Matching Efficiency in the Italian Regions.
Some Frontier Estimates.

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ABSTRACT: In this paper we consider the unemployment-vacancy relationship across Italian regions and estimate it as a production frontier for recent years. We rely on recently released data from the ISTAT Labour Survey and the ISAE series on labour scarcity. We extend upon existing evidence, providing estimates of matching efficiency across the Northern area and examining the performance of the labour markets within four main territorial areas (North-West, North-East, Centre and Mezzogiorno) throughout 1992:4-2003:4.

Keywords: matching function, matching theory, dual labour markets
JEL-Code: J63, J64, E64, J43.

1. Introduction

In the last two decades, a very rich literature (both theoretical and empirical) developed from the theory of matching proposed in Pissarides (1990). In this literature, labour market transactions are supposed to be characterised by high costs and co-ordination problems, originating difficulties in the matching between jobs and workers and bringing about the existence in the same labour market of unemployment and vacancies. Hence the interest of the framework for the Italian labour market, well known for being characterised by serious regional and skill mismatch. (Brunello et al., 1999; Sestito, 1991b). In this paper we consider the unemployment-vacancy relationship across Italian regions and estimate it as a production frontier for recent years. We examine data from 1992:4 to 2003:4, measuring vacancies through the ISAE labour scarcity indicator.

The matching function, re-parameterised as a Beveridge Curve, is modelled and estimated as a production frontier. In empirical labour economics the efficiency of labour markets has often been analysed through matching functions. Furthermore,

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the interpretation of the matching function as a production function is quite common, and some research has been devoted to unveiling the micro foundations of this ”black box” (Petrongolo and Pissarides, 2001). However, only recently the matching function has been used for analysing matching efficiency with the tools of production frontier analysis (after the seminal contribution of Warren, 1991, see Ibourk *et al.*, 2001, for France; Fahr and Sunde, 2002, for Germany; Ilmakunnas and Pesola, 2003, for Finland).

The paper has the following structure. Section 2 considers the relationships between matching functions and production frontiers, while the Italian empirical literature on the Beveridge Curve is surveyed in Section 3. The empirical specification is presented in Section 4. Data and results are commented in Section 5. Section 6 contains some concluding remarks.

2. Matching Functions and Production Frontiers

The matching function is based on the idea that the existence of frictions on the labour market implies that firms (jobs) and workers can match each other only with some delay (this account is largely based on the approach developed in Pissarides, 1990). New matches between workers and jobs produce new hirings, a process which can be described by the following function:

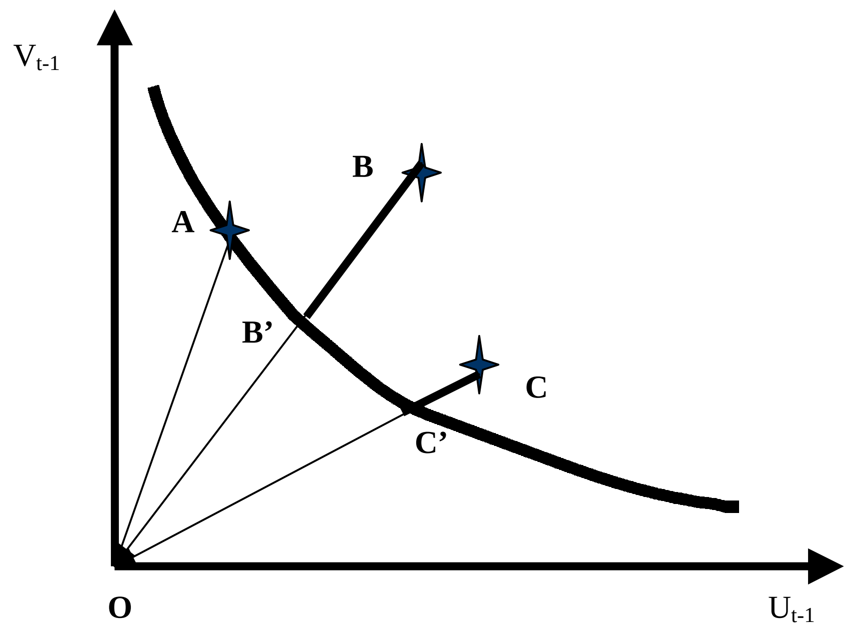
(1) $H_{it} = h\,(U_{it-1}, V_{it-1})\,e_{it}$

where *i* are the units defining the labour market (areas, industries, occupations, …), *t* is the time period, H are hirings, U the number of job-seekers (here proxied by the unemployed) and V the number of vacancies. Higher levels of e_{it}, usually defined in the literature as the efficiency term, bring about higher H_{it} levels, for given U_{it-1} and V_{it-1} stocks. This term is influenced by the search intensity of firms and workers, by the effectiveness of search channels, by the labour mismatch across micro markets defined over areas, industries or skills. Obviously, it is extremely important to ascertain whether e_{it} varies across time and categories.

Some interesting contributions have been appearing in the empirical analysis of the matching function, which exploit the deep conceptual and analytical resemblance between this function and the commonly adopted production function. Consider again equation (1). If the estimation of this function concentrates upon the term e_{it}, its evolution and its determinants, then the analysis can profit of the methodologies developed in the field of the stochastic production frontiers (see in particular Kumbhakar and Lovell, 2000).

Stochastic production frontiers are based on the assumption that the technical efficiency of a productive unit is measured by the distance between the input and output mixes observed for the unit itself and the input and output mixes on the point of the production frontier relevant for the observed unit. In the case of the matching function, consider Figure 1, where various mixes of U_{t-1} and V_{t-1}, all of them capable of producing the output H_{0t}, are considered along an isoquant.

Figure 1 – The Matching Function as an Isoquant



Obviously, the U_{t-1} and V_{t-1} combinations on the isoquant are efficient points. For each value of U_{t-1} on the isoquant they single out the minimum V_{t-1} value consistent with obtaining H_{0t}, and conversely for each U_{t-1} value. It will always be possible to obtain H_{0t} for U_{t-1} and V_{t-1} values higher than those on the isoquant, but this will not be technically efficient. Then, both points B and C are inefficient, while A is technically efficient. Adopting the measure of technical efficiency proposed in Farrell (1957), that is the largest radial input contraction consistent with obtaining a given output (in this case H_{0t}), the technical efficiency of C is OC'/OC, that of B is OB'/OB and that of A is OA/OA. The latter, being fully efficient, has an efficiency score equal to one. On the other hand, the technical efficiency of C is higher than that of B, which is situated further away from the isoquant.

The literature treating matching functions within the frontier approach is still rather recent. The seminal contribution is Warren (1991). Three much more recent studies have been carried out for European countries. All these studies share the assumption of a Cobb-Douglas functional form for the matching function. They fundamentally differ for the data-sets utilised and the variables considered in the explanation of inefficiency.

Ibourk *et al*. (2001) consider monthly data for the 22 French regions from March 1990 to February 1995. They include in the estimates (beside a linear trend), a rather considerable number of potential determinants for inefficiency. Their results suggest the existence of wide regional differences in efficiency and that on average a decline in efficiency occurs over the time period considered. The hypothesis of constant returns to scale for the matching function is not rejected. The potential efficiency determinants considered in Ibourk et al. (2001) explain about 30% of the variability in efficiency (across both time and space). Interestingly, the decline occurring in open-end contracts over the time period considered has apparently little impact on hirings.

Ilmakunnas and Pesola (2003) consider annual data for the 14 Finnish regions from 1988 to 1997. They too include in the estimates a linear trend and allow for some potential determinants of inefficiency. Among the latter of particular interest are the average unemployment and vacancy rates of the neighbouring regions. The authors believe that in this way allowance can be made for the spillover effects recently highlighted by Burda and Profit (1996), Burgess and Profit (2001). Indeed, the average unemployment and vacancy rates of the neighbouring regions enter significantly and with the expected signs in the estimates (the average unemployment rate of the neighbouring regions has a negative impact on efficiency, while the average vacancy rate has a positive impact).

The analysis by Fahr and Sunde (2002) is based upon two different sets of German annual data, relating to the occupational as well as to the territorial dimension of matching. In the first case 117 local labour markets are considered from 1980 to 1997. In the second case data are taken from 1980 to 1995 for 82 occupational groups. The results suggest that, both across areas and occupations, wide efficiency differentials exist. Furthermore, like in the studies surveyed above, average efficiency seems to decrease over time.

3. Vacancies and Unemployment in Italy. The Empirical Literature

In Italy there are no official data on vacancies. However, there are two surveys allowing the empirical appraisal of the relationship between vacancies and unemployment, also over a regional dimension. The CSA (Centro di Studi Aziendali, Florence) and the ISFOL, Rome, carry out a survey on the help-wanted ads published in some important daily newspapers. Another data source relates to the quarterly business survey carried out by ISAE (formerly ISCO) in manufacturing. Among other things, firms are asked whether the scarcity of labour prevents them from expanding their activity. Furthermore, until 1999 it was also possible to utilise another (administrative) source: the data from the Ministry of Labour (*Ministero del Lavoro e della Previdenza Sociale*) relating to the vacancy notices posted by the firms carrying out some types of hirings (usually firms only posted these notices when they already had actually decided upon the hiring).

Perhaps because of the absence of official data on vacancies, not many studies have examined in Italy the nature and evolution of the Beveridge Curve. Sestito (1988) and Bragato (1990) utilise the ISFOL-CSA data on vacancies, and find a significant relationship between unemployment and vacancies only in the presence of a growing linear trend. Bragato (1990) also finds a significant Beveridge Curve for the North and the Centre, but not for the South. A significant difference between the Southern labour market and the rest of the country also shows up in Sestito (1991a), where vacancies are measured using the data from the ISAE survey. In this case, however, there is no need to include any linear trend in the estimates to find a significant relationship between unemployment and vacancies. The analysis in Di Monte (1992) is based on a similar econometric specification, but utilises the Ministry of Labour data on vacancies. The main difference in the results obtained by Di Monte relative to previous evidence is that a significant Beveridge Curve also shows up for the South.

More recent evidence is provided by Mocavini and Paliotta (2000), who examine Beveridge Curve plots based on the ISFOL-CSA data, and by Destefanis and Fonseca (2004). Only in the latter study a direct comparison of the three vacancy indicators is carried out, obtaining, at least as far as the 1990s are concerned, substantially consistent results. The recent evidence is largely similar to the previous one. A Beveridge Curve shows up also in the 1990s, with some outer shift over this period. Also similarly to previous works, the Southern labour market behaves somehow differently from the rest of the country.

Finally there are some studies that evaluate measures of labour market mismatch without proceeding to the estimation of Beveridge Curves. Padoa-Schioppa (1991) finds that mismatch worsens over the 1980s. In that paper, the ISAE indicator was used within a macroeconomic rationing model. Sestito (1991b) utilises the ISFOL-CSA vacancy measure to compute various mismatch indices for the 1979-1990 period, for the whole country as well as for the three main areas, also finding that mismatch increases after the mid 1980s.

4. The Econometric Specification

Equation (1) can be utilised not only for measuring the distance of each observation from the isoquant, but also to assess which factors determine the efficiency of these observations. Consider the following panel specification (without any loss of generality, we assume a Cobb-Douglas functional form):

$$(2)\ h_{it} = \alpha + \mathbf{x}_{it-1}\beta + \varepsilon_{it} - \upsilon_{it}$$

h_{it} is the natural log of H_{it}; $\mathbf{x}_{it-1}$ is the vector containing the natural logs of U_{it-1} and V_{it-1}; β is a parameter vector; ε_{it} is a stochastic variable assumed to be iid. N $(0, \sigma_\varepsilon^2)$ and independent from $\mathbf{x}_{it-1}$ and υ_{it}. The latter is a stochastic non-negative variable measuring technical inefficiency (the complement to one of the Farrell definition of technical efficiency). It is customary to make some assumptions about the variation of the inefficiency terms through time. For instance the model proposed in Cornwell *et al*. (1990) assumes that:

$$(3)\ \alpha - \upsilon_{it} = \alpha_{it} = \delta_{i1} + \delta_{i2}\, t + \delta_{i3}\, t^2$$

This model can be easily estimated through a within procedure. Hence, if we define $\hat{\alpha}_t = \max_i \{\hat{\alpha}_{it}\}$, from the within estimates of this model one obtains the following measure of technical efficiency for observation *i* at time *t* :

$$(4)\ TE_{it} = \exp\{-\hat{\upsilon}_{it}\} = \exp\{\hat{\alpha}_t - \hat{\alpha}_{it}\}$$

Through the terms $\delta_{i1} + \delta_{i2}\, t + \delta_{i3}\, t^2$ this model nests the explanation of inefficiency within the estimation of the production function. More can be done in this sense, including in (2), beside the $\mathbf{x}_{it-1}$ vector, a $\mathbf{z}_{it}$ vector of variables potentially determining the technical efficiency of observation *i* at time *t*. Usually this is done along the lines suggested in Kumbhakar et al. (1991), Battese and Coelli (1995): the **z** variables are supposed to shift the mean of υ_{it}. However, these attractive models cannot be implemented here as they produce biased results in the presence of heteroskedasticity, and the residuals of our estimates turn out to be quite severely heteroskedastic. The model proposed in Reifschneider and Stevenson (1991) is not much of help. The existence of heteroskedasticity makes it generally not possible to compute the marginal effects of the **z** variables on efficiency (Wang, 2002), which would seriously impair our quantitative evaluation of the Treu Act effects.

The simple dynamic specification of (2) contrasts with the sometimes complex dynamic structure of the relationship between vacancies and unemployment (see for instance the Beveridge Curves surveyed in Section 3). In order to facilitate the empirical search for an appropriate dynamic specification, we re-parameterise the matching function as a Beveridge Curve. This also has the advantage of making our estimates easier to compare with previous Italian evidence. In order to re-parameterise the matching function as a Beveridge Curve we must assume constant returns to scale for the matching function and the existence of a steady state with constant average rate of unemployment. It is commonly believed that these assumptions are not particularly restrictive. Under the hypothesis of constant returns to scale, equation (1) becomes:

$$(5)\quad H_{it} / U_{it-1} = h\,(V_{it-1} / U_{it-1})\, e_{it}$$

In its turn, this function can be rewritten as:

$$(6)\quad (H_{it} / N_{it-1})\,[\,(L_{it-1} / U_{it-1}) - 1\,] = h\,[\,(V_{it-1} / L_{it-1}) / (U_{it-1} / L_{it-1})\,]\, e_{it}$$

In a steady state with constant rate of unemployment, the hiring rate (H_{it} / N_{it-1}) is equal to $s + g$, where s is the separation rate and g is the rate of growth in the labour force, L. Hence equation (6) becomes an inverse relationship between the unemployment and the vacancy rates, the Beveridge Curve, whose position depends on s, g, and e_{it}. The interpretation of the last term does not change vis-à-vis equation (1); however empirical measures of efficiency will reflect the evolution not only of e_{it}, but also of s and g. Below, we keep this in mind when interpreting our results.

Following customary praxis, a Cobb-Douglas functional form was initially assumed for the Beveridge Curve. Actual estimation of the Curve suggested however that slightly different functional forms sometimes gave better results. Because of the notorious presence of loops in the Beveridge Curve, we proceeded to a careful dynamic specification search within an error correction mechanism, where the log differences of the dependent variable depend not only on current and lagged log differences of other variables (as well as of the dependent variable itself), but also on lagged *levels* of the dependent variable and of other variables. For the sake of clarity, we write below an equation almost identical to the most successful empirical specifications obtained in estimation:

$$(7)\quad \Delta u_{it} = \beta_1 \Delta u_{it-4} + \beta_2 u_{it-1} + \beta_2 V_{it-j} + \sum_{i=1}^{4} \beta_{2+i} C_i + \sum_{i=1}^{4} \beta_{7+i} T_i + \sum_{i=1}^{4} \beta_{11+i} T^2{}_i$$

where i = 1, 2, 3, 4 stands for the territorial area, and t for the time period (quarter). In (7) the log differences of the rate of unemployment are a linear function of their own one- and four-quarter lagged values, of the one-quarter lagged natural log of the rate of unemployment, of a function of the vacancy rate taken at an unspecified lag,[2] and of a variable vector standing for the potential determinants of matching efficiency. This vector will always include, following the suggestions from Cornwell et al. (1990), a constant term, C, a linear trend term, T, and a quadratic trend term, T^2, for each one of the four territorial areas considered.

5. The Estimates

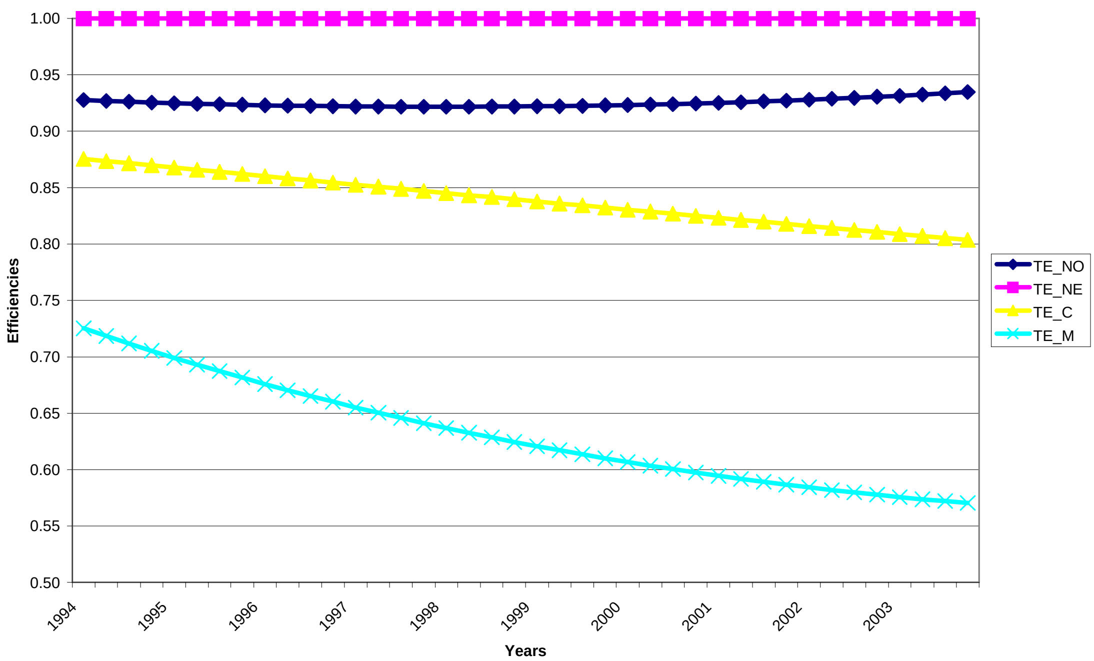
The unemployment data are taken from the quarterly Labour Force Survey from ISTAT (*Indagine trimestrale sulle forze di lavoro*). We utilise data only from 1992:4 onwards because of a very important change in surveying methods occurring at this date, and rely on a recent release from ISTA which provides consistently measured data. In order to measure vacancies we adopt a very recent release of the ISAE indicator of labour scarcity. While the ISAE survey relates to manufacturing only, it was found to perform very well in Destefanis and Fonseca (2004). We consider data for the four main territorial areas of Italy: North-West, North-East,

[2] The nature of the function and the order of the lag will be specified below.

Centre and Mezzogiorno). As we want to compare our estimates with previous evidence, we constrain the level of territorial disaggregation of our analysis.

In order to save space we report in the Appendix only the most significant results. We find evidence largely favourable to the existence of a Beveridge Curve in the 1990s across the main territorial areas. Notice however that a semi-log specification was preferred by the data to the Cobb-Douglas (which gave in any case very similar results). The hypothesis that the slope of the Curve is the same across regions cannot be rejected.[3] However, huge differences show up between the Mezzogiorno and the rest of the country. The Southern labour market turns out to be much less efficient than that of the other areas. In Figure 2 we depict throughout the estimation period the efficiency scores for the four areas. The North-East turns out to be always on the efficiency frontier, with the North-West as a close second.

Figure 2 – The Evolution of Labour Market Efficiency



Efficiency varies from 88 to 80% in the Centre and from 73 to 57% in the

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[3] We tested for this hypothesis allowing the vacancy coefficients to differ across areas. The test values, available on request, do not reject the null hypothesis of a common coefficient.

Mezzogiorno. On the whole, efficiency decreases over the sample period.

7. Concluding Remarks

In this paper we the unemployment-vacancy relationship across Italian regions and estimate it as a production frontier for recent years. We mainly rely on series from the ISTAT Labour Survey and on the ISAE data on labour scarcity. We extend upon existing evidence, providing estimates of matching efficiency across the Northern area and examining the performance of the labour markets within four main territorial areas (North-West, North-East, Centre and Mezzogiorno) throughout 1992:4-2003:4. We find largely favourable evidence to the existence of a Beveridge Curve in the 1990s across the main territorial areas. Huge efficiency differences show up between the Mezzogiorno and the rest of the country.

In future work, we plan to get more robust evidence on these matters by providing estimates of matching efficiency across the 20 Italian administrative regions, and comparing unrestricted estimates of the matching function with estimates of the function re-parameterised as a Beveridge Curve In this manner we could shed light upon the role of constant returns to scale and of long-run constancy of separation rates in the measurement of matching efficiency.

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TABLE A.1

Dependent variable: Δu_{it} (measure of vacancies: ISAE Indicator of Labour Scarcity)

	Coeff.	*t-ratio*
Δu_{it-4}	-0.15	-1.61
u_{it-1}	-0.41	-5.12
V_{it-1}	-0.96	-3.20
C_NO	-0.99	
C_NE	-1.07	
C_C	-0.94	
C_M	-0.75	
T_NO	0.0010	0.31
T_NE	0.0016	0.04
T_C	0.0023	0.75
T_M	0.0098	3.46
T^2_NO	-0.0002	-2.15
T^2_NE	-0.0001	-1.45
T^2_C	-0.0001	-2.04
T^2_M	-0.0002	-3.84
Treu_NO		
Treu_NE		
Treu_C		
Treu_M		
Adjusted R^2	0.21	

LEGEND OF TABLES AND FIGURES:

Subscripts i = NO, NE, C, M stand for North-West, North-East, Centre and Mezzogiorno, and t is a given quarter.
All variables are deseasonalised.
The sample relates to the 1994:1 - 2003:4 period, for a sum total of $40 \times 4 = 160$ observations.
T-ratios are obtained from variance-covariance matrices corrected for heteroskedasticity through White procedure.
Adjusted R^2 is the coefficient of determination corrected for degrees of freedom.

Figure 2: the efficiency scores were calculated applying expression $\delta_{i1} + \delta_{i2} t + \delta_{i3} t^2$ to the Beveridge Curve of Table A.1.