Revisiting Okun's relationship

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Abstract

Our paper investigates whether Okun's relationship between the output gap and unemployment has changed, post the Great Recession, and whether it explains the high youth unemployment. We estimate the relationship between observed unemployment rates, on the one hand and both the equilibrium unemployment rates and output gaps on the other. The model also includes the effect of labour market institutions as well as age and gender effects. Our empirical analysis is based on 20 OECD countries over the period 1985-2013. We find that the share of temporary workers (which includes a high and rising share of young workers) played a crucial role in explaining changes in the Okun coefficient (the impact of the output gap on the unemployment rate). Okun's coefficient is not only different for young, prime-age and older workers, it decreases with age, suggesting that policies to increase economic growth (i.e., close the output gap) will, on balance, result in a relatively large reduction in youth unemployment. We also find that an increase in the share of temporary workers increases Okun's coefficient for prime-age workers the most.

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1 Introduction

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 cited relationship is "Okun's law". It is a reduced-form relationship that has underpinned numerous academic and policy discussions about growth and employment.[1]

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 and Sekhposyan (2012) using quarterly data over the period 1949-2011 estimated various specifications of the Okun relationship and found that during the three most recent U.S. recessions and the Great Recession the unemployment rate was more sensitive to output growth and output gap fluctuations. Cazes et al. (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 less responsive to the negative economic growth shock. The authors relate these differences to differences in employment protection claiming that the responsiveness of unemployment through the Great Recession was smaller in countries with more employment protection.

Our paper is motivated by the need to investigate whether Okun's relationship between output gaps and unemployment has changed, post the Great Recession, and more importantly by whether and how the change has impinged on youth unemployment. 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 our intention of examining the impact on unemployment of deviations from potential output.[2] Also we will introduce in Okun's relationship labour market institutions meaning by that term "a system of laws, norms, or conventions resulting from a collective choice and providing constraints or incentives that alter individual choices over labour and pay" (Boeri and van Ours (2013), p 8).

Previous studies relating the unemployment gap (or the unemployment rate) to the output gap and to labour market institutions mostly look at a sub-set of OECD countries. All of the studies we have looked at find that the unemployment rate is negatively

[1] Okun specified an empirical relationship without clear indications of causality. Perman and Stephan (2015) for example present a meta-analysis of 269 estimates of Okun's relationship from 28 studies. According to this overview about 60 percent of all estimates have real output as left-hand-side variable, three-quarters use country level data and slightly more than half of the studies use a static model.

[2] The regression equation in Okun (1962) is $u = a + b(gap)$" (ibid p 99). One of the criteria Okun used for judging the validity of his estimates is that the results should agree "with the principle that potential GNP should equal actual GNP when $u = 4$", this is because he believed the target rate of unemployment (or full employment rate of unemployment) was 4%.

related to the output gap. The findings on the relationship between unemployment rates and labour market vary.[3] It is very common for studies to include the unemployment benefit replacement rate and sometimes measures of the duration and eligibility requirements.[4] 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 et al. (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. Again there are mixed results. While Scarpetta (1996) and Elmeskov et al. (1998) find a positive relationship between the unemployment rate and employment protection Griffith et al. (2007), Bassanini and Duval (2009) and Vandenberg (2010) do not find any statistically significant relationship between them. Owyang and Sekhposyan (2012) and Cazes et al. (2013) use a different set-up to the studies cited, but they also argue that the Okun relationship is affected by employment protection legislation.

The influence of wage coordination and/or centralisation on the unemployment rate has also been examined. While Vandenberg (2010) finds no evidence of any impact of centralisation[5], others (eg Scarpetta (1996) and Elmeskov et al. (1998)) conclude that there is a 'hump-shaped' relationship between the unemployment rate and centralisation as suggested by Calmfors and Driffill (1988).

Two studies look for the impact of active labour market programs. Scarpetta (1996) finds no evidence of any impact on the unemployment rate of ALMPs whereas Elmeskov et al. (1998) find some evidence of a negative relationship between the two.

The most common additional explanatory variables included in studies are the tax wedge and non-wage labour costs (Adams et al. (1987), Coe (1990), Scarpetta (1996), Elmeskov et al. (1998), Griffith et al. (2007) and Bassanini and Duval (2009)), the real exchange rate (Adams et al. (1987) and Griffith et al. (2007)) and terms of trade (Scarpetta (1996)). Other (less common) variables included are the minimum wage (Adams and Coe (1990), Coe (1990) and Elmeskov et al. (1998)), the rate of structural change (Herwartz and Niebuhr (2011)), the level of product market competition (Bassanini and Duval (2009)) and demographic factors such as the proportion of the labour force who

[3]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 et al. (2005). Holmlund (2014) provides a recent discussion on the relevance of various labour market institutions. van Ours (2015) estimates a 'difference version' of Okun's relationship linking changes in unemployment to labour market institutions.

[4]Bassanini and Duval (2009) and Vandenberg (2010) for example include measures of the duration and eligibility requirements.

[5]Note that Vandenberg does not include union density as an explanatory variable.

are 'young' (Adams et al. (1987), Adams and Coe (1990)).

The final point to make here is in relation to the use of time-series data. Ball et al. (2013) study Okun's relationship for the US from 1948 to 2011 and for 20 OECD countries from 1980 to 2011. They conclude that there is a strong and stable relationship "by the standards of macroeconomics" in most countries although the magnitude of the relationship between output and unemployment varies across countries. Pereira (2013) analysed quarterly US data from 1948:1 to 2012:4 and finds that there are asymmetries in Okun's relationship with a weaker relationship between economic growth and unemployment during periods of expansion.

We revisit Okun's relationship using data from 20 OECD countries over the period 1985-2013. The aim of our paper is to study Okun's relationship for a range of countries covering a sample period that includes the Great Recession. In this regard, we will test for asymmetries in the relationship between the output gap and the unemployment rate, specifically, whether the Okun coefficient is different in boom and bust periods. Furthermore, we will examine whether and by how much the Okun coefficient has changed over time, especially post the Great recession.

We have three contributions to the literature. First, we investigate how the relationship between the (equilibrium) unemployment rate, the output gap and labour market institutions differ depending upon age and gender. This is an important extension as the determinants of the equilibrium unemployment rate (u*) and the size of the Okun coefficient are likely to vary across age groups and across gender. Second, we allow market institutional factors to influence *both* the equilibrium rate of unemployment as well as 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 whether there are marked differences in the apparent trends in the equilibrium unemployment rates between countries (especially those in the EU). The analysis at the age-gender level, taken in conjunction with findings about labour-institutional factors, allows us to draw some policy implications. We conclude that equilibrium unemployment rates are positively related to union density, the replacement rate and the tax wedge and negatively related to the level of the 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 conclude 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 paper is set-up as follows. In section 2 we discuss possible theoretical foundations for the gap version of Okun's relationship and we provide a description of our empirical model. Section 3 presents the parameter estimates of Okun's relationship at a country-level, assuming that each country has a constant equilibrium unemployment rate. We

extend our analysis by allowing labour market institutional factors to affect the equilibrium unemployment rate while the effect of the output gap on the unemployment rate is (inter alia) allowed to depend on the share of temporary workers in employment. Section 4 presents estimates of Okun's relationship distinguished by age and gender. Section 5 concludes.

2 Revisiting Okun's relationship

2.1 Background

We begin with the gap approach to Okun's law, i.e.

$$(u_t - u_t^*) = -\Phi(y_t - y_t^*) \tag{1}$$

where u is the unemployment rate and y is real GDP, the $*$ indicates 'full-employment' or 'optimal' values of the variables.

2.1.1 The 'surprise' theory

One way to motivate the 'gap' version of Okun's law is to draw on the surprise theory of the labour market. This theory of the labour market relates (temporary) deviations of actual unemployment from the equilibrium rate of unemployment $(u - u^*)$ to inflation 'surprises' i.e. to deviations of actual inflation from expected inflation $(\pi - \pi^e)$ such that

$$(u_t - u_t^*) = -\alpha_1(\pi_t - \pi_t^*) \tag{2}$$

The two are negatively related essentially because if actual inflation exceeds expected inflation (and thus nominal wage demands) and workers mistakenly believe nominal wage increases are real wage increases when in fact they are not, then they will be prepared to supply more labour while at the same time firms will have an incentive to demand more labour. Employment will rise above its equilibrium value and unemployment will fall below the equilibrium rate. Under various assumptions relating to the production function, hours, participation rates etc. (negative/positive) inflation 'surprises' not only result in deviations of actual unemployment from the equilibrium rate of unemployment, but will also be associated with (positive/negative) deviations of actual output from the equilibrium level of output $(y - y^*)$. So that

$$(y_t - y_t^*) = \alpha_2(\pi_t - \pi_t^e) \tag{3}$$

Combining (2) and (3) gives a relationship between deviations of actual unemployment from the equilibrium rate of unemployment $(u - u^*)$ and deviations of actual output from the equilibrium level of output $(y - y^*)$, such that

$$(y_t - y_t^*) = -\alpha_3(u_t - u_t^*) \tag{4}$$

For convenience we will write this as

$$(u_t - u_t^*) = -\Phi(y_t - y_t^*) \tag{5}$$

where Φ is the Okun coefficient.

2.1.2 An accounting approach

More usefully for our purposes, Okun's relationship may also be derived from an accounting relationship (see also Okun (1962) and Gordon (1984)),

$$Y_t = (Y_t/W_t).(W_t/E_t).(E_t/L_t).(L_t/M_t).M_t \tag{6}$$

where Y is real GDP, W is total hours worked, E is number of people employed, L is the labour force and M is population. This may be written as

$$Y_t = A_t.H_t.(1 - u_t).P_t.M_t$$

where A is real output per hour worked (i.e. labour productivity), H is average hours per worker, u is the unemployment rate and P is the participation rate. Assume the same applies in equilibrium (indicated by a *), so that

$$Y_t^* = A_t^*.H_t^*.(1 - u_t^*).P_t^*.M_t$$

Taking logs, subtracting the second from the first, and assuming that the unemployment rate is 'small', gives[6]

$$(y_t - y_t^*) = (a_t - a_t^*) + (h_t - h_t^*) - (u_t - u_t^*) + (p_t - p_t^*) \tag{7}$$

where lower case denotes the log of the variable. Now, assume that both productivity and hours worked depend on $(y_t - y_t^*)$ such that $(a_t - a_t^*) = \beta_1(y_t - y_t^*)$, with $\beta_1 > 0$ and $(h_t - h_t^*) = \beta_2(y_t - y_t^*)$, with $\beta_2 > 0$, and further assume that participation depends on $(u_t - u_t^*)$ such that $(p_t - p_t^*) = \beta_3(u_t - u_t^*)$, with $\beta_3 < 0$. Substituting and rearranging

[6]This implicitly assumes no migrant flows due to variations in the size of the gap as population is assumed to be the same in the equilibrium and actual scenarios.

yields:

$$(u_t - u_t^*) = -\Phi(y_t - y_t^*) \tag{8}$$

where $\Phi = \frac{1-\beta_1-\beta_2}{1-\beta_3}$, which is to say that the effect of a change in the output gap on the unemployment gap will be larger (i) the smaller is the elasticity of output per hour with respect to output, (ii) the smaller is the induced change in average hours worked and (iii) the larger is the effect of any change in unemployment on the participation rate (i.e. the larger the encouraged/discouraged worker effect).

We also note in passing that, to the extent that the parameters β_1, β_2 and β_3 are gender and age-specific, the way the output gap affects the unemployment rate will differ according to gender and age.

2.2 Empirical Model

Okun's law is an empirical relationship between output and unemployment. The econometric model is based on (8) and can be written as:

$$\begin{aligned} u_{it} &= \alpha_i - \Phi(y_{it} - y_{it}^*) + \varepsilon_{it} \\ E(\varepsilon_{it}\varepsilon_{jt}) &= \sigma_{ij} \\ E(\varepsilon_{is}\varepsilon_{it}) &= 0;\ s \neq t \end{aligned} \tag{9}$$

where as before, u is the unemployment rate; y is (log) real output; y^* is (log) potential output. 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). The errors are related cross-sectionally (i.e. across countries), but not across periods (i.e. years). The model is estimated by GLS allowing for cross-sectional heteroskedasticity.

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^* of y by minimising the variance of y around y^* subject to a penalty function that constrains the change in the trend growth of y^*:

$$\Theta = \sum_{t=1}^{T}(y_t - y_t^*)^2 + \lambda \sum_{t=2}^{T-1}((y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*))^2 \tag{10}$$

The penalty parameter λ controls the smoothness of the series and the suggested value by HP is 100.[7]

[7] 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 $\lambda = 100$.

3 Okun's relationship at the country-level

3.1 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). Details on our data are presented in Appendix A.

Output gaps are created for each country in the data set. By construction the mean value of each country's output gap is zero. Figure 1 provides information about the evolution over time of the unemployment rates and the (inverse of the) output gap for the 20 countries in our sample. The vertical scales differ between countries as for some countries the fluctuations in unemployment rate and/or output gap are much smaller than in other countries. Clearly, in many countries both fluctuations are highly correlated, i.e. variations in unemployment rates and output gaps go hand in hand. The output gap associated with the Great Recession, which (because of the inverse scale presented as a strong increase) has a greater impact on some countries than on others. In Australia for example there is hardly any peak visible. It is also the case that in some countries such as Germany and the United States, unemployment is on the way down after the strong increase caused by the Great Recession. In other countries such as France, Italy, Portugal and Spain unemployment rates show no sign of a decline in recent years.

– Figure 1 and Table 1 about here –

3.2 Parameter estimates

Table 1 shows the parameter estimates of the baseline version of Okun's relationship i.e., the estimation of equation (9) above which assumes that the equilibrium rate of unemployment (u*) varies across countries but for each country is constant over time. The GDP-gap has a significant and negative effect on the unemployment rate. This is not surprising given the high correlation between the two as shown in Figure 1.

Table 1 also shows that there is considerable cross-country variation in the implied equilibrium unemployment rates, with estimates of α ranging from a low 4% in Austria, Japan and Norway to a high 17% of in Spain. Figure 2 shows that there is a strong cross-country correlation between the average unemployment and the estimated values of the equilibrium unemployment rate.

– Figure 2 and Table 2 about here –

Table 2 shows the parameter estimates when we modify equation (9) to allow for

asymmetry, in the sense that a positive output gap may have a different effect on unemployment than a negative output gap. As shown in the second column of Table 2 we are unable to reject the 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. As shown we cannot reject the hypothesis that they are different for this simple model.

3.3 Introducing labour market institutions

So far, equilibrium unemployment is assumed to be constant over time. However, previous studies suggest labour market institutions may affect the level of equilibrium unemployment u^*. We investigate the relevance of the following labour market institutions with respect to the equilibrium unemployment as estimated in Okun's relationship: union coverage, union density, wage coordination, gross UI replacement rate and tax wedge. In addition to this we investigate the relevance of the terms of trade. Furthermore, since labour markets have become more flexible in the past decades we investigate whether the responsiveness of unemployment to a change in the output gap is influenced by the ratio of temporary workers to the total of employees. After all, the bigger the share of temporary workers the easier (ceteris paribus) the adjustment of employment to output shocks and thus the bigger the effect of an output shock on unemployment.[8]

– Figure 3 about here –

Figure 3 gives a graphical representation of the developments in the labour market institutions and the share of temporary workers. Appendix A provides details on the data used. Each of the graphs in Figure 3 plots, for each country, the values of the variables at two points in time - 1985 and 2013. Clearly, for many countries not much has happened between these two years 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 not on the diagonal, it is below indicating 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. In the same countries, the fall in union density has been substantial as well. Union density is high in Scandinavian countries (which has to do with unemployment insurance (UI) benefits run by unions) while union density is low in France, the United States and Spain. Panel b shows the

[8]Note that we did not include Employment Protection Legislation (EPL) among the explanatory variables for a variety of reasons. First, EPL is found to influence labour market flows rather than labour market stocks. Second, current EPL-indicators measure strictness of the legislation but ignore enforcement. Third, how employment protection affects the labour market will depend on the share of workers with permanent and temporary contracts rather than on the legislation applied to these groups of workers.

evolution of wage coordination (left) and UI gross replacement rate (right). There is quite a wide range in 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 was reduced while in Italy wage coordination substantially increased. As to the replacement rate in most countries there was a decrease over our period of analysis but in for example Italy, Portugal and Norway there was a substantial increase. Panel c shows the developments in the tax wedge (left) and the share of temporary workers in employment (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 the share of temporary workers increased a lot in Italy, France, the Netherlands, Portugal and Spain.

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

$$u_{it} = \alpha_i + \beta z_{it} - (\Phi_0 + \Phi_1 q_{it})(y_{it} - y^*_{it}) + \varepsilon_{it} \tag{11}$$

where z represents a vector of labour market institutions, q is the share of temporary workers and where the time-varying equilibrium rates of unemployment are modelled as: $u^*_{it} = \alpha_i + \beta z_{it}$.

– Table 3 about here –

Table 3 shows the results of estimating equation (11) under three different assumptions about the variability of the Okun coefficient (Φ). Column (1) shows the results when (11) is estimated imposing the restriction that there is no variation in the Okun coefficient either across countries or across time and without allowing for it to interact with the share of temporary workers (i.e. Φ_1 is set equal to zero).

Column (2) shows the parameter estimates if we allow the Okun coefficient to have different values before and after the Great Recession. Column (3) shows the results when the Okun coefficient is allowed to interact with the share of temporary workers (q_{it}) and thus the effect of a unit change in 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). 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 the unemployment rate. Column (4) of Table 3 shows the results when we estimate equation (11) allowing for the Okun coefficient (Φ_0) to be different pre- and post- the Great Recession and also allowing the Okun coefficient to interact with the

share of temporary workers.

Inspection of the estimated values of the coefficients and their standard errors 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 change in 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 must reject the hypothesis that the Okun coefficient has remained the same over time. (b) Once we introduce labour market institutions or allow the size of the Okun coefficient to vary with the share of temporary workers there is no longer any need to allow the Okun coefficient to differ depending upon whether we are trying to explain the Okun relationship after the Great Recession or before. Clearly, changes in labour market institutions or the share of temporary workers across time are the explanation (in this model at least) for the apparent change in the Okun coefficient after the Great Recession which we noted earlier when discussing Table 2. (c) The sign of the coefficient on the interaction term implies that the larger is the share of temporary workers the 'larger' (i.e. the more negative) is the impact of a change in the output gap on the unemployment gap. Now, over time the share of temporary workers has been rising on average and across all age groups and this implies that the 'true' Okun coefficient i.e. the impact of a change in the output gap on the unemployment gap has been trending upwards (becoming more negative) over time. Note that similar conclusions were reached in an 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, p 1).

We turn now to the role of variables other than the output gap in explaining differences in the unemployment rate across countries and over time. The signs and significance of these variables do not depend upon which of the three models of the gap is used, in that sense our results are quite robust. The results given 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) whilst we do find a significant and, as expected, positive relationship between the (equilibrium) unemployment rate and union density (defined as the proportion of workers who are union members). As a check of robustness we also estimated the model for different sets 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 10 Euro-zone countries. The results are robust across these different combinations of European countries. However, comparing these results with the set of 20 countries (ie including the 5 non-European countries of United States, Japan, Australia, Canada, New Zealand to the European set) reveals two important results. The effect

of union coverage changed from being significant for the European set of countries, to being insignificant for the set of 20 advanced countries. In contrast, the effect of the terms of trade which was insignificant for the European group, became significant for the expanded global group. The other results are also as expected, the (equilibrium) unemployment rate is significantly and positively related to the replacement rate and the tax wedge.[9] and is significantly and as expected negatively related to the level of wage coordination and the terms of trade.[10]

– Figure 4 about here –

Figure 4 plots the observed and our estimated equilibrium unemployment rates for country in our sample over the period 1985-2013. The equilibrium rates have been generated from equation (11), where the relevant coefficients are those reported in the third column of Table 3.[11]

What is noteworthy about these figures is the very different behaviour of the equilibrium rate over time. For some countries (Belgium, Finland, France, Portugal, Spain and Sweden) the equilibrium rate was roughly constant over the period as the labour market institutions hardly changed. For others (Austria, Japan, Norway and Switzerland) the equilibrium rate of unemployment was 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, New Zealand, the United Kingdom and the United States) labour market institutions improved since the equilibrium rate was falling over the period albeit again at markedly different rates (compare the United Kingdom with the Netherlands for example).

What is particularly interesting about this is that for the ten countries in our sample who are the Euro-zone (and thus have fixed exchange rates vis a vis each other) – namely Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain – five (Belgium, Finland, France, Portugal and Spain) experienced a roughly constant equilibrium rate, one (Austria) experienced a rising equilibrium rate and four (Germany, Ireland, Italy and the Netherlands) experienced a falling equilibrium rate.

Given the model of unemployment used to generate the equilibrium rates of unemployment in this paper, the explanation for different tends in the equilibrium rate must have its origin in different trends in labour market institutions. We make two observations here about the link between equilibrium rates of unemployment and labour market

[9]Note that Lehmann et al. (2014) find that for a given overall level of labour income taxation, a more progressive tax schedule reduces the unemployment rate.

[10]To investigate the nature of the country fixed effects we also used the Mundlak (1978) approach. The results confirm that time variation in equilibrium unemployment rates can be attributed to changes in labour market institutions, but that persistent cross-country differences cannot be explained by differences in labour market institutions.

[11]As noted above the signs and size of the coefficients do not vary markedly as we estimate equations under different assumptions about the coefficients on the output gap.

institutions. 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 (cet par) lead to convergence in the equilibrium rates. Another example would be differences in the equilibrium rate resulting from differences in the UB 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 (cet par) lead to convergence in the equilibrium rates.

4 Okun's relationship by age and gender

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 percent, they are above 25 percent for young men and women in Italy and Spain. Also for prime age workers there are differences 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 percent). The highest unemployment rates for old men are in Spain with 10.2 percent and for old women in Germany with almost 11 percent, while the lowest rates for old men and women are in Norway (both less than 2 percent).

– Table 4 and Figure 5 about here –

Figure 5 shows the evolution of unemployment rates over the period 1985-2013 averaged for the 20 countries and distinguished by age and gender. The unemployment rates shown in panel a are very different depending on age. The unemployment rates of young individuals are by far the highest and they fluctuate much more than the unemployment rates of prime age and old individuals. Conditional on age the differences between men and women are small.

There are three studies that investigate the age or age and gender specific version of the difference form of Okun's law. Hutengs and Stadtmann (2013) estimate Okun's relationship over the period 1984-2011 for 11 Eurozone countries and five age groups. Zanin (2014) studies 5 age cohorts by gender for 33 OECD countries over the period 1998-2012. Hutengs and Stadtmann (2014) estimate Okun's relationship for five Scandinavian countries and five age groups over the period 1984-2011. All studies find that the change in unemployment is more sensitive to economic growth for young workers than for prime age and older workers. We modified Okun's relationship to allow estimation of the unemployment rates by age and gender distinguishing between 6 groups:

$$u_{ikt} = \alpha_{ik} - \Phi_k(y_{it} - y^*_{it}) + \varepsilon_{ikt} \tag{12}$$

where k represents 3 age groups (15-24, 25-54, 55-64) for both males and females (k = 1,..,6). We assume that the equilibrium rates are not only country-specific, they also differ across age groups.

– Table 5 and Figure 6 about here –

The parameter estimates are presented in Table 5. There are clear differences in Okun's relationship by age and gender. To start with, the effect of the GDP-gap on unemployment rates decreases with age. Whereas, the relevant coefficient has a value of 1.14 for young males, it has a value of 0.56 for prime age males and a value of 0.45 for old males. A similar pattern though with smaller values of the relevant coefficients is present for females. If output changes this has an effect on unemployment rates that is more than twice as large for young workers than it is for older workers. This explains why the evidence in Figure 5 that shows that fluctuations in unemployment rates are highly correlated across age and gender but with substantially bigger fluctuations for young workers.

Figure 6 shows the cross-country relationship between equilibrium unemployment rates for youngsters and prime age workers, separately for males and females. Panel a shows the relationship for males. There is cross-country a strong correlation between the unemployment rates of young and prime age males. The ratio of the two unemployment rates is about 2.5. Clear outliers are Italy with a relatively 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. In the cross-country relationship Italy and Germany are similar outliers as for males.

Finally, we allow labour institutions to affect the separate Okun's relationships by age and gender (thereby allowing the equilibrium rates to be time-varying); for k = 1,..,6

$$u_{ikt} = (\alpha_{ik} + \beta_k z_{it}) - (\Phi_0 + \Phi_k q_{ikt})(y_{it} - y^*_{it}) + \varepsilon_{ikt} \tag{13}$$

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 5 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 is on average about 10 percentage-point over the period of analysis from 25 to 35 percent.

Table 6 shows the relevant parameter estimates of equation 13. 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 could have to do with the low share of temporary workers among older employees as well as with the relative stability in that share. The parameter estimate for the interaction term between output gap and share of temporary workers is smaller for young workers but one has to take into account that the share of temporary workers is much higher and increasing more strongly among young workers. Finally, the magnitude of the effects of labour market institutions on the equilibrium unemployment rates of unemployment are age and gender specific but the general pattern is not different from the pattern presented in Table 3.

– Table 6 about here –

5 Conclusions

Okun's empirical relationship has been shown repeatedly, in a large number of studies to be an enduring stylised fact. While the gap specification (i.e., the relationship between the output gap and deviation of the unemployment rate from its equilibrium rate) is closer to the spirit of Okun's Law, the gap specification is rarely adopted as it involves the estimation of two latent variables. In this paper we revisit Okun's 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 firstly, because the introduction of institutional labour factors which changed over time allowed the derivation of time-varying equilibrium unemployment rates and secondly, 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 the young the share of temporary workers is not only high but also increasing fast. In terms of Okun's relationship this means that the effect of shocks in output increase over time. Therefore, fluctuations in unemployment rates are expected to increase as the labour market becomes more flexible.

The empirical analysis was conducted using a panel dataset covering 20 OECD countries over the sample period 1985-2013. Although the observations were diverse over space and time, they are all indicative of economic behaviour in advanced economies linked by significant trade and financial flows. The study focused on drawing broad inferences, but we have also drawn attention to country-specific differences. We find that the equilibrium unemployment rate is (as expected) positively related to union density, the replacement rate and the tax wedge and is (again as expected) negatively related to the level of the wage coordination and the terms of trade.

Finally, since the unemployment rates for younger workers (aged between 15 and 24 years) were considerably higher than unemployment rates of both prime age and older workers, we also estimated Okun's relationship using unemployment rates disaggregated by age and gender. The results provide statistically significant empirical 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, it will also have the distributional effect of lowering youth unemployment.

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Appendix A: Details on data

1. Unemployment and employment data: Unemployment national averages for 20 countries. Sources : (1) 1985-2003: Bassanini and Duval (2006), (2) 2004-2013: OECD labour force statistics. Unemployment rates and employment rates by gender and age. Source: OECD labour force statistics

2. GDP: World Bank.

3. Labour market institutions:

   - Union coverage: share of workers covered by collective bargaining
   - Union density: union members as a share of all workers
   - Wage coordination; scale 1–5, low to high
   - UI replacement rate: UI benefits as a percentage of the previous wage
   - Tax wedge: One-earner married couple at 100% of average earnings, 2 children

4. Share of temporary workers, average and by gender and age: OECD labour force statistics

5. Terms of trade: ratio of export prices to import prices

The table below provides information about averages of unemployment rates (%) and annual 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%.

	u	growth		u	growth
Australia	6.9	3.4	Japan	3.9	1.8
Austria	4.0	2.2	Netherlands	5.9	2.2
Belgium	8.5	1.9	New Zealand	6.2	2.4
Canada	8.3	2.5	Norway	3.9	2.4
Denmark	6.5	1.5	Portugal	7.7	2.1
Finland	9.0	2.1	Spain	17.3	2.4
France	9.9	1.8	Sweden	6.4	2.2
Germany	7.7	1.8	Switzerland	3.1	1.8
Ireland	11.1	4.4	United Kingdom	7.5	2.4
Italy	10.1	1.2	United States	6.2	2.7

Note that by definition the average output-gap is 0 for every country.

Table 1: Okun's relationship – 1985-2013

$\overline{u}^*$	7.50	(0.08)			
GDP-gap	0.54	(0.04)			
u_j^*					
Australia	6.89	(0.28)	Japan	3.88	(0.23)
Austria	4.04	(0.15)	Netherlands	5.89	(0.47)
Belgium	8.46	(0.22)	New Zealand	6.21	(0.20)
Canada	8.33	(0.19)	Norway	3.93	(0.16)
Denmark	6.47	(0.24)	Portugal	7.71	(0.54)
Finland	8.90	(0.49)	Spain	17.31	(0.79)
France	9.94	(0.20)	Sweden	6.35	(0.41)
Germany	7.73	(0.31)	Switzerland	3.06	(0.26)
Ireland	11.12	(0.76)	United Kingdom	7.46	(0.33)
Italy	10.14	(0.33)	United States	6.23	(0.20)

Note: standard errors in parentheses

Table 2: Symmetry and stability of Okun's relationship

Variable	(1)		(2)		(3)	
u*	7.50	(0.08)	7.34	(0.13)	7.51	(0.13)
GDP-gap	0.54	(0.04)				
GDP-gap_pos			0.44	(0.07)		
GDP-gap_neg			0.64	(0.08)		
GDP-gap_pre GR					0.63	(0.01)
GDP-gap_post GR					0.56	(0.03)
Wald test						
No asymmetry			2.36	(0.12)		
No break GR					2.40	(0.02)

Note: All estimates contain country fixed effects; the estimates in the first column are identical to the ones presented in Table 1; parameter estimates (standard errors); Wald-tests (p-values)

Table 3: Parameter estimates – including labour market institutions

Variable	(1)		(2)		(3)		(4)		(5)	
GDP-gap	0.48	(0.03)			0.48	(0.03)			0.47	(0.04)
GDP-gap-pre GR			0.53	(0.09)			0.48	(0.03)		
GDP-gap-post GR			0.47	(0.04)			0.48	(0.03)		
GDP-gap*share temp					0.05	(0.02)	0.05	(0.02)	0.04	(0.02)
Union coverage	*0.01*	*(0.01)*	*0.01*	*(0.01)*	*0.01*	*(0.01)*	*0.01*	*(0.01)*	-0.08	(0.02)
Union density	0.05	(0.02)	0.05	(0.02)	0.05	(0.02)	0.05	(0.02)	0.05	(0.02)
Wage coordination	-0.74	(0.11)	-0.74	(0.11)	-0.70	(0.11)	-0.70	(0.11)	-0.90	(0.13)
UI replacement rate	0.04	(0.02)	0.04	(0.02)	0.04	(0.01)	0.04	(0.01)	0.05	(0.02)
Tax wedge	0.13	(0.02)	0.14	(0.02)	0.14	(0.02)	0.14	(0.02)	0.26	(0.06)
Terms of trade	-0.06	(0.01)	-0.06	(0.01)	-0.06	(0.01)	-0.06	(0.01)	-0.04	(0.02)
Constant	7.50	(0.07)	7.49	(0.07)	7.51	(0.07)	7.51	(0.07)	7.91	(0.09)
Wald test – no break GR			0.50	(0.48)			0.00	(0.98)		

Note: All estimates contain country fixed effects; parameter estimates (standard errors) ; Wald test (p-value); parameters in *italics* are not significantly different from zero (at a 10%-level).

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

	Women			Men		
	15-24	25-54	55-64	15-24	25-54	55-64
Australia	12.7	5.5	3.4	14.0	5.3	6.3
Austria	7.6	4.1	3.1	7.3	3.5	4.2
Belgium	21.7	9.6	5.0	17.5	5.9	4.1
Canada	12.3	7.1	6.5	15.6	7.3	7.1
Denmark	10.4	6.5	6.0	9.9	5.1	5.2
Finland	18.6	7.0	8.6	18.7	7.5	9.2
France	24.6	10.2	6.7	21.0	7.3	6.7
Germany	8.5	7.8	10.8	9.3	6.7	9.5
Ireland	16.5	9.2	5.7	20.5	10.5	6.9
Italy	34.9	11.0	3.3	25.9	5.7	3.6
Japan	6.5	3.6	2.6	7.7	3.1	5.1
Netherlands	10.4	6.2	3.8	9.6	4.3	3.6
New Zealand	13.0	4.9	3.1	13.8	4.8	3.9
Norway	9.7	2.9	1.3	10.4	3.3	1.9
Portugal	19.3	7.6	4.1	14.2	5.4	5.5
Spain	39.2	19.5	10.0	29.7	12.2	10.2
Sweden	15.2	4.8	4.1	16.5	5.3	5.3
Switzerland	6.5	4.0	2.7	6.7	2.7	3.0
United Kingdom	12.4	5.5	3.8	16.6	6.5	7.2
United States	11.7	5.1	3.7	13.6	5.1	4.3
Average	15.8	7.2	5.0	15.1	5.9	5.7

Note that the data for Austria refer to the period from 1994 onwards, for New Zealand from 1986 onwards and for Switzerland from 1991 onwards.

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

	15-24				25-54				55-64			
	Males		Females		Males		Females		Males		Females	
GDP-gap	1.14	(0.06)	0.76	(0.06)	0.56	(0.04)	0.36	(0.04)	0.45	(0.03)	0.26	(0.03)
u*												
Australia	13.97	(0.42)	12.74	(0.39)	5.28	(0.26)	5.47	(0.19)	6.29	(0.48)	3.41	(0.13)
Austria	7.18	(0.55)	7.52	(0.46)	3.46	(0.16)	4.03	(0.15)	4.19	(0.28)	3.04	(0.23)
Belgium	17.48	(0.61)	21.68	(0.57)	5.93	(0.15)	9.56	(0.51)	4.11	(0.16)	4.96	(0.28)
Canada	15.61	(0.15)	12.26	(0.16)	7.26	(0.17)	7.08	(0.25)	7.13	(0.15)	6.48	(0.19)
Denmark	9.90	(0.37)	10.37	(0.31)	5.12	(0.23)	6.46	(0.31)	5.21	(0.19)	6.03	(0.34)
Finland	18.66	(0.71)	18.56	(1.04)	7.50	(0.40)	6.97	(0.50)	9.23	(0.79)	8.61	(0.81)
France	20.99	(0.40)	24.59	(0.57)	7.29	(0.17)	10.18	(0.32)	6.67	(0.16)	6.71	(0.21)
Germany	9.35	(0.55)	8.53	(0.37)	6.70	(0.32)	7.81	(0.30)	9.52	(0.45)	10.80	(0.62)
Ireland	20.49	(1.32)	16.48	(0.85)	10.48	(0.69)	9.22	(0.86)	6.94	(0.50)	5.66	(0.50)
Italy	25.89	(0.68)	34.86	(0.98)	5.71	(0.24)	11.05	(0.36)	3.55	(0.21)	3.35	(0.17)
Japan	7.70	(0.52)	6.48	(0.33)	3.13	(0.26)	3.57	(0.19)	5.06	(0.15)	2.56	(0.12)
Netherlands	9.65	(0.71)	10.35	(0.75)	4.33	(0.40)	6.19	(0.55)	3.58	(0.26)	3.83	(0.17)
New Zealand	13.79	(0.33)	12.96	(0.36)	4.74	(0.24)	4.90	(0.16)	3.92	(0.20)	3.09	(0.12)
Norway	10.37	(0.38)	9.66	(0.37)	3.27	(0.16)	2.91	(0.12)	1.94	(0.14)	1.29	(0.09)
Portugal	14.18	(1.31)	19.29	(1.23)	5.41	(0.59)	7.65	(0.51)	5.51	(0.63)	4.13	(0.53)
Spain	29.66	(1.79)	39.21	(1.68)	12.16	(0.77)	19.53	(0.93)	10.19	(0.57)	10.03	(0.59)
Sweden	16.54	(1.19)	15.15	(1.16)	5.27	(0.37)	4.77	(0.35)	5.35	(0.37)	4.14	(0.24)
Switzerland	6.57	(0.37)	6.38	(0.42)	2.64	(0.15)	3.93	(0.11)	2.92	(0.15)	2.67	(0.17)
United Kingdom	16.58	(0.54)	12.43	(0.51)	6.48	(0.33)	5.53	(0.32)	7.20	(0.49)	3.77	(0.30)
United States	13.58	(0.38)	11.70	(0.24)	5.12	(0.22)	5.07	(0.17)	4.29	(0.20)	3.71	(0.17)

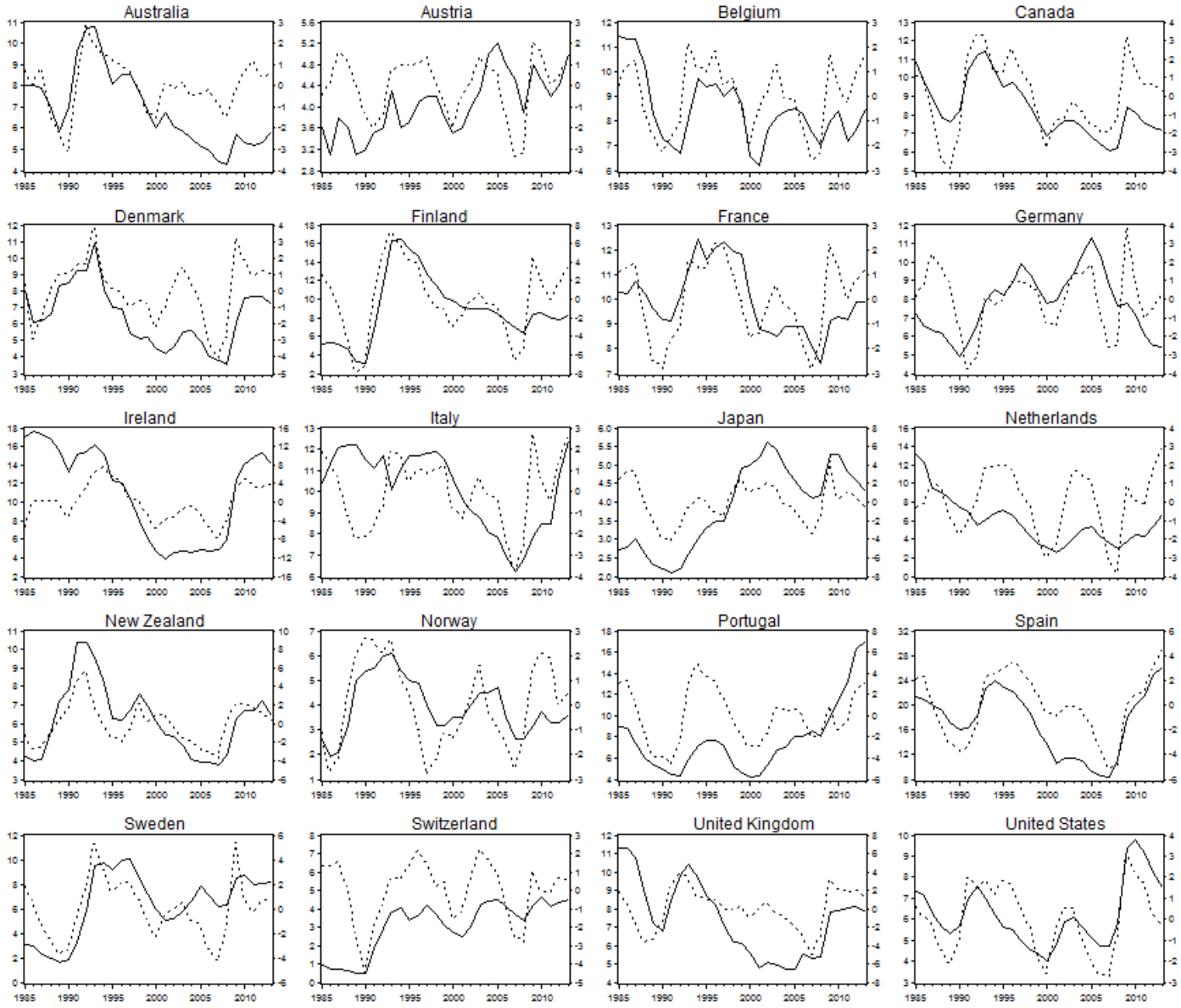
Note: standard errors in parentheses

Table 6: Parameter estimates, institutions by age & gender

	Males						Females					
	15-24		25-54		55-64		15-24		25-54		55-64	
GDP-gap	1.06	(0.06)	0.52	(0.03)	0.45	(0.03)	0.70	(0.06)	0.29	(0.03)	-0.23	(0.02)
GDP-gap*share temp	0.03	(0.01)	0.07	(0.02)	*0.03*	*(0.03)*	0.02	(0.01)	0.05	(0.02)	*-0.01*	*(0.02)*
Union coverage	0.07	(0.03)	*0.00*	*(0.01)*	*-0.01*	*(0.01)*	*0.01*	*(0.02)*	-0.03	(0.01)	-0.05	(0.01)
Union density	-0.11	(0.04)	0.04	(0.02)	0.06	(0.02)	*-0.01*	*(0.04)*	0.10	(0.02)	0.09	(0.02)
Wage coordination	-1.01	(0.22)	-0.48	(0.09)	-0.38	(0.10)	-0.86	(0.19)	-0.51	(0.11)	-0.24	(0.08)
UI Repl rate	*0.02*	*(0.03)*	0.09	(0.01)	0.06	(0.01)	*-0.04*	*(0.03)*	0.04	(0.01)	0.06	(0.01)
Tax wedge	*0.03*	*(0.05)*	0.09	(0.02)	0.03	(0.02)	0.11	(0.04)	0.16	(0.02)	0.08	(0.01)
Terms of trade	-0.10	(0.03)	-0.08	(0.02)	-0.05	(0.01)	-0.05	(0.02)	-0.04	(0.01)	-0.03	(0.01)
Constant	15.06	(0.12)	5.92	(0.07)	5.69	(0.06)	15.77	(0.13)	7.20	(0.06)	4.97	(0.04)

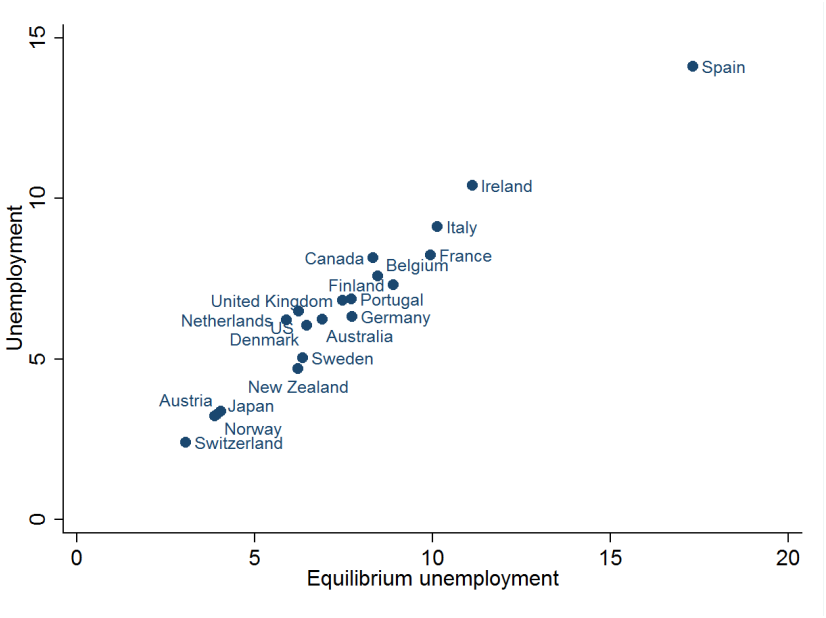
Note: All estimates contain country fixed effects; Standard errors in parentheses; parameters in *italics* are not significantly different from zero (at a 10%-level).

Figure 1: Unemployment rates and output gaps (inverse); 1985-2013



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

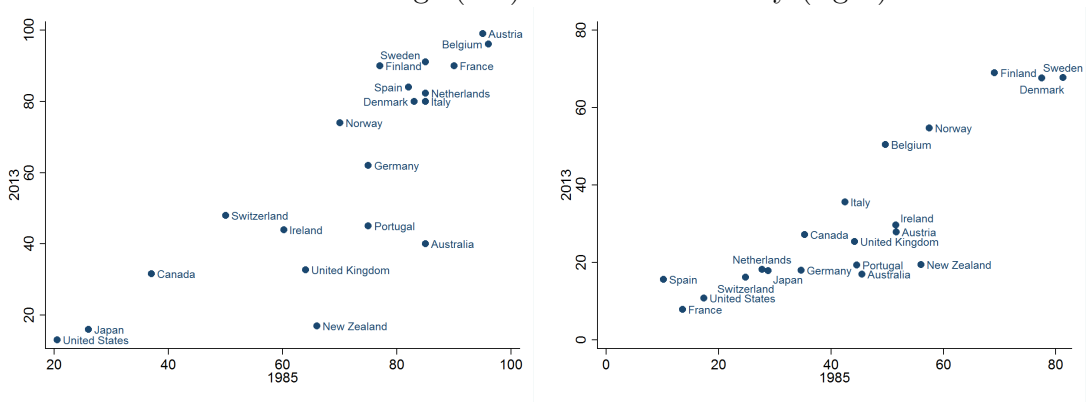
Figure 2: Averages of unemployment rates and equilibrium unemployment rates 20 countries; 1985-2013



Note: the estimates of the equilibrium unemployment rates are from Table 1.

Figure 3: Labour market characteristics 1985 and 2013

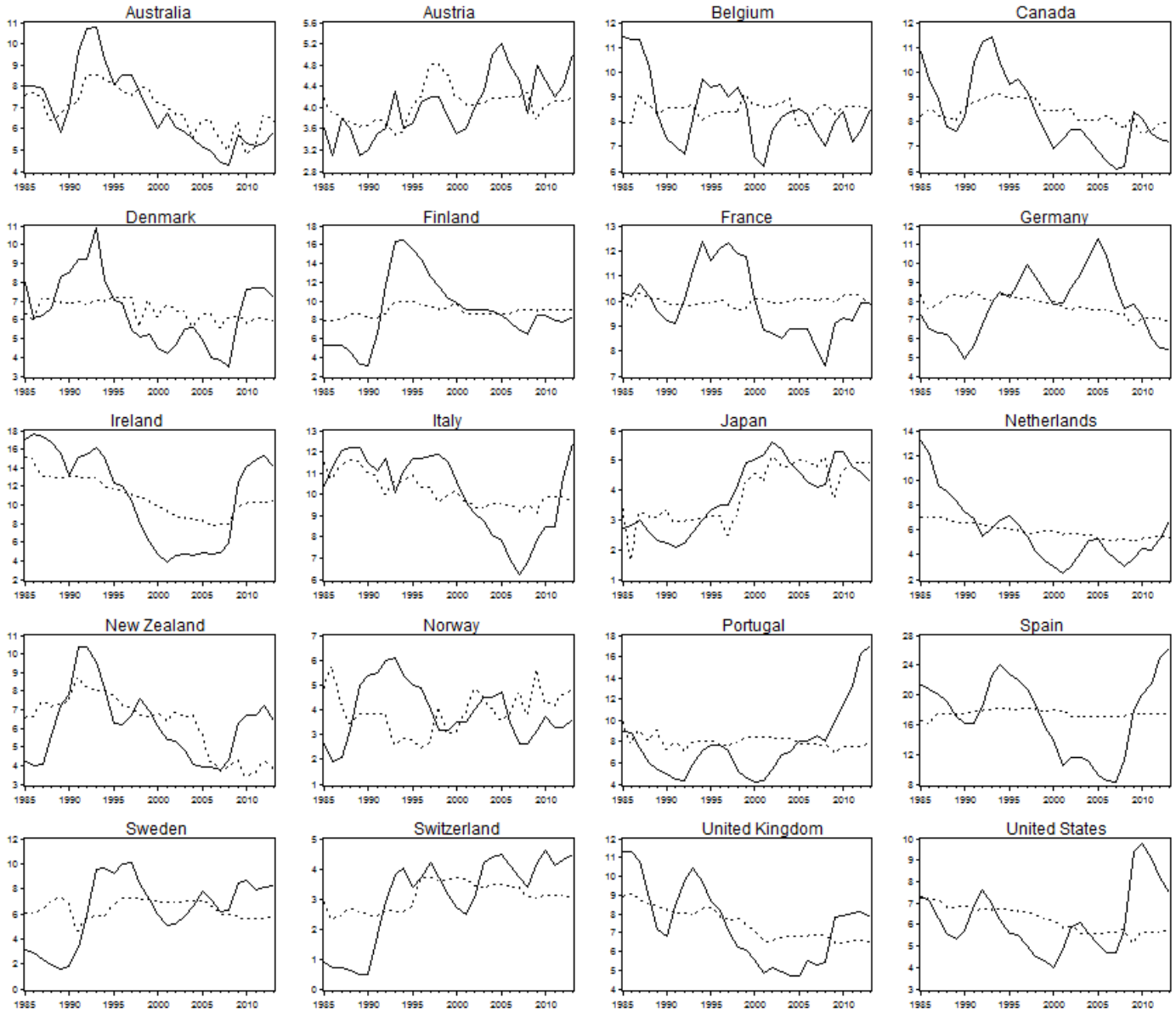
a. Union Coverage (left) and Union Density (right)



b. Wage Coordination (left) and Gross Replacement Rate (right)

c. Tax wedge (left) and Share of Temporary Workers (right)

Figure 4: Actual Unemployment Rates and Equilibrium Unemployment Rates; 1985-2013



Note: The solid lines are the actual unemployment rates and the dashed lines are the equilibrium unemployment rates computed using the estimates in Table 3.

Figure 5: Unemployment rates and shares of temporary workers by age and gender – averaged over 20 countries; 1985-2013

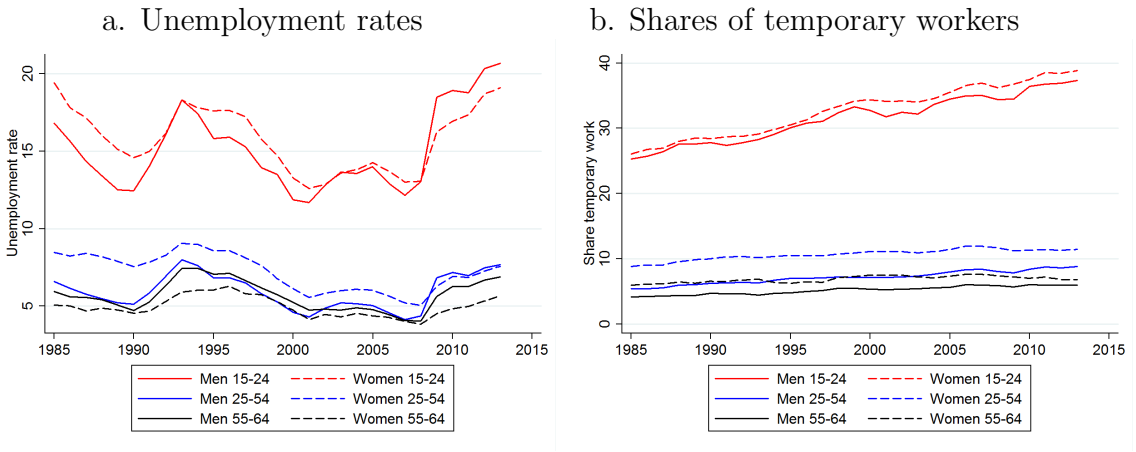


Figure 6: Equilibrium unemployment males by country and age and by gender; 1985-2013