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Revisiting the Okun relationship

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Our article revisits the Okun relationship between observed unemployment rates and output gaps. We include in the relationship the effect of labour market institutions as well as age and gender effects. Our empirical analysis is based on 20 OECD countries

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I. Introduction

I. Introduction

II. Okun's relationship at the country level

Fluctuations in unemployment and growth go hand in hand and there are numerous empirical studies of the relationship between the two. The simplest and most widely

III. Introducing labour market institutions

cited relationship is 'Okun's law', i.e. the relationship between unemployment and the cyclical component of GDP. It is a reduced-form relationship that has underpinned

IV. Okun's relationship by age and gender

numerous academic and policy discussions about growth and employment.¹

V. Conclusions

Acknowledgements

Recent papers suggest that the nature of the relationship has changed over time and that it is also different during expansions and during recessions. For example, Owyang

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and Sekhposyan (2012) using quarterly data over the period 1949–2011 estimated

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various specifications of the Okun relationship and found that during the three most

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recent US recessions and the Great Recession, the unemployment rate was more

Appendices

sensitive to output growth and output gap fluctuations. Cazes, Verick and Al Hussami (2013) analysed country-specific changes in unemployment in the Great Recession and found that Okun's relationship varied across countries and time. In some countries, unemployment was more responsive and in other countries, it was less responsive to negative economic growth shocks.

Okun (1962) examined three models including a 'difference version' which relates the change in the unemployment rate to the GDP growth rate and a 'gap version' which relates the unemployment rate to the output gap. There is by now an extensive literature covering both versions. We will be adopting the 'gap version' in keeping with

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We offer three contributions to the literature. First, we investigate how the relationship between the (equilibrium) unemployment rate, the output gap and labour market institutions differs depending upon age and gender. This is an important extension as the determinants of the equilibrium unemployment rate and the size of the Okun coefficient are likely to vary across age groups and across gender. Second, we allow labour market institutions to influence both the equilibrium rate of unemployment and the effect of the change in the output gap on the unemployment gap (i.e. the Okun coefficient). Third, we provide estimates of time-varying country-specific equilibrium unemployment rates and explore differences in the apparent trends in the equilibrium unemployment rates between countries (especially those in the Eurozone).

The analysis at the age-gender level, taken in conjunction with findings about labour-institutional factors, allows us to draw some policy implications. We show that equilibrium unemployment rates are positively related to union density, the unemployment insurance (UI) replacement rate and the tax wedge and negatively related to the level of wage coordination and the terms of trade. We also find that the effects of changes in the output gap on the unemployment rate decreases with age. From this, we infer that an increase in economic growth will not only reduce the overall unemployment rate but it will also bring about a more than proportional decline in the youth unemployment rate.

Our article is structured as follows. In [Section II](#), we provide a short overview of previous studies and a description of our empirical model. We also present the parameter estimates of Okun's relationship assuming to begin with that each country

has a constant unemployment rate. Our analysis by allowing for age-specific unemployment rate while the equilibrium unemployment rate depend on the share of labour market institutions of the Okun relationship.



II. Okun

Previous

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empirical evidence on the impact of labour market institutions on labour market performance, especially the connection between labour market institutions and the equilibrium or natural rate of unemployment. Important studies that relate unemployment to labour market institutions but not to the output gap are Blanchard and Wolfers (2000), Belot and van Ours (2001), Belot and van Ours (2004) and Nickell, Nunziata, and Ochel (2005). Holmlund (2014) provides a recent discussion on the relevance of various labour market institutions and van Ours (2015) estimates a 'difference version' of the Okun relationship linking changes in unemployment to labour market institutions.

Previous studies relating the unemployment gap (or the unemployment rate) to the output gap and to labour market institutions mostly look at a subset of OECD countries. All of the studies we have examined find that the unemployment rate is negatively related to the output gap. The findings on the relationship between unemployment rates and labour market institutions vary. It is common for studies to include the unemployment benefit replacement rate and sometimes measures of the duration and eligibility requirements.³ All of the studies we have looked at find a positive relationship between the unemployment rate and the replacement rate. Most studies also include union density as an explanatory variable. While Adams and Coe (1990), Coe (1990) and Scarpetta (1996) find a positive relationship between the unemployment rate and union density, Elmeskov, Martin and Scarpetta (1998) and Bassanini and Duval (2009) do not find any statistically significant relationship between the two.

Many researchers include a measure of employment protection as an explanatory variable and Scarpetta (1996) and Elmeskov, Martin and Scarpetta (1998) find that employment protection has a positive impact on the unemployment rate. Bassanini and Duval (2009) find a positive relationship between employment protection and the unemployment rate. The impact of employment protection on the unemployment rate has also been studied by Elmeskov, Martin and Scarpetta (1998) who conclude that employment protection has a positive impact on the unemployment rate and centralisation of wage setting has a negative impact on the unemployment rate.

The most common additional explanatory variables included in studies are active labour market programs (Scarpetta [1996](#); Elmeskov, Martin, and Scarpetta [1998](#)), the tax wedge and non-wage labour costs (Adams, Fenton, and Larsen [1987](#); Coe [1990](#); Scarpetta [1996](#), Elmeskov, Martin, and Scarpetta [1998](#); Griffith, Harrison, and Macartney [2007](#); Bassanini and Duval [2009](#)), the real exchange rate (Adams, Fenton, and Larsen [1987](#); Griffith, Harrison, and Macartney [2007](#)) and the terms of trade (Scarpetta [1996](#)). Other (less common) variables included are the minimum wage (Adams and Coe [1990](#); Coe [1990](#); Elmeskov, Martin, and Scarpetta [1998](#)), the rate of structural change (Herwartz and Niebuhr [2011](#)), the level of product market regulation (Bassanini and Duval [2009](#)) and demographic factors such as the proportion of the labour force who are 'young' (Adams, Fenton, and Larsen [1987](#); Adams and Coe [1990](#)).

The studies noted cover different sample periods. Ball, Leigh and Loungani ([2013](#)) studied the Okun relationship for the United States from 1948 to 2011 and for 20 OECD countries from 1980 to 2011. They concluded that there was a strong and stable relationship 'by the standards of macroeconomics' in most countries, although the magnitude of the relationship between output and unemployment varied across countries. Pereira ([2013](#)) analysed quarterly US data from 1948:1 to 2012:4 and found that there are asymmetries in the Okun relationship with a weaker relationship between economic growth and unemployment during periods of expansion.

Empirical model

Okun's law is an empirical relationship between output and unemployment which in its 'gap' version may be written as

$$u - u^* = -\alpha(\Delta \ln Y)$$

where u is the unemployment rate, u^* is the natural rate of unemployment, $\Delta \ln Y$ is the log change in output, α is a positive constant and t is time.

Our benchmark model is based on the following assumptions:

$$u_t = \alpha_i - \alpha_j \Delta \ln Y_t$$

$$E \epsilon_{it} \epsilon_{jt} = 0$$

$$E \epsilon_{it} \epsilon_{it} = \sigma^2$$



The subscript i denotes the country and t is time in years. α_i Are the country-specific fixed effects (which, in this model, are equal to u_i^* the country-specific equilibrium unemployment rates). It is assumed that the errors are related cross-sectionally (i.e. across countries), but not across periods (i.e. years). The model is estimated by generalised least squares allowing for cross-sectional heteroscedasticity.

As is common in the literature, the output gap is estimated using the Hodrick–Prescott filter. Specifically, the HP filter is a two-sided linear filter that computes the smoothed series y_t^* of y_t by minimising the variance of y_t around y_t^* subject to a penalty function that constrains the change in the trend growth of y_t^* :

$$\Theta = \sum_{t=1}^T (y_t - y_t^*)^2 + \lambda \sum_{t=2}^{T-1} (y_{t+1}^* - y_t^* - y_t^* - y_{t-1}^*)^2 \quad (3)$$

The penalty parameter λ controls the smoothness of the series and the suggested value by HP is 100.⁴

Appendixes

Data

Because of data availability, the focus of the analysis is on 20 OECD countries over the period 1985–2013. There are 5 countries outside Europe (Australia, Canada, Japan, New Zealand and the United states) and 15 countries in Europe of which 10 adopted the Euro (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal and Spain) and 5 did not (Denmark, Norway, Sweden, Switzerland and the United Kingdom).

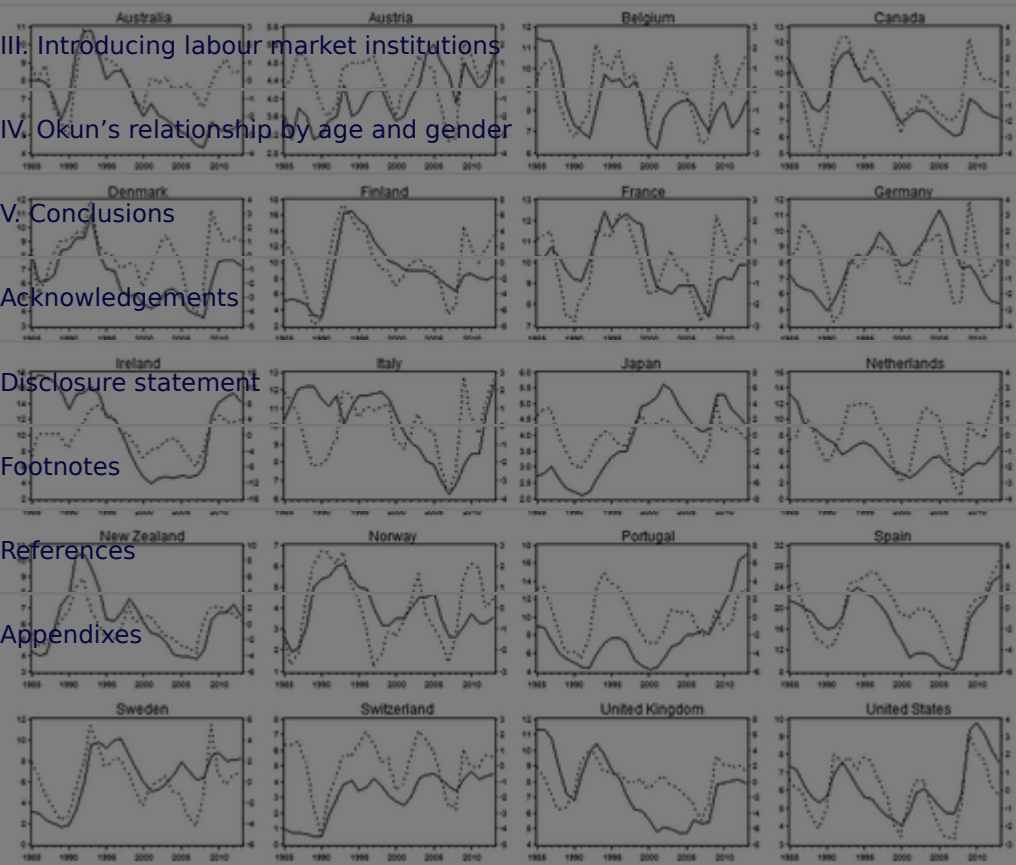
Output gaps are created for each country in the data set. By construction, the mean

value of the output gap for each country is zero. The evolution of the output gap for the 20 countries is shown in Figure 1. The output gap fluctuates around zero, in all countries, and the magnitude of the fluctuations is relatively small. The output gap for Ireland is particularly small while the output gap for the United Kingdom is relatively large. The output gap for Ireland was relatively small after the Great Recession.

Figure 1. Unemployment rates and output gaps (inverse); 1985–2013.

I. The solid lines are the actual unemployment rates (LHS) and the dashed lines are the (inverse) output gaps (RHS)

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Parameter estimates

Table 1 shows the parameter estimates of the baseline version of the Okun relationship, i.e. the estimation of Equation (2) above which assumes that the equilibrium rate of unemployment is constant over time. This is not the case in Figure 1.



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between the average unemployment rate and the estimated values of the equilibrium unemployment rate.

I. Introduction

Table 2 shows the parameter estimates when we modify Equation (2), to allow for asymmetry, in the sense that positive/negative output gaps have different effects on unemployment. As shown in the second column of Table 2, we are unable to reject the

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hypothesis of symmetry. The third column shows parameter estimates if we allow the effect of the output gap on unemployment to be different after the Great Recession from that before the Great Recession. We cannot reject the hypothesis that they are different for this simple model.

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Labour market institutions

So far, equilibrium unemployment rates have been assumed to be constant over time. However, previous studies suggest that labour market institutions may affect the equilibrium unemployment rate. We investigate the significance of the following labour

market institutions. We investigate the significance of the following labour market institutions: (i) the role of labour market institutions in the determination of the equilibrium unemployment rate, (ii) the role of labour market institutions in the determination of the equilibrium unemployment rate, (iii) the role of labour market institutions in the determination of the equilibrium unemployment rate. We investigate the significance of the following labour market institutions: (i) the role of labour market institutions in the determination of the equilibrium unemployment rate, (ii) the role of labour market institutions in the determination of the equilibrium unemployment rate, (iii) the role of labour market institutions in the determination of the equilibrium unemployment rate.



Figure 2. The role of labour market institutions in the determination of the equilibrium unemployment rate.

institutional changes in the labour market.

Figure 2. The role of labour market institutions in the determination of the equilibrium unemployment rate.

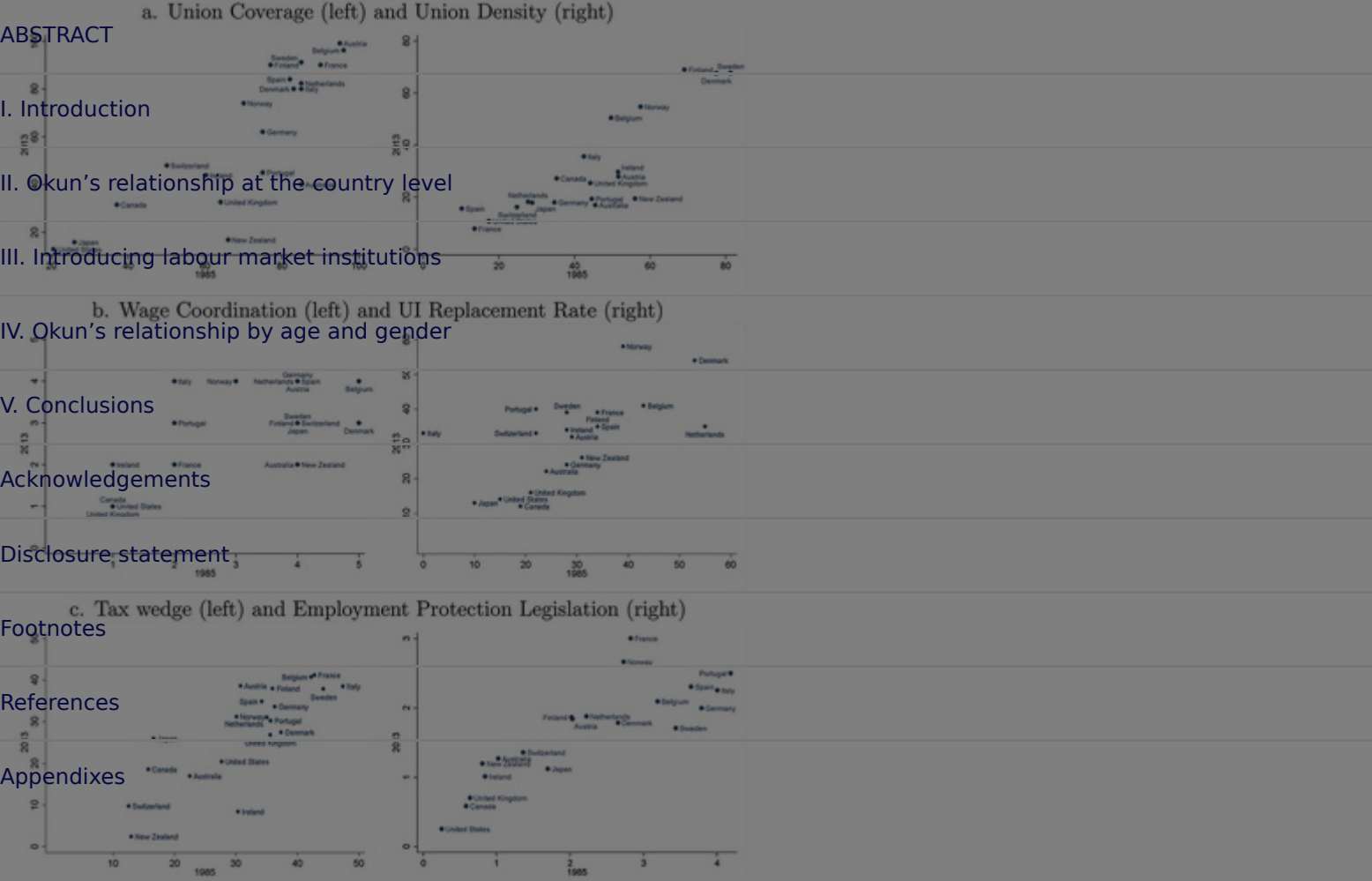
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as they are on the diagonal or close to it. However, there are also some exceptions. The graphs in panel a indicate the evolution in union coverage (left) and union density (right). Union coverage is high in Austria, Belgium and France and low in Japan and the United States. If a country is below the diagonal, it indicates a drop in union coverage or union density. The fall in union coverage has been greatest in Australia, New Zealand, Portugal and the United Kingdom. For these countries, the fall in union density has been substantial as well. Union density is high in the Scandinavian countries (which has to do with UI benefits run by unions) while union density is low in France, the United States and Spain. Panel b shows the evolution of wage coordination (left) and UI replacement rate (right). There is quite a wide range of wage coordination with Canada, the United Kingdom and the United States having the lowest value of the indicator. In Australia and New Zealand, wage coordination has fallen while in Italy, wage coordination has increased substantially. With respect to the UI replacement rate in most countries, there was a decrease over our sample period but for Italy, Portugal and Norway, there was a substantial increase. Panel c shows the developments in the tax wedge (left) and EPL (right). In many countries, the tax wedge did not change a lot but in Ireland, there was a substantial drop while in Japan, there was a substantial increase. Finally, as shown in the bottom-right graph, in many countries, EPL shows persistence over time but there are also countries for which EPL was reduced a lot (Belgium, Italy, Germany, Portugal, Spain and Sweden).

Figure 2. Labour market characteristics 1985 and 2013. (a) Union coverage (left) and union density (right). (b) Wage coordination (left) and UI replacement rate (right). (c) Tax wedge (left) and employment protection legislation (right).





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Okun relationship with labour market institutions

To take the effect of labour market institutions into account, we estimate the Okun relationship in the following form:

$$\Delta u_{it} = \alpha_i + \beta z_{it} - \Phi_0 + \Phi_1 a_{it} v_{it} - v_{it} * + \epsilon_{it} \quad (4)$$

where z_{it} is a vector of labour market institutions, a_{it} is the average of the temporary and permanent unemployment rates, and v_{it} is the unemployment rate of temporary workers. For the number of temporary workers, we allow for the number of temporary workers to be a function of the unemployment rate of temporary workers. Table 3 shows the results. The results show that the effect of temporary workers on the unemployment rate is positive and significant. This is consistent with the assumption that temporary workers are more likely to be hired when the unemployment rate is high. The results also show that the effect of temporary workers on the unemployment rate is larger in countries with higher unemployment rates. This is consistent with the assumption that temporary workers are more likely to be hired in countries with higher unemployment rates. In this article



Table 3. Parameter estimates – including labour market institutions



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Column (2) shows the parameter estimates if we allow the Okun coefficient to have

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different values before and after the Great Recession having removed labour market institutions which do not have a significant effect on the unemployment rates.

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Column (3) shows the results when we allow for the Okun coefficient (Φ_0) to be

different pre- and post-the Great Recession and the Okun coefficient is allowed to

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interact with the share of temporary workers (q_{it}). Thus, the effect of a unit change in

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the size of the output gap upon the unemployment rate is allowed to vary across

countries and across time (as the share of temporary workers varies across countries

and across time).⁶ Column (4) of [Table 3](#) shows the results of [Equation \(4\)](#), on the

assumption that the Okun coefficient (Φ_0) is the same pre- and post-the Great

Recession (consistent with the findings reported in column (3)).

Inspection of the estimated values of the coefficients and their p-values in the top part

of the table (the part which reports coefficients on the output gaps) and also the result

of a Wald test for a significant difference between the value of the Okun coefficient

before and after the Great Recession (this is reported at the bottom of the Table) leads

us to conclude that (a) for the base model, we reject the hypothesis that the Okun

coefficient is the same pre- and post-the Great Recession.

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IMF study of Okun's Law. 'The responsiveness of unemployment to output has increased over the past 20 years in many countries. This reflects (inter alia) the greater use of temporary employment contracts' (International Monetary Fund (2010), Ch 3, 1).

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We turn now to the effect of labour market variables in explaining differences in the unemployment rate across countries and over time. The signs and significance of most of these variables are robust across the different specifications. The results given in column (1) in the lower part of Table 3 show that there is no significant relationship between the (equilibrium) unemployment rate and union coverage (defined as the proportion of workers covered by collective bargaining) but we find a significant and, as expected, positive relationship between the unemployment rate and union density (defined as the proportion of workers who are union members). Furthermore, wage coordination has a significant negative effect on unemployment while the UI replacement rate has a significant positive effect. EPL has no significant effect on unemployment. The tax wedge has a significant positive effect⁸ and terms of trade has a significant negative effect on unemployment. We removed union coverage and EPL from the analysis.⁹

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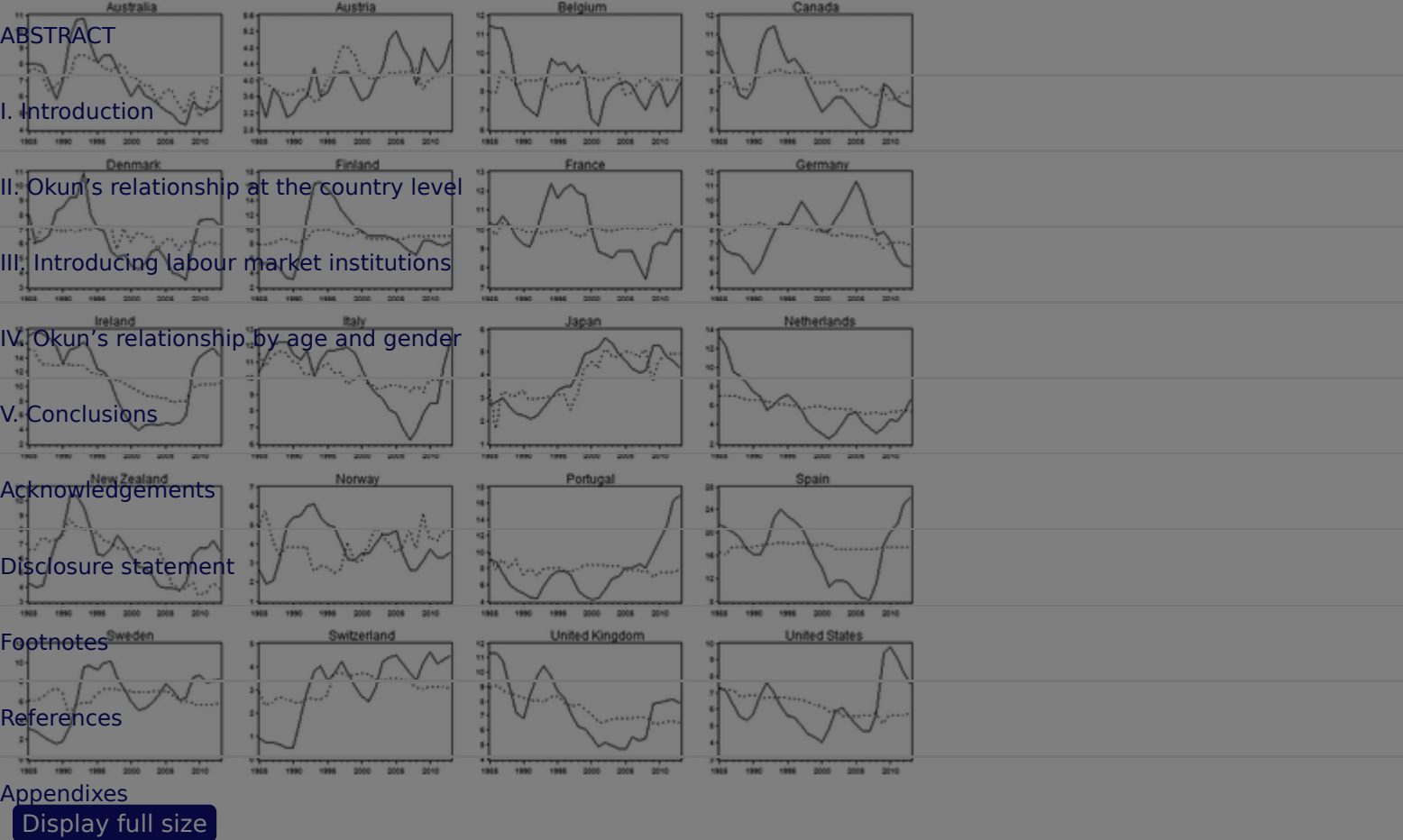
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As a check of robustness, we also estimated the model for different groups of countries. Column (5) of Table 3 shows the parameter estimates if we restrict the sample to 15 European countries. Not reported are estimates for the 13 European Union countries and for the 10 Eurozone countries. The results are robust across these different combinations of European countries.

Equilibrium unemployment rates

Figure 3 shows the equilibrium unemployment rates over the sample period 1985-2013. The solid line shows the equilibrium unemployment rate from column (1) of Table 3. The dashed line shows the equilibrium unemployment rate from column (4) of Table 3.

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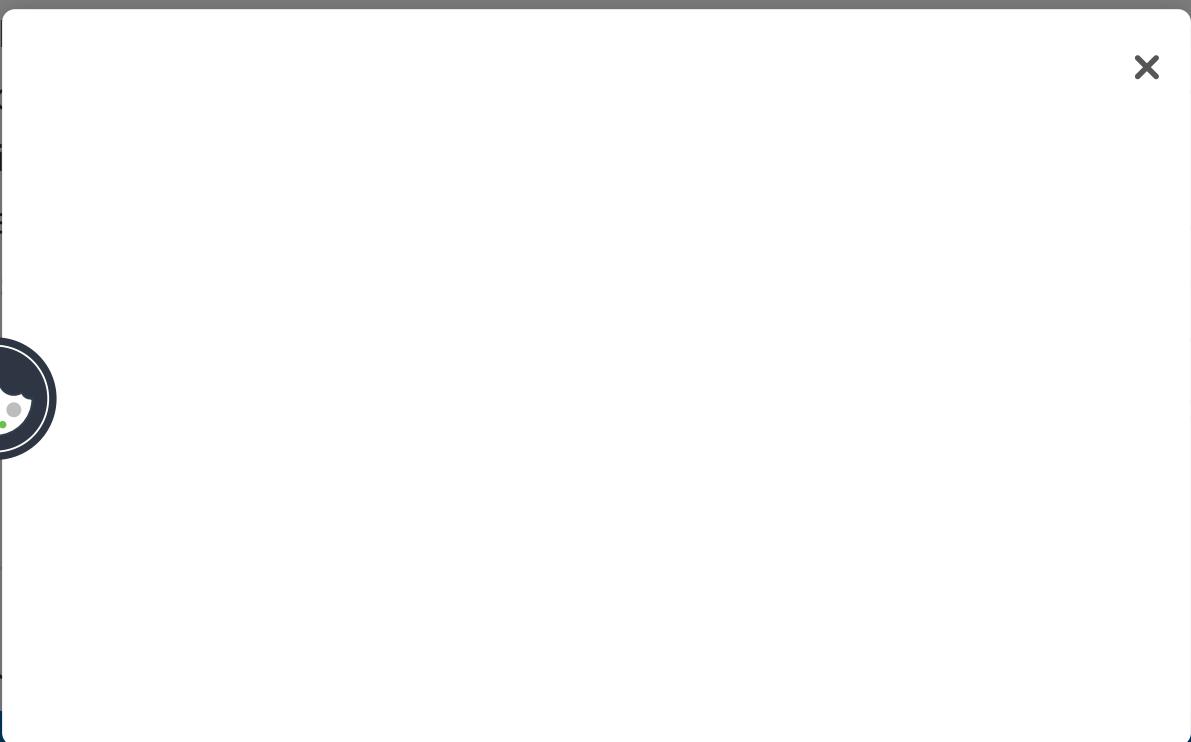
What is noteworthy about these figures is the different behaviour of the equilibrium rate over time. For some countries (Belgium, Finland, France, Portugal, Spain and Sweden), their equilibrium rates were roughly constant over the period as the labour market institutions hardly changed. For others (Austria, Japan, Norway and Switzerland), their equilibrium rates of unemployment were rising over the period, albeit at markedly different rates (compare Japan with Switzerland for example). While for a larger group of countries (Canada, Denmark, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain and Sweden), their equilibrium rates were falling over the period, albeit at markedly different rates (compare the Netherlands with Sweden for example).

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Abstract Given the model of unemployment used to generate the equilibrium rates of unemployment in this article, the explanation for the different trends in the equilibrium rate reflects different trends in labour market institutions. We make two observations here about the equilibrium rates of unemployment. To the extent, for example, that different trends in the equilibrium rate reflect different trends at the national levels in the amount of frictional unemployment – where frictional unemployment in this context is defined as a situation where the characteristics of an unemployed worker in one EU country are matched by the characteristics of a vacancy in that or another EU country – then facilitating labour mobility would seem to be the desirable and effective policy response. To the extent that low mobility is a reflection of current labour market institutions, a change in the institutions in a way that would enhance mobility will lead to convergence in the equilibrium rates. Another example would be differences in the equilibrium rate resulting from differences in the UI replacement rate, differences which effectively ensures differences in the minimum reservation wage. Here, again a harmonisation of labour market institutions – and specifically in this case social protection objectives and policies – would lead to convergence in the equilibrium rates.

Sensitivity analysis

To explore the robustness of our findings, we performed additional sensitivity analyses. First, we added a common global factor into the Okun model. As discussed in more detail in Appendix B1, this hardly influences our parameter estimates. Second, we introduced product market regulation as an additional explanatory variable. Although product market regulation has a significant positive effect on unemployment rates, it



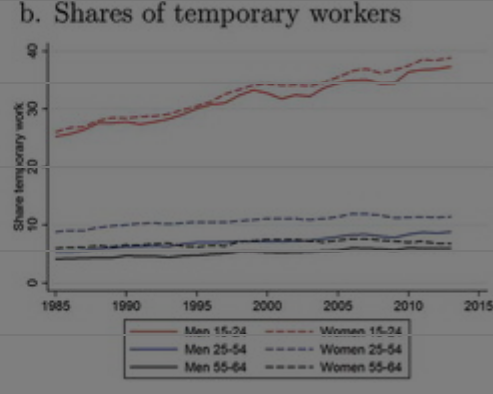
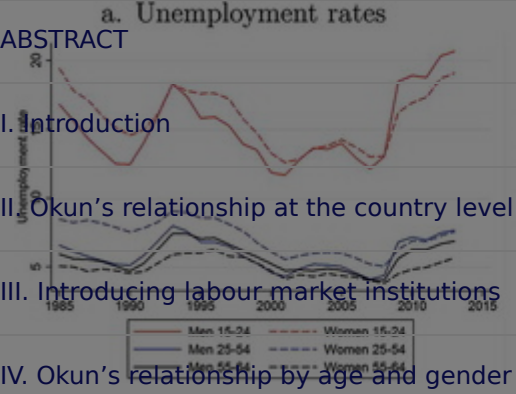
There are large and persistent differences in the labour market characteristics of workers according to their age and gender. [Table 4](#) provides an overview of country-specific averages of the unemployment rates by age and gender. Clearly, there are substantial differences both within and between countries. Youth unemployment rates are on average twice as high as unemployment rates among prime age workers, whereas unemployment rates among old men and women are on average the lowest. There are differences between unemployment rates of young men and young women but the dominant difference amongst the young is according to country, not gender. Whereas on average, youth unemployment rates in Austria, Germany, Japan and Switzerland are below 10%, they are above 25% for young men and women in Italy and Spain. There are also differences for prime age workers but they are substantially smaller in absolute terms. The lowest unemployment rates over the time period for prime age men and women are in Norway and Japan (below 4%). The highest unemployment rates for old men are in Spain with 10.2% and for old women in Germany with almost 11%, while the lowest rates for old men and women are in Norway (both less than 2%).

Table 4. Country-specific unemployment rates by age and gender; average 1985–2013 (%).

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Modified Okun relationship


It is well known and has been illustrated in the previous subsection that unemployment

rates of young workers are on average higher and more volatile than unemployment rates of prime age and old workers (Bell and Blanchflower [2011](#)). There are various

reasons why Okun's relationship may be age-specific.¹¹ Compared to older workers, young workers have less company-specific skills and less dismissal protection (Dunsch [2015](#); O'Higgins [1997](#)). Furthermore, to the extent that age is related to experience, Becker ([1964](#)) argues that the amount of specific training affects the incentives of firms and workers to separate - an idea developed by Cairo and Cajner ([2014](#)). Since the labour market position of females is different from the labour market position of males, it is likely that Okun's relationship is both age and gender-specific.

We begin by modifying our baseline model (2) to allow estimation of the unemployment rates by age and gender for six groups:

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twice as large for young workers than it is for older workers. This explains [Figure 4](#)

which shows that, while fluctuations in unemployment rates are highly correlated across age and gender, they are substantially larger for young workers.

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Table 5. Okun's relationship by age and gender; 1985-2013.



IV. Okun's relationship by age and gender

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[Figure 5](#) shows the cross-country relationship between the estimated equilibrium

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unemployment rates for young and prime age workers, separately for males and

females. Panel a shows the relationship for males. There is across countries a strong

correlation between the unemployment rates of young and prime age males. The ratio

[References](#)

of the two unemployment rates is about 2.5. Clear outliers are Italy with a relatively

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high male youth unemployment rate and Germany with a relative low male youth

unemployment rate. Panel b shows the same relationship for females. In many

countries, the female equilibrium unemployment rates are substantially higher for both

prime age and young females. Across countries, Italy and Germany are likewise

outliers, as for males.

Figure 5. Equilibrium unemployment rates by country and age and by gender; 1985-2013. (a) Males. (b) Females.

Based on parameter estimates from [Table 5](#).



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$$y_{ikt} = \alpha_{ik} + \beta_k z_{it} - \phi_0 + \phi_k q_{ikt} y_{it} + \varepsilon_{ikt} \quad (6)$$

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where z represents labour market institutions, q is the share of temporary workers and k represents 3 age groups (15–24, 25–54, 55–64) for both males and females. As shown in panel b of Figure 4, the share of temporary workers is substantially higher among young workers and also increasing much faster than among prime age and older workers. The increase in the share of temporary workers over the sample period is on average about 10 percentage-point higher from 25% to 35%.

Table 6 shows the relevant parameter estimates of Equation (6). Clearly, the estimated gap-coefficients are not very different from those in Table 5. The share of temporary workers has a significant effect on the gap-coefficient except for older workers. This may be due to the low share of old temporary workers as well as with the relative stability of that share. The parameter estimate for the interaction term between the output gap and their share of temporary workers is smaller for young workers but one has to take into account the fact that the share of temporary workers is much higher and increasing. Finally, the magnitude of the effects of labour market institutions on the unemployment rates is age and gender specific. In particular, a high level of wage coordination seems to be mostly beneficial for young workers. A possible explanation is that a high level of wage coordination more strongly internalizes the unemployment effects of wage negotiations, especially youngsters suffer high unemployment rates. Therefore, they may be more affected by a high level of wage negotiations, i.e. for them, the dampening effect on unemployment rates is strongest. Nevertheless, the overall results are not very different from those presented in Table 3.


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Okun's empirical relationship has been shown repeatedly, in a large number of studies to be an enduring stylised fact. In this article, we revisit the Okun relationship using a hybrid specification, namely we relate the unemployment rate, on the one hand, to the (determinants of the) equilibrium unemployment rate and the output gap, on the other.

The computation of the output gap follows standard practice in the literature, namely the output gap is the difference between the actual (log) GDP less the trend (log) output (estimated using the Hodrick–Prescott filter). However, we augment the estimating equation to allow labour market institutional factors to affect the equilibrium

rate of unemployment and moreover, we also allow the share of temporary workers to affect the relationship between the output gap and the unemployment rate. These features improved the analysis first, because the introduction of institutional labour factors which changed over time allowed the derivation of time-varying equilibrium unemployment rates and second, the introduction of a term to capture flexibility in the

labour market (the share of temporary workers) was particularly important as it captured effectively changes in the Okun coefficient over time and allows us to avoid the need to arbitrarily impose different coefficients pre- and post-the Great Recession. Introducing an interaction between the share of temporary workers and the output gap is also relevant from an economic point of view. Labour markets have become more flexible in the past decades and especially among young workers, the share of temporary workers is not only high but also increasing fast. In terms of the Okun relationship, this means that the unemployment effects of shocks to output have increased over time.

The empirical relationship between the output gap and the unemployment rate in OECD countries is more diverse over space and time. We find that the relationship is more pronounced in countries with a high density of temporary workers. Finally, since 2008, the relationship has become more negative in all countries. In 2015 and 2016, the average age and unemployment rates

evidence that the effect of changes in the output gap on the unemployment rate decreases with age. in particular, that a positive change in the output gap is likely to result in a greater reduction in unemployment among younger job-seekers compared to the other age groups. From a policy perspective, it follows that an increase in economic growth (to close the output gap) will not only have the desired outcome of reducing the unemployment rate but it will also have the distributional effect of lowering youth unemployment.

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No potential conflict of interest was reported by the authors.

Notes

- ¹ Okun specified an empirical relationship without clear indications of causality. Permanent and Step... relationship
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4. Ravn and Uhlig (2002) suggest 6.25 for annual data. The results using this value of λ are essentially the same as those reported using $\lambda=100$. As an alternative to the HP filter, we used a Band-pass filter and a Beveridge–Nelson decomposition but neither led to any change in our main findings.

5. In many countries, the share of temporary workers in employment has increased substantially in the past decades. This is related to reforms of employment protection legislation which are predominantly on the use of temporary contracts and not so much on the employment protection of regular workers (Boeri and Van Ours 2013). In Spain, for example, the share of temporary workers increased a lot when temporary workers were allowed to perform regular activities (Dolado, Garcia-Serrano, and Jimeno 2002).

Faccini (2014) argues that temporary contracts became more popular as a screening device, whereas Segal and Sullivan (1997) indicate that the use of temporary workers offers firms a greater flexibility in case of volatile demand. It is this greater flexibility that we capture by including the share of temporary workers as a determinant of the Okun coefficient.

6. We think that compared with non-temporary workers, a higher proportion of temporary workers are likely to move between employment and not in the labour force (or 'inactive') relative to the proportion who move between employment and unemployment. As a result, the effect of a change in the output gap (and thus the number of temporary workers employed) may impact more on the labour force participation rate than on the unemployment rate.

7. In order to allow for the possible effect of endogeneity in the share of temporary workers, we used a simultaneous equations model (SEM) instead of the VAR model. The results using the SEM are very similar to those using the VAR. The results are robust to using the SEM.

8. Note that the effect of the output gap on the unemployment rate is positive. This is due to the fact that the output gap is measured as the log deviation from the long-run level of output. A positive output gap implies that the economy is above its long-run level of output, which leads to a higher unemployment rate.

9. To investigate the role of the output gap in the unemployment rate, we used the Okun's law (1978) as a benchmark. The results show that the output gap has a significant and positive effect on the unemployment rate. This is consistent with the findings of Okun (1978) and other studies on the relationship between the output gap and the unemployment rate.



10 As noted above, the signs and size of the labour market coefficients do not vary markedly under different specifications of the model.

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11 There are three studies that have investigated age-specific versions of the difference form of Okun's law. Hutengs and Stadtmann (2013) estimated Okun's relationship over the period 1984–2011 for 11 Eurozone countries and 5 age groups. Zanin (2014)

studied 5 age cohorts by gender for 33 OECD countries over the period 1998–2012.

Hutengs and Stadtmann (2014) estimated Okun's relationship for five Scandinavian countries and five age groups over the period 1984–2011. All studies found that the

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4. UI replacement rate: unemployment insurance and unemployment assistance benefits as a percentage of the Average Production Worker wage; this OECD summary measure is defined as the average of the gross unemployment benefit replacement rates for two earnings levels, three family situations and three durations of unemployment. Series 1985–2005 available for odd years – even years are calculated as average of adjacent odd years; from 2006 onwards, unemployment insurance and unemployment assistance benefits as a percentage of the Average Worker wage; the jump in series from 2005 to 2006 has been accounted for by the authors. Source: OECD statistics.

5. Tax wedge: One-earner married couple at 100% of average earnings with two children expressed as a percentage of labour costs. Source: OECD Taxing Wages – Comparison of Countries.

6. Employment rate: ratio of total employment to total population aged 15 and over from 1985. Source: OECD Statistics.

7. Average wage: average of real wages of full-time employees in manufacturing, construction and services, weighted by the number of employees in each sector. Source: OECD Statistics.

8. Terms of trade: ratio of the price index of exports to the price index of imports. Source: OECD Statistics and CPI.

0. Share of temporary workers, average and by gender and age. Source: OECD labour

force statistics.

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II. Okun's relationship at the country level

product market competition in seven non-manufacturing industries. Source: OECD

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Regulatory Base.

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Table A1 provides information about averages of unemployment rates (%) and annual

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GDP-growth rates (%) over the period 1985-2013. Averaged over the 20 countries, the

unemployment rate was 7.5% and the annual GDP-growth rate was 2.3%.

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Table A1. Unemployment and GDP growth; averages 1985-2013.

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Table A2 presents correlations between labour market institutions. To remove cross-sectional correlation, all series are transformed to differences from country-averages. Clearly, the correlations between union coverage and union density, between product market regulation and union density and between product market regulation and employment protection legislation are quite high.

Table A2. Correlations between labour market institutions 1985-2013.

Download

Appendix

B1:



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In this article



with κ as additional parameter and $F_t = F_{t-1} + \nu t$. That is the equilibrium unemployment rates are driven by labour market institutions and a common (global) latent variable.

I. Introduction
Preliminary factor analysis using a principle components approach showed that the first principle component accounts for around 40% of the variation of unemployment rate in the panel and it needs at least five factors to account for about 90% of the variations.

II. Okun's relationship at the country level
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The results with a common factor are shown **Table B1**. This table compares the parameter estimates of our baseline model where column (1) replicates column (4) of **Table 9** while column (2) present the parameter estimates of the common factor approach.

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Table B1. Adding a common factor.

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From a comparison of the parameter estimates in both columns, it is clear that some of the parameter estimates are affected but with the exception of union density the parameter estimates are not quantitatively different from each other. It would seem that the common factor is mainly picking up the effect of union density. Since our aim is to be explicit about labour market institutions, we have opted to concentrate on the model with the union density variable rather than the one with the common (global) factor.


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Product market regulations have a significant positive effect on the unemployment rate. However, now union density becomes insignificant. If we remove union density, the effect of product market regulations remains significantly positive. As shown in Table A2, product market regulation and union density are highly correlated. This correlation could arise because in many countries over time, PMR has been reduced at the same time as union density also dropped. For illustrative purposes, Table B3 shows estimates of the Okun relationship by age and gender when we remove union density as an explanatory variable and introduce PMR instead.

Acknowledgements

Table B3: Estimates by age and gender with PMR.



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Now, we find that that PMR has significant negative effects on the unemployment rate of young and prime age men. This is an odd result. Since these groups make up such a large proportion of the total labour force, the finding that PMR has significant negative effects on the unemployment rate of young and prime age men strengthens the case against including PMR in the 'aggregate model'. We think that the effect of PMR is actually picking up the effect of union density going down.

B3: Retirement ages

As a final note, we find that that PMR has significant negative effects on the unemployment rate of young and prime age men. This is an odd result. Since these groups make up such a large proportion of the total labour force, the finding that PMR has significant negative effects on the unemployment rate of young and prime age men strengthens the case against including PMR in the 'aggregate model'. We think that the effect of PMR is actually picking up the effect of union density going down.



Table B4. Additional estimates workers aged 55-64.

ABSTRACT



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