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Beveridge Curve, Job Matching and Labour Market Dynamics: a Multi-Level Empirical Analysis

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Coordinatore
Prof. Sergio Pietro DESTEFANIS

Relatore:
Prof. Sergio Pietro DESTEFANIS

Candidato:
Dott. Francesco A.D. Addesa

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Introduction and Main Results

The aim of this thesis is to contribute to the debate on the Beveridge Curve: more specifically, after providing a theoretical introduction to the Curve in Chapter I, we focus on some empirical points, concerning globalisation and technological progress, which the international empirical literature has not dealt with closely (Chapter II), and on a level analysis which no previous study has dealt with in the Italian literature (Chapter III).

Chapter I centres on the matching approach founding the studies on the Beveridge Curve since the late 1970's, it also mentions the recent production frontier approach and gives a look to the possible consequences of the Great Recession on the matching process and the Curve.

The aim of Chapter II is to test the existence of a Beveridge Curve analysing the economies of nineteen OECD countries from 1980 to 2004, and to investigate whether and how technological progress and globalisation affect the unemployment-vacancies trade-off. Indeed, in the literature concerning the Beveridge Curve, only a few contributions (Pissarides, 1990; Aghion and Howitt, 1994) have examined the role of technological progress as a significant shift factor for labour market performance. However, there is no unanimity about the sign of its impact. Furthermore, few economists would deny that globalisation, that is the growing international interdependence in communications, trade, finance, labour markets (migration), social systems, is one of fundamental socio-economic phenomena of this turn of century. Consequently, globalisation is another factor which is expected to impact on the Beveridge Curve, but no full-fledged estimation has, to the best of our knowledge, ever been carried out of this nexus. We can sum up the main results as follows: a) we find largely favourable evidence for the existence of a OECD Beveridge Curve; b) lagged values of technological progress impact positively on unemployment and shift the Beveridge Curve outwards, producing evidence in support of the creative destruction effect; c) lagged values of the globalisation index have a positive impact on unemployment, also shifting the Beveridge Curve outwards; d) a critical econometric issue, extremely neglected by the previous literature, is represented by endogeneity, as shown by tests and other kind of evidence.

Finally, Chapter III focuses on the Italian labour market. There are not many studies that have analyzed the Beveridge Curve in Italy, likely because of the lack of official data on vacancies. Moreover, no previous study has focused specifically on a regional level analysis of the Beveridge Curve. Chapter III aims at filling this gap of the literature using quarterly data for the 1992-2009 period. In particular, the ISAE labour scarcity indicator, which is available for all the regions, is used to build regional vacancy rates. Like in Destefanis and Fonseca (2007), we also investigate the impact on matching efficiency of the recent strong development in the number of so-called atypical jobs (both part-time and temporary). Differently from these authors, as well from most of the previous literature, we allow for the role of some direct mismatch indicators. Furthermore, drawing inspiration from some studies about other countries, we investigate the existence of a significant spatial inter-dependence between Italian regional labour markets, trying to verify whether externalities by non-resident unemployed workers and from job openings in neighbouring regions impact on the labour market performance of each region. We find the following main results: a) there is no evidence that either gender or sectoral mismatch bring about shifts in the territorial Curves; b) on the other hand, spillover effects are very strong, although further research on their proper specification must be yet carried out; c) the Great Recession has a very strong (negative) impact upon the territorial Curves.

Chapter I. The Beveridge Curve: Analytical Foundations and Recent Developments

1.1. Introduction

Since William Beveridge first highlighted the existence of a negative relationship between unemployment and job vacancies, the Beveridge Curve has been frequently used to sum up the state of the labour market. The efficiency at which workers are matched to available jobs is crucial for the duration of unemployment spells and the capability of the economy to make use of its resources. Due to frictions deriving from factors, such as coordination failure, heterogeneities or congestion from large numbers, the matching process is imperfect. For instance, even if there are unsatisfied vacancies around, a mismatch between the skills supplied by workers and demanded by employers can prevent the completion of a working contract.

For a fixed matching technology, the Beveridge Curve postulates a negative relationship between the unemployment rate (u) and the rate of vacancies (v), both rates being measured in terms of labour force. It is important to note that we do not interpret this relationship in a structural sense as it is not derived from optimization behaviour of individuals: indeed, the curve shows an empirical correlation arising indirectly from the decision of workers and employers regarding hiring and firing, accumulation of human capital etc. (Blanchard and Diamond, 1989). In periods of rising economic activity, vacancies increase; thus, it is easier for the unemployed to find a job and this will push unemployment rate down. Likewise, in periods of weak activity, vacancies are closed and new workers enter the unemployed population. Whereas movements along a Beveridge Curve reflect adjustments over the business cycle, shifts are usually considered an evidence of structural change. In general, the position of the Beveridge Curve in the (u, v) space is related to the degree of frictions in the labour market. The closer the curve to the origin, the smaller are the frictions and the more efficient is the matching function. This chapter aims at providing a theoretical introduction to the Beveridge Curve and is structured as follows: Section 2 focuses on the matching approach founding the studies on the Beveridge Curve since the late 1970's; in Section 3 we proceed to derive the Beveridge Curve following Pissarides (2000); Section 4 deals in detail with the shifts of the Beveridge Curve; Section 5 presents the recent production frontier approach, whereas Section 6 gives a look to the possible consequences of the Great Recession on the matching process and the Curve. Section 7 contains some concluding remarks.

1.2. The Matching Approach

A stable negative relationship between unemployment and job vacancies was found out by William Beveridge (1944), and was called for that reason Beveridge Curve. The first studies on the Beveridge Curve did not consider the existence of a matching function and aimed at developing a more robust equilibrium unemployment theory, due to the high interest in the Phillips Curve and the natural unemployment rate theory[1].

The appearance of the matching models starting from the late 1970's-early 1980's[2] linked the study of the Beveridge Curve to the matching function and yielded new analyses aimed at understanding the dynamics of employment and unemployment in modern labour markets.

Matching models are nowadays one of the most important theoretical and analytical tools for the study of unemployment through the business cycle unemployment, as well as for assessing the impact of policy interventions in labour markets. Indeed, they seem to empirically succeed in explaining what goes on in labour markets (Pissarides, 2000). In empirical labour economics the efficiency of labour markets has often been analysed through matching functions. The matching approach is justified by the awareness that modern labour markets are characterized by large flows of workers and jobs

[1] See Dow and Dicks-Mireaux (1958), Holt and David (1966), Hansen (1970).
[2] See for example Hall (1979), Pissarides (1979), Diamond and Maskin (1979), Bowden (1980).

(employment inflows and outflows, job positions creation and destruction) and mainly aims at deriving an empirically realistic equilibrium unemployment theory. The recognition of the importance of these flows for unemployment persistence is the rationale for the crucial concept of matching models: the matching process between job-seeker workers and vacancies posted by firms. As search activity by both workers and firms is decentralized, not coordinated and takes time and other real resources, this process is imperfect, in sense that the worker-job match is not immediate due to frictions such as search externalities, heterogeneities in the skills possessed by workers and those required by firms or in the location of jobs and workers and in the timing of job creation, imperfect information, coordination failures, etc. Particularly important are the search externalities, also called congestion externalities: a firm posting a new job vacancy yields positive externalities for job-seekers, making it is easier to find a job, and negative externalities for the other firms, making it is more difficult to fill their own vacancies. In this environment, there is uncertainty about the possibility that job-seekers find good jobs and hiring firms find good workers, and firms and workers have to decide whether to take up what is available, wait for a better alternative or affect the matching process by spending resources on the acquisition of information, retraining employees or changing location.

The matching function provides the outcome of the investment of resources by firms and workers in the trading process and is a modelling device which captures the implication of the trading process without making the heterogeneities and other features, that cause the process itself, explicit. The key idea is that a complex trading process can be summarized by a well-behaved function which yields the number of jobs created at any moment in time as a function of the number of workers looking for a job, the number of firms looking for workers and a small number of other variables. In this sense, it is conceptually similar to a production function, with unemployed and job vacancies as inputs and job matches as the output.

The interpretation of the matching function as a production function is quite common, and a considerable amount of research has been devoted to revealing the micro foundations of this "black box" (Petrongolo and Pissarides, 2001). In this chapter we present a theoretical analysis of the Beveridge Curve based on Pissarides matching model (2000). This model is very attractive for several reasons, as it provides an appealing description of how the labour market works, is analytically tractable, has rich and intuitive comparative statics and can be easily adapted to study a number of labour market policy issues. There are other definitions of the relationship between unemployment and vacancies, which we shortly mention: a) the Bowden model (1980), based on the constant-level equilibrium unemployment rate; b) the Blanchard and Diamond model (1989), based on constant-level unemployment rate and vacancies; c) the definition of Beveridge Curve in rationing models, based on the idea of frictionless micro-markets (Lambert, 1988).

1.3. The Theoretical Matching Model

1.3.1. Deriving the Beveridge Curve

Assume the economy produces only one good consumed by pairs of risk-neutral workers and employers. They decide what to do with full knowledge of the job-matching and job-separation processes but do not coordinate their actions: each firm or worker operates as an atomistic competitor. The equilibrium considered is a full rational expectations equilibrium, where firms and workers maximize their respective objective functions, subject to the matching and separation technologies, and where the flows of workers into unemployment is equal to the flow of workers into unemployment: these assumptions warrant that there is a unique unemployment rate at which the two flows are equal. The matching process considers two different types of both workers and firms. Each worker who already has a job is defined employed, *N*, whereas each worker who is searching for a job is defined ad unemployed, *U*: if the total labour force, *L*, is normalized to one for the sake of analytical convenience, then U = *1-N*. Firms both take part in the existing job matches and seek new employees as well. The firm's effort to find an employee is proxied by the number of vacancies, *V*. The number of new hires, *M*, is determined in each period by the matching function, which displays the effectiveness of the technology that brings workers searching for jobs together with employers searching for workers and depends on the search effort of both workers and firms. The matching function is increasing in both its arguments, concave and homogeneous of degree one (constant returns to scale):

(1)
$$M = em(V, U)$$
$$m(v, 0) = 0, m(0, u) = 0$$
$$m_u \geq 0, m_v \geq 0$$

where *e* captures the effectiveness of the search intensity of both firms and workers in creating new job matches and can be influenced by structural changes in the labour market (labour force reallocation). Thus, this efficiency term is considered as a mismatch indicator and reflects both shocks (causing occupational, sectoral, skill and regional mismatch between unemployed and vacancies) and labour market institutions. First-degree homogeneity is an important property and is empirically supported and reasonable, since in a growing economy constant returns ensure a constant unemployment rate along the balanced-growth path.

Moreover, assume that matches between vacancies and unemployed occur randomly after an arbitrarily short period of time: hence, the process that changes the state of vacant jobs follows a Poisson process with rate $q(\theta) = M/V$, that is the probability a vacant job is matched to an unemployed worker, so the mean duration of a vacant job is $1/q(\theta)$. Unemployed workers move into employment according to a related Poisson process with rate $\theta q(\theta) = M/U$, that is the probability an unemployed finds a job: the mean duration of unemployment is $1/\theta q(\theta)$. Therefore, unemployed workers find jobs more easily when there are more jobs relative to the available workers, and firms with vacancies find workers more easily when there are more workers relative to the available jobs. The process which defines the transition out of unemployment is related to the process which defines the filling of jobs by the fact that jobs and workers meet in pairs. Due to the homogeneity of the matching function, $q(\theta)$ and $\theta q(\theta)$ are functions of the vacancies-unemployment ratio θ, that is an appropriate measure of the tightness of the labour market. Thus, unemployed workers find jobs more easily when there are more jobs relative to the available workers, and firms with vacancies find workers more easily when there are more workers relative to the available jobs. The dependence of the functions $q(\theta)$ and $\theta q(\theta)$ on the relative number of traders is an example of trading externalities defined as congestion effects, as they are caused by the congestion that searching firms and workers cause for each other during trade. They arise because, during trade, price is not the only allocative mechanism. During a short interval of time δt, there is a positive probability $1-q(\theta)\delta t$ that a firm will not find a worker and another positive probability $1-\theta q(\theta)\delta t$ that an unemployed will not find a job, whatever the set of prices: there is a stochastic rationing, which cannot be removed by price adjustments, but can be made better or worse for the representative trader by adjustments in the relative number of traders in the market. If the ratio of hiring firms to searching workers grows, the probability of rationing is higher for the average firm and lower for the average worker, and conversely. The existence of the congestion effects is important for most of the properties of equilibrium unemployment and its efficiency.

We assume that the job-worker pairs that experience adverse shocks are randomly selected. During a small time interval δ_t a worker moves from employment to unemployment with exogenous probability *s*, and an occupied job separates with the same probability. Therefore, these job separations follow a Poisson process with rate *s* which is independent of the process that describes the filling of jobs, which is exogenous in this version of the model. The evolution of total employment is given by the sum of the flows of new jobs created and existing jobs maintained:

(2) $$N_{t+1} = M_t + (1-s)N_t$$

In terms of unemployment,

(3) $$U_{t+1} - U_t = s(1-U_t) - \theta q_t(\theta)U_t$$

where $s(1-U_t)$ is the flow of employees moving into unemployment with rate s (inflow rate), and $\theta q_t(\theta)U_t$ is the flow of unemployed finding new jobs with probability $\theta q_t(\theta)$.

In a steady state, as the mean rate of unemployment is constant, the matching function can be restated in order to obtain the Beveridge Curve. Actually, if the mean rate of unemployment is constant, we can write:

(4) $$s(1-U) = \theta q(\theta)U$$

We can rewrite (4) as an equation determining unemployment in terms of both transition rates, s and $\theta q(\theta)$:

(5) $$U = {}^{s}\!/\!\left(s - \theta q(\theta)\right)$$

By the properties of the matching function, the flow equilibrium condition (5) can be represented in vacancy-unemployment space by a downward-sloping and convex to the origin curve, the Beveridge Curve.

1.3.2. Job Creation and Steady-state Equilibrium in the Labour Market

In the Pissarides matching model, the key driving force is job creation, which takes place when a firm and a worker meet and agree to an employment contract. Before this can take place, the firm has to open a job vacancy and search, and unemployed workers have to search. The number of jobs is endogenous and determined by profit maximization: any firm is free to open a job vacancy and engage in hiring, and profit maximization requires the profit from one more vacancy should be zero (zero-profit condition from firm entry). Let J be the present-discounted value of expected profit from an occupied job and V the present-discounted value of expected profit from a vacant job. V satisfies the Bellman equation

(6) $$rV = -pc + q(\theta)(J - V)$$

where pc represents the vacant job costs and changes state according to a Poisson process with rate $q(\theta)$. In equilibrium all profit opportunities from new jobs are exploited, thus the equilibrium condition for the supply of vacant jobs is $V = 0$, implying that

(7) $$J = \frac{pc}{q(\theta)}.$$

J satisfies a value equation similar to the one for vacant jobs: the flow capital cost of the job is rJ, whereas the job yields net return p-w, where p is real output and w is the cost of labour. The job also runs a risk s of an adverse shock, which leads to the loss of J. Therefore, J satisfies

(8) $$rJ = p - w - sJ.$$

Assuming the interest rate and product value as given and making use of (8) to substitute J out of (7), we derive

(9) $$p - w - \frac{(r+s)pc}{q(\theta)} = 0.$$

Equation (9), labelled as job creation condition, corresponds to a marginal condition for the demand for labour, where p is the marginal product of labour and $\frac{(r+s)pc}{q(\theta)}$ is the expected capitalized value of the firm's hiring cost, and can be represented by a downward-sloping curve in θ, w space.

Workers normally affect the equilibrium outcome through their job search and their influence on wage determination. In equilibrium, occupied jobs yield a total return greater than the sum of the expected returns of a searching firm and a searching worker. If the firm and worker who are together separate, each will experience an expensive search process before meeting another partner. Assuming all job-worker pairs are equally productive, the expected joint return after firm and worker form new matches must be the same as the joint return from their current match. Hence a realized job match produces some pure economic rent, which is equal to the sum of the expected search costs of the firm and the worker: wages need to share this economic rent, in addition to balancing the costs from forming the job. The monopoly rent is assumed to be shared according to the Nash solution to a bargaining problem, and the wage derived from this solution is the w_i that maximizes the weighted product of the worker's and the firm's net return from the job match. In order to form the job match, the worker and the firm give up the expected return from the search (U and V respectively) for the expected return from the job (W_i and J_i, respectively); thus,

(10) $$w_i = \arg\max(W_i - U)^{\beta}(J_i - V)^{1-\beta},$$

where $\beta \in (0,1)$ is a relative measure of labour's bargaining strength. The first-order maximization condition satisfies

(11) $$W_i - U = \beta(J_i + W_i - V - U),$$

and β is labour's share of the total surplus that an occupied job creates. Since U satisfies

(12) $$rU = z + \theta q(\theta)(W - U),$$

where z is the real return enjoyed by the worker during search that is assumed constant and independent of market returns, and making use of (11) and (7) to substitute $W - U$ out of (12), we obtain the wage equation

(13) $$w_i = (1 - \beta)z + \beta p(1 + c\theta),$$

which replaces the labour supply curve of Walrasian models and implies an upward-sloping relation in θ, w space. $pc\theta$ is the average hiring cost for each unemployed worker. Workers are rewarded for the saving of hiring costs that the firm enjoys when a job is formed. The way the labour market tightness enters (13) is through the bargaining power of both parts: a higher θ denote that jobs arrive to workers at higher rate than workers do to vacant jobs, relative to an equilibrium with lower θ. Therefore the worker's bargaining strength is higher and the firm's lower, and this leads to a higher wage rate.

Labour market equilibrium is a triple (u, θ, w) that satisfies the flow equilibrium condition (5), the job creation condition (9) and the wage equation (13). Figure 1 in the Appendix shows equilibrium for labour market tightness and wages. The job creation curve slopes down in θ, w space and replaces the Walrasian demand curve: higher wage rates make job creation less profitable and leads to a lower equilibrium ratio of jobs to workers. The wage curve replaces the supply curve and slopes up: at higher tightness, the relative bargaining strength of market participants shifts in favour of workers. Equilibrium (θ, w) is at the intersection of the two curves and is unique.

Figure 1 shows that equilibrium θ is independent of unemployment. The equation for this θ can be explicitly derived by substituting wages from (13) into (9):

(14) $$(1-\beta)(p-z)-\frac{r+s+\beta\theta q(\theta)}{q(\theta)}\,pc=0.$$

In the vacancy-unemployment space of Figure 2 in the Appendix, this is shown as a line through the origin, with slope θ. The steady state condition for unemployment is the Beveridge Curve and is convex to the origin by the properties of the matching technology. Equilibrium vacancies and unemployment are at the unique intersection of the job creation line and the Beveridge Curve.

1.4. The Aggregate Beveridge Curve: Definition and Shifts.

The Beveridge Curve can represent the relationship between unemployment and vacancies in any segment of the labour market, which is characterized by important inflows and outflows of workers. Each worker and each job have specific features in terms of skills, localization, sectors, etc. Imperfect information on the characteristics of job vacancies opened by firms and job seekers makes the match between labour demand and supply more difficult implying the simultaneous existence of frictional unemployment and unsatisfied job vacancies. The relationship between unemployment and vacancies is influenced by the economic situation: when the number of job vacancies is equal to the number of unemployed, U=V, the whole labour market is in equilibrium, although disequilibria can exist at disaggregated (sectoral, regional, etc.) level. A rightward shift of the Beveridge Curve corresponds to higher frictional unemployment rates, the equality between unemployment and vacancies (U=V) determined by the intersection with the job creation curve is characterized by higher levels of unemployment.

The position of the aggregate Beveridge Curve depends on the dispersion of both the unemployment-vacancies ratio across labour market segments and efficiency term. Therefore, the Beveridge relationship is unlikely to be stable over sufficiently long periods of time. An analytical definition of the aggregate Bevridge Curve is formulated by Sneessens and Shadman-Mehta (1995), who focus on the distinction between skilled and unskilled labour markets. Defining the structural unemployment rate as the one that would prevail when the vacancy and the unemployment rates are equal, they obtain

(15) $$structural\ unemployment\ rate = 1 - \left\{1 + \left(\frac{1}{\mu}\right)^{\rho}\right\}^{1-\rho}.$$

Therefore, the position of the aggregate Beveridge Curve depends on both parameters ρ and μ: the inverse of ρ measures the importance of frictions on the skilled labor market, whereas the inverse of μ measures the importance of skill mismatch.

Structural shocks determine movements along the Beveridge Curve (aggregate shocks, which have temporary effects) or shifts of the curve itself (sectoral or reallocative shocks, which have permanent effects). Aggregate shocks are cyclical variations in productivity: a negative (positive) technological shock reduces (increases) labour's marginal product and induces firms to open less (more) job vacancies, which ceteris paribus entails less (more) workers/job matches and lowers (increases) the inflow rate from unemployment. Aggregate shocks are temporary and move the economy along the Beveridge Curve. They correspond to rotations of the job creation curve: vacancy rate decreases (increases) and unemployment rate increases (decreases). Moreover, under the reasonable assumption that vacancies adjust to shocks more quickly than does unemployment, the return to an initial Beveridge curve equilibrium after an aggregate shock will follow an anticlockwise loop, with vacancies adjusting upwards more quickly than unemployment falls. For example, a rise in productivity shifts the wage curve up and the job creation curve to the right, causing an immediate rise in both labour market tightness and wages, which jump to their new equilibrium without adjustment dynamics. In the Beveridge Curve diagram (see Figure 3 in the Appendix), the impact effect is an anticlockwise rotation of job creation line. If the initial equilibrium point is *A*, initially equilibrium jumps to B, as firms open more vacancies to take advantage of the higher productivity. Unemployment dynamics move the economy down the new job creation line, toward the new steady-state equilibrium point *C*. In the case of a fall in productivity, the economy moves in the opposite direction, from *C* to *D* and then up to *A*. Therefore, vacancies and unemployment trace anticlockwise loops around the Beveridge Curve.

On the other hand, reallocative shocks bring about a change in the matching technology, which shifts the Beveridge Curve. For example, an outward shift (see Figure 4 in the Appendix) of the curve can be interpreted as a reduction of matching efficiency, because of: a) a deterioration of human capital (Okun, 1973; Layard and Bean, 1989; Pissarides, 1992) or of the search ability of the unemployed (Layard and Nickell, 1987); b) a negative perception of the long-term unemployed on the part of potential employers (Pissarides, 1992; Blanchard and Diamond, 1994)[3]; c) a higher availability of unemployment benefits, which reduces the propensity of the unemployed to look for a job and their willingness to fill out the vacancies (Layard and Nickell, 1987).

Furthermore, changes in the condition for special groups of the labour force could be relevant: for example, the employment and income perspectives have worsened for unskilled workers in the process of economic globalisation, as their jobs have been exported to the low-wage countries (Nickell and Bell, 1995). If the Beveridge Curve for the low skilled has drifted outwards, a corresponding shift could also occur in the aggregate curve (Song and Webster, 2003). Changing trends in the demographic composition of the labour force because of an increase in the participation rate of women or immigration might also be relevant. The sectoral shift hypothesis suggested by Lilien (1982) can also be relevant here: in periods of crisis, labour and capital market imperfections may limit the possibility of moving resources between sectors and matching efficiency may worsen due to the lacking skills of displaced

[3] Microeconomic studies provide corroborating evidence that, when firms receive multiple acceptable applications, they hire the worker who has been unemployed for the least amount of time. An adverse effect of unemployment on workers' psychological health has been found by Warr (1987) and Heady and Smith (1989), and an adverse effect on workers' motivation by Banks and Jackson (1982).

workers who have to fill positions in the newly expanding sectors. Finally, hysteresis in the course of unemployment could affect the position of the curve. Indeed, a movement along the curve would imply an outward shift in the next period. Hysteresis might be traced to human capital deterioration of the long term unemployed or a negative perception of long unemployment spells on employers.

Provided that shifts can be precisely attributed to structural factors, the above framework can provide important insights to policymakers. For instance, if reforms try to improve the efficiency of the search process on the labour market, their success could be measured by a marked inward shift of the Beveridge Curve. If, however, other factors different from those usually singled out were also relevant in explaining the shifts, this evidence would be seriously biased.

There is no consensus in literature about the role played by the above-mentioned factors in determining the behaviour of the Beveridge Curve. Börsch-Supan (1991) and Wall and Zoega (2002) estimate Beveridge Curves and analyze their shifts for United Kingdom and Spain respectively, finding that the behaviour of the Beveridge Curve is explained better by business cycle than by structural imbalances. Different results are achieved by Blanchard and Diamond (1989), Layard *et al.* (1991) and Padoa-Schioppa (1991), who actually verify the existence of imbalances between labour demand and supply increasing at the same time the number of firms looking for workers and the number of workers looking for jobs. Other studies (Jackman *et al*., 1991; Lescure and L'Horty, 1994; Sneessens *et al*., 1998; Dolado and Gomez, 1997; Fonseca e Munoz, 2003) confirm the crucial role of the reallocative shocks in explaining the performance of the Beveridge Curve.

1.5. The production Frontier Approach

Recently, some interesting empirical analyses concerning the empirical analysis of the matching function (Warren, 1991; Gorter and van Ours, 1994, for Netherlands; Fahr and Sunde, 2002, 2006, for Germany; Ilmakunnas and Pesola, 2003, for Finland; Ibourk *et al.*, 2004, for France; Destefanis and Fonseca, 2007, for Italy) have exploited the deep conceptual and analytical resemblance between this function and the production function. This has implied a use of the methodologies developed in the field of stochastic production frontiers (Kumbhakar and Lovell, 2000) in the empirical analysis of the matching function and the Beveridge Curve.

Stochastic production frontiers rely 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

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

where *e* is the efficiency parameter, examine Figure 5 in the Appendix, where various mixes of U_{t-1} and V_{t-1}, all of them capable of producing the output H_t (H_{0t}), are considered along an isoquant. 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 mark 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 achieve H_{0t} for U_{t-1} and V_{t-1} values higher than those on the isoquant, but this will not be technically efficient. Thus, both points B and C are inefficient, whereas A is technically efficient. Adopting the measure of technical efficiency suggested 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, while the technical efficiency of C is higher than that of B, which is situated further away from the isoquant.

Let us now consider more closely the most recent among the above-mentioned empirical contributions.

Gorter and van Ours (1994) use annual data for 11 Dutch regions over the period 1980-1988. First, they estimate a basic matching function with regional dummies, allowing to the efficiency parameter to vary over time and across regions; then, they compute regional efficiency scores from the coefficients of the dummy variables. The estimation results show that the matching process can be described by a “search production” function with constant returns to scale and the efficiency increased substantially during the economic recession that took place in the beginning of the 1980s. Furthermore, the labour markets in the peripheral regions perform somewhat better than the core regions, but efficiency differences appear to be modest for most regions, suggesting that unfavourable regional labour market conditions are caused by a lack of regional demand.

Ibourk *et al*. (2004) consider monthly data for the 22 French regions from March 1990 to February 1995, including in the estimates (beside a linear trend) a considerable number of explanatory variables meant to capture workers and firm characteristics as potential determinants for inefficiency. After obtaining regional efficiency scores for each year using maximum likelihood according to Battese and Coelli (1995) approach, they verify how much efficiency is explained by the potential efficiency determinants through the difference between average gross efficiency (the average efficiency score obtained when the explanatory variables take their actual values) and average net efficiency (the average efficiency score obtained when the explanatory variables are set as a fixed value, equal to their sample average). They find that: a) average matching efficiency declines over the time period considered, and about 30% of this decrease can be traced back to changes in the explanatory variables considered; b) there are also wide - and quite stable over time – regional differences, reflecting in part (for about 25%) differences in the characteristics of firms and workers. The hypothesis of constant returns to scale for the matching function is not rejected.

Ilmakunnas and Pesola (2003) consider annual data for the 14 Finnish regions from 1988 to 1997 and include among the potential determinants of inefficiency the average unemployment and vacancy rates of the neighbouring regions, which in authors' opinion allow for the spillover effects highlighted by Burda and Profit (1996) and Burgess and Profit (2001). Both variables enter significantly and with the expected signs in the estimates.

Fahr and Sunde (2006) analyze the efficiency of the matching process in West-Germany using annual data for a panel of 117 labour market regions over the period 1980-1997. After achieving regional efficiency scores and showing that regions vary substantially with respect to the matching efficiency of their labour markets and the efficiency pattern and the implied ranking of regions is stable over the observation period, they investigate the spatial dependencies in job creation across regions and regress the estimated efficiency of the matching process in a given region in a given year on the spatial autocorrelation pattern in form of the value of the Local Moran's I Statistic for the respective period in the respective region. They find that high spatial autocorrelation (high job creation activity in a certain region is associated with high job creation in nearby regions) is associated with a relatively low matching efficiency, which implies indirect evidence for crowding externalities.

Focusing on the Italian labour market, Destefanis and Fonseca (2007) use a matching theory approach to assess the impact on this market of the so-called 1997 Treu Act (*Legge Treu*), which considerably eased the regulation of temporary work and favoured its growth in Italy. They re-parameterize the matching function as a Beveridge Curve and estimate it as a production frontier, finding huge differences in matching efficiency between the South and the rest of the country. The Treu Act appears to have improved matching efficiency in the North of the country, particularly for skilled workers, but also to have strengthened competition among skilled and unskilled workers, especially in the South, reducing efficiency in the latter market segment.

1.6. The Matching Process and the Great Recession

The severity of the current recession, labelled as the *Great Recession* because of its fall in world trade and the stock markets worst than in the first years subsequent to the 1929 US Stock market crash, raises obvious concerns about the labour market adjustment and its persistency. Job losses may translate in longer spells of unemployment (the hysteresis phenomenon), through the deterioration of skills and the negative perception of the long-term unemployed on the part of potential employers, and a falling labour supply, ultimately translating in higher natural rate of unemployment. Thus, as we have seen in Section 4, longer spells of unemployment may increase the labour market mismatch and bring about an outward shift of the Beveridge Curve.

Indeed, the extensive unemployment inflows, which a recession usually generates, can be detrimental for the strength of the following recovery. If the large stock of the newly unemployed workers is not absorbed very quickly when the recovery sets in, labour supply may be negatively affected, which may result in an obstacle to future growth. Unemployed workers may become less effective in their job-search, because the recession may affect either the efficiency with which information about vacancies is transferred or the time and effort the unemployed dedicate to the job search. In particular, a lengthy period of weak labour demand may reduce the search effort of unemployed as despondency originates after many not successful attempts of finding a job (the so-called "discouraged" worker effect).

Unconditional and extremely generous unemployment benefits (increased to soften the social consequences of the crisis) may bring about a moral hazard problem which hardens the propensity of job-searcher to be highly selective with regard to a job offer and increase their reservation wage, that is the wage level at which they are willing to accept job offers. At the same time, however, during recessions households' income can be heavily weakened by the risks of unemployment of the bread-winner (typically the male components of the household). This creates a negative wealth effect that drives other components of the household to put more effort in the job search to compensate for the expected loss in household income and smooth consumption. This 'added' worker effect implies that in periods of high unemployment the labour supply of women increases, as the consumption smoothing motive prevails on factors, such as the low substitution of leisure between the husband and the wife (for cultural reasons or lack of childcare services), that keeps women out of the labour market. Whether the 'discouraged worker' or the 'added worker' effect prevails in the recessions is an empirical question.

Another potential reason for a persistent reduction in match efficiency is the likelihood of a mismatch between the skills of the unemployed and the skill requirements of job openings. Groshen and Potter (2003) have claimed that the jobless recoveries after the 1990 and 2001 recessions were in large part due to structural reallocation of workers across sectors in the economy. They assert that this reallocation led to a mismatch in skill-mix resulting in a slower adjustment of the labor market than in previous recessions.

More recently, Phelps (2008) has reiterated this concern in relation to construction and finance workers in the 2007 recession. Hence, structural imbalances, concerning mainly construction and finance, should be countered favouring the mobility of workers across different industries. Protracted sectoral shifts (recall Lilien's (1982) sectoral shift hypothesis) may make the skills of some workers – particularly those formerly employed in industries with non-transferable skills – obsolete, leading to very serious skill mismatches. When, due to the process of sectoral reallocation, job destruction is high and unemployment remains high, the human capital of the labour force deteriorates, strengthening the skill mismatch through hysteresis and leading to an outward shift of the Beveridge Curve and to the risk of unemployment hysteresis.

The first analyses of the response of the labour market to the *Great Recession* have been carried out by Arpaia and Curci

(2010), with regard to the European economies, and Elsby *et al.* (2010), as regards the USA.

Arpaia and Curci assess the labour market adjustment in the EU member countries, highlighting that the size of the labour market adjustment and its composition have been significantly different across countries, because of the size of domestic and external imbalances, and of the particular characteristics of the workforce in those industries mostly affected by the crisis. Workers with weaker employment contracts, the less qualified and less experienced workers are the socio-economic groups hit harder by the current recession. In many countries job destruction has been more intense in male dominated sectors, but the relative effects of the current recession on men and women are not particularly unusual if compared with previous recessions, whereas the increase in the young unemployment rates is a distinctive element of the latest recession. Moreover, European countries show very heterogeneous patterns in inflows into and outflows from unemployment: for example, both flows increase in the Nordic countries, whereas some countries like Spain and Ireland are experiencing an impressive surge in the inflow rate; inflows and outflows do not change much for countries such as Germany and Italy. Finally, Arpaia and Curci suggest that the expected increase in unemployment is similar to that estimated for the recession of the early 1990s but will probably be *less* persistent over time. This persistence can be influenced by a deterioration of the matching between vacancies and unemployed as the average unemployment rate increases. Evidence based on survey data suggests that, so far, in this recession the increase in unemployment rates linked to mismatching is due to a lack of demand for labour rather than an increase in the mismatch between vacancies and skills. Thus, there have been moves along rather than shifts of the Beveridge curve. It is true that the size of adjustment required in certain sectors may imply that sectoral shifts may take time to occur, making the skills of workers, particularly those formerly employed in industries with non-transferable skills, obsolete. Nevertheless, according to Arpaia and Curci, past evidence suggests that the impact of Lilen-type effects on structural unemployment has been, on average, small.

As regards the US labour market, Elsby *et al.* suggest that, even though the current downturn is definitely the deepest deterioration in labor market outcomes on record in the postwar era, many of the features of labor market dynamics in the Great Recession until the latter half of 2009 are similar to those seen in earlier recessions, both in terms of the behaviour of employment and labour force participation rate and in terms of the demographic groups most affected, with young, male, less-educated, workers from ethnic minorities being more damaged. Moreover, in terms of flows, just as in previous deep recessions, increased unemployment in the downturn can be determined by both increased rates of inflow, as well as increased duration, with inflows being relatively more important early on in the downturn. Increased inflows into unemployment have been driven predominantly by a change in the composition of separations toward layoffs, who are very likely to become unemployed, and away from quits, who are very likely to flow to a new job upon separation. Thus, contrary to claims of recent literature that has emphasized the relatively acyclical behaviour of the rate at which workers separate from employers, increases in layoffs have played a key role in driving increased unemployment in the recession.

Despite the above-mentioned similarities, some of recent evidence suggests an important difference with respect to past phenomena: rates of exit of unemployed workers from joblessness have slowed to record levels, drawing into focus the importance of a rebound in outflow rates for the recovery. However, this is unlikely to create for the US labour market an hysteresis problem as severe as the European one of the 1980's: the US unemployed still leave unemployment as much as four times faster than those in continental Europe.

1.7. Concluding Remarks.

This chapter has provided a conceptual introduction to the recent Beveridge Curve literature.

First, we focused on the matching approach founding the studies on the Curve since the late 1970's.

Then, we relied on Pissarides (2000) in order to derive analytically the Curve and to consider some potential determinants of matching efficiency which determine its shifts, and introduced the more recent production frontier approach. Among the potential determinants of matching efficiency, we have just mentioned some significant shift factors that literature on Beveridge Curve did not take into account exhaustively. More specifically, we refer to the role of globalisation and technological progress and the potential existence of spillover effects in the matching process. In the next chapters we will focus just on the impact of these variables on the Beveridge Curve, and will take again into consideration the shifting role of mismatch indicators (it is not clear why they did disappear from the most recent empirical literature).

Finally, we presented some explanatory analyses about the impact of the *Great Recession* on the matching process: according to them the current recession is unlikely to create an hysteresis problem such as to determine shifts of the Beveridge Curve in the European and US labour markets.

In conclusion, we point out some considerations for future reference: a) the matching process has often been specified in terms of a Cobb-Douglas production function with constant returns to scale. Abandoning the constant returns to scale may be tricky, but there seems to be no great analytical price to pay (and eventually some empirical gain to obtain) from using more flexible functional forms. This is however a consideration which is likely to have more importance for studies based on micro-data rather than for the usual macroeconometric set-up of the Beveridge Curve; b) most empirical analyses rely on a single-equation approach to the matching function (or the Beveridge Curve). It would be interesting to see more estimates based on a multi-equation approach considering matching jointly with job creation and wage formation (an early but isolated example of this approach is given by Dolado and Gomez, 1997). Obviously, such an approach would gain greatly from the adoption of cointegration-based techniques, requiring appropriately long time series.

Appendix

Figure 1. Equilibrium wages and market tightness

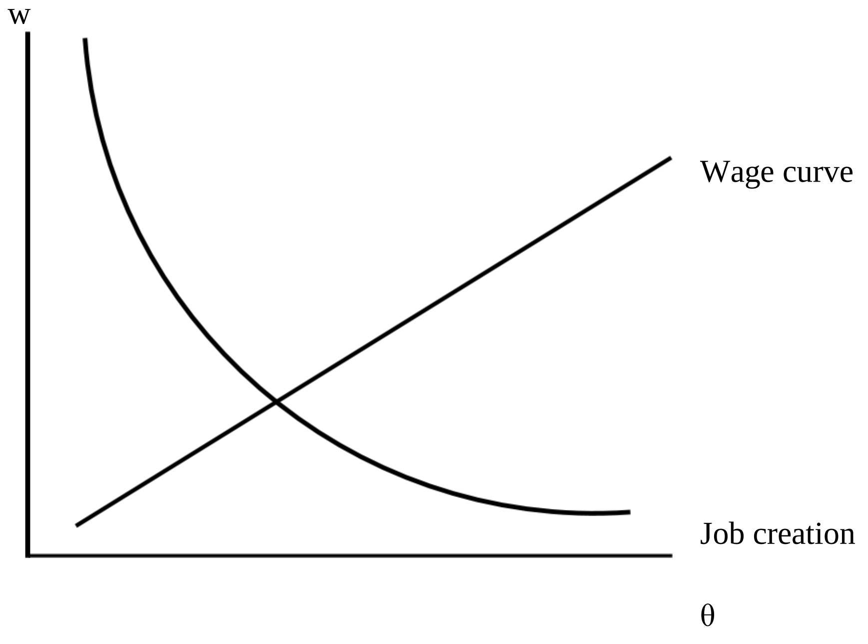


Figure 2. Equilibrium vacancies and unemployment

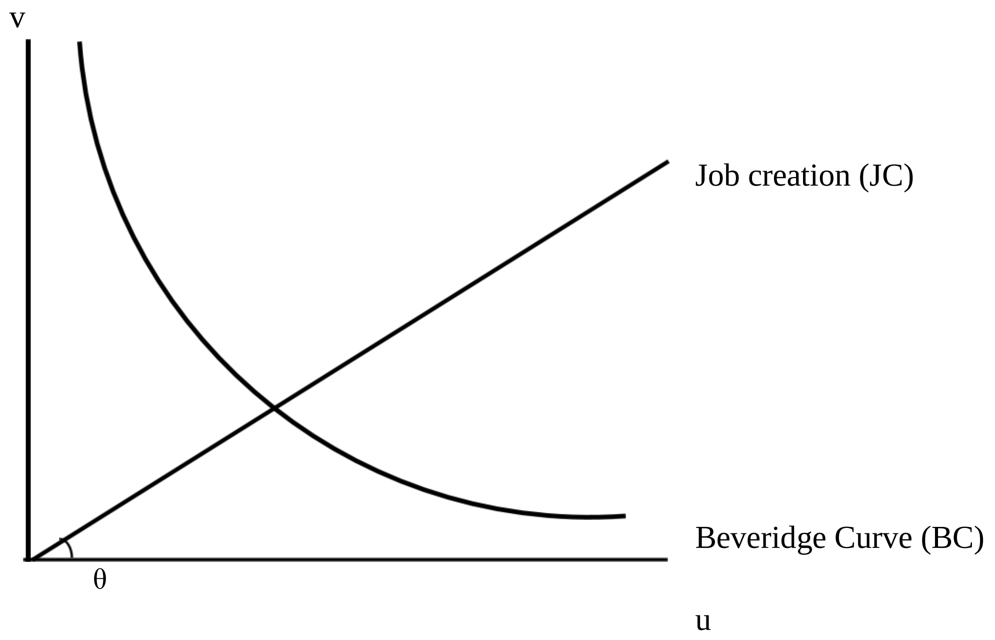


Figure 3. The Beveridge Curve: a counter-clockwise loop

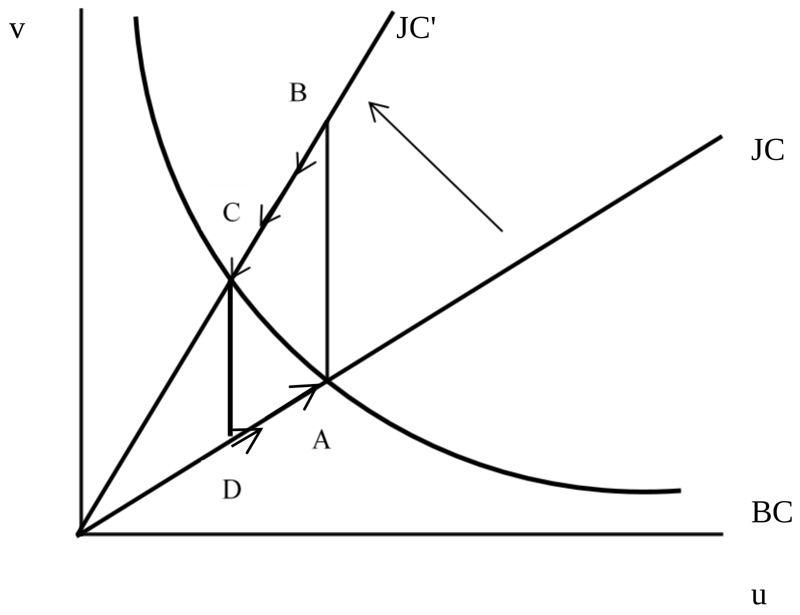


Figure 4. An outward shift of the Beveridge Curve

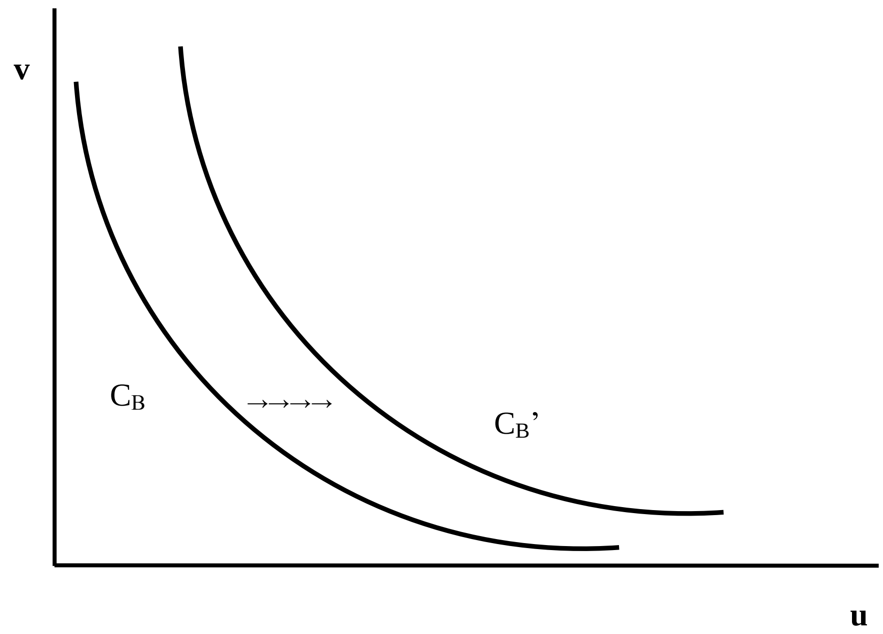
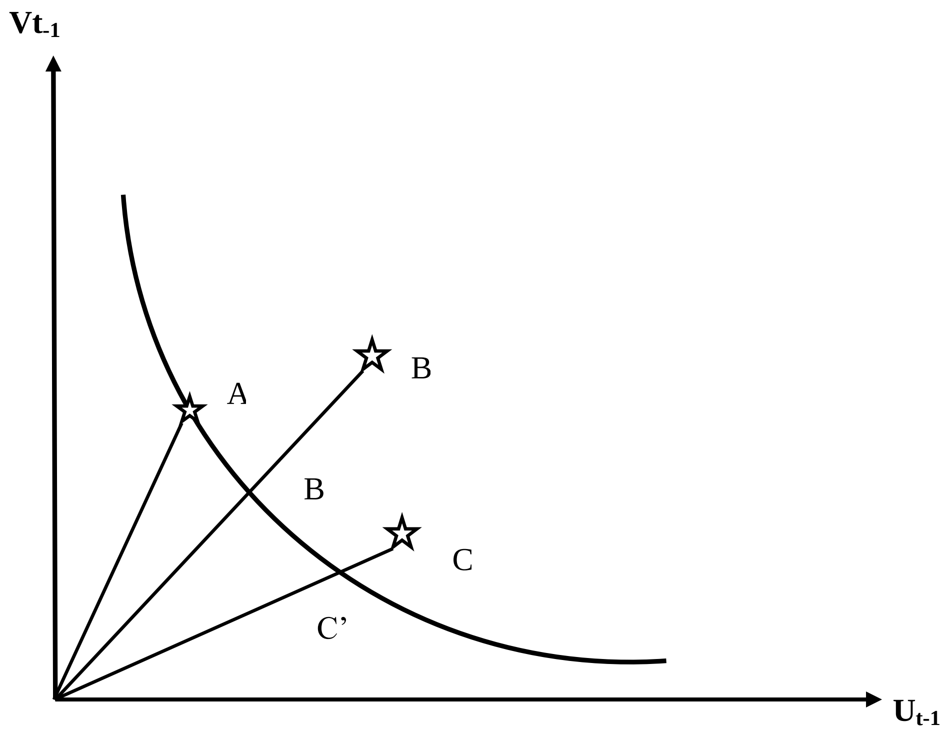


Figure 5. The matching function as an isoquant



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Chapter II. Beveridge Curve, Technological Progress and Globalisation

2.1. Introduction

In the literature concerning the Beveridge Curve, only a few contributions (Pissarides, 1990; Aghion and Howitt, 1994) have examined the role of technological progress as a significant shift factor for labour market performance. However, there is no unanimity about the sign of its impact. In the conventional matching model with technological change (Pissarides, 1990; Mortensen and Pissarides, 1998), a higher rate of growth implies a higher present value of jobs, which spurs the recruiting activity and raises the job finding rate of unemployed workers: thus, in terms of Beveridge Curve, the so-called capitalization effect should increase the willingness of employers to open new positions and the matching efficiency, which shifts the curve inwards. On the contrary, Aghion and Howitt (1994) propose the creative-destruction effect (Schumpeterian models), whose underlying intuition is that growth has a reallocative aspect that the previous conventional model ignores: faster technological change is accompanied by faster obsolescence of skills and technologies, hence, more intense labour turnover and higher frictional unemployment. In terms of Beveridge Curve, a faster obsolescence should worsen matching efficiency, regardless of search intensity, which shifts the curve outwards.

Few economists would deny that globalisation, that is the growing international interdependence in communications, trade, finance, labour markets (migration), social systems, is one of fundamental socio-economic phenomena of this turn of century. Consequently, globalisation is another factor which is expected to impact on the Beveridge Curve. Indeed, as we have seen in Chapter I, according to Nickell and Bell (1995) and Song and Webster (2003), the Beveridge Curve for unskilled workers should have shifted outwards in recent years, due to exportation of their jobs to the low-wage countries entailed by the process of globalisation. A corresponding outward shift in the aggregate Beveridge Curve should also follow.

The aim of this chapter is to test the existence of a Beveridge Curve analysing the economies of nineteen OECD countries from 1980 to 2004, and to investigate whether and how technological progress and globalisation affect the unemployment-vacancies trade-off. The empirical set-up draws inspiration from Nickell *et al.* (2003), that analysed the Curve for a similar OECD sample, but did not allow for technological progress and globalisation.

The paper has the following structure. In Sections 2 and 3, we present in detail some recent contributions focusing on the impact of technological progress and globalisation on unemployment; in Section 4 we examine some empirical literature on OECD countries (chiefly Nickell et *al*., 2003, as well as Koeniger et *al.*, 2007) providing further motivation to our study; in Section 5 we present the empirical specification and the data; the results are commented in Section 6, whereas Section 7 contains some concluding remarks.

2.2. The Impact of Technological Progress and Labour Market Matching

In the most recent literature concerning labour market performance and the Beveridge Curve, some contributions have stood out focusing on technological progress as one of the key variability factors in the labour market. On the one hand, technological developments change the structure of the labour demand, which tends to be biased in favour of higher professional competences, especially if orientated towards growing sectors. On the other hand, more powerful means of communication make the flow of information faster and cheaper and, consequently, labour market, as well as other kinds of market, more efficient.

Postel-Vinay (2002) aims at analysing the influence of the rate of technological change on the level of unemployment and, in particular, comparing the short- and long-run effects of technological progress on employment. He starts from the statement (Mortensen and Pissarides, 1998) that faster growth reduces the long-run unemployment rate through capitalization effect, or leads to a rise in long-run unemployment through a creative destruction effect (the so-called Schumpeterian models developed in Aghion and Howitt, 1994), depending on the particular technological assumptions adopted: the capitalization effect rests on the assumption that firms are able to update their technology continuously and at no expense, which precludes technological obsolescence, whereas creative destruction arises from the extreme opposite assumption of total irreversibility in the firms' technological choices.

The above results are grounded on the long-run analysis of the relationships between unemployment and economic growth. Aside from that, the short-run behaviour of the conventional matching model is quite well known, but, importantly, not much has been said so far about the short-run behaviour of unemployment in a creative destruction context.

Then, let us suppose that the correct model is of Schumpeterian inspiration, that is there is total irreversibility and the economy leaves no space for any form of capitalization effect. A speedup in growth eventually leads to a fall in long-run employment. Postel-Vinay's purpose is to find out whether, in that case, sustained technological change is detrimental to employment even in the short-run. Critics of the Schumpeterian usually view come up with the argument that there is very convincing evidence according to which unemployment rates respond negatively to changes in the productivity growth rates. For instance, the productivity slowdown of the mid-1970's was accompanied by a rise in unemployment in most OECD countries. However, this argument implicitly ignores the possible differences among short-run and long-run predictions of the model. Short-run predictions may go in the opposite direction of long-run ones, and be closer to the usually quoted evidence. Postel-Vinay adds that there is no a priori reason to think that the long-run effects should be the only ones to consider, or even that they should be in some sense more important than short-run effects.

Then, Postel-Vinay shows a simple model of job destruction, studies its steady-state and comparative static properties, proceeds to a theoretical study of its dynamics, finally presents some numerical simulations of the model. Simulations confirm that the short-run adjustment of unemployment goes the ''wrong way'' with respect to long-run outcomes and point out that impact effects are of potentially great magnitude. How much more empirical support do the short-run predictions of the model get? Unfortunately, the answer to that question appears to be: not so much. In particular, the model fails to explain unemployment persistence. According to the model, the time it takes the unemployment rate to be back at its original level after a negative shock on productivity growth is well under the duration of a business cycle. Even though the 1970's slowdown was typically deeper in Europe than in the United States, which, as the model would have predicted, led to higher peaks in unemployment, the U.S. unemployment rate went back down since then, whereas the European unemployment rates remained at very high levels, and even kept on increasing in the early 1980's, in spite of the partial recovery of productivity growth.

Pissarides and Vallanti (2007) aim at investigating the impact of total factor productivity (TFP) growth on unemployment, considering that theoretical predictions are ambiguous and depend on the extent to which new technologies is embodied in new jobs: therefore, they evaluate a model with embodied and disembodied technology and capitalization and creative destruction effects, including some measures of capital per worker and TFP in the model, which are expected to have different effects on unemployment, because the costs of adjustment in capital are different from the technology implementation lags. As job destruction reacts faster than job creation to shocks, the impact effect of productivity growth (capital stock) on unemployment should be positive (negative) in the short-run and turn negative (positive) in the medium- to long-run.

They start from the econometric estimates of the impact of TFP growth on steady-state unemployment for the period 1965-

1995 for the countries of the European Union (except for Spain and Greece), the USA and Japan. The conclusion is that the negative impact of TFP growth on unemployment is substantial, both in terms of the estimated elasticities and in terms of the contribution of TFP growth to the explanation of the evolution of the unemployment rate in the last thirty years. Moreover, both productivity growth and capital stock have the expected short- and long-run effects on unemployment.

Then, "creative destruction" appears to play no part in the steady-state unemployment dynamics of the countries in the sample and the Solow growth model augmented by an unemployment equation is an appropriate framework for the study of unemployment dynamics.

Consequently, Pissarides and Vallanti evaluate a matching model with embodied and disembodied technology, capitalization and creative destruction effects and verify whether this model matches the estimated impacts. They find that: a) consistency between the empirical evidence and the model requires totally disembodied technology, because when technology is embodied creative destruction effects have a much bigger quantitative impact on unemployment than capitalization effects; b) with entirely disembodied technology, the capitalization effect of faster growth is quantitatively sufficiently strong to explain alone the full impact of TFP growth on unemployment when two other conditions are satisfied: 1) wages need to be insulated from labour market conditions, in particular the vacancy-unemployment ratio, and 2) the firms need to discount the revenues from new jobs over an infinite horizon.

2.3. Globalisation and Labour Market Matching

As international interdependence and integration grew significantly and more and at a furious pace in the last decades, the impact of globalisation on labour market matching and performance looks like another issue highly worthy of discussion. As shall be clear from the following discussion, however, this discussion has never been embodied in economic models similar to those examined in the previous section.

Higher unemployment and loss of jobs are quite commonly associated with globalisation, mainly due to the following arguments: a) multinationals have exported jobs from developed countries to developing countries through foreign investments and outward production in special economic zones; b) through trade liberalization, governments have encouraged the replacement of domestically produced goods with goods produced abroad; c) the increased application of technology, especially in globally operating companies, can reduce the use of and dependence on labour (clearly this point overlaps with the role of technological progress highlighted in the previous section).

With regard to that, an interesting analysis is represented by the report produced by the International Confederation of Free Trade Unions (ICFTU) at its 16th World Congress (1996). It claims that our societies are more and more polarized between those who have the wealth or skill to gain from global integration and those who remain trapped in poverty without productive employment. Unlike free-market ideologists' beliefs, who argue the vast numbers of low-paid jobs will gradually become better-paid through investment and productivity, rationalization and restructuring are causing the disappearance of secure decently paid jobs and world unemployment is rising. World growth rates are stuck at levels which allow little or no scope for the poorest countries to expand their way out of poverty, neither is growth in industrialized and transition countries being translated into more employment. The fundamental problem is that the overriding objective of organizing production to meet basic human needs is not being achieved as a result of governments' infatuation with market-oriented policies. African urban unemployment had doubled since the 1970's to reach between 15 and 20% ; unemployment had risen to 10% and more in several countries of Latin America, and in most countries of Central and Eastern Europe as well. But the global social crisis has reached into the world's most advanced economies. The high levels of unemployment of the early 1980's recession have fallen at an agonizingly slow pace. In industrial countries, unemployment is rising amongst low-skilled and relatively low-paid male workers, who have traditionally found work in the manufacturing sectors that are most exposed to increased competition.

Another relevant contribution is provided by Thorpe (1997). Corporations have used their international power to increase their power also within countries. Through this power they have been able to secure government compliance with social and economic policies which suit their global objectives - especially deflationary policies, abandonment of full-employment policies, labour market flexibilisation, lower taxation of executive salaries, higher interest rates, restructuring of the welfare state and privatisation. The same strategies have been deployed within the intergovernmental structures (World Bank, International Monetary Fund and OECD, for example) by ideologically captive governments. These global and national policies resulted in a marked deterioration of effectiveness in social policy and have undermined previously accepted roles for governments and norms in relation to social justice and the public good. Through their power the corporations have been able to externalise much of their costs onto national welfare systems through shedding labour and employing higher-yielding capital. Their control over international trade and investment has enabled them to use threats to intensify inter-government and inter-worker competition and to weaken attempts at improving working conditions and benefits. The result has been to reduce social equity, to increase unemployment and unstable employment and to achieve high rates of income growth for the higher income groups.

The opposite view is that globalisation (e.g. through foreign investment, trade, new technology and liberalization) contributes to growth, which is the key to employment. Unemployment, on the other hand, is mainly due to governments' failure to adopt sound macroeconomic and labour market policies. In particular, International Monetary Fund (IMF) and OECD[4] share the opinion that structural adjustment policies and globalisation, far from being the main sources of unemployment, can be taken advantage of in a strategy for better growth and employment. The example of the countries which represent the world growth locomotives would demonstrate how such programs, applied with perseverance, can contribute to improving human living standards, but such improvement will never be an automatic result of a miraculous economic model able to prevent the major plagues of our societies as well. Thus, it is required that governments have

[4] See for example IMF (1996) and OECD (1997).

their priorities right, and accept to complement the structural adjustment program by a major effort at reforming the state, including, in particular, reducing unproductive spending, collecting properly the taxes from those who can pay, and allocating them more efficiently to key social priorities.

Below we do not provide a discussion of the relationships between globalisation and labour market matching within a model similar to those examined in the previous section. We proceed however to set up a framework for empirical analysis where the effects of globalisation and technological progress are jointly measured and appraised.

2.4. The Empirical Literature on OECD Countries

Our framework for empirical analysis draws inspiration chiefly from a paper by Nickell *et al.* (2003), which analyzes empirically the unemployment patterns in the OECD countries from the 1960s to the 1990s, through a detailed study of changes in real wages and unemployment, as well as shifts in the Beveridge Curves in twenty countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States). Their basic aim was to ascertain, using a very simple empirical model, if these shifts can be explained by changes in those labour market institutions which might be expected to impact on equilibrium unemployment. Actually, Nickell *et al.* include in their regression analysis both a set of institutional variables expected to influence equilibrium unemployment in the long-run, and a set of other structural factors (changes in the rate of growth of the nominal money stock, changes in TFP growth or deviations of TFP growth from trend, labour demand shocks measured by the residual from a simple labour demand model, proportional changes in real import prices weighted by the trade share, the ex-post real interest rate) which might explain the short-run deviations of unemployment from its equilibrium level.

Table 1. Factors affecting equilibrium unemployment, Nickell *et al.* (2003)

Institutional variables	Unemployment benefit replacement ratio Benefit duration index Bargaining coordination index Collective bargaining coverage Union density Employment protection legislation Labour taxes Owner occupation rate
Structural variables	Rate of growth of nominal money stock TFP growth Labour demand shocks Real import prices weighted by trade share Ex-post interest rate

What is however remarkable from our point of view is that, without any theoretical or empirical justification, no structural factor is included in the Beveridge Curve estimates. This obviously also includes variables which may be linked to the role of technological progress or globalisation. On the other hand, an important role is played in the estimates by the inflow rate, defined as the monthly inflow into unemployment divided by employment. Given that the Beveridge Curve equation is estimated through LSDV, and that the inflow rate is likely to be determined jointly with unemployment, there is some concern that the Nickell *et al.* estimates may be affected by endogeneity issues[5].

In any case, the Nickell *et al.* results indicate the Beveridge Curves of all the countries except Norway and Sweden shifted to the right from the 1960s to the early/mid 1980s. At this point, the countries divide into two distinct groups, those whose Beveridge Curves continued to shift out and those where they started to shift back. Second, these movements in the Beveridge Curves are partly explained by changes in labour market institutions. In particular, union density, unemployment benefit duration and owner occupation shift the Curves to the right whereas stricter employment protection shift them to the left. Indeed, stricter employment laws may lead to an increased professionalisation of the personnel function within firms, as was the case in Britain in the 1970's (see Daniel and Stilgoe, 1978), which can increase matching efficiency. The possibility

[5] In our opinion, endogeneity issues are also likely to concern the vacancy rate, as well as the institutional variables. It is anyway true that neglect of the issues is quite pervasive in the Beveridge Curve empirical literature.

that the estimates are affected by endogeneity and omitted variable bias raises however some doubt about the soundness of these results. Further inspiration for our empirical framework was also drawn from a paper by Koeniger *et al.* (2007). This paper first shows in a simple model of bilateral monopoly how labour market institutions affect labour demand, the surplus of the firms and workers and thus the wage differential, then uses panel data from 11 OECD countries (Australia, Canada, Finland, France, Germany, Italy, Japan, Netherlands, Sweden, UK and USA) to determine how much of the increase in wage inequality across countries can be attributed to changes in institutions within countries, employing an empirical set-up similar to Nickell *et al.* (2003). Crucially, from our point of view, this paper also directly relates wage inequality to a set of variables related to technological progress and globalisation: R&D intensity and import (from non-OECD countries) intensity as well.

Table 2. Factors affecting wage inequality, Koeniger *et al.* (2007)

	Koeniger *et al.* (2007)
Institutional variables	Unemployment benefit replacement ratio Benefit duration index Bargaining coordination index Union density Employment protection legislation Tax wedge Minimum wage
Other variables	R&D intensity Import (from non-OECD countries) intensity

From the joint analysis of these two papers, we have then drawn the idea of assessing the impact of institutional variables on the Beveridge Curves of various OECD countries, also allowing for the impact of globalisation and technological progress.

2.5. The Econometric Analysis: Empirical Specification and Data

2.5.1. The Model

The basic model is a proper Cobb-Douglas dynamic specification of the Beveridge Curve given the inflow rate,

$$(1)\ u_{it} = \beta_1 u_{it-1} + \beta_2 u_{it-2} + \beta_3 v_{it} + \beta_4 v_{it-1} + \beta_5\, inf_{it} + \beta_6\, inf_{it-1} + \beta_7 glob_{it} + \beta_8 glob_{it-1} + \beta_9\, tp_{it} + \beta_{10} tp_{it-1} + \beta_{11} k_{it} + \beta_{12} k_{it-1} + \beta_{13} tfp_{it} + \beta_{14} tfp_{it-1} + z_{it}\gamma_1 + z_{it-1}\gamma_2 + D\delta_i + E\theta_t + \tau_{i1} t + \tau_{i2} t^2 + \varepsilon_{it},$$

where i = 1, …, N stands for the country, and t = 1, …, T stands for the time period (year). We posit a simple fixed-effects AutoRegressive-Distributed Lags (1,1) specification. u_{it} is the natural log of the unemployment rate, v_{it} the natural log of the vacancy rate, inf_{it} the natural log of the inflow rate, $glob_{it}$ the natural log of the globalisation index, tp_{it} the technological progress index, k_{it} the natural log of capital per worker, tfp_{it} the total factor productivity, z_{it} a vector of institutional variables which are expected to influence unemployment either because of their impact on the effectiveness with which the unemployed are matched to available jobs or because of their direct effect on wages, *D* and *E* are vectors of yearly and country dummies respectively, *t* a time trend, ε_{it} a stochastic variable assumed to be independently and identically distributed and β, γ, δ, θ, and τ are the parameters of the model. We follow Pissarides and Vallanti (2007) in introducing two lags for unemployment and in including capital per worker and TFP in the model. As suggested by the authors, we expect the capital stock and TFP have different effects on unemployment, because the costs of adjustment in capital are different from the technology implementation lags: as job destruction reacts faster than job creation to shocks, the impact effect of productivity growth (capital stock) on unemployment should be positive (negative) in the short-run and turn negative (positive) in the medium- to long-run.

The TFP is computed using the formula from Pissarides and Vallanti (2007):

(2) $$d\ln A = \frac{1}{1-a}[d\ln Y - \bar{a}\, d\ln K - (1-\bar{a})\, d\ln L\,],$$

where *Y* is gross domestic output at constant price and national currencies, *K* is capital stock as defined above, *L* is total employment, *(1-ā)* is a smoothed share of labour following the procedure described in Harrigan (1997).

The measure of capital we use is the ratio of the private non-residential net capital stock (i.e. the capital stock of the business sector) to the total employment.

Notice at any rate that TFP, a variable whose measurement notoriously gathers many different influences, is *not* our preferred measure of technological progress. We rather include it in the estimates as a control variable for macroeconomic shocks. Our preferred measure of technological progress, like in Koeniger *et al.* (2007), is the ratio of R&D expenditure over value added in the manufacturing sector (both variables at current prices).

The globalisation index, also like in Koeniger *et al.* (2007), is given by the ratio of total manufacturing imports from no-OECD countries to manufacturing value added (both variables at current prices)[6]. We would like to rely on at least another globalisation index, allowing for capital flows and outsourcing, but problems of data availability prevent us from doing so.

The inflow rate is measured by the ratio of inflow into unemployment to total employment.

In selecting our institutional variables, we relied on those considered in Nickell *et al.* (2003). In particular, we introduce: a) union density and bargaining coordination, as trade union power in wage setting has a significant positive impact on unemployment, but highly coordinated bargaining may

[6] We are very grateful to Marco Leonardi (University of Milan, Italy) for making these data available to us.

completely offset the negative impact of unionism on employment[7]; b) employment protection legislation, whose overall impact is an empirical issue: actually, on the one hand it tends to make firms more prudent about filling vacancies, which slows the speed at which the unemployed move into work, reducing the efficiency of job matching; on the other hand, however, employment protection laws often lead to an increased professionalization of the personnel function within firms and lean to reduce involuntary separations and consequently reduce inflows into unemployment; c) unemployment benefits, which negatively affect the willingness of unemployed to fill vacancies; d) the total tax wedge including employer payroll taxes.

Finally, we would like to stress that, unlike in many macroeconometric studies (including Nickell *et al.*, 2003, and Koeniger *et al.*, 2007), we do not restrict a priori the dynamic specification of our structural and institutional variables. All of them enter (1) with a current *and* a lagged value.

2.5.2. The Data

The sample is formed by nineteen OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, United Kingdom and

[7] See Nickell and Layard (1999) and Booth *et al.* (2000) for example.

United States. We consider a 25-year period, from 1980 to 2004.

The main data source is the CEP-OECD Institutions Data Set by William Nickell, updated by OECD datasets or integrated by other sources where gaps come out, especially for the latest years or for single variables in given countries.

The unemployment rates are derived from Nickell and Nunziata (2001): they are based on OECD standardized rates and are an extension of those used in Layard *et al.* (1991).

The vacancy rates are taken from Nickell and Nunziata (2001) and extended with data from OECD Main Economic Indicators (2006). For Italy, vacancies data derive from the survey on the help-wanted advertisements published in some important daily newspapers, carried out by CSA (Centro di Studi Aziendali, Florence) and ISFOL (Istituto per lo Sviluppo della Formazione Professionale dei Lavoratori, Rome).

With regard to the globalisation index, total manufacturing imports from non-OECD countries are drawn by the OECD STAN Bilateral Trade Database and International Trade by Commodity Statistics (2004), and value added by the OECD STAN Database for Industrial Analysis (2005). With regard to technological progress, instead, the data for R&D expenditure are taken from the OECD Research and Development Expenditure in Industry Database (2005).

The source of the private non-residential net capital stock is the OECD Analytical Database (2002), whereas gross domestic output is drawn from OECD.Stat Extracts and the smoothed share of labour from the OECD Unit Labour Costs Dataset (2009).

The inflow rate series is mainly taken from Nickell and Nunziata (2001). However, the data for Italy are derived from the ISTAT MARSS Database, and those for Switzerland from the OECD Database on Unemployment by Duration.

Employment protection legislation series are obtained from Allard (2005a): they use the OECD methodology generating an index increasing on the range {0,5}.

Union density is calculated using administrative and survey data from the OECD Labour Market Statistics Database and extending them by splicing in data from Visser (2006).

The index of bargaining coordination is taken from OECD (2004), has range {1,5} and is increasing in the degree of coordination in the bargaining process on the employers' as well as the unions' side.

Unemployment benefits series are obtained from Allard (2005b), who develops an indicator which combines the amount of the subsidy with their tax treatment, their duration and the conditions that must be met in order to collect them.

Finally, the total tax wedge is drawn from OECD.Stat Extracts.

2.6. The Estimates

2.6.1. The Econometric Set-up

Before presenting our results, we focus on the econometric approach we used and the reasons which guided our choices.

A basic influence was the paper by Judson and Owen (1999), that aims at providing a guide to choosing appropriate techniques for panels of various dimensions. Their results, based on a Monte Carlo analysis, show that Kiviet's corrected Least Squares Dummy Variable estimator (LSDVC) is the best choice for any balanced panel, whereas for unbalanced panels: a) if T = 30, where T is the time dimension of the panel, LSDV performs just as well or better than the viable alternatives; b) when T $\leq$ 10, Arellano and Bond's one-step Generalized Method of Moments estimator (AB GMM) is the best choice; c) when T = 20, AB GMM or Anderson and Hsiao estimator (AH) may be chosen. These results are summarized in Table 2.

Table 3. Judson and Owen's recommendations on dynamic panel data estimations.

	T≤10	T=20	T=30
Balanced panel	LSDVC	LSDVC	LSDVC
Unbalanced panel	AB GMM	AB GMM or AH	LSDV

Moreover, Blundell *et al.* (2001), reviewing developments to improve on the relatively poor performance of the standard one-step difference GMM estimator for highly autoregressive panel series, provided Monte Carlo simulation comparison between one-step difference and a new estimator, denoted system GMM, that relies on relatively mild restrictions on the initial condition process, and made an application to a simple panel Cobb-Douglas production function for US data, showing that system GMM has substantial asymptotic efficiency gains, as it not only greatly improves the precision but also greatly reduces the finite sample bias.

Soto (2007) analysed through Monte Carlo simulations the properties of various GMM and other estimators when the number of individuals is small, as typical in country studies. He found that the system GMM estimator has a lower bias and higher efficiency than all the other estimators analysed, including the standard one-step difference GMM estimators.

We have an unbalanced panel with T = 25: thus, we have implemented LSDV and AB GMM (one-step difference and system) estimators.

Moreover, we consider the useful advices provided by Roodman (2009a, 2009b) in order to make appropriate specification choices for AB GMM and correctly face up to the econometric problems which may emerge, particularly autocorrelation and endogeneity. More specifically, Roodman suggests: a) to use orthogonal deviations, in order to maximize sample size; b) to put every regressor into the instrument matrix: if a regressor is strictly exogenous, it is inserted as a single column; if it is predetermined but not strictly exogenous (such as our regressors), lags 1 and deeper are used in GMM-style; if it is endogenous, lags 2 and deeper are used in GMM-style; c) to pay attention in evaluating the results of autocorrelation and endogeneity tests, as a small number of cross-country observations makes Arellano-Bond test for autocorrelation not very reliable and too many instruments weaken the power of Sargan and Hansen tests to detect overidentification[8].

2.6.2. The Econometric Results

Before discussing our results, we recapitulate in Table 4 the main predictions about the role of globalisation and technological progress within the Beveridge Curve.

[8] For this reason, we "collapse" the instrument set into a single column.

Table 4. Expected shifts of the Beveridge Curve: institutional variables, globalization and technological progress.

	Expected Shifts
Tax wedge	Outward shift: Nickell *et al.* (2003)
Unemployment benefits	Outward shift: Nickell *et al.* (2003)
Employment protection legislation	Outward **or** inward shift: Nickell *et al.* (2003)
Bargaining coordination	Inward shift: Nickell *et al.* (2003)
Union density	Outward shift: Nickell *et al.* (2003)
Globalisation	Outward shift: Nickell and Bell (1995); Song and Webster (2003)
Technological progress	Outward shift (creative-destruction effect: Aghion and Howitt, 1994, Postel-Vinay, 2002: but inward shift in the short-run?) **or** Inward shift (capitalization effect: Pissarides, 1990; Mortensens and Pissarides, 1998; Pissarides and Vallanti, 2007)
Capital deepening	Inward shift (short-run) **and** Outward shift (medium- to long-run): Pissarides and Vallanti (2007)
TFP growth	Outward shift (short-run) **and** Inward shift (medium- to long-run): Pissarides and Vallanti (2007)

Table A.1 shows the LSDV estimation results, which confirm the existence of a Beveridge Curve for the countries considered and reveal a significant positive effect of both current and lagged technological progress, which tends to shift the curve outwards through the creative destruction effect, whereas the coefficients of the globalisation index are not significant. Among the institutional variables, just union density and bargaining coordination are significant and have the expected impact on unemployment. The Durbin-Watson statistic indicates the absence of autocorrelation, whereas the Hausman test reveals that regressors are not exogenous.

In Table A.2 one-step difference GMM estimation results are considered. We notice that the Beveridge trade-off is again confirmed, but now a significant positive impact of the lagged values of both globalisation and technological progress comes out. Furthermore, employment protection legislation shows a negative effect on unemployment: stricter legislation shifts the Beveridge Curve inwards. Interestingly, the previously significant inflow rate wholly loses significance, shedding doubts on the specification proposed in Nickell *et al.* (2003). The Arellano-Bond test for autocorrelation is not significant, and Sargan and Hansen tests for endogeneity produce very high p-values. For the latter, as pointed out by Roodman, this is a potential signal of trouble[9].

One-step system GMM estimation results are presented in Table A.3. In terms of Beveridge Curve, globalisation and technological progress, these results are similar to those achieved by difference GMM estimation, whereas among institutional variables coordination bargaining and unemployment benefits are significant and have the expected impact on unemployment. Capital deepening gains however significance, while TFP growth heavily loses it. The inflow

[9] Too many instruments can overfit endogenous variables and fail to expunge their endogenous components. Thus, we have to be beware of taking comfort in a Hansen test p-value below 0.1, whereas higher values, such as 0.25, may represent a problem.

rate is again insignificant. Also, higher employment protection legislation shifts now the Beveridge Curve outwards. Tests for correlation and endogeneity confirm the previous results as well, and Difference-in-Hansen test of exogeneity of instrument subsets proves the validity of the additional instruments in system GMM.

Tables A.4, A.5 and A.6 contain similar estimates, which however exclude the institutional variables from the model. We can notice that including the labour market institutions help to improve considerably the estimates, as technical progress, globalisation and capital deepening coefficients gain significance. Also RESET tests performed for the LSDV regressions show that specifications omitting institutional variables are not well-behaved.

Summing up, we notice some common results across the various estimation methods: a) a Beveridge trade-off is actually found; b) institutional variables are mostly not significant; c) lagged values of technological progress have a significant positive impact on unemployment and shift the Beveridge Curve outwards (creative destruction effect). Thus, the empirical analysis does not support the predictions of Postel-Vinay's simulations about the short-run adjustment of unemployment to technological progress. Indeed, the coefficient of current and lagged technological progress have the same sign in LSDV estimation, whereas in GMM estimations current technological progress is not significant at all.

However, there are some different points as well: a) the vacancy rate coefficient is considerably higher in GMM estimates (0.231 in difference GMM, 0.251 in system GMM) than in LSDV (0.159); b) in GMM estimates, the position of the Beveridge Curve is influenced by lagged values of globalisation as well: the process of economic integration has a positive impact on unemployment and shifts the Curve outwards; c) in system GMM estimation, the coefficients of capital deepening are significant and have the expected sign: its effect on unemployment is negative in the short-run and turns positive in the long-run, as predicted by Pissarides and Vallanti.

Thus, technological progress does not reveal any sign reversal as would be implied by the hypothesis that the model behaves differently in the short- and in the long-run. On the other hand, for TFP and capital stock the sign reversal that was suggested by Pissarides and Vallanti’s model is actually verified.

Moreover, endogeneity is a non trivial problem in our model, as shown by the overidentifying restrictions tests, by the loss of significance of the inflow rate in the GMM models, and by the changing signs of various institutional factors. This leads to the conclusion that endogeneity is underestimated in the literature, which very often does not deal with this matter properly.

We have gathered sufficient evidence according to which globalisation and technological progress have significant effects on the Beveridge Curve. However, it could be thought that these impacts are not economically significant. We address this issue in Table A.7, A.8 and A.9, showing the percent changes in the dependent variable brought about by a unit standard deviation change in a given independent variable. In this case we focus only on steady-state solutions. We notice that technological progress and capital deepening have a very strong impact in all the estimations: the impact of capital deepening is more pronounced at the beginning and end of the period, whereas technological progress has constant effects over time. Globalisation has a lower and more discontinuous in time impact compared to technological progress, whereas the more significant institutional variables present very different values depending on the estimation method. In system GMM their impact is not large.

Thus, we conclude that the impact of technological progress and, to some extent, capital deepening on the Beveridge Curve is not only statistically, but also economically significant.

2.7. Concluding Remarks

In this chapter we considered the economies of nineteen OECD countries in 1980-2004 period in order to appraise the existence of a OECD Beveridge Curve and to investigate whether and how technological progress and globalisation affect the Curve. To the best of our knowledge, although in the literature various hints are dropped to the effect that these two factors should influence the unemployment-vacancies trade-off (even if there is not unanimity on the sign of their respective impacts), no formal tests of this kind had been carried out so far.

We followed Judson and Owen's suggestions and, considering also Blundell *et al.* findings, used three different estimation methods, which turn out consistent with our (unbalanced) panel. We can sum up the main results as follows: a) we find largely favourable evidence for the existence of a Beveridge Curve; b) lagged values of technological progress impact positively on unemployment and shift the Beveridge Curve outwards, producing evidence in support of the creative destruction effect; c) lagged values of the globalisation index have a positive impact on unemployment, also shifting the Beveridge Curve outwards. However...; d) a critical econometric issue, extremely undervalued by the previous papers, is represented by endogeneity, as consistently shown by the appropriate tests.

Appendix

Table A.1. LSDV estimation (dependent variable: natural log of current unemployment)

	Coefficients	**p-values**
cons	0.599	0.300
u_{it-1}	0.966	0.000
u_{it-2}	-0.296	0.000
v_{it}	-0.159	0.000
v_{it-1}	0.064	0.074
inf_{it}	0.099	0.004
inf_{it-1}	0.027	0.345
$glob_{it}$	0.052	0.387
$glob_{it-1}$	0.088	0.135
tp_{it}	1.755	0.000
tp_{it-1}	1.168	0.021
k_{it}	-0.169	0.173
k_{it-1}	0.076	0.467
tfp_{it}	4.022	0.006
tfp_{it-1}	-4.728	0.000
nrw_{it}	0.202	0.502
nrw_{it-1}	0.463	0.134
epl_{it}	-0.038	0.308
epl_{it-1}	0.020	0.569
co_{it}	-0.280	0.000
co_{it-1}	-0.208	0.004
ud_{it}	2.120	0.002
ud_{it-1}	-2.313	0.001
t_{it}	-0.256	0.502
t_{it-1}	-0.253	0.528
R-squared	0.943	
Breusch-Pagan test (P-value)	0.358	
Durbin Watson statistic (P-value)	1.934	
Hausman test (P-value)	0.000	
RESET test (P-value)	0.608	

Table A.2. One-step difference GMM estimation (dependent variable: natural log of current unemployment)

	Coefficients	**p-values**
u_{it-1}	1.109	0.000
u_{it-2}	-0.328	0.003
v_{it}	-0.231	0.003
v_{it-1}	0.185	0.003
inf_{it}	0.040	0.371
inf_{it-1}	0.006	0.895
$glob_{it}$	-0.114	0.415
$glob_{it-1}$	0.278	0.001
tp_{it}	1.284	0.442
tp_{it-1}	2.467	0.022
k_{it}	0.048	0.940
k_{it-1}	-0.126	0.829
tfp_{it}	5.263	0.397
tfp_{it-1}	-13.035	0.011
nrw_{it}	0.307	0.758
nrw_{it-1}	0.331	0.655
epl_{it}	-0.237	0.002
epl_{it-1}	0.130	0.142
co_{it}	-0.285	0.096
co_{it-1}	0.275	0.014
ud_{it}	1.850	0.167
ud_{it-1}	-1.460	0.211
t_{it}	0.735	0.620
t_{it-1}	-1.744	0.189
AR (1) (P-value)	0.027	
AR (2) (P-value)	0.125	
Sargan Test (P-value)	0.981	
Hansen Test (P-value)	1.000	

Table A.3. System GMM estimation (dependent variable: natural log of current unemployment)

	Coefficients	**p-values**
cons	3.350	0.431
u_{it-1}	1.147	0.000
u_{it-2}	-0.391	0.003
v_{it}	-0.251	0.000
v_{it-1}	0.122	0.028
inf_{it}	-0.029	0.537
inf_{it-1}	-0.017	0.701
$glob_{it}$	-0.146	0.177
$glob_{it-1}$	0.197	0.030
tp_{it}	-0.179	0.851
tp_{it-1}	2.370	0.033
k_{it}	-2.890	0.039
k_{it-1}	2.825	0.043
tfp_{it}	3.659	0.418
tfp_{it-1}	-4.268	0.382
nrw_{it}	0.873	0.017
nrw_{it-1}	-0.563	0.189
epl_{it}	-0.098	0.138
epl_{it-1}	0.109	0.046
co_{it}	-0.248	0.013
co_{it-1}	0.288	0.000
ud_{it}	0.300	0.859
ud_{it-1}	-0.780	0.641
t_{it}	0.103	0.911
t_{it-1}	-0.899	0.223
AR (1) (P-value)	0.010	
AR (2) (P-value)	0.082	
Sargan Test (P-value)	0.419	
Hansen Test (P-value)	1.000	
D-i-H Test (P-value)	1.000	

Table A.4. LSDV estimation, no institutional variables (dependent variable: natural log of current unemployment)

	Coefficients	**p-values**
cons	0.431	0.495
u_{it-1}	1.036	0.000
u_{it-2}	-0.368	0.000
v_{it}	-0.161	0.003
v_{it-1}	0.067	0.221
inf_{it}	0.104	0.024
inf_{it-1}	0.023	0.556
$glob_{it}$	0.027	0.795
$glob_{it-1}$	0.100	0.120
tp_{it}	1.441	0.070
tp_{it-1}	2.671	0.019
k_{it}	-0.275	0.013
k_{it-1}	0.060	0.250
tfp_{it}	2.634	0.062
tfp_{it-1}	-1.570	0.410
R-squared	0.935	
Breusch-Pagan Test (P-value)	0.145	
Durbin Watson statistic (P-value)	1.938	
RESET Test (P-value)	0.024	

Table A.5. One-step difference GMM estimation, no institutional variables (dependent variable: natural log of current unemployment)

	Coefficients	p-values
u_{it-1}	1.257	0.000
u_{it-2}	-0.470	0.019
v_{it}	-0.239	0.044
v_{it-1}	0.188	0.027
inf_{it}	-0.016	0.862
inf_{it-1}	0.035	0.642
$glob_{it}$	0.149	0.374
$glob_{it-1}$	0.077	0.582
tp_{it}	2.834	0.174
tp_{it-1}	8.420	0.758
k_{it}	0.144	0.867
k_{it-1}	-0.093	0.894
tfp_{it}	13.868	0.106
tfp_{it-1}	-20.533	0.041
AR (1) (P-value)	0.063	
AR (2) (P-value)	0.798	
Sargan Test (P-value)	0.983	
Hansen Test (P-value)	1.000	

Table A.6. System GMM estimation, no institutional variables (dependent variable: natural log of current unemployment)

	Coefficients	**p-values**
Cons	12.324	0.007
u_{it-1}	1.162	0.000
u_{it-2}	-0.434	0.000
v_{it}	-0.113	0.257
v_{it-1}	0.088	0.156
inf_{it}	-0.051	0.293
inf_{it-1}	0.040	0.450
$glob_{it}$	0.050	0.789
$glob_{it-1}$	-0.011	0.954
tp_{it}	-1.174	0.255
tp_{it-1}	1.138	0.378
k_{it}	-6.368	0.037
k_{it-1}	6.293	0.039
tfp_{it}	4.340	0.515
tfp_{it-1}	-6.800	0.328
AR (1) (P-value)	0.019	
AR (2) (P-value)	0.149	
Sargan Test (P-value)	0.212	
Hansen Test (P-value)	1.000	
D-i-H Test (P-value)	1.000	

Table A.7. Percent changes in unemployment rate, LSDV estimation

year	glob	tp	k	tfp	co	epl
1980	0.14	0.33	-0.52	-0.01	-0.88	-0.02
1981	0.09	0.31	-0.49	-0.01	-0.99	-0.02
1982	0.10	0.30	-0.45	-0.01	-1.11	-0.02
1983	0.12	0.30	-0.42	-0.01	-0.96	-0.02
1984	0.10	0.30	-0.39	-0.01	-0.82	-0.01
1985	0.09	0.30	-0.35	-0.01	-0.70	-0.02
1986	0.09	0.29	-0.31	-0.01	-0.60	-0.02
1987	0.06	0.30	-0.28	-0.01	-0.54	-0.02
1988	0.09	0.29	-0.24	-0.01	-0.36	-0.02
1989	0.14	0.28	-0.18	-0.01	-0.19	-0.01
1990	0.10	0.31	-0.12	-0.01	-0.16	-0.01
1991	0.07	0.31	-0.03	-0.04	-0.30	-0.01
1992	0.04	0.33	-0.02	-0.01	-0.48	-0.01
1993	0.05	0.34	-0.07	-0.01	-0.48	-0.01
1994	0.04	0.34	-0.11	-0.01	-0.48	-0.01
1995	0.05	0.34	-0.15	-0.01	-0.48	-0.01
1996	0.06	0.33	-0.19	-0.01	-0.48	-0.01
1997	0.06	0.29	-0.24	-0.01	-0.48	-0.02
1998	0.07	0.30	-0.29	-0.01	-0.48	-0.02
1999	0.07	0.30	-0.33	-0.01	-0.48	-0.02
2000	0.06	0.28	-0.38	-0.01	-0.48	-0.02
2001	0.06	0.27	-0.43	-0.01	-0.48	-0.02
2002	0.08	0.28	-0.48	-0.01	-0.48	-0.02
2003	0.09	0.31	-0.53	-0.01	-0.48	-0.02
2004	0.10	0.35	-0.58	-0.01	-0.48	-0.02

Table A.8. Percent changes in unemployment rate, One-step difference GMM

year	glob	tp	k	tfp	co	epl
1980	0.24	0.64	-0.66	-0.15	-0.03	-0.22
1981	0.15	0.59	-0.61	-0.20	-0.03	-0.22
1982	0.18	0.59	-0.57	-0.15	-0.03	-0.21
1983	0.22	0.59	-0.54	-0.13	-0.03	-0.21
1984	0.18	0.58	-0.49	-0.12	-0.03	-0.13
1985	0.15	0.58	-0.45	-0.14	-0.02	-0.16
1986	0.15	0.56	-0.39	-0.17	-0.02	-0.16
1987	0.10	0.57	-0.35	-0.14	-0.02	-0.16
1988	0.15	0.55	-0.30	-0.10	-0.01	-0.17
1989	0.24	0.55	-0.23	-0.14	-0.01	-0.11
1990	0.18	0.60	-0.15	-0.09	0.00	-0.09
1991	0.12	0.60	-0.04	-0.72	-0.01	-0.09
1992	0.07	0.65	-0.03	-0.20	-0.01	-0.08
1993	0.10	0.66	-0.08	-0.11	-0.01	-0.09
1994	0.08	0.65	-0.14	-0.15	-0.01	-0.08
1995	0.09	0.65	-0.19	-0.10	-0.01	-0.13
1996	0.10	0.63	-0.24	-0.09	-0.01	-0.13
1997	0.10	0.57	-0.30	-0.17	-0.01	-0.17
1998	0.12	0.58	-0.37	-0.16	-0.01	-0.17
1999	0.11	0.59	-0.42	-0.10	-0.01	-0.17
2000	0.10	0.54	-0.48	-0.14	-0.01	-0.17
2001	0.11	0.52	-0.55	-0.14	-0.01	-0.17
2002	0.13	0.54	-0.61	-0.10	-0.01	-0.17
2003	0.15	0.60	-0.67	-0.08	-0.01	-0.17
2004	0.18	0.68	-0.73	-0.09	-0.01	-0.17

Table A.9. Percent changes in unemployment rate, System GMM estimation

year	glob	tp	k	tfp	co	epl
1980	0.07	0.33	-0.49	-0.01	0.10	0.02
1981	0.04	0.31	-0.46	-0.01	0.11	0.02
1982	0.05	0.31	-0.43	-0.01	0.12	0.02
1983	0.06	0.31	-0.40	-0.01	0.11	0.02
1984	0.05	0.30	-0.37	-0.01	0.09	0.01
1985	0.04	0.30	-0.33	-0.01	0.08	0.02
1986	0.04	0.30	-0.30	-0.01	0.07	0.01
1987	0.03	0.30	-0.26	-0.01	0.06	0.01
1988	0.04	0.29	-0.22	-0.01	0.04	0.02
1989	0.07	0.29	-0.17	-0.01	0.02	0.01
1990	0.05	0.32	-0.12	-0.01	0.02	0.01
1991	0.03	0.31	-0.03	-0.05	0.03	0.01
1992	0.02	0.34	-0.02	-0.01	0.05	0.01
1993	0.03	0.35	-0.06	-0.01	0.05	0.01
1994	0.02	0.34	-0.10	-0.01	0.05	0.01
1995	0.03	0.34	-0.14	-0.01	0.05	0.01
1996	0.03	0.33	-0.18	-0.01	0.05	0.01
1997	0.03	0.30	-0.23	-0.01	0.05	0.02
1998	0.03	0.30	-0.27	-0.01	0.05	0.02
1999	0.03	0.31	-0.31	-0.01	0.05	0.02
2000	0.03	0.28	-0.36	-0.01	0.05	0.02
2001	0.03	0.27	-0.41	-0.01	0.05	0.02
2002	0.04	0.28	-0.45	-0.01	0.05	0.02
2003	0.04	0.31	-0.50	-0.01	0.05	0.02
2004	0.05	0.36	-0.54	-0.01	0.05	0.02

Legend of tables

The sample relates to 1980-2004 period and 19 countries, for a sum total of 475 observations.

The dependent variable is always u_{it}, the natural log of the unemployment rate, where i = 1, …, N stands for the country, and t = 1, …, T stands for a given year.

Among the independent variables, *v* is the natural log of vacancy rate, *inf* the natural log of the inflow rate, *glob* the natural log of the globalisation index, *tp* the technological progress, *k* the capital deepening index, *tfp* the total factor productivity, *nrw* the unemployment benefits index, *epl* the employment protection legislation index, *co* the bargaining coordination index, *ud* the union density index, *t* the total tax wedge.

In the model we have included yearly and country dummies and linear and quadratic trends, not shown in the interest of parsimony. The p-values belong to the z-statistics (akin to t-ratios) for the regression coefficients.

In Tables A.1 and A.4, *R-squared* is the coefficient of determination, *Breusch-Pagan test* is the test of residual contemporaneous correlation independence, *Durbin Watson statistic* is the test statistic of first-order autocorrelation in the residuals, *Hausman test* tests the exogeneity of regressors and *RESET test* stands for Ramsey's Regression Error Specification Test.

In Table A.2, A.3, A.5 and A.6, *AB(1) and AB(2)* are the Arellano–Bond tests for first and second order serial correlation (distributed as a normal), *Sargan* and *Hansen tests* are tests of overidentifying restrictions that detect the exogeneity of the instruments as a group, and *D-i-H Test* is the Difference-in-Hansen test of exogeneity of instrument subsets.

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Chapter III. The Italian Beveridge Curve: a Regional Analysis

3.1. Introduction

After treating in the previous chapter the effectiveness of labour market matching across OECD countries, now we focus on the Italian labour market. There are not many studies that have analyzed the Beveridge Curve in Italy, likely because of the lack of official data on vacancies. Moreover, no previous study has focused specifically on a regional level analysis of the Beveridge Curve. This chapter aims at filling this gap of the literature using quarterly data for the 1992-2009 period. In particular, the ISAE labour scarcity indicator, which is available for all the regions, is used to build regional vacancy rates. Like in Destefanis and Fonseca (2007), we investigate the impact on matching efficiency of the development in the number of so-called atypical jobs (both part-time and temporary). Differently from these authors, as well from most of the previous literature, we explicitly allow for the role of some direct mismatch indicators.

Furthermore, drawing inspiration from some studies about other countries, we investigate the existence of a significant spatial inter-dependence between Italian regional labour markets, trying to verify whether externalities by non-resident unemployed workers and from job openings in neighbouring regions impact on the labour market performance of each region. Finally, we explore the impact of the current *Great Recession* on the Beveridge Curve. We do this in this chapter (and not in the previous chapter on OECD countries) because cross-country data for recent years are not widely available. At the same time, our regional set-up allows us to appraise how different labour markets have reacted to the current aggregate depression.

The chapter is organised as follows. Section 2 presents a short description of the Beveridge Curve, largely referring to Chapter I for in-depth analysis; in Section 3 we overview the empirical literature on the Beveridge Curve in Italy, whereas in Section 4 we present some contributions from other European countries on the existence of spillover effects in regional labour market matching; Section 5 describes the empirical specification and the data we used; Section 6 presents our results, and Section 7 concludes.

3.2. The Beveridge Curve: a Brief Reference

The Beveridge Curve is formally defined as the path formed by all those vacancy and unemployment rate combinations, where unemployment is stable, i.e. where the inflow into unemployment is equal to the flow out of it. Given the matching process on the labour market, the higher the level of vacant jobs, the lower the level of unemployment, as the probability of finding a job increases.

Thus, the Beveridge Curve shows the relationship between the unemployment rate and the vacancy rate and can provide a synthetic description of developments in the matching process. Movements along the Curve (i.e. where vacancies and unemployment move in different directions) reflect cyclical fluctuations in economic activity. An outward shift of the Curve, where vacancies and unemployment increase simultaneously, might indicate a deterioration in the matching process owing to structural factors such as inadequately functioning labour market institutions. Conversely, an inward shift of the Curve may indicate an improvement in the matching process. For a more exhaustive theoretical treatment and derivation of the Beveridge Curve, we refer to Chapter I (sections 2 to 4 in particular).

3.3. Unemployment and Vacancies in Italy: the Empirical Literature

In Italy there are no official data on vacancies[10]. However, there are two ongoing surveys allowing the empirical appraisal

[10] At least, this was true until last year: ISTAT has now started producing some official data. This is anyway irrelevant for the present analysis, as these data are only available for a few years, and not on a regional basis.

of the relationship between vacancies and unemployment at a business-cycle frequency.

The CSA (Centro di Studi Aziendali, Florence) and the ISFOL (Istituto per lo Sviluppo della Formazione Professionale dei Lavoratori, Rome) carry out a quarterly survey on the help-wanted advertisements published in some important daily newspapers. These data, however, are not available on a regional basis, but only for a restricted number of macro-areas (three - North, Centre and South - for a lengthy time period, and four - North-West, North-East, Centre and South - in more recent years).

The other data source relates to the quarterly business survey undertaken by ISAE (Istituto di Studi e Indagine Economica, formerly ISCO, Istituto per la Congiuntura Economica) in manufacturing, and is also available on a regional basis. Among other things, firms are asked whether the scarcity of labour prevents them from expanding their activity. Under some assumptions (which will be examined in detail in section 5 of this chapter), the replies to this question allow the construction of a vacancy rate indicator.

Furthermore, until 1999 it was also possible to utilise another (administrative) source on a regional basis: the data from the Italian Ministry of Labour (*Ministero del Lavoro e della Previdenza Sociale*) relating to the vacancy notices posted by firms (usually firms only posted these notices when they already had actually decided upon the hiring). Unfortunately these data are no longer available.

Perhaps because of the absence of official data on vacancies, not many studies have examined the nature and evolution of the Beveridge Curve for the Italian labour market.

3.3.1. The First Studies of the Italian Beveridge Curve

Sestito (1988) and Bragato (1990) use 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 (1991), who analyses Italian labour market between 1967 and 1988 and uses the data from the ISAE survey as proxy for vacancies. In this case, nevertheless, no linear trend has to be included in the estimates to find a significant relationship between unemployment and vacancies. This analysis shows that the worsening performance of the Italian labour market can be mainly interpreted as a shift of the Beveridge Curve rather than in terms of a reduction of the supply of vacancies along a given Beveridge Curve. 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.

3.3.2. The Latest Empirical Analyses

More recent evidence is provided by Mocavini and Paliotta (2000), Brandolini and Cipollone (2001) and Destefanis and Fonseca (2004, 2007).

Utilising the ISFOL-CSA data for the 1980's and the 1990's, Mocavini and Paliotta (2000) provide an exploratory analysis of the Beveridge Curve, examining the trend of the unemployment-vacancies relationship over time. First, they find a largely favourable evidence for the existence of an aggregate Beveridge curve, which in a first period (1980-1983) shifts downwards, subsequently (1984-1987 and 1993-1999) upwards. Whereas the vacancy rate showed rises and falls, the unemployment rate always increases except in 1990-1991 and in 1999. Therefore, the Curve seems to reflect mainly the movements of vacancies and the help-wanted advertisements index seems to anticipate the business cycle. This feature also comes out in the subsequent step of the analysis, focused on the three macroareas (North, Centre, South).

More precisely, help-wanted advertisements seem to anticipate the business cycle in the Northern labour market: indeed, the vacancy rate starts declining in 1990 in a situation of economic growth, whereas the unemployment rate, that immediately reacts to the crisis, starts going up only in 1992. Before, the vacancy rate started rising during the period of recession, followed just two years later by the decrease of the unemployment rate. Thus, it appears that vacancies anticipate the business cycle by two years.

Furthermore, comparing the three macroareas, Mocavini and Paliotta find that, whereas the Centre reflects essentially the national trend, a strong dualism between the North and the South comes out. While in the Northern labour market they verify, except in 1992-1994 period, a substantial negative relationship between unemployment and vacancies, characterised by a reduction of the former and a growth in the latter, in the South there have been an uncertain movement of vacancies, characterised by repeated rises and falls of the number of the help-wanted advertisements index, and a constantly high unemployment rate. Therefore, Mocavini and Paliotta argue that, whereas the Northern labour market is characterised by frictional imperfections and by a Beveridge Curve driven by movements in vacancies, the Southern labour market reflects an economic stagnation where unemployment includes a strong structural component and the Beveridge Curve mainly follows the movements of the unemployment rate.

Mocavini and Paliotta's study is important inasmuch as it drew again attention to the existence of an Italian Beveridge Curve, highlighting the strong heterogeneity between the Northern and the Southern labour markets, which could be a driving factor of the shifts in the aggregate Beveridge Curve.

Brandolini and Cipollone (2001) focus their attention on the analysis of territorial, sectoral and skill mismatch, trying to prove its existence in the Italian labour market in 1970-2000 period using different mismatch indicators. The territorial mismatch is determined by different growth and development rates between the regions of a same country: basically the vacancies are not located where unemployed are and strong rigidities limit the productive factors mobility and the possibility to reduce the mismatch as well. The sectoral mismatch stems from wage, productivity and technology differences between the different productive sectors. Finally, the skill mismatch refers to the mismatch between the skills the workers supply and the skills employers demand.

The first mismatch indicator Brandolini and Cipollone consider, M1, is the turbulence index by Jackman *et al.* (1991), based upon the number of workers that have changed sector[11]

(1) $$M1 = \frac{1}{2}\sum_i \left| \Delta\left(\frac{E_{it}}{E_t}\right) \right|$$

[11] The word *sector* here refers indifferently to regions, industries, employment and skills.

where E_{it} is the employment in sector *i* and in period *t*, and $E_t = \sum_i E_{it}$ is the total employment. The second indicator that they consider is the labour reallocation indicator by Lilien (1982), which is closely related to the turbulence index. It measures the relative dispersion of the growth rates across sectors,

(2) $$M2 = \left[\sum_i \left(\frac{E_{it-1}}{E_{t-1}} \right) \left(\frac{\Delta E_{it}}{E_{it-1}} - \frac{\Delta E_t}{E_{t-1}} \right)^2 \right]^{1/2}$$

While these two measures of mismatch rely on the occupational growth, the last indicator considered, M3, suggested by Jackman *et al.* (1991) as well, is based on the variance of the relative unemployment rates,

(3) $$M3 = \frac{1}{2} \operatorname{var} \left(\frac{u_{it}}{u_t} \right)$$

where u_{it} is the unemployment rate in sector *i* and in period *t* and u_t is the national unemployment rate. Under the hypothesis that the latter reflects some notion of equilibrium, then mismatch is measured as the distance between actual unemployment rates and equilibrium unemployment rate.

By using these three indicators, Brandolini and Cipollone estimate the different types of mismatch and find out that: a) sectoral mismatch does not vary significantly; b) a higher unemployment rate of skilled workers shows up until 1992, while later and especially from 1995 Italy follows the European trend, characterised by a higher incidence of unemployment among unskilled workers. On the whole, skill mismatch shows a very moderate increase in the second half of the 1990's; c) regarding regional mismatch, there have been strong fluctuations, with some divergences among the various indicators.

Indeed, M1 and M2 highlight that, after an increasing trend in the 1980’s, regional mismatch seems to fall suddenly at the end of the same decade and keeps on having a negative trend during the 1990’s except in 1993. However, the other indicator, M3, depicts a completely different situation, where regional mismatch rises at the end of the 1980’s and during the 1990’s. Brandolini and Cipollone try to play down the strong divergence between the results by minimising the rise of regional mismatch as measured by M3. They first consider the fact that the unemployment rate often, especially in the Southern regions, tends to rise as the labour demand rises, that is as many discouraged workers, that previously have not looked for a job actively and, thus, have not been classified as unemployed, tend to enter the labour market; then, they consider the possibility to justify the regional dispersion of the unemployment rates during the periods of economic growth through the lag of the business cycle in the South compared to the North, which gets the unemployment rates to keep on rising in the Southern regions when they are already going down. So, on the one hand the problem of the divergence of the results is just partially solved, on the other hand they consider reasons of the regional mismatch deeper than the frictions in the matching process, such as the great difficulty or unwillingness of the Southern inhabitants to move to the Northern regions where vacancies are open, or the disinclination of the firms to settle in the South.

More interestingly for our purposes, Brandolini and Cipollone proceed to analyse mismatch within a Beveridge Curve framework. Using the ISFOL-CSA indicator for vacancies, they examine the behaviour of the Curve over time, under the hypothesis that its outward shifts can be interpreted as an increase in the mismatch. This kind of analysis suggests that mismatch increase during the 1980's. Finally, Brandolini and Cipollone construct a job matching function à la Pissarides (1990, 2000) in order to appraise the impact of some of the structural changes which seem to emerge from their previous analyses. More precisely, they consider two factors: 1) a possible rise in the inputs of the matching technology, considering the increase in the participation rates from 1995 to 2000; 2) the possibility of a complete process of institutional reform of the market, which, inputs being equal, raised the matching efficiency. Utilising a measure of vacancies relying upon the ISCO-ISAE labour scarcity indicator, they obtain the following equation

(4) $\log(M_t) = a_1 + a_2 t + a_3 t^2 + b \log(U_{t-1}) + c \log(1 -$

$LSt-1+et$

where U_{t-1} is the lagged rate of unemployment and LS_{t-1} is the lagged share of firms which are experiencing labour scarcity, whereas e_t is an error term. As a proxy for hirings, Brandolini and Cipollone elaborate data from the ISTAT Labour Force Survey, derived from transition matrices and recall questions. We stress that this kind of information is not readily available at a regional level.

From the OLS and IV estimation of (4) in the 1979-2000 period, it turns out that: a) matches react more to the demand-side than to the supply-side, as shown by the fact that *c* is twice higher than *b*; b) a significant and quick improvement of matching efficiency takes place in the last decade.

Destefanis and Fonseca (2004) utilise a matching theory approach (see Chapter I, sections 2 and 3 in particular) in order to analyse the links between territorial and skill mismatch. Exploiting the resemblance between the matching function and a production function and re-parameterising the matching function as a Beveridge Curve, they carry out estimates of the Beveridge Curve for the Italian economy and for the three macroareas through stochastic frontier techniques.

They use vacancy data from three different sources (ISFOL-CSA, ISAE, Ministry of Labour), examining carefully the dynamic specification of the Curve, including some potential determinants of the efficiency as regressors and comparing directly the performance of the three above-mentioned vacancy indicators. The main aim is to produce technical efficiency scores through a within-effect technique and to utilise their variance as measure of the mismatch in the labour market considered. Their results first highlight a largely favourable evidence to the existence of an aggregate Beveridge Curve in the 1990s, and across the main territorial areas as well, whatever indicator is used. Furthermore, from the comparison of the different areas and of the high- and low-skilled segments of the labour market, it turns out that the imbalance between skilled labour demand and supply is not able to explain the huge differences between the Southern labour market and the rest of the country. Instead, it is the poor performance of the Southern labour market to heighten in that area of the country the efficiency differentials between high- and low-skilled segments.

Considering quarterly data over the period 1992-2001, Destefanis and Fonseca (2007) use a matching theory approach to assess the impact on the Italian labour market of the so-called 1997 Treu Act (*Legge Treu*) as well, which considerably eased the regulation of temporary work and favoured its growth in Italy. They reparameterise the matching function as a Beveridge Curve and estimate it as a production frontier using a fixed effects feasible GLS procedure, finding huge differences in matching efficiency between the South and the rest of the country. The Treu Act appears to have improved matching efficiency in the North of the country, particularly for skilled workers, but also to have strengthened competition among skilled and unskilled workers, especially in the South, leading a decrease in matching efficiency for this market segment.

Table 1. Italian empirical literature on Beveridge Curve

	Data source	**Period of analysis**	**Higher territorial disaggregation**	**Mismatch indicators**	**Spillover effects**	**Efficiency scores**
Sestito (1988)	ISFOL-CSA	1978-1987	North, Centre, South	Not included	Not included	Not computed
Bragato (1990)	ISFOL-CSA	1980-1988	North, Centre, South	Not included	Not included	Not computed
Sestito (1991)	ISAE	1980's	North, Centre, South	Not included	Not included	Not computed
Di Monte (1992)	Ministry of Labour	1980's	North, Centre, South	Not included	Not included	Not computed
Mocavini and Paliotta (2000)	ISFOL-CSA	1980-1999	North, Centre, South	Not included	Not included	Not computed
Brandolini and Cipollone (2001)	ISAE	1979-2000	North, Centre, South	Not included (explicitly)	Not included	Not computed
Destefanis and Fonseca (2004)	ISFOL-CSA, ISAE, Ministry of Labour	1992-1999	North, Centre, South	Not included	Not included	Computed (Stochastic frontier approach)
Destefanis and Fonseca (2007)	ISFOL-CSA, ISAE	1992-2001	North, Centre, South	Not included	Included but not significant	Computed (Stochastic frontier approach)

In Table 1, we have summed up some important characteristics of the studies examined in this section. The lack of studies on regional (NUTS2) data clearly comes out, as well as the prevalent lack of analysis for the mismatch indicators. Only Destefanis and Fonseca have proceeded to the computation of efficiency scores, which could be a useful tool in the study of regional differences and mismatch. From the bulk of the Italian studies, the latter dimension appears indeed of paramount importance. As is apparent from the last-but-one column of the table, there is another distinctive lack in the Italian literature. Basically, the relevance of territorial spillover effects is never considered. The relevance of this lack will become more apparent in the light of the papers surveyed in the following section.

3.4. Matching and Regional Spillovers: a Literature Overview

In the most recent international literature concerning labour market matching, a growing number of contributions have focused their attention on regional analysis taking into account spillover effects with neighbouring regions.

Burgess and Profit (2001) estimate matching functions for 303 travel-to-work areas (TTWAs) in a ten year (1985-1995) panel of monthly data on unemployment and vacancy stocks and flows in Britain. More precisely, they first estimate a basic matching function through different models (pooled OLS, fixed effects regression, three-stage GLS), finding that a strong relationship exists in the data between job formation and unemployment and vacancies (and the matching function exhibits decreasing returns to scale). Then, they investigate spatial dependence in local labour markets, estimating by three-stage GLS an augmented matching function where the spatial spillover variables are specified as a weighted sum of the unemployed and vacancies in the neighbouring TTWAs, and find strong evidence of spillover effects between local labour markets, including significant negative congestion effects in matching: conditional on local conditions, high unemployment in neighbouring areas raises the number of local filled vacancies but lowers the local outflow from unemployment.

Ilmakunnas and Pesola (2003) consider annual data for the 14 Finnish regions from 1988 to 1997 using the frontier approach. They include in the estimates a linear trend and allow for some potential determinants of inefficiency: specifically, they incorporate explanatory variables directly in the (in)efficiency term so that the (in)efficiency can vary across regions and over time. Firstly they estimate a traditional matching function with the explanatory variables included directly in the equation, using ordinary least squares with region-specific fixed effects.

Secondly they estimate the stochastic matching frontier, where the explanatory variables do not appear directly in the model but are included in the mean function of the truncated error term, using maximum likelihood according to Battese and Coelli (1995) approach. Among the explanatory variables they include the average unemployment and vacancy rates of the neighbouring regions, that enter significantly and with the expected signs in the estimates (the average unemployment rate of the neighbouring regions has a negative impact on efficiency, whereas the average vacancy rate has a positive impact).

Ahtonen (2005) considers monthly data for 173 Finnish Local Labour Office (LLO) areas over a 12-year period between January 1991 and August 2002 in order to study spatial aspects in local labour markets from the perspective of a matching approach. The basic matching function is extended (as in Burgess and Profit) to account for spatial spillovers between the local labour markets. Estimating by pooled OLS and fixed effects model, they find that Finnish labour markets suffer from a strong congestion effect among job seekers, and spatial spillovers even strengthen the congestion: an open vacancy is filled much easier than a job seeker is employed. Then, they examine also the role of population density in the matching process, adding it as an interaction dummy variable in the model. The results show that the matching efficiency is remarkable lower in dense areas than elsewhere, which indicates that mismatch is a problem in the local labour markets with high population density.

Kosfeld (2006) considers monthly data from December 1997 to December 2004 for 439 German districts in order to address the issues of regional spillovers and spatial heterogeneity in the matching of workers and employers in the unified Germany. More precisely he considers 180 regional labour markets (133 in the western and 47 in the eastern part of Germany) using data on job commuters across German districts. He estimates the usual spatially augmented matching function both through pooled OLS and a spatial seemingly unrelated regressions (spatial SUR) model that allows for temporal and spatial dependencies. More specifically, he first focuses on the aggregate matching function, then on West-East regimes of the matching function separately, finally on the regional matching functions (considering 12 macroregions) in order to assess the importance of regional mismatch. He finds that: a) the significance of spatial externalities in job matching is clearly confirmed; b) West and East regimes of the matching process differ mainly with respect to the strength of spatial interaction: larger response coefficients of the spatial lag variables reflect the higher regional mobility of Eastern German workers; c) conditional on regional labour markets structures and tightness, inefficiencies in job matching prove to be closely related to business cycle fluctuations. Although regional mismatch varies over the business cycle as well, it can only explain a relatively small fraction of the cyclical behaviour of matching inefficiency.

Table 2. The international literature on spillovers

	Country	Territorial disaggregation	Approach	Spillover effects
Burgess and Profit (2001)	Britain	303 travel-to-work areas	Augmented matching function	Strong evidence
Ilmakunnas and Pesola (2003)	Finland	14 regions	Stochastic matching frontier	Strong evidence
Ahtonen (2005)	Finland	173 local labour offices	Augmented matching function	Strong evidence
Kosfeld (2006)	Germany	180 local labour markets	Augmented matching function	Strong evidence

From Table 2, the high significance of spillover effects is well apparent, highlighting the relevance of this lack in the Italian literature. Because of the lack of regional data on hirings already pointed out in section 3, it is not possible to carry out an analysis of spillovers in the Italian case within a matching function. However, reparameterising the matching function as a Beveridge Curve along the lines of Destefanis and Fonseca (2004, 2007), it will still be possible to assess the relevance of spillover effects on regional labour matching in Italy.

3.5. The Econometric Analysis: Empirical specification and Data

As above mentioned, hirings data are not available at regional data, which prevents us to proceed to a matching function analysis. Thus, we focus on the Italian Beveridge Curve.

From Chapter I (Section 3) we recall that the matching function is increasing in both its arguments, concave and homogeneous of degree one (constant returns to scale):

(6) $$M = em(V, U)$$

$$m(v, 0) = 0, m(0, u) = 0$$

$$m_u \geq 0, m_v \geq 0$$

where e captures the effectiveness of the search intensity of both firms and workers in creating new job matches and can be influenced by structural changes in the labour market (labour force reallocation). Thus, the efficiency term is interpreted as a mismatch indicator and reflects both shocks (causing occupational, sectoral, skill and regional mismatch between unemployed and vacancies) and labour market institutions.

Starting from the matching function, we can obtain the Beveridge Curve and the efficiency term does not lose its original meaning.

The evolution of total employment is given by the sum of the flows of new jobs created and existing jobs maintained:

(7) $$N_{t+1} = M_t + (1 - s)N_t$$

In terms of unemployment,

(8) $$U_{t+1} - U_t = s(1 - U_t) - \theta q_t(\theta) U_t$$

where $s(1 - U_t)$ is the flow of employees moving into unemployment with rate s (inflow rate), and $\theta q_t(\theta) U_t$ is the flow of unemployed finding new jobs with probability $\theta q_t(\theta)$.

In a steady state, as the mean rate of unemployment is constant, the matching function can be restated in order to obtain the Beveridge Curve. Actually, if the mean rate of unemployment is constant, we can write:

(9) $$s(1 - U) = \theta q(\theta) U$$

We can rewrite (9) as an equation determining unemployment in terms of both transition rates, s and $\theta q(\theta)$:

(10) $$U = {}^{s}\!/\!\left(s - \theta q(\theta)\right).$$

By the properties of the matching function, the flow equilibrium condition (10) can be represented in vacancy-unemployment space by a downward-sloping and convex to the origin curve, the Beveridge Curve.

More precisely, under the hypothesis of constant returns to scale, equation

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

becomes

(12) $$ {}^{H_{it}}\!/\!_{U_{it-1}} = h\left({}^{V_{it-1}}\!/\!_{U_{it-1}} \right) e_{it}.$$

In its turn, this function can be rewritten as

$$(13)\quad {}^{H_{it}}/_{N_{it-1}}\left[\left({}^{L_{it-1}}/_{U_{it-1}}-1\right)\right]=h\left[\left(\frac{{}^{V_{it-1}}/_{L_{it-1}}}{{}^{U_{it-1}}/_{L_{it-1}}}\right)\right]e_{it}.$$

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 (13) 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* (11); however, empirical measures of efficiency will reflect the evolution not only of e_{it}, but also of s and g.

The following specification

$$(14)\quad u_{it} = \beta_1 u_{it-1} + \dots + \beta_4 u_{it-4} + \beta_5 \bar{v}_{it-1} + \beta_6 nu_{it-4} + \beta_7 \overline{nv}_{it-1} + \beta_8 \overline{gm}_{it-1} + \beta_9 \overline{sm}_{it-1} + \beta_{10} \overline{ish}_{it-1} + \beta_{11} partt_{it-1} + \beta_{12} temp_{it-1} + \theta_{i1} t + \theta_{i2} t^2 + \theta_{i3} t^3 + \theta_{i4} t^4 + f_i + \varepsilon_{it}$$

is used to estimate the Italian Beveridge Curve: $i = 1, \dots, N$ stands for the region, and $t = 1, \dots, T$ stands for the time period (quarter). u_{it} is the natural log of the unemployment rate, $\bar{v}_{it}$ is the vacancy rate, $\overline{nu}_{it}$ and $\overline{nv}_{it}$ are averages of the unemployment and vacancies in the neighbouring regions respectively, $\overline{gm}_{it}$ and $\overline{sm}_{it}$ gender and sectoral mismatch indicators respectively, $\overline{ish}_{it}$ the share of employment in industry, $temp_{it}$ and $partt_{it}$ shares of temporary and part-time employment on labour force respectively, t a time trend (to allow for a more flexible specification of time-related structural changes, we include in the equation powers of this trend up to the fourth), f_i regional fixed effects and ε_{it} a stochastic variable assumed to be independently and identically distributed and β, and θ are the parameters of the model[12]. All the regressors, except for the lags of the unemployment rate and of the shares of temporary and part-time employment, are expressed through (one-period lagged) moving averages over four quarters.

The main data source used is the quarterly Labour Force Survey from ISTAT (various years) (*Indagine trimestrale sulle forze di lavoro*). This survey involves every quarter about 200,000 persons in 1,400 municipalities from all over the country. In particular, individual data from 1992:4 to 2009:3 are used to measure stocks of unemployed and labour force for the twenty Italian regions.

Moreover, we rely on the ISAE indicator of labour scarcity[13] in order to measure regional vacancy rates, as it is available for all the Italian regions, unlike the ISFOL help-wanted ads. More

[12] Given that the empirical analysis of Chapter II reveals a statistically and economically significant role for technological progress and, to some extent, capital deepening in the labour matching process, it may be asked why no such variable is included in (14). The (all too obvious) answer is the lack of appropriate regional data. This variable omission is likely to be mitigated, anyway, by the inclusion of a quartic function of time in (14).

[13] We are very grateful to Dr. Marco Malgarini (ISAE) for making data on labour scarcity indicators available to us.

precisely, we used the transformation of the ISAE indicator suggested in Sestito (1991):

(15) $$G(ISAE) = \pi \times \Phi^{-1}(\pi) + f[\Phi^{-1}(\pi)],$$

where π is the percentage of firms reporting that the scarcity of labour does not prevent them from expanding their activity, $\Phi^{-1}(\cdot)$ is the inverse of a standardized normal distribution function, and $f[\cdot]$ is a standardized normal density function. Hence G(ISAE) is a monotonic transformation of the percentage of firms constrained by the scarcity of labour, consistent with the hypothesis that firms are normally distributed across constrained and non-constrained states. For that reason, in our estimates the coefficient of vacancy rate is positive, but the interpretation is the usual negative relationship between unemployment and vacancies.

Note that in (14) we model spillover effects through the (unweighted) mean unemployment and vacancy rates of the neighbouring regions. We do not have data for commuter and migration flows that would allow a more sophisticated specification, and as Ilmakunnas and Pesola (2003) we assume that relying on averages of neighbouring regions is appropriate for the NUT2 territorial level of our analysis.

As regards mismatch indicators, in order to obtain values varying across both regions and quarters according to the data availability, we used M3 as gender mismatch indicator, and M1 as sectoral mismatch indicator, where s_{ijt} is the share of i in region j at time t. Following the evidence from Brandolini and Cipollone (2001) and Destefanis and Fonseca (2007), we include in our specification some indicators for the so-called atypical labour contracts, whose development is widely thought to be one of the main changes in the Italian labour market in recent years. However, the Confinterim data for temporary workers used by Destefanis and Fonseca are no longer available to the public, and we must use the Istat data for temporary and part-time employment, only available for four macroareas (North-West, North-East, Centre and South). Thus, shares of temporary (or part-time) employment on labour force for each region are derived dividing the temporary (or part-time) employment of the macroarea a region belongs to by the labour force of that macroarea (the evolution of these shares is depicted in Figures A.1 and A.2). Unlike Destefanis and Fonseca (2004, 2007), we do not consider the difference between skilled and unskilled workers due to the lack of microdata concerning these two categories.

Finally, we consider Piemonte and Val d'Aosta jointly, as ISAE treats them as a single region in collecting data about labour scarcity indicator, and exclude Sardegna from the sample because of the lack of neighbouring regions, which prevents us to investigate reasonably spillover effects. Thus, our sample consists of 18 (and not 20) regions.

3.6. The Estimates

Building upon the suggestions of Judson and Owen (1999) for our type of sample (see Chapter II, Section 6), we proceed to the estimation of the model (14) through a simple fixed-effects LSDV procedure. Although our panel is balanced, we prefer LSDV to Kiviet's LSDVC because of the complexity of the dynamic specification of our model.

Two different specifications are estimated, one excluding and one including mismatch indicators and spillover effects. The two specifications are respectively labelled (1) and (2) in the tables of the Appendix.

We first focus on the period up to 2007 and then consider also the last two years, in order to better appraise the impact of the Great Recession on the Beveridge Curve.

Table A.1 shows that the spillover effects have a very significant impact on the Beveridge Curve: an increase of the average unemployment rate of the neighbouring regions has a negative effect on efficiency and shifts the Curve outwards, which indicates increased competition in job search, whereas an increase of the average vacancy rate has a positive impact on efficiency and shifts the Curve inwards, reflecting more job opportunities for the unemployed. Furthermore, the inclusion of the spillover effects reduces coefficients and significance of both unemployment and vacancy rates, and the coefficient of the average vacancy rate of the neighbouring regions is even higher than the coefficient of the vacancy rate. This evidence is largely consistent with the results of Ilmakunnas and Pesola (2003). Other significant determinants of matching efficiency are the share of employment in industry (positive sign) and part-time employment (negative sign), whereas mismatch indicators and temporary employment appear not to have a significant impact on the Beveridge Curve. Among atypical labour contracts, only part-time thus seems to (favourably) affect labour market matching. Further evidence on this point must however wait for the production by ISTAT of genuinely regional measures for these indicators.

In Table A.2, we consider the whole sample, introducing in both specifications two dummy variables (cr08, cr09) which capture the effects of the Great Recession in each year. The results of Table A.1 are confirmed, but the impact of the Great Recession on the Curve turns out to be very strong, especially in 2009. On the other hand, a dummy allowing for the (rather severe) recession of the early 1990's is not significant at all.

These results are confirmed also in Table A.3, which shows a specification including spillovers and dummy variables capturing the effects of the Great Recession in each year *and* in each region. We can notice that Friuli Venezia Giulia and Molise are the regions more affected by the current recession even in 2008, but in the following year dummies' coefficients get much higher in almost all Italian regions.

However, some specification problems are highlighted from Ramsey's Regression Error Specification Tests, likely due to the territorial disaggregation of our dataset and to the choice of the variables which proxy the spillover effects. Arguably, the strong spillover effects we find are not appropriately represented through the simple contiguity approach that was pursued here.

This hunch finds some confirmation as we proceed, like in Destefanis and Fonseca (2007), to estimation for the four macroareas (North-West, North-East, Centre and South) - instead of regions - excluding all spillover effects, which were found to be insignificant for this kind of territorial aggregation.

The results are shown in Tables A.4, A.5 and A.6: RESET Tests indicate that the specification of the model improves very much, even though regressors generally lose significance.

Resorting to (labour-force) weighted means for neighbouring vacancies and unemployment did not improve matters appreciably. Spillovers were always strongly significant (the relevant estimates are available upon request), but so was the RESET Test. We lack, on the other hand, data for commuter and migration flows that would allow a more sophisticated specification of spillovers. A more appropriate modelling of these effects must then be left for future research.

In any case, according to the exploratory analyses about the impact of the *Great Recession* on the matching process that we presented in Chapter I, the current recession is unlikely to determine shifts of the Beveridge Curve in the European and US labour markets. The evidence we gather from our estimates does not afford much room for such optimism, at least for Italy. A large shift in the Curve is found to have taken place in the last two years, for which there was no counterpart during the rather severe recession of the early 1990's[14]. As this is true both for specifications (1) and (2), this finding is not likely to be affected by specification of spillovers.

Equally unlikely to be affected by specification issues is the absence of significance for gender and sectoral indicators[15]. To some extent, this reiterates the results for Italy in Brandolini and Cipollone (2001). Regional imbalances seem indeed to be the key source of mismatch in the Italian labour market.

As a consequence of all this, it would be tempting to close this chapter by computing matching efficiency scores and building a regional mismatch indicator as in Destefanis and Fonseca (2004). We do not pursue this exercise, however: there are specification issues still open with our regional estimates. Also, we lack the regional data for the separation rates required for

[14] It is however true that a full comparison of the two recessions would very much gain from having more observations in the early 1990's.

[15] These indicators are always grossly insignificant, also in a specification including them, but not the spillovers (for the sake of parsimony, these results are not reported here but are available on request).

the proper identification of the efficiency terms from our estimates.

3.7. Concluding Remarks

In this chapter we considered - for the first time, to the best of our knowledge - a Beveridge Curve for the twenty Italian administrative regions[16]. Particular attention is paid to appraise the relevance of mismatch, spillover effects and the current Great Recession for the regional labour matching process.

Using a standard LSDV estimation approach, we find the following main results: a) we find no evidence that either gender or sectoral mismatch bring about shifts in the territorial Curves; b) on the other hand, spillover effects are very strong, although further research on their proper specification must be yet carried out; c) the Great Recession has a very strong (negative) impact upon the territorial Curves; d) finally, we find some tentative evidence that part-time jobs (but not temporary ones) favourably affect matching efficiency.

[16] As we have seen in the text, estimation must be restricted to eighteen regional data points (one of them including two administrative regions) because of various reasons.

Appendix

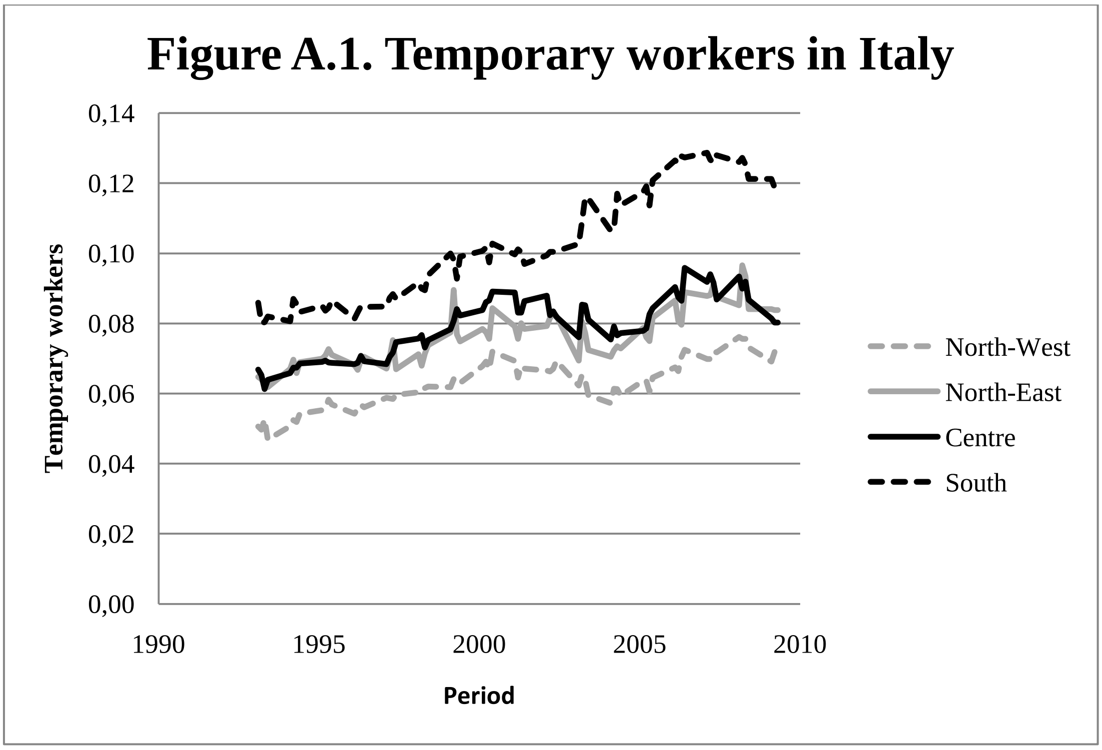

Figure A.1. Temporary workers in Italy
Temporary workers
0,14
0,12
0,10
0,08
0,06
0,04
0,02
0,00
1990
1995
2000
2005
2010
Period
North-West
North-East
Centre
South

Figure A.2. Part-time workers in Italy
Part-time workers
0,16
0,14
0,12
0,10
0,08
0,06
0,04
0,02
0,00
1990
1995
2000
2005
2010
Period
North-West
North-East
Centre
South

Legend of regions

Piemonte-Val d'Aosta	01
Lombardia	02
Liguria	03
Trentino Alto Adige	04
Veneto	05
Friuli Venezia Giulia	06
Emilia Romagna	07
Marche	08
Toscana	09
Umbria	10
Lazio	11
Campania	12
Abruzzo	13
Molise	14
Puglia	15
Basilicata	16
Calabria	17
Sicilia	18

Legend of areas

North-West	1
North-East	2
Centre	3
South	4

Legend of tables

The sample relates to 1992:4-2009:3 period and 18 regions, for a sum total of 1224 observations.

The dependent variable in all estimates is u_{it}, the natural log of the unemployment rate, where $i = 1, \ldots, N$ stands for the region or the macroarea, and $t = 1, \ldots, T$ stands for a given quarter.

Among the independent variables, *v* is the vacancy rate, *nu* and *nv* are labour force unweighted averages of the unemployment and vacancies in the neighbouring regions respectively, *gm* and *sm* are gender and sectoral mismatch indicators respectively, *ish* the share of employment in industry, *temp* and *partt* shares of temporary and part-time employment on labour force respectively. All the independent variables, except for the lags of the unemployment rate and of the shares of temporary and part-time employment, are expressed through the (one-period lagged) moving averages of four quarters. P-values are in brackets.

Variables are not deseasonalised. Seasonal dummies - not shown in the interest of parsimony – are always significant.

In the model we have also included regional fixed effects and linear, quadratic, cubic and quartic trends, not shown in the interest of parsimony.

AB(1) and AB(2) are the Arellano–Bond tests for first and second order serial correlation (distributed as a normal), *RESET test* stands for Ramsey's Regression Error Specification

Test.

Table A.1. LSDV estimation, 1992:4-2007:4, regions (dependent variable: natural log of current unemployment)

	(1)	**(2)**
cons	1.147 (0.01)	0.608 (0.062)
u_{it-1}	0.157 (0.03)	0.135 (0.022)
u_{it-2}	-0.080 (0.024)	-0.113 (0.011)
u_{it-4}	0.219 (0.002)	0.190 (0.010)
v_{it-1}	0.087 (0.011)	0.056 (0.045)
nu_{it-4}		0.152 (0.025)
nv_{it-1}		0.160 (0.020)
gm_{it-1}		-0.001(0.630)
sm_{it-1}		-0.000 (0.992)
ish_{it-1}	0.15 (0.006)	0.017 (0.001)
$partt_{it-1}$	-0.037 (0.001)	-0.30 (0.005)
$temp_{it-1}$	-0.002 (0.907)	-0.001 (0.911)
cr93	0.54 (0.129)	
AR (1) (P-value)	0.670	0.540
AR (2) (P-value)	0.421	0.550
RESET Test (P-value)	0.000	0.000

Table A.2. LSDV estimation, 1992:4-2009:3, regions (dependent variable: natural log of current unemployment)

	(1)	**(2)**
Cons	1.139 (0.000)	0.898 (0.001)
u_{it-1}	0.186 (0.000)	0.171 (0.003)
u_{it-2}	-0.017 (0.572)	-0.044 (0.256)
u_{it-4}	0.197 (0.001)	0.175 (0.003)
v_{it-1}	0.092 (0.003)	0.065 (0.024)
nu_{it-4}		0.117 (0.032)
nv_{it-1}		0.167 (0.025)
gm_{it-1}		-0.001(0.621)
sm_{it-1}		-0.003 (0.711)
ish_{it-1}	0.010 (0.029)	0.011(0.032)
$partt_{it-1}$	-0.039 (0.002)	-0.033 (0.004)
$temp_{it-1}$	-0.015 (0.243)	-0.014 (0.237)
cr93	0.016 (0.624)	
cr08	0.157 (0.000)	0.180 (0.000)
cr09	0.297 (0.000)	0.296 (0.000)
AR (1) (P-value)	0.485	0.381
AR (2) (P-value)	0.938	0.916
RESET Test (P-value)	0.000	0.000

Table A.3. LSDV estimation, 1992:4-2009:3, regions, Great Recession regional dummies (dependent variable: natural log of current unemployment)

	(1)	(2)
cons	1.386 (0.000)	0.884 (0.001)
u_{it-1}	0.157 (0.002)	0.143 (0.011)
u_{it-2}	-0.021 (0.516)	-0.051 (0.224)
u_{it-4}	0.205 (0.000)	0.181 (0.003)
v_{it-1}	0.092 (0.004)	0.064 (0.043)
nu_{it-4}		0.121 (0.032)
nv_{it-1}		0.168 (0.036)
gm_{it-1}		-0.001 (0.589)
sm_{it-1}		-0.002 (0.841)
ish_{it-1}	0.012 (0.012)	0.014 (0.004)
$partt_{it-1}$	-0.043 (0.002)	-0.036 (0.004)
$temp_{it-1}$	-0.012 (0.319)	-0.012 (0.306)
cr0801	0.163 (0.000)	0.178 (0.000)
cr0802	0.092 (0.000)	0.106 (0.000)
cr0803	0.142 (0.000)	0.169 (0.000)
cr0804	0.201 (0.000)	0.275 (0.000)
cr0805	0.011 (0.642)	0.022 (0.388)
cr0806	0.466 (0.000)	0.505 (0.000)
cr0807	0.133 (0.000)	0.144 (0.000)
cr0808	0.220 (0.000)	0.251 (0.000)
cr0809	0.143 (0.000)	0.164 (0.000)
cr0810	0.066 (0.002)	0.094 (0.001)
cr0811	0.187 (0.000)	0.219 (0.000)
cr0812	0.213 (0.000)	0.227 (0.000)
cr0813	0.088 (0.000)	0.129 (0.000)
cr0814	0.336 (0.000)	0.363 (0.000)
cr0815	0.195 (0.000)	0.222 (0.000)
cr0816	0.132 (0.000)	0.124 (0.000)
cr0817	-0.005 (0.000)	0.021 (0.719)
cr0818	0.088 (0.000)	0.077 (0.000)
cr0901	0.295 (0.000)	0.206 (0.000)
cr0902	0.356 (0.000)	0.340 (0.000)
cr0903	0.069 (0.227)	0.072 (0.278)
cr0904	0.324 (0.000)	0.382 (0.000)
cr0905	0.279 (0.000)	0.214 (0.000)
cr0906	0.712 (0.000)	0.749 (0.000)
cr0907	0.580 (0.000)	0.577 (0.000)
cr0908	0.489 (0.000)	0.521 (0.000)
cr0909	0.289 (0.000)	0.266 (0.000)
cr0910	0.406 (0.000)	0.426 (0.000)
cr0911	0.215 (0.000)	0.221 (0.000)
cr0912	0.300 (0.000)	0.289 (0.000)
cr0913	0.344 (0.000)	0.359 (0.000)
cr0914	0.498 (0.000)	0.540 (0.000)
cr0915	0.380 (0.000)	0.379 (0.000)
cr0916	0.109 (0.015)	0.051 (0.297)
cr0917	-0.138 (0.000)	-0.132 (0.000)
cr0918	0.027 (0.569)	0.010 (0.813)
AR (1) (P-value)	0.281	0.199
AR (2) (P-value)	0.610	0.533
RESET Test (P-value)	0.000	0.000

Table A.4. LSDV estimation, 1992:4-2007:4, areas (dependent variable: natural log of current unemployment)

cons	1.490 (0.191)
u_{it-1}	0.098 (0.387)
u_{it-2}	-0.190 (0.079)
u_{it-4}	0.141 (0.294)
v_{it-1}	0.249 (0.049)
gm_{it-1}	0.000 (0.907)
sm_{it-1}	-0.044 (0.235)
ish_{it-1}	0.879 (0.797)
$partt_{it-1}$	-0.022 (0.078)
$temp_{it-1}$	0.013 (0.555)
AR (1) (P-value)	0.327
AR (2) (P-value)	0.608
RESET Test (P-value)	0.083

Table A.5. LSDV estimation, 1992:4-2009:3, areas (dependent variable: natural log of current unemployment)

cons	1.660 (0.005)
u_{it-1}	0.168 (0.131)
u_{it-2}	-0.048 (0.717)
u_{it-4}	0.164 (0.240)
v_{it-1}	0.208 (0.103)
gm_{it-1}	-0.002 (0.326)
sm_{it-1}	-0.030 (0.523)
ish_{it-1}	-0.002 (0.929)
$partt_{it-1}$	-0.024 (0.104)
$temp_{it-1}$	-0.007 (0.772)
cr08	0.208 (0.053)
cr09	0.363 (0.091)
AR (1) (P-value)	0.082
AR (2) (P-value)	0.732
RESET Test (P-value)	0.569

Table A.6. LSDV estimation, 1992:4-2009:3, areas, Great Recession territorial dummies (dependent variable: natural log of current unemployment)

cons	1.535 (0.052)
u_{it-1}	0.154 (0.154)
u_{it-2}	-0.067 (0.638)
u_{it-4}	0.177 (0.207)
v_{it-1}	0.242 (0.066)
gm_{it-1}	-0.001 (0.582)
sm_{it-1}	-0.041 (0.432)
ish_{it-1}	0.001 (0.969)
$partt_{it-1}$	-0.028 (0.041)
$temp_{it-1}$	-0.001 (0.948)
cr081	0.153 (0.013)
cr082	0.355 (0.003)
cr083	0.148 (0.053)
cr084	0.204 (0.006)
cr091	0.131 (0.139)
cr092	0.618 (0.002)
cr093	0.441 (0.004)
cr094	0.300 (0.001)
AR (1) (P-value)	0.062
AR (2) (P-value)	0.539
RESET Test (P-value)	0.063

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