in region i / GDP in region i
HIGH	Value added by high-tech manufacturing in region i / GDP in region i
HISE	Value added by high-tech services in region i / GDP in region i
c. The measures of labour force and gross migration flows:	
AGED	The number of employees aged from 55 to 65+ in labour force in region i / labour force in region i
UNSK	The number of employees with basic education only in labour force in region i / labour force in region i
DENS	The number of employees in region i divided by surface area in region i (m^2)
MIGR	(Gross inward migration to region i + gross outward migration from region i) – | gross inward migration to region i – gross outward migration from i | divided by average population in region i. This means that MIGR is an index of simultaneous gross inward and outward migration.
d. The measures of restructuring at the establishment level of the regions:	
EJR	The excess job reallocation rate in region i
CF	The churning rate in region i
e. The additional regional variables:	
UN	The number of unemployed persons in region i / labour force in region i (i.e. unemployment is measured as fractions. For example, 34-percent unemployment is represented as 0.34)
DEBT	Long-term municipal debt held in region i / average population in region i
f. The macroeconomic indicators:	
TERM	Terms of trade (export price index divided by import price index) (Source: Statistics Finland)
REAL	Real average lending rate by the Finnish banks (deflated by production price index) (Source: Bank of Finland and Statistics Finland)

The level of regional labour productivity is measured by dividing the annual value added in a given region by the number of employees (PROD1) and by dividing the annual value added in a given region by the number of total hours of work (PROD2). There is naturally a strong positive correlation between PROD1 and PROD2. The correlation coefficient between these measures of productivity is 0.94. The applied regional measure of value added is based on the regional GDP accounts constructed by Statistics Finland that covers all Finnish regions. The measures of employment and the total hours of work are based on the Labour Force Survey by Statistics Finland.

The variables that characterize the structure of the regional economic fundamentals (including a measure of gross migration flows across regions) have been collected from various registers by Statistics Finland. The so-called new economy is captured in the following investigation by the share of ICT manufacturing (ICT1) and the share of ICT services (ICT2) as recently defined by OECD (2000).[8]

The density of economic activity is captured by the DENS variable, because an effort is made to investigate the impact of the thickness of regional labour markets on the determination of regional labour productivity in Finland. By a wide margin, the density of economic activity in Finland is, at its highest level, in the Helsinki metropolitan area. The dispersion in the density of economic activity is evidently enormous across the Finnish regions. The aim of the study is therefore to address the question of the presence of various positive externalities and feedbacks associated with the agglomeration of economic activity that has been one of the focal points of the discussions in the emerging literature in the context of the so-called new economic geography (see, for example, Fujita, Krugman and Venables 1999).

The heterogeneity at the plant level in adjustment of the regions is captured by the measures of gross flows of jobs and workers. The measurement of regional gross job and worker flows is based on large longitudinal data of employees during the period from 1988 to 1997 (Böckerman and Maliranta 2001). The applied measures of gross job and worker flows cover the non-farming business sector of the Finnish economy excluding social and personal services. The so-called excess job reallocation rate provides a measure of restructuring among establishments.[9] In contrast, the fact that the available vacancies of the labour markets are subject to various idiosyncratic shocks within establishments is captured by the so-called churning rate.[10]

All in all, the study is therefore able to include three fundamental forces that have most likely shaped the evolution of productivity across the Finnish regions as follows: the industry structure, which is characterized by an expansion in the share of ICT, the enormous dispersion in the density of economy activity across the regions, and the intensive turbulence and the heterogeneity within and between the regional labour markets that is captured by gross flows of jobs and workers.

The evaluation of regional labour productivity in Finland is therefore based on the unique, linked panel data that is created by matching the economic fundamentals with the measures based on gross job and worker flows at the establishment level of the economy. The business cycle movements of the Finnish economy are captured by including the key macroeconomic indicators. However, the estimation results remain the same with dummies that are attached to years. In particular, as Partridge (2001) stresses, a key advantage of regional data is that it is not necessary to control for the aggregate factors that have common regional effects because they are accounted for by the year-fixed effects. This tends to reduce any omitted variable bias.

Figure 1 depicts a Kernel density of PROD1 and Figure 2 provides a Kernel density of PROD2.[11] The distributions of PROD1 and PROD2 are almost similiar. The location of ICT sectors across regions is presented in Figures 3-4. Appendix 1 provides selected descriptive statistics, which reveals that there are indeed extremely large disparities in all applied indicators of regional economic activity across the Finnish regions.

The correlation matrix of the most important variables is presented in Appendix 2a-2b. An interesting feature of the correlations is that the share of private services and the share of ICT services are strongly and positively correlated with the density of economic activity across the Finnish regions. This means that services are located based on demand conditions. In contrast, there is no relationship between the density of economic activity and the share of ICT manufacturing across the Finnish regions.

Figure 1. Kernel density of PROD1.

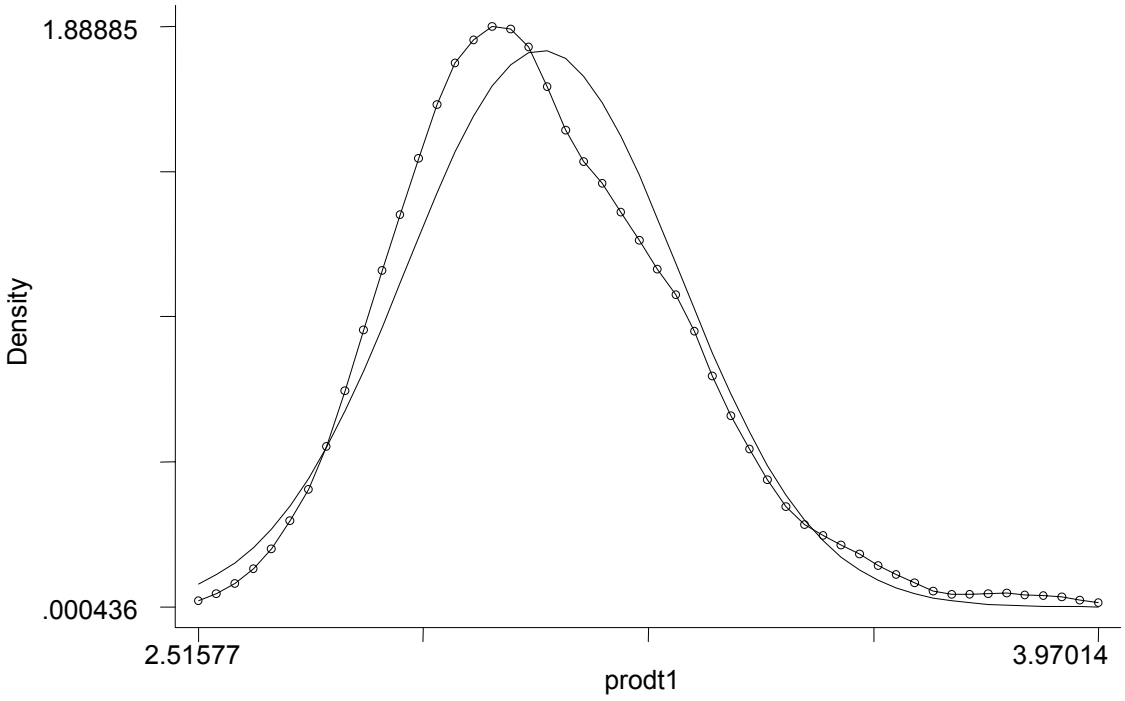


Figure 2. Kernel density of PROD2.

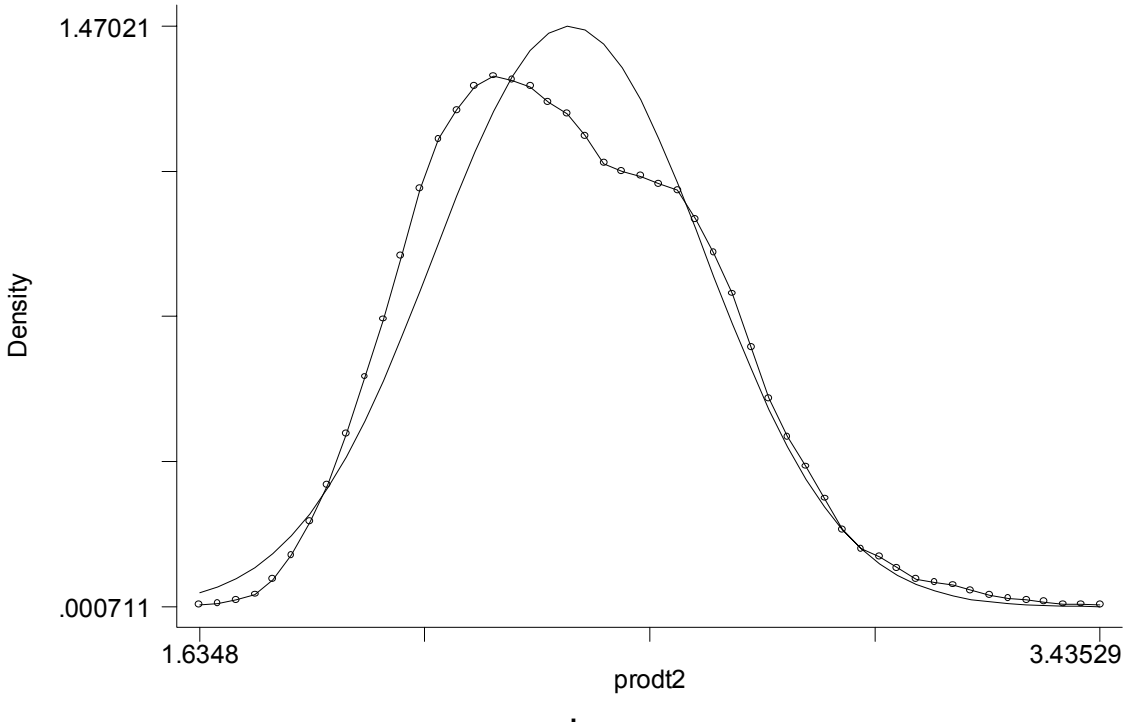


Figure 3. The share of ICT manufacturing across the Finnish regions in 1997.

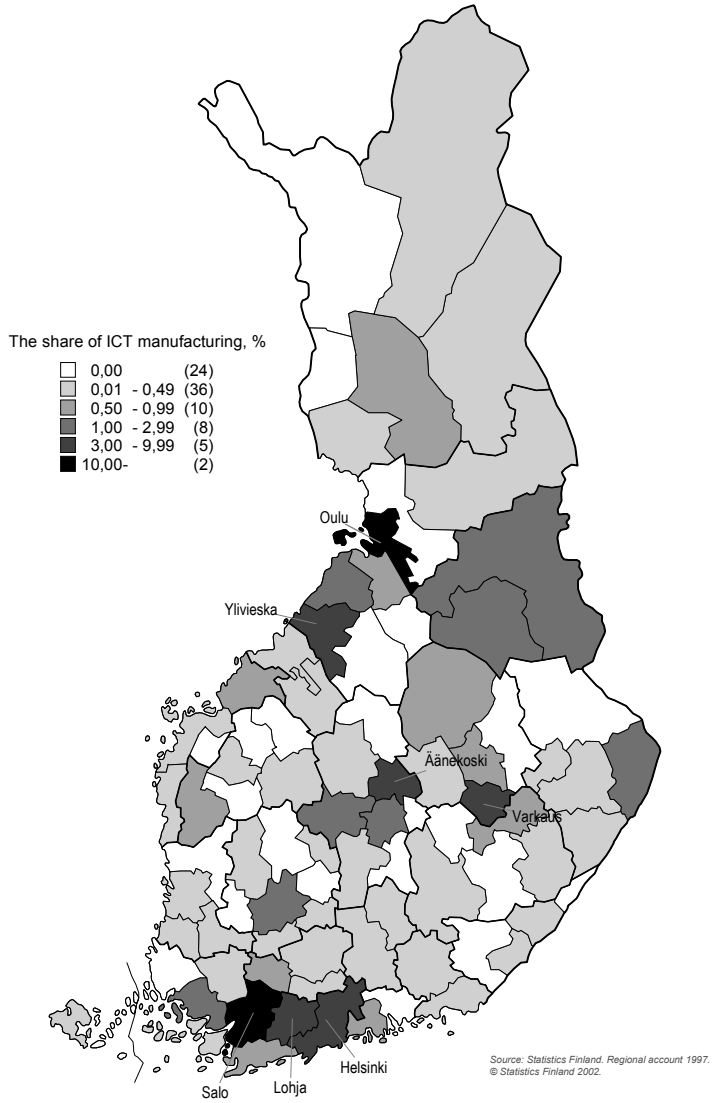
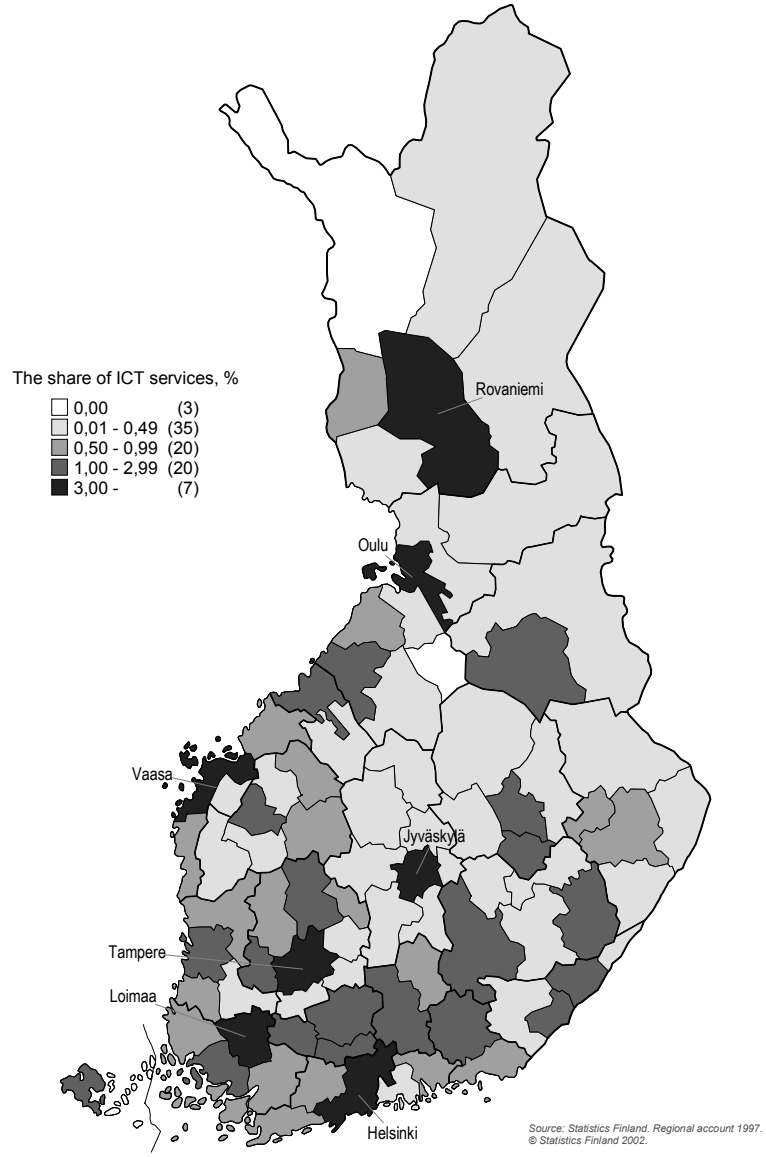


Figure 4. The share of ICT services across the Finnish regions in 1997.



4. The results

Since the data of the study covers all NUTS4-regions in Finland, the determination of labour productivity in the Finnish regions is captured by applying a fixed effects model, as follows:

(1) $PROD_{it} = a + \nu_i + b'\mathbf{X}_{it} + e_{it}$

where i = 1,…,85; t = 1,…,8, and PROD stands for the applied measure of labour productivity (PROD1, PROD2 or PROD3). **X** is a vector of the regional economic fundamentals and the measures of restructuring based on gross job and worker flows. In addition, ν_i represents a fixed-effects measure by the regional dummies and e_{it} is a normally distributed error term.

The results that are robust for the inclusion of the dummies that are attached to years can be summarized as follows (Table 2 and Appendix 3-4). Along with common sense, the industry structure is an important determinant of labour productivity. In particular, the emerging new economy in terms of ICT manufacturing yields a boost to labour productivity in the Finnish regions. However, the empirical observation concerning the impact of the new economy on regional productivity fails to hold when labour productivity is measured by the value-added divided by the number of employees (as reported in Appendix 3).

Moreover, the effect of ICT on labour productivity was estimated by excluding the ICT sectors from the calculation of the labour productivity of the regions. There was no evidence for the view that the share of ICT sectors is able to generate positive externalities on the level of labour productivity of other sectors in the Finnish regions (as reported in Appendix 4). In other words, the positive impact of ICT manufacturing on the labour productivity of the regions is tightly limited to the direct contribution of ICT manufacturing to the labour productivity that is reported in Table 2. In addition, the share of ICT services has no impact on the level of labour productivity (as reported in Table 2).[12] This means that the roles of ICT manufacturing and ICT services differ sharply in the determination of regional labour productivity across the Finnish regions.

The density of economic activity has no role at all in the determination of labour productivity in the Finnish regions (as reported in Table 2). In other words, an increase in the thickness of regional labour markets fails to yield an increase in regional labour productivity. For the sake of possible interaction between the density of economic activity and the share of ICT sectors, the density variable was calculated by dividing the value-added of the ICT sectors by the surface area in a region i (m^2). The estimation results indicated no impact from the regional concentration of ICT sectors on labour productivity across the Finnish regions.[13]

The Finnish evidence is therefore in conflict with the findings by Ciccone and Hall (1996), according to which a doubling of the employment density increases average labour productivity by around 6 percent. It is argued that this effect is due to the economics of agglomeration. Davis and Weinstein (2001) investigate the determinants of productivity for forty regions in Japan. The study shows that the density of economic activity definitely matters for productivity despite the fact that there has recently been a popular discussion about 'the death of the distance' in the context of digital economy. In particular, Davis and Weinstein (2001) report that a doubling of region's size raises

productivity by 3.5 percent. This means that if economic activity were spread evenly over the forty regions of Japan, aggregate output would fall by nearly twenty percent (see Davis and Weinstein 2001). Graham (2001) observes that more favourable locational effects arise for the population of firms that are adjacent to large urban centres within the British manufacturing industries. In addition, in a recent empirical study, Ciccone (2002) discovers out that agglomeration effects in selected European countries (France, Germany, Italy, Spain and the UK) are only slightly smaller than the agglomeration effects in the US. The estimated elasticity of average labour productivity with respect to employment density is about 4.5 percent. However, one of the major differences between the study by Ciccone and Hall (1996), Ciccone (2002) and the Finnish evidence is that the applied data on U.S. states and European regions tends to exclude the industry structure of the regions, which is evidently an extremely important element in the determination of labour productivity across the regions.

Table 2. The results from a fixed effects model (dependent variable: PROD2).

Variable	*Coefficients*	*t-statistics*
Constant	1.94	5.86
MANU	**0.73**	**3.46**
META	0.13	0.66
ICT1	**1.81**	**3.14**
ICT2	-1.02	-0.99
SERV	**-0.70**	**-2.43**
PUBL	**-1.02**	**-3.09**
HIGH	**-1.27**	**-2.93**
HISE	**2.84**	**2.87**
AGED	**-1.84**	**-2.18**
UNSK	**2.72**	**3.01**
DENS	0.00	1.21
MIGR	0.92	0.31
EJR	-0.01	-0.15
CF	0.02	0.24
UN	0.11	0.48
DEBT	-0.01	-1.45
R^2	0.61	
F(23, 572)	39.01	

Notes: The model includes the dummy variables that are attached to years.

The estimation results concerning structural change reveal that the high level of restructuring in terms of excess job reallocation at the establishment level of the Finnish regions fails to have an effect on the level of labour productivity. The same result holds

in the case of simultaneous gross inward and outward migration despite the fact that the high volume of simultaneous gross migration flows might lead to a more efficient matching between employees and establishments.[14] Pissarides (2000), in particular, argues that an increase in the efficiency of matching between workers and establishments yields substantial gains in labour productivity. There is even some evidence for the view that an increase in the magnitude of simultaneous gross migration flows can lead to a decline in the labour productivity of the Finnish regions (as reported in Appendix 3).

An increase in the churning rate (i.e. excess worker turnover) fails to provide an increase in the level of labour productivity in the Finnish regions. This observation is in disagreement with a plant-level study by Ilmakunnas, Maliranta and Vainiomäki (1999), according to which an increase in the churning rate yields a rise in labour productivity in the Finnish economy. OECD (2001), in particular, concludes that low tenure countries tend to have high productivity growth. The reason for the fact that there is no evidence for the view that restructuring is able to yield an increase in labour productivity may be that the fruits of restructuring at the plant level of the economy take some time to realize in the regions of Finland.

The rest of the results can be summarized in a nutshell as follows. The results show that a high share of manufacturing industries pushes up labour productivity, but a rise in the share of the private services and the public sector leads to a decline in labour productivity across the Finnish regions. Economic fundamentals include elements that characterize the structure of the labour force. The features of the labour force indeed have some role in the determination of labour productivity across regions, but the evidence tends to be somewhat mixed. An increase in the share of the aging labour force leads to a decline in the labour productivity of the regions when labour productivity is measured by the value-added divided by the total hours of work of the regions (as reported in Table 3). There is no empirical evidence for the view that an increase in the share of unskilled employees (i.e. employees with basic education only) yields a decline in the level of labour productivity in the Finnish regions (as reported in Table 2). Finally, the results show that the high level of public debt held by municipalities does not lead to an increase in the level of labour productivity despite the fact that the high level of regional public debt tends to equal the high level of taxation that depresses economic activity in the regions.

5. Conclusions

Regional labour productivity was related to industry structure, demographic factors and the variables that capture the reorganization of labour markets by employing the data of 85 Finnish regions during the period of 1988-1997.

Industry structure is an important determinant of labour productivity in the Finnish regions. In particular, the emerging new economy in terms of ICT manufacturing yields a boost to labour productivity measured by the value-added divided by the total hours of work of the regions, but the positive impact of ICT manufacturing is tightly limited to its direct contribution. In addition, the share of ICT services has no impact on the level of labour productivity across the Finnish regions. In contrast to the U.S. and European empirical evidence, the results reveal that an increase in the density of economic activity fails to produce an increase in the level of labour productivity in the Finnish regions. In addition, restructuring at the plant level of the regions is not directly related to the evolution of labour productivity based on the evidence.

What are the key policy lessons to be learned? Since the manufacture of ICT is highly concentrated across the Finnish regions and because an increase in the share of ICT manufacturing yields an increase in the level of labour productivity measured by the value-added divided by the total hours of work, the large regional disparities that exist in the Finnish economy are most likely to remain in the era of the so-called new economy. The large scale of transfers of economic resources across regions will therefore be needed to overcome the underlying disparities of the regions in the Nordic welfare states in the future, too.

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Appendix 1. The selected descriptive statistics.

Variable	*Mean*	*STD*	*MIN*	*MAX*
PROD1	3.07	0.22	2.57	3.92
PROD2	2.38	0.27	1.70	3.37
PROD3	2.35	0.27	1.70	3.34
AGRI	0.15	0.09	0.00	0.42
MANU	0.32	0.12	0.07	0.64
META	0.04	0.07	0.00	0.53
ICT1	0.01	0.03	0.00	0.47
ICT2	0.01	0.01	0.00	0.07
SERV	0.33	0.07	0.18	0.63
PUBL	0.20	0.06	0.08	0.40
HIGH	0.01	0.03	0.00	0.34
HISE	0.02	0.01	0.00	0.06
AGED	0.11	0.02	0.07	0.20
UNSK	0.35	0.05	0.20	0.51
DENS	107.45	200.34	2.05	1862.48
MIGR	0.01	0.00	0.00	0.03
EJR	0.25	0.08	0.09	0.84
CF	0.20	0.06	0.07	0.52
UN	0.17	0.07	0.01	0.34
DEBT	4.71	1.48	0.94	10.61
TERM	97.23	3.15	91.70	101.50
REAL	7.28	2.66	4.18	12.47

Appendix 2a. The correlation coefficients.

	PROD1	PROD2	ICT1	ICT2	SERV	PUBL	DENS
PROD1	1.00						
PROD2	0.94	1.00					
ICT1	0.18	0.19	1.00				
ICT2	0.20	0.28	0.11	1.00			
SERV	0.09	0.15	-0.05	0.53	1.00		
PUBL	-0.27	-0.22	-0.15	0.22	0.25	1.00	
DENS	0.29	0.34	0.10	0.58	0.57	-0.11	1.00

Appendix 2b. The correlation coefficients.

	PROD1	PROD2	AGED	UNSK	MIGR	EJR	CF
PROD1	1.00						
PROD2	0.94	1.00					
AGED	-0.28	-0.32	1.00				
UNSK	-0.45	-0.45	0.55	1.00			
MIGR	0.44	0.48	-0.35	-0.64	1.00		
EJR	-0.17	-0.14	-0.03	0.05	0.09	1.00	
CF	-0.06	-0.03	-0.24	0.10	0.12	0.37	1.00

Appendix 3. The results from a fixed effects model (dependent variable: PROD1).

Variable	*Coefficients*	*t-statistics*
Constant	3.52	24.03
MANU	**0.52**	**5.59**
META	0.07	0.85
ICT1	0.29	1.13
ICT2	**-1.82**	**-3.97**
SERV	**-0.79**	**-6.18**
PUBL	**-1.21**	**-8.28**
HIGH	-0.24	-1.28
HISE	**2.14**	**4.90**
AGED	**-0.92**	**-2.47**
UNSK	-0.03	-0.07
DENS	0.00	0.24
MIGR	**-3.53**	**-2.68**
EJR	0.00	0.12
CF	0.08	1.73
UN	**0.52**	**5.13**
DEBT	-0.00	-0.35
R^2	0.90	
F(23, 572)	212.10	

Notes: The model includes the dummy variables that are attached to years.

Appendix 4. The results from a fixed effects model (dependent variable: PROD3).

Variable	*Coefficients*	*t-statistics*
Constant	1.91	5.77
MANU	**0.72**	**3.44**
META	0.12	0.62
ICT1	0.68	1.18
ICT2	-1.96	-1.89
SERV	**-0.68**	**-2.34**
PUBL	**-1.02**	**-3.09**
HIGH	**-1.37**	**-3.15**
HISE	**2.84**	**2.86**
AGED	**-1.90**	**-2.25**
UNSK	**2.80**	**3.10**
DENS	0.00	1.35
MIGR	1.03	0.35
EJR	-0.01	-0.13
CF	0.03	0.26
UN	0.11	0.48
DEBT	-0.01	-1.48
R^2	0.60	
F(23, 572)	37.11	

Notes: The model includes the dummy variables that are attached to years.

[1] For example, Baily and Solow (2001) provide a discussion of measurement problems associated with international comparisons of productivity. Gerking (1994) provides a survey of the literature that has investigated the determination of productivity across regions within the same country.

[2] ICT is an abbreviation for 'Information and Communication Technology'. Kiander and Vartia (1996) provide a description of the great slump of the early 1990s.

[3] Hicks and Nivin (2000) investigate the determination of productivity measured by output-per-worker growth in the context of IT infrastructure investments in the regions of the United States. They are able to find some positive effects arising from IT investments on the level of productivity.

[4] Glaeser *et al.* (1992) and Sjöholm (1998) provide a discussion of externalities.

[5] The number of provinces is five excluding the province of Åland.

[6] Rigby and Essletzbichler (2000) provide the decompositions of labour productivity growth for the US states over the period from 1963 to 1992.

[7] "TOL95" refers to the classification of industries by Statistics Finland (1995).

[8] The sum of ICT1 and ICT2 in the following is called by the term 'ICT sectors'.

[9] Gross job reallocation (JR) is the sum of gross job creation (JC) and gross job destruction (JD). Thus, the net rate of change of employment (NET_t) is JC_t-JD_t. The excess job reallocation rate (EJR) equals (gross) job reallocation (JR) minus the absolute value of the net employment change: $EJR_t = JR_t - |NET_t|$ .This means that excess job reallocation is an index of simultaneous job creation and destruction in the economy. Caballero (1998) notes that, for this reason, it is appropriate to measure the magnitude of restructuring by the excess reallocation rate. Davis and Haltiwanger (1999) summarize the literature on gross job and worker flows.

[10] The worker flow rate (WF) is simply the sum of the hiring and separation rates. Thus, the so-called churning rate (CF) can be defined as follows: $CF_t = WF_t - JR_t$. The churning rate can also be called by the expression "excess worker turnover rate" for obvious reasons.

[11] Epanechnikov is the applied kernel density estimate. It has the property that it is the most efficient in minimizing the mean integrated squared error.

[12] The sum of the share of ICT sectors has a positive and statistically significant impact on the level of productivity across the Finnish regions.

[13] The results are available from the author upon request.

[14] Pekkala and Ritsilä (1999) provide an analysis of net migration across the Finnish regions.

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