Does Employment Protection Legislation Induce Structural Unemployment? Evidence from 15 OECD Countries

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Abstract

This paper estimates the Non-Accelerating Inflation Rate of Unemployment (NAIRU) for 15 OECD economies from 1990 to 2012 using an iterative Phillips curve process and tests the relationship between strictness of employment protection and the NAIRU. Using Prais-winsten estimation correcting for panel-level heteroscedasticity and panel-specific first-order autoregressive process, results indicate that there is no relationship between strictness of protection for individual and collective dismissals for regular contracts and the NAIRU. The effect of strictness of employment protection for regular contracts is sensitive to model specification; the coefficient loses its significance when full controls are used in estimation. An implication is that deregulation is not a necessary policy tool in addressing the problem of structural unemployment.

Keywords: NAIRU, natural rate, structural unemployment, employment protection legislation

JEL Classification: E24, J48, K31

I. Introduction

According to Cahuc and Zylberberg (2004), "measures to protect employment comprise a set of instruments such as severance payments, administrative firing taxes, advance notice of dismissal, administrative authorization, and prior negotiation with trade unions." The Organization for Economic Co-operation and Development (OECD) has quantified employment protection with summary measures – regulations concerning regular contracts, collective dismissals, fixed-term contracts and temporary contracts. Venn (2009) defines three summary measures. Regulations concerning regular contracts outline the number, nature and complexity of procedures for dismissals, the length of time employers are required to provide employees with notices of dismissals, severance payments and conditions under which dismissals are permitted. The measure for collective dismissals quantifies the additional procedures and costs involved when dismissing a large number of people. For temporary contracts, the measure quantifies rules on duration of contracts and types of work for which employers can draw temporary contracts. In addition, it covers wages and fringe benefits for temporary employees relative to those with regular contracts. OECD (2013) defines the fourth component which measures strictness of employment protection for fixed-term contracts.

Without employment protection, there is the potential for a higher level of dismissals and unfair employment practices that lead to unemployment which is costly. There are individual and social costs associated with unemployment (Pîrvu and Totîlca, 2011). Individuals lose their income and fringe benefits. If unemployment duration is lengthy, human capital depreciates. Governments increase expenditure on unemployment compensation and other programs designed for the unemployed, using tax revenues. Also, lack of advance notice may result in longer unemployment duration. Individuals who are separated from their jobs start the search process only when they have information about their separation. Advance notice encourages job search prior to separation. By the time of separation, some workers would have found employment if job search intensity is high enough and workers have the characteristics that potential employers desire.

Dismissals are a negative externality that results from strategic decision-making by firms. Reductions in labor demand occur due to depressed demand in the goods market, declining costs of substitutable inputs, increases in the wage rate and decreased labor productivity among other factors. In some cases, dismissals may occur due to discrimination based on characteristics such as race, age, gender, citizenship, marital status, nationality and sexual orientation. Regardless of the factors that lead to changes in demand for labor, the result is unemployment. However, unemployment associated with business cycle fluctuations is expected. As such, this paper focuses on non-cyclical unemployment or that caused by structural and frictional factors including employment protection - the Non-Accelerating Inflation Rate of Unemployment (NAIRU).

The NAIRU has been widely discussed by academic researchers and policymakers, highlighting its importance. According to Stiglitz (1997), the utility of the NAIRU depends on whether it explains the variation in the rate of inflation, whether we are able to explain changes in the NAIRU, and how relevant it is regarding policy. This paper attempts to explain changes in the NAIRU using employment protection and additional structural and frictional variables. Identifying the relevant structural and frictional factors will help in narrowing possible policy options; identifying a target or a set of targets streamlines the direction of policy.

The NAIRU is estimated using Ball's (2009) iterative Phillips curve process for 15 OECD economies from 1990 to 2012. Results indicate that strictness of employment protection for individual and collective dismissals for regular contracts has no effect on the NAIRU. The effect of strictness of employment protection for temporary contracts is sensitive to model specification. Tax wedge has no impact on the NAIRU. The degree of union density positively affects the NAIRU in the current period with a negative coefficient on the first-order lag. Results support the hysteresis argument with a weaker effect over time. Growth in productivity does not affect the NAIRU. An increase in the proportion of females in the labor force does not increase frictional unemployment. A higher proportion of young people in the labor force leads to increased structural unemployment. An implication of the results is that deregulation is not a necessary policy option to reduce structural unemployment in OECD economies.

The next section reviews literature on estimation and determination of the NAIRU. Section III presents the expectations-augmented Phillips curve and NAIRU estimates. Results of estimation are presented in Section IV. Section V concludes the paper.

II. Review of Literature

The NAIRU – Definition and Measurement

The NAIRU has been well defined in previous literature. Changes in aggregate demand and monetary policy create a short-run negative relationship between unemployment and wage inflation - the Phillips curve – established using data on the United Kingdom by Phillips (1958). Subsequently, a negative relationship between unemployment and price inflation was established theoretically and empirically by researchers (Romer, 2006). According to Ball and Mankiw (2002), if there is such a negative relationship between unemployment and price inflation, then, there is a long-run level of unemployment that exists when the actual level of inflation does not deviate from its expected level; this is the NAIRU. Abel and Bernanke (2005) refer to an expectation-augmented Phillips curve which posits a negative relationship between unanticipated inflation and cyclical unemployment based on the works of Friedman (1968) and Phelps (1970). Lucas' (1976) critique supports the expectations-augmented Phillips curve hypothesis in that policies tend to be ineffective if they are incorporated into expectations. The continued use of inflation as a policy measure to reduce unemployment will alter the statistical relationship between the two as expectations change over time to take into account previous policies. (Cahuc and Zylberberg, 2004).

Estimation of the NAIRU is outlined in Ball and Mankiw (2002), Ball (2009) and Einarsson and Sigurdsson (2013). The measure of NAIRU generated is dependent on the method used in estimation. Ball and Mankiw (2002) estimate the relationship between inflation changes and unemployment rate, and utilize the estimated parameters in calculating a variable which comprises the time-varying NAIRU and a cyclical component. The authors use the Hodrick-Prescott (HP) filter to decompose the sum. Ball (2009) enhances Ball and Mankiw's (2002) method through the use of an iterative process. In the initial estimation of the Phillips curve, the NAIRU is unknown. After the NAIRU is extracted using the HP filter, Ball (2009) re-estimates the expectations-augmented Phillips curve equation using the estimates from the first step, and calculates the new sum of the NAIRU and the cyclical component. This process is repeated until convergence is achieved for the NAIRU and its coefficient. Einarsson and Sigurdsson (2013) follow the iterative process but decompose the calculated sum with the Kalman filter.

Previous literature suggests that the NAIRU is determined by a myriad of variables including but not limited to employment protection, union density, tax wedge, productivity growth, the unemployment rate and demography of the labor force.

Employment Protection and the NAIRU

Labor market rigidities such as employment protection affect the level of the NAIRU by increasing the cost of firing employees. The costs imposed through administrative processes and severance payments to employees force firms to keep workers they may not subsequently need. Firms may not hire additional workers to satisfy temporarily higher production requirements to avoid the possible prohibitive cost of firing them in the future (Bertola, 2006; Lindbeck 1999). In previous literature, some authors estimate a positive effect of stricter employment protection on the unemployment rate, others estimate no significant effects, and in some cases, estimates that are inconsistent in significance and sensitive to sample selection and method of estimation.

Positive effects of more stringent employment protection measures on unemployment are estimated by Lazear (1990), Scarpetta (1996) and DiTella and McCulloch (2005). Lazear (1990) analyzes the impact of severance payments on unemployment in 22 European countries from 1956 to 1984, and estimates a positive relationship. Scarpetta (1996), using data for 19 OECD countries from 1983 to 1995 finds that stricter employment protection increases structural unemployment - Non-Accelerating Wage Rate of Inflation (NAWRU). The employment protection measure used is the average of protection for regular and fixed-term contracts. DiTella and McCulloch (2005) examine the effect of labor market flexibility on employment rate and labor force participation rate by gender, weekly hours worked, unemployment rate, and long-term unemployment rate for 21 OECD countries from 1984 to 1990. The measure of flexibility is created by the World Competitiveness Report using opinions of top and middle managers. Restricting discussion of results to the variable of interest, the authors find that increasing the level of flexibility reduces the unemployment rate.

In previous empirical work, stricter employment protection does not impact unemployment according to Addison, Teixeira and Grosso (2000), Bassanini and Duval (2006) and Cahuc and Zylberberg (2004). Addison, Teixeira and Grosso (2000) report a statistically insignificant coefficient on severance pay using the dataset from Lazear's (1990) analysis and using several estimation methods including feasible generalized least squares to correct for interclass heteroscedasticity between countries and serial correlation. Bassanini and Duval (2006) fail to establish a relationship between employment protection and aggregate unemployment using the OECD summary indicator. According to Cahuc and Zylberberg (2004), Bertola (1990) and Garibaldi et al (1997) are unable to establish a significant relationship between employment protection and the unemployment rate using the OECD summary measure.

In some cases, the effect of employment protection depends on the time period used in estimation, model specification, method of estimation and groups of countries in the sample among others. Elmeskov, Scarpetta and Martin (1998) extend the work of Scarpetta (1996) by adding two more OECD economies, adding more recent data on employment protection and exploring interaction effects. The authors find that strict firing regulations positively impact structural unemployment. Employment protection does not affect structural unemployment for highly centralized or decentralized economies; the effect is dependent on particular characteristics of countries in the sample. Freeman (2001), using data for 22 countries from 1970 to 1999 finds that with the addition of country dummies, economic freedom does not significantly impact outcome measures including the unemployment rate. The inclusion of the square to economic freedom to test the U-shaped hypothesis renders the coefficient on the economic freedom index positive and significant; the coefficient is sensitive to model specification. The index used, the Fraser Index of Economic freedom measures "military conscription, top marginal tax rates, transfers and subsidies" and "the size of government expenditure." For 18 OECD economies from 1960 to 1996, Belot and van Ours (2001) find that the significance of the coefficient on employment protection in determination of unemployment rate depends on model specification.

This paper uses the NAIRU to measure the sum of structural and cyclical unemployment. Measures of employment protection used are strictness of employment protection for individual and collective dismissals for regular contracts and strictness of employment protection for temporary contracts.

Other Determinants of the NAIRU

Flows in and out of employment, unemployment and the labor force generate frictional unemployment. The actual level of frictional unemployment may be higher than the efficient level due to non-competitive wage setting behavior in the labor market between firms and those employed. The natural rate of unemployment, then, includes a structural component. Blanchard and Katz (1997) define three wage setting approaches that result in higher than optimal levels of frictional unemployment. First, in a matching approach, firms and workers have bargaining power. Firms cannot replace employees without incurring monetary and time costs in recruitment and training, and employees cannot find alternative jobs instantly and incur search costs. Under good economic conditions, employees are easily able to find other opportunities and bargain for wages that are significantly higher than their reservation wages. The higher wage level that results under good economic conditions leads to a higher level of unemployment. When economic conditions are bad, there are relatively fewer job opportunities and firms are able to pay wages that are close to reservation wages. Second, the efficiency wage approach suggests that firms pay workers higher than their reservation wages to attract and keep the best workers, and prevent shirking, resulting in a higher rate of unemployment (Lindbeck, 1999). Finally, the competitive approach suggests that some workers are easily replaceable either because their functions are routine or that a low level of skill does not matter. Here, wages may be competitive because the workers have limited bargaining power. Individuals in this group will work only if the wages offered are higher than their reservation wages; if not, they prefer not to work and may consider themselves either out of the labor force or unemployed. All three approaches summarized indicate that higher than optimal levels of equilibrium wage lead to higher levels of unemployment (King and Morley, 2007) or create structural unemployment. Regardless of the business cycle or the nature of jobs, bargaining power can be created and maintained through labor unionization. Unions have the ability to bargain for higher wages which reduces the ability of firms to hire additional employees due to increased labor costs. As such, unionization stimulates unemployment (Elmeskov, Scarpetta and Martin, 1998; Afdagic, 2013).

The tax wedge, defined as the difference between unit labor costs and wages paid less direct and indirect taxes increases unemployment (Gianella et al, 2008; Bassanini and Duval, 2006). The tax wedge is affected by changes in social security contributions, direct and indirect taxes (Scarpetta, 1996).

Stiglitz (1997) explains how the “wage aspiration effect” alters the level of the NAIRU. Changes in the growth rate of productivity *temporarily* affect the NAIRU. When the growth rate of productivity changes, expectations of growth in real wage remain unchanged and are based on previous real wage growth rates. For instance, at lower levels of productivity, workers may not alter their expectations of changes in real wages. Workers still expect growth in wages similar to the growth rate that existed before the decline in growth rate of productivity. However, higher real wages, with lower growth rate of productivity, is achieved at a higher level of unemployment. Over time, workers adjust their expectations to match the new sustained growth rate in productivity (Bertola, 2006); as such, the disparity between the growth rate of productivity and wages expectations may be temporary and return to its previous level with no effect on the NAIRU (Murphy, 1998). Slacalek (2005) mentions that many authors, including, Ball and Moffit (2001) and Manikiw and Reis (2003), usually estimate the relationship between the natural rate of unemployment and the *growth rate* of productivity; however, the author estimates a negative correlation between the NAIRU and the *level* of productivity for the U.S. and other countries.

The demographic composition of the labor force determines the level of frictional unemployment. There are certain groups of people who typically have higher levels of unemployment. According to Stiglitz (1997), the rate of unemployment is usually higher for young individuals and women than other groups in the labor force. Young individuals have lower levels of education and experience (Murphy, 1998), important attributes in job matching. For the purpose of profit maximization, firms give preference to those who possess higher levels of education and experience since these positively affect productivity and output. Young individuals switch jobs more frequently than older workers (Brauer, 2007). Females and young people often have a higher level of non-cyclical unemployment than the rest of the labor force. Females may leave the labor force to care for infants and return to the labor force in search of jobs. The rate at which females enter into a state of unemployment while moving in and out of the labor force may be higher than that for males.

Einarsson and Sigurdsson (2013) posit that hysteresis has a stronger impact on the NAIRU than do structural factors, citing Blanchard and Summers (1986). NAIRU is characterized by countercyclicality and is affected by previous rates of unemployment which result high levels of long-term unemployment in downturns. According to Ball (2009), hysteresis contributes significantly to the variation in long-run unemployment. Under classical theory, variation in the natural rate of unemployment is determined by supply factors and not demand factors. As such, demand factors, including monetary policy, affect the unemployment rate in the short-run. Ball (2009) acknowledges the role of supply side factors in changing the natural rate of unemployment; however, he believes that the actual rate of unemployment affects the natural rate of unemployment. Therefore, demand factors affect variation in the natural rate of unemployment – hysteresis. Ball (2009) suggests that the lack of appeal of the long-term unemployed to employers and/or reduced efforts at finding jobs better explains hysteresis in economies with unemployment benefits granted over long periods of time. Cahuc and Zylberberg (2004) suggest that duration of unemployment is a signal of quality to employers. With higher levels of unemployment and increasing unemployment duration, outsiders may experience heightened depreciation of human capital and reduced employment probability

(Stiglitz, 1997; Blanchard and Summers, 1986, Cahuc and Zylberberg, 2004). Thus, what might begin as demand deficient unemployment may transform into structural unemployment.

III. Expectations-Augmented Phillips Curve and NAIRU Estimation

Following Ball and Mankiw (2002), the current level of inflation, π_t, depends on expected inflation, π_t^e, and how much the unemployment rate, μ_t, differs from the natural rate of unemployment, $\breve{\mu}_t$, or cyclical unemployment. The inverse relationship between inflation and unemployment in the short-run is

$$\pi_t = \pi_t^e - \alpha(\mu_t - \breve{\mu}_t) + \varepsilon_t \tag{1}$$

The last term in equation (1) represents supply shocks and α is a slope parameter. The process by which expectations are formed is central to the effectiveness of stabilization policies in altering the level of output. If we assume rational expectations, then, individuals anticipate inflation correctly such that any deviation from actual inflation is random (Branson, 1989). Stabilization policies are effective once, and repeated use of policies does not impact aggregate output subsequently. Assuming adaptive expectations, expected inflation consists of the actual level of inflation at the time when expectations are formed and an error term weighted by an adjustment factor. We simply assume,

$$\pi_t^e = \pi_{t-1} \tag{2}$$

Substitute the definition of expected inflation following the assumption of adaptive expectations in equation (2) into the expectations-augmented Phillips curve formulated in equation (1) with the result,

$$\pi_t = \pi_{t-1} - \alpha(\mu_t - \breve{\mu}_t) + \varepsilon_t \tag{3}$$

The first-order lag of inflation, π_{t-1}, can be moved to the left-hand side of equation (3),

$$\Delta\pi_t = -\alpha(\mu_t - \breve{\mu}_t) + \varepsilon_t \tag{4}$$

where $\Delta\pi_t = \pi_t - \pi_{t-1}$ or the change in the rate of inflation. For an economy operating at the natural rate of unemployment ($\mu_t = \breve{\mu}_t$), if aggregate demand increases unexpectedly, cyclical unemployment decreases ($\mu_t - \breve{\mu}_t < 0$) and the actual rate of inflation exceeds expected inflation ($\Delta\pi_t > 0$). Conversely, an unexpected decrease in aggregate demand increases cyclical unemployment ($\mu_t - \breve{\mu}_t > 0$) and decreases inflation ($\Delta\pi_t < 0$); therefore, $\frac{d\Delta\pi_t}{d(\mu_t - \breve{\mu}_t)} < 0$. I estimate the relationship between unanticipated inflation and the rate of unemployment for each country using the following econometric specification,

$$\Delta\pi_t = \gamma - \alpha\mu_t + \varepsilon_t \qquad (5)$$

The first term on the right-hand side of equation (5) is an intercept parameter. Expand equation (4),

$$\Delta\pi_t = \alpha\breve{\mu}_t - \alpha\mu_t + \varepsilon_t \qquad (6)$$

Comparison of equations (5) and (6) shows that the intercept, γ, is the interaction, $\alpha\breve{\mu}_t$. The NAIRU estimated in equation (5) is constant. To estimated a time-varying NAIRU, after estimating equation (5), extract $\breve{\mu}_t$ using available data and estimated parameters in the form,

$$\breve{\mu}_t + \frac{\varepsilon_t}{\alpha} = \mu_t + \frac{\Delta\pi_t}{\alpha} = \varphi_t \qquad (7)$$

In equation (7), ε_t represents supply shocks which are cyclical in nature. The series, φ_t, comprises a cyclical component, $\frac{\varepsilon_t}{\alpha}$, and a trend component, $\breve{\mu}_t$. Using the Hodrick-Prescott (HP) filter, I estimate the trend component by optimizing

$$\min_{[\breve{\mu}_t]_{t=1}^{T}} \left[\sum_{t=1}^{T}(\varphi_t - \breve{\mu}_t)^2 + \lambda\sum_{t=2}^{T}(\nabla^2\breve{\mu}_{t+1})^2\right];\ \lambda > 0 \qquad (8)$$

where λ is a smoothing parameter which penalizes the variability in $\breve{\mu}_t$. As λ approaches infinity, $\breve{\mu}_t$ becomes linear, and as λ approaches 0, $\breve{\mu}_t$ becomes the series, φ_t. For annual data, it is suggested that $\lambda = 100$. Differentiate equation (8) with respect to $\breve{\mu}_t$, and obtain the solution,

$$\breve{\mu}_t = (\boldsymbol{I}_T + \lambda\boldsymbol{F})^{-1}\varphi_t$$

$$\left(\frac{\varepsilon_t}{\alpha}\right)_T = \varphi_t - \breve{\mu}_t \qquad (9)$$

In equation (9), $\boldsymbol{F}$ is the matrix,

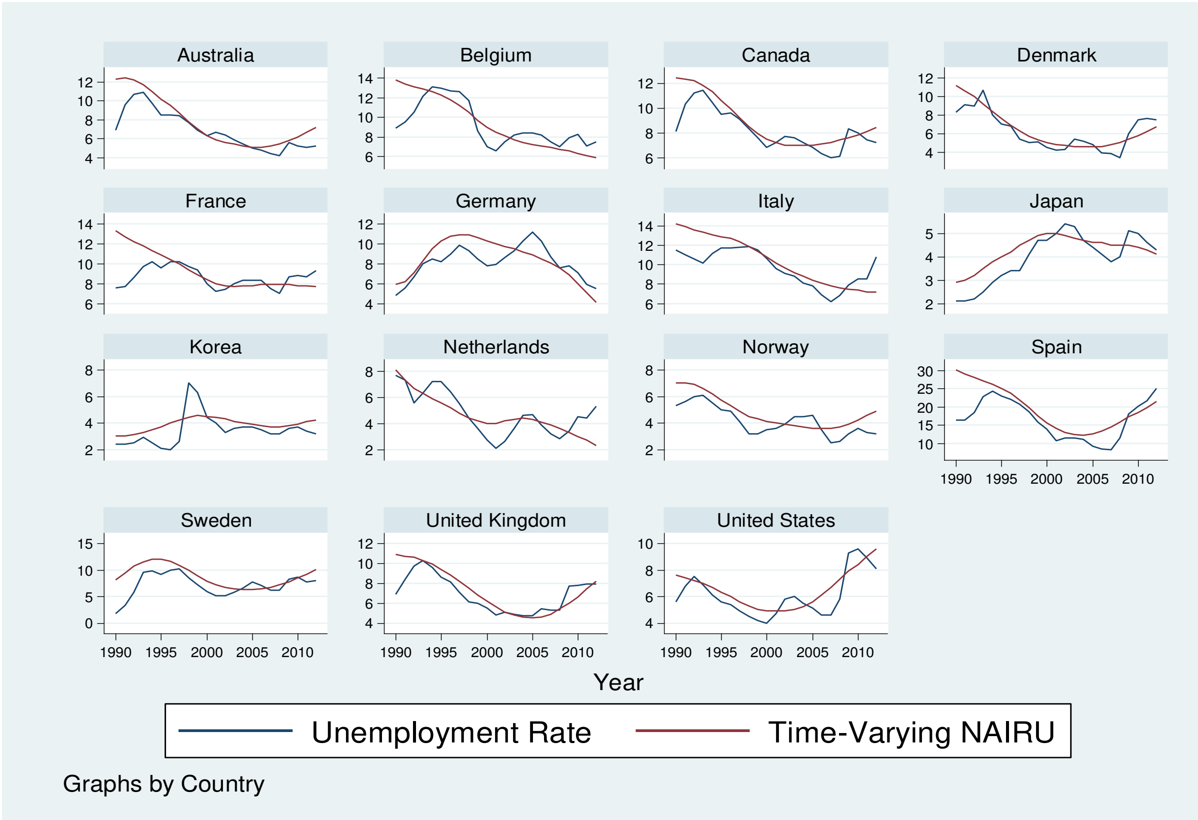
$$\boldsymbol{F} = \begin{pmatrix} 1 & -2 & 1 & & & & \\ -2 & 5 & -4 & \ddots & & & \\ 1 & -4 & 6 & \ddots & \ddots & & \\ & \ddots & \ddots & \ddots & \ddots & \ddots & \\ & & \ddots & \ddots & 6 & -4 & 1 \\ & & & \ddots & -4 & 5 & -2 \\ & & & & 1 & -2 & 1 \end{pmatrix}$$

The Phillips curve is re-estimated and the resulting trend-cycle component is decomposed until convergence is achieved for α and the NAIRU using unemployment and inflation figures for 15 OECD countries.

The variables used in estimating the NAIRU are change in inflation and unemployment rate, sourced from OECDstat. Inflation is measured as growth in the Consumer Price Index (CPI). The CPI represents average changes in a basket of goods and services purchased by households over a period of time. The OECD states that comparability across countries may be affected by different weights used in estimating the CPI, frequency with which the weights are revised, how changes in quality are addressed, replacement and addition of items in the basket, and price distortions. The base period for the CPI is 2005. Unemployment rate is measured as the proportion of the number of unemployed individuals to the total number of individuals in the labor force. The labor force comprises those *15* years and over who are classified as employed or unemployed.

The initial year for estimation of NAIRU varies by country depending on the earliest available data for unemployment rate and inflation series. Figure 1 plots the estimated NAIRU and unemployment rate for each country in the sample. For about half of the countries in the sample, including Australia, Belgium, Canada, Denmark, France, Italy, Netherlands and Norway, the NAIRU and unemployment rate have decreased considerably since the 1990s. Germany's rates in 2012 were similar to the rates at the beginning of the 1990s. Japan's rates have followed increasing trends. The most recent recession caused the unemployment rate to increase but has since decreased close to its pre-recession level. The NAIRU continued on a consistently decreasing trend throughout the recession. Korea's NAIRU has been stable throughout the period shown in the graph. Spain has experienced steep increases in its unemployment rate and NAIRU since 2007 and 2004, respectively. The United Kingdom and United States experienced increases in the unemployment rate and NAIRU during the recession. For the United Sates, unemployment rate has started to decrease while that for the United Kingdom has remained constant in 2011 and 2012.

Figure 1: Unemployment Rate and NAIRU from 1990 to 2012



IV. Determinants of the NAIRU

For 15 countries, I regress the estimated NAIRU on structural and frictional factors in

$$\breve{\mu}_{it} = \boldsymbol{x}_{it}'\boldsymbol{\beta} + \boldsymbol{g}_i'\boldsymbol{\theta} + \varepsilon_{it} \qquad (10)$$

where $\boldsymbol{x}_{it}$ is a matrix of structural and frictional regressors, $\boldsymbol{\beta}$ is a vector of coefficients, $\boldsymbol{g}_i$ comprises a constant term and country-specific fixed effects, $\boldsymbol{\theta}$ is a vector of coefficients on the country-specific regressors which do not vary with time, and ε_{it} is a stochastic white noise error term.

The matrix, $\boldsymbol{x}_{it}$, comprises strictness of employment protection for individual and collective dismissals for regular contracts, strictness of employment protection for temporary contracts, union density, tax wedge, lags of unemployment rate, growth in productivity, percent of females in the labor force, percent of labor force made up of individuals between the ages of 16 and 29, summarized in Table 1. Employment protection indices range between 0 and 6 with higher values indicating higher levels of protection. The average levels for regular and temporary contracts are 2.01 and 1.88, respectively. Union density is defined as the proportion of workers who are part of labor unions. Approximately 33.11% of workers are part of unions. Average tax wedge is available in OECDstat from 2000, limiting the number of observations when the variable is included. The average tax wedge is 37.84%. Productivity is measured as Gross Domestic Product (GDP) per hour worked in 2005 U.S. dollars. Change in productivity is the current level of productivity minus the level of productivity in the previous year. All variables are sourced from OECDstat and are summarized in Table 1. Data cover 15 countries from 1990 to 2012 (except tax wedge) totaling 345 observations.

Table 1: Summary Statistics from Determination of NAIRU

Variable	Mean	Std. Dev.	Min.	Max.
NAIRU (%)	8.0	4.4	2.3	30.1
Employment Protection for Regular and Collective Dismissals (Regular)	2.01	0.79	0.26	3.55
Employment Protection for Temporary Contracts	1.88	1.30	0.25	4.88
Union Density	33.11	21.24	7.54	83.86
Tax Wedge	37.84	10.23	16.11	57.1
Productivity Growth	1.71	1.79	-3.36	8.52
Unemployment Rate (%)	7.3	3.7	1.8	25.1
Labor Force Percent Female	44.17	2.92	34.97	48.37
Labor Force Percent 15-19 years	4.25	2.24	0.83	9.94
Labor Force Percent 20-24 years	9.49	1.72	5.10	14.32
Labor Force Percent 25-59 years	12.11	1.89	8.75	17.23

The variables discussed are used in estimation of equation (10). Since $\boldsymbol{g_i}$ is unobserved, ordinary least squares method of estimation of the pooled sample is not appropriate. If $\boldsymbol{g_i}$ and ε_{it} are correlated, ordinary least squares estimates will be biased and inconsistent. If $\boldsymbol{g_i}$ and ε_{it} are uncorrelated, ordinary least squares estimates will be inefficient. We need to determine the relationship between $\boldsymbol{g_i}$ and ε_{it} in order to employ an appropriate model that will produce unbiased, consistent and efficient estimates. Greene (2003) clearly outlines methods of estimation based on the relationship between $\boldsymbol{g_i}$ and ε_{it} and provides a test that determines the better method.

If $\boldsymbol{g_i}$ and ε_{it} are correlated, use

$$\breve{\boldsymbol{\mu}}_{\boldsymbol{i}} = \boldsymbol{X_i \beta} + \mathbf{i}\boldsymbol{\theta_i} + \boldsymbol{\varepsilon_i} \qquad (11a)$$

Where $\boldsymbol{X_i}$ is a matrix of regressors totaling T observations for the ith country**,** $\mathbf{i}$ is an identity matrix comprising ones, and $\boldsymbol{\theta_i}$ is a vector of coefficients. Greene (2003) explains that the differences in the constant term represent the differences across groups, in this case, countries, such that equation (11a) can be written as

$$\begin{bmatrix} \breve{\boldsymbol{\mu}}_1 \\ \breve{\boldsymbol{\mu}}_2 \\ \vdots \\ \breve{\boldsymbol{\mu}}_m \end{bmatrix} = \begin{bmatrix} \boldsymbol{X}_1 \\ \boldsymbol{X}_2 \\ \vdots \\ \boldsymbol{X}_m \end{bmatrix} \boldsymbol{\beta} + \begin{bmatrix} \mathbf{i} & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \mathbf{i} & \cdots & \mathbf{0} \\ & & \vdots & \\ \mathbf{0} & \mathbf{0} & \cdots & \mathbf{i} \end{bmatrix} \begin{bmatrix} \theta_1 \\ \theta_2 \\ \vdots \\ \theta_m \end{bmatrix} + \begin{bmatrix} \boldsymbol{\varepsilon_1} \\ \boldsymbol{\varepsilon_2} \\ \vdots \\ \boldsymbol{\varepsilon_m} \end{bmatrix} \tag{11b}$$

The matrix representation provides a clear picture of the least squares dummy variable (LSDV or fixed effects) method of estimation where the vector containing the dependent variable, NAIRU, is regressed on the matrix of structural and frictional variables and columns of ones, each representing a country, and a constant term. Equation (11b) can be compactly written as

$$\boldsymbol{\mu} = \boldsymbol{X\beta} + \boldsymbol{K\theta} + \boldsymbol{\varepsilon} \tag{12}$$

If $\boldsymbol{g_i}$ and ε_{it} are uncorrelated, use an error components model (ECM or random effects) in the following,

$$\breve{\mu}_{it} = \boldsymbol{x}_{\boldsymbol{it}}^{'}\boldsymbol{\beta} + (\theta + \omega_i) + \varepsilon_{it} \tag{13}$$

where ω_i is a country-specific effect and time-invariant. Assuming that $\varpi_{it} = \omega_i + \varepsilon_{it}$, based on Greene's (2003) specification, assume

$$\begin{aligned} &E[\varpi_{it}^2|X] = \sigma_\varepsilon^2 + \sigma_\omega^2, \\ &E[\varpi_{it}\varpi_{is}|X] = \sigma_\omega^2\,, \quad t \neq s \\ &E\left[\varpi_{it}\varpi_{js}|X\right] = 0 \text{ for all } t \text{ and } s \text{ if } i \neq j \end{aligned} \tag{14}$$

The least squares dummy variable method is assumed to be efficient but results in loss of degrees of freedom with each additional regressor. On the other hand, the ECM may generate inefficient parameters if assumptions about stochastic error terms are not met but saves degrees of freedom. To determine the method that is more appropriate for the data, the Hausman specification test performs an evaluation based on the Wald statistic which is χ^2 distributed with k-1 degrees of freedom, where k = number of parameters estimated. The null hypothesis is that the difference between the coefficient estimates of the LSDV model and ECM are the same. The alternative specifies that the LSDV estimates are consistent while the ECM estimates are inconsistent.

$$\begin{aligned} &H_0: b - \hat{r} = 0 \\ &H_1: b - \hat{r} \neq 0 \end{aligned} \tag{15}$$

where b = matrix of fixed effects parameters

$\hat{r}$ = matrix of random effects parameters

The Wald statistic is represented by

$$W = \chi^2[k-1] = [b-\hat{r}]'\hat{\zeta}^{-1}[b-\hat{r}] \quad (16)$$

In equation (16), $\hat{\zeta}^{-1}$ excludes the constant terms in estimating the LSDV model and ECM. Table 2 presents the results of Hausman's specification test.

Table 2: Results of Hausman's Specification Test

	Coefficients			
	$[b]$ LSDV Model	$[\hat{r}]$ ECM	$[b-\hat{r}]$ Difference	Sqrt(diag $[V\_b - V\_\hat{r}]$) S.E.
Employment Protection for Regular and Collective Dismissals (Regular)	2.4068	0.1394	2.2673	0.5297
Employment Protection (Temporary Contracts)	0.8260	0.5654	0.2606	0.1374
Union Density	0.0823	0.0065	0.0758	0.0307
Unemployment Rate (-1)	0.6282	0.7800	-0.1518	0.0255
Productivity growth (%)	-0.0375	-0.0331	-0.0044	0.0230
Female Percent of Labor Force	-0.4841	-0.1615	-0.3227	0.1098
Labor Force Percent 15 to 19 years	0.0877	0.1513	-0.0636	0.1452
Labor Force Percent 20 to 24 years	-0.1296	0.2220	-0.3515	0.0735
Labor Force Percent 25 to 29 years	-0.0679	0.0439	-0.1118	0.0733

b = consistent under Ho and Ha; obtained from xtreg

$\hat{r}$ = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(9) = $(b-\hat{r})'(V\_b - V\_\hat{r})^{-1}(b-\hat{r})$

= 89.03 ; Prob>chi2 = 0.0000

The models estimate a positive relationship between both measures of employment protection and the NAIRU. The LSDV model estimates larger effects for both measures. Union density has a positive coefficient with a stronger effect in the LSDV model. The results support the hysteresis argument; coefficients on the first order lag of unemployment rate are positive. An increase in productivity growth decreases the NAIRU. A higher proportion of females in the labor force decreases the NAIRU contrary to expected results. While an increase in the proportion of the labor force aged 16 to 19 increases the NAIRU, the age groups 20 to 24 and 25 to 29 have negative coefficients. The Hausman statistic is large with a low p-value. I reject the null hypothesis in favor of the alternative that LSDV estimates are consistent while ECM estimates are not. A modified Wald test shows evidence of groupwise heteroscedasticity in the LSDV model under the hypothesis that the model is homosedastic.

Modified Wald test for groupwise heteroscedasticity in fixed effect regression model

H_0: sigma(i)^2 = sigma^2 for all *i*

chi2 (15) = 212.84

Prob>chi2 = 0.0000

Under a null hypothesis of no autocorrelation, Wooldridge's test for autocorrelation indicates the presence of autocorrelation in the model.

Wooldridge test for autocorrelation in panel data

H_0: no first-order autocorrelation

F(1, 14) = 737.618

Prob > F = 0.0000

I use Prais-Winsten regression with heteroscedastic panels corrected standard errors assuming a panel-specific autocorrelation structure with results from six models presented in Table 3.

Employment Protection

An increase in the level of employment protection for individual and collective dismissals for regular contracts has no impact on the NAIRU in all six models. The sign on the variable is also inconsistent. In the first three models, an increase in employment protection for temporary contracts is associated with an increase in the NAIRU between 0.53 and 0.75 percentage points. In model (2), the coefficient on the first-order lag is positive and significant with an effect of 0.66 percentage points. The coefficients lose their significance when additional controls are introduced in models (4), (5) and (6). Model (4) includes lags of the unemployment rate and demographic composition of the labor force. In model (5), the tax wedge is added but reduces the sample size from 315 to 168 (data are from 2000 to 2012). The tax wedge is removed from model (6) and the percentage of the labor force aged 16 to 19 and 20 to 24 are combined. The impact of employment protection for temporary contracts is sensitive to model specification. There is no clear evidence that employment protection affects the NAIRU.

Table 3: Regression Results

Dependent Variable: NAIRU						
Prais-Winsten regression, heteroscedastic panels corrected standard errors, panel-specific AR(1)						
Explanatory Variable	(1)	(2)	(3)	(4)	(5)	(6)
Employment Protection (Regular)$_t$	0.4153 (0.4418)	0.0813 (0.8639)	-0.1348 (0.2321)	0.1820 (0.8313)	-0.0313 (0.7191)	0.1568 (0.8280)
Employment Protection (Regular)$_{t-1}$		0.0893 (0.8740)		-0.0339 (0.8401)	-0.6159 (0.7129)	-0.0483 (0.8368)
Employment Protection (Temporary)$_t$	0.7458*** (0.1423)	0.5804*** (0.1750)	0.5330*** (0.1354)	0.1729 (0.1838)	0.0659 (0.6465)	0.2107 (0.1849)
Employment Protection (Temporary)$_{t-1}$		0.6557*** (0.1678)		0.0739 (0.1811)	0.3822 (0.6464_	0.1149 (0.1821)
Union Density$_t$	-0.0158 (0.0152)	0.0213 (0.0574)	0.0014 (0.0059)	0.3510*** (0.0723)	0.2581*** (0.0891)	0.3531*** (0.0733)
Union Density$_{t-1}$		-0.0486 (0.0581)		-0.3423*** (0.0728)	-0.2706*** (0.0894)	-0.3478*** (0.0738)
Tax Wedge$_t$					-0.0401 (0.0468)	
Tax Wedge$_{t-1}$					0.0557 (0.0465)	
Unemployment Rate$_{t-1}$			0.6542*** (0.0975)	0.5853*** (0.0846)	0.5148*** (0.1043)	0.6033*** (0.0836)
Unemployment Rate$_{t-2}$			0.2211** (0.0967)	0.2147** (0.0841)	0.2188** (0.1038)	0.2044** (0.0824)
Productivity Growth$_t$			-0.0205 (0.0315)	-0.0292 (0.0296)	-0.0429 (0.0264)	-0.0338 (0.0293)
Female Percent of Labor Force$_t$				-0.0407 (0.0508)	-0.0810 (0.0762)	-0.0840* (0.0502)
Labor Force Percent 15 to 19$_t$				0.0202 (0.0786)	0.1970* (0.0997)	
Labor Force Percent 20 to 24$_t$				0.3608*** (0.1042)	-0.1302 (0.1396)	
Labor Force Percent 15 to 24$_t$						0.1846*** (0.0476)
Labor Force Percent 25 to 29$_t$				0.2015** (0.0974)	0.2090* (0.1164)	0.2623*** (0.0882)
Constant	7.2430*** (0.8004)	6.8991*** (0.7806)	0.8672* (0.5235)	-2.8249 (2.5289)	3.7737 (3.0470)	-0.6849 (2.4187)
Wald Chi-square	35.47	76.07	299.13	515.95	342.89	***563.04***
Number of Observations	345	330	315	315	168	315

Union Density and Tax Wedge

A higher degree of union density increases the NAIRU between 0.26 and 0.35 percentage points based on results from models (4), (5) and (6) which have additional controls. These results confirm the findings of Elmeskov, Scarpetta and Martin (1998) and Afdagic (2013). The structure of wages proposed by unions raises the average wage of the employed and increases labor costs for firms, which increases the NAIRU directly in two ways. First, there is a direct reduction in labor demand. In industries where other factors are highly substitutable with labor, firms prefer those other factors since their employment will tame production costs relative to labor services. Second, employers are likely to be more selective in hiring. With higher wages, higher levels of productivity are expected from employees. The marginal product of the new batch of workers must be higher if a higher level of wages is to be paid. Those affected the most by the more stringent screening process are individuals with lower levels of education and experience. A defined group of individuals will be systematically screened out of potential employment as the degree of unionization deepens. Young people fit both criteria and may suffer extended periods of unemployment.

The first-order lag of union density is included in the models to find out if unionization has any effects beyond the current period. The coefficient on the first-order lag is negative and significant in models (4), (5) and (6). While this result is unexpected, a plausible explanation is that the initial reaction from firms is to reduce labor demand; however, without a significant decrease in demand for goods and services (job losers have access to unemployment insurance to help maintain consumption), it is quite difficult to maintain the level of labor services needed from a reduced workforce leading to increased employment in the next period.

In model (5), an increase in the tax wedge and its first-order lag are do not affect the level of the NAIRU. The coefficient for the current period is negative while that for the first-order lag is positive.

Hysteresis

The results support the hysteresis argument. An increase in the first order lag of the unemployment rate increases the NAIRU between 0.51 and 0.65 percentage points. A previously high unemployment rate is likely to increase unemployment duration if the number of unemployed cannot be fully absorbed into the working population. In recessions, unemployment rates increases. During recovery, an economy may not be ready soon enough to absorb the large pool of unemployed individuals. A fraction of those who lose their jobs during recessions will stay unemployed for an extended period of time as demand for goods and services picks up and the economy recovers. During the period of unemployment, they do not add to their human capital unless they participate in some education and training which is difficult given the loss of income that occurs with unemployment and an income replacement rate that is less than one as is characteristic of unemployment insurance benefits. Opportunities for on-the-job training are also lost. However, their human capital continues to depreciate. The net change in human capital is likely to be negative given that the only factor that affects the stock of human capital during the period of unemployment is depreciation in the absence of any additions to the stock. A longer period of unemployment reduces employability of individuals. Two years after the unemployment rate increases by 1 percentage point, the NAIRU increases by 0.20 to 0.22 percentage points. The hysteresis effect lasts beyond one year but the effect decreases with time.

Productivity Growth and Composition of the Labor Force

There is no relationship between the growth rate of the productivity and the NAIRU. If there an increase in the rate of productivity growth, workers expectation of wage increases are tied to previous increases which are associated with lower growth rates of productivity. With time, expectations are revised to match the new growth rate of productivity with no effect on the NAIRU (Murphy, 1998).

The sign on the coefficient of percent of the labor force that is female is negative and significant in model (6). Females do not have a higher level of frictional unemployment than males as expected. It is possible that women who leave employment to care for their children are assured of getting their jobs back, supported by legislation, such that they do not have to go through the job search process. *If* this is the case, then taking time off to care for kids will not impact the unemployment rate. Some mothers may also resort to decreasing hours of work instead of leaving employment, keeping unemployment unchanged.

The effect of an increase the labor force aged 15 to 19 increases the NAIRU by 0.20 percentage points in model (5) but has no effect in model (4). The coefficient on the labor force aged 20 to 24 is 0.36 in model (4) and significant at 1% but negative and insignificant in model (5). The coefficients on both variables are sensitive to model specification. In model (6), the two groups are combined with a coefficient of 0.18 which is significant at 1%. For those in the labor force aged 25 to 29, an increase in their population by 1 percentage point increases the NAIRU by 0.26 percentage points. As the proportion of young people in the labor force increases, the

NAIRU increases as expected. Young people generate higher levels of frictional unemployment as they enter the labor force for the first time after secondary or tertiary education, change jobs to find the right fit and are more geographically mobile with lower psychic costs. Occupational mobility may also be higher among young individuals. Older individuals who have established their careers in certain occupations may not be able to easily switch their occupations and may stay in employment (Brauer, 2007) while younger individuals with no solid grip on any particular occupation have more options since they can start at the bottom of the ladder in any occupation and are not restricted by experience acquired in particular occupations.

V. Conclusion

Employment protection is intended to benefit employees through increased cost of firing for firms. A possible negative externality is a higher level of structural unemployment if firms use the minimum level of employment necessary to maintain production to meet demand and prefer increased hours over additional employment for short-term increases in demand in the goods market. This paper investigates the relationship between employment protection and the NAIRU for 15 OECD economies from 1990 to 2012. First, the NAIRU is estimated using an iterated Phillips curve procedure for each country. Control variables include employment protection for individual and collective dismissals for regular contracts, employment protection for temporary contracts, union density, tax wedge, growth rate of productivity, lagged unemployment rate and gender and age composition of the labor force. NAIRU is determined using Prais-winsten estimation with heteroscedastic panels corrected standard errors assuming a panel-level AR(1) process.

Results show that employment protection for regular contracts has no effect on the NAIRU. The effect of strictness of employment protection for temporary contracts depends on model specification. When full controls are used, the coefficient loses its significance. Deregulation is not an effective policy tool to reduce structural unemployment.

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