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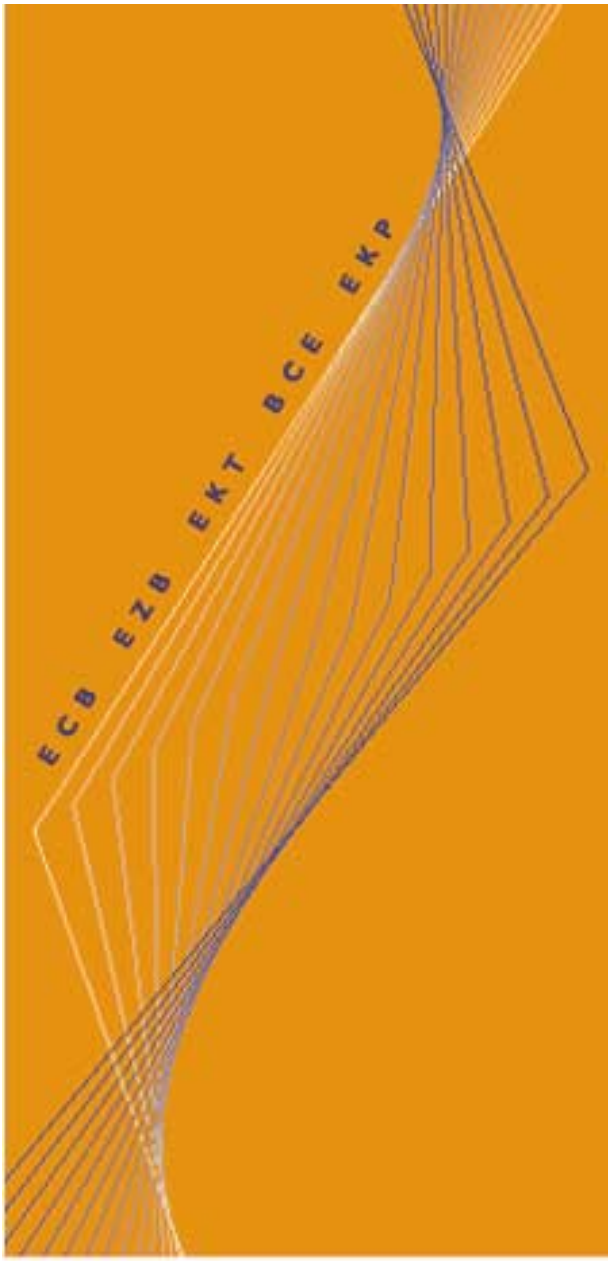

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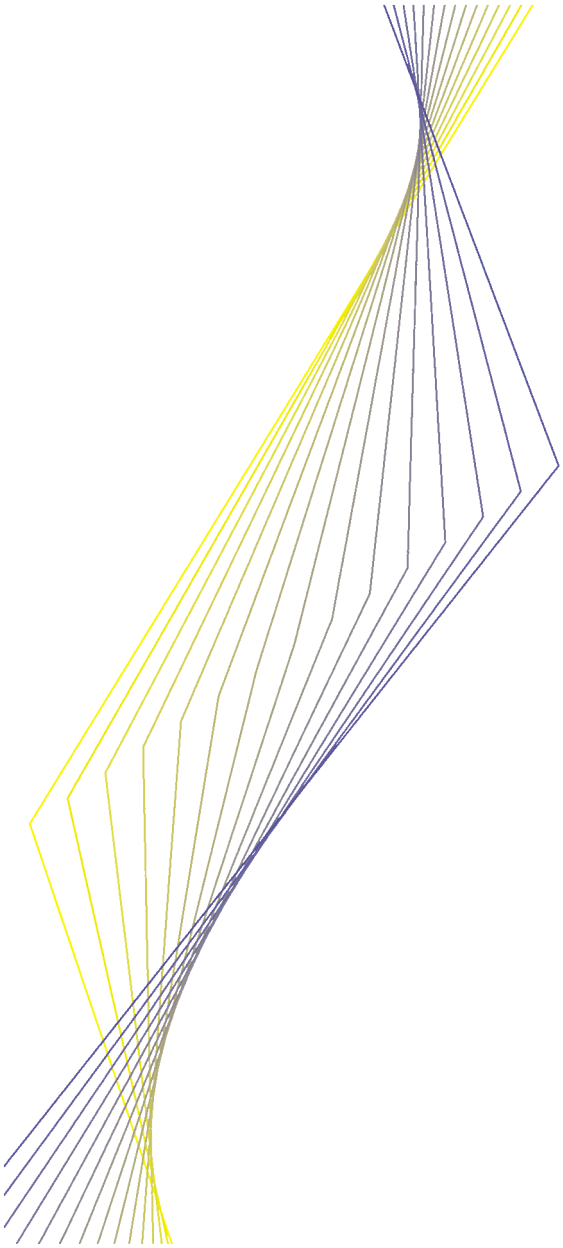

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MODEL-BASED INDICATORS OF LABOUR MARKET RIGIDITY

BY SILVIA FABIANI AND DIEGO RODRIGUEZ-PALENZUELA*

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* *European Central Bank. We are grateful to Frank Brown, Gonzalo Camba-Mendez, Guenter Coenen, Gabriel Fagan, Vitor Gaspar, Ramon Gomez Salvador, Jerome Henry, Juan Francisco Jimeno, Gabriel Perez-Quiros, Pedro Portugal, an anonimous referee and participants in the second ECB Labour Markets Workshop for comments and suggestions. The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the European Central Bank.*

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ISSN 1561-0810

Contents

Abstract

We derive indicators of labour market flexibility that are comparable across countries and time intervals. Our indicators build on a structural VAR model of real wages, output and unemployment dynamics. We compute our indicators for thirteen OECD countries and for two time periods, and we compare them with existing indicators of labour market flexibility in the literature. The main result of the paper is that we did not find evidence of a closing gap in terms of labour market flexibility between the United States and continental European countries, although our findings suggest that medium-sized and small countries have experienced greater improvements in this regard than the large countries since the mid-eighties.

I Introduction

It has been well known since Mundell (1961) that labour market flexibility is a central aspect of currency area optimality. Yet, the actual degree of labour market flexibility in countries forming a monetary union ultimately depends on the political action of governments, mostly at the country level. The interaction between the formation of a common currency area and government's incentives to deliver reform is complex and not yet well understood. In the European context, Saint-Paul and Bentolila (1999) have recently argued that the European and Monetary Union (EMU) is more compatible with gradual reform in labour markets than with rapid transformation. Wyplosz (2000) argues more informally that the largest European countries will face relatively higher barriers in implementing flexibility-enhancing reforms. But the empirical analysis of the interaction between a monetary union and the incentives for structural reform in labour markets is still an open issue. In this light, it becomes important to measure and monitor developments related to labour market flexibility in countries forming a monetary union.

Although a number of measures of labour market flexibility are available (an important source for this being the OECD's Jobs Study), there is not a commonly agreed indicator. The literature has followed a number of different approaches. First, Layard, Nickell, and Jackman (1991) provide a leading and pioneering approach to the issue, which builds on structural wage and price equations and uses proxy variables of labour market institutions. A shortcoming of this approach is its reliance on the quantitative characterisation of labour market institutions - a daunting task, considering the complexity of labour regulations. Certain institutional aspects are particularly hard to pin down quantitatively, like the court's attitude towards dismissal procedures or the complex and overlapping structures of collective bargaining regimes.[1]

Second, possibly the most precise method of measuring the degree of institutional flexibility is to rely on micro-economic panels at the firm or employee level of disaggregation. Recent examples in this vein for Europe are Abowd and Kramarz (1997) and Bover, Garcia-Perea, and Portugal (1995). But the lack of comparable data across countries implies that this approach is probably not sufficient for monitoring changes in a large set of countries simultaneously or for testing theories related to the interaction between the formation of integrated markets or currency areas and the incentives to undertake structural reforms.

Third, an alternative strategy to measure labour market flexibility - and the one that will be followed in this paper - is to build on the structural vector autoregression (SVAR) methodology developed by Blanchard and Quah (1989). If

[1] For a comprehensive discussion of the difficulties surrounding the measurement of institutional factors in the context of Portugal and Spain, see Bover, Garcia-Perea, and Portugal (1995).

sufficient and reasonable restrictions from a theoretical model can be imposed, the SVAR approach combines statistical robustness in the estimation of dynamic effects of shocks on the variables of interest with a structural interpretation of the shocks and, possibly, the ability to distinguish among different sources of flexibility. Important advantages of this method are, in the first place, that it circumvents the measurement problems that characterise in general the attempts to find proxies for both shocks and institutional variables. Second, it provides a direct measure of the actual performance of labour markets in terms of the persistence of shocks, which is ultimately the object of interest.[2] Finally, estimates of flexibility can be obtained from small to medium-sized systems that use aggregate country data. This type of data is generally available and the comparison of estimates across countries and along time is somewhat less problematic than under approaches relying on micro-economic evidence.

Clearly, the SVAR approach is not exempt from limitations. In particular, results are often sensitive to the identifying restrictions imposed on the model. In addition, institutional and structural changes in the labour market are reflected both in shocks and in changes in the propagation mechanism, and this last feature is not easily captured by a fixed parameter approach such as the SVAR. These aspects point to the need for exercising a large degree of caution when trying to extract conclusions on the functioning of labour markets from SVAR-based indicators, as well as the need to use such indicators complementarily with other approaches.[3]

This paper provides an analysis of the dynamics of real wages, output and unemployment for a group of 13 OECD countries (mainly European) over the last three decades. The aim of the analysis is to characterise countries' labour markets in terms of rigidity and of persistence in the effects of aggregate structural shocks.

The econometric tool we adopt is a structural VAR in the version specified by Gamber and Joutz (1993) and Balmaseda, Dolado, and Lopez-Salido (1996). For each of the countries in our sample, we focus on the impulse response functions, at given time horizons, of the endogenous variables - real wage growth, output growth and the unemployment rate - to three structural shocks - productivity, labour supply and aggregate demand shocks. The time horizons are chosen to approximate the short, medium and long-run effects of such shocks on the variables of interest.

We argue that the long-term elasticity of output with respect to productivity shocks (as measured by our structural VAR model) is a useful indicator of labour

[2] This is particularly relevant since some case studies suggest that the relationship between institutions and macroeconomic performance may not be linear. See, for example, the comparisons of Portugal and Spain in Bover, Garcia-Perea, and Portugal (1995) and Blanchard and Jimeno (1995).

[3] The SVAR approach to the analysis of labour market has been developed extensively in the literature. Recent contributions are Jimeno and Dolado (1997) and Fabiani, Locarno, Oneto, and Sestito (2000).

market flexibility, for three main reasons. First, because, on theoretical grounds, such elasticity can be shown to depend on labour market institutions. Namely, plausible models imply that economies with greater insiders' power and rents feature a smaller impact of productivity shocks upon output. Second, because we find that, for a set of countries and time spans, this indicator is, as expected, negatively correlated with average unemployment. Moreover, such a correlation is higher than for other indicators of labour market rigidity. Third, the picture of labour market rigidity that we obtain with our indicator for a sample of countries is overall consistent with received knowledge. In particular, we find a sizeable gap between the degree of flexibility in the United States and continental European countries, with the United Kingdom being in a middle ground. We find moreover no evidence that this flexibility gap has narrowed since the mid-eighties. Finally, we find that, among the continental European countries, only medium-sized and small ones (particularly the Netherlands, Spain and Finland) have seen a substantial improvement in flexibility, whereas the larger ones (particularly France and Italy) have not.

The paper is organised as follows. Section 2 introduces the formal framework on which the identification restrictions are based. Section 3 describes the identification of the structural VAR, the data used and preliminary results. The main results are in Section 4. Section 5 discusses the comparison of our indicators with existing indicators in the literature. Section 6 concludes.

2 The model

In order to derive model-based indicators of labour market flexibility we follow the modelling strategy of Blanchard (1990), Vinals and Jimeno (1998) and Dolado and Lopez-Salido (1996). The latter lay out a simple aggregate supply/aggregate demand model from which a structural VAR specification is derived. The main thrust of the model is its implications on the long-term effects of structural shocks on real wages, output and unemployment. In particular, it is shown that wages depend in the long run on one type of shock only, which should be interpreted as a technological or productivity shock. Output is determined in the long run by two types of shock: productivity shocks and a second shock, which is linked to demand factors.[4] Finally, long-term unemployment is determined by institutional characteristics and not by either of the three structural shocks.

[4] The theoretical framework in Saint-Paul and Bentolila (2000), may be used to yield similar identification restrictions to the ones in this section. In this alternative setting, real wages are determined by productivity in the long run. Moreover, in Saint-Paul and Bentolila (2000) output is shown to depend on productivity shocks and the rent q from being employed of an insider, where the latter does not affect wages in the long run. If the rent q is subject to shocks over time and if the model is extended to have a constant NAIRU, this framework would support as well our identification restrictions.

Specifically, consider the following set-up. Let y, p, n, w and l be the log of, respectively, output, the GDP deflator, total employment, nominal wages and total labour force. Let u be the unemployment rate. The model is summarised in the following six equations:

$$\begin{aligned}
y_{it} &= m_{it} - p_{it} && (1)\\
y_{it} &= n_{it} + \theta_{it} && (2)\\
p_{it} &= w_{it} - \theta_{it} && (3)\\
l_{it} &= c\left(w_{it} - p_{it}\right) + \tau_{it} && (4)\\
w_{it} &= \left\{w : E\left[n_{it|t-1} \mid w\right] = \lambda_i l_{it-1} + \left(1 - \lambda_i\right) n_{it-1}\right\} && (5)\\
u_{it} &= l_{it} - n_{it} && (6)
\end{aligned}$$

where t is time and i is a country index. The variables θ, m and τ are functions of the shocks to the system: θ aggregates productivity shocks ε^s, τ accumulates shocks to labour participation ε^l, and m results of shocks to aggregate demand ε^d. These three variables are assumed to follow a random walk process with drift. We have: $\theta_{it} = \mu_\theta + \theta_{it-1} + \varepsilon^s_{it}$, $m_{it} = \mu_m + m_{it-1} + \varepsilon^d_{it}$ and $\tau_{it} = \mu_\tau + \tau_{it-1} + \varepsilon^l_{it}$. Finally, ε^z_{it}, is $i.i.d$ for $z = s, d, l$.

Equation (1) is the aggregate demand function. (2) is a constant returns to scale aggregate production function. (3) is the pricing rule. Aggregate labour market participation is described by (4).

Equation (5) captures wage formation. $E\left[n_{it|t-1} \mid w\right]$ is expected employment in country i and period t as of period $t-1$. The expectation is conditional on nominal wages paid in period t, that are negotiated at $t-1$. When λ_i is equal to zero unions set wages under rational expectations, so as to make expected employment next period equal to realised employment this period. This is the case of full labour market rigidity where insiders choose wages and where the labour market, in expectation, does not clear. When $\lambda_i = 1$, equilibrium wages are expected to clear the market. Unions have no power in this case of full labour market flexibility. $\lambda_i \in (0, 1)$ are intermediate cases. Unions' power, measured by λ_i^{-1}, is the main dimension of labour market flexibility in our setting.

Finally, (6) is an accounting identity of the labour related variables.

Notice that we are assuming a data generating process where countries are subject to idiosyncratic shocks ε^z_{it} but are characterised by similar fundamentals (the distribution of shocks and the elasticity c), except for the case of labour market institutions. Hence, the degree of unions' power λ_i^{-1} varies across countries. This set-up captures the prior that labour market institutions are an important source of heterogeneity in industrial economies.

It is straightforward to derive the vector stochastic process of the endogenous variables of interest $((w_{it} - p_{it}), y_{it}, u_{it})$ as a function of the structural shocks. Let

$\rho_i \equiv 1 - \lambda_i$:

$$
\begin{aligned}
w_{it} - p_{it} &= \mu_\theta + \theta_{it-1} + \varepsilon^s_{it} && (7)\\
y_{it} - \rho_i y_{it-1} &= \varepsilon^s_{it} + \lambda_i (1+c)\,\theta_{it-1} + \lambda_i \tau_{it-1} + \varepsilon^d_{it} && (8)\\
u_{it} - \rho_i u_{it-1} &= \left[c\mu_\theta + \mu_\tau + c\varepsilon^s_{it} + \varepsilon^l_{it} - \varepsilon^d_{it}\right] && (9)
\end{aligned}
$$

From (7) real wages depend on productivity shocks only. (8) implies that output is not affected in the long run by aggregate demand shocks. From (9) all shocks have transitory effects on unemployment, which fade away in the long run. Hence the model illustrates how the long-run identification restrictions introduced at the start of this section may operate and moreover it shows how institutional characteristics determine the medium and long-run adjustments of variables to shocks. In particular, the parameter ρ_i captures the persistence of shocks on output and unemployment; that is, labour market rigidities increase the persistence of shocks in the economy.

The unconditional expectation of unemployment differs across countries and is given by:

$$E(u_i) = \frac{c\mu_\theta + \mu_\tau}{\lambda_i} \qquad (10)$$

Clearly, expected unemployment increases with labour market rigidities.

From (7)-(9) we derive the dynamic effects of the structural shocks on the endogenous variables. Let $e^x_z(T)$ be the elasticity of variable x with respect to a shock z after T quarters. The elasticity of output with respect to productivity shocks after T periods and in the long run ($T \to \infty$), respectively, are:

$$
\begin{aligned}
e^y_s(T) &= \rho_i^T + \frac{1-\rho_i^T}{1-\rho_i}\left[\lambda_i(1+c) - 1\right] && (11)\\
e^y_s(\infty) &= c - \frac{1}{\lambda_i} && (12)
\end{aligned}
$$

The effect of labour supply shocks on unemployment and the corresponding cumulated effect after T quarters are:

$$
\begin{aligned}
e^u_l(T) &= \rho_i^{T-1} && (13)\\
ae^u_l(T) &\equiv \sum_{t=1}^{T} e^u_l(t) = \frac{1-\rho_i^T}{1-\rho_i} && (14)
\end{aligned}
$$

i.e., $e^u_l(T)$ and the cumulated effect $ae^u_l(T)$ depend (increasingly) on labour market rigidity.

These elasticities have a structural interpretation, although there is not a one to one mapping between them and the parameters of the model. In particular,

since λ_i is an index of labour market flexibility (or alternatively ρ_i is an index of rigidity), increases in flexibility tend to increase the long-term elasticity of output with respect to productivity shocks. Increases in flexibility will decrease the elasticity of unemployment with respect to labour supply shocks.

Under the assumption of heterogeneity in countries' labour market institutions, the effects $e_s^y(\infty)$, $e_l^u(T)$ and $ae_l^u(T)$ are candidate indices, respectively, of labour market flexibility and rigidity, since their value depends on the persistence of structural shocks on output and unemployment. Moreover, although the elasticity of real wages with respect to labour supply shocks in the short and medium term is not restricted by the model, this elasticity is an obvious additional candidate to measure real wage rigidities.[5]

The above discussion has a number of empirical implications. The first one is that it suggests the interpretability of the elasticities as indices of labour market rigidities. The second implication is that the model restricts the sign of the correlation between these elasticities and average unemployment rates across countries. This follows directly from the comparison of (10), (12), (13) and (14): as flexibility (λ_i) increases, the expected unemployment rate decreases, the effect $e_s^y(\infty)$ increases and the terms $e_l^u(T)$ and $ae_l^u(T)$ decrease.

In summary, we have that:

1. Countries with rigid labour markets are characterised by a small long-term elasticity of output with respect to productivity shocks. Moreover, since labour market rigidity implies higher average unemployment, there should be a negative correlation between this elasticity and average unemployment across countries.

2. The short and medium-term elasticities of unemployment with respect to labour supply shocks are indicators of labour market rigidities. In addition, we expect a positive correlation between the effect of labour supply shocks on unemployment and average unemployment.

3. Countries with higher real wage rigidity should have a smaller short and medium-term elasticity of wages with respect to labour supply shocks. This elasticity should be positively correlated with average unemployment across countries.

In the following sections we compute as a first step the discussed elasticities for each country, and the correlation between them and average unemployment. We then discuss in more detail the comparison of the results across countries and their changes over time.

[5] The model-based index of wage rigidity has been proposed in Vinals and Jimeno (1998).

3 Empirical implementation

3.1 The structural VAR model

In order to test the empirical implications of the model above, we consider a multivariate system with three endogenous variables and no exogenous variables. The three variables included are the (quarterly) rate of growth of real wages, $\Delta(w-p)$, the quarterly growth rate of output, Δy, and the quarterly unemployment rate, u. Let $\boldsymbol{x}_t = (\Delta(w-p)_t, \Delta y_t, u_t)'$ be the vector of interest and let $\boldsymbol{\varepsilon}_t = \left(\varepsilon_t^s, \varepsilon_t^l, \varepsilon_t^d\right)'$ be the vector of structural shocks to productivity, labour supply, and aggregate demand respectively. The structural moving average representation of the system is given by:

$$\boldsymbol{x}_t = \sum_{j=0}^{\infty} \boldsymbol{A}_j \boldsymbol{\varepsilon}_{t-j} \tag{15}$$

The coefficients in (15) are not identified and cannot be estimated without additional assumptions. The theoretical model in the previous section yields three long-term restrictions that are sufficient to just-identify the model. Steady-state real wages are governed by productivity shocks only. Output depends in the long term on productivity shocks and on shocks to labour supply, but not on demand shocks.[6] The identifying restrictions imply that the matrix of long-term elasticities $\boldsymbol{A}(1) = \sum_{j=0}^{\infty} \boldsymbol{A}_j$ is a lower-triangular matrix:

$$\boldsymbol{A}(1) = \begin{pmatrix} A_{11}(1) & 0 & 0 \\ A_{21}(1) & A_{22}(1) & 0 \\ A_{31}(1) & A_{32}(1) & A_{33}(1) \end{pmatrix}$$

As explained in the previous section, we will focus on the estimated long-run elasticity of output to supply shocks, that is, $A_{21}(1) = e_s^y$ for 13 countries and different time horizons. Moreover, we will consider the medium-run elasticity of unemployment and real wages to labour supply shocks.

As mentioned in the introduction, the methodological approach we adopt here has a number of advantages as well as clear drawbacks. We believe that the most relevant advantage of applying structural VAR techniques to the analysis of labour markets is that it partly avoids the measurement issues which often characterise alternative methodologies such as, for example, the Layard-Nickell type of approach. A clear mapping between single measurable variables and labour market features which are thought to be relevant for understanding unemployment patterns is in fact often difficult because of the complexity and the large number of these features themselves. On the other hand, the sensitivity of the results to

[6] These identification assumptions have been adopted for US data by Gamber and Joutz (1993).

the specific restrictions imposed to the model in order to identify the structural shocks - which is a limitation of the SVAR approach - points to the need of being cautious on the empirical evidence provided in the remainder of this paper.

3.2 The data

Data are seasonally adjusted quarterly time series for the longest available period for each country, covering a range spanning from the beginning of the sixties to the second quarter of 1999. In order to have the maximum degree of homogeneity such series have mainly been taken from the OECD databases Main Economic Indicators (MEI) and Quarterly National Accounts (QNA). However, where necessary, other sources have also been used, namely the BIS database and data provided by National Central Banks.

Output is the seasonally adjusted series of total GDP by expenditure at constant prices from National Accounts contained in the MEI database. For Germany, France, Sweden and Portugal the series are from the QNA database.

The price level is the seasonally adjusted series of GDP deflator from National Accounts contained in the MEI database. For Germany, Sweden and Portugal the series are from the QNA database.

The rate of unemployment is the seasonally adjusted standardized total unemployment rate computed by Eurostat - from the MEI database - for Portugal, Japan, Canada, and the US. It is the seasonally adjusted rate computed by national sources as a percentage of the total labour force for Germany, Finland, Sweden, the UK, Spain and France. In the case of Italy the series takes into account - through adjustments performed by Banca d'Italia - relevant changes occurred in 1992 in the labour force survey, while for Austria the rate is computed by national sources as a percentage of the dependent labour force. Finally, for the Netherlands the series is from the BIS database and represents the seasonally adjusted unemployment rate computed by the National Central Bank as the number of registered unemployed as a percentage of the total labour force.[7]

Wage rates are from the MEI database and generally refer to the manufacturing sector only: hourly earnings for Germany, Finland, Sweden, Canada, the US and France; hourly wage rates for Italy and the Netherlands; weekly earnings for the UK, monthly earnings for Japan. The only exceptions are Spain, where the data refer to hourly earning in all activities, and Austria, where they refer to the mining and manufacturing sector. The time series for Portugal derives from data elaborated by Banco de Portugal. All series are seasonally adjusted.

[7] The labour force underlying the calculation is adjusted once per year and kept constant over 12 months; the data on registered unemployment are estimates of the BCS based upon the registration of the public labour offices and the labour force survey.

3.3 VAR specification and estimation

The estimation of the model described in section 3.1 requires the assumption of stationarity of the endogenous variables. For this purpose, the first step of the empirical analysis has been to pre-test the relevant time series in order to gain a clear understanding of the statistical properties of the data. We have run a battery of preliminary unit-root tests on (the log of) real wages, output and the unemployment rate and standard cointegration tests. We have performed the augmented Dickey-Fuller test, the semi-parametric Phillips-Perron test and unit-root tests allowing for the presence of structural breaks in the mean of the variables. As for the latter, we have followed both the procedure suggested by Perron (1997) and the one proposed by Zivot and Andrews (1992), which allow the timing of the shift in mean not to be fixed a priori.

The results show that in no case it is possible to reject the hypothesis that the real wage and output are I(1) around a linear trend. As for the unemployment rate, results are less clear-cut. Although for most countries the standard Dickey-Fuller and Phillips-Perron tests do not allow to reject the hypothesis of a unit root in the absence of a linear trend, the results of Perron (1997) and Zivot and Andrews (1992) tests provide some evidence supporting the hypothesis that the generating process for the unemployment rate time series involves stationary fluctuations around a shifting mean in virtually all the economies considered. These tests allow the timing of such a shift to be endogenously determined and hence to be different across countries.[8]

In the final specification of our system, hence, we have modelled the real wage and output in first differences and the unemployment rate in levels, after "de-meaning" it (i.e. after removing a shifting mean) where necessary.

In order to have the maximum degree of homogeneity to enable us to interpret and compare the results across all the countries included in our sample, we have tried to keep the specification of the models as simple as possible, imposing the minimum amount of structure and exogenous information. Therefore, we have estimated for each country a simple VAR with the three endogenous variables and a constant term. No deterministic time trend has been imposed and dummy variables have been included only in the few cases where the presence of large outliers required it. The order of the VAR, which is country-specific, has been chosen according to both likelihood ratio test and Akaike and Schwartz information criteria. The specification of the models is shown in Table 1.

The models have been estimated over different sample periods, using for each economy the largest amount of information available. However, they have also been estimated over a shorter (common) period starting in the mid-eighties. The aim of this experiment is twofold. First, it allows to test for the stability of the

[8] Details on the mentioned procedures and results of the tests are not presented here. However, they are available from the authors on request.

systems and to check for eventual significant changes in the performance of the labour market.[9] Second, it allows to have a common reference time horizon across countries, given that in a few cases - namely the Netherlands, Portugal, Finland, Belgium and Denmark - complete data are available only from the beginning or the mid-eighties.

4 Results

4.1 Correlation between elasticities and unemployment

As discussed in section 2, the elasticities of the variables of interest with respect to the structural shocks should satisfy specific correlation patterns, across countries, with average unemployment. This is a necessary condition for the elasticities to be valid indicators of labour market flexibility.

The correlation between each dynamic effect (estimated over the time horizons listed in table 1 and also over the shorter sample period starting in the mid-1980s) and the average unemployment rates (over the corresponding sample period) is presented in table 2. The columns of the table contain different measures of correlation: the OLS coefficient from a regression of (de-meaned) average unemployment rates on (de-meaned) estimated effects; the t-statistic and the R-squared from such a regression and the correlation between the two variables.

Regarding the long-run elasticity of output with respect to productivity shocks $e_s^y(T \to \infty)$ we find, as expected, a negative correlation with the average unemployment rate: countries (and time periods) with a higher long-term elasticity tend to have lower unemployment.

The correlation between the unemployment rate and the effects of labour supply shocks on unemployment is found, also as expected, to be positive: countries with a larger elasticity of unemployment with respect to labour supply shocks suffer higher unemployment.

As we showed in section 2, both the elasticities e_s^y and e_l^u (at different time horizons) can be thought of as indicators capturing the degree of labour market flexibility/rigidity, mainly reflecting unions' power in the wage formation mechanism. The evidence provided by the correlation of each of these two measures with average unemployment tends, however, to attribute a somewhat larger weight to the former. For this reason (and also for the economy of the paper) in the reminder of the empirical exercise presented in the following sections, we concentrate our attention on the long-run elasticity of output to supply shocks.

[9] Unfortunately, due to the lack of long enough time series, we could not simply split the period into two non-overlapping sub-periods and estimate the systems over the two different time ranges.

As for our measure of wage flexibility, we find a clear correlation between average unemployment and the effect of labour supply shocks on real wages (both cumulated up to 12 quarters and on impact). Although e_l^w cannot be directly related to our theoretical model, this finding has an obvious interpretation: countries where real wages increase more upon negative labour supply shocks (where real wages adjust more rapidly to clear the labour market) have lower average unemployment rates.

In summary, from table 2 we select the following two indicators since, on the one hand, they are compatible with the basic empirical implications of the theoretical model and, on the other hand, they show the highest correlation with average rate of unemployment across countries and time periods.:

1. the long-run effect of productivity shocks on output, $e_s^y(T \to \infty)$, is an indicator of labour market flexibility;

2. the effect on impact of labour supply shocks on real wages, $e_l^w(T = 1)$, is an indicator of real wage rigidity.[10]

4.2 Impulse responses over various time horizons

In this section we discuss the estimated indicators of labour market flexibility and analyse the evidence of changes in such indicators over time, which might reflect modifications in the functioning of labour markets due to structural reforms.

For sake of brevity, we do not present here the results of the SVAR estimation for each country.[11] We focus instead on the response of the endogenous variables to the structural shocks at different time horizons and in particular on the elasticities we highlighted in the previous sections. Therefore, depending on the time horizon we consider as relevant for each elasticity, we will discuss results in terms of impact effect (the level of the response as the shocks hit the system), medium-run effect (the cumulated level of the response after 12 quarters) or long-run effect (the level of the response after 40 quarters).[12] All the results refer to the average impulse response functions and the 80 per cent confidence bands obtained by bootstrap-based techniques (1000 replications).

4.2.1 Output

The elasticity of output with respect to labour supply shocks is reported in table 3 for the longer sample period and in table 4 for the shorter, more recent sample period. The tables show the long-term elasticities, the structural interpretation of

[10] However, in section 4.2.2 we will briefly discuss also the medium-term effect.

[11] Results are available from the authors on request.

[12] Also Balmaseda, Dolado, and Lopez-Salido (1996) discuss their results by focusing on three different time horizons: the short run (one year), the medium run (five years) and the long run (asymptotically).

which is given by: $c - \frac{1}{\lambda_i}$. This is the measure we selected in the previous sections as an indicator of labour market flexibility. Note that, although we expect its value to be positive, a negative estimated elasticity is not inconsistent with the model if labour markets are sufficiently rigid. This could be due to high union power (low λ_i). Moreover, the possibility that c changes across countries cannot be ruled out.

Inspection of tables 3 and 4 reveals that countries with the highest degree of flexibility are the US, the UK, Austria, Germany and Denmark. The country with the highest degree of rigidity is Finland. Spain has the highest degree of rigidity in the longer sample period but seems to have performed a considerable catch-up in flexibility, since it is in a middle position in the more recent sample. For Germany, France and Italy our evidence points to considerable increase in rigidity, particularly in the case of France and Italy and less so for Germany, that nonetheless drifts further away from the US. Canada follows a similar trend of suffering an increasing differential of rigidity relative to the countries with highest flexibility.

4.2.2 Real wages

The elasticity of real wages with respect to labour supply shocks is reported in table 5 for the whole sample period and in table 6 for the shorter one. Note that the sign of the estimated elasticity can be either positive or negative, i.e. real wages can either decrease or increase in response to an unexpected increase in labour supply.

The results show that in the short run real wages are not significantly affected by increases in labour supply - i.e. their response on impact does not significantly depart from zero - in the case of Canada and Sweden. Conversely, in all other countries but Italy and Spain real wages adjust downwards. As for the medium-run effect, the cumulated response of this variable after twelve quarters appears to be significantly negative only in France, the UK, Canada and the US.

From section 4.1 the preferred indicator of real wage rigidity is the elasticity on impact of real wages with respect to labour supply shocks, that is, $e_l^w(T=1)$. Countries with high rigidity in this sense are Finland, Italy, Canada and Sweden. Spain registers the highest degree of rigidity in the longer sample period, but, remarkably, becomes a country with relatively flexible wages in the more recent sample. Flexible countries in terms of real wage elasticity are Austria, France, the UK, Portugal and the Netherlands. Germany appears to suffer a deterioration in time in this respect, as it shifts from a relatively high degree of flexibility to a relatively high degree of rigidity.

4.3 Evidence of change over time

The comparison of the elasticities deriving from the estimation of the VAR over the full sample period and over the shorter one (1985-1999) yields evidence of some systematic differences in the coefficients for a number of countries.

Table 7 implies a decrease in flexibility as measured by the long-run response of output to productivity shocks - panel (1) - for the cases of France, Italy and Sweden and a slight increase for Spain. The latter could be tracked to structural change associated to industry and service deregulation and privatisation of a large proportion of public corporations.

For Spain results presented in panel (2) imply also an improvement in wage flexibility in the sub-period starting in 1985. The evidence signals instead a deterioration in this indicator for the case of Italy and Germany.

In order to test the statistical robustness of these results, we perform Likelihood Ratio tests for the economies for which we have sufficiently long series. The test compares the likelihood of the reduced-form VAR in the case where coefficients are assumed to be constant over the whole sample period with the likelihood of the reduced-form VAR when coefficients are allowed to change at a given point in time (the first quarter of 1985), that we take as exogenous.

The probability values from the test are reported in Table 8. The null hypothesis of no change in 1985 is rejected for Spain, France and Italy at the 5% level of significance. The null is not rejected for Sweden, Austria, the US and the UK. For Germany the p-value is close to rejection at the 10% level.

5 Discussion

In this section we compare our results with existing country measures of labour market rigidity in the literature and with comparable indicators constructed by the OECD.

Table 9 combines results of a number of studies on the topic with our flexibility indices. Columns 1 and 2 are the measures of real wage rigidity and hysteresis based on structural estimates from wage-price equations from Layard, Nickell, and Jackman (1991). Columns 3 and 4 are the results produced in Table 2.3 in Vinals and Jimeno (1998), arising from a VAR estimation. Column 5 presents our measure of real wage elasticity with respect to labour supply shocks (from table 6), expressed in percentage terms. Finally, columns 6 and 7 reproduce our results from tables 4 and 3 in percentage terms.

We find that the measure of hysteresis from Vinals and Jimeno (1998) and our measure of rigidity, based on the long-term elasticity of output with respect to supply shocks, are quite consistent with each other. The US appears to be in all cases the country with the highest flexibility. Countries with high degree of

rigidity are in both cases Finland, Italy and France, and also Spain when we take the long sample result for the output-supply shock elasticity.

There is disagreement between the measure in Vinals and Jimeno (1998) and our SVAR measure particularly for the case of the UK, Austria and Sweden, for which we find more flexibility. This could be due to the different weights that indicators give to different sources of labour market rigidity. A symmetric argument can be made for the disagreement between columns 3 and 6 in the case of the Netherlands: Vinals and Jimeno (1998) find this country as a relatively flexible one whereas we characterise it as relatively rigid. These inconsistencies are reduced in all cases if we consider the measure of real wage flexibility, reported in column 5.

As concerns the larger countries in EMU, our results are very similar to the ones from Vinals and Jimeno (1998) where Germany appears to be more flexible than France and Italy. This also the result obtained by Balakrishnan and Michelacci (1998) using aggregate flow data in a SVAR specification.

We find less agreement between our measure and the index from Layard, Nickell, and Jackman (1991). Particularly odd cases are their characterisation of Italy, Finland and Sweden as flexible cases. This lower level of similarity is parallel to the relative disparity of measures between the latter and Vinals and Jimeno (1998).

As an additional way to assess the reliability and usefulness of our results we investigate their consistency with the measures of labour market flexibility constructed by the OECD. In particular, we focus on the OECD summary indicators on the strictness of employment protection legislation (EPL).[13] These measures are based on a detailed dataset - covering regular as well as temporary employment contracts - on the provisions that govern the hiring and firing of workers. We compare our results to two different sets of OECD summary indicators. In the first case they are obtained by aggregating detailed indicators with a subjective weighting scheme (see OECD (1999)). In the second case the aggregation of the detailed indicators is obtained by means of factor analysis, in which the various components are weighted in accordance of their contribution to the overall variance of the data (see Nicoletti, Scarpetta, and Boylaud (1999)).[14] Both measures refer to the late 1990s.

A comparison between the country ranking provided by the OECD indicators and by the long-run elasticity of output to productivity shocks derived from our

[13] Clearly, the measures provided by the OECD are only one among the several possibilities for assessing the relative flexibility/rigidity of countries' labour markets. A number of other international organisations have produced empirical evidence on this issue, such as the International Organisation of Employers and the European Commission. The main difference between these studies and the OECD ones is that the former are based on ad hocsurveys among employers while the latter draw from a large dataset on legislative requirements and common practices.

[14] For a more detailed description of the methodological framework adopted for the derivation of the OECD summary indicators, see Appendix A.

SVAR estimation shows a number of common features (Table 10). Column 1 in the table presents the ranking from OECD (1999); column 2 presents the one from Nicoletti, Scarpetta, and Boylaud (1999); columns 3 and 4 the ones obtained from tables 3 and 4 in this paper, respectively.

In all cases the US and the UK are characterised by the highest degree of flexibility. The group formed by Italy, France and Spain (when the whole sample period is considered for our estimation) performs rather poorly with respect to all the indicators under exam. Germany, Canada (for the long sample period) and the Netherlands rank somewhat in between. A discrepancy between the two measures appears in the case of Portugal: while we characterise this country as relatively flexible with respect to our indicator, the OECD locates it among the most rigid in terms of employment protection legislation.

In summary, we find that our indicator based on the output-productivity shock relationship produces reasonable results when compared to similar measures developed in the empirical literature on the labour market or produced by international organisations such as the OECD. This is the case especially when such indicator is presented together with the wage flexibility measure derived from the SVAR. Note on the other hand that given the multi-faceted nature of labour market rigidity, which may arise as a result of nominal or real wage rigidity or insiders' entrenchment, it is natural that different measures of rigidity feature a degree of discrepancy, since they will tend to put different weight on different dimensions of institutional rigidity.

6 Conclusions

This paper contributes to the literature on the measurement of labour market rigidities. We exploit the modelling strategy in Jimeno and Dolado (1997) and Balmaseda, Dolado, and Lopez-Salido (1996) in order to yield a structural interpretation of the elasticities from a VAR with three endogenous variables (real wages, output and unemployment) with respect to shocks, in fixed horizons. Selecting a few fixed horizons approximates the effects of shocks in the short, medium and long run and facilitates the comparability of results across countries and time periods, relatively to the whole impulse response function.

We estimate a model that incorporates theory-driven identifying restrictions. We implement the SVAR analysis separately for each of thirteen countries (mainly European) and two overlapping sub-periods. Using the implications of the theoretical model, we interpret the level of responses of variables to shocks, in the short, long and medium run, as measures capturing the extent of labour market flexibility.

Among the various indicators of labour market flexibility that can be drawn from the structural VAR model, we single out as particularly meaningful the long-

term elasticity of output with respect to productivity shocks. This indicator is shown from the theoretical model to reflect relevant aspects connected with labour market functioning. Additionally, when estimated for a number of countries and sub-sample periods, it has the highest (in absolute value) correlation with the corresponding unemployment rate.

Our results reproduce the commonly shared notion that, compared with the United States, most European countries have fairly rigid labour markets, and are broadly consistent with the existing empirical literature, particularly with the VAR-based estimates from Vinals and Jimeno (1998) and with the results for the larger European countries from Balakrishnan and Michelacci (1998). This consistency, together with the finding of negative correlation across countries between the unemployment rate and our proposed indicator of labour market flexibility, suggest that the latter merits interest as a tool for monitoring labour market developments.

Our more novel results are those relating to time trends in labour market rigidity. Although it should be interpreted with a large degree of caution, the evidence suggests that since the mid-eighties the gap in flexibility among European countries and the United States appears to have increased, particularly so for the largest European countries. The latter finding is much in line with the arguments in Wyplosz (2000). Countries that have experienced substantial improvement in terms of labour market flexibility are Austria and particularly Spain. Data limitations do not allow us to draw this type of comparison for other medium-sized and small European countries.

From a broader perspective, our results tend to favour the view (developed in Saint-Paul and Bentolila (1999), and Wyplosz (2000)) that the effects of the unique market on the incentives to undertake institutional reform at the country level are likely to be considerably heterogeneous across EU countries. Since institutions and their reform over time are ultimately endogenous variables, an important item in future research agenda is to deepen our understanding of which country characteristics (like size, industry and political structure) facilitate governments' incentives to undertake reforms, particularly those which reduce unemployment persistence.

Table 1

Estimated Models

Country	Model	Sample period
Spain	VAR(3)	76:3 - 98:4
Canada	VAR(2)	61:1 - 99:2
France	VAR(6)	70:1 - 98:4
Italy	VAR(6)	70:1 - 99:1
UK	VAR(3)	63:1 - 99:1
US	VAR(6)	60:1 - 99:2
Netherlands	VAR(5)	80:1 - 99:1
Germany	VAR(4)	69:1 - 99:2
Austria	VAR(4)	64:1 - 99:2
Portugal	VAR(4)	83:1 - 98:4
Finland	VAR(2)	88:1 - 99:2
Sweden	VAR(3)	71:1 - 99:2
Denmark	VAR(3)	88:1 - 99:2
Belgium	VAR(2)	85:1 - 99:2

Table 2

Correlations between elasticities and unemployment rates

Elasticity	OLS coeff.	t-stat.	R-squared	Correlat.
ϵ_s^y $(T \to \infty)$	-3.27	-2.17	0.18	-0.43
ϵ_l^u $(T = 1)$	1.47	0.36	0.01	0.08
$a\epsilon_l^u$ $(T = 12)$	1.38	1.49	0.10	0.32
ϵ_l^w $(T = 1)$	7.64	1.81	0.14	0.37
$a\epsilon_l^w$ $(T = 12)$	1.17	0.74	0.03	0.16

Table 3

Effect of productivity shocks on output (long sample period)[a]

Country	e_s^y $(T \to \infty)$
Spain	0.0000
Sweden	0.0021**
Austria	0.0037**
Canada	0.0038**
France	0.0038*
Italy	0.0043**
Germany	0.0058**
UK	0.0060**
US	0.0060**

[a](**) indicates that the impulse response function is always significantly different from zero over the time interval considered, while (*) indicates that it is not always significantly different from zero. The absence of asterisks signals statistically insignificant measures.

Table 4

Effect of productivity shocks on output (short sample period)[a]

Country	e_s^y $(T \to \infty)$
Finland	-0.0049
France	-0.0021
Italy	-0.0019
Canada	-0.0006
Netherlands	-0.0003
Belgium	0.0000
Sweden	0.0006
Spain	0.0008
Germany	0.0014*
Denmark	0.0015*
Portugal	0.0026**
Austria	0.0033**
UK	0.0043**
US	0.0048**

[a]See previous table.

Table 5

Effect of labour supply shocks on real wages (long sample period)[a]

Country	$\varepsilon_l^w(T=1)$	$a\varepsilon_l^w(T=12)$
Austria	-0.0032*	0.000
France	-0.0027**	-0.015*
UK	-0.0023*	-0.009*
Germany	-0.0014**	-0.005
US	-0.0006*	-0.004*
Canada	0.0004	-0.007*
Sweden	0.0005	0.000
Italy	0.0017*	0.000
Spain	0.0056**	0.003

[a](**) indicates that the impulse response function is always significantly different from zero over the time interval considered, while (*) indicates that it is not always significantly different from zero. The absence of asterisks signals statistically insignificant measures. A negative sign implies a decrease in the real wage upon an unexpected increase in labour supply; a positive sign implies an increase in the real wage.

Table 6

Effect of labour supply shocks on real wages (short sample period)[a]

Country	$\varepsilon_l^w(T=1)$	$a\varepsilon_l^w(T=12)$
Portugal	-0.0030**	-0.019*
UK	-0.0024**	-0.005*
Austria	-0.0020**	-0.003
Spain	-0.0019*	0.000
Netherlands	-0.0011	-0.006*
France	-0.0010**	-0.007*
Belgium	-0.0003	-0.001
Denmark	-0.0001	-0.008*
US	0.0002*	-0.002*
Sweden	0.0004	0.000
Germany	0.0005	0.002
Canada	0.0009	0.000
Italy	0.0021**	0.004
Finland	0.0022**	0.000

[a]See previous table.

Table 7

Changes in indicators from long to short sample

Country	$e_s^y(T \to \infty)$ (1)		$e_l^w(T = 1)$ (2)	
	long sample	short sample	long sample	short sample
Austria	0.0037**	0.0033**	-0.0032*	-0.0020**
France	0.0038*	-0.0021	-0.0027**	-0.0010**
Germany	0.0058**	0.0014*	-0.0014**	0.0005
Italy	0.0043**	-0.0019	0.0017*	0.0021**
Spain	0.0000	0.0008	0.0056**	-0.0019*
Sweden	0.0021**	0.0006	0.0005	0.0004
UK	0.0060**	0.0043**	-0.0023*	-0.0024**
US	0.0060**	0.0048**	-0.0006*	0.0000

Table 8

Test of significance of differences across periods

Country	Date of break	d.of f.	LR test	p-value
Austria	1985:2	45	46.89	0.3950
France	1985:4	45	61.03	0.0558
Germany	1985:4	45	55.50	0.1357
Italy	1985:4	36	57.23	0.0137
Sweden	1981:1	27	20.86	0.7926
Spain	1985:4	36	78.99	0.0000
UK	1985:2	45	37.50	0.7789
US	1985:2	45	30.75	0.9480

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Table 9

Comparison of measures of labour market rigidities[a]

Country	Layard et al. (1991)		Vinals-Jimeno (1998)		SVAR indicators		
	(1) Real-wage rigidity	(2) Hyster.	(3) Real-wage rigidity	(4) Hyster.	short sample $\varepsilon_l^w(T=1)$ (5)	$\varepsilon_s^y(T\to\infty)$ (6)	long sample $\varepsilon_s^y(T\to\infty)$ (7)
Finland	0.29	0.79	9.55	0.83	0.22**	-0.49	-
France	0.23	0.84	5.13	0.81	-0.10**	-0.21	0.38*
Italy	0.06	0.69	4.29	0.82	0.21**	-0.19	0.43**
Canada	-	-	-	-	0.09	-0.06	0.38**
Netherlands	0.25	0.71	2.11	0.76	-0.11	-0.03	-
Belgium	0.25	0.77	2.86	0.77	-0.03	0.00	-
Sweden	0.08	0.81	4.92	0.83	0.04	0.06	-
Spain	0.52	0.59	4.20	0.78	-0.19*	0.08	0.00
Germany	0.63	0.76	3.76	0.77	0.05	0.14*	0.58**
Denmark	0.58	0.60	3.44	0.72	-0.01	0.15*	-
Portugal	-	-	-	-	-0.30**	0.26**	-
Austria	0.11	0.53	4.49	0.79	-0.20**	0.33**	0.37**
UK	0.77	0.48	3.43	0.72	-0.24**	0.43**	0.60**
US	0.25	-0.02	2.39	0.60	0.02*	0.48**	0.60**

[a]Columns 1 and 2 are the measures of real wage rigidity and hysteresis from Layard et al (1991). Columns 3 and 4 are the results produced in Table 2.3 in Vinals and Jimeno (1998). Column 5 presents our measure of real wage elasticity with respect to labour supply shocks (from table 6) in percentage terms. Columns 6 and 7 reproduce our results from tables 4 and 3, in percentage terms.

Table 10

Comparison with OECD indicators

Rank	OECD: EPL		SVAR: $e_s^y(T \to \infty)$	
	subjective weights	factor analysis weights	short sample period	long sample period
1	US	US	US	US
2	UK	UK	UK	UK
3	Canada	Canada	Austria	Germany
4	Belgium	Finland	Portugal	Italy
5	Finland	Belgium	Germany	Canada
6	Netherlands	Netherlands	Spain	France
7	Austria	Austria	Sweden	Austria
8	Sweden	Sweden	Belgium	Spain
9	Germany	Germany	Netherlands	
10	France	France	Canada	
11	Spain	Spain	Italy	
12	Italy	Italy	France	
13	Portugal	Portugal	Finland	

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A The OECD methodology for computing EPL summary indicators

We provide here a brief explanation of the methodological framework adopted by the OECD for the construction of synthetic indicators of one aspect of labour market flexibility, namely the stringency of employment protection legislation (see Nicoletti, Scarpetta, and Boylaud (1999))[15].

The basic data are 15 detailed indicators concerning regulations affecting both regular and temporary workers, available for most OECD countries for the late 1980s and 1998. They have been constructed, in collaboration with the national authorities, on the basis of a thorough review of existing regulations and laws affecting the hiring and firing of workers across countries. Qualitative information has been transformed into numerical format using a scoring system, i.e. each of the indicators has been converted into a cardinal score normalised to range from 0 to 6, with higher scores representing stricter regulation.

The detailed indicators thus obtained are grouped into two broad domains, one referring to workers with regular contract and one to workers with fixed term contract. The first group of regulations covers procedural requirements, notice and severance pay, standards of and penalties for unfair dismissals. The second refers to the maximum number of successive renewals and the maximum cumulated duration of the contract.

For each of the two groups, such indicators are aggregated into summary measures by means of factor analysis, whereby each individual indicator is weighted according to its contribution to the total variance in the data. The overall stringency of EPL is then obtained as a simple average of the two summary indicators. This aggregation methodology is different from earlier work by the OECD (see OECD (1999)), which uses judgements about the relative importance of each indicator to construct summary measures. The approach of using factor analysis can be seen as more objective in the sense that no judgement is made by the researchers as to the relative relevance of the various components of EPL.

[15] The same approach has been adopted for the computation of indicators of product market regulation.

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