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# Monetary Policy and Real Cost Imbalances in Currency Unions

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## Abstract

The real unit labor cost is an important variable in today's debate over competitiveness and labor cost imbalances in the Eurozone. This paper documents the link existing between developments in the labor share and relative monetary policy stance across euro area members. First I present the theoretical foundations of such link using a standard New Keynesian framework, then I investigate empirically this relationship using a panel of countries from the Eurozone. I find evidence that real interest rates differentials are key determinants of the evolution of real unit labor costs across Europe. Policy implications are significant as in the Eurozone the problem of divergent labor cost competitiveness cannot be separated from the one of differentials in monetary policy stance. Within this logic the reduction of State cross-differences in product and market frictions (structural reforms) are necessary but not sufficient for the elimination of labor cost imbalances. Other persistent sources of inflation differentials should be addressed as, for example, fiscal stance.

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# Monetary Policy and Real cost imbalances in Currency Unions

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## Abstract

The real unit labour cost is an important variable in today's debate over competitiveness and labour cost imbalances in the eurozone. Making reference to the recent european experience, this paper presents a theoretical and empirical characterisation of the link between developments in the labour share and relative monetary policy stance. I articulate this relationship using a simple model where non-unitary capital and labour substitution relates capital deepening dynamics, in turn connected to monetary policy stance, to fluctuations in the labour share. In this framework, different paths in the labour share emerge simply as a consequence of persistent cross-European differentials in real interest rates. Empirically this relationship is established using a panel of eurozone members. Policy implications are significant as in the eurozone the problem of divergent labour cost competitiveness cannot be separated from the one of differentials in monetary policy stance.

*Keywords:* Real unit labour cost; Macroeconomic imbalances; Euro area.

*JEL classification:* E31, E44, E50

## 1 Introduction

The presence of macroeconomic imbalances in the euro area is at the centre of the current debate over the macroeconomic stability of the currency union, generating great concern among European policy makers. Within the jargon of the European Central Bank (ECB)

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and of the European Commission, imbalances do not involve only a country external position (i.e. the current account) but also a number of other indicators which generally refer to the concepts of competitiveness (the unit labour cost, the real effective exchange rate, and the export market share), economic overheating (inflation, asset prices and unemployment) and indebtedness (public and private debt). The build-up of macrocosmic imbalances among euro area members has become a pivotal issue in European policy circles, so far as to lead the European Commission to establish a Macroeconomic Imbalance Procedure (MIP) now pairing the Excessive Deficit Procedure, foreseen in the Art. 104 of the Growth and Stability Pact.

For their role in determining cross-country competitiveness differentials, labour costs are at the centre of the Commission's assessment of macroeconomics imbalances for the euro area. However, while within the context of European policy making, labour cost dynamics are generally explained making reference to supply side factors, thus affected by so called *structural reforms*, in this paper I show that there is a natural link relating the labour share to capital accumulation dynamics when the assumption of a unitary factor substitution is dropped. If labour and capital show less substitutability than what is postulated within the traditional Cobb-Douglas framework; capital deepening, a consequence of lower real interest rates, shifts the distribution of income towards wages, thus leading to a higher unit labour cost. Consistent with this reasoning, and contrary to a widespread paradigm, the explosive behaviour in the labour share in countries of the eurozone such as Greece and Spain, can be simply explained by their process of convergence and capital accumulation after joining the eurozone.

This paper extends the existing literature on the determinants of the labour share, focusing mainly on factor and product markets frictions (Saint Paul (2003), Arpaia et al. (2009), Lebrun and Perez (2011)), skill-biased technological change (Elsby et al. (2013) and Acemoglu (2014)) and factor substitution (Blanchard (1997), Blanchard and Katz (1992)), by presenting unit labour cost fluctuations as a natural consequence of production factors' dynamics. The increase in the labour share, witnessed in many euro area members between 1999 to the beginning of the crisis, which is considered by many as the key cause of the loss in labour competitiveness of the euro area periphery, is then explained as an obvious consequence of the process of convergence of the some eurozone members.

I begin the investigation by providing evidence of significant differences in the relative tightness of monetary policy and of the different dynamics of the labour share across euro area countries. The paper continues by describing how real cost imbalances relate to relative monetary policy stance: I present a simple theoretical framework in which the real unit labour cost relates to monetary policy (real interest rates) through adjustments in the capital output ratio.

This framework serves both as a theoretical support for the empirical analysis that follows and to clarify a crucial identification problem relating the labour share and inflation. After having proposed a solution to this empirical issue, I estimate an equation relating the labour share and real interest rates using data from individual euro area members.

From a cross-sectional point of view, I find that in the euro area countries experiencing lower real interest rates witnessed higher increases in the real unit labour cost. This work builds on a range of different research streams. First and foremost, the paper fits into the policy debate on real cost imbalances across eurozone countries and more generally, in the literature on the determinants of real unit labour costs. In this stream of literature some key contributions are Bentolila and Saint Paul (2003), Arpaia et al. (2009), Lebrun and Perez (2011), Blanchard (1997), Blanchard and Katz (1992), Jones (2002), Blanchard and Giavazzi (2002), Kydland and Prescott (1990), Boldrin and Horvath (1995), Gomme and Greenwood (1995). This research also relates to the work by Fagan and Gaspar (2007), Brzoza-Brzezina (2010) and the ECB (2003) suggesting a role for real interest rate yield differentials as a primary source of imbalances among countries of the euro block. These authors stressed how, after joining the euro area, sovereign yields of some peripheral countries decreased significantly, while persistent differences in inflation at national level produced wedges in real yields which fuelled current account deficits and a boom in private and public consumption. In this paper I refer more generally to monetary policy stance thus implicitly abstracting from sovereign risk considerations. The theoretical framework presented takes inspiration from the work of Carlstrom and Fuerst (2005), Kurizumi and Zandweghe (2008) and Khramov (2012). Many key references are also to the literature identifying a link between the labour share and inflation, most notably Gali and Gertler (1999), Sbordone (2002), Smets and Wouters (2003), Watson and King (2012).

The reminder of the paper has the following structure: in the first section I briefly review the process of growing macroeconomic imbalances for some euro area countries, then I focus on the real unit labour cost and its relation with monetary policy presenting a theoretical model and a relating empirical investigation. The last section concerns conclusions and policy implications.

## 2 Imbalances in the euro area: some facts

Within the terminology of european policymakers, the concept of imbalances is interpreted extensively; this conveys economic developments in a number of indicators that concern a country external position (the current account and the net asset position) but also its competitiveness (the unit labour cost, the real effective exchange rate and the export market share) and indebtedness (public and private debt). It should be noted that this extensive interpretation has little in common with the existing literature on macroeconomic imbalances, mainly focusing on the current account. In this paragraph I briefly review developments in a number of macroeconomic indicators for euro area members; these are the real unit labour cost, the current account, export market share and credit to the private sector.

Figure 1, displays the evolution of the these variables for major euro area countries since 1999. Cross-country divergence in some of these indicators is evident especially after

2003. So-called converging economies such as Spain, Ireland, Greece and (to a lesser extent) Portugal experienced until 2007 persistent and increasing current account deficits, a sizable increase in unit labour costs, a significant real appreciation and losses in export market share.

Between 1999 to 2008 and especially after 2003, current accounts of converging economies have been persistently deviating from those of euro core countries, with the former accumulating large deficits and the latter showing balances or surpluses (Figure 1, first panel). Over the same period, significant cross-country wedges also accumulate across real exchange rates (Figure 1, second panel). Nominal unit labour costs, a proxy for labour competitiveness<sup>1</sup>, in Ireland, Greece and Spain, increased dramatically since 1999, while in other countries, like Germany and Austria, it showed substantial stability or moderate increase (Figure 1, third panel).

Few facts stand out from the panels presented:

1) Differences in all considered indicators existed at the time when the eurozone was created in 1999 and extended after 2003.

2) Dynamics in many of the indicators considered appear to be correlated at country level; for example Spain, Ireland and Greece fared worse in terms of current account deficits, real appreciation, wage inflation and credit growth.

Moving to the real unit labour cost, Figures 2 and 3, focus specifically on the relationship between the labour share and monetary policy stance; in Figure 2 (first panel) I show the average increase in the labour share for euro area members since 1999 and up to 2008. Significant cross-country differences are evident: In countries such as Ireland, Italy, Finland, Greece and Portugal real labour cost for unit of value added grew significantly more than in others. The second panel of Figure 2 shows a cross-country scatter plot between the average increase in the labour share and the average real interest rate. This figure shows a clear negative relationship, suggesting that those countries that accumulated higher increases in the labour share were also those characterised by lower real interest rates. In Figure 3 I disentangle this relationship into two: the left hand side panel shows the relationship between real interest rates and capital output ratios. This simply expresses the link existing between cost of capital and capital accumulation dynamics: lower real interest rates are associated to capital deepening. The right hand side panel shows the relationship between capital deepening and the labour share. It should be noted that this scatter plot displays a negative slope, this is crucially due to the elasticity of substitution among production factors.

Figure 3 is pivotal for understanding the economic reasoning suggested in this paper and it represents rough evidence supporting the theoretical model presented later in this paper. If we depart from a unitary elastic factor substitution, or alternatively if we depart from a Cobb-Douglas production function, using instead a CES schedule, capital accumulation

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<sup>1</sup>Under the assumption that labour cost represents the most relevant share of firms cost structures. This indicator could be particularly ineffective in measuring companies' costs in periods of credit constraints, as it completely ignore financing costs.

(triggered by relative monetary policy stance) has an effect of the labour share (real unit labour cost).

### 3 Relative monetary policy stance and the real unit labour cost

Relative monetary policy stance varied significantly across euro area countries between 1999 and the beginning of the crisis. Figure ?? shows the average real interest rates computed for major euro area country between 1999 and 2008; peripheral economies such as Spain, Greece and Ireland experienced relatively loose monetary policy stance while, for countries of the core, policy interest rates were about right. This section links the evidence provided so far about the evolution of the labour share and real interest rates dynamics in the eurozone.

The intuition behind such link is simple and it entirely relies on dropping the assumption of unitary elastic substitution among factors, meaning moving from a Cobb-Douglas to a more general CES production schedule: a decline in the real interest rate leads households and/or firms to borrow more until the marginal return of capital equals the new level of the interest rate. This process implies capital accumulation. If output is produced via a CES production function, the ultimate effect of capital accumulation on the labour share (real unit labour cost) depends on the elasticity of  $\sigma$  substitution. To contextualise this reasoning in the recent experience of the eurozone, countries like Spain, Ireland and Greece experienced lower real interests rates up to the beginning of the crisis, as a consequence they went through capital deepening that, due to a lower than unity elasticity of substitution, produced an increase in the labour share.

I start the theoretical exposition presenting a simple general equilibrium model without frictions in products or factor markets. This first formulation aims at showing that real unit labour cost and interest rate are related even in a frictionless world, contrary from what is generally argued in the literature. Then I modify the model introducing monopolistic competition for an intermediate good sector and thus price stickiness along with the standard Neo-Keynesian paradigm. This modification allows to analyse a key identification problem related to the target relationship. The model presented here mirrors the one by Carlstrom and Fuerst (2005) and discussed by Kurizumi and Zandweghe (2008) and Khramov (2012) with little ad hoc modifications, the main of which is the use of a CES production function. The discussion of this model in the text will be limited to the features of interest to the analysis. While the purpose of this discussion is simply the derivation of an equation relating interest rates with the real unit labour cost, the model is presented in a more organic fashion in the appendix.

### 3.1 A frictionless model

A representative economy is populated by an large number of individual households whose preference are expressed by a standard utility function:

$$\sum_{t=0}^{\infty} \beta^t U(C_t, L_t) \quad (1)$$

Households in each period can purchase a one period bond  $B_t$  at a price  $Q_t$ . They can consume  $C_t$  at prices  $P_t$  and they can buy next period capital  $K_{t+1}$ . They earn a real wage  $W_t L_t$  and a capital market rent  $R_t K_t$ . Household budget constraint is:

$$B_{t-1} + P_t[W_t L_t + R_t K_t] = Q_t B_t + P_t C_t + P_t K_{t+1} \quad (2)$$

and the non-Ponzi condition:

$$\lim_{T \rightarrow \infty} E_t[B_T] \geq 0 \quad (3)$$

Firms produce output in a competitive setting via a CES production schedule:

$$Y_t = A \left[ (\alpha) K_t^{\frac{\sigma-1}{\sigma}} + (1-\alpha) L_t^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \quad (4)$$

Where  $K_t$ ,  $L_t$  and  $A$  are respectively capital, labour and an exogenous technological parameter,  $\alpha \in (0, 1)$  is the factor share and  $\sigma$  represents factors' elasticity of substitution.

In each period firms maximise profits

$$Y_t - W_t L_t - R_t K_t \quad (5)$$

The two optimality conditions associated with firms' maximisation problem are:

$$W_t = A F_l(K_t, L_t) \quad (6)$$

$$R_t = A F_k(K_t, L_t) \quad (7)$$

with  $R_t$  and  $W_t$  the real interest rate and wage.

From the first order condition of the consumer maximisation problem, we obtain the inter-temporal condition relating the nominal interest rate to expected real interest rate:

$$i_t - E_t[\pi_{t+1}] = E_t[A F_k(K_{t+1}, L_{t+1})] \quad (8)$$

or equivalently (using the Fisherian equation)

$$r_t = E_t\{A F_k(K_{t+1}, L_{t+1})\} \quad (9)$$

Given perfect competition in product and factors markets, the real unit labour cost (or labour income share) is defined as:

$$RULC_t = \frac{W_t L_t}{Y_t} = \frac{L_t A F_l(K_t, L_t)}{Y_t} \quad (10)$$

Where  $W_t$  is the real wage and  $MPL_t$  is the marginal product of labour. Thus in case of a CES production function we have:

$$RULC_t = (1 - \alpha) \left( \frac{Y_t}{L_t} \right)^{\frac{1-\sigma}{\sigma}} = 1 - \alpha \left( \frac{K_t}{Y_t} \right)^{\frac{\sigma-1}{\sigma}} \quad (11)$$

For  $\sigma = 1$  equation 11 collapses to  $1 - \alpha$  and the production schedule becomes Cobb-Douglas. The Cobb-Douglas production function represents a limiting case<sup>2</sup> in which output elasticities are equal to one and the labour income share is constant and equal to  $1 - \alpha$ . However it is clear that this specification is not fitted for the short run and in this analysis I relax the hypothesis of unit substitutability, assuming  $\sigma$  to be a finite number greater than zero.

Equation 11 is interesting because it establishes a relationship between the real unit labour cost and the capital output ratio. The sign of this relationship depends crucially on the magnitude of the parameter  $\sigma$ : for values between 0 and 1 (low factor elasticity of substitution) the relationship is positive, for values higher than one it is negative.

Also:

$$\frac{K_t}{Y_t} = \left( \frac{R_{t-1} + v_t}{\alpha} \right)^{-\sigma} \quad (12)$$

where  $v_t = F_k(K_t, L_t) - E_{t-1}\{F_k(K_t, L_t)\}$  is the forecasting error at time  $t$  of the one step ahead expectation for the marginal product of capital at time  $t-1$ . Finally substituting into 11 the following equilibrium relationship between the real unit labour cost and real interest rate can be obtained:

$$RULC_t = 1 - \alpha \left( \frac{R_{t-1} + v_t}{\alpha} \right)^{1-\sigma} \quad (13)$$

Denoting with lower cases the percentage deviations from the steady state 13 becomes:

$$s_t = \phi r_{t-1} + \epsilon_t \quad (14)$$

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<sup>2</sup>Among the reasons of the success of Cobb-Douglas production functions in theoretical modelling there is the fact that such production schedule is the only able to insure a constant elasticity of substitution, homogeneity of degree one and constant factor shares overtime. This latter characteristic contributed largely to its diffusion as (relatively) constant shares of factors on output overtime was among the Kaldor's stylised facts of economic growth.



where  $s_t$  is the (log) real unit labour cost,  $\phi = \frac{s}{1-s}(\sigma - 1)$  and  $\epsilon_t = \frac{s}{1-s}(\sigma - 1)v_t$ . Under rational expectations the forecasting error  $v_t$  is orthogonal to the information set at date  $t - 1$ , thus the identification of equation is achieved yielding the OLS estimator of  $\phi$ .

Equation 14 establishes a linear relation between the real unit labour and the real interest rate and it represents the theoretical base for the empirical investigation that follows in the rest of the paper.

The economic interpretation of the above relation is the following: when the interest rate declines, borrowing increases with capital accumulation until the marginal return of capital equals the new real interest rate. The final effect on the real unit labour cost depends critically on the elasticity of substitution: for  $\sigma > 1$ , capital accumulation results in a decrease of the labour share; the real unit labour cost increases instead for  $\sigma < 1$ .

What is noteworthy in equation 14 is that it establishes a link between relative monetary policy stance, measured with differentials in real interest rates, and differentials in the real unit labour cost, in a completely frictionless framework. This is to say that wedges in real unit labour cost in currency unions can arise, consequence of a non-unitary elastic factor substitution, even if economies are not affected by different market frictions.

The model presented in this paragraph abstracts from price stickiness. The empirical, short-run, investigation of equation 11 however clashes with one crucial fact of the New Keynesian Economics: real marginal costs (closely related to the real unit labour cost in a Cobb-Douglas framework) are a key short run determinant of price dynamics. The New Keynesian Phillips Curve in models with price stickiness features, in fact, inflation as determined by current and expected firms' marginal costs. To the extent real interest rates are implicitly determined by the difference between the nominal rate and the level of inflation, it comes to reason that an empirical estimation of equation 14, might be affected by endogeneity.

The problem however is more complex: the standard NKPC is typically derived under the assumption of a production function only comprising labour and featuring Cobb-Douglas technology. These two assumptions obviously clash with key aspects on which the relationship between the labour share and real interest rates presented in this paper is based. A formally more correct investigation of the this relationship in conjunction with a NKPC should consider these two equations as resulting from the same general equilibrium model, this is what I do in the next paragraph. There I will explore in more analytic fashion the simultaneity bias between the NKPC and equation 14, by modifying the presented model to include price stickiness (and thus a feedback from real marginal costs to inflation).

However there is still a possibility to estimate directly or indirectly equation 14 without incurring in a identification problem: this is by considering a long-run relationship. In fact, to the extent the identification of equation 14 is put into jeopardy by the short term link between marginal costs and inflation (the Phillips curve), in the long-run the same equation should be identifiable.

### 3.2 The long-run

Equation 13 can be estimated directly or indirectly, I choose this second possibility. In fact the long run counterpart of equation 13 can be consistently estimated and after taking logs would be<sup>3</sup>:

$$\ln(1 - RULC_t) = \sigma \log(\alpha) + (1 - \sigma)r_{t-1} + \epsilon_t \quad (15)$$

It should be noted that the coefficient relating the real interest rate with the labour share solely depends on the elasticity of substitution  $\sigma$  while the constant depends on both  $\sigma$  and  $\alpha$ . However a more intuitive way of estimating these two parameters in the long-run is by estimating equation 11. This means estimating the (long-run) relationship between the real unit labour cost and output per worker (labour productivity), after taking logs:

$$s_t = \gamma_1 + \gamma_2 y_t \quad (16)$$

where  $\gamma_1 = \log(1 - \alpha)$ ,  $\gamma_2 = \frac{\sigma-1}{\sigma} y_t = \frac{Y_t}{L_t}$  (value added per worker). This equation represents a linear relationship between the labour share and labour productivity. Note that the estimation of this relationship also corresponds to a test on the elasticity of factor substitution when Hicks-neutral technological change is assumed: for values of  $\gamma$  significantly different from 0,  $\sigma$  is significantly different from 1.

Equation 16 is in fact similar to econometric models used for the estimation of  $\sigma$  in the literature on aggregate production functions. In their seminal work on CES production function, Arrow et al. (1961) regress the log of the value added per worker on a constant and the real wage, they interpret the coefficient on this regressor as the elasticity of substitution among capital and labour. They find that, in the US,  $\sigma$  varies across industrial sectors but is equal to 0.57 for the overall economy. Assuming neutral technological change, Kendrick and Sato (1962) using US data from 1919 to 1960 estimate a elasticity of factor substitution of 0.58, Bodkin and Klain (1967) estimate this parameter to be between 0.5 and 0.7, while more recent studies find  $\sigma$  to be closer to one (Berndt (1976) and Antras (2004)). The identification of equation 16 relies on the assumption of Hicks-neutral technological change. Factor augmenting technology in fact introduces a bias in the estimate of  $\sigma$  that should be taken explicitly into account (as in Len-Ledesma et al. (2010)). Fewer studies exist for European countries: Klump et al. (2008) estimate the elasticity of factor substitution using a time-varying, factor-augmenting technical progress, they find  $\sigma$  to be 0.7. While Bernes et al. (2006) and Smith et al. (2008) find an elasticity of substitution close to 0.4 using UK data.

I estimate the long-run relationship represented by equation 16 with a panel VECM for 13 countries of the eurozone (the initial block of 12 and Greece from 2001), the time

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<sup>3</sup>So far I have considered only a frictionless model; however considering a product market markup will not modify the discussion developed below, in this case the long run counterpart of equation 13 would it would be convenient to estimate:  $\ln(RULC_t) = \log(\frac{1-\alpha}{\mu}) + (\frac{1-\sigma}{\sigma}) \frac{Y_t}{L_t}$

sample is from 1999 to 2008 and the frequency quarterly. The first step in to verify whether the variables considered effectively are integrated of order one. I run a battery of unit root tests for labour productivity and the real unit labour cost. The Fisher-type unit-root tests using both Phillips-Perron and Dickey-Fuller specifications fail reject the null hypothesis of unit roots in all panel variables<sup>4</sup> and for all variables considered. Having established that the real unit labour cost and real interest rates are integrated, I perform the Westerlund error-correction-based panel cointegration tests. Tests statistics reject the null hypothesis of no cointegration among real interest rates and the real unit labour cost at panel level<sup>5</sup>.

The autoregressive distributed lag specification corresponding to model 16 is:

$$\Delta s_{it} = \lambda_i s_{i,t-1} + \delta_{1i} y_{i,t-1} + \delta_{2i} y_{i,t-2} + \mu_i + \eta_{it} \quad (17)$$

The error correction re-parametrisation is:

$$\Delta s_{it} = \psi_i (s_{it-1} - \gamma_{1,i} - \gamma_{2,i} y_{it-1}) + \delta_{1i} \Delta y_{it-1} + \eta_{it} \quad (18)$$

where  $\psi_i = -(1 - \lambda_i)$  is the parameter indicating the speed of adjustment.  $\gamma_{1,i} = \frac{\mu_i}{1 - \lambda_i}$  and  $\gamma_{2,i} = \frac{\delta_{1i} + \delta_{2i}}{1 - \lambda_i}$  are the long run coefficients that we seek to estimate. As the time dimension of the data is large enough, I estimate independent models for each country and construct the Mean Group (MG) estimator for heterogeneous panels, proposed by Pesaran and Smith (1995). This simply consist in arithmetic averages of estimated coefficients across groups.

Estimation results are presented in table 1: the first column shows coefficients for the short and long run relationships between the labour share output per worker considering a coincident specification for the ECM; the second column reports the same estimates when one additional lag of output per worker and the labour share are added to the specification. Considering the first model the implied long-run parameters for the elasticity of substitution and the factor shares are 0.69 and 0.30. This first result is significant as it confirms the hypothesis of a non-unitary factor substitutability. A key implication of this result is the support of a CES production function specification. Having obtained estimates for  $\lambda$  and sigma  $\sigma$  the implied coefficients for equation 16 are:

$$\ln(1 - RULC_t) = -0.831 + 0.31 \ r_{t-1} \quad (19)$$

implying a negative relationship between the real unit labour cost and lagged real interest rates. The sign of this relationship directly depends on the magnitude of the elasticity of substitution: for a value lower than unity (in this case 0.69) factors are relative complements and a negative relationship exists between the labour share and the real unit labour cost. In this case capital accumulation is crucially related to increases in the labour share.

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<sup>4</sup>4 lags are inserted for the computation of the test statistics. Results are robust to different lags number and the introduction of trends.

<sup>5</sup>P-values for the Pt statistics is 0.05 and for Pa 0.074.

### 3.3 Introducing price stickiness: labour share, real interest rates and inflation

The real unit labour cost plays a key role in the determination of prices in the standard NK framework. In the analysis presented in this paper, real interest rates are considered in their link with fluctuations in the labour share. However in the short run price stickiness is a key determinant of inflation and within the standard<sup>6</sup> framework of the New Keynesian Economics, the real unit labour cost is an important determinant of prices changes. As the relationship presented in this paper involves the real interest rate, which is implicitly defined by the inflation level, the short-run estimation of such relationship poses some issues. In this paragraph I formalise the short-run relationship between the real unit labour cost and real interest rates when a CES production function is used. I will do so by extending the model presented above with the introduction price stickiness. Again the model is presented in some detail in the appendix while in this paragraph I will focus only on the aspects which are relevant for the discussion.

Let's modify the framework presented introducing an intermediate good sector characterised by monopolistic firms that set prices in a staggered fashion *a la* Calvo. This development follows strictly the derivation of standard NK models. The intermediate goods producers cost minimisation problem yields the two conditions relating factors' productivity and marginal cost:

$$w_t = Z_t MPL_t \quad (20)$$

$$r_t = Z_t MPK_t \quad (21)$$

Where  $W_t$  and  $R_t$  are the real wage and interest rate and  $Z_t$  is the real marginal cost. The real unit labour cost then becomes:

$$RULC_t = Z_t \left[ 1 - \alpha \left( \frac{R_{t-1} - v_t}{\alpha Z_t} \right)^{1-\sigma} \right] \quad (22)$$

$R_{t-1}$  in this case is the real interest rate computed with the actual inflation rate  $i_{t-1} - \pi_t$  as the forecasting error for the inflation rate is included in  $v_t$ . Again for  $\sigma = 1$  and perfect competition  $z_t = 1$ , this equation collapses to  $1 - \alpha$ , the constant labour share in case of a Cobb-Douglas. Considering deviations from the steady state this relation becomes:

$$s_t = \gamma z_t + \phi r_{t-1} + \eta_t \quad (23)$$

Where lower cases indicate deviations from the equilibrium;  $s_t$  is the real unit labour cost and  $\gamma = \frac{\mu}{s} [1 - \alpha \sigma (\frac{1}{\beta \mu \alpha})^{1-\mu} + \mu (\sigma - 1) (\frac{1}{\beta \mu \alpha})^{1-\sigma} \frac{1}{\mu}]$ ,  $\phi = (\sigma - 1) \frac{1}{\beta s} (\frac{1}{\beta \alpha \mu})^{-\sigma}$  and  $\eta_t =$

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<sup>6</sup>Meaning when a standard Cobb-Douglas production function is used.

$v_t \frac{1}{\mu}(\sigma - 1)(\frac{1}{\beta\alpha\mu})^{-\sigma}$ . It could be noted that, as in the previous case, the existence and the sign of the relationship between the RULC and the real interest rate depends solely on the elasticity of substitution  $\sigma$ .

Due to the fact that marginal costs are not directly observable, the above equation has the following empirical counterpart:

$$s_t = \phi r_{t-1} + v_t \quad (24)$$

Where  $v_t = \gamma z_t + \eta_t$ . This equation can be read together with the NKPC which originates directly from the Calvo price setting:

$$\pi_t = \lambda z_t + \beta E_t[\pi_{t+1}] \quad (25)$$

where  $z_t$  is the real marginal cost.

Using the first of this conditions to substitute for the real interest rate in equation 24 we have:

$$s_t = \phi(i_{t-1} - \pi_t) + v_t \quad (26)$$

Then using the NKPC again, we can re-write the inflation level at time  $t$  as a function of the marginal cost:

$$s_t = \phi \underbrace{(i_{t-1} - \lambda z_t - \beta E_t[\pi_{t+1}])}_{r_t} + v_t \quad (27)$$

It is evident that equation 27 cannot be directly estimated due the bias originating from  $E(r_t, v_t) \neq 0$  as  $v_t$  depends on the marginal cost at time  $t$  ( $v_t = \gamma z_t + \eta_t$ ).

However equation 27 could be estimated if we find an instrument for the level of inflation, that is not dependent on coincident real marginal costs. Let's consider the following equation:

$$s_t = \phi(i_{t-1} - E_{t-1}[x_t]) + \eta_t \quad (28)$$

where  $\eta_t = \phi_1 z_t - \phi_2 v_t$  and  $x_t$  is a variable such that  $E(x_t, \pi_t) \neq 0$  and  $E(x_t, z_t) = 0$ , meaning an instrument for the inflation rate that is not correlated with marginal cost at time  $t$ . In this case, to the extent the nominal interest rate is exogenous to the inflation level at time  $t$  (this is the case in a currency union to the extent local economic condition are orthogonal to the centralised monetary policy process), equation 31 can be correctly identified. The identification of equation 27 then requires the identification of a shock to inflation that is not affected by coincident marginal costs, considering the NKPC, I would need to identify a variable affecting  $\zeta_t$  in the equation below:

$$\pi_t = \lambda z_t + \beta E_t[\pi_{t+1}] + \zeta_t \quad (29)$$

I argue that a good candidate could be represented by discretionary net fiscal spending. The relevance of this instrumented is guaranteed by the substantial literature that has related fiscal policy to inflationary pressure (Sargent and Wallace, (1981), Alesina and Drazen, (1991), Cukierman et al. (1992), Calvo and Vegh, (1999)). The exogeneity to marginal cost is insured by its common use in the empirical literature on fiscal multipliers (this literature is particularly vast, however a notable contribution is by Blanchard and Perotti (1999)): the idea is that discretionary fiscal action does not respond within a quarter to macroeconomic variables (such as output and inflation), as it takes policymakers more time to effectively learn about the status of the economy. The solidity of this exclusion restriction lies on its wide use in the fiscal policy literature.

I estimate the following equation for a panel of 12 euro area countries<sup>7</sup> using quarterly series:

$$s_{it} = \alpha_i + \phi r_{i,t-1}^{IV} + v_{it} \quad (30)$$

Estimation is performed using two stage regressions. Lagged real interest rates are instrumented using discretionary fiscal balance at time  $t$ , as argued before this variable is assumed to be correlated with coincident inflation level but exogenous to the marginal cost within the same quarter. Discretionary fiscal balance is constructed by extrapolating the trend component via HP filtering, from quarterly series for fiscal surplus (deficit) on gap. Country fixed effects are considered in the model. Estimation results are reported in Table 2.

The first 3 models are estimated on the whole country sample. The first column reports the coefficient when no instrumental variable is used, in this case real interest rates are directly regressed on the labour share. The resulting coefficient is not significant at 10 percent significance level.

In the second equation I used discretionary fiscal balance as an instrument for the inflation rate, determining real interest rates. In this case the coefficient is negative and significant: in average across euro area members, a one percent change in the real interest rate correspond to a two percent change in the labour share with opposite sign. Recalling that the sign of this relationship depends directly on the elasticity of substitution, we can infer that this result is consistent with a less than unitary factor substitutability.

The third model is placebo regression that aims at testing weak instruments: the regression output is produced via bootstrapping and considering a random variable having equal moments to the instrument considering in the second equation. No evidence of spurious relationship exist in this case.

The evidence reported in this table strongly suggests that the estimation of equation 30 produced unbiased coefficients that are consistent with the model predictions. Also it confirms that a link exists between the real interest rate and the real unit labour cost even in the short-term.

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<sup>7</sup>These correspond to the original euro block and Greece that joined in 2001.

## 4 Cross-section evidence

To assess the role of such relationship in the process of accumulation of imbalances relating the real unit labour cost across euro area countries, it is now convenient to move to the cross sectional dimension of the data. In this paragraph I establish whether those countries experiencing lower interest rates also faced higher increases in the labour share. To answer this question I estimate the following panel:

$$\Delta s_{it} = a + \psi r_{it} + u_{it} \quad (31)$$

In this case however I will use the cross sectional dimension of the data, meaning I will use the between estimator<sup>8</sup>. In this case the estimated coefficient will express the relationship between the average (overtime) change in the labour share for each country  $i$  and the average real interest rate. A negative and significant coefficient signal that those countries experiencing lower real interest rates also presented higher increases in real unit labour cost. Regression results are reported in Table ???. Different specifications are attempted but all produce consistent results. Results suggest the existence of a negative relationship between the average overtime change in the labour share and the average level in real interest rates: In the euro area countries experiencing in average the lower real interest rates during the time sample considered also witnessed higher increases in the real unit labour cost.

The implications of this finding are significant as this implies that persistent differentials in relative monetary policy stance contribute to the accumulation of imbalances in real labour cost. Persistency real interest rates differentials is key as relative monetary policy stance is considered overtime.

## 5 A comparison with the US

The evidence presented in this paper supports the existence of a link between monetary policy stance and the accumulation of real labour cost imbalances in currency unions. If fluctuations in the labour share are determined by real interest rates, relative monetary policy stance becomes a determinant of real labour competitiveness differentials across regions of a monetary area.

If a certain local variation in real interest rates is implicit in every currency area, then a policy relevant question is whether the existing cross-country variation in real interest rates in the eurozone is comparable to that in other currency unions. A natural comparison

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<sup>8</sup>Considering first differences of the dependent variable eliminates country fixed effects, this also includes the steady state level of marginal cost which correspond to the inverse of the price markup. The between estimator in fact construct an overtime average of dependent and independent variable before estimating the cross-sectional coefficient. We can consider the overtime value of the marginal cost (computed on a sufficiently long time sample) as the actual price markup.

is represented by the US States, where a unique nominal interest rate is set at the Federal level, despite possible regional variations in fundamentals. In Figures 5 and 6 I compare the standard deviation of both real interest rates and of (changes) in the labour share for the US<sup>9</sup> and the eurozone. In the first panel of Figure 5 I plot the cross-regional standard deviation of inflation for the two economies over time; in the second the dispersion of RULC changes overtime. In the two tables displayed in Figure 6 I show mean tests for both dispersion measures.

A few significant facts stand out from this comparison: effectively both cross-State variation in the inflation rate and in RULC changes are higher in the eurozone than across US States. This difference is significant at the 10 percent significance level for the time sample considered (Figure 6). This evidence is consistent with the existence of a link between real interest rates and developments in the labour share as presented in this paper.

Evidence reported in Figures 5 and 6 clearly show that cross-State variation in both inflation and real labour costs is significantly higher in the eurozone than in the US. There might be a number of different reasons why in the eurozone regional inflation and RULC differentials are more significant than across US States: we can imagine that the eurozone is subject to cost push shocks that are more diverse in nature, or that similar shocks might have a more heterogeneous effect across individual countries than in the US, in this paper however I explicitly consider a different source of persistent inflation differentials: fiscal policy. To the extent that fiscal balance can generate inflationary pressures, heterogeneous State level fiscal policy can be a significant determinant of European cross-regional inflation differentials. Clearly even individual US States have a fiscal budget and thus their spending might contribute to local price dynamics, however in general fiscal policy in the US is mainly implemented at the centralised (Federal) level while in the eurozone it is mainly local (National). In Figure 7 I show the share of public expenditure implemented at local (National-State) and Federal Communitarian level.

This structural difference between the two currency unions, which refers to the level of government responsible for the largest share of the fiscal budget, might explain the different cross-State price dynamics in the eurozone and the US.

A final consideration concerns the magnitude of cross-regional differentials in real unit labour cost developments in the US and the eurozone and how such differentials are perceived in policy circles of the two economies. In Figure 6 I showed that in average the standard deviation of RULC changes is (roughly) 25 percent higher in the euro area than across US States. There are few technical tools to establish whether this is enough for justifying the (far) more significant attention that the issue of imbalances has gained in Europe with respect to the US. However despite the damaging consequences that a loss of real labour competitiveness can generate at the local level, it is difficult to explain why

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<sup>9</sup>Regional data for individual US states are taken from the National Bureau of Economic Analysis (BEA), the labour share is computed as nominal compensation on nominal income, for the inflation rate (and thus for computing real interest rates), I use the producer price index (PPI) for both economies as this is the only one available for individual US States.



polarisation in real cost dynamics should affect competitiveness of a currency union as a whole. Probably, the reason why macroeconomic imbalances, including cost imbalances, are perceived as an issue in Europe and not in the US is more attributable to the significant difference in the structure of the two currency unions than to the magnitude of imbalances themselves. Local cost dynamics and thus competitiveness are more important across European States because of the role that National Governments have in the European context with respect to the US. To the extent European Sovereigns are responsible for essentially the entire provision of public services, investments and public guarantees (i.e. on the banking sector) and in the absence of relevant cross-European transfers, national competitiveness dynamics that can affect the ability of euro area members to fulfill their obligations, become relevant, even when they are merely the expression of a zero sum redistribution across regions of the currency union.

## 6 Conclusions

In the euro area relative monetary policy stance was significantly diverse across individual countries, especially so from 2003 to the beginning of the economic crisis. This paper provided evidence of the empirical link between the relative tightness of monetary policy and real cost imbalances in the eurozone. After having presented the theoretical foundation for this relationship, I estimated a model relating the real unit labour cost to interest rates. Estimation results supported the existence of such a link empirically for a panel of countries of the eurozone.

To a certain extent cross-regional variation in real interest rates is common to all currency areas, however evidence showed that the monetary policy stance and developments in the labour share are significantly more diverse across euro area members than across US States. Explaining this difference is a crucial question for policy making: within the logic of the analysis presented in this paper, I consider an important factor that can potentially explain higher cross-regional differences in inflation rates in the eurozone: fiscal policy.

Fiscal policy is implemented mainly at the state level in Europe and at the federal level in the US. Since 1999 and up to the beginning of the crisis in 2008, the absence of coordination in fiscal action across euro area members created persistent inflation differentials that are at the origin of the divergent labour cost dynamics across members of the eurozone.

The bottom line of the analysis presented in this paper is that heterogeneous labour cost developments are, to a certain extent, common to all currency areas. It is true that such heterogeneity is more prevalent in the eurozone than across US States. However, the perception, in Europe, that cost imbalances are an urgent issue, which does not exist in the US probably has more to do with the different structures of the two currency unions: the former having its focal point on the regional (state level) dimension and the latter on the federal level. In a currency union cross-regional divergence in real labour costs could cause unpleasant consequences at the local level (individual States), but it is not clear how it

should affect the monetary area as a whole. In the specific case of the euro area, however, a significant loss of competitiveness at the state level could have more severe macroeconomic consequences, such as the economic undermining of national fiscal authorities, responsible of the vast majority of public spending. In the absence of a system of fiscal transfers, the eurozone adds an additional constraint to the, per se, already challenging target of collective (Communitarian) economic growth and this involves the homogeneity of economic perspectives for all its members. Such a constraint becomes relevant to the extent that the economic risk affecting the National (local) dimension can easily put the stability of the entire communitarian system in jeopardy. It is clear that it is within the structure of the eurozone, in which the National dimension prevails on the Communitarian, that cross-states imbalances become relevant and perilous.

Referring to the empirical analysis developed, this paper has two main messages: the first is that real cost imbalances might accumulate across regions of a currency union without the existence of cross-regional differentials in products or factor markets frictions, but simply as a consequence of differences in relative monetary policy stance. Within this logic, policy efforts to reduce frictions across members of the euro area are important but not sufficient to eliminate intra euro labour cost imbalances. The second is that, if the eurozone wants to increase the homogeneity of its real cost developments, it should work on one crucial aspect: higher fiscal coordination.

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## .1 Interest rates and real unit labor cost in a New Keynesian model

The real unit labor cost has a key role in determining inflation models with stick prices, to the extent it is linked to marginal costs. In this section I present a New Keynesian Model with capital accumulation that I use for deriving a general equilibrium condition relating the real unit labor cost to the real interest rate. In this section the model is presented briefly, for a deeper discussion I invite the interested reader to make reference to the mentioned papers. The main modification of this model concern the use of a CES production function (in line with the analysis developed previously) and the small open economy framework (international borrowing at an exogenous interest rate).

Consider an infinite number of household seeking to maximise:

$$\sum_{t=0}^{\infty} \beta^t U(C_t, L_t) \quad (32)$$

Households in each period can purchase a one period bond  $B_t$  at a price  $Q_t$ . They can consume  $C_t$  at prices  $P_t$  and they can buy next period capital  $K_{t+1}$ . They earn a real wage  $W_t L_t$  and a capital market rent  $(R_t)K_t$ . Household budget constraint is:

$$B_{t-1} + P_t[W_t L_t + R_t K_t] = Q_t B_t + P_t C_t + P_t K_{t+1} \quad (33)$$

and the non-Ponzi condition:

$$\lim_{T \rightarrow \infty} E_t[B_T] \geq 0 \quad (34)$$

First order condition for the household maximisation problem are equations 33, 34 and:

$$U_c(C_t, L_t) = \lambda_t P_t \quad (35)$$

$$U_l(C_t, L_t) = -\lambda_t P_t W_t \quad (36)$$

$$\lambda_t P_t = \beta \lambda_{t+1} R_{t+1} P_{t+1} \quad (37)$$

$$Q_t \lambda_t = \beta \lambda_{t+1} \quad (38)$$

Combining equations 37 and equation 38, log-linearising and calling  $i_t = -\log(Q_t)$ , we obtain the intertemporal condition relating the nominal interest rate to expected real interest rate:

$$i_t - E_t[\pi_{t+1}] = E_t[R_{t+1}] \quad (39)$$

## .2 Firms

Firms are monopolistic competitors in the intermediate market, final output is produced from intermediate goods with Dixit-Stiglitz technology:

$$Y_t = \left[ \int_0^1 y(i)_t^{\frac{\eta-1}{\eta}} di \right]^{\frac{\eta}{\eta-1}} \quad (40)$$

The demand function for intermediate goods is:

$$y_t(i) = Y_t \left[ \frac{P_t(i)}{P_t} \right]^\eta \quad (41)$$

Intermediate goods are produced via CES production function:

$$f(K_t, L_t) = A \left[ (\alpha) K_t^{\frac{\sigma-1}{\sigma}} + (1-\alpha) L_t^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \quad (42)$$

Where  $K_t$ ,  $L_t$  and  $A$  are respectively capital, labor and an exogenous technological parameter,  $\alpha \in (0, 1)$  is the factor share and  $\sigma$  represents factors' elasticity of substitution.

First order conditions for cost minimisation yield:

$$R_t = z_t f_k(K_t, L_t) \quad (43)$$

$$W_t = z_t f_l(K_t, L_t) \quad (44)$$

## .3 Equilibrium

Combining this last equation with equation 39 we obtain the inter temporal condition relating the interest rate with the expected marginal product of capital:

$$i_t - E_t[\pi_{t+1}] = E_t[z_{t+1} f_k(K_{t+1}, L_{t+1})] \quad (45)$$

where  $i_t$  is the net interest rate.

Assume the existence of a number of identical firms, producing different products and facing constant price elasticity of demand given by 41. As in Calvo (1983) assume further that in each period each firm has a fixed probability  $\theta$  of adjusting its price and a probability  $1 - \theta$  of keeping its price unchanged. It can be shown that the aggregate price level  $p_t$  can be expressed as a linear combination of the price at time  $t - 1$  and the optimal price at time  $t$ :

$$p_t = \theta p_{t-1} + (1 - \theta) p_t^* \quad (46)$$

Where the optimal price level  $p_t^*$  is defined as the price that maximises the all future discounted profits subject to Calvo staggered pricing:

$$p_t^* = (1 - \beta\theta) \sum_{j=0}^{\infty} (\beta\theta)^j E_t[z_{t+j} + p_{t+j}] \quad (47)$$

Where  $z_t$  is the marginal cost. Combining equations 46 and 47 and calling  $\pi_t = p_t - p_{t-1}$  we obtain the standard New Keynesian Pricing Equation:

$$\pi_t = \lambda z_t + \beta E_t[\pi_{t+1}] \quad (48)$$

where  $\lambda = \frac{(1-\theta)(1-\theta\beta)}{\theta}$  and the marginal cost  $z_t$  is measured as deviation from the steady state.

In this case the real unit labor cost is:

$$RULC_t = Z_t \left[ 1 - \alpha \left( \frac{K_t}{Y_t} \right)^{\frac{\sigma-1}{\sigma}} \right] \quad (49)$$

Again for  $\sigma = 1$  and perfect competition  $z_t = 1$ , this equation collapses to  $1 - \alpha$ , the constant labor share in case of a Cobb-Douglas.

The inter-temporal Euler equation (equation 45) can be re-written as:

Calling the real interest rate at time  $t$   $R_t = i_t - E_t[\pi_{t+1}]$ , then the inter-temporal Euler equation (equation 45) becomes:

$$i_t = E_t[z_{t+1} f_k(K_{t+1}, L_{t+1}) + \pi_{t+1}] \quad (50)$$

Stating that the nominal rate should be equal to the expected marginal turn of capital in the next period in nominal terms.

Or equivalently:

$$i_{t-1} - \pi_t = z_t \alpha \left( \frac{Y_t}{K_t} \right)^{\frac{1}{\sigma}} - v_t \quad (51)$$

where  $v_t$  is the forecasting error at time  $t$  of  $z_t f_k(K_t, L_t) + \pi_t$ .

$$R_{t-1} = z_t \alpha \left( \frac{Y_t}{K_t} \right)^{\frac{1}{\sigma}} - v_t \quad (52)$$

where  $v_t$  is the forecasting error at time  $t$  of  $z_t f_k(K_t, L_t)$ . Then solving for the capital output ratio, calling  $R_{t-1} = i_{t-1} - \pi_t$  and substituting into 49 we have:

$$RULC_t = Z_t \left[ 1 - \alpha \left( \frac{R_{t-1} + v_t}{\alpha Z_t} \right)^{1-\sigma} \right] \quad (53)$$



Which is equation 22 in the text.

Taking Taylor approximation around the steady state we obtain:

$$s_t = \gamma z_t + \phi r_t + \eta_t \quad (54)$$

Where lower cases indicate deviations from the steady state,  $s_t$  is the real unit labor cost and  $\gamma = \frac{\mu}{s} [1 - \alpha \sigma (\frac{1}{\beta \mu \alpha})^{1-\mu} + \mu (\sigma - 1) (\frac{1}{\beta \mu \alpha})^{1-\sigma} \frac{1}{\mu}]$ ,  $\phi = (\sigma - 1) \frac{1}{\beta s} (\frac{1}{\beta \alpha \mu})^{-\sigma}$  and  $\eta_t = v_t \frac{1}{\mu} (\sigma - 1) (\frac{1}{\beta \alpha \mu})^{-\sigma}$ .

This is a linear equation relating the labor share to the real interest rate and it represents the theoretical base for the estimation performed in this paper.

Table 1: Imbalances and monetary policy: panel ECM

	(1) $\Delta$ RULC	(2) $\Delta$ RULC
Long Run		
Output Per Worker (t)	0.440** (0.165)	0.636** (0.276)
Constant	-0.358** (0.097)	-0.388** (0.101)
$\psi$ (Speed of Adjustment)	-0.572** (0.077)	-0.053** (0.019)
Short Run		
$\Delta$ Output Per Worker (t)	-0.378** (0.031)	-0.383** (0.032)
$\Delta$ Output Per Worker (t-1)		-0.02 (0.037)
$\Delta$ RULC (t-1)		-0.177** (0.049)
Time FE	Yes	Yes
Implied LR Parameters		
$\sigma$	0.69	0.61
$\alpha$	0.30	0.32
Sample	1999-2008	1999-2008
N	468	468

Standard errors in parentheses. Panel error correction models, dynamic fixed effect estimation. The long run relationship between the real unit labor cost and output per worker is presented in the first part of the table. Implied long run elasticity of substitution  $\sigma$  and factor shares  $\alpha$  are in the last part of the table. Quarterly Frequency from 1999q1 to 2008q2. Time fixed effects.

\*  $p < 0.10$ , \*\*  $p < 0.05$

Table 2: Imbalances and monetary policy, real interest rates and changes in unit labor cost.

	OLS	IV	Placebo
	(1) RULC	(2) RULC	(3) RULC
L.Real Rate <sup>+</sup>	0.353 (0.342)	-2.005* (1.124)	
Placebo			0.00336 (0.00580)
Constant	-0.606** (0.00291)	-0.586** (0.00974)	-0.611** (0.0153)
Country FE	Yes	Yes	Yes
Sample	All	All	All
Weak Identification Test			
K-P rk Wald F statistic		26.729	
S-Y critical values		16.38	
N	470	470	470
Adjusted $R^2$	0.0177	0.222	
Sample	1999-2008	1999-2008	1999-2008
Countries	12	12	12

Standard Errors in parenthesis. FE estimator. Quarterly Frequency from 1999q1 to 2008q2 for the Euro area members from 1999 plus Greece, Estonia is excluded for data limitation. <sup>+</sup> in the first and forth equation real interest rates are simply computed as difference between the Eonia rate and expected inflation, in the send and fifth real interest rates are instrumented via cyclically adjusted fiscal balance. Placebo regression consider a model where the regressor has same first and second moment of the instrument used in equation 2 and 5. K-P stands for Kleibergen-Paap, S-Y stands for Stock-Yogo, reported critical values for both tests are at 10 percent.

\*  $p < 0.10$ , \*\*  $p < 0.05$

Table 3: Robustness controls, the real interest rate and changes in unit labor cost

	Baseline (1) RULC	NW SE (2) RULC	Dynamic (3) D.RULC	Relevance (3) RULC
L.Real Rate <sup>iv</sup>	-2.005*	-2.056* (1.233)	-5.824* (3.119)	-0.176 ( 0.183)
L.RULC			-0.267** (0.0464)	
Constant	-0.586** (0.00974)	-0.507** (0.0234)	-0.00128** (0.000570)	-0.0417** (0.0130)
L.Real Rate				-0.023 (0.062)
Country FE	Yes	Yes	N/A	Yes
Sample	All	All	All	All
N	470	470	470	470
Sample	1999-2008	1999-2008	1999-2008	1999-2008
Countries	12	12	12	12

Standard Errors in parenthesis. Quarterly Frequency from 1999q1 to 2008q2 for the Euro area members from 1999 plus Greece, Estonia is excluded for data limitation. Real interest rates are instrumented via cyclically adjusted fiscal balance. First model is the baseline specification, second model uses Newey-West SE to account for possible serial correlation, third model is a dynamic panel estimated using Arellano-Bond linear dynamic panel-data estimator.

\*  $p < 0.10$ , \*\*  $p < 0.05$

Table 4: Imbalances and monetary policy: the real interest rate and changes in unit labor cost, cross-country evidence

	IV (1) $\Delta$ RULC	OLS (2) $\Delta$ RULC	IV (3) $\Delta$ RULC	OLS (4) $\Delta$ RULC
L.Real Rate <sup>iv</sup>	-0.384** (0.132)			
L $\Delta$ Real Rate <sup>iv</sup>			-0.0820** (0.0238)	
L. Real Rate		-2.295 (2.638)		
L. $\Delta$ Real Rate				0.914 (0.542)
Constant	0.0875 (0.152)	-0.292** (0.123)	-0.00179** (0.000624)	0.0114 (0.0142)
N	433	458	391	432
Adjusted $R^2$	0.382	-0.0207	0.498	0.144
Sample	1999-2008	1999-2008	1999-2008	1999-2008
Countries	12	12	12	12

Standard errors in parenthesis. Between estimator. Quarterly Frequency from 1999q1 to 2008q2 for euro area members since 1999 and Greece. Real interest rates computed subtracting one step forward inflation from the Eonia rate. Inflation is instrumented via discretionary fiscal balance when instrument are used.

\*  $p < 0.10$ , \*\*  $p < 0.05$

Figure 1: Evolution of key macroeconomic variables for major euro area countries

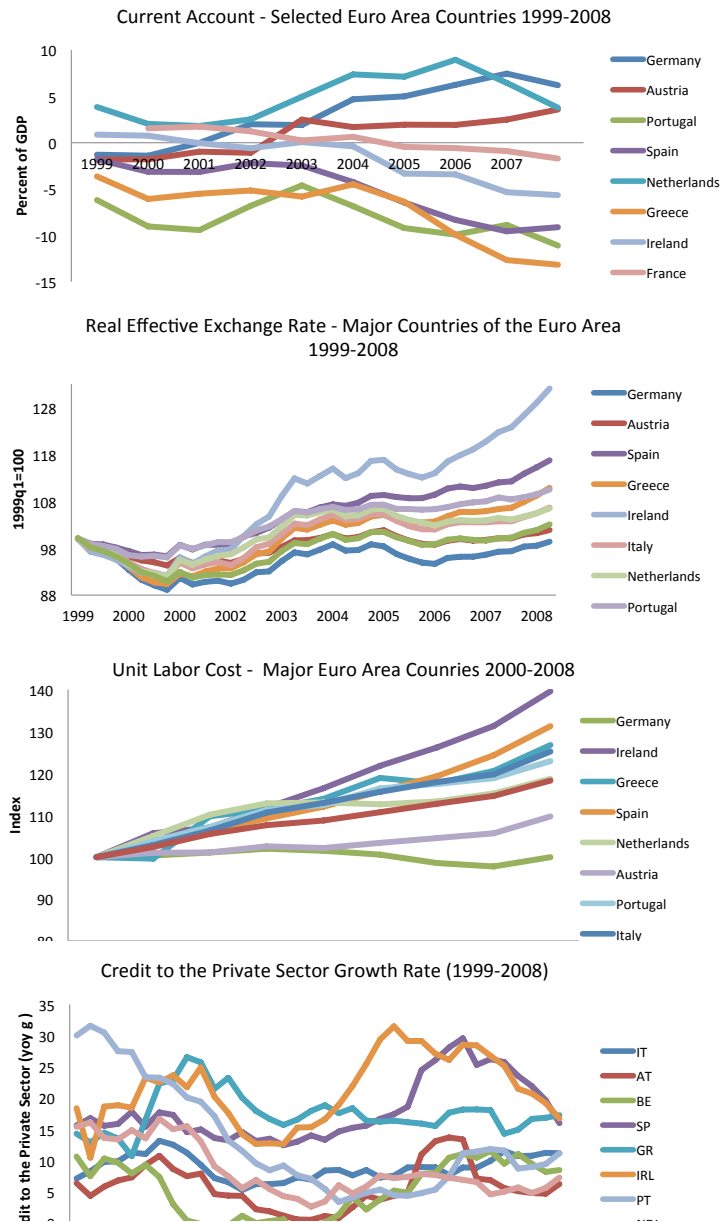


Figure 2: Real unit labor cost imbalances in the euro area

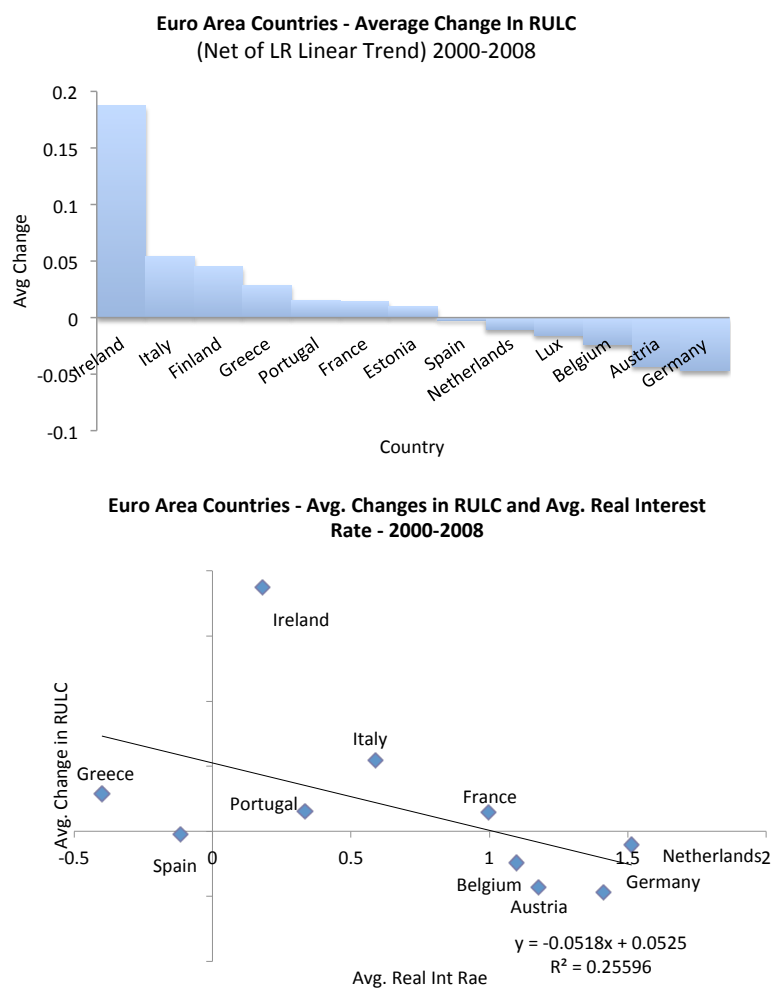


Figure 3: The real unit labour cost and real interest rates

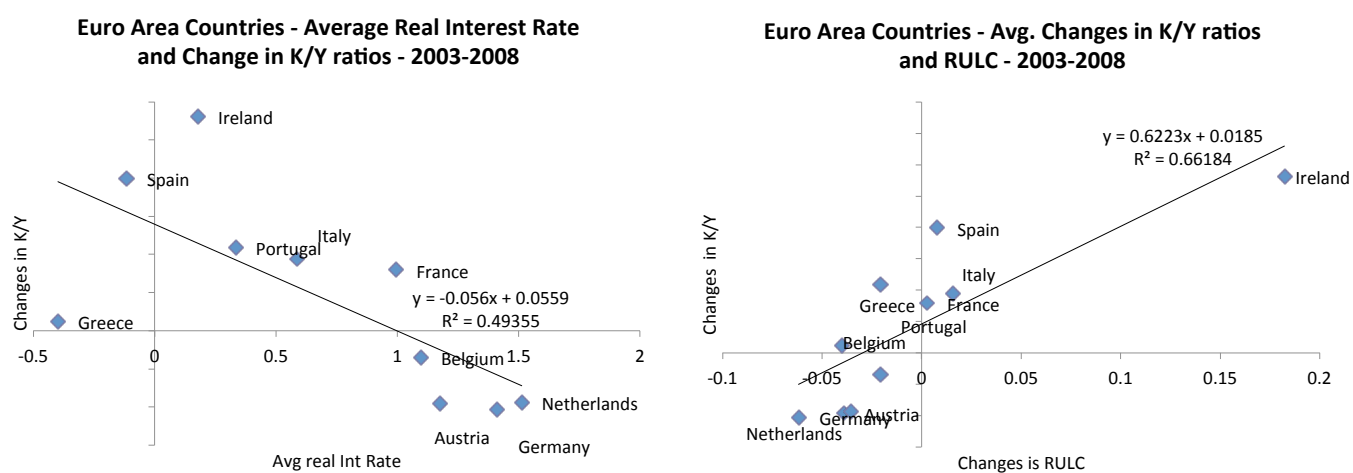




Figure 4:

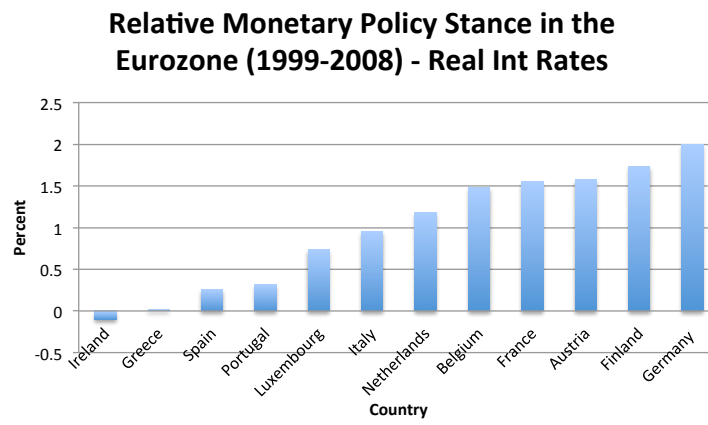
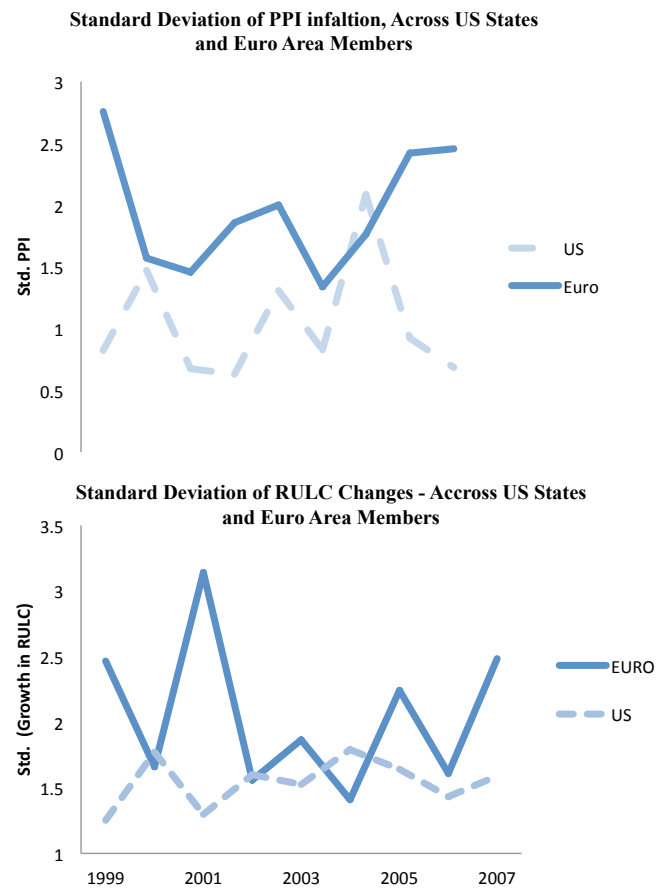


Figure 5: Inflation and RULC differentials: comparing the US and the eurozone



Real unit labor cost and PPI inflation imbalances in the eurozone and the US. Standard deviation of growth rate across countries and states.

Figure 6: Inflation and RULC differentials: tests on the average standard deviation of PPI and RULC growth for the US and eurozone

Std. Of PPI Inflation 1999-2007: Paired t-test

STD PPI	Obs	Mean	Std.Err,	Std. Dev	95% conf int	
US	9	1.047	0.161	0.4851		
EURO	9	2.194	0.121	0.3615		
Diff.		-1.146	0.193	0.579	-1.592	-0.7014

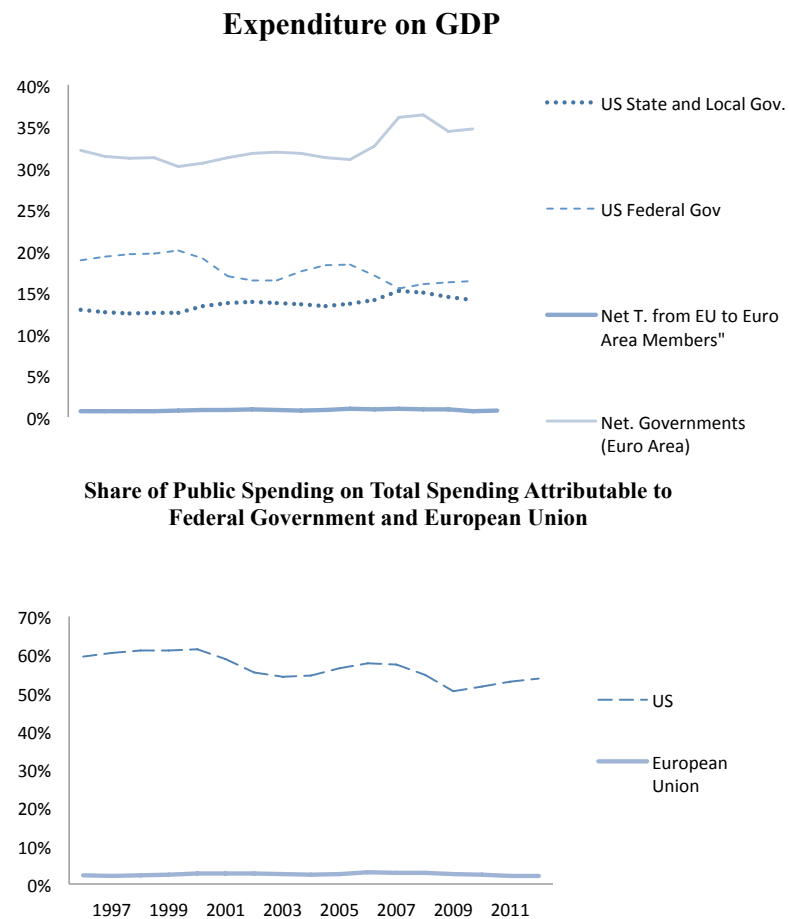
Degrees of Freedom 8  
t= -5.937  
H1: mean(diff)<0 Pr(T<t)=0.0002

Std. Of Changes in RULC 1999-2007: Paired t-test

STD PPI	Obs	Mean	Std.Err,	Std. Dev	95% conf int	
US	9	1.544	0.0631	0.189		
EURO	9	2.048	0.1909	0.573		
Diff.		-0.504	0.2371	0.713	-1.052	0.043

Degrees of Freedom 8  
t= -2.12  
H1: mean(diff)<0 Pr(T<t)= 0.033

Figure 7: Centralisation of fiscal policy: comparing the US and the eurozone.



*Notes:* Fiscal policy in the US and European Union: the first panel show the share of fiscal expenditure implemented at Federal (Communitarian) and State (Country) level in the US (dashed lines) and European Union. The second panel shows the share of total public spending that is implemented at Federal (Communitarian) level in the US (dashed line) and European Union.