Employment protection and the non-linear relationship between the wage-productivity gap and unemployment

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Abstract

This paper studies the relationship between the wage-productivity gap and unemployment in OECD countries during the last 25 years. In particular, we investigate whether differences in the employment protection across countries affect the link between these two variables. We show that the elasticity of unemployment with respect to the wage-productivity gap is nonlinear and it switches from a positive to a negative value for stricter employment legislation. From a theoretical point of view, we argue that this result is related to the a set of labour market reforms introduced in many OECD countries, which affected the relative strictness of the institutions

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1 Introduction

For many years, one of the major issues in macroeconomics has been the link between unemployment, wages and productivity. Indeed, in their influential work, Bruno and Sachs (1985) suggested that the rise in the real wage gap, defined as the proportion of real wages in excess of the full employment marginal productivity of labour, was one of the main contributor to the rise in the OECD unemployment rate during the 1970's.

Indeed, conventional theory suggest that the wage a worker earns, measured in units of output, equals the amount of output the worker can produce. Otherwise, competitive firms would have an incentive to alter the number of workers they hire, and these adjustments would bring wages and productivity in line. If the wage were below productivity, firms would find it profitable to hire more workers. This would put upward pressure on wages and, because of diminishing returns, downward pressure on productivity. Conversely, if wages were above productivity, firms would find it profitable to shed labour, putting downward pressure on wages and upward pressure on productivity. in other words, equilibrium requires the wage of a worker equating what that worker can produce. Therefore, we would expect deviations of this relationship between real wages and productivity to result in higher (temporary) unemployment rates.

However, ten years after their finding, Gordon (1995) pointed out that an examination of the wage gap data for Europe and the US became obsolete during the 1980's. He showed that there was no cross-country correlation between the increase in unemployment and the increase in the manufacturing wage gap during this period. Together with these two studies, there was an abundant literature dealing with the link between the wage-productivity gap and unemployment, showing a small positive effect or even the lack of support for the wage gap as a determinant of unemployment[1].

Yet, it is still a question of controversy whether unemployment is the result of real wages which are "too" high. For example, using various panel data techniques on 22 OECD countries over the period 1960 to 1993, Junankar and Madsen (2004) find a statistically significant, but economically

[1]See for example, Madsen (1994), McCallum (1986), Myatt and Septhon (1990).

insignificant, positive relationship between unemployment and the wage gap. In turn, applying a set of unit root and cointegration tests with non-linear error correction mechanism, Pascalau (2007) finds mixed evidence on the response of unemployment to increments on the wage productivity gap. Moreover, these studies also reflect heterogeneous results across countries.

Recently, attention has turned to the impact of institutional characteristics of the labour market on job and worker flows. For instance, in a seminal paper, Blanchard and Wolfers (2000) find that the interaction between shocks and institutions is crucial to explain both the rise in unemployment since the 1960s and the heterogeneity of individual country experiences. In particular, they suggest that institutions determine the relevance of the unemployed to wage-setting, thereby determining the evolution of equilibrium unemployment rates following a shock.

In this vein, particular attention has been paid to differences in the employment protection legislation (EPL) across OECD countries. Indeed, since the middle of the 1980s, a set of labour market reforms introduced in many OECD countries have affected the relative strictness of the EPL on fixed-term and permanent contracts. According to the OECD (2004), most of these reforms have alleviated the strictness of EPL for fixed-term contracts relative to the one on permanent contracts. As a result, two types of labour market characteristics can be found in many OECD economies. The first type shows a small degree of EPL in regular contracts, and no limitations on the renewal and duration of temporary contracts[2]. The second type of countries combines a high degree of employment protection in the regular segment with a limited flexibility in the use of temporary contracts[3].

Even though most of the labour market regulations have often being blamed for high and persistent unemployment in Europe, evidence on their impact remains mixed (see, e.g., Nickell and Layard, 1999).

[2]Some of them are the well-known Anglo-Saxon economies; Australia, Canada, Ireland and US.

[3]For example, in Spain fixed term contracts are restricted to 3 the maximum number of successive contracts with a top accumulated duration of 2 years (OECD, 2004). Other countries with limited duration and renewal process of temporary contracts are Belgium, Denmark, France Germany, Italy, Korea, Netherland, Norway and Sweden.

Despite this previous efforts, there is still an important question that remains unanswer: What can explain the differences observed in the relationship between the wage-productivity gap and unemployment across OECD countries?. In this paper, we propose that the influence of institutions on the performance of the labour market can help us to answer this question. In particular, the employment protection legislation can play a central role behind the observed heterogeneous relationship between the wage-productivity gap and the unemployment rate.

Therefore, the objective of this paper is three-fold. First, we empirically study the relationship between the wage-productivity gap and unemployment in the OECD countries during the last 25 years. Second, we investigate whether the differences across countries in the EPL can affect the link between unemployment and the wage gap. In order to do so, we first explore the conditional comovement between the wage-productivity gap and the unemployment rate using the correlation coefficients of a vector autoregressive (VAR) forecast errors as proposed in den Haan (2000). Alternatively, we rely in panel nonlinear smooth transition (PSTR) models to explain the switching relationship. Finally, we present a model that rationalizes the empirical evidence presented. In particular, by relying in a matching model with two types of jobs, we explore how employment protection in regular jobs affects the co-movement between these two variables.

We show empirical evidence that the unemployment rate does not react linearly to alterations between real wages and productivity gains. On the one hand, in countries where the labour market is highly protected, unemployment and the wage gap exhibit a negative relationship. On the other, we observe a positive relationship in those economies with low employment protection. The PSTR models show that the elasticity of unemployment with respect to the wage-productivity gap switches from a positive to a negative value when EPL increases above a certain threshold, which is around 2.[4]

[4]The EPL index scores from 0 to 6 with higher values representing stricter regulation. However, the highest level reached by our group of countries was 3.82 in Spain between 1985 and 1993. On the contrary, the US had 0.21, the lowest value, during the whole period.

From a theoretical point of view, we show that the wage of a permanent worker increases by a higher magnitude than average labour productivity while the wage of a temporary one increases in a much lower magnitude. This result takes place because with a relatively higher implicit bargaining power, permanent workers can negotiate extra wage adjustments to the productivity shock in good times. In contrast, temporary workers have lower bargaining power because firing costs are not operational at this level. Thus, firms can discount to these workers the extra wage adjustments in the side of regular contracts. According to this result, the relationship between unemployment and the wage gap in countries characterized by different degrees of EPL can be positive or negative depending on how temporary and permanent workers interact in each particular labour market.

The rest of the paper is organized as follows. In the next section we present a first empirical analysis by exploring the conditional correlation between the wage-productivity gap and the unemployment rate. In section 3 we present and simulate the matching model with employment protection in permanent jobs and limited flexibility in the use of temporary contracts. In section 4 we estimate the panel smooth transition model (PSTR). Finally, section 5 gives the main conclusions.

2 Empirical evidence: The conditional correlations

The purpose of this section is to conduct a first empirical analysis for the link between the unemployment rate, the wage gap and the level of employment protection in 17 OECD countries. In order to do so, we explore the conditional comovement between the wage-productivity gap and the unemployment rate using the correlation coefficients of a vector autoregressive (VAR) forecast errors as proposed in den Haan (2000). We then compare these correlations with the EPL index of each country.

Data for the unemployment rate comes from the OECD's Main Economic Indicators Database. To estimate the wage productivity gap we proceed as follows. First, we calculate productivity per worker as the ratio of the volume of GDP to the employment index (both series 2005=100). Second, real wages correspond to IMF's data on earnings, deflated by the GDP deflator. The wage-

productivity gap is the log difference between real wages and productivity. The data sample consists of annual observations over the period 1985-2007 of the following 17 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Spain, Sweden, the United Kingdom (UK) and United States (US).

The Employment Protection Legislation Index (EPL) measures regulations concerning hiring and firing, even if they are not grounded primarily in the law, but originate from the collective bargaining of the social partners. It is provided by the OECD. [5]

2.1 Methodology

The co-movement with VAR forecast errors can be briefly described in the following terms.

$$X_t = A_0 + \sum_{i=1}^{m} A_i X_{t-1} + v_t,$$

where X_t is an n-vector of random variables that may include both stationary and integrated processes; A_0 is an n-vector of constant terms or a matrix of deterministic coefficients; i are $n \times n$ matrices of coefficients; v_t is an n-vector of error terms, and m is the total number of lags included. Denote the $k - period$ ahead forecast of variable y by $E_t y_{t+k}$ and its forecast error by $y_{fe,t+k}$. The same applies to variable x. Denote the covariance between $x_{fe,t+k}$ and $y_{fe,t+k}$ by $COV(k)$ and the correlation coefficient between these two variables by $CORR(k)$. One way to construct estimates of these covariance and correlation coefficients is to construct time series for the forecast errors using the difference between subsequent realizations and their forecasts. The constructed time series are then used to generate covariance and correlation coefficients. We estimate a set of bivariate VARs between the logarithm of the wage-productivity gap and unemployment rate.

The VARs were estimated without imposing the unit-root restriction and considering linear and quadratic trend if it is necessary[6]. The lag length in the VAR, as well as the deterministic

[5] Unfortunately, the EPL series covers only from 1985 to 2007 which is why our models are estimated just for this period.

[6] The matlab program was writing by Steve Sumner and can be download at Den Haan's web page http://faculty.london.edu/wdenhaan/

components were chosen by the Akaike Information Criterion.

2.2 Results

Table 1 summarizes the correlation coefficients between the wage-productivity gap and unemployment for a forecast horizon of 5 years .

Table 1: **Correlation coefficients between the wage-productivity gap and unemployment from 1985 to 2005. k-period ahead forecast error**

Forecast Horizon	1	2	3	4	5	average
Australia	0.420	0.260	0.168	0.145	0.143	0.227
Austria	0.377	0.343	0.330	0.328	0.328	0.341
Belgium	0.363	0.278	0.208	0.157	0.123	0.226
Canada	0.549	0.628	0.656	0.667	0.673	0.635
Denmark	0.676	0.414	0.225	0.158	0.147	0.324
Finland	0.286	0.465	0.374	0.217	0.129	0.294
France	-0.245	-0.362	-0.443	-0.500	-0.539	-0.418
Germany	-0.090	-0.205	-0.305	-0.388	-0.452	-0.288
Ireland	0.566	0.737	0.800	0.832	0.852	0.757
Italy	-0.538	-0.677	-0.724	-0.743	-0.752	-0.687
Japan	0.529	0.513	0.500	0.492	0.490	0.505
Netherland	-0.165	-0.121	-0.144	-0.166	-0.147	-0.149
Norway	-0.104	-0.090	-0.185	-0.188	-0.218	-0.157
Spain	-0.344	-0.288	-0.213	-0.163	-0.137	-0.229
Sweden	-0.541	-0.697	-0.765	-0.801	-0.822	-0.725
UK	-0.273	-0.369	-0.406	-0.394	-0.369	-0.362
US	0.313	0.334	0.326	0.572	0.690	0.505

Clearly, we can identify two types of countries. On the one hand, France, Italy, Germany,

Netherland, Norway, Spain Sweden and UK display a negative correlation coefficient between the wage gap and unemployment. On the other, the rest of the countries show a positive relationship. Thus, when real wage exceed labour productivity, unemployment tends to increase in some countries and to decrease in others. For example, as it can be shown in Figure 1, US and Canada unemployment rates seem to follow very closely the upwards and downwards of the wages-productivity ratio in the US and Canada: whenever real wages have increased above productivity, unemployment has boosted. Yet, the relationship in Spain and Sweden is less clear-cut and periods of high unemployment do not necessarily follow increases of wages above productivity.

Finally, notice that the sign of the conditional correlation coefficients remains invariable for a forecast horizon of up to five years, suggesting a stable relationship between unemployment and the wage-productivity gap.

At the same time, Table 2 presents the EPL index in 17 OECD's countries in 1985, 2007 and the period average. As it can be seen, we can clearly identify countries with low labour protection legislation, such as Australia, Canada, Ireland the US and the UK, on the one side, and countries with more strict legislations, such as Germany, Italy, Spain, Sweden, etc.

Table 2: **EPL index OECD countries, 1985, 2007 and period average**

Country	1985	2007	Average	Country	1985	2007	Average
Australia	0.94	1.15	1.07	Italy	3.57	1.82	2.92
Austria	2.21	1.93	2.15	Japan	1.84	1.43	1.65
Belgium	3.15	2.18	2.68	Netherlands	2.73	2.04	2.49
Canada	0.75	0.75	0.75	Norway	2.90	2.69	2.75
Denmark	2.40	1.50	1.90	Spain	3.82	2.98	3.31
Finland	2.33	2.02	2.15	Sweden	3.49	2.24	2.71
France	2.8	3.05	2.94	UK	0.60	0.75	0.65
Germany	3.17	2.12	2.70	USA	0.21	0.21	0.21
Ireland	0.93	1.11	0.97				

Figure 1: **Unemployment rate and the wage productivity gap. United states, Canada, Spain and Sweden. 1970-2007.**

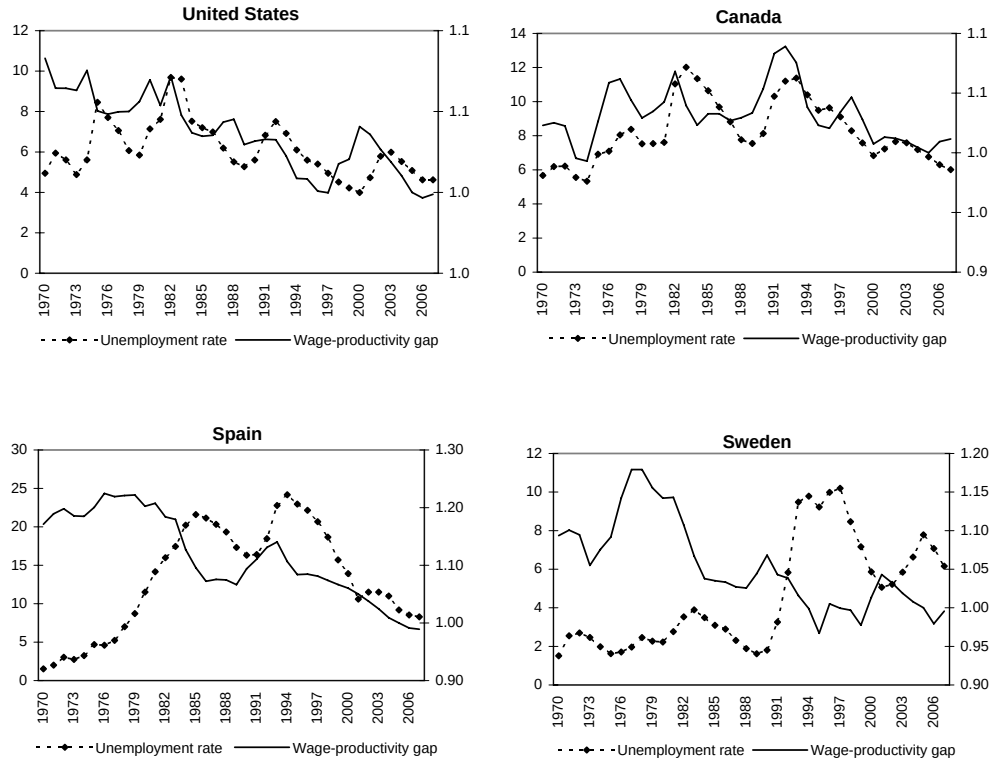
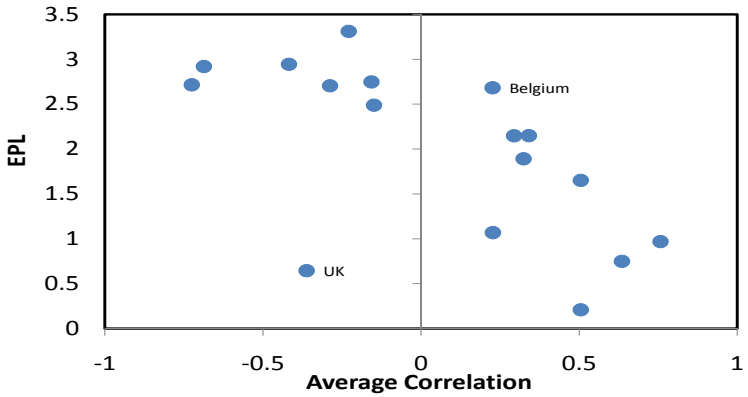


Figure 2: EPL index and the correlation between the wage-productivity gap and unemployment.



The relationship between the average EPL index between 1985 and 2007 and the average estimated correlation coefficients between the wage gap and unemployment is capture in Figure 2. Most of the countries (except Belgium) with negative correlation between the wage-productivity gap and the unemployment rate present relatively high levels of EPL (higher than 2.5).[7] In contrast, those economies (except the UK) characterized by a smaller degree of EPL (lower than 2.5) show a positive correlation between the wage-productivity gap and the unemployment.[8]

3 The model

In this section, we propose a stylized model to rationalize the first empirical findings and, in particular, to illustrate how the interaction of the EPL with the wage-productivity gap may affect unemployment. Given that our model is, basically, the same as the one used in Sala and Silva (2009), its presentation is reduced to the minimum.

[7]These countries are France Germany, Italy, Netherland, Norway, Sweden and Spain.

[8]These countries are Australia, Austria, Canada, Denmark, Finland, Ireland, Japan and the US.

The economy is integrated by a continuum of risk-neutral, infinitely-lived workers and firms. Workers have linear utility over consumption of an homogeneous good. Workers and firms discount future payoffs at a common and constant rate δ, and capital markets are perfect. In addition, time is discrete.

There is a time-consuming and costly process of matching workers and job vacancies, captured by a constant-return-to-scale matching function

$$m(u_t, v_t) = \frac{u_t v_t}{(u_t^{\varphi} + v_t^{\varphi})^{1/\varphi}}, \qquad \varphi > 0, \tag{1}$$

where u_t denotes the unemployment rate and v_t are vacancies. From the properties of the matching function, unemployed workers and vacancies meet to each other at the rates $\frac{m(u_t,v_t)}{u_t} = f(\theta_t)$ and $\frac{m(u_t,v_t)}{v_t} = q(\theta_t)$, respectively. Due to the CRS assumption, these rates only depend on the vacancy-unemployment ratio θ_t. The higher the number of vacancies with respect to the number of unemployed workers, the easier is for each of these workers to find a job $f'(\theta_t) > 0$, and the more difficult is for a firm to fill its vacancy $q'(\theta_t) < 0$.

Workers can be either unemployed or employed. Unemployed workers get b units of the consumption good each period, which can be understand as the value of leisure, home production, or unemployment benefits. Those who are employed can be either temporary (T) or permanent employees (P). The productivity of the match is a function of aggregate productivity A_t, and a term z_t idiosyncratic to the match. There is a firm-specific productivity term independent and identically distributed across firms and time, with a cumulative distribution function $G(z)$ and support $[0, \bar{z}]$. We also assume that $\log A_t$ follows a Markovian stochastic process.

In turn, firms have a constant-return-to-scale production technology that uses only labour. A job can be either filled or vacant. Job creation takes place when a firm and a worker meet and agree on an temporary contract. However, before a position is filled, the firm has to open a job vacancy with flow cost c. Each filled job yields instantaneous profit equal to the difference between labour productivity and the wage, which is either $A_t z_t - w_t^T$ for a temporary position or $A_t z_t - w_t^P$ for a job filled with a permanent employee.

Firms face firing costs when a permanent match is endogenous destroyed. In particular, firms lose γ when a match with an permanent worker is terminated by the firm. This cost is assumed to be fully wasted and not a transfer, reflecting dismissal protections imposed by the government. Due to legal restrictions, temporary positions are bounded to convert into permanent ones with probability ι.There are also worker-initiated separations with exogenous probability ϕ and no firing costs. Additionally, endogenous job destruction of temporary contracts does not mean any firing cost to firms.

To summarize, on the firm's side, we have the value of a vacancy, V_t; the temporary position, $J_t^T(z_t)$; and the permanent position $J_t^P(z_t)$. On the workers' side, the values of the different statuses are unemployed, U_t; temporary employee, $W_t^T(z_t)$; and permanent employee, $W_t^{iP}(z_t)$. These six different values are given by the following Bellman equations:

$$U_t = b + \delta E_t \left[f(\theta_t) \int_{\widetilde{z}_{t+1}^T}^{\bar{z}} W_{t+1}^T(z) dG(z) + [1 - f(\theta_t)(1 - G(\widetilde{z}_{t+1}^T))] U_{t+1} \right], \tag{2}$$

$$\begin{aligned} W_t^T(z_t) = {} & w_t^T(z_t) + \delta(1-\phi) E_t \left[\iota \left(\int_{\widetilde{z}_{t+1}^C}^{\bar{z}} W_{t+1}^P(z) dG(z) + G(\widetilde{z}_{t+1}^C) U_{t+1} \right) \right. \\ & \left. + (1-\iota) \left(\int_{\widetilde{z}_{t+1}^T}^{\bar{z}} W_{t+1}^T(z) dG(z) + G(\widetilde{z}_{t+1}^T) U_{t+1} \right) \right] + \delta\phi E_t U_{t+1}, \end{aligned} \tag{3}$$

$$W_t^P(z_t) = w_t^P(z_t) + \delta E_t \left[(1-\phi) \left(\int_{\widetilde{z}_{t+1}^P}^{\bar{z}} W_{t+1}^P(z) dG(z) + G(\widetilde{z}_{t+1}^P) U_{t+1} \right) + \phi U_{t+1} \right]. \tag{4}$$

$$V_t = -c + \delta E_t \left[q(\theta_t) \int_{\widetilde{z}_{t+1}^T}^{\bar{z}} J_{t+1}^T(z) dG(z) + [1 - q(\theta_t)(1 - G(\widetilde{z}_{t+1}^T))] V_{t+1} \right], \tag{5}$$

$$\begin{aligned} J_t^T(z_t) = {} & A_t z_t - w_t^T(z_t) + \delta(1-\phi) E_t \left[\iota \left(\int_{\widetilde{z}_{t+1}^C}^{\bar{z}} J_{t+1}^P(z) dG(z) + G(\widetilde{z}_{t+1}^C) V_{t+1} \right) \right. \\ & \left. + (1-\iota) \left(\int_{\widetilde{z}_{t+1}^T}^{\bar{z}} J_{t+1}^T(z) dG(z) + G(\widetilde{z}_{t+1}^T) V_{t+1} \right) \right] + \delta\phi E_t V_{t+1}, \end{aligned} \tag{6}$$

$$\begin{aligned} J_t^P(z_t) = {} & A_t z_t - w_t^P(z_t) + \delta(1-\phi) E_t \left[\int_{\widetilde{z}_{t+1}^P}^{\bar{z}} J_{t+1}^P(z) dG(z) + G(\widetilde{z}_{t+1}^P) \left(V_{t+1} - \gamma \right) \right] \\ & + \delta\phi E_t V_{t+1}, \end{aligned} \tag{7}$$

where $\widetilde{z}_{t+1}^j$, $j = \{T, C, P\}$, are match-specific productivity thresholds defined such that nonprofitable matches (i.e., with negative surplus) are severed. These thresholds must satisfy the following

conditions:

$$J_t^T(\widetilde{z}_t^T) - V_t = 0, \tag{8}$$

$$J_t^P(\widetilde{z}_t^C) - V_t = 0, \tag{9}$$

$$J_t^P(\widetilde{z}_t^P) - V_t + \gamma = 0. \tag{10}$$

Expressions (8) and (10) define the reservation productivity for temporary and permanent workers, respectively, whereas (9) refers to those temporary workers on the verge of becoming permanent.

It follows that the permanent and temporary workers separate with probabilities

$$s_t^P = \phi + (1-\phi)G(\widetilde{z}_t^P), \tag{11}$$

$$s_t^T = \phi + (1-\phi)\left[(1-\iota)G(\widetilde{z}_t^T) + \iota G(\widetilde{z}_t^C)\right]. \tag{12}$$

Moreover, job creation takes place with probability $q(\theta_t)(1-G(\widetilde{z}_{t+1}^T))$ when a firm and a worker meet and agree on a temporary contract. Similarly, unemployed workers find a job with probability $f(\theta_t)(1-G(\widetilde{z}_{t+1}^T))$.

We close the model by introducing two more assumptions. One is the free entry condition for vacancies. Therefore, in equilibrium we must have:

$$V_t = 0. \tag{13}$$

The other assumption is that wages are set through Nash bargaining. The Nash solution is the wage that maximizes the weighted product of the worker's and firm's net return from the job match. The first-order conditions for temporary and permanent employees yield the following two conditions:

$$(1-\beta)(W_t^T(z_t) - U_t) = \beta(J_t^T(z_t) - V_t), \tag{14}$$

$$(1-\beta)(W_t^P(z_t) - U_t) = \beta(J_t^P(z_t) - V_t + \gamma), \tag{15}$$

where $\beta \in (0,1)$ denotes workers bargaining power relative to firms.

Using the equations above, we can now solve for the equilibrium wages as a function of the aggregate state variables A_t and θ_t,

$$w_t^T(z_t) = (1-\beta)b + \beta\theta_t c + \beta A_t z_t - \delta\beta\iota(1-\phi)[1-G(\widetilde{z}_{t+1}^C)]\gamma, \tag{16}$$

$$w_t^P(z_t) = (1-\beta)b + \beta\theta_t c + \beta A_t z_t + \beta[1-\delta(1-\phi)]\gamma. \tag{17}$$

Introducing firing costs in permanent jobs decreases the wage of a temporary worker (16) by a fraction of the separation costs. In contrast, the permanent wage (17) is higher because separation costs are now operational, which increase his bargaining power.

To fully characterize the dynamics of the model economy, we need to define the law of motion for the unemployment rate u_t, and the mass of temporary and permanent workers, n_t^T and n_t^P, respectively. These evolve according to the following difference equations:

$$u_t = u_{t-1} + s_t^T n_{t-1}^T + s_t^P n_{t-1}^P - f(\theta_{t-1})(1-G(\widetilde{z}_t^T))u_{t-1}, \tag{18}$$

$$n_t^T = n_{t-1}^T + f(\theta_{t-1})(1-G(\widetilde{z}_t^T))u_{t-1} - s_t^T n_{t-1}^T - (1-\phi)\iota(1-G(\widetilde{z}_t^C))n_{t-1}^T, \tag{19}$$

$$n_t^P = n_{t-1}^P + (1-\phi)\iota(1-G(\widetilde{z}_t^C))n_{t-1}^T - s_t^P n_{t-1}^P, \tag{20}$$

$$1 = u_t + n_t^T + n_t^P. \tag{21}$$

The average separation probability is equal to

$$s_t = \frac{s_t^T n_{t-1}^T + s_t^P n_{t-1}^P}{(1-u_{t-1})}. \tag{22}$$

Finally, total output y_t is equal to

$$y_t = A_t \bar{z}_t^P n_t^P + A_t \bar{z}_t^T n_t^T - cv_t, \tag{23}$$

where $\bar{z}^j = E[z|z \geq \widetilde{z}^j]$.

3.1 Calibrated parameters

Our benchmark model is the one-type of job model without employment protection, such as the US economy. Thus we calibrate the model at quarterly frequency in order to match four targets

for this economy between 1985 and 2007. Following Blanchard and Diamond (1990) we set an average unemployment rate at $u = 11\%$ (target 1). Following Shimer (2005) we target a steady-state job separation probability s equal to 0.10 per quarter (target 2), and an elasticity of the matching function with respect to unemployment of $\varepsilon_{m,u} = 0.72$ (target 3). As mentioned in Silva and Toledo (2008), the 1982 Employment Opportunity Pilot Project and the 1992 Small Business Administration Surveys estimate total hiring costs to be about 4.3 percent of the quarterly compensation of a new hired worker. Therefore, we set c such that in the steady state it is equal to $0.043w^T$ (target 4).

We set the discount factor $\delta = 0.99$, which implies a reasonable quarterly interest rate of nearly 1 percent. We normalize the aggregate labour productivity A to 1. The logarithm of this variable follows an AR(1) process such that $\log A_t = \rho \log A_{t-1} + \varepsilon_t$. The values of the autoregressive parameter and the standard deviation of the white noise process, $\rho = 0.96$ and $\sigma_A = 0.01$, have been calibrated to match the cyclical volatility (2.0 percent) and persistence (0.88) of the average US labour productivity $y_t/(1 - u_t)$ between 1985 and 2007.

Regarding the exogenous separation probability ϕ, we follow den Haan et al. (2000) by interpreting exogenous separations as worker-initiated separations. Hence, since only endogenous separations are associated with the layoff rate, firms do not incur in firing costs when separations are exogenous. According to the evidence from the Job Opening labor Turnover Survey (JOLTS) layoffs represent on average about 35% of total separations. Thus, the value for ϕ is 0.065.

Since our baseline parametrization describes the US labour market, we assume that there are no firing costs restrictions in this economy. Thus, we set $\gamma = 0$. Since temporary and permanent become perfect substitutes, this implies the existence of just one type of job. Therefore, the job conversion probability ι becomes irrelevant. According to the OECD (2004), the average duration of a fixed-term contract in the OECD economies is six months. Thus , these contracts are assumed to expire stochastically with probability ι=0.5.

The idiosyncratic productivity z_t is assumed to be log-normally distributed with parameters

$(\mu; \sigma_z)$. As in as in Walsh (2005), we choose the mean and the standard deviation of log z_t to be $\mu = 0$ and $\sigma_z = 0.13$, respectively. Finally, the hiring cost parameter c, is calibrated together with the matching technology parameter φ, the workers' bargaining power β, and the employment opportunity cost b. We select these parameters such that the steady-state equilibrium satisfies our four calibration targets. This yields $c = 0.043$, $\varphi = 1.891$, $\beta = 0.576$, and $b = 0.897$.

3.2 Simulated results

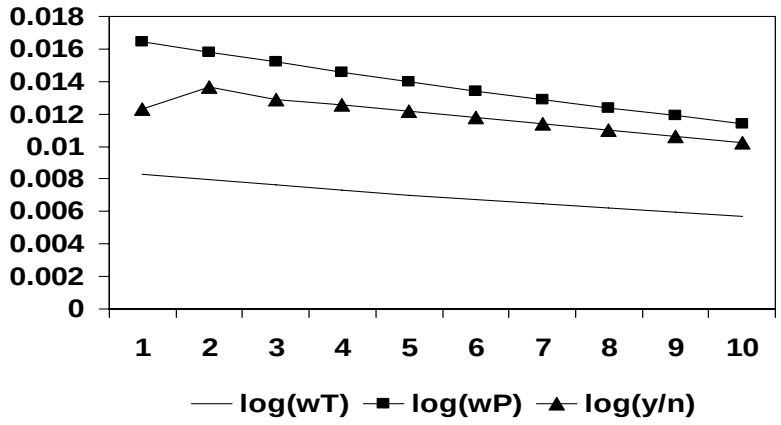
We simulate the model presented above 10,000 times. Each time we simulate the economy for 1,072 quarters and throw away the first 1,000 of them in order to obtain the US period between 1985-2007. We calculate the correlation matrix of the temporary and permanent wage gaps (express both in logs) with respect to unemployment for different levels of firing costs γ. When modifying this parameter, we hold all the others constant and compute the new equilibrium values of the endogenous variables in the steady state. Table 3 shows the simulated correlations.

Table 3: **Simulated correlations with different levels of firing costs**

	$corr(log(w_t^T) - log(\frac{y_t}{n_t}), u_t)$	$corr(log(w_t^P) - log(\frac{y_t}{n_t}), u_t)$
No employment protection:		
$\gamma = 0$	0.972	0.972
Employment protection:		
$\gamma = 0.05$	0.997	0.797
$\gamma = 0.10$	0.993	0.584
$\gamma = 0.25$	0.986	-0.579
$\gamma = 0.50$	0.988	-0.771
$\gamma = 0.75$	0.975	-0.802

Notes: Average labour productivity is equal to $\frac{y_t}{n_t} = \frac{A_t \overline{z}_t^T n_t^T + A_t \overline{z}_t^P n_t^P - cv_t}{(1-u_t)}$ where $\overline{z}_t^T$ and $\overline{z}_t^P$ are, respectively, the average idiosyncratic productivity shocks across entrants and insider jobs.

Figure 3: Impulse response in the model with temporary and permanent jobs to an aggregate productivity shock (A).



It is interesting to observe that in the benchmark case, there is an almost perfect positive correlation (0.972) between the log of wage-productivity gap and the unemployment rate. The value added of this exercise, however, lies in the second case, with the presence of firing costs as our proxy of employment protection. As shown in Table 3, the correlation coefficient between the log of the permanent wage gap, $log(w_t^P) - log(\frac{y_t}{n_t})$, and unemployment, u_t, becomes negative (-0.579) when firing costs account for 25 percent of the aggregate labour productivity ($\gamma = 0.25$). In contrast, the correlation between the log of the temporary wage gap, $log(w_t^T) - log(\frac{y_t}{n_t})$, and unemployment (0.986) resembles very much the one of the pure deregulated labour market with no firing costs (0.972).

To understand this result we can look to the wage response to a productivity shock with $\gamma = 0.5$. Figure 3 shows the response of the conditional mean of the temporary and permanent wages, $E[w_t^T(z)|z \geq \tilde{z}_t^T]$ and $E[w_t^P(P)|z \geq \tilde{z}_t^P]$, to a 1 percent increase in aggregate labour productivity (A_t). One quarter after the impact, the average labour productivity increases in 1.2%, the permanent

wage increases by 1.6% while the temporary wage increases in a lower magnitude (0.8%). Intuitively, with a relatively higher implicit bargaining power, permanent workers can negotiate an additional wage increase to a favorable productivity shock. In contrast, temporary employees have lower bargaining power because firing costs are not operational at this type of job. Thus, firms can discount to these workers the extra wage adjustments in the permanent job side. This is the reason why we observe a negative correlation between the permanent wage and unemployment. The relationship between the temporary wage gap and unemployment remains positive because these workers are the relevant ones to the marginal employment decision. It is not profitable to keep the level of hired workers when the temporary wage is increasing more than the average labour productivity.

4 An empirical analysis of the non-linear relationship between wage gap and unemployment

According to our previous model, the relationship between the wage gap and unemployment depends on different states of the world or regimes that prevail at any point in time. It is therefore a nonlinear relation. That is, unemployment's reaction to real wages being too high (or too low) with respect to the productivity is likely to depend on institutional characteristics of the labour market. In particular, the model states that in economies with high level of employment protection (captures through the firing costs parameter γ) the relationship between the wage-productivity gap and unemployment may be negative due to the presence of permanent workers who have the power to negotiate wage adjustments higher than the increment on labour productivity. Thus, there is no reason to expect the same coefficient in countries characterized by a low labour regulation (as the United States) than in countries with stricter regulations (as Spain)[9]. We capture this nonlinearity

[9]Notice that we are not trying to measure the direct effects of the labour protection on the unemployment rate. Rather, we want to consider it indirectly when estimating the relationship between the wage gap and the unemployment.

by means of a panel smooth transition model (PSTR) using EPL as the threshold variable.

4.1 Methodology

Therefore, to introduce this regime-switching behaviour in the model, we employ the PSTR model developed by Gonzales, et. al (2004) and Fok, et. al. (2005). The PSTR model has several interesting features that make it suitable for our purposes. First, regression coefficients can take on a small number of different values, depending on the value of another observable variable. In other words, the observations in the panel are divided into a small number of homogenous groups or "regimes", with different coefficients in different regimes. Second, regression coefficients are allowed to change gradually when moving from one group to another. That is, PSTR is a regime-switching model that allows for a small number of extreme regimes associated with the extreme value of a transition function and where the transition from one regime to the other is smooth rather than discrete. Finally, individuals are allow to change between groups according to variations in the "threshold variable".

More in detail, the basis of our empirical approach consists in estimating the parameter of a function which relates the unemployment rate with the wage-productivity gap as the explanatory variable, together with a set of control variables usually used in the literature[10]. Denoting u_{it} the dependent variable (the unemployment rate), the model can be expressed as follows:

$$u_{i,t} = \mu_i + \beta_0' x_{i,t} + \beta_1' x_{i,t} g\left(s_{i,t}; \gamma, c\right) + \alpha_0' z_{i,t} + \varepsilon_{i,t}, \tag{24}$$

[10]There is an extensive but not conclusive discussion regarding the order of integration of the unemployment rate. On the one hand, the so-called "natural" rate of unemployment or NAIRU, characterizes unemployment dynamics as a mean reverting process. On the other, the "hysteresis" hypothesis states that cyclical fluctuations have permanent effects on the level of unemployment. In this paper, we abstract from this issue and estimate the equation in levels. However, as noticed by Colletaz and Hurlin (2006), the consequences of the non-stationarity in linear and nonlinear panel are not equivalent to those generally pointed out in a time series context, providing then consistent estimates of some long-run regression coefficients.

for $i = 1, ..., N$ and $t = 1, ..., T$. In (24) μ_i is an unobservable time invariant regressor, x_{it} is the the wage-productivity gap, s_{it} is the observable transition variable (the EPL), z_{it} is a k-dimensional vector of consider exogenous variables with constant coefficients (gross replacement rate, tax wedge, real interest rate and union's density) and ε_{it} are the residuals. At the same time, $g(s_{i,t}; \gamma, c)$ is a continuous bounded function of s_{it} defined by:

$$g(s_{i,t}; \gamma, c) = \left[1 + \exp\left(-\gamma \prod_{j=1}^{m} (s_{i,t} - c_j)\right)\right]^{-1}, \tag{25}$$

where $g(s_{it}; \gamma, c)$ is the transition function between regimes, normalized and bounded between 0 and 1, γ is the speed of transition, c denotes the threshold parameter and s_{it} is the transition variable which, for our particular case, is represented by the EPL. Depending on the realization of $s_{i,t}$, the link between $u_{i,t}$ and the wage-productivity gap will be specified by a continuum of parameters, namely β_0 in regime 1 (when $g(.) = 0$), and $\beta_0 + \beta_1$ in Regime 2, when $g(.) = 1$. That is, according to the value of the EPL, the wage-productivity gap have a different impact (elasticity) on the unemployment rate. In other words, this model allows us to investigate if nonlinearity in the elasticity of unemployment to the wage-productivity gap could be associated with changes in the magnitude of the EPL.

Finally, in the PSTR model the elasticity is estimated as:

$$e_{it} = \frac{\delta u_{it}}{\delta x_{it}} = \beta_0 + \beta_1 g(s_{it}; \gamma, , c) \tag{26}$$

where, by definition of the transition function, $\beta_0 \leq e_{it} \leq \beta_0 + \beta_1$ if $\beta_1 \geq 0$ or $\beta_0 + \beta_1 \leq e_{it} \leq \beta_0$ if $\beta_1 < 0$ since $0 \leq g(s_{it}; \gamma, c) \leq 1$. Therefore, the elasticity of the unemployment rate with respect to the wage gap x_{it} for the i^{th}country at time t is defined by the weighted average of the parameters β_0 and β_1 obtained in the extreme regimes (i.e. when $\leq g(s_{it}; \gamma, c) = 0$ and when $\leq g(s_{it}; \gamma, c) = 1$)[11].

Gonzales, et. al (2004) suggest a three step strategy to apply to PSTR models: (i) specification, (ii) estimation and (iii) evaluation.

[11] See Colletaz and Hurlin (2006) for more details.

The aim of the identification step is to test for homogeneity against the PSTR alternative. The estimation step, nonlinear least squares are used to obtain the parameter estimates, once the data have been demeaned[12]. Finally, the evaluation step consist of applying misspecification tests in order to check the validity of the estimated PSTR model and determining the number of regimes[13].

The main series and data sample are the same used in section 2. Regarding the control variables, the real interest rate series comes from the IMF statistics and corresponds to the long-term interest rate. We expect it to be positively associated with unemployment, since other things equal, an increase in the interest rate increases the user cost of capital, investment decreases, leading over time to lower capital accumulation, and a decrease in employment (see Blanchard and Wolfers (2000)).

The gross replacement rate (i.e. the unemployment benefits) captures the degree of generosity of the unemployment insurance system. At this respect, it has been suggested that a more generous insurance systems may cause unemployment to rise through multiple channels. For instance, generous unemployment benefits may "make unemployment less painful and thus strengthen the hand of workers in bargaining" (Blanchard, 2005). Also, generous employment benefits may "reduce the effectiveness of unemployed individuals as potential fillers of vacancies, by allowing them to be more choosy" (Nickell, 1997). At the same time, a generous unemployment system may lead to a more efficient matching between the unemployed and available jobs, in which case the sign of the coefficient may be theoretically indeterminate. Our source is the OECD main economic indicator, with linear interpolation for missing data.

The tax wedge, obtained from the OECD, is the difference between what employers pay out in wages and social security charges and what employees take home after tax, also taking into account social security deductions and cash benefits. The common hypothesis is that a lower tax wedge corresponds to lower unemployment rate.

[12]It should be noted that demeaning the data is not straightforward in a panel context (see Hansen (1999), and Gonzales (2004)).

[13]For further details, see Hansen (1999), Gonzales (2004) and Colletaz and Hurlin (2006).

Finally, union's density, also provided by the OECD, is intended to capture union bargaining power and should be positively associated with the unemployment rate. However, the effect of unionisation is theoretically indeterminate. It has been argued that when collective bargaining is coordinated, unions tend to internalise the externalities associated with their wage policies (Soskice (1990), Nickell (1997)).

4.2 Empirical results

We start by testing the null hypothesis of linearity in model (24). In other words, we test if there exists some difference in the response of unemployment to the wage-productivity gap and if the transition from one regime to another depends on the size of the EPL index.

The results from a test based on a first-order Taylor series expansion of a nonlinear smooth transition regression model show that linearity can be rejected at the 5% significance level for our panel of countries[14]. Therefore, we proceed to the estimation of the nonlinear growth relationship between the unemployment rate and the wage productivity gap considering, at the same time, the real interest rate (LTIR), the union's density, the gross replacement rate (GRR) and the tax wedge (TW) as control variables (equation (24)). Table (4) provides the results of the estimation.

As it can be seen, the threshold, given by $c = 1.96$, divides a regime for which the relationship is positive from another regime where this relationship changes to a negative one. That is, for an EPL below 1.96, the unemployment rate reacts positively to changes in the wage-productivity gap. Yet, when the threshold variable increases (for higher levels of the employment protection legislation), the elasticity of the wage gap starts decreasing turning to a negative one. In other words, since β_0 in equation (24) is positive, it implies that an increase in the ratio of real wages to productivity induces an increase in the unemployment rate. However, $\beta_0 + \beta_1$ is negative, indicating that the elasticity switches from a positive to a negative one.

Given the parameters estimates of the PSTR model, it is now possible to compute, for each

[14]Test results are available from the authors upon request.

Table 4: **PSTR model for the unemployment rate**

	Regime 1		Regime 2	
Variables	Coef.	t-stat	Coef.	t-stat
With constant coefficients				
LTIR	0.7060	10.38		
Union's density	0.0282	0.97		
GRR	-0.0887	-3.72		
TW	0.0804	3.68		
With nonlinear coefficients				
Wage gap	0.1169	4.83	-0.1851	-10.31
Transition parameters				
$\hat{c}$	1.959			

Notes: Regime 1 and Regime 2 correspond to β_0 and $\beta_1 + \beta_2$, respectively, in equation (24).

country of the sample and for each date, the time varying elasticity of unemployment with respect to the wage-productivity gap. The individual averages of these smoothed elasticities for the year 1985, 2007 and for the period average are reported in table (5).

Table 5: **Individual unemployment-wage productivity gap elasticities, 1985, 2007 and period average**

Country	1985	2007	Average	Country	1985	2007	Average
Australia	0.1169	0.1168	0.1168	Italy	-0.1851	0.0594	-0.1222
Austria	-0.1645	-0.0115	-0.1312	Japan	0.0491	0.1157	0.0829
Belgium	-0.1851	-0.1576	-0.1708	Netherlands	-0.1850	-0.0942	-0.1645
Canada	0.1169	0.1169	0.1169	Norway	-0.1851	-0.1850	-0.1851
Denmark	-0.1821	0.1144	-0.0145	Spain	-0.1851	-0.1851	-0.1851
Finland	-0.1789	-0.0805	-0.1311	Sweden	-0.1851	-0.1697	-0.1775
France	-0.1851	-0.1851	-0.1851	UK	0.1169	0.1169	0.1169
Germany	-0.1851	-0.1375	-0.1703	US	0.1169	0.1169	0.1169
Ireland	0.1169	0.1169	0.1169				

Notes: The elasticity is obtained according to equation (26).

As it can be seen, countries that have remained with a positive elasticity in the whole period are Australia, Canada, Ireland, Japan, the UK and the US (most of them, the so-called "Anglo-Saxo economies"). For the rest of the countries, on the contrary, there is a negative, but not always constant, relationship. In most of these countries, the negative elasticities have slowly moved towards smaller negative values. This coincides with general reductions in the EPL. As we can see, broadly speaking, these elasticities present the same pattern that we found with the conditional correlation coefficients in most of the countries (see Table 1).

We also observe that, in some countries, the sign of the elasticity has changed from a negative value to a positive one. One of this "switching" countries is Denmark, which, according to the PSTR specification, changed from a negative elasticity of -0.182 to a positive elasticity of 0.114. Along this line, the EPL index was reduced from 2.4 to 1.5 between 1985 and 2007. Similar changes

in the elasticity from a negative value to a positive one can be observed in Italy in 2003, coinciding also with an important reduction of the EPL (from 3.57 in 1985 to 1.82 in 2007).

Finally, with the exception of the union's density, the rest of the institutional and control variables are significant: whereas a higher interest rate and tax wedge increase the unemployment rate, a more generous unemployment benefit corresponds to lower unemployment rates.

5 Conclusions

In this paper, we have analyzed the different reaction of the unemployment rate to the the wage-productivity gap in a set of OECD countries during the last 25 years.

Looking to the conditional correlation coefficients of a vector autoregressive (VAR) forecast errors as proposed in den Haan (2000), and using panel nonlinear smooth transition (PSTR) models, we have found an important difference between economies with a low degree of employment protection legislation and countries with high levels of protection in regular contracts. Indeed, while the first group is characterized by a positive relationship between unemployment and the wage gap, countries belonging to the second group react differently. According to our theoretical model, in some countries, such as France and Spain, firing costs and the important weight of permanent workers give workers a market power that can be use to push up their wages in a higher magnitude than the increment of labour productivity during good times. In contrast, since temporary workers have lower bargaining power, firms can discount to these workers the extra wage adjustments in the side of regular contracts. As a result, in this type of labour market, unemployment can be reduced even though the average wage is increasing more than labour productivity.

We have also identified some countries like Denmark and Italy, in which the elasticity of unemployment with respect to the wage-productivity gap changed from a negative to a positive value. According to our results, the fact that at the end of the sample period, in most of the countries, an increase in the wage gap encourages an increase in the unemployment rate is due to reductions observed in the EPL, especially in the size of temporary contracts. In other words, persistent reduc-

tions in the labour regulations, that characterized many OECD countries in recent years, can help to explain the positive relationship between unemployment and the wage-productivity gap observed in most OECD economies nowadays.

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