The OECD Beveridge Curve: The Role of Energy Prices, Technological Progress and Globalisation

[PRELIMINARY DRAFT. PLEASE DO NOT QUOTE WITHOUT AUTHORS' APPROVAL]

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ABSTRACT:
This paper tests the existence of a Beveridge Curve across the economies of nineteen OECD countries from 1980 to 2007, and investigates whether and how oil prices, technological progress and globalisation affect the unemployment-vacancies trade-off. Results can be summed up 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) lagged values of oil prices also caused an outward shift of the Beveridge Curve, having a positive impact on unemployment; e) a critical econometric issue, extremely neglected by the previous literature, is represented by endogeneity, as shown by tests and other kind of evidence.

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, 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.

On the other hand, the impact of energy (especially oil) prices on the Beveridge Curve has received little, if any, attention in the literature. Yet energy prices are widely believed to be one of the dominant factors in the world economy.

The aim of this paper is to test the existence of a Beveridge Curve analysing the economies of nineteen OECD countries from 1980 to 2007, and to investigate whether and how technological progress, globalisation and oil prices 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. We leave out from our sample the current crisis, as its modelling is fraught with various problems and is not the actual focus of our work

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. 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.

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.

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.

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[1] 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 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.

1See for example IMF (1996) and OECD (1997).

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.

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[2].

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 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

2In 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 Bevridge Curve empirical literature.

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.

5. The econometric analysis: empirical specification and data

5.1. The model

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

(4)

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. is the natural log of the unemployment rate, the natural log of the vacancy rate, the natural log of the inflow rate, the natural log of the globalisation index, the technological progress index, the natural log of capital per worker, the total factor productivity, 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, and are vectors of yearly and country dummies respectively, a time trend, a stochastic variable assumed to be independently and identically distributed and , , , , and 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. 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): , where Y is gross domestic output at constant price and national currencies, K is capital stock as defined above, L is total employment, 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)[3]. 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.

3 We are very grateful to Marco Leonardi (University of Milan, Italy) for providing these data.

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 completely offset the negative impact of unionism on employment[4]; 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., 2001, and Koeniger et al., 2004), we do not restrict a priori the dynamic specification of our structural and institutional variables. All of them enter (4) with a current *and* a lagged value.

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 United States. We consider a 25-year period, from 1980 to 2007.

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).

4See Nickell and Layard (1999) and Booth *et al.* (2000) for example.

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.

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

6. The estimates

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 ≤ 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[5].

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.

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 (ICFTU, Thorpe) **or** Inward shift (IMF, OECD)
Technological progress	Outward shift (creative-destruction effect: Aghion and Howitt, 1994, Postel-Vinay, 2002) **or** Inward shift (capitalization effect: Pissarides, 1990; Mortensens and Pissarides, 1998; Pissarides and Vallanti, 2007)
Oil prices	Outward shift: Nickell *et al.* (2003)
Capital deepening	Inward shift (short run) **and** Outward shift (medium-long run): Pissarides and Vallanti (2007)
TFP growth	Outward shift (short run) **and** Inward shift (medium-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.

5For this reason, we "collapse" the instrument set into a single column.

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[6].

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 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 tests 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.

6 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.

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.

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 statistically 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 one-standard deviation change in a given independent variable. We notice that technological progress and capital deepening have a very strong impact in all the estimations, especially in FD GMM: 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 institutional variables considered due to their significance in the regressions present very different values depending on the estimation methods.

7. Concluding Remarks

In this paper we considered the economies of nineteen OECD countries in 1980-2007 period in order to appraise the existence of a OECD Beveridge Curve and to investigate whether and how technological progress, globalisation and oil prices affect the Curve. To the best of our knowledge, although in the literature various hints are dropped to the effect that these three 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, which produces evidence in support of the creative destruction effect; c) lagged values of globalisation index have a positive impact on unemployment: globalisation caused an outward shift of the Beveridge Curve as well; d) lagged values of oil prices also caused an outward shift of the Beveridge Curve, having a positive impact on unemployment; e) 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 1980-2007 period and 19 countries, for a sum total of 475 observations.

The dependent variable is always , 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 test 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 tests of exogeneity of instrument subsets.

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