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ABSTRACT

The Unemployment Inflation Trade-Off in the Euro Area*

This paper analyzes the relationship between unemployment and wage inflation for 10 of the euro area countries. The combination of low wage inflation and high unemployment in Europe is usually attributed to a rise in the natural rate of unemployment. Using a panel data approach, this paper models directly the specific structural determinants of the natural rate of unemployment that may account for a changing pattern in the unemployment inflation trade-off. Moreover, it analyzes whether the responsiveness of wages crucially depends on the level of inflation and the level of unemployment. This allows to detect possible downward rigidity of wages and grease or sand effects of positive levels of inflation.

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1 Introduction

"Unemployment and inflation still preoccupy and perplex economists, statesmen, journalists, housewives, and everyone else..."

James Tobin

What James Tobin noted in the 1970s still holds true until today. One of the most striking facts about the European economies has been rising and prolonged unemployment. In fact, in most European countries unemployment has risen considerably since the 1970s without returning to its initial levels. On the other hand, both price and wage inflation in Europe have fallen and remained low since the beginning of the 1980s. The salient feature that ever higher unemployment is associated with low inflation alludes to a changing pattern of the euro area Phillips curve.

This paper's contribution is to provide new evidence for the euro area Phillips curve on the basis of country panel data.[1] Advancing on single country and aggregate euro area studies, the panel framework allows to identify and test more specific hypothesis on the determinants of the Phillips curve relation. In particular, the aims of the paper are: first, to account for shifts in the Phillips curve by explaining the underlying structural determinants of the natural rate of unemployment. And second, to investigate whether there are convexities or non-linearities in the euro area Phillips curve relation which implies the slope of the trade-off hinging on the level of inflation or unemployment.

In contrast to the European case, in the U.S. a favorable inflation performance comes along with low unemployment. The most prominent explanation for the divergent developments of the U.S. and European Phillips curve is a time varying natural rate of unemployment or NAIRU (Non Accelerating Inflation Rate of Unemployment).[2] A falling NAIRU in the U.S. and a rising NAIRU in Europe may account for a changing unemployment inflation trade-off. For example, Gordon (1997) stresses the role of a declining NAIRU as well as favorable supply shocks to explain why falling unemployment can be reconciled with low inflation in the U.S.. In contrast, in the euro area a rise of the NAIRU has been documented by a number of studies.[3] An impor-

[1] See Staiger, Stock, and Watson (2001) for a study on U.S. state Phillips curves, Nickell, Nunziata, Ochel, and Quintini (2003) who explain OECD real wages in a panel framework and a recent study by Hassler and Neugart (2003) using German regional data.

[2] Note that the two terms are used interchangeably throughout the paper.

[3] See e.g. Estrada, Hernando, and Lopez-Salido (2000), Irac (2000), Richardson, Boone, Giorno,

tant shortcoming of most studies is that the NAIRU is simply modelled as a random walk leaving any structural determinants of the NAIRU unspecified.[4] In order to get a comprehensible picture, this paper employs panel econometric techniques to scrutinize carefully which factors actually contribute to a rising NAIRU shifting the European Phillips curve.

The prime suspect for rising natural unemployment are overly restrictive labor market institutions. Indeed, European labor markets are generally characterized by a restrictive job security legislation, generous unemployment benefits and a broad coverage of labor union agreements. Yet, unemployment rose in a couple of large upward jumps, while most labor market institutions were established in the 1960s and 1970s and have remained merely unchanged ever since. Therefore, it seems difficult to explain a rising NAIRU exclusively with worsening labor market institutions over time. However, institutions may interact with macroeconomic conditions. Building on a framework proposed by Blanchard (1999) and Blanchard and Wolfers (2000) I will investigate whether the trade-off between unemployment and wage inflation is governed not only by labor market institutions but also by the interplay with macroeconomic shocks.

Furthermore, several authors have stressed the importance of product and capital market regulations for outcomes on the labor market, see e.g. Krueger and Pischke (1997). Such regulations generally lead to an inelastic labor demand curve which impedes employment effects even if wages are totally flexible. Assuming that the equilibrium unemployment rate depends on a wide range of economic and institutional characteristics, this paper analyzes the respective effects within a model of the wage Phillips curve.

The simultaneous occurrence of low and stable wage inflation and high and increasing unemployment would require a dramatic increase in the natural rate of unemployment. Alternatively, wage inflation could become less responsive to disequilibria in the labor market. In this case, the slope of the Phillips curve becomes smaller and wages would respond less to a deviation of unemployment from its natural level.

Given a state of low inflation and high unemployment in many euro area countries and given the ECB's commitment for price stability it is natural to ask whether this

Meacci, Rae, and Turner (2000), Franz (2001) for euro area country evidence and Fabiani and Mestre (2000) and Fabiani and Mestre (2004) for studies using aggregate euro area data.

[4] Note also that since the NAIRU is an unobservable theoretical construct its estimation is subject to considerable uncertainty, see e.g. Staiger, Stock, and Watson (1997).

state of inflation itself affects the Phillips curve trade-off. It is widely accepted and documented in numerous studies that high inflation exerts high welfare cost to the economy. Most importantly, the higher the inflation the more variable is relative price variability distorting the information content of prices.[5] However, too low inflation may involve considerable costs as well. Tobin (1972) argued that inflation could facilitate real wage changes in the face of downward nominal wage rigidity. Formalizing Tobin's argument in a model, Akerlof, Dickens, and Perry (1996) showed that indeed moderate levels of inflation grease the wage setting process reducing unemployment in the long run.[6] Similarly, Wyplosz (2001) provides evidence that a sand effect is present at very low rates of inflation while grease effect dominates at inflation rates above 2%.[7] In this paper, I will investigate whether the trade-off between unemployment and wage inflation hinges on the level of inflation.

The grease effect of inflation rests on the assumption of downward nominal wage rigidity. Many studies using micro data of individual wages confirm some degree of wage stickiness.[8] This paper studies downward rigidity of wages from a macro perspective. It will be analyzed whether wages respond differently to a labor market disequilibrium, i.e. unemployment above its natural level in low inflation environments. If so, it is investigated whether there is a nonzero inflation rate that greases the wheels of the labor market.

The responsiveness of wages to changes in unemployment may also give indication for the degree of persistence in nominal wages. If unemployment is high and persistent, the resulting growing share of long term unemployed might not exert enough pressure on wages to bring down unemployment. Therefore, wages may be generally more

[5] See Friedman (1977) who referred to inflation as "sand" since it interferes with the transmission of price signals. See also Issing (2001) for a recent review on the costs of inflation and e.g. Nautz and Scharff (2005) for recent evidence.

[6] More recently, Akerlof, Dickens, and Perry (2000) demonstrated that if people ignore inflation at low levels, i.e. money illusion prevails, then operating the economy at low inflation will be favorable for aggregate output and employment.

[7] The grease effect refers to the flexibility benefit arising from firms' ability to lower workers' real wages in a state of low inflation without a cut in nominal wages. The sand effect refers to the situation when inflation distorts the information content of prices and wages. See also Groshen and Schweitzer (1999) showing for the U.S. that inflation below 5% has a positive grease effect while inflation above 5% will generate a sand effect, i.e. leading to suboptimal employment outcomes. Clearly, when inflation rises money illusion vanishes and price uncertainty rises which implies that the sand effect will eventually dominate the grease effect.

[8] See Card and Hyslop (1997) who show that an increase in inflation allows wages to fall faster, i.e. to respond more flexibly on changing labor market conditions. More recently, several studies for the European countries have also documented a considerable degree of downward nominal wage rigidity, see e.g. Smith (2000), Knoppik and Beissinger (2003), Bauer, Bonin, and Sunde (2003), Dessy (2004) and Holden and Wulfsberg (2004).

persistent. To shed light on this hypothesis, the Phillips curve is analyzed under different unemployment environments and the share of long term unemployment will be included into the Phillips curve specification.

The main results of the paper can be summarized as follows. First, the natural rate of unemployment can be well explained by labor market institutions and macroeconomic shocks. Second, a one percent increase in the unemployment gap triggers a 0.2% fall in wage growth. Third, wage flexibility increases with higher inflation, i.e. wages respond stronger on a deviation of unemployment from its natural level. Fourth, wages respond much less when unemployment is above its natural rate compared to unemployment below its natural rate. And finally, the Phillips curve becomes significantly flatter in high unemployment environments with particularly the share of long term unemployment not exerting any significant pressure on wages. Taken the result together, a changing Phillips curve pattern can be explained by both, a movement in the natural rate of unemployment and a change in the Phillips curve slope depending on the level of inflation and unemployment.

The remainder of the paper is organized as follows. The next section discusses possible structural influences on the unemployment inflation trade-off and introduces the variables that will enter the empirical model of the Phillips curve. Section 3 specifies the wage Phillips curve that will be used for estimation. Section 4 introduces the specific estimation approach chosen for the wage Phillips curve in a panel econometric framework. The empirical results are given in Section 5. Finally, the conclusions offer some discussion of the main results.

2 Structural Factors Affecting the Unemployment Inflation Trade-Off

Inflation in Europe is not falling too much as to explain the huge increase in unemployment by a simple Phillips curve trade-off. In particular, over the past 10-15 years inflation has remained at low levels while unemployment still increased in most euro area countries. This implies that ever higher unemployment in Europe is associated with low levels of wage inflation. Clearly, the general time pattern of the trade-off between unemployment and wage inflation as seen in Figures 1 and 2 gives rise to the conjecture that the Phillips curve relation might have changed over time. De-

spite some degree of diversity in terms of the unemployment experience, in all euro area countries there might be factors at work that shift or tilt the trade-off between unemployment and wage inflation.

The proponents of a Phillips curve relation offer several kinds of explanations for possible changing patterns. First, external supply shocks could have affected the evolution of inflation leaving unemployment unchanged. However, the question in the European case is not why inflation is so low given unemployment, but rather why unemployment is so high given low inflation. Therefore, a shift in the Phillips curve may arise from a rising natural rate of unemployment that leaves the unemployment gap in the Phillips curve relation unchanged. Another explanation may be traced back to inflationary expectations in the Phillips curve relation. In fact, Akerlof et at. (1996) have argued that at low inflation, people may ignore inflation reducing the impact of inflation expectation on the Phillips curve relation. The fact that the unemployment inflation trade-off crucially depends on the level of inflation introduces a form of state dependence or nonlinearity to the Phillips curve relation.

The preferred explanation for a changing Phillips curve relation in Europe is, however, that equilibrium unemployment, or the NAIRU, is varying over time and has considerably increased in recent years.[9] Unemployment rates in euro area countries have hardly returned to low levels. The persistent evolution of unemployment suggests the influence of structural factors rather than mere business cycle movements. The question is what factors have contributed to the rise in unemployment or, more generally, what are the factors behind the movements of the natural rate of unemployment.

In Europe there seems to be a widespread agreement that the rising NAIRU is due to rigid labor markets governed by overly restrictive labor market institutions, see e.g. Siebert (1997). Especially in the light of diverging developments in the U.S. and Europe this might be a reasonable explanation. An institutional based explanation has, however, two important shortcomings. First, labor market institutions were already in place when unemployment was lower in Europe than in the U.S. and many of the institutional rigidities are declining since the 1980s, see Blanchard and Wolfers (2000). Second, labor market institutions did not change that significantly to explain large changes in European unemployment, see Machin and Manning (1999). Therefore, Blanchard (1999) and Blanchard and Wolfers (2000) stressed that not only the

[9] See e.g. Fabiani and Mestre (2000) for evidence on an increasing NAIRU for the euro area.

institutional setting but also unfavorable macroeconomic shocks may have led to the rise in European unemployment.[10] Since the oil price shock of the 1970s it is evident that macroeconomic shocks severely influence labor market outcomes. In fact, the effect of macroeconomic shocks on unemployment may depend on the particular institutional setup prevalent in the individual country. Labor market institutions interact with macroeconomic shocks giving rise to an additional channel through which the NAIRU can be affected. This study will include various structural variables that might alter the unemployment inflation trade-off. In the following I will survey the forces on the NAIRU and on wage inflation that are analyzed in the empirical model given in Section 3.

Macroeconomic Shocks and Labor Market Institutions

Although one expects no long run relationship between the level of unemployment and the level of productivity, assuming a short run trade-off in terms of the growth rate is quite reasonable. Reductions in productivity growth, for example, can result in higher unemployment if real wages keep rising at their customary pace. This can be the case if workers and firms are too slow in adapting to slowed down **total factor productivity (TFP)** growth. Indeed, total factor productivity has slowed down considerably for the euro area countries since 1971. For example, in Germany average total factor productivity growth declined from around 3% in the 1970s to 0.2% in the 1990s.

Real interest rates may be seen as a measure of the cost of capital. Higher real interest rates are expected to slow down economic activity since capital costs increase which leads to lower investment eventually decreasing employment.[11] More general, higher interest rates simply depress aggregate demand. The restrictive stance of monetary policy of many European central banks in the last decades suggests that high interest rates may have played a decisive role for the evolution of wage inflation and unemployment in Europe. In Germany average real interest rates were around 2.8% in the 1970s while around 3.8% in the 1990s. However, empirical evidence remains unclear whether there is a long run effect of interest rates on unemployment, compare

[10] Notice that the term "shock" is used here following the terminology by Blanchard and Wolfers (2000). The shocks are not shocks in a time series econometric sense since they are not generated from a VAR and are not mean reverting.

[11] Another channel through which interest rates affect unemployment proposed by Phelps (1994) works through the increase of the mark up chosen by imperfectly competitive firms.

Blanchard (1999).

The variable **labor demand** is measured as the labor's share of total business sector income. The labor share may decrease due to shifts in technological change away from labor or a decrease in the wage relative to the capital costs.[12] A fall in labor demand is expected to be associated with higher unemployment if a slow down in the labor demand is not neutralized by falling real wages. For the present sample of the euro area countries a fall in the labor share over the period from 1970-1999 is apparent.[13]

Labor market institutions affect the unemployment inflation trade-off influencing the bargaining process of workers and employers. Institutions that increase the bargaining power of workers are likely to increase wages and worsen workers' employment prospects. An institutional factor often stressed in this context is the extent of **employment protection**. Usually it is quite cumbersome and expensive to lay off workers in Europe. However, as noted by Blanchard and Katz (1997), there is no unequivocal theoretical case on whether more employment protection raises the unemployment rate or not. On the one hand, employment protection increases wage costs and hence reduces labor demand.[14] On the other hand, it increases employment security which induces employees to invest in firm specific human capital and hence increases firm specific productivity and output.[15]

Collective bargaining is an important institutional setting that determines wages of workers in Europe. Generally, a higher union density is associated with higher union power resulting in upward pressure on wages. Moreover, a highly coordinated centralized bargaining has been associated with low unemployment since the system allows to internalize external shocks, see Calmfors and Driffill (1988). Union density increased until the late 1970s and early 1980s but then declined modestly until today in most euro area countries.[16]

[12] If wages grow faster than productivity there will be a long run substitution effect against labor, see Blanchard (1999).

[13] A couple of authors have argued that this fall is especially pronounced for the least skilled workers since labor demand shifted towards more skilled labor due to technological change and increased international competition, see e.g. Gottschalk and Smeeding (1997)

[14] One could also argue that high employment regulation strengthens the position of incumbent workers, i.e. "insiders", on the wage bargaining process, leading to higher wage growth despite high levels of unemployment, see Lindbeck and Snower (1988).

[15] A wide consensus exists, however, that high employment protection leads to an increase in unemployment duration since it reduces the overall labor turnover.

[16] Notice that union density may in some cases be an imperfect measure of bargaining strength. In France, for example, union density is relatively low while union coverage is high. Therefore, bargaining strength is generally considered to be high in France.

Government policies may also directly influence the unemployment inflation trade-off. The **replacement rate** used in this study is defined as the ratio between unemployment benefits and the median wage. Unemployment benefits are more generous in Europe than in the U.S. and are, therefore, usually perceived to play a predominant role in explaining the divergent unemployment developments. Higher unemployment benefits lead to lower search activity and affect most importantly the duration of unemployment, see Hunt (1995). Unemployment benefits also have a direct effect on the aspiration wage and thus directly affect the wage bargaining process through demanding higher gross wages. However, usually unemployment benefits are linked to the wage level. So any productivity driven change in wages may change unemployment benefits as well and thus should leave unemployment unchanged, see Blanchard and Katz (1997).

In addition to the level of unemployment benefits, the **duration** of the unemployment benefit payment may play a role in determining the level unemployment. Lengthy unemployment benefit payments are usually associated with disincentives to unemployed persons to search for a job. If the unemployed remains unemployed human capital will depreciate and chances for re-employment decrease. Therefore, long term unemployment will rise.

Another variable possibly associated with changes in unemployment are **labor taxes**. If taxes are increased, wages must fall as to leave labor costs unchanged. Assuming wages to remain unchanged or even to rise this will increase unemployment, see Nickell, Nunziata, Ochel, and Quintini (2003).

In a recent study Belke and Fehn (2001) included measures representing the capital market into the analysis of German unemployment. The intuition is that not only labor market institutions but also restrictions on capital and product markets affect labor market outcomes.[17] Two variables measuring the general access to **venture capital** are included in this paper to proxy the impact of capital market institutions on unemployment. This, of course, is far from capturing all effects associated with possible influences from capital and product markets.

In general, the structural factors presented above are assumed to affect the trade-off between unemployment and wage inflation either directly or indirectly through the

[17] See also Krueger and Pischke (1997) for further details. The authors argue that the labor demand curve becomes more inelastic in the presence of constraints in capital markets. This implies that lower wages will only have a modest effect on employment.

natural rate of unemployment. The next section explains the specific specification of the wage inflation Phillips curve chosen in this paper.

3 The Specification of the Wage Phillips Curve

The relationship between wages and unemployment is a widely debated issue in the theoretical as well as the empirical literature. In particular, discussion has mainly centered around the question of whether the relation can be described by a traditional Phillips curve or a wage curve, see Blanchflower and Oswald (1994). The latter framework describes the relation between wages and unemployment in levels while the former relates unemployment to the growth rate of wages.[18] While many theoretical models, e.g. the efficiency wage or matching model generate a relation between the level of the real wage and unemployment, from a macroeconometric perspective the evidence is clearly in favor of a Phillips curve specification, see Grubb (1986), OECD (1997) and Blanchard and Katz (1997, 1999).[19] These studies argue that wage growth will be determined by both the level of productivity and the unemployment rate. Therefore, the more appropriate specification is a wage Phillips curve that also includes an error correction term in which the real wage adjusts to the level determined by productivity.[20]

The specification chosen in this paper acknowledges the unit root properties of the data. Using single time series and panel unit root tests, unemployment, price inflation and wage inflation were found to be nonstationary time series for the sample period and for the countries under observation, see Table 1 in the Appendix.[21] Moreover, the relationship between the real wage and the level of productivity was also found to be instationary. Therefore, the specification of the wage Phillips curve in this paper is a variant of the wage equation in Grubb (1986) and Blanchard and Katz (1997) which

[18] Blanchflower and Oswald (1994) show that there is little autoregression in regional wage equations when appropriately controlling for region and time effects. Blanchard and Katz (1997), however, concludes that Blanchflower and Oswald's results are not robust (at least for the U.S.) to changes in the wage measure, see also Card and Hyslop (1997) for similar results. On the other side, the Blanchard and Katz (1997) results is also still open to debate, see Bratsberg and Turunen (1996).

[19] It can be shown that if the reservation wage is perceived as an aspiration wage based an past wages this will generate a Phillips curve reaction as observed in the data, see Blanchard and Katz (1997).

[20] See Blanchard and Katz (1999) who derive theoretical conditions under which one can generate a theoretical underpinning for the empirical wage Phillips curve. In particular, they propose that the reservation wage is determined by past real wages and the level of productivity.

[21] Inflation persistence is a well known phenomenon in macroeconometric research. Wage inflation persistence might have various explanations such as loss aversion, union power or fairness considerations, see Bewley (1999) for a survey.

is given as follows:[22]

$$\Delta^2 w_{it} = \alpha_i + \beta(u_{it-1} - u^n_{it-1}) + \gamma(\Delta w_{it-1} - \pi_{it-1} - \theta_{it-1}) + lags + \epsilon_{it} \qquad (1)$$

where w_{it}, u_{it}, u^n_{it}, π_{it}, θ_{it} represent the individual country series of nominal wages, the unemployment rate, the natural rate of unemployment, price inflation and trend labor productivity growth, respectively. The residual ϵ_{it} is assumed to be $i.i.d.$ distributed and with mean zero and variance σ^2_ϵ.

The model contains two long run equilibrium relations. First, the real wage equilibrium relation which enters the equation in the form of an error correction term. The term reflects that real wage growth adjusts in the long run to productivity growth. Second, the specification above includes the long run relation between the unemployment rate and its natural rate.

The variable u^n_{it} represents the country specific natural rate of unemployment specified as:

$$u^n_{it} = \phi_i + \rho X_{it} + \eta_{it} \qquad (2)$$

with ϕ_i representing features unique to each country that are constant over the sample, X_{it} denoting structural variables that affect the natural rate of unemployment, and η_{it} are unmeasured influences that are assumed to be uncorrelated with all other explanatory variables. In general, the variable u^n_{it} reflects all structural factors that are perceived to shift the unemployment inflation trade-off, see Ball and Mankiw (2002). In this respect, the vector X_{it} plays a crucial role in explaining shifts in the Phillips curve associated with changes in the natural rate of unemployment. In this paper, the vector X_{it} includes the structural variables introduced in the previous section.

The error correction term $(\Delta w - \pi - \theta)$ can be interpreted as a long run equilibrium relationship between real wage growth and productivity growth. The panel unit root test as shown in Table 1 in the Appendix indicates that the relationship is indeed stationary. The term usually has a negative coefficient, γ, implying that wages will grow faster if productivity growth is below real wage growth. Furthermore, the lags of price and wage inflation in Equation (1) are added to account for expected inflation.[23]

[22] Sargan (1964) also estimated wage equation containing an error correction term for real wages adjusting to the level of productivity.

[23] Assuming adaptive expectations is a common modelling procedure in the empirical literature on the Phillips curve, see e.g. Gordon (1997).

The error term ϵ_{it} is usually interpreted as some kind of supply shock that shifts the unemployment inflation trade-off, see Ball and Mankiw (2002).[24]

4 Estimation Procedure

The model given in Equation (1) is estimated using a two step procedure. Since the natural rate of unemployment is an unobservable theoretical construct it is modelled using the structural variables introduced in Section 2. If the unemployment rate, u_{it}, and the structural variables, X_{it} form a cointegrating relation such that $(u_{it} - u_{it}^n) \sim I(0)$, i.e. is stationary, the unemployment rate can be regressed on the structural variables where the parameters can be estimated superconsistently.[25] The following equation is estimated in a first step:

$$u_{it} = \phi_i + \rho X_{it} + \eta_{it} \tag{3}$$

where

$$u_{it} - (\hat{\phi}_i + \hat{\rho} X_{it}) = u_{it} - \hat{u}_{it}^n$$

In a second step, the following equation is estimated to display the Phillips curve relation, see Equation (1):

$$\Delta^2 w_{it} = \alpha_i + \beta(u_{it-1} - \hat{u}_{it-1}^n) + \gamma_1(\Delta w_{it-1} - \pi_{it-1} - \theta_{it-1}) + lags + \epsilon_{it} \tag{4}$$

with $\hat{u}_{it}^N = \hat{\phi}_i + \hat{\rho} X_{it}$ from the previous step. The estimated wage equation includes also lags of past changes in price and wage inflation. Note that the structural factors represented by the vector X_{it} shift the Phillips curve via movements in the natural rate of unemployment, u_{it}^n.

4.1 Specification Issues

The model given in Equations (3) and (4) is estimated using various versions of a fixed effects panel model. The fixed approach seems appropriate in a cross-country context

[24] Note that there might be an identification problem stemming from the fact that ϵ_{it} is likely to be correlated with movements of the natural rate of unemployment, u_{it}^n, and hence with the other exogenous variables. Attempting to avoid this identification problem, in most Phillips curve applications the supply shock is proxied by adding energy, food and import price inflation, see Gordon (1997).

[25] According to the panel unit root tests, the unemployment gap is found to be stationary, see Table 1 in the Appendix.

when the differences across countries can be seen as shifts of the regression function, see Baltagi (2001).[26] The random effects specification was rejected by a standard Hausman test. The typical assumption of *i.i.d.* residuals in the fixed effects approach is critical in the context of panel data set where the number of cross sectional units is relatively small and the number of time periods is relatively large. In the cross country case it seems reasonable to expect differences in the variance of the variables across countries that might cause a heteroscedastic and cross-correlated error structure. For the present data, simple likelihood ratio tests point towards the existence of heteroscedasticity and cross correlation. Therefore, a FGLS (feasible generalized least squares) estimator allowing for cross sectional heteroscedasticity as well as cross correlation between units will be used.

A problem of the fixed effects FGLS estimation arises from the dynamic character of the model in Equation (4). In the presence of lagged variables the fixed effects estimation becomes inconsistent, see Nickell (1981). However, the bias crucially depends on the number of time periods, T. If the number of individuals, N goes to infinity the bias remains unless T also goes to infinity which would eliminate the bias. In the case of this model with a fixed $T = 120$, the estimation bias can be considered as negligible.[27]

When estimating an aggregate Phillips curve for Europe (see e.g. Fabiani and Mestre, 2004), there is an implicit assumption of common underlying determinants for the unemployment inflation trade-off in individual countries. However, to speak of "one" Europe is not always appropriate since for example significant differences in unemployment and in its underlying determinants exist across European countries. The panel data approach taken in this study mitigates the problem of common underlying determinants in so far as to allow country differences in terms of country specific intercepts.

[26] The fixed effects model, however, ignores the information coming from a cross sectional comparison. It is clear, however, that the country panel does not deliver enough cross sectional information as to efficiently apply an approach based purely on the cross sectional variation.

[27] According to Hsiao (2003) the bias generates a correlation between the explanatory variables of order $(1/T)$. In addition, the parameter estimate will be biased downward by about 0.008, see Hsiao (2003, p.72).

5 Empirical Results

Natural unemployment and the wage Phillips curve are estimated using a sample of 10 euro area countries, namely Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain.[28] The sample ranges from the first quarter of 1970 to the fourth quarter of 1999, see Table 2 in the Appendix for data definitions and sources.

5.1 Structural Shifts in the Wage Phillips Curve

This section provides evidence on how macroeconomic as well as institutional factors affect the trade-off between unemployment and wage inflation. In particular, it analyzes how several structural variables directly affect the natural rate of unemployment, taking into account that any change in the latter can be interpreted as a shift in the Phillips curve. Table 4 shows the results from the first step regression of Equation (3) explaining the natural rate of unemployment.[29]

Table 4, column (2) displays the benchmark specification (Model I) that includes the basic set of institutional variables and macroeconomic shocks from the Blanchard-Wolfers data set. The coefficient on **total factor productivity** (*TFP*) is significantly negative, which means that a fall in total factor productivity is associated with an increase in the natural rate of unemployment. The negative coefficient of the **labor demand** variable indicates a subsequent rise in equilibrium unemployment if labor demand drops. The result that a rise in the **real interest rate** comes along with a rise in unemployment confirms the notion that an increase in capital costs depresses investment and employment.

Labor market institutions generally affect the natural rate of unemployment through influencing the wage setting process, see Nickell, Nunziata, Ochel, and Quintini (2003). **Employment protection** has a significant positive impact on the natural rate of unemployment. Moreover, **union density** displays a significant negative effect on unemployment. The result may indicate a high level of coordination among the collective

[28] Greece and Luxembourg were omitted due to data availability constraints.

[29] Note that there are several studies that analyze the impact of shocks and institutions in more detail, see e.g. Belot and van Ours (2001), Nickell, Nunziata, and Ochel (2005), or Nunziata (2003). The objective of this paper is not to find an exact specification for actual unemployment but rather to propose a reasonable specification for the determinants of the natural rate of unemployment.

bargaining parties as well as the unions which can actually have a positive impact on employment, see Calmfors and Driffill (1988).[30] The coefficient of the **replacement rate** has a positive sign. An increase in the replacement rate can be interpreted as an increase in reservation wages and thus increasing overall unemployment. The results are generally consistent with the findings of Blanchard and Wolfers (2000) for OECD unemployment rates.

Figure 3 shows the shares of the different macroeconomic shock and labor market institution variables in accounting for the change in natural unemployment from 1970 to 1999 in the euro area countries. It is apparent from the graph that both, labor market institutions and macroeconomic shocks contribute to the explanation of natural unemployment. In particular, in most countries the contribution of total factor productivity and the replacement rate is more pronounced. Explaining the increase in euro area countries' natural unemployment solely by labor market rigidities seems, therefore, too shorthanded.

Table 4 also exhibits the relevance of further institutional variables. Due to data availability problems, the sample size is reduced considerably in the following regressions. Therefore, the results must be interpreted with caution since results are based on a smaller time period and/or only a subset of countries. Model II presented in column (3) of Table 4, shows that **taxes** have a significant positive impact on equilibrium unemployment, compare Daveri and Tabellini (2000).

Belke and Fehn (2001) have claimed that capital market variables like the availability of venture capital also affect European employment prospects. The intuition for the inclusion of capital market variables is that possibly not only labor market institutions but also institutions in product or capital market hinder job creation in Europe. Model III includes the amount of **early stage venture capital investment** (*venture capital I*) and **venture capital and expansion investment** (*venture capital II*) as a proxy for the relevance of the capital market for the determination of unemployment. In line with the results in Belke and Fehn (2001) both variables exhibit a significant negative impact on unemployment, see Table 4, column (4). The finding that an increase in the availability of venture capital reduces the natural rate of unemployment underlines that the defect of European labor markets may not be entirely due to rigid labor markets, see also Pissarides (2003) and Lopez-Garcia (2003).

[30] This is in line with Nickell (1997) who found that a high degree of union coordination and highly centralized unions leads to lower unemployment.

In Model IV, country specific trends have been included into the specification of equilibrium unemployment to proxy additional unobserved upward trending variables, see Table 4, column (5). All country specific trends were found to be significant and the R^2 increases. This suggests that simply modelling equilibrium unemployment by the macroeconomic shocks and labor market institutions is not sufficient to account for the rise in euro area natural unemployment. In the following I will, therefore, analyze whether the interaction of the variables in the model might help to improve the explanation of equilibrium unemployment.

In a first step, interactions between different labor market institutions are added to the benchmark specification (Model V).[31] The results shown in Table 5, column (2) indicate that an increase in benefit payment duration for a given level of unemployment benefits tends to increase unemployment. Similarly, an increase in employment protection for a given state of union power also increases unemployment. This demonstrates that even if individual institutions do not affect unemployment, they might be relevant for the evolution of unemployment in combination with other labor market institutions.

Similar shocks across countries can have very different effects depending on the institutions prevalent in the particular country. In particular, the institutional setup may affect the persistence of unemployment in response to specific shocks. This point was emphasized by Blanchard (1999) and Blanchard and Wolfers (2000) who show for the set of OECD countries that differing unemployment performances can well be explained by the interplay of shocks and institutions.[32] For that reason, Model VI includes interactions between all macroeconomic shocks with the labor market institutions variables while Model VII also adds the interaction of the institutional variables with each other. The results are reported in Table 5, column (3) and (4).

Overall, most of the interaction terms' coefficients are significantly different from zero which means that indeed labor market institutions and macroeconomic shocks are interrelated issues. The interaction of TFP with employment protection and union density has a positive sign indicating that a higher employment protection and union

[31] See Belot and van Ours (2001) for a more comprehensive study of such institutions on the evolution of actual unemployment.

[32] Blanchard (1999) provides a theoretical discussion on how the interplay of shocks and institutions work through the channels of duration dependence and marginalization. See this source for details on these aspects. See also Den Haan, Haefke, and Ramey (2001) for a theoretical treatment of shocks and institutions within a job matching framework.

density mitigate a negative TFP shock. The interactions with the replacement rate, however, accentuate the effect of a TFP shock. Concerning the interactions with labor demand, employment protection as well as union density worsen the dampening effect of a fall in labor demand on unemployment. Most interactions with the real interest rate do not exhibit any significant impact.

In Model VIII country specific trends are added to the previous model, see Table 5, column (5). The country trends are again significant in this specification and the R^2 increases indicating that the model still does not fully capture the steady increase in unemployment rates in the euro area.

To summarize, the results show that modelling equilibrium unemployment by macro shocks and labor market institutions gives a good approximation to the data representing equilibrium unemployment. Yet, the significance of the country specific trends suggests that there are still variables missing in the specification to account for the upward trend in most euro area countries' unemployment rates.

5.2 The Unemployment Inflation Trade-Off

This section presents the estimation results from the wage Phillips curve specified in Equation (4). In particular, it examines how strongly wages respond to deviations from equilibrium determined by productivity growth and to changes in the state of labor market slack. By including the unemployment gap it is analyzed whether the Phillips curve can be implicitly explained by movements in the natural rate of unemployment.

Unemployment gaps are constructed from the models presented in the previous section. Table 6 shows the results from estimating several versions of Equation (4), varying only the unemployment gap measure. In general, independently of the choice of the specific unemployment gap measure, a rise in the unemployment gap of 1% is associated with a fall in wage growth of about 0.10% to 0.20%.[33] Several authors have interpreted the unemployment coefficient as some kind of wage flexibility measure, see e.g. Bean (1994). It constitutes the responsiveness of wages towards changes in labor market conditions as indicated by the unemployment gap. The results reveal that wages in the euro area respond significantly to changes in the unemployment gap. The

[33] Note that this result is fairly robust to the estimation procedure. Even when using a one step estimation with the inclusion of the structural variables in a reduced form, the coefficient of the unemployment rate is around -0.15.

coefficient is, however, lower than the one found for the U.S., see Staiger, Stock, and Watson (2001).[34] In addition, the country effects reveal that there are considerable differences in the location of the country specific regression lines. An F-test indicates that the coefficients are jointly greater than zero and differ significantly from each other.

The long run real wage and productivity growth equilibrium term ($\Delta w - \pi - \theta$) is highly significant and displays the expected sign. A negative coefficient implies that wage growth will increase if real wage growth is below its average determined by productivity growth, see Grubb (1986). There is also significant short run adjustment in the model as indicated by the differences of wage growth and inflation. Gordon (1997) suggested to include supply shocks like energy and import price inflation into the Phillips curve specification to explain the favorable Phillips curve shift in the U.S. These supply shocks were not found to be significant and are, therefore, omitted from the specifications shown in the tables.

In the following section it is investigated whether there are additional factors at work changing the pattern of the euro area Phillips curve.

5.2.1 The Unemployment Inflation Trade-Off and Downward Nominal Wage Rigidity

Wage inflation has declined only slightly in recent years implying that actual unemployment must have been close to its natural level. Therefore, to explain low wage inflation and increasing unemployment at the same time, this would require a dramatic increase of the natural rate of unemployment in recent years. The question, however, arises whether a moving NAIRU alone suffices to account for a changing pattern of the Phillips curve. Especially with fairly stable wage inflation observed in recent years, wages could have become less responsive to disequilibria in the labor market implying a smaller slope of the Phillips curve. Explanations for a changing Phillips curve pattern in this direction have been provided by Akerlof, Dickens, and Perry (2000) who argue that the level of inflation itself is crucial for the pattern of

[34] The coefficient found by Staiger, Stock, and Watson (2001) is about 0.6 indicating a higher responsiveness of wages towards changes in unemployment. This difference can mean both, a higher wage flexibility or simply that the unemployment rate is a better measure of capacity utilization in the U.S..

the Phillips curve.[35]

The Phillips curve coefficient can be interpreted as displaying the responsiveness of wages towards changes in unemployment gap. If wages are downward rigid then wages will be unresponsive to changes in labor market conditions when inflation is essentially zero. According to Tobin (1972) a certain amount of inflation benefit the economic performance in labor market by allowing greater wage flexibility. In particular, some degree of positive inflation allows firms to reduce real wages without having to cut workers' nominal wages. Indeed, Card and Hyslop (1997) provide evidence for the U.S. that wages fall faster, i.e. are more flexible, when inflation is high.

In this study aggregate data on wage inflation is used to analyze whether there are signs for downward rigidity in wages when economic conditions vary. Moreover, it will be analyzed whether there are levels of inflation that allow a flexible movement of nominal wages. In a first step, the wage Phillips curve is estimated with two different samples, the first one ends in 1985 and the second one starts in 1985. After 1985 wage inflation in most euro area countries decreases significantly. The results shown in Table 7, column (2) and (3) display that the Phillips curve is much flatter in the time after 1985, i.e. in a low inflation environment than in the first half of the sample. Apparently, the unemployment gap is not sufficient to generate a stable Phillips curve coefficient over time. A change in the unemployment gap affects wage growth much less in the post 1985 era than before. This result suggests that the change in inflation itself might have contributed to a changing Phillips curve pattern over time.[36]

To further investigate the hypothesis of an inflation state dependent Phillips curve slope, the equation is estimated conditioning on different inflation environments. The specifications include the unemployment gap for low inflation, i.e. below 2% and high inflation, i.e. above 2% respectively. The results shown in Table 7, column (4) and (5) clearly indicate that the Phillips curve is much steeper in high inflation environments and vice versa. In line with Card and Hyslop (1997) the result shows that wages respond stronger, i.e. are more flexible when inflation is high.

[35] Notice, however, that Akerlof, Dickens, and Perry (1996, 2000) derive a long run trade-off between inflation and unemployment at low rates of inflation. In this paper, a long run trade-off is ruled out by the inclusion of the unemployment gap, i.e. the long run equilibrium of actual unemployment and its natural level.

[36] Notice that, of course, other parameters in the model may also change. Brainard and Perry (2000) have found the coefficient on the proxy of inflation expectations changed considerably over time. This is just another justification that a wide range of unemployment rates can be associated with low inflation.

If wages are downward rigid then lowering wages is much harder than to increase wages. An unemployment rate above its natural rate would necessitate lowering wages to move unemployment back to equilibrium. Similarly, unemployment below the natural level would push up wages. Table 8, columns (2) and (3) show the results from estimating the benchmark model in two different labor market setups, namely when unemployment is above and below its natural rate, respectively. Interestingly, the results reveal that the responsiveness of wage growth seems to be asymmetric. When unemployment is above the natural rate lowering wages seems to happen at a much slower pace than pushing wages upward in the case when unemployment is below its equilibrium. This result further underlines the hypothesis of downward rigidity of wages.

Shedding more light on the issue of downward rigidity of wages, Equation (4) is estimated under the condition that inflation is low and the economy is hit by an adverse shock, i.e. unemployment is below its natural level. At inflation below 3% percent the Phillips curve slope becomes relatively small indicating that wages growth will not change much in response to an adverse shock, see Table 8, column (4). At lower inflation the trade-off between unemployment and wage inflation even breaks down. In this case, i.e. inflation being close to zero, unemployment does not exert any pressure at all on wages giving clear evidence of downward nominal wage rigidity. Raising inflation the slope coefficient becomes significant and rises with the level of inflation. The result suggests that there is a level of inflation that helps to grease the wheels of the labor market, i.e. that circumvents the problems associated with downward rigidity in nominal wages.

5.2.2 The Unemployment Inflation Trade-Off and Wage Persistence

Unless unemployment is close to its natural level, ever increasing unemployment should trigger large movements in wages to bring back the former back to its equilibrium. In particular, an upward trend in unemployment should lead to falling wage growth over time. However, in the euro area, the observed evolution of wage growth is generally fairly persistent. For example, German aggregate quarterly real wage changes exceed 3% per quarter only in a few cases, see Christoffel and Linzert (2005). Moreover, instead of constant falling, wage growth remained fairly constant over time. The question, therefore, arises of what hampers the equilibrium reaching forces in the

labor market. If the Phillips curve slope depends on the level of unemployment itself, i.e. falls when unemployment increases, then wage persistence can be reconciled with rising and persistent unemployment in the euro area.

An unemployment gap of a particular magnitude may affect wages quite differently in different unemployment environments. Equation (4) is estimated conditional on unemployment being above and below 6%, respectively. The results shown in Table 9 indicate that the Phillips curve becomes steeper if unemployment is low. The labor market is tighter and hence wages are more responsive to changes in labor market conditions. In contrast, if unemployment is high, the Phillips curve is flatter suggesting that labor market conditions are less decisive for the wage bargaining process. Unemployment apparently becomes a poor indicator of labor market slack and distorts the adjustment process through not exerting sufficient pressure on wage inflation.

High and persistent unemployment as observed in many euro area countries is usually accompanied by a high share of long term unemployment.[37] According to insider-outsider theories of the labor market, long term unemployed persons become less attached to the labor market while insiders actively set wages in the bargaining process, see e.g. Lindbeck and Snower (1988) for a survey. The reason for that may be that long term unemployed lose skills over time. Moreover, the longer a person's unemployment spell, the more likely it is that long term unemployed become discouraged and reduce their search effort.[38] Therefore, long term unemployed become less relevant for the wage formation process increasing the bargaining power of insiders.

To test this hypothesis, the share of long term unemployment is included into the estimation of Equation (4). Table 9, column (4) shows that long term unemployment does not display any effect on wage growth. Apparently, the pool of long term unemployed will not help to bring down wage inflation. The empirical evidence supports the presence of high and persistent unemployment in the euro area that is unable to exert enough pressure on wages to bring down unemployment. More research in this direction will be necessary, to assess which part of the unemployed pool actually is a good measure of labor market slack.

In general, wages respond much stronger to changes in the unemployment gap when

[37] At a given unemployment rate in Europe, unemployment spells are larger and flows in and out of unemployment are substantially lower than in the U.S., see Blanchard and Portugal (2001)

[38] Blanchard and Diamond (1994) argue that it is also in the firms' interest to employ those with the shortest unemployment spell.

the overall labor market slack is small. In this case labor markets are likely to be tighter and hence wages are more flexible. In case of high unemployment, unemployed persons exert less pressure on wages generating slow and persistent adjustments in wages. Hence, the results in this paper suggest that labor market conditions are crucial for understanding wage inflation dynamics.[39]

6 Conclusions

This paper analyzed how wage growth has been related to unemployment in euro area countries. The fact that in Europe ever higher unemployment is related to low wage inflation suggests that the Phillips curve pattern is changing over time. This change in the Phillips curve is generally attributed to a rise in the European NAIRU. Moreover, it is widely believed that labor market rigidities are at the root of explaining this upward moving natural rate of unemployment. One objective of this paper was to test this view by explaining the natural rate of unemployment with a set of structural variables including labor market institutions as well as macroeconomic shocks. In addition, it was investigated whether the Phillips curve trade-off remains stable over time and states.

The attempt to identify possible determinants of the natural rate of unemployment proved to be quite successful. Most of the macroeconomic and labor market variables showed a statistically significant impact. Not only did macroeconomic shocks and labor market institutions individually affect equilibrium unemployment, but also the interplay of shocks and institutions was identified as an additional channel through which the movement of the euro area unemployment rate can be explained. Moreover, an increase in the availability of venture capital has been found to reduce unemployment. Therefore, capital market restrictions seem to affect the natural rate of unemployment as well. However, the significance of the country specific trends suggests that there is still an unexplained part of the increase in euro area unemployment rates.

On average a one percent higher unemployment gap is associated with a 0.2% fall in wage growth. The overall euro area coefficient is, however, smaller than coefficients usually found for the U.S., which confirms the somewhat higher wage rigidity in Eu-

[39] If one constitutes a link between wage and price inflation, then labor market conditions also become decisive for inflation dynamics in general. Slow adjustments in labor markets generating wage persistence translates directly into persistent movements in the overall inflation rate, see Christoffel and Linzert (2005).

rope, see Staiger, Stock, and Watson (2001). According to Akerlof, Dickens, and Perry (1996, 2000) the unemployment inflation trade-off may be qualitatively different for low and high inflation environments. The results show that wage flexibility increases with higher inflation, i.e. wages respond stronger to a deviation of unemployment from its natural level. On the other hand, for inflation rates lower than 2-3%, downward rigidity of wages becomes binding, resulting in an insignificant reaction of wages to disequilibria in the labor market. Furthermore, wages respond much less when unemployment is above its natural rate compared to unemployment below its natural rate. This suggests that countries with more rigid labor markets, i.e. more rigid wages may allow for higher inflation as it helps to grease the wheels of the labor market.

While labor markets in the euro area are generally more rigid then e.g. its U.S. counterpart there is still much heterogeneity across the euro area, see Nickell (1997). If labor market rigidities differ then a single inflation target of the central bank becomes problematic since the grease effect becomes effective at different states of inflation for the different countries. In a common monetary policy setup more adjustments need to be put on wages. If wages are, however, unresponsive to changes in labor market conditions when inflation is low, then employment becomes very sensitive to country specific or area wide shocks. Therefore, moderate levels of inflation might be beneficial for euro area wide output and employment.

It has been documented that the responsiveness of wages and hence the persistence in wages crucially depends on the persistence and the level of unemployment. In particular, the Phillips curve becomes significantly flatter in high unemployment environments. In addition, it was shown that long term unemployed, i.e. persons less attached to the labor market, cannot exert significant pressure on wages. The results confirm the notion of hysteresis in European unemployment that help to explain more persistent wage dynamics.

Taken the results together, it can be concluded that the changing pattern of the Phillips curve can be explained by both a movement in the natural rate of unemployment and a fall in the Phillips curve slope. In particular, wages became less responsive to disequilibria in the labor market in a state of low inflation and high and persistent unemployment.

In general, the empirical model presented in this paper contributed to sorting out more clearly the inflationary pressures coming from non-monetary factors like demand

factors, supply shocks as well as institutional factors. However, the analysis has shown that the exclusive focus on labor market institutions determining the natural rate of unemployment is not sufficient. The European labor market slack may not necessarily be rooted solely in the labor market itself but may also be influenced by various factors outside the labor market. What additional variables drive natural unemployment and how labor markets interact with product or capital markets seems still to be an unsettled issue.

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A Data and Sources

A.1 Unit Root Properties of the Macroeconomic Variables

The major advantage of employing panel unit root tests for the country panel series is the greater power of these tests compared to individual ADF tests. Table 1 shows the results from the Im, Pesaran, and Shin (2003) (IPS), Levin, Lin, and Chu (2002) (LLC) and Breitung (2000) panel unit root test. The IPS test is based on the null of non-stationarity which is $N(0,1)$ distributed under the null hypothesis. The test is characterized by the combining of individual unit root tests to derive a panel-specific result. In contrary, the LLC and Breitung panel unit root tests assume that there is a common unit root process. Like the IPS test, both tests employ a null hypothesis of a unit root.

The results indicate that most importantly wage inflation and price inflation are both I(1). Unemployment is also found to be I(1). Concerning the two long run relations in the wage equation, i.e. the unemployment gap as well as the relation of real wages adjusting to productivity growth the panel unit root tests show that both relations are stationary. Note that the results of the panel unit root tests are in line with the individual series ADF tests that for brevity reasons are not reported here.

Table 1: Panel Unit Root Tests

	IPS	LLC	Breitung
Unemployment (u)	0.46 (0.67)	-0.91 (0.18)	1.89 (0.97)
Wage Inflation (Δw)	0.59 (0.72)	1.67 (0.95)	-0.31 (0.37)
Price Inflation (π)	-1.05 (0.14)	0.03 (0.51)	-1.27 (0.10)
Unemployment gap ($u - u^n$)	-2.91 (0.001)	-2.52 (0.005)	-1.19 (0.11)
Real wage/productivity equ. ($\Delta w - \pi - \theta$)	-2.84 (0.002)	-4.07 (0.000)	-0.78 (0.21)

Notes: p-values are given in parenthesis. The lags for the unit root test equations are chosen according to the Schwartz information criterion. All equations include individual intercepts. Unemployment, wage inflation and price inflation in first differences were clearly found to be stationary. The unemployment gap refers to our benchmark model unemployment gap from Model I. All other unemployment gaps used in the estimations were also found to be stationary.

A.2 Data Sources

Table 2: Data Sources

Macroeconomic Time Series:	
Unemployment (u)	Unemployment as % of the civilian labor force. Seasonally adjusted. For Germany, registered unemployment as % of the civilian labor force. Source: OECD
Price Inflation (π)	Annualized quarterly growth rates of the Consumer Price Index (CPI). Source: OECD
Wage Inflation (Δw)	Annualized quarterly growth rates in in hourly earnings in manufacturing. For Spain, hourly earnings of all activities. Source: OECD
Energy Price Inflation (π_e)	Consumer Price Index (CPI) Energy (Fuel, gas, electricity). Source: OECD
Import Price Inflation (π_i)	Import Price Inflation Index Source: OECD
Productivity growth (θ)	Trend GDP labor productivity Source: OECD
Shocks:	
Total Factor Productivity (TFP)	Total factor productivity obtained from the Solow residual scaled by the labor share Source: Blanchard and Wolfers (2000)
Real Interest Rates	Real interest rate is the nominal interest rate on long term government securities less the anualized rate of inflation over the last five years. Source: Blanchard and Wolfers (2000)
Labor Demand	Measure of labor demand shifts. See Blanchard and Wolfers (2000) for details. Source: Blanchard and Wolfers (2000)

Table 3: Data Sources (continued)

Institutions:	
Replacement Rate (RR)	Average replacement rate over the first year of an unemployment spell. Source: Blanchard and Wolfers (2000)
Employment Protection	Index of employment protection. See the Blanchard and Wolfers (2000) data appendix for details on the construction of this index. Source: Blanchard and Wolfers (2000)
Union Density	Trade union members as a percentage of all wage earners. Source: OECD (1994)
Benefit Duration	Duration of unemployment benefit payment. Source: Nickell, Nunziata, Ochel, and Quintini (2003)
Tax Rate	Effective tax rate on labor income Source: Daveri and Tabellini (2000)
Venture Capital I	Early stage venture capital investment as per mil of average GDP. Source: Belke and Fehn (2001)
Venture Capital II	Venture capital investment as per mil of average GDP. Source: Belke and Fehn (2001)

Notes: The data on shocks and institutions was kindly provided by Justin Wolfers and the data on venture capital by Ansgar Belke which I gratefully acknowledge. The general reference on the shocks and institutions data is Blanchard and Wolfers (2000). However, as the authors note, some of the institutional data is taken from Nickell (1997). See also that reference for more details on the data. The primary reference for the construction of the shocks is Blanchard (1997).

B Tables and Figures

Table 4: FGLS Panel Estimation Results of $u_{it} = \alpha_i + \delta X_{it} + \nu_{it}$

	Model I	Model II	Model III	Model IV
TFP	-49.87 (-13.61)	-4.64 (-0.55)	28.45 (3.64)	-3.26 (-1.65)
Labor Demand	-7.31 (-8.16)	-21.72 (-4.48)	35.10 (23.27)	-19.52 (-27.29)
Real Interest Rate	15.61 (11.77)	8.44 (2.29)	-48.31 (-17.68)	5.44 (4.60)
Employment Protection	0.09 (23.96)	0.08 (5.76)	0.24 (10.11)	0.01 (2.34)
Union Density	-0.17 (-2.06)	-2.83 (-4.02)	0.14 (0.52)	0.46 (4.93)
Replacement Rate	0.07 (14.31)	-0.01 (-0.18)	0.13 (11.62)	0.13 (17.08)
Benefit Duration	0.89 (3.95)	8.35 (7.94)	3.45 (4.54)	0.81 (4.97)
Tax		0.54 (17.99)		
Venture capital I			-0.67 (-3.57)	
Venture capital II			-0.42 (-10.03)	
Country Trends	No	No	No	Yes
R^2	0.57	0.77	0.63	0.79
No. of Observations	1200	560	400	1200
No. of Cross Sections	10	7	10	10

Notes: The dependent variable in all regressions is the unemployment rate. t-values are reported in parenthesis. Country fixed effects were included in all regressions. The country effects are jointly significantly different from zero and the equality of the country effects was rejected by an F-test. The FGLS estimation method allows for heteroscedasticity and cross correlation in the residuals. The R^2 is calculated as the square of the correlation coefficient between actual and fitted values.

Table 5: FGLS Panel Estimation Results of $u_{it} = \alpha_i + \delta X_{it} + \nu_{it}$ with Interaction Terms.

	Model V	Model VI	Model VII	Model VIII
TFP	42.06 (10.71)	-148.04 (-5.88)	-163.30 (-6.51)	-185.04 (-9.53)
Labor Demand	4.46 (4.21)	108.38 (16.72)	115.11 (17.51)	60.91 (11.52)
Real Interest Rate	15.84 (10.32)	34.35 (3.18)	20.47 (1.70)	-5.61 (-0.66)
Employment Protection	0.02 (4.09)	0.13 (10.47)	0.083 (5.38)	0.033 (2.86)
Union Density	-1.34 (-4.34)	-1.07 (-4.67)	0.51 (0.88)	4.28 (8.37)
Replacement Rate	-.14 (-5.20)	0.17 (6.44)	0.33 (6.10)	0.54 (12.01)
Benefit Duration	3.11 (10.62)	12.92 (16.13)	13.73 (17.19)	2.73 (6.44)
RR/Duration	0.20 (16.91)		0.18 (7.59)	0.10 (5.77)
Protection/Union	0.03 (4.19)		-0.04 (-3.90)	-0.09 (-8.95)
TFP/Protection		19.22 (4.98)	25.63 (6.51)	16.12 (4.30)
TFP/Union		0.43 (0.93)	0.42 (0.92)	2.60 (8.23)
TFP/RR		-0.03 (-0.12)	0.06 (0.24)	1.50 (8.74)
TFP/Duration		251.37 (14.86)	235.43 (14.07)	61.85 (6.18)
LD/Protection		-19.77 (-13.66)	-22.80 (-15.28)	-20.81 (-15.48)
LD/Union		-0.69 (-5.91)	-0.80 (-6.92)	-0.22 (-2.44)
LD/RR		0.97 (15.22)	0.79 (11.04)	-0.03 (-0.88)
LD/Duration		-18.88 (-3.44)	-7.52 (-1.33)	-4.97 (-1.70)
Interest/Protection		-0.57 (-0.27)	2.84 (1.23)	9.50 (5.55)
Interest/Union		-0.15 (-0.89)	-0.20 (-1.03)	-0.28 (-2.09)
Interest/RR		-0.16 (-1.92)	-0.37 (-4.41)	-0.23 (-4.51)
Interest/Duration		-40.06 (-4.84)	-28.02 (-3.35)	-23.68 (-4.82)
Country Trends	No	No	No	Yes
R^2	0.58	0.61	0.62	0.82
No. of Observations	1200	1200	1200	1200
No. of Cross Sections	10	10	10	10

Notes: The dependent variable in all regressions is the unemployment rate. t-values are reported in parenthesis. Country fixed effects were included in all regressions. The country effects are jointly significantly different from zero and the equality of the country effects was rejected by an F-test. The FGLS estimation method allows for heteroscedasticity and cross correlation in the residuals. The R^2 is calculated as the square of the correlation coefficient between actual and fitted values.

Table 6: FGLS Panel Estimation Results of $\Delta^2 w_{it} = \alpha_i + \beta(u_{it-1} - \hat{u}^N_{it-1}) + (\Delta w_{it} - \pi_{it} - \theta_{it}) + lags + \epsilon_{it}$.

	Model I	Model II	Model III	Model IV
Unemployment Gap (β)	-0.20 (-6.09)	-0.14 (-1.96)	-0.14 (-2.18)	-0.18 (-5.45)
$(\Delta w_t - \pi_t - \theta_t)$	-0.49 (-13.55)	-0.38 (-7.45)	-0.46 (-7.13)	-0.48 (-13.27)
$\Delta^2 w_{t-1}$	-0.36 (-9.83)	-0.45 (-8.48)	-0.18 (-2.48)	-0.36 (-10.02)
$\Delta^2 w_{t-2}$	-0.15 (-5.02)	-0.18 (-4.16)	-0.01 (-0.24)	-0.15 (-5.13)
$\Delta\pi_{t-1}$	0.02 (0.90)	0.15 (3.35)	-0.02 (-0.64)	0.02 (0.93)
$\Delta\pi_{t-2}$	0.05 (2.06)	0.14 (3.23)	-0.05 (-1.72)	0.05 (2.04)

	Model V	Model VI	Model VII	Model VIII
Unemployment Gap (β)	-0.19 (-5.94)	-0.18 (-6.12)	-0.09 (-1.96)	-0.08 (-1.81)
$(\Delta w_t - \pi_t - \theta_t)$	-0.47 (-13.27)	-0.47 (-13.34)	-0.43 (-11.98)	-0.43 (-11.92)
$\Delta^2 w_{t-1}$	-0.36 (-10.08)	-0.37 (-10.13)	-0.39 (-10.60)	-0.39 (-10.61)
$\Delta^2 w_{t-2}$	-0.15 (-5.01)	-0.15 (-5.06)	-0.16 (-5.29)	-0.16 (-5.26)
$\Delta\pi_{t-1}$	0.02 (1.00)	0.02 (1.01)	0.02 (0.76)	0.02 (0.75)
$\Delta\pi_{t-2}$	0.05 (2.19)	0.05 (2.19)	0.05 (1.93)	0.05 (1.92)

Notes: t-values are reported in parenthesis. The country effects are jointly significantly different from zero and the equality of the country effects was rejected by an F-test.

Table 7: FGLS Panel Estimation Results of $\Delta^2 w_{it} = \alpha_i + \beta(u_{it-1} - \hat{u}^N_{it-1}) + (\Delta w_{it} - \pi_{it} - \theta_{it}) + lags + \epsilon_{it}$.

	Before 1985	Post 1985	High Infl.	Low Infl.
Unemployment Gap (β)	-0.31 (-5.11)	-0.11 (-3.35)	-0.35 (-6.03)	-0.09 (-2.63)
$(\Delta w_t - \pi_t - \theta_t)$	-0.56 (-10.05)	-0.35 (-7.64)	-0.59 (-11.16)	-0.26 (-6.06)
$\Delta^2 w_{t-1}$	-0.30 (-5.74)	-0.46 (-9.47)	-0.30 (-5.98)	-0.55 (-11.12)
$\Delta^2 w_{t-2}$	-0.14 (-3.40)	-0.18 (-4.49)	-0.11 (-2.96)	-0.26 (-6.65)
$\Delta\pi_{t-1}$	0.04 (1.21)	-0.02 (-0.81)	0.04 (1.25)	0.001 (0.06)
$\Delta\pi_{t-2}$	0.10 (2.80)	0.001 (0.04)	0.11 (2.94)	-0.01 (-0.16)

Notes: t-values are reported in parenthesis. The country effects are jointly significantly different from zero and the equality of the country effects was rejected by an F-test.

Table 8: FGLS Panel Estimation Results of $\Delta^2 w_{it} = \alpha_i + \beta(u_{it-1} - \hat{u}^N_{it-1}) + (\Delta w_{it} - \pi_{it} - \theta_{it}) + lags + \epsilon_{it}$.

	U-Gap>0	U-Gap<0	Below 3%	Below 2%
Unemployment Gap (β)	-0.15 (-2.32)	-0.27 (-3.01)	-0.12 (-2.10)	-0.03 (-0.42)
$(\Delta w_t - \pi_t - \theta_t)$	-0.48 (-10.52)	-0.45 (-7.84)	-0.28 (-5.52)	-0.43 (-6.32)
$\Delta^2 w_{t-1}$	-0.38 (-8.11)	-0.36 (-6.56)	-0.58 (-9.39)	-0.47 (-6.58)
$\Delta^2 w_{t-2}$	-0.15 (-3.81)	-0.16 (-3.61)	-0.22 (-4.19)	-0.17 (-2.41)
$\Delta\pi_{t-1}$	-0.06 (-2.15)	0.10 (2.40)	-0.03 (-0.98)	0.02 (0.46)
$\Delta\pi_{t-2}$	-0.07 (-2.59)	0.18 (4.60)	-0.02 (-0.85)	0.05 (1.22)

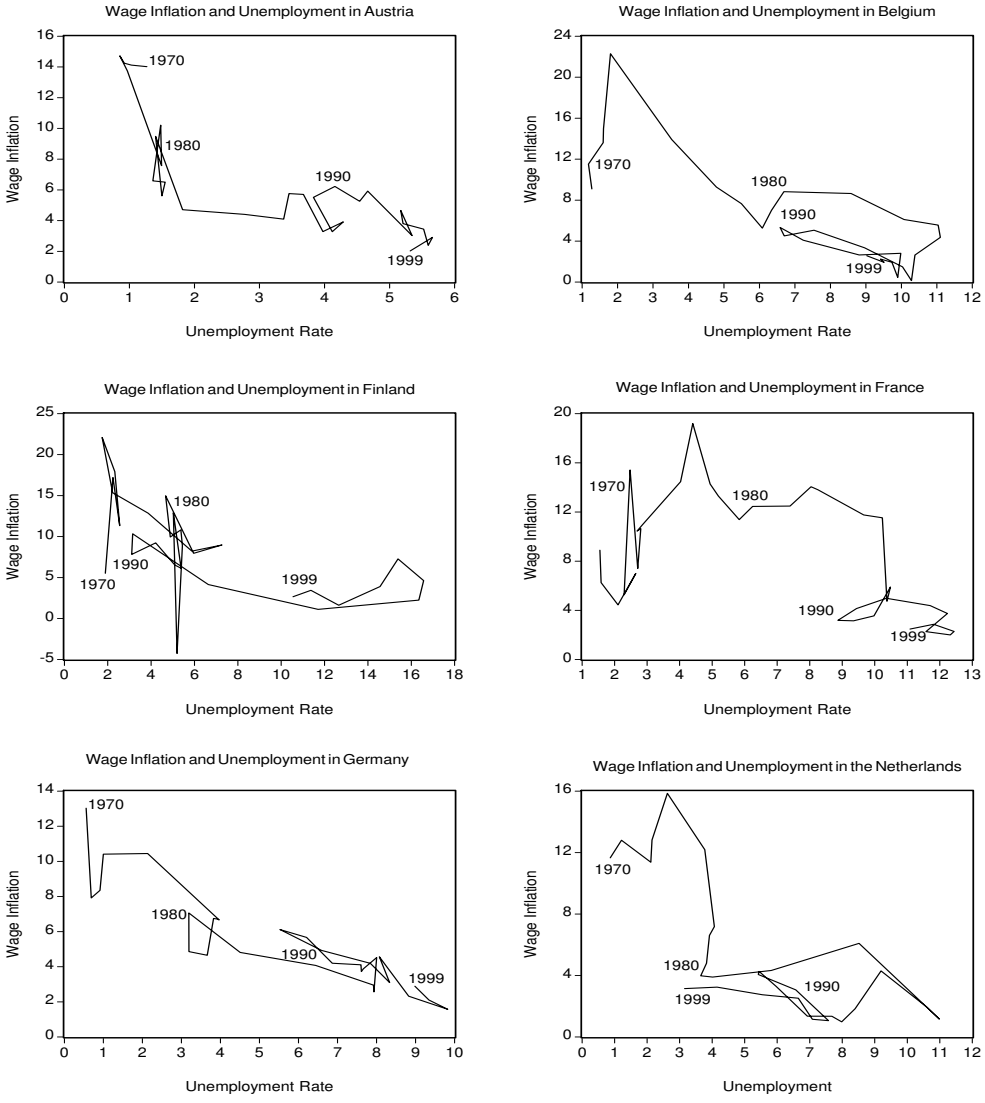
Notes: t-values are reported in parenthesis. The country effects are jointly significantly different from zero and the equality of the country effects was rejected by an F-test.

Table 9: FGLS Panel Estimation Results of $\Delta^2 w_{it} = \alpha_i + \beta(u_{it-1} - \hat{u}^N_{it-1}) + (\Delta w_{it} - \pi_{it} - \theta_{it}) + lags + \epsilon_{it}$.

	U above 6%	U below 6%	With U_{long}
Unemployment Gap (β)	-0.18 (-3.93)	-0.22 (-2.76)	-0.23 (-4.73)
$(\Delta w_t - \pi_t - \theta_t)$	-0.48 (-10.06)	-0.50 (-8.16)	-0.48 (-9.82)
$\Delta^2 w_{t-1}$	-0.39 (-8.45)	-0.36 (-6.06)	-0.41 (-8.43)
$\Delta^2 w_{t-2}$	-0.21 (-5.64)	-0.09 (-2.02)	-0.22 (-5.53)
$\Delta\pi_{t-1}$	0.01 (0.19)	0.04 (1.11)	0.07 (1.98)
$\Delta\pi_{t-2}$	0.06 (1.86)	0.06 (1.70)	0.07 (2.25)
U_{long}			-0.002 (-0.20)

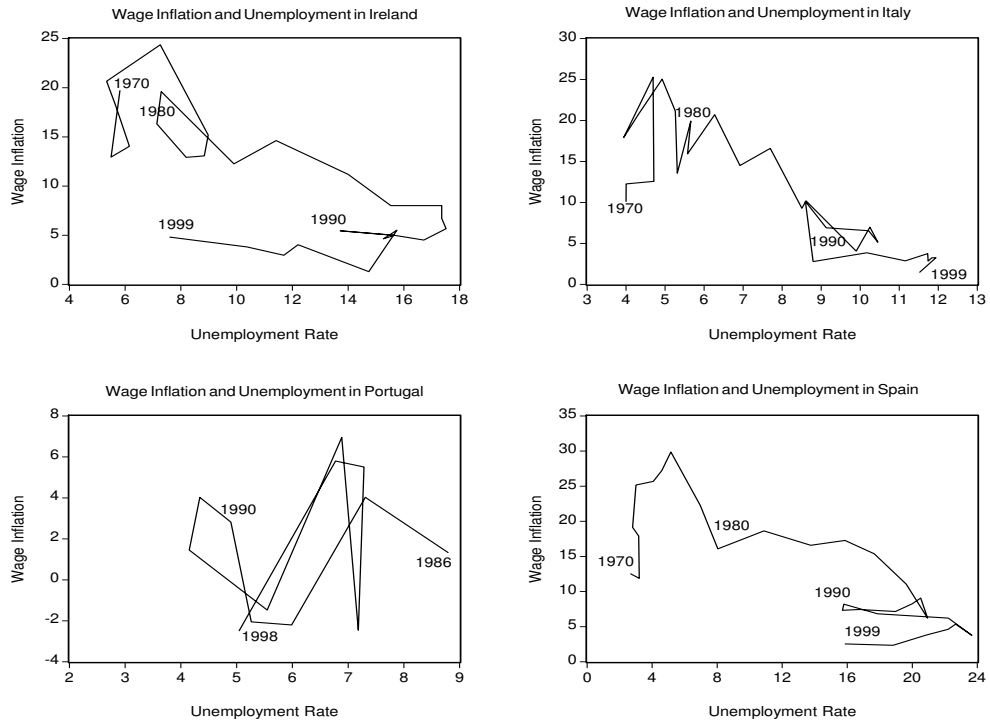
Notes: t-values are reported in parenthesis. The country effects are jointly significantly different from zero and the equality of the country effects was rejected by an F-test.

Figure 1: Euro Area Wage Phillips Curves



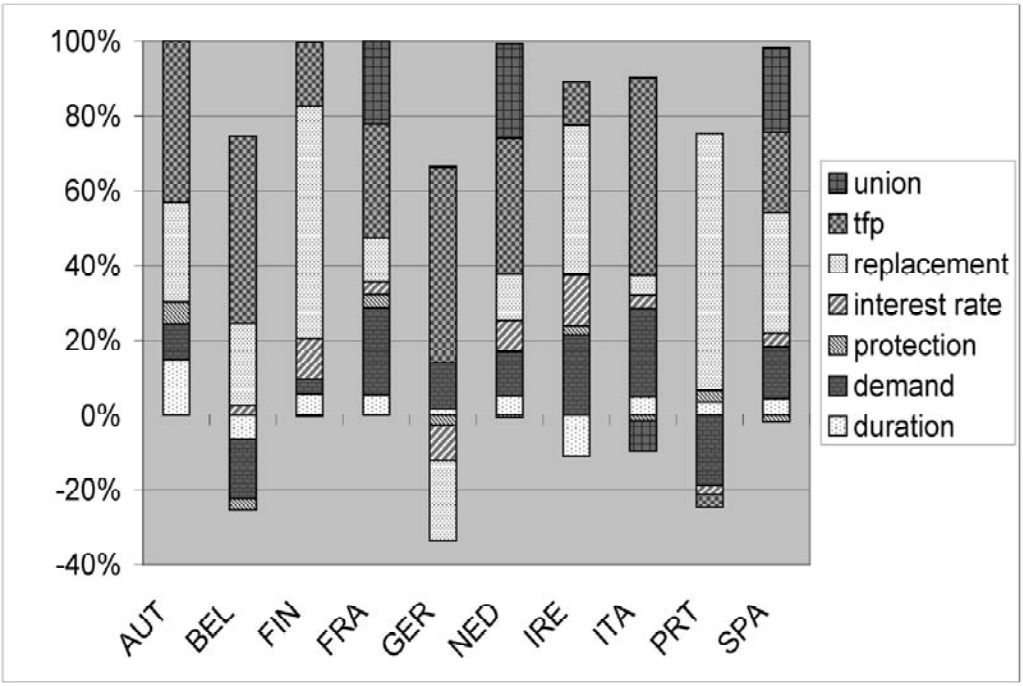
Notes: The unemployment rate is expressed in terms of the civilian labor force. From 1991:1 the data refers to unified Germany. Wage inflation is measured as the annual growth rate of nominal hourly earnings. Data source: OECD

Figure 2: Euro Area Wage Phillips Curves (continued)



Notes: The unemployment rate is expressed in terms of the civilian labor force. From 1991:1 the data refers to unified Germany. Wage inflation is measured as the annual growth rate of nominal hourly earnings. Data source: OECD

Figure 3: Shares of Shocks and Institutions



Notes: The figure shows the contribution (in percent) of each macroeconomic shock and labor market institution variable to the change in unemployment from 1970 to 1999 in the euro area countries.