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Valtion taloudellinen tutkimuskeskus
Government Institute for Economic Research
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Abstract

In this paper we apply a stochastic frontier approach to examine how matching efficiency and regional differences in structural factors contribute to regional and aggregate unemployment. Our results suggest that there would be a substantial decline in aggregate unemployment if (i) all local labour offices operated with full efficiency or (ii) they shared the same structure of job seekers and vacant jobs as the most favourable office. In the former case an increase in hirings would lower the average unemployment rate by 2.4 percentage points. In the latter case the decrease would be 1.4 percentage points. Further, we find that fixed effects are positively c0orrelated with both a more favourable structure and higher efficiency. This suggests that the fixed effects may capture some part of time invariant features in the structure and efficiency. Thus, the role of structural factors and efficiency in regional unemployment disparities may be higher than estimated.

Key words: technical efficiency, structural factors, matching, regions, aggregate unemployment

JEL classification numbers: J64

Tiivistelmä

Tutkimuksessa arvioidaan työvoimatoimistojen tehokkuuden ja alueellisten tekijöiden vaikutusta koko maan työttömyysasteeseen. Tulosten mukaan työttömyys laskisi 2,4 %-yksikköä, jos kaikki työvoimatoimistot saavuttaisivat koko maan tehokkaimman toimiston tason. Jos työttömien ja avointen työpaikkojen rakenne olisi koko maassa samanlainen kuin se on kaikkein suotuisimman toimiston alueella, työttömyys alenisi 1,4 %-yksiköllä. Estimoidut tulokset voivat olla todellisuutta pienemmät, koska osa vaikutuksista voi kanavoitua estimoinneissa käytettyihin kiinteisiin vaikutuksiin.

Asiasanat: tekninen tehokkuus, kohtaanto, alueet, työttömyys

JEL-luokittelu: J64

Contents

1. Introduction

Regional differences in unemployment rates tend to be distinct and persistent. This shows up well in many OECD countries where regional unemployment disparities have remained stable, some regions having continuously high and others low unemployment rates.[i] The common view is that regional differences in unemployment reflect the slow operation of equilibrating mechanisms, such as the inadequate response of migration to income and employment differentials.[ii] The same applies to the response of regional wages to excess demand or supply and that of employment to regional wage rates. Blanchard and Katz (1992) and Armstrong and Taylor (2000), for example, stated that the persistence of regional disparities is the net result of shocks and adjustment processes: regional disparities arise because regions respond in different ways to exogenous shocks, and the adjustment mechanism is not instantaneous because of economic and social barriers.[iii] An alternative view emphasises that differences in regional unemployment are due to different (long-term) regional equilibrium unemployment rates. Marston (1985), among others, stated that geographical areas are in an equilibrium relationship with respect to one another, and the equilibrium unemployment rate in each area will be a function of the amenities and land endowment in the area. Because of variations in preferences and infrastructure, equilibrium unemployment rates differ among areas.

In this study we examine how differences in the matching efficiencies of local labour offices and structural factors of regions contribute to regional unemployment rates and the level of aggregate unemployment. Addressing these questions is topical and important, since recent research has indicated that the characteristics of the matching process, i.e. how job seekers and vacant jobs match, affect unemployment (Holden and Nymoen, 2002; Yashiv, 2004; and Shimer, 2005).[iv] Studying Finland is instructive, as the regional differences in labour market performance have been particularly large and persistent. In this study the role of matching frictions in regional and aggregate unemployment is scrutinised by distinguishing the effects of structural factors from inefficiencies in the matching process.

The empirical analysis of this study is based on a stochastic frontier approach that offers a convenient method to examine matching processes. Using this methodology, Ibourk et al. (2004) observed that cross-regional matching inefficiencies are large in France. Fahr and Sunde (2006) reported wide efficiency differentials across German areas, whereas Ilmakunnas and Pesola (2003), in turn, found regional differences to be modest in Finland.

The novelty in the study at hand is twofold. First, the empirical analysis is carried out by applying a recently developed estimation method that can distinguish between unobserved fixed effects and technical inefficiency in the panel data context. This allows us to gain information on the relation between estimated fixed effects, inefficiencies and the observed structural factors of regions. Second, the results of the empirical analysis are utilized to examine how much the estimated efficiency differences in matching contribute to the number of hirings and further to the aggregate unemployment. In particular, the number of observed matches is compared with the hypothetical number of matches that could have been achieved if all the local labour offices (LLOs) had the full net efficiency. In addition, we assess the role of structural factors in the matching process by comparing the number of obtained hirings and the level of unemployment to the cases with the best structural factors in the whole country or within the NUTS3 level regions. It is worth emphasising that these calculations are illustrative, since they are based on certain simplifying assumptions. In short, the purpose of the exercises is to highlight the magnitude and relative role of estimated inefficiencies and observed regional characteristics in determining regional and aggregate unemployment.

The empirical analysis suggests that differences in the structure of unemployment and vacancies across local labour offices are considerable and that matching inefficiency has a substantial role in the matching function. The first finding suggests that there would be a substantial decline in the aggregate unemployment rate if all local labour offices shared the same structure of unemployment and vacancies with the most favourable office. The second finding implies that full net efficiency would decrease aggregate unemployment more than the most favourable structure. We also find that estimated fixed effects and efficiencies are positively correlated. The number of matches due to higher fixed effects is higher in local labour offices that are more efficient and have a more favourable structure. This implies that the role of efficiency and structure may be higher than estimated, as the fixed effects capture the time invariant parts of them.

The rest of this paper is organised as follows. Section 2 introduces the stochastic frontier approach to the matching function and describes the data. The matching efficiencies of 145 local labour offices in 19 NUTS 3 regions in Finland are examined. The high data quality allows us to explore the matching process at a monthly rather than a lower (annual) frequency, thereby reducing the problems of time aggregation (see Burdett et al., 1994). The data also permit us to divide the pool of job seekers and that of vacancies into sub-categories, allowing us to account for job competition amongst the job seekers as well as to proxy the suitability of labour demand with respect to the supply. Section 3 discusses the results of the efficiency analysis, followed by an analysis of the quantitative effects of efficiency differences on matches and unemployment. Section 4 concludes.

2. Matching in the labour market: models and data

2.1 The stochastic frontier matching model

We assume that labour market matching follows the production process determined by the familiar Cobb-Douglas production function (Pissarides, 2000):

$$H_{i,t} = AU^{\alpha}{}_{i,t-1}V^{\beta}{}_{i,t-1}, \qquad (1)$$

where $H_{i,t}$ denotes hirings from unemployment (outflow from unemployment to employment, excluding subsidized jobs) during a month t in a local labour office i. $U_{i,t-1}$ is the stock of unemployed job seekers and $V_{i,t-1}$ the stock of vacancies at the beginning of the month. The stochastic logarithmic production frontier model combines the models defined by Battese and Coelli (1995) and Greene (2005a and b) taking the following form:

$$\ln H_{i,t} = [\mu_i + \alpha \ln U_{i,t-1} + \beta \ln V_{i,t-1} + year + month] + \upsilon_{i,t} - \tau_{i,t} \qquad (2)$$

The expression in square brackets states the matching frontier that gives the maximum output, or matches, that can be produced by given quantities of production inputs, job seekers and vacancies. Year and month refer to the respective time dummies.

The observable error term $\varepsilon_{i,t} = \upsilon_{i,t} - \tau_{i,t}$ consists of two components that are not directly observed. The "normal" error term $\upsilon_{i,t}$ is i.i.d. and follows the $N(0, \sigma_{\upsilon}{}^2)$ distribution. $\tau_{i,t}$ denotes non-negative random variables accounting for technical inefficiency in the production of matches, and they are assumed to be distributed independently of the error terms $\upsilon_{i,t}$. The variance of the composed error term $\varepsilon_{i,t}$ is expressed as $\sigma^2 = \sigma^2{}_{\upsilon} + \sigma^2{}_{\tau}$, and the relative importance of the residual associated to the inefficiency term is estimated by $\gamma = \sigma^2{}_{\tau} / \sigma^2$ (see Battese and Coelli, 1995).

The inefficiency term consists of two parts, one being explained by the inefficiency regressors and the other being a random error term, and is expressed as $\tau_{i,t} = \sum Z_{j,it}\delta_j + w_{i,t}$. There are j inefficiency regressors, $Z_{j,it}$. The vector of coefficients to be estimated is denoted by δ_j. The efficiency regressors can vary between cross-sectional units and over time. Term $w_{i,t}$ is defined by the truncation of the normal distribution with zero mean and variance σ^2_{τ} such that the point of truncation is $-\sum Z_{j,it}\delta_j$, i.e., $w_{i,t} \geq -\sum Z_{j,it}\delta_j$. These assumptions are

consistent with $\tau_{i,t}$ being a non-negative truncation of the $N(\sum Z_{j,it}\delta_j, \sigma_\tau^2)$ distribution (Battese and Coelli, 1995).

The parameters of the stochastic frontier and the efficiency term are jointly estimated by maximising the log-likelihood of the model (Coelli, 1997; Coelli et al., 1998). The conditional estimates of the efficiency coefficients $TE_{i,t}$ are computed as

$$TE_{i,t} = [\exp(-\tau^*_{i,t}) \mid H, U, V, Z]. \quad (3)$$

The efficiency measure is absolute, not relative to the best in the sample. It is equal to 1 when matches lie on the frontier; otherwise $TE_{i,t} < 1$.

The frontier part of the model includes fixed panel effects for LLOs. According to Greene (2005a and b), the model is in fact termed a true fixed-effects model, since it allows for the true fixed effect, μ_i, to be distinguished from the inefficiency terms. In other words, time-invariant cross-sectional heterogeneity is separated from inefficiency causing deviations from the frontier. The model assumes that any time-invariant heterogeneity between LLOs is not derived from inefficiency, which raises the question of whether or not the fixed effects in the frontier capture part of the variation in the inefficiency terms. The other way to deal with unobserved heterogeneity in estimations would be to assume that all time-invariant heterogeneity enters the model through inefficiency and to include the fixed effects into the inefficiency terms. In this case, however, the frontier would be estimated without any panel effects. Therefore, we choose the true fixed effects modelling strategy augmented by detailed analysis of the relationship between the fixed effects and inefficiency terms.

2.2 Job and vacancy competition

Different job seeker groups might have different search intensities and employers also rank job seekers differently in recruitment processes. The same holds for vacancies: they are advertised with different intensities and job seekers rank vacancies differently. As a result, the employability of job seekers as well as the probability of vacancies becoming filled might differ (e.g. Anderson and Burgess, 2000; Fahr and Sunde, 2005). In order to take into account job and vacancy competition between different types of vacancies we divide the unemployment and vacancy stocks into groups. The unemployment stock is divided into long-term (>1 year) and shorter-term (<1 year) unemployment and the vacancy stock into easy-to-fill (<7 days) and difficult-to-fill (>61 days) vacancies. In addition, we add the competition from outside the unemployment stock into the model and control for the flow to active labour market programmes (ALMPs) in order to capture their effects on the unemployment outflow and the

unemployment composition. The unemployment stock is also divided according to age in order to capture the age-associated differences in employability.

When different groups of job seekers, k, and different groups of vacancies, m, have deviating effects on matching efficiency, the vector of the inefficiency regressors in the inefficiency term is written as:

$$\sum Z_{j,it}\delta_j = \sum_k \varphi_k \frac{U^k{}_{i,t-1}}{U_{i,t-1}} + \sum_m \phi_m \frac{V^m{}_{i,t-1}}{V_{i,t-1}}, \qquad (4)$$

where δ_j vector includes φ_k and ϕ_m coefficients (see Ibourk et al., 2004). The inefficiency term $\tau_{i,t}$ in the stochastic frontier matching function (2) hence takes the form

$$\tau_{i,t} = \sum_k \varphi_k \frac{U^k{}_{i,t-1}}{U_{i,t-1}} + \sum_m \phi_m \frac{V^m{}_{i,t-1}}{V_{i,t-1}} + w_{i,t}, \qquad (5)$$

where φ_k and ϕ_m denote the deviant effects of the different groups of job seekers or vacancies on matching efficiency, respectively. If all φ_k or ϕ_m were zero, there would be no differences between the groups in their effects on the matching efficiency.

2.3 Data description

The data comprise 117 months (from January 1995 to September 2004) and 145 local labour offices (LLOs)[v] in Finland, yielding almost 17,000 observations and covering the state-run employment agencies. LLOs are grouped according to 19 NUTS3 level regions and the results are considered at this level as well as at the whole-country level.[vi] The data sources are the Ministry of Labour in Finland and Statistics Finland. The registers of the Ministry of Labour include all job seekers, vacancies and matches recorded at LLOs. The state-run employment agencies play an important role in the Finnish labour market. The proportion of jobs mediated by LLOs varied between a low of 49 per cent in 1993 and a high of 71 per cent in 1996 over the period 1993-2002. On average, the market share of the LLOs has been about 60 per cent of all hirings.[vii]

There are many ways to measure the dependent variable of the matching function (matches) in empirical studies. Typical proxies for matches are (i) the total flow into employment (new hires), (ii) the flow out of unemployment (unemployment outflow) and (iii) the flow of filled vacancies (vacancy outflow).[viii] In this study the output of the matching function, hirings, is the outflow from registered unemployment to employment (excluding the outflow to subsidised jobs) during a month.[ix] The inputs in the matching function are the stocks of unemployed job

seekers and vacancies at the end of the previous month. The average number of hirings during a month can exceed the number of vacancies, since a part of the job seekers become hired and a part of the vacancies become filled within a month and are therefore not included in the stocks in the data. [x]

Following the earlier literature (Ilmakunnas and Pesola, 2003; Ibourk et al., 2004; Fahr and Sunde, 2006), we introduce control variables that capture certain characteristics of the behaviour of job seekers and firms, thus providing evidence for the role of frictions in the matching process. Four groups of variables are used in the empirical analysis. First, we use the proportions of younger (< 25 yrs) and older unemployed (> 55 yrs) in the whole unemployment stock to control for the effect of the age structure of the unemployment pool on matching efficiency. Second, the share of long-term unemployed job seekers (over one year) is a control for the differences in search intensities among job seekers and firms' hiring attitudes towards the loss of skills among job seekers. In addition, we assume that the number of employed job seekers and job seekers out of the labour force as a fraction of the unemployment stock controls for job competition from outside the unemployment stock. The proportion of employed and out-of-the-labour-force job seekers is considerable, being on average 57 per cent in relation to the unemployment stock.[xi] The fraction of other than unemployed job seekers is pro-cyclical, being higher in upturns and lower in downturns. During the research period, the fraction was at its lowest in 1995, 41 per cent, and at its highest level of 72 per cent in 2004.

Third, the flow of unemployed job seekers to active labour market programmes (ALMPs) relative to the unemployment stock captures the effect of ALMPs on the structure of the unemployment pool. ALMPs might have a positive effect on matching efficiency, since persons participating in these programmes are those for whom employment on the open labour market tends to be the most problematic (Ibourk et al., 2004). In addition, the variable for the volume of ALMPs captures the effect of regional policies that aim at reducing differences between local labour markets. On the other hand, the increase in the flow to ALMP can decrease the relevant stock of job seekers and hence also decrease matching efficiency.[xii] Fourth, our data allow us to classify the vacancy stock according to the duration of vacancies. Two extreme groups are separated from the stock: vacancies that have been in the market for less than 7 days and vacancies over 61 days old. We assume that the duration of vacancies is a proxy for their ability to become filled, reflecting the characteristics of the vacancies from the perspective of job seekers.

During an average month in an average LLO there are 2,779 unemployed job seekers (U) searching for jobs and 273 vacant jobs (V) needing workers (Table 1). The average number of hirings (H) is 200 per month. The average hiring rate, H/U in the period is 8 per cent, being the highest in Southern Ostrobothnia (12 per cent) and the lowest in Uusimaa (4 per cent). The average labour market

tightness V/U is 10 per cent, varying from 6 (Central Finland) to 16 per cent (Ostrobothnia).

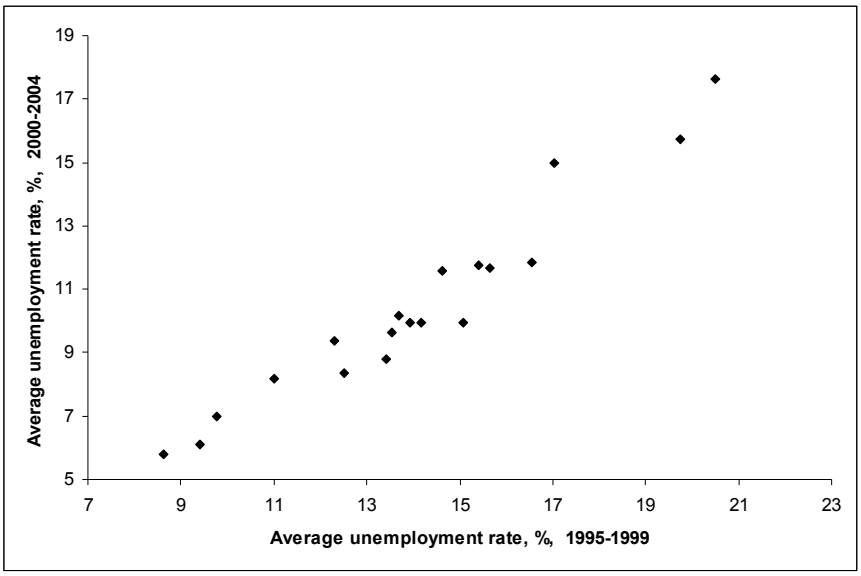
A large proportion of the unemployment pool is of the long-term type, 25 per cent on average. In other words, one fourth of those registered as unemployed at the public employment agency are those whose placing on the open labour market is difficult. The volume of ALMPs in as a proportion of the unemployment stock is 5 per cent. According to age, about one third of the unemployed are over 55 years old and about 13 per cent are younger than 25 years. The number of non-unemployed job seekers as a proportion of the unemployment stock is almost 60 per cent. Almost one fourth of the vacancies are of the short-term type, and 13 per cent have been on the market for over two months.

The persistence of regional differences in the unemployment and employment rates (the employed labour force as a proportion of the whole population aged between 15 and 64 years) are illustrated in Figures 1 and 2. The rank correlation in both rates between the average values from the period 1995-1999 and from the period 2000–2004 is as high as 0.98. Therefore, despite the unemployment rate being notably reduced and the employment rate increased in all of the regions over the period, the ranking of regions remained stable. The same also applies to other aspects of the regional labour markets. For example, the Spearman rank correlation coefficient between variable values 1995 and 2004 is highest (0.92) for hiring rate, and is 0.89 and 0.72, respectively, for long-term unemployment and the ALMP volume. In addition, the rank correlation in labour market tightness and in new vacancies is quite high, being over 0.40, but not significant.

Table 1. Descriptive statistics according to NUTS3 Region; averages across LLOs

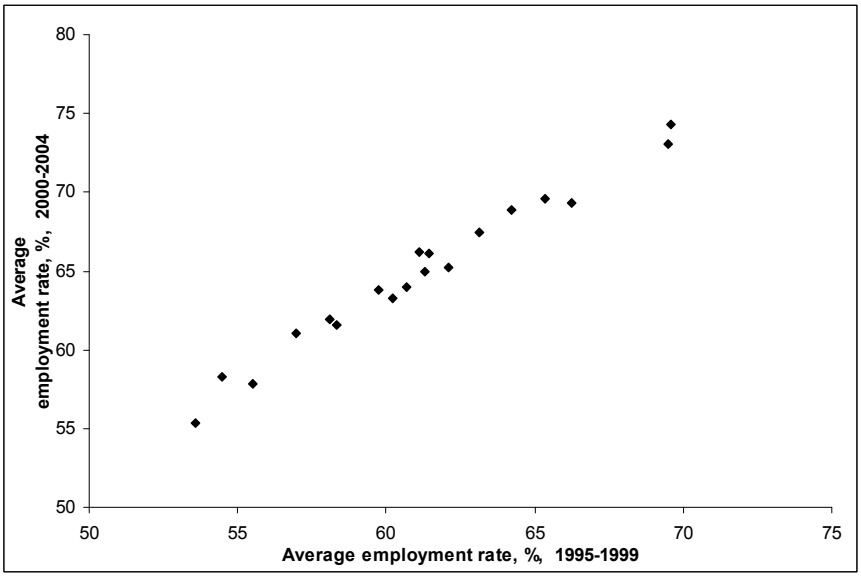
NUTS3 Region	H	U	V	Share LTU	Share ALMP	Share Other	Share <25 years	Share >55 years	Share V<7 days	Share V>61 days	Hiring rate	Tightness
1 Uusimaa	225	5075	733	0,29	0,04	0,56	0,11	0,34	0,24	0,11	0,04	0,14
2 Southwest Finland	259	2500	308	0,23	0,04	0,60	0,12	0,35	0,25	0,10	0,10	0,12
3 Eastern Uusimaa	102	2269	164	0,30	0,04	0,46	0,11	0,34	0,22	0,15	0,04	0,07
4 Satakunta	203	2767	269	0,26	0,05	0,59	0,12	0,35	0,19	0,20	0,07	0,10
5 Kanta-Häme	243	2801	279	0,31	0,04	0,49	0,13	0,34	0,23	0,12	0,09	0,10
6 Tampere Region	186	2554	244	0,27	0,05	0,54	0,12	0,33	0,23	0,13	0,07	0,10
7 Päijät-Häme	379	8241	715	0,33	0,04	0,49	0,12	0,35	0,21	0,20	0,05	0,09
8 Kymenlaakso	244	2903	266	0,27	0,04	0,57	0,14	0,32	0,22	0,11	0,08	0,09
9 Southern Karelia	223	3797	272	0,32	0,04	0,43	0,12	0,34	0,23	0,11	0,06	0,07
10 Southern Savo	146	1706	135	0,24	0,05	0,68	0,11	0,32	0,22	0,14	0,09	0,08
11 Northern Savo	163	1792	217	0,22	0,06	0,63	0,13	0,28	0,26	0,13	0,09	0,12
12 Northern Karelia	176	2275	168	0,27	0,05	0,49	0,11	0,29	0,27	0,07	0,08	0,07
13 Central Finland	162	2397	155	0,29	0,05	0,47	0,13	0,30	0,21	0,17	0,07	0,06
14 Southern Ostrobothnia	155	1338	154	0,18	0,05	0,61	0,14	0,29	0,23	0,11	0,12	0,12
15 Ostrobothnia	148	2234	358	0,24	0,04	0,63	0,14	0,32	0,22	0,14	0,07	0,16
16 Central Ostrobothnia	209	2584	236	0,21	0,06	0,64	0,16	0,28	0,25	0,09	0,08	0,09
17 Northern Ostrobothnia	361	3340	349	0,21	0,05	0,64	0,16	0,25	0,24	0,12	0,11	0,10
18 Kainuu	121	1136	82	0,17	0,07	0,60	0,12	0,28	0,25	0,12	0,11	0,07
19 Lapland	103	1097	85	0,19	0,07	0,61	0,11	0,28	0,21	0,14	0,09	0,08
All	200	2779	273	0,25	0,05	0,57	0,13	0,31	0,23	0,13	0,08	0,10

Figure 1. Persistency of the ranking of NUTS3 regions according to the average unemployment rates. Source: Statistics Finland



Note. The Spearman rank correlation between the periods is 0.98 at the 0.1% level of significance.

Figure 2. Persistency of the ranking of NUTS3 regions according to the average employment rates. Source: Statistics Finland



Note. The Spearman rank correlation between the periods is 0.98 at the 0.1% level of significance.

3. Empirical results

3.1 Stochastic frontier estimates for the matching function

We begin the empirical analysis by estimating five alternative matching models. First, we estimate conventional random and fixed effects specifications with all explanatory variables included in the matching function (Table 2, columns 1 and 2). The Hausman test suggests that fixed effects fit the data better than random effects. Second, we estimate a fixed effects specification and control for possible endogeneity of the explanatory variables by using the IV techniques. The results of the GMM model, where the variables for the unemployment and vacancy stocks are instrumented by their own lags, are shown in column 3. The GMM C statistic, however, suggests that the instrumented regressors are not endogenous. Consequently, we proceed to estimate the stochastic frontier model without instrumenting the explanatory variables.

The results for the true fixed-effects stochastic frontier model suggest that the inefficiency part, τ, of the composed error term, ε, is statistically significant, i.e., γ is significant (Table 2, column 5). We also ran the Battese and Coelli (1995) specification without any panel effects (column 4), but gamma was not statistically significant. The coefficients estimated for the two main inputs of the matching function, U and V, are consistent with the earlier international as well as the Finnish evidence.[xiii] In particular, the estimates stress the importance of unemployed job seekers relative to vacancies in the hiring function. Furthermore, the specifications exhibit slightly decreasing returns to scale.

Coefficients on the structural controls merit particular attention (column 5). First, the matching efficiency decreases by about 2.4 per cent with a one percentage point increase in the proportion of long-term unemployed (shareLTU) in the unemployment stock, the group with the lowest search effort and a stigma effect among employers.[xiv] This finding accords well with the emphasis in the theoretical literature on the role of the search intensity of job seekers and the ranking behaviour of firms as determinants of matching frictions.[xv] The effect of non-unemployed job seekers is not, however, as expected: the coefficient indicates a positive effect of job competition on the hiring rates of unemployed job seekers. It is possible that unemployed and other job seekers do not compete for the same jobs, and hence job competition between these groups does not negatively affect hirings from the unemployment pool.

The age structure of the job seeker stock matters: both younger and older job seekers positively contribute to matching relative to the middle-aged. The result suggests that the long-term unemployment variable captures the negative effect of those older job seekers who are difficult to employ, and therefore older age

itself positively affects matching efficiency. An increase in the flow to active labour market programmes has a negative effect: a one percentage point increase in the flow to ALMPs decreases matching efficiency by 8.4 per cent. Hence, ALMPs do not seem change the composition of the stock of unemployed towards better employability. The increased volume of ALMPs rather seems to reduce the relevant stock of job seekers and hence reduces the efficiency of the matching process. The composition of the vacancy stock does not have any significant effect on matching efficiency.

Table 2. Estimation results. The dependent variable is ln(hirings), the estimation period is 1995–2004

	Conventional panel data models			**Stochastic frontier models**	
	Random	Fixed	GMM	Battese and Coelli	True fixed effects
Dependent variable: ln Ht					
ln U t-1	0.83***(0.02)	0.8***(0.03)	0.65**(0.23)	0.86***(0.01)	0.76***(0.02)
ln V t-1	0.04***(0.003	0.04***(0.003)	0.03 (0.02)	0.05***(0.003)	0.04***(0.003)
Constant	-1.35***(0.14)			-1.24***(0.07)	
				Inefficiency regressors	
(Share LTU)t-1	-1.32***(0.07)	-1.24***(0.07)	-1.28***(0.17)	3.42***(0.07)	2.4***(0.63)
(Share OTHER)t-1	0.07***(0.02)	0.05*(0.02)	0.02 (0.04)	-0.4***(0.03)	-5.49***(1)
(Share ALMP)t-1	0.45*** (0.1)	0.46*** (0.1)	-2.13 (5.57)	0.5**(0.15)	8.37***(1.76)
(Share < 25)t-1	-0.45** (0.14)	-0.5*** (0.14)	-1.14**(0.39)	-2.4*** (0.15)	-5.58***(1.53)
(Share > 50)t-1	0.13 (0.1)	0.14 (0.11)	-0.27 (0.16)	-0.21* (0.09)	-3.1***(0.86)
(Share V<7 days)t-1	-0.01 (0.01)	0.01 (0.01)	-0.18 (1.4)	-0.02 (0.02)	-0.04 (0.11)
(Share V>61 days)t-1	-0.02 (0.01)	-0.02 (0.01)	-0.07 (0.29)	0.01 (0.02)	0.16 (0.13)
Constant	-1.35***(0.14)			0.48***(0.08)	1.77***(0.37)
Returns to scale	0.87*	0.84***	0.68***	0.91***	0.8***
R2	0,8	0,81	0.80		
Number of observations	16,965	16,965	16,820	16,965	16,965
sigma-squared				0.14	0.27
gamma				0.48	0.83***
log likelihood				-6,823	-523
Hausman, Chi2		107.9***			
Average efficiency				0.50 (0.15)	0.89 (0.08)

Notes. All specifications include monthly and yearly dummies in the matching function. Endogeneity of the variables related to unemployment and vacancy stocks in the GMM specification is tested with GMM C statistics. None of the variables are endogenous. In stochastic frontier models, a positive coefficient of an inefficiency control means a negative effect and a negative coefficient a positive effect on technical efficiency. *** denotes statistical significance at the 0.1%, ** at the 1% and * at the 5% level.

3.2 Technical efficiency, net efficiency and structural factors

Technical (gross) efficiency is obtained when all the efficiency regressors take their actual values in all LLOs and in all periods. Hence, in technical efficiency the explanatory variables are allowed to affect it as they do in reality. Technical efficiency can be divided in two types: *net efficiency* and *structural efficiency* (see Coelli et al., 1999; Ibourk et al., 2004). *Net efficiency* measures technical efficiency when all LLOs are set to operate in equal environments, i.e., the structure of unemployment and vacancy stocks in our case, is set to be equal across LLOs and periods. Following Coelli et al. (1999), we calculate the net efficiency scores by replacing the actual set of variables capturing the quality of unemployment and vacancy stocks with the most favourable set among the time averages of the LLOs, $^{\min[\sum Z_{j,it}\delta_j]}$. Net efficiency is the distance of the LLOs from the technological frontier when they are set to operate in the optimal environment. Net efficiency captures the part of technical efficiency that is independent of the environments where matching takes place. *Structural efficiency* is the distance between technical (gross) efficiency and the net. Structural efficiency is determined by the difference between the own set of structural factors and the most favourable set of structural factors.

Averages of the different efficiency scores according to region are presented in Table 3[xvi]. Among the NUTS3 regions, the average technical (gross) efficiency ranges from 0.84 in Central Finland to 0.91 in Southern Savo and Northern Ostrobothnia (column 1). In other words, technical inefficiency is between 9 and 16 per cent (column 4). The average net efficiency is close to 0.95 and the average net inefficiency about 0.07 (columns 2 and 6). Differences in net efficiency between regions are minimal, ranging from 0.946 to 0.951. When net efficiency is calculated regionally by including the most favourable characteristics of unemployment and vacancy stocks within each region in the efficiency estimates, the average net efficiency slightly decreases and the average net inefficiency increases while the differences between regions become larger (columns 3 and 7). The range in regional net efficiency varies from 0.920 in the Tampere region to 0.946 in Eastern Uusimaa (column 3). The structural inefficiency (the difference between technical and the net) is on average 5.1 percent, ranging between 4.9 and 5.4 per cent (column 5). The minimum and maximum efficiency scores within the NUTS 3 regions are reported in Appendix.

Table 3. Averages of different efficiency measures according to NUTS3 Region

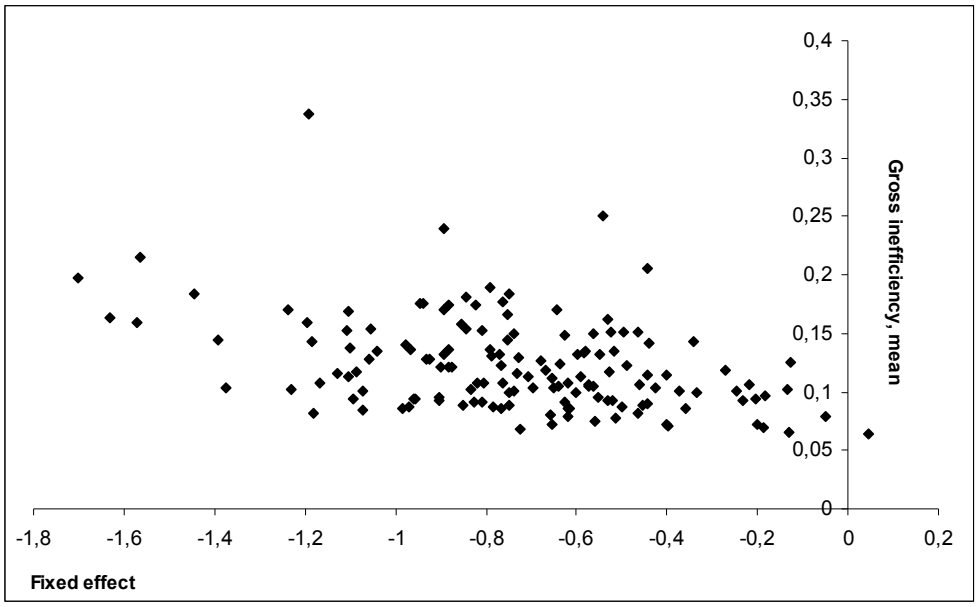
	Efficiency			Inefficiency			
	Gross	Net	Net, regional	Gross	Structural	Net	Net, regional
Northern Ostrobothnia	0.913	0.951	0.942	0.087	0.049	0.058	0.038
Southern Savo	0.913	0.951	0.903	0.087	0.049	0.097	0.038
Central Ostrobothnia	0.909	0.951	0.943	0.091	0.049	0.057	0.042
Ostrobothnia	0.904	0.951	0.944	0.096	0.049	0.056	0.047
Southwest Finland	0.902	0.950	0.943	0.098	0.050	0.057	0.048
Northern Savo	0.900	0.950	0.933	0.100	0.050	0.067	0.050
Kymenlaakso	0.900	0.950	0.934	0.100	0.050	0.066	0.050
Kainuu	0.891	0.950	0.937	0.109	0.050	0.063	0.059
Uusimaa	0.889	0.950	0.922	0.111	0.050	0.078	0.061
Päijät-Häme	0.885	0.950	0.932	0.115	0.050	0.068	0.065
Satakunta	0.885	0.949	0.921	0.115	0.051	0.079	0.064
Lapland	0.881	0.949	0.930	0.119	0.051	0.070	0.068
Kanta-Häme	0.880	0.949	0.925	0.120	0.051	0.075	0.069
Southern Ostrobothnia	0.877	0.949	0.941	0.123	0.051	0.059	0.072
Northern Karelia	0.868	0.948	0.923	0.132	0.052	0.077	0.080
Tampere region	0.867	0.948	0.920	0.133	0.052	0.080	0.081
Eastern Uusimaa	0.860	0.948	0.946	0.140	0.052	0.054	0.088
Southern Karelia	0.850	0.947	0.932	0.150	0.053	0.068	0.097
Central Finland	0.838	0.946	0.932	0.162	0.054	0.068	0.108
mean	0.885	0.949	0.932	0.115	0.051	0.068	0.064
max	0.913	0.951	0.946	0.162	0.054	0.097	0.108
min	0.838	0.946	0.903	0.087	0.049	0.054	0.038

Figure 3 plots the technical (gross) inefficiency terms against the fixed effects according to the LLOs. The figure shows that the variation across the fixed effects is wide: from -1.7 in Parikkala to 0.04 in Kauhava. The fixed effects of the LLOs have negative relationship with the technical inefficiency, the correlation coefficient being -0.40. The fixed effects are included in the frontier part of the model, meaning that a higher fixed effect means more hirings. The negative correlation with the inefficiency terms hence indicates that those LLOs that are benefited by higher fixed effects also tend to achieve a higher gross efficiency.

The fixed effects are correlated with the both of the ingredients of technical efficiency. The LLOs with higher fixed effects also tend to have favourable structural factors. The correlation between structural inefficiency and the fixed effects is -0.39. Similarly, the correlation between the fixed effects and net inefficiencies is -0.36. The number of matches due to higher fixed effects is

higher in local labour offices that are more efficient and have a more favourable structure. This implies that the role of efficiency and structure may be higher than estimated, as fixed effects capture the time invariant part of both of them.

Figure 3. Correlation between fixed effects and gross inefficiency



Note. The correlation coefficient is -0.40 at the 0.1% level of significance.

3.3 Inefficiency, aggregate hires and aggregate unemployment

To assess the quantitative role of inefficiency in the matching process, we transform the relative efficiencies obtained above to the number of matches. The effect of net efficiency is substantial. If all LLOs were fully efficient in net terms, ceteris paribus, the number of hirings would increase by 12.6 per cent (Table 4, column 3). Factors related to the quality of job-seeker and vacancy stocks also play a significant role in the achieved number of hirings. If all LLOs shared the same structure of job-seeker and vacancy stocks with Kauhava, where the structure is the most favourable in the whole country, the hirings per month would increase by 7.3 per cent (column 5). This effect is calculated using the national level as a reference point. The effect can also be computed by using the best environment in the region in question as the reference point. Differences in structural factors are also clear within regions, the effect on hirings being 4.4 per cent (column 7).

Table 4. Effects of efficiency differences on hirings

Effects of inefficiency on hirings in an average month	**All LLOs** Hirings own eff.	Increase in H with zero net	%	Increase in H with the best structure	%	**Regional level** Increase in H with the best structure	%
1 Uusimaa	5890	740	12,6	494	8,4	324	5,5
2 Southwest Finland	3130	374	12,0	193	6,2	177	5,6
3 Eastern Uusimaa	560	75	13,4	54	9,7	10	1,7
4 Satakunta	2228	294	13,2	170	7,6	100	4,5
5 Kanta-Häme	1357	165	12,2	101	7,5	31	2,3
6 Tampere Region	3704	504	13,6	312	8,4	181	4,9
7 Päijät-Häme	1501	185	12,3	129	8,6	38	2,5
8 Kymenlaakso	1770	207	11,7	96	5,4	42	2,4
9 Southern Karelia	1203	161	13,3	118	9,8	39	3,3
10 Southern Savo	1814	206	11,4	81	4,5	42	2,3
11 Northern Savo	2600	303	11,6	132	5,1	93	3,6
12 Northern Karelia	1918	241	12,5	148	7,7	77	4,0
13 Central Finland	2360	363	15,4	279	11,8	122	5,2
14 Southern Ostrobothnia	1651	224	13,6	141	8,5	141	8,5
15 Ostrobothnia	1167	140	12,0	58	4,9	25	2,1
16 Central Ostrobothnia	630	74	11,8	34	5,4	24	3,9
17 Northern Ostrobothnia	3078	350	11,4	133	4,3	99	3,2
18 Kainuu	1293	155	12,0	72	5,6	49	3,8
19 Lapland	2689	350	13,0	210	7,8	188	7,0
All	40544	5112	12,6	2954	7,3	1800	4,4

The results on the number of hirings from Table 4 can be used to assess the role of matching efficiencies in the aggregate unemployment rate. This exercise is illustrative, since the calculations are based on a number of simplifying assumptions. The purpose of these simulations is to highlight the relative role of estimated inefficiencies and observed regional characteristics in determining regional and aggregate unemployment.

We assume that the level of participation in the labour force remains stable in all regions, and that people participating in the labour force only move between unemployment and employment. Changes in matching efficiency affect the rate at which the unemployed transit to employment, i.e., the number of hirings. The more efficiently the unemployed are matched with the vacancies, the more unemployed persons move to employment, leading to a decrease in the unemployment rate.

Monthly changes in hirings due to changes in the applied efficiency score are aggregated to the level of one average year of the period (increase in the average monthly hirings from unemployment * 12) and further to the average yearly unemployment rate. The yearly unemployment rate with the increased amount of hirings is calculated in the following way: [(average size of the stock of the unemployed) – (increase in average monthly hirings from unemployment * 12)] / (size of the labour force). This hypothetical lower rate of unemployment is then compared to the average unemployment rate obtained in the research period.

Net inefficiency substantially affects unemployment. The aggregate unemployment rate with a zero level of net inefficiency in all LLOs would be 2.4 percentage points lower than the obtained unemployment rate (Table 5, column 5). The effect is largest in Lapland (4.7 percentage points) and smallest in Uusimaa (1.3 percentage points). The differences in structural factors between LLOs also notably contribute to unemployment. The unemployment effect of the structural inefficiency is 1.4 percentage points (column 7), being largest in Lapland (2.8 percentage points) and smallest in Uusimaa and Ostrobothnia (0.8 percentage points in both of the regions). The differences in structural factors between LLOs within NUTS3 regions also matter (column 9). If all the LLOs within each of the regions shared the structural factors of the most favourable LLO, the aggregate unemployment rate would drop by 0.8 percentage points, the effect being largest in Lapland (2.5 percentage points) and smallest in Eastern Uusimaa (0.3 points).

Table 5. Contribution of net inefficiency and structural inefficiency to unemployment

Unemployment effects			**All LLOs**					**Regional level**	
in an average year	Unemployed job seekers	Size of the labour force	Unempl. rate	Unempl. with zero net	- % -points	Unempl. with the the best structure	- % -points	Unempl. with the the best structure	- % -points
1 Uusimaa	54100	705900	7,7	6,41	1,3	6,82	0,8	7,11	0,6
2 Southwest Finland	21100	222600	9,5	7,46	2,0	8,44	1,0	8,53	1,0
3 Eastern Uusimaa	3300	45000	7,3	5,33	2,0	5,89	1,4	7,07	0,3
4 Satakunta	14000	114700	12,2	9,13	3,1	10,43	1,8	11,16	1,0
5 Kanta-Häme	8100	80600	10,0	7,59	2,5	8,54	1,5	9,59	0,5
6 Tampere Region	25700	222700	11,5	8,82	2,7	9,86	1,7	10,56	1,0
7 Päijät-Häme	12100	96000	12,6	10,29	2,3	11,00	1,6	12,13	0,5
8 Kymenlaakso	10500	88300	11,9	9,08	2,8	10,58	1,3	11,32	0,6
9 Southern Karelia	7800	64500	12,1	9,11	3,0	9,90	2,2	11,36	0,7
10 Southern Savo	10000	76100	13,1	9,89	3,3	11,86	1,3	12,48	0,7
11 Northern Savo	15700	114800	13,7	10,51	3,2	12,30	1,4	12,70	1,0
12 Northern Karelia	12400	77100	16,1	12,34	3,7	13,78	2,3	14,89	1,2
13 Central Finland	17200	121600	14,1	10,57	3,6	11,40	2,7	12,94	1,2
14 Southern Ostrobothnia	10000	91500	10,9	7,99	2,9	9,09	1,8	9,09	1,8
15 Ostrobothnia	6900	82600	8,4	6,32	2,0	7,52	0,8	7,99	0,4
16 Central Ostrobothnia	3700	33700	11,0	8,33	2,6	9,78	1,2	10,11	0,9
17 Northern Ostrobothnia	23200	172000	13,5	11,05	2,4	12,56	0,9	12,80	0,7
18 Kainuu	7500	40300	18,6	13,99	4,6	16,47	2,1	17,16	1,4
19 Lapland	15900	89300	17,8	13,10	4,7	14,98	2,8	15,28	2,5
All	279700	2551700	11,0	8,56	2,4	9,57	1,4	10,11	0,8

4. Conclusions

In this study we examined how differences in the matching efficiencies and the structural factors of local labour offices contribute to regional unemployment rates and the level of aggregate unemployment. The role of matching frictions was scrutinised as a determinant of matches by distinguishing between structural factors, net efficiencies and fixed effects in the matching process.

The results suggest that net inefficiency in the matching process and the differences in structural factors across regions substantially contribute to the aggregate unemployment rate. In particular, if LLOs achieved the full net efficiency, the average aggregate unemployment rate would have dropped by 2.4 percentage points in the research period. Second, if all LLOs shared the same structure of unemployment and vacancies as the most favourable office, the increase in hirings would lower aggregate unemployment by 1.4 percentage points. This suggests that inefficiencies in practises and management processes in local labour offices affect unemployment more than variations in structural factors.

The true fixed effects stochastic frontier model separates all the unobserved time invariant heterogeneity from inefficiency. This raised the question of the role of fixed effects in the matching function and the relationship of the fixed effects with inefficiency as well as that with the structural factors. We find that the fixed effects and efficiencies are positively correlated. The number of matches due to higher fixed effects is higher in local labour offices that are more efficient and have a more favourable structure. This implies that the role of efficiency and structure may be higher than estimated, as the fixed effects capture the time invariant part of both of them.

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Appendix *Minimum and maximum gross and net efficiency scores within the NUTS3 Regions.*

LLO	Gross efficiency	Net efficiency	NUTS3 Region
Vihti	0,922	0,952	Uusimaa
Kirkkonummi	0,833	0,946	
Paimio	0,937	0,952	South-West Finland
Uusikaupunki	0,876	0,949	
Porvoo	0,867	0,948	Eastern Uusimaa
Loviisa	0,853	0,947	
Eura	0,922	0,952	Satakunta
Rauma	0,828	0,945	
Hämeenlinna	0,900	0,950	Kanta-Häme
Janakkala	0,847	0,947	
Virrat	0,904	0,951	Tampere Region
Kangasala	0,815	0,944	
Heinola	0,898	0,950	Päijät-Häme
Lahti	0,873	0,949	
Kotka	0,916	0,951	Kymenlaakso
Kuusankoski	0,860	0,948	
Lappeenranta	0,890	0,950	Southern Karelia
Parikkala	0,821	0,945	
Pieksämäki	0,928	0,952	Southern Savo
Mäntyharju	0,901	0,950	
Kiuruvesi	0,926	0,952	Northern Savo
Juankoski	0,841	0,947	
Joensuu	0,914	0,951	Northern Karelia
Ilomantsi	0,806	0,944	
Saarijärvi	0,886	0,949	Central Finland
Karstula	0,714	0,933	
Kauhava	0,939	0,952	Southern Ostrobothnia
Lapua	0,779	0,940	
Vaasa	0,918	0,951	Ostrobothnia
Pietarsaari	0,894	0,950	
Kaustinen	0,919	0,951	Central Ostrobothnia
Kokkola	0,899	0,950	
Raahe	0,931	0,952	Northern Ostrobothnia
Haukipudas	0,876	0,949	
Sotkamo	0,933	0,952	Kainuu
Hyrynsalmi	0,858	0,947	
Ylitornio	0,934	0,952	Lapland
Sodankylä	0,832	0,946	
All, on average	0,885	0,949	

Endnotes

i The question of the cyclical responsiveness of regional unemployment to changes in the national rate has been widely investigated since the pioneering work of Thirlwall (1966) and Brechling (1967).

ii Migration can even strengthen regional income disparities through brain-drain from lagging to leading regions; see Ostbye and Westerlund (2007).

iii Regional unemployment differences are found to be more persistent in Europe than in the USA; for country analysis and comparisons, see Blanchard and Katz (1992), Broersma and van Dijk (2002), Decressin and Fatas (1995), Pehkonen and Tervo (1998), Jimeno and Bentolila (1998), Fredriksson (1999) Pekkala and Kangasharju (2002) and Rowthorn and Glyn (2006).

iv Blanchard and Diamond (1989, 1990) concluded that in the U.S. labour market, short- and medium-term fluctuations in unemployment have mainly been due to aggregate activity shocks rather than to changes in the degree of reallocation intensity related to the matching of jobs and workers. See also Albaek and Hansen (2004) for more recent findings.

v The Åland Islands are left outside the analysis due to their exceptional labour market conditions.

vi Kangasharju, Pekkala and Pehkonen (2005) suggest that this level of regional disaggregation suits this type of analysis better than the national or LLO level.

vii Lahtonen (2006) combines several sources of data to estimate the market share of local labour offices. Statistics Finland figures from quarterly surveys suggest that in 2002-2005, 59 per cent of all open vacancies were announced in labour offices. Annual questionnaires to employers suggest that 60 per cent of vacancies were announced in LLOs during 1993-2002. Pension Security Centre has estimated that the total number of filled vacancies during the period 1992-2001 exceeded the number of filled vacancies at LLOs by about 50 per cent.

viii Different measures of hirings are used, for example, in Warren (1996), Mumford and Smith (1999), Anderson and Burgess (2000). The unemployment outflow measure is used in Burgess (1993), Burda and Wyplosz (1994), Broersma (1997), Eriksson and Pehkonen (1998) and Ilmakunnas and Pesola (2003). Filled vacancies are employed in Gorter and van Ours (1994), Coles and Smith (1996), Kangasharju, Pekkala and Pehkonen (2005) and Coles and Petrongolo (2008). Both of the latter measures are utilised in Broersma and van Ours (1999), Burgess and Profit (2001), Gregg and Petrongolo (2005).

ix Data on new hirings are not available and data on vacancy outflow are problematic, since a large number of job matches are transitions from other jobs or from outside the labour force into employment. Akerlof, Rose and Yellen (1988) record that in the US, flows between jobs account for 15 per cent, hirings from unemployment 45 per cent and hirings out of the labour force 40 per cent of the total flows. A recent study by Fallick and Fleischman (2001), in turn, reported that in about 40 per cent of all separations, employed workers leave one employer for another. The labour markets in Finland share similar features: in 2001-2002 flows between jobs accounted for about 42 per cent of all hirings, whereas hirings outside the labour force and unemployment were both around 27 per cent; see Hämäläinen (2003).

[x] The use of flow vacancy information would necessitate the use of a stock-flow specification and estimation procedures; see Gregg and Petrongolo (2005) for a recent example.

[xi] Job seekers are defined as all those registered as such at the local employment office. To be classified as unemployed it is necessary that the individual is actively seeking a job and is not currently employed, i.e. he/she is either fully unemployed or temporarily laid off and not receiving pay. Job seekers also include those who are working but hope to switch jobs, are threatened by unemployment, or are in subsidized jobs and looking for other types of employment. Job seekers not currently in the labour force may include students, persons doing household work or in the armed services looking for a job. Finally, job seekers also include those who are working a shortened week or are on a disability pension.

[xii] The volume of ALMP follows a modest counter-cyclical pattern with some differences across administrative regions; for statistics, see the Finnish Labour Review (4/ 2008).

xiii See Petrongolo and Pissarides (2001), Kangasharju, Pehkonen and Pekkala (2005) and Ilmakunnas and Pesola (2003).

xiv For inefficiency regressors in the SFA model, a positive coefficient means a negative effect on efficiency, and a negative coefficient a positive effect on efficiency: inefficiency = -(ln efficiency)

xv See, e.g., Pissarides (1992), Burgess (1993) Blanchard and Diamond (1994), van Ours (1995), Anderson and Burgess (2000) and Eriksson and Lagerström (2006).

xvi Our results imply that the efficiency ranking of the regions has remained relatively stable over the period. Although the Spearman rank correlation between the gross efficiency estimates in 1995 and 2004 is only 0.35, Southern Savo being at the top in 1995, while Southern Ostrobothnia took first place in 2004, differences between regions are small, and they have notably decreased together with the continuous positive development of efficiency and a positive time trend.

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