



# IMF Working Paper

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## Real Unit Labor Costs Differentials in EMU: How Big, How Benign and How Reversible?

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**IMF Working Paper**

European Department

**Real Unit Labor Costs Differentials in EMU:  
How Big, How Benign and How Reversible?**

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Authorized for distribution by Luc Everaert

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**Abstract**

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Real unit labor costs (RULC) growth differentials between euro area members have persisted since EMU began and even widened out in the run-up to the crisis. This paper focuses on the causes underlying such dispersion. According to our empirical findings, persistent RULC growth differentials can be attributed to divergent evolutions in capital-output ratios, nominal effective exchange rates and country-specific institutional features, coupled with an increased sensitivity of RULC to fundamentals following the shift in the monetary regime. Because these RULC growth discrepancies in EMU partly result from heterogeneous structural characteristics, policy action seeking more homogenous regulation across the euro area can make a significant contribution to reduce them.

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## I. INTRODUCTION

This paper investigates the factors underlying the dispersion in RULC growth rates across euro area countries with a focus on the EMU period. The shift in monetary regime did not bring about a narrowing of real unit labor costs (RULC) growth differentials across euro area members. On the contrary, differentials persisted or even widened out in the run-up to the crisis.

The normative assumption adopted in this paper is that RULC should display no growth under equilibrium conditions. This implies that divergences in RULC growth across euro area countries should gradually fade away. The zero-growth rule has become all-pervasive in the past literature, reading RULC as, alternatively, the ratios of real wages to productivity, labor compensation to nominal GDP or nominal unit labor costs to the GDP deflator. Relevant papers looking at RULC from each angle are, respectively, Blanchard (1997), Bentolila and Saint Paul (1999) and Rotemberg and Woodford (1991). All three assume stability of RULC in equilibrium while deviations from this rule (mostly arising from imperfect competition) typically emerge if a wage push is not fully offset by an increase in prices and/or productivity. This compresses margins, deteriorates competitiveness, and contracts employment and activity until a new equilibrium is reached—characterized by higher levels of nominal variables (i.e. prices and wages) and lower levels of real variables (i.e. employment and output).

This paper addresses three questions. First, how big are RULC growth differentials in EMU by historical perspective? Second, what are the reasons underlying such differentials and why does growth dispersion remain after the start of EMU? Third, how can policy narrow such differentials?

The answer to the first question is that RULC growth divergence has persisted in spite of the launch of EMU. This is at odds with the intuition that setting a common anchor for inflation should facilitate convergence in prices and wages across euro area countries, thus narrowing growth differentials in GDP deflators and nominal unit labor costs—the two variables involved in the definition of RULC. To investigate the causes underlying existing divergences we rely on a model postulating a relationship between RULC and three types of variables: (i) technological, including capital accumulation and the effect of changes in the price of intermediate inputs; (ii) external, captured by the degree of openness, narrow and broad measures of nominal effective exchange rates; and (iii) institutional, featuring the degree of competition in product and labor markets.

According to our empirical findings, continued dispersion in RULC differentials is to be related to an increased sensitivity of RULC to fundamentals after the shift in the monetary regime together with divergent evolutions of such fundamentals, especially the capital-output ratios, nominal effective exchange rates and country-specific institutional features. This result suggests that giving up monetary policy makes one country's RULC growth gap with

EMU more sensitive to country-specific structural features. As divergences are in part related to heterogeneous regulatory options, policy action seeking more homogenous regulation can make a significant contribution to narrow them.

The remainder of the paper is set out as follows. The next section looks at the empirical evidence on relative RULC in eleven euro area countries. Section 3 presents the theoretical model proposed to explain the drivers of RULC movements. Section 4 lays out the empirical strategy and discusses the econometric results. Section 5 concludes the paper and discusses some policy implications.

## II. REAL UNIT LABOR COSTS: THE FACTS

The main goal of this section is to look at developments in relative prices and costs among EMU members in historical perspective. We are interested in the evolution of each Member State's domestic prices and costs (denominated in national currency) compared to the rest of the euro area, both before and after the shift in monetary regime. We shall explore later in the paper whether adjustments in price and costs differentials within EMU are prompted by capital accumulation, market imperfections or external developments.

By relative prices and costs we mean, for each euro area member, the GDP deflator and the whole-economy nominal unit labor costs (NULC hereafter) expressed with respect to the weighted average of the remaining euro area countries.<sup>2</sup> In turn, the difference between these two variables is equal to RULC, our main variable of interest. Before we focus on RULC, let us first examine its two components separately.

Convergence in GDP deflator inflation came to a halt during the EMU decade. This is immediately apparent in Figure 1, which plots the GDP deflator growth differentials between each euro area member and its partners, as measured by the cumulated percent change in relative GDP deflators over a five-year rolling window.<sup>3</sup> Clearly, while cross-country divergences were drastically reduced in the decade preceding the launch of the EMU, the pace of convergence has slowed down since then. To illustrate, the cross-country standard deviation of the 5-year cumulated changes in relative GDP deflator fell from around 30 percent in the mid-1980s to 9 percent in 1999 and 3.5 percent in 2009.

The same convergence analysis on NULC reveals that, while decreasing till 2003, the dispersion among euro area members has been on the rise in the run up to the crisis. This was

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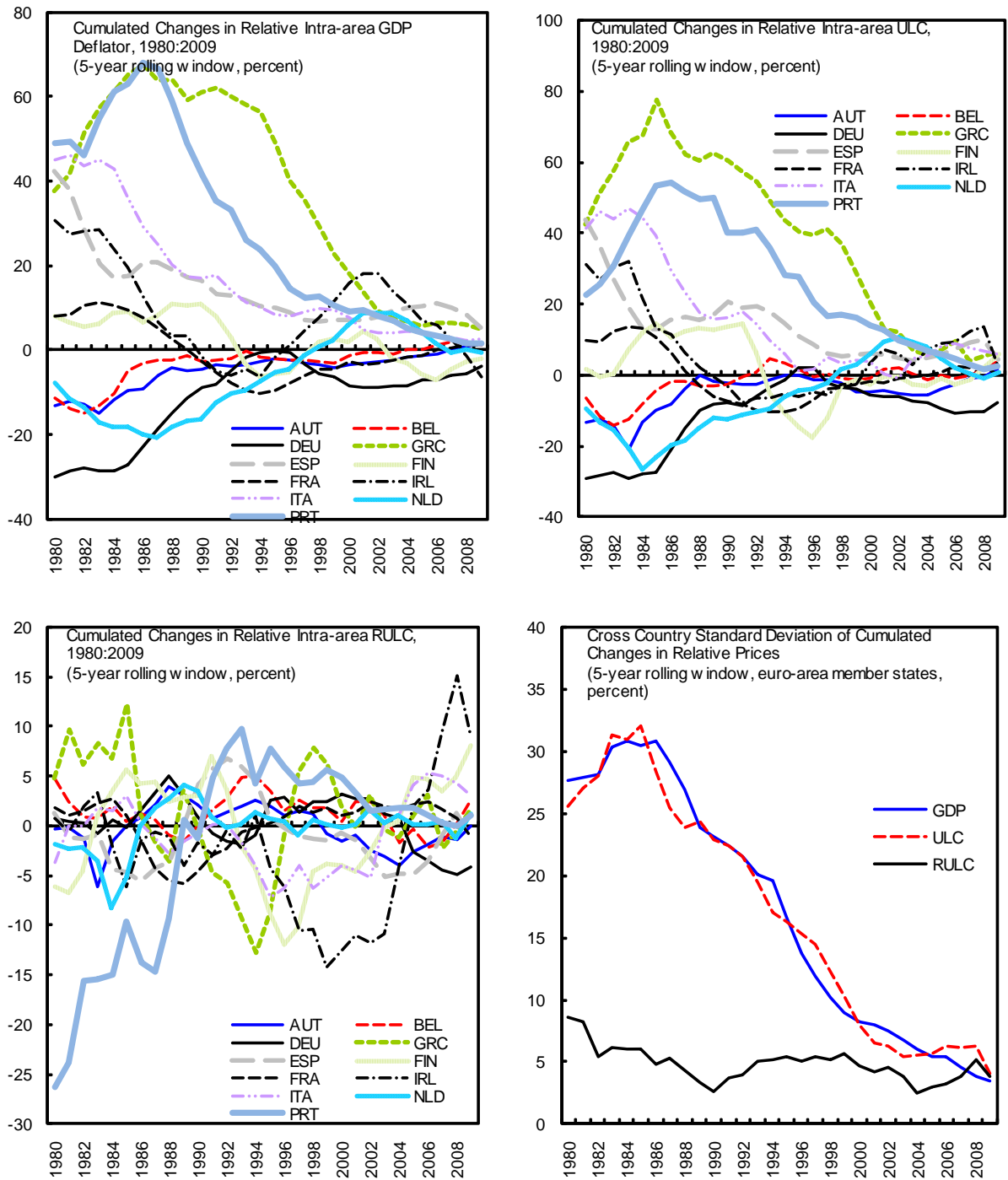
<sup>2</sup> The data are computed based upon the DG ECFIN price and cost competitiveness indicators. The weights are those used by the European Commission to compute the associated intra-area real exchange rates. This data are located at [http://ec.europa.eu/economy\\_finance/db\\_indicators/competitiveness/index\\_en.htm](http://ec.europa.eu/economy_finance/db_indicators/competitiveness/index_en.htm).

<sup>3</sup> By considering a five-year moving average we can judge whether there is a significant persistence in the divergence of growth rates at a country level.

particularly true for Germany, for which the growth rates in NULC remained well below the euro area average, revealing the strong focus on wage cost control by German companies. In contrast, NULC in Spain, Greece and Ireland experienced a significant increase relative to the average.

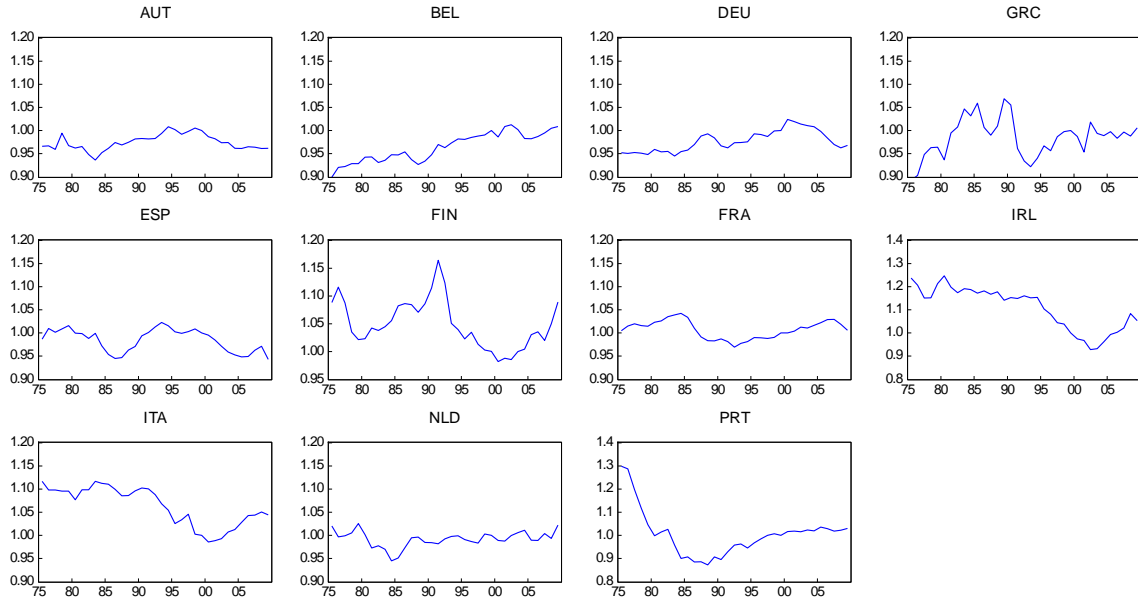
As RULC from one country cannot drift away indefinitely from other EMU members, this variable is expected to be stable in the long run. However, reflecting fluctuations in enterprises' margin behavior, observed changes in relative RULC display significant medium-run deviations from zero. Dispersion in RULC growth differentials has not been markedly reduced since the launch of the euro with this phenomenon being largely explained by the dynamics of the NULC component. Noteworthy, in a context characterized by a single currency and low inflation, closing the gap in RULC growth with the rest of the euro area can be particularly painful, as evidenced by the episodes of public wages cuts and abrupt unemployment increases witnessed in the GIIPS reflected in the 2009 downward adjustment in RULC.

Figure 1. Euro Area: Intra-Area GDP Deflator, Nominal and Real Unit Labor Costs (Relative to average of remaining euro area countries)



Source: Price and cost competitiveness indicators (European Commission) and authors' computations.

Figure 2. Relative Intra-area Real Unit Labor Costs  
Annual Data 1975–2009  
(Index 1999=100)



Source: Price and cost competitiveness indicators (European Commission) and authors' computations.

Note: Scales are the same for all countries except for Ireland and Portugal.

### III. THE MODEL

#### A. Basic Equations

The theoretical model of real unit labor cost determination presented in this section heavily relies on Bentolila and Saint Paul (2003), Arpaia and others (2009). The starting point of the analysis is a monotonic relationship between RULC and the capital-output ratio, which hinges upon the assumptions of perfect competition and a technology of the CES form. We subsequently proceed to study the role of factors which displace this schedule one by one, including changes in the price of intermediate inputs, markups of prices over marginal costs, union bargaining power, or labor adjustment costs. This allows us to obtain a general equation for real unit labor costs, which we will estimate in Section 4.

Let us consider a CES technology with two inputs, capital and labor

$$(1) \quad Y = A \left( \alpha K^{\frac{\eta-1}{\eta}} + (1-\alpha)L^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$



where  $Y$  is aggregate value added,  $K$  is capital,  $L$  is labor,  $A$  is total factor productivity,  $\alpha$  is a share parameter and  $0 < \eta < \infty$  represents the elasticity of substitution between capital and labor. As long as there is perfect competition, labor is paid its marginal product, thus RULC are given by

$$(2) \quad \frac{WL}{PY} = 1 - \alpha \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}}$$

where  $W$  and  $P$  denote nominal wages and the price of value added. Equation (2) implies a monotonic relationship between the labor share and the capital-output ratio, either increasing or decreasing depending on the sign of  $\eta$ . If labor and capital are high substitutes ( $\eta > 1$ ), capital deepening will come along with decreasing RULC, and conversely if they are low substitutes ( $\eta < 1$ ). Empirical research estimating equation (1) based on large samples of countries tends to find an elasticity of substitution between aggregate capital and labor lower than one.

When looking at equation (2) it is important to note that zero growth of RULC is a necessary though not sufficient condition for equilibrium. RULC are shown to be a function of capital output ratios. Thus defining the steady state level for RULC requires pinning down the stable (i.e. long-run equilibrium) value for the capital output ratio. The latter is a function of fundamentals in the standard neoclassical growth model, as given by technological progress, population growth, the savings rate and the factor elasticity of substitution. Should all these factors be the same across euro area countries (i.e. absolute convergence applies) all countries would converge to the same RULC in the long run. Where these factors are thought to vary across euro area countries, RULC would converge to different levels (i.e. relative convergence hypothesis). This paper does not attempt to determine RULC steady state levels but rather test a sufficient condition for equilibrium.

We can now ask ourselves what happens if there are intermediate inputs in production whose price fluctuates. To see this formally, the production function needs to be defined in terms of gross aggregate output, rather than aggregate value added, as in

$$(3) \quad \tilde{Y} = A \left( \alpha_1 K^{\frac{\eta-1}{\eta}} + \alpha_2 L^{\frac{\eta-1}{\eta}} + (1 - \alpha_1 - \alpha_2) I^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

where  $\tilde{Y}$  and  $I$  respectively denote gross output and intermediate inputs. The relationship between gross output and value added is given by (see Bruno and Sachs, 1985)

$$(4) Y = \tilde{Y} - \frac{p_I}{\tilde{p}} I$$

where  $p_I$  and  $\tilde{p}$  are the price deflators of intermediate inputs and gross output. In this case RULC adopt the expression

$$(5) \frac{WL}{PY} = 1 - \left( \left( 1 - (1 - \alpha_1 - \alpha_2) \left( \frac{p_I}{\tilde{p}} \right)^{\eta-1} \right)^{\frac{1}{\eta}} \alpha_1 \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}} \right)$$

where we see that the relative price of intermediates shifts the relationship between RULC and the capital-output ratio in a way that depends on the factor elasticity  $\eta$ .

The analysis so far assumed that all markets are perfectly competitive. In the event of imperfect competition, real wages are no longer equal to the marginal product of labor and, as we shall show, RULC may change for reasons other than purely technological. To see this, let us assume that firms operate under imperfect competition, thus they set prices according to the markup rule

$$(6) p = \mu MC = \mu \frac{W}{Y'_L}$$

where  $MC$ ,  $Y'_L$  and  $\mu$  respectively stand for the firm's marginal cost, the marginal product of labor and the markup. RULC are now given by

$$(7) \frac{WL}{PY} = \frac{Y'_L L}{\mu Y} = \frac{1}{\mu} \left( 1 - \alpha \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}} \right)$$

Suppose that, in line with the efficient bargaining hypothesis, wages are set in a Nash-bargaining fashion as a weighted average between the marginal and the average product of labor, each representing the worker's and firm's fallback positions in wage bargaining

$$(8) \frac{W}{P} = \beta \frac{Y}{L} + (1 - \beta) Y'_L$$

where  $\beta$  is the workers' bargaining power. In this case RULC take the form

$$(9) \frac{WL}{PY} = 1 - \left( (1 - \beta) \alpha \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}} \right)$$

We finally want to explore how labor adjustment costs affect the basic relationship between RULC and the capital-output ratio (2). By labor adjustment costs we mean hiring and firing restrictions weighing on employment changes. In presence of such costs the firm optimizes at the point where the marginal product of labor is equal to the marginal cost generated by an extra unit of labor, that is

$$(10) \quad Y'_L = \frac{W}{P} + E'(\delta L)$$

where  $E'(\delta L)$  represents the marginal cost of adjusting (either increasing or decreasing) an extra unit of labor. This implies the following expression for RULC

$$(11) \quad \frac{WL}{PY} = (Y'_L - E'(\delta L)) \frac{L}{Y} = 1 - \alpha \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}} - E'(\delta L) \frac{L}{Y}$$

With employment regulations, market clearance is satisfied at levels of employment and RULC lower than what would have prevailed otherwise. In presence of uncertainty, employment protection rules can be expected to inhibit job creation further, as output variability increases the likelihood that a worker be fired, thus raising the shadow cost of labor and pushing the RULC-capital-output schedule downwards.

The discussion above suggests that in a context characterized by a CES technology, imperfectly competitive firms, varying price of intermediate inputs, efficient bargaining and adjustment costs in the labor market, profit maximization behavior implies the following rule for RULC

$$(12) \quad \frac{WL}{PY} = \frac{1}{\mu} \left( 1 - \left( (1 - \beta) \left( 1 - (1 - \alpha_1 - \alpha_2) \left( \frac{p_l}{\tilde{p}} \right)^{\eta-1} \right)^{\frac{1}{\eta}} \alpha_1 \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}} \right) \right) - E'(\delta L) \frac{L}{Y}$$

## B. Model Predictions

How does the model behave? This section investigates the predictions implied by the proposed model of RULC (detailed derivations are presented in Appendix 1), while section 4 will be devoted to test empirically our theoretical priors. Overall, the theory used in this paper suggests that there is a one-for-one relationship between RULC and the capital-output ratio. A number of factors displace this schedule in an unambiguous direction, the sign of which may or may not depend on the factor elasticity of substitution as discussed below. Figure 3 provides a graphical characterization of the model.

*Proposition 1: Capital accumulation comes along with increasing RULC if the factor elasticity of substitution is lower than unity, that is*

$$(13) \quad \frac{\partial RULC}{\partial(K/Y)} > 0 \text{ if } \eta < 1$$

An increase in the capital-output ratio induces an increase in wages relative to the price of capital and a reduction in the labor to capital ratio. If labor and capital are low substitutes, the rise in relative wages (price effect) will be accompanied by a less-than-proportional reduction in labor relative to capital (quantity effect) and RULC will be higher.

*Proposition 2: RULC increases when the relative price of intermediates rises if the elasticity of substitution is lower than one, that is*

$$(14) \quad \frac{\partial RULC}{\partial(p_1/\tilde{p})} > 0 \text{ if } \eta < 1$$

This is because in order to maintain a constant ratio between capital and value added as intermediates' prices rise, the labor to capital ratio must rise, which pushes RULC upwards. If the elasticity is lower than one, this effect offsets the fall in wages triggered by the required increase in the labor to capital ratio and the decline in the marginal product of labor directly induced by the lower use of intermediates in production.

*Proposition 3: The direction of change of RULC in response to changes in institutional factors is not affected by the factor elasticity of substitution.*

*Proposition 3.1: RULC are a decreasing function of firms' markup and an increasing function of workers' bargaining power*

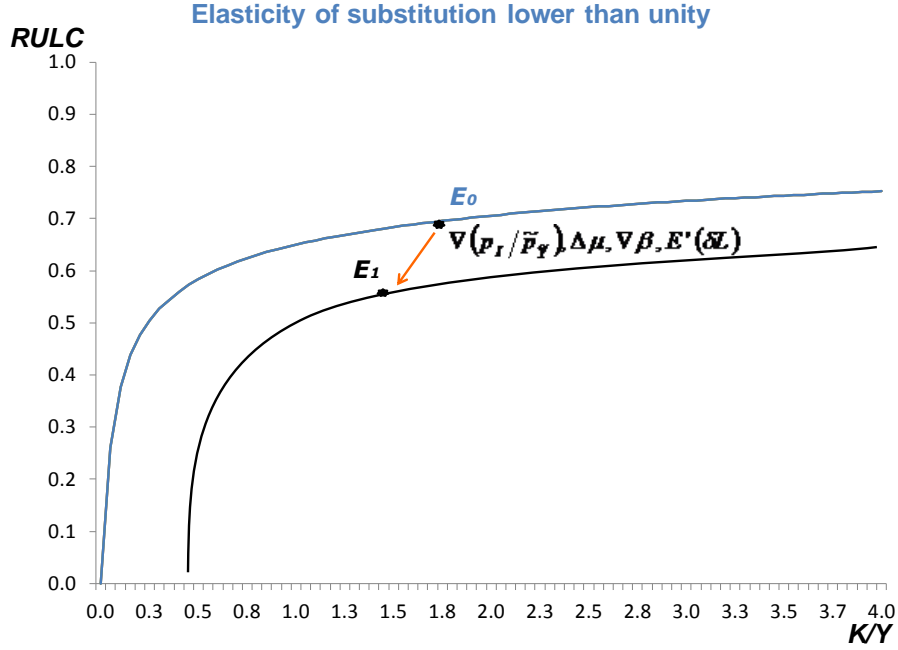
$$(15) \quad \frac{\partial RULC}{\partial \mu} < 0, \frac{\partial RULC}{\partial \beta} > 0, \text{ for any } \eta > 0$$

RULC are a decreasing function of the markup, the reason being twofold. First, a rise in the markup increases prices, thus for given nominal wages, real wages fall. Put differently, because the rents going to firms come from consumers who now pay more for the goods they buy, workers lose as consumers. Second, a lower degree of competition shrinks the number of firms in the market and leads to an equilibrium characterized by lower levels of employment and RULC. An increase in the workers' bargaining power increases the proportion of rents going to workers, and is associated with a higher real wage and RULC in the short run.

*Proposition 3.2: RULC are a decreasing function of labor marginal adjustment costs under the assumption of convex adjustment costs*

$$(16) \frac{\partial RULC}{\partial E'(\delta L)} < 0, \text{ for } E'(\delta L) > 0, E''(\delta L) > 0 (< 0) \text{ if } \delta L > 0 (< 0)$$

Figure 3. Real Unit Labor Costs and the Capital-Output Ratio



#### IV. ESTIMATING THE MODEL

##### A. Data and Empirical Strategy

As empirical specification, we propose the following log-linear version of the theoretical model presented above:

$$(17) \begin{aligned} d \log RULC_t^{i,emu-i} = & \alpha + \gamma_i + \beta_0 \log RULC_{t-1}^{i,emu-i} + \beta_1 d \log (K/Y)_t^{i,emu-i} + \beta_2 d \log (p_I / \tilde{p})_t^{i,emu-i} \\ & + \beta_3 d \log NEER\_EA_{t-1}^{i,emu-i} + \beta_4 d \log NEER\_12 / 29_{t-1}^{i,emu-i} \\ & + \beta_5 (u - nawru)_t^{i,emu-i} + \beta_6 d \left( (X + M / GDP)_t^{i,emu-i} \right) + \beta_7 d (pmr)_{t-1}^{i,emu-i} \\ & + \beta_8 d (rr)_{t-1}^{i,emu-i} + \beta_9 d (barcent)_t^{i,emu-i} + \beta_{10} d (epl)_t^{i,emu-i} + \beta_{11} d (\sigma * epl)_t^{i,emu-i} + \varepsilon_t^{i,emu-i} \end{aligned}$$

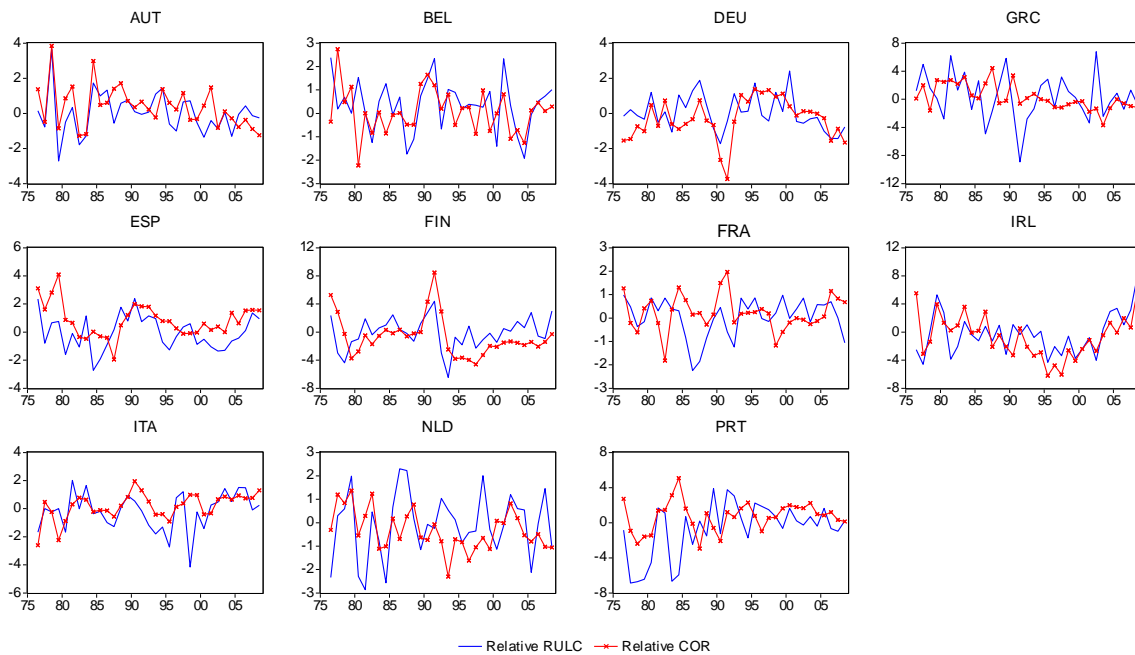
where  $d$  indicates first difference,  $i$  is a country index,  $emu-i$  is a weighted average of all EMU countries excluding  $i$ .<sup>4</sup> Thus all variables are expressed in (log) first-difference form

<sup>4</sup> Weights are time varying and reflect each country's trade composition. The trade weighting structure takes into account the competition faced by exporters in a given market from both domestic and third-country  
(continued)

and relative to the weighted average of the remaining euro area partners, which we indicate with the superscript  $i,emu-i$ .<sup>5</sup> The specification allows for country-fixed effects.

In line with the theoretical framework proposed in this paper, the change in the relative RULC is regressed against two technological factors, the (relative) capital-output ratio and the (relative) price of intermediate inputs (energy, material and services inputs) in terms of the price of gross output, both coming for the EU KLEMS database (O'Mahony and Timmer, 2009). Among these two, the relative capital-output ratios can be shown to be strongly and positively correlated with the evolution of relative RULC (Figure 4). As we will discuss in the next sub-section, such positive co-movements point to a value of the elasticity of substitution lower than unity.

Figure 4. Evolution of relative RULC and Capital-Output Ratios  
(Percentage change over preceding year)



Sources: Price and cost competitiveness indicators (European Commission); EU KLEMS; and authors' calculations

Besides the responsiveness of RULC to technological drivers we also test the significance of a number of institutional dimensions supposed to match our theoretical concepts. All institutional variables increase with the strictness of regulation. They are subsequently expressed in relative terms in the same way as the technological variables and then standardized to have zero mean and unit standard deviation. This standardization allows

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producers.

<sup>5</sup> Depending on the unit in which the variable is expressed, either the ratio or the difference is used as relative measure.

interpreting the results in terms of the change associated with a one-standard-deviation variation in each institutional variable. The labor and product market indicators used in our regressions includes:

- Three measures having an influence on the worker's bargaining strength: bargaining centralization, the replacement rate of unemployment benefits and the degree of openness. Bargaining centralization (coded as *barcent*) takes into account both union authority and union concentration at multiple levels. The indicator comes from the Database on institutional characteristics of trade unions, wage setting, state intervention and social pacts (Visser, 2007). The replacement rate (coded as *rr*) is the OECD average of gross replacement rates for two earnings levels, three family situations and three durations of unemployment (Martin, 1996). The degree of openness is measured as the volume of imports plus exports divided by GDP, where all variables come from the European Commission AMECO database.
- One measure affecting the hiring and firing costs of firms (coded as *eplreg*): the indicator of employment protection legislation for regular workers is taken from the Nickell-Nunziata Labor market institutions database (Nickell et al., 2001) until 2003 and extended further based on the most updated OECD data. As discussed in the previous section, the adverse effect of job regulations is likely to have a greater impact in countries where output is more volatile. As a measure of uncertainty, we take the standard deviation of output growth.
- An indicator reflecting the general state of product market regulation in the economy (coded as *pmr*): the OECD indicator of product market regulation in the seven non-manufacturing industries where anti-competitive regulation tends to be more concentrated, namely gas, electricity, post, telecommunications, passenger air transport, railways and road freight. The indicator encompasses the dimensions of state control, barriers to entrepreneurship and barriers to trade and investment. The data taken from the Bassanini-Duval database (Bassanini and Duval, 2006) range from 1977 to 2003 and have been extended using the most recent OECD vintage.

All indicators described so far are supposed to influence RULC behavior over the medium run, as implied by the model adopted in this paper. To embed this model into a long-run-perfectly competitive equilibrium setting, the equality between growth in real wages and labor productivity must hold in every country over long periods of time. In other words, RULC growth differentials should converge towards zero. We test empirically the convergence hypothesis by entering the lagged level of the endogenous variable in our regressions—the sign of each we expect to be negative. To account for short-run dynamics, a country's (relative) RULC indicator is hypothesized to vary in response to changes in its (relative) labor market tightness, as measured by the (relative) unemployment gap. The observed and natural rates of unemployment (NAWRU) used to compute unemployment gaps are taken from the European Commission AMECO database.

To test the responsiveness of RULC differentials to changes in nominal effective exchange rates—before and after the start of EMU—we compare euro area members against two country groupings, intra- and extra-area (a similar approach is adopted in Honohan and Lane, 2003). These are, for the long sample (1980-2007), the first-wave of euro area members (coded as *NEER\_EA*) and a narrow group of mature economies outside the eurozone (including Denmark, Sweden, the U.K., Australia, Canada, the U.S., Japan, Norway, New Zealand, Mexico, Switzerland and Turkey, coded as *NEER\_I2*). For the sample focusing exclusively on the euro area period a broader group of 29 countries is considered (coded *NEER\_29*), including, in addition to the previous list, the remaining non-euro area EU countries and the emerging economies of Russia, China, Brazil, Korea and Hong Kong.

## B. Results

Estimation work is performed on a panel of 11 euro area countries<sup>6</sup> ranging from 1980 to 2008. Equation (17) is initially estimated using Generalized Least Squares (GLS). To check for robustness we carry out sensitivity analyses to the country sample and to the shift in the monetary regime. Because the GLS estimator may yield inconsistent coefficients, we also run the regression using instrumental variables (GIV). Estimation results are presented in Table 1. We start by presenting the results with the GLS estimator on the whole sample, then go on to discuss sensitivity analyses.

The long- and short- run behavior of RULC growth differentials confirms our priors. RULC growth differentials converge to zero over the very long run, but convergence is relatively slow—the coefficient of the lagged endogenous variable is negative but small in absolute value.<sup>7</sup> In the short term, relative RULC are found to decrease in response to a depressing labor market, with our estimates implying a reduction of about 0.3 percent in relative RULC for each point of additional unemployment gap differential with EMU.

As a result of their heightened economic interdependence, past movements in intra-area nominal effective exchange rates tended to affect RULC growth differentials more markedly than changes in nominal competitiveness with the rest of the world. By accelerating labor compensation beyond nominal GDP growth, nominal appreciations (depreciations) tended to drive relative RULC upwards (downwards) in the country loosing (regaining) nominal competitiveness.

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<sup>6</sup> The sample includes Austria, Belgium, Germany, Greece, Finland, France, the Netherlands, Ireland, Italy, Portugal and Spain.

<sup>7</sup> Note that equation (13) can be rewritten as

$$\log RULC_t^{i,emu-i} = \alpha + \gamma_i + (1 + \beta_0) \log RULC_{t-1}^{i,emu-i} + \beta_i \sum_i dX_{it}$$

Thus the smaller the absolute value of the coefficient  $\beta_1$ , the longer it will take for RULC to adjust to a shock. A value of -0.14 implies that it takes about five years for RULC to absorb half the size of the shock.



Theoretical priors on technological and institutional determinants are confirmed by the econometric results. Comparatively higher capital accumulation and increases in the price of intermediates both lead to relatively higher growth in RULC. The positive coefficient of the capital-output ratio is consistent with an elasticity of substitution lower than one, in line with earlier empirical work directly estimating CES production functions. The value of the elasticity implied by our estimates (around 0.7)<sup>8</sup> suggests that for a one-percent relative increase in the capital-output ratio, a country will see a rise of 0.4 percent in RULC relative to its euro area partners. As discussed in Section 3, when capital and labor are low substitutes, capital accumulation pushes up RULC, as the price effect (rise in relative wages) dominates the quantity effect (reduction in labor relative to capital). A higher relative price of intermediate inputs further increases RULC, pointing again to a value of the elasticity of substitution below one.

Labor and product market imperfections affect RULC (profit margins) as predicted by the theory. As discussed in the previous section, the interplay between institutions and RULC takes place through three channels, namely markups, wage bargaining and labor adjustment costs, with estimated coefficients allowing for the following economic interpretation:

- In line with the theory presented in this paper, comparatively stringent product market regulation is associated with relatively lower RULC, as imperfect competition leads to an equilibrium characterized by higher prices and lower employment.
- The three indicators supposed to influence wage formation are significant and affect RULC with the expected sign. First, comparatively higher replacement rates are found to increase relative RULC, as more generous unemployment benefits improve the fallback position of employed workers in wage bargaining and reduce job search intensity, overall limiting the unemployment's disciplining effect on wages. Second, countries characterized by high levels of bargaining centralization also tend to deliver relatively higher levels of employment, and thus RULC. This result is an empirical confirmation of the hypothesis that centralization moves the economy closer to the efficient bargaining model, to the extent that unions internalize the effect of their wage choice on national employment (Calmfors and Drifill, 1988). It also validates previous findings pointing in the same direction (see, for instance, OECD 2004). Third, a relatively higher degree of openness (tradable sector) puts downward pressure on RULC, possibly through two channels, the disciplining effect on wage formation and the positive impact on labor productivity brought about by the assimilation of new technologies.
- More rigid employment regulations shrink employment bringing down RULC. This is in line with past studies providing evidence of marked increases in structural

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<sup>8</sup> The computation of the factor elasticity is discussed in Appendix 2.

unemployment during downturns as a result of strict employment rules (Furceri and Mourougane, 2009, OECD 2009). It also squares well with the observation that, during upturns, employment rates are the highest in labor markets characterized by intense labor flows (Garibaldi and Mauro, 2002, Sapir, 2006). Noteworthy, the negative effect of employment protection on job creation is magnified in presence of uncertainty, to the extent that higher output volatility increases the likelihood that a worker be fired, and firing restrictions become an impediment to firms' adjustment in the event of a downturn.

Results are generally robust to the country sample, the change in monetary regime and the estimation technique, as discussed below.

- The exclusion of individual countries from the sample (Table 2, Appendix 3) hardly alters the point estimates and t-statistics for technological and external factors, product market regulation and employment protection legislation indicators. The estimated coefficients for the other institutional factors show less stability.
- The shift to EMU by and large preserves the sign of the estimated coefficients but leads to a higher sensitivity of differentials to fundamentals. To examine this, we provide separate estimates for the period 1996-2008 (second column of Table 1).<sup>9</sup> We find that the degree of inertia was slightly reduced during EMU years. RULC differentials also became more reactive to the capital-output ratio and the price of materials. The sensitivity to the extra-NEER increased further, pointing to Member States' rising trade exposure to the rest of the world.<sup>10</sup> Country-specific institutional characteristics also tended to generate larger differentials in RULC under EMU conditions. In particular, the coefficients of product market regulation, bargaining centralization and the interplay between uncertainty and employment rules became larger. A notable exception to this general pattern is the post-EMU reduced sensitivity of RULC differentials to the unemployment gap.
- Applying GLS on an equation including both the lagged dependent variable and serial correlation in the error term may lead to inconsistent estimators. Lack of consistency could also arise if some of the other explanatory variables were to be correlated with the disturbance term, which cannot be excluded a priori either. To deal with potential inconsistency problems, equation (17) was re-estimated using the GIV estimator. The lagged dependent variable, the unemployment gap, the capital-output ratio, the

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<sup>9</sup> The seemingly unrelated regression methodology used in the estimation results presented in Table 1 requires that the number of years in the panel be higher than the number of cross-section units, thus the sample cannot be limited to the period 1999-2008. Taking 1996 as initial year in our estimates plausibly assumes that between 1996 and 1999 countries were, to a large extent, behaving as if EMU was already in place.

<sup>10</sup> To control for the shift in monetary regime we kept the intra-area exchange rate as an explanatory variable, with its variation becoming zero as of 2000.

relative price of intermediate inputs, the degree of openness and the change in employment were all instrumented using a minimum of two lags.<sup>11</sup> For institutional variables, considered as predetermined given their sticky nature, one and two-period lagged values are used as instruments (see, for a similar approach, Guichard and Rusticelli, 2010). All coefficients estimated by GIV—bar employment protection legislation—remain significantly different from zero and their sign is confirmed (Table 1). In addition, GIV estimates result in sizable upward revisions, excluding the parameters of the persistence term and the unemployment gap, which are only marginally affected. The coefficient of the AR process, now insignificant, is restricted to zero.

Table 1. Panel RULC Regression

<i>Dependent variable: <math>\Delta \log RULC</math></i>	GLS				GIV	
	1980-2008		1996-2008		1980-2008	
<i>Sample</i>						
log RULC(-1)	-0.136	(5.64) ***	-0.183	(15.54) ***	-0.125	(5.86) ***
Unemployment gap	-0.336	(4.49) ***	-0.186	(6.08) ***	-0.338	(2.46) **
$\Delta \log$ NEER_EA	0.104	(5.37) ***	0.223	(8.08) ***	0.199	(4.28) ***
$\Delta \log$ NEER12	0.009	(3.31) ***			0.095	(5.09) ***
$\Delta \log$ NEER29			0.047	(10.49) ***		
$\Delta$ Degree of openness	-0.048	(2.57) **	0.060	(6.21) ***	-0.137	(2.62) ***
$\Delta \log$ Capital-output ratio	0.446	(10.68) ***	0.771	(28.70) ***	0.648	(7.09) ***
$\Delta \log$ Relative price of intermediate inputs	0.084	(2.30) **	0.142	(5.70) ***	0.528	(4.34) ***
$\Delta$ Product market regulation(-1)	-0.463	(3.17) ***	-0.714	(8.32) ***	-0.725	(2.76) ***
$\Delta$ Employment protection legislation	-0.814	(1.83) *	0.421	(1.81) *	0.676	(0.62)
$\Delta$ Unemployment replacement rate(-1)	0.900	(2.19) **	0.350	(1.74) *	1.266	(2.42) **
$\Delta$ Bargaining centralization	1.271	(1.87) *	5.841	(12.28) ***	3.664	(1.64) *
<i>Interaction between:</i>						
$\Delta$ EPL and volatility of output growth	-0.119	(1.82) *	-0.519	(8.43) ***	-0.719	(3.50) ***
AR(1)	0.205	(3.35) ***	-0.107	(2.81) ***		
<i>S.E. of regression</i>	1.01		1.06		1.02	
<i>R-squared (weighted)</i>	0.48		0.96		0.48	
<i>R-squared (unweighted)</i>	0.33		0.50		0.13	
<i>Total panel (balanced) observations</i>	319		143		319	

Note: The sample includes data for 11 euro-area members (first wave plus EL minus LU). The estimation includes cross-country fixed effects (not displayed). The feasible Generalized Least Squares (GLS) estimator corrects for both cross-section heteroskedasticity and contemporaneous correlation and foresees an AR(1) error autocorrelation structure. In the Generalized Instrumental Variables (GIV) estimation, institutional variables were all instrumented using one and two-period lagged values while for the macroeconomic variables a minimum of two lags was adopted. Variables are scaled such that the coefficients can be interpreted as the impact in percent on the dependent variable. The absolute value of the t-statistics are reported in parenthesis. Superscripts \*, \*\* and \*\*\* indicate that the estimated coefficient is significantly different from zero at 10, 5 and 1 percent level, respectively. The R-squared is provided based on both the GLS weighted data and the original data.

<sup>11</sup> The presence of second-order autocorrelation in the error term was tested and rejected. Thus variables lagged by two or more periods are uncorrelated with the disturbance term.

Using the estimated coefficients provided in Table 1, it is possible to compute the relative importance of each explanatory factor to RULC growth differentials as explained by equation (17). Specifically, we compute the contributions of each factor to RULC differentials during the period 2000-08 based on the coefficients estimated on the sample 1996-2008.

Technological factors (capital-output ratio and relative price of intermediate inputs) stand out as the main driver behind RULC growth disparities (46 percent of the total deviation explained by the model from the RULC zero growth equilibrium condition) together with the lagged dependent variable (24 percent). External factors as captured by changes in the degree of openness and the nominal value of the euro have a non-negligible impact (9 percent). The contribution of the relative unemployment gap is slightly lower (7 percent). Contributions of differences in product and labor market regulations are relatively modest in size (14 percent) but may persist indefinitely in the absence of institutional changes.

## V. CONCLUSIONS AND POLICY IMPLICATIONS

Contrary to expectations, the launch of EMU was not marked by a reduced dispersion in RULC growth differentials, reflecting in turn persistent divergences in firms' profitability across euro area members. To the extent that such divergences stem from heterogeneous regulatory options, they can be regarded as non-benign.

What is the role for policy in narrowing RULC growth differentials within euro area countries? This paper has argued that the most important driver of such divergences is capital accumulation. In particular, relative RULC increased in countries where the capital-output ratio grew comparatively faster, with capital accumulation being financed by loose credit conditions especially in construction sectors. A key challenge for policy makers is therefore to devise reforms that limit the pro-cyclicality of credit supply. This could mean (without prejudice to the internal market) to ensure that bank capital requirements duly reflect country differences in asset price overvaluation. Structural features of the housing market increasing the likelihood of building bubbles (e.g. tax incentives for mortgages) also need to be reviewed.

Our empirical work also highlights the increasing responsiveness of RULC differentials to nominal changes in competitiveness with the rest of the world. All other things being equal, one country's RULC growth gap with the regional average responds more markedly than before EMU to movements in the extra-area component of the NEER. This is potentially an important source of real divergence going forward, not least given the heterogeneous response of euro area members' NEERs to changes in the value of the euro—resulting from different specialization patterns and degrees of exposure to the rest of the world. By implication, both an increasing degree of openness and a specialization upgrade in the periphery should help reduce the dispersion in RULC growth in the medium term. This is in line with Chen and others (2011), who point to the differential impact on the current accounts of both core and peripheral countries induced by the emergence of China, Central and

Eastern Europe. It also raises the question whether countries in need for transformation should benefit from EU transfers while they engage into productivity-enhancing structural reforms or, conversely, whether such transfers may, by removing incentives to change, delay the necessary adjustment.

The divergences are ultimately a function of product and labor market regulations, largely shaped by country-specific preferences. Our findings suggest that this heterogeneity tends to amplify RULC dispersion. The implication being that without further coordination of labor and product market policies those institutional disparities will continue to impair RULC convergence in Europe. In this context, it will be important to reconsider the view that regulatory frameworks, especially labor market policies, should remain an exclusive competence of the member states.

Overall, continued dispersion in RULC differentials appears to be the result of an increased sensitivity of RULC to fundamentals after the shift in the monetary regime coupled with divergent evolutions in such fundamentals, especially the capital-output ratios, nominal effective exchange rates and country-specific institutional features. This result suggests that giving up monetary policy makes one country's RULC growth gap with EMU more sensitive to country-specific structural features. We tend to think that this result goes beyond the specific set of fundamentals used in this paper, but more work needs to be done to prove this going forward.

## APPENDIX

## APPENDIX I. MODEL PREDICTIONS

This appendix derives the model's comparative statics predictions presented in Section 3.

Consider the specification for RULC (12), reproduced here for convenience

$$(12) \quad \frac{WL}{PY} = \frac{1}{\mu} \left( 1 - \left( (1 - \beta) \left( 1 - (1 - \alpha_1 - \alpha_2) \left( \frac{p_I}{\tilde{p}} \right)^{\eta-1} \right)^{\frac{1}{\eta}} \alpha_1 \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}} \right) \right) - E'(\delta L) \frac{L}{Y}$$

For the sake of brevity, let us denote  $\Omega = \left( 1 - (1 - \alpha_1 - \alpha_2) \left( \frac{p_I}{\tilde{p}} \right)^{\eta-1} \right)^{\frac{1}{\eta}}$ , so that (12) can be rewritten as

$$(12') \quad \frac{WL}{PY} = \frac{1}{\mu} \left\{ 1 - \Omega (1 - \beta) \alpha_1 \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}} \right\} - E'(\delta L) \frac{L}{Y}$$

The derivative of RULC with respect to the capital-output ratio is equal to

$$(18) \quad \frac{\partial RULC}{\partial (K/Y)} = -\frac{1}{\mu} \frac{\eta-1}{\eta} \alpha_1 \Omega (1 - \beta) \left( \frac{K}{Y} \right)^{\frac{1}{\eta}} < 0 (> 0) \text{ if } \eta > 1 (\eta < 1)$$

The derivative of RULC with respect to the relative price of intermediate inputs is given by

$$(19) \quad \frac{\partial RULC}{\partial (p_I/\tilde{p})} = -\frac{\eta-1}{\eta} \frac{1}{\mu} (1 - \beta) (1 - \alpha_1 - \alpha_2) \alpha_1 \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}} \left( 1 - (1 - \alpha_1 - \alpha_2) \left( \frac{p_I}{\tilde{p}} \right)^{\eta-1} \right)^{\frac{\eta+1}{\eta}} \left( \frac{p_I}{\tilde{p}} \right)^{\eta-2}$$

thus

$$(20) \quad \frac{\partial RULC}{\partial (p_I/\tilde{p})} > 0 (< 0) \text{ if } \eta < 1 (> 1)$$

The derivative of RULC with respect to the markup is equal to

$$(21) \frac{\partial RULC}{\partial \mu} = -\frac{1}{\mu^2} \left\{ 1 - \Omega(1 - \beta)\alpha_1 \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}} \right\} < 0$$

The derivative of RULC with respect to the workers' bargaining power is given by

$$(22) \frac{\partial RULC}{\partial \beta} = \frac{1}{\mu} \Omega \alpha_1 \left( \frac{K}{Y} \right)^{\frac{\eta-1}{\eta}} > 0$$

The derivative of RULC with respect to labor marginal adjustment costs is equal to

$$(23) \frac{\partial RULC}{\partial (E'(\delta L))} = -\delta L \frac{L}{Y} E''(\delta L)$$

Under the assumption of convex labor adjustment costs,  $E''(\delta L)$  is positive if  $\delta L > 0$  and negative if  $\delta L < 0$ . Thus the above derivative is unambiguously negative.

## APPENDIX II. COMPUTING THE FACTOR ELASTICITY OF SUBSTITUTION FROM ESTIMATION RESULTS

As implied by equation (2), relative RULC of country  $i$  against the remaining euro area trading partners at any time  $t$  is given by

$$(24) RULC_t^{i,EMU-i} = 1 - \alpha \left( \frac{K}{Y} \right)_{t,i}^{\frac{\eta-1}{\eta}} \bigg/ 1 - \alpha \left( \frac{K}{Y} \right)_{t,EMU-i}^{\frac{\eta-1}{\eta}}$$

Consequently, relative profit margins ( $PM$ ) take the form

$$(25) PM_t^{i,EMU-i} = \left( \frac{K}{Y} \right)_{t,i}^{\frac{\eta-1}{\eta}} \bigg/ \left( \frac{K}{Y} \right)_{t,EMU-i}^{\frac{\eta-1}{\eta}}$$

Taking logs and first differentiating yields

$$(26) \log PM_t^{i,EMU-i} - \log PM_{t-1}^{i,EMU-i} = \frac{\eta-1}{\eta} \left[ \log \frac{(K/Y)_t^i}{(K/Y)_t^{EMU-i}} - \log \frac{(K/Y)_{t-1}^i}{(K/Y)_{t-1}^{EMU-i}} \right]$$

Thus  $\log PM_t^{i,EMU-i} - \log PM_{t-1}^{i,EMU-i} > 0 (< 0)$  if  $\eta > 1$  ( $\eta < 1$ ). In words, if country  $i$  accumulates capital relatively faster (slower) than its trading partners, its relative profit margins will increase (decrease) over time as long as capital and labor are highly (low) substitutes. By implication, a rise in relative RULC is associated with a comparatively faster pace of capital accumulation provided that the elasticity of substitution is lower than unity. Running an augmented regression of (26) to control for the impact of the additional explanatory variables presented in Table 1, allows for an empirical computation of the factor elasticity of substitution.



## APPENDIX III. SENSITIVITY VIS-À-VIS THE COUNTRY SAMPLE

Table 2. GLS Estimates

Sample	RULC(-1)	UGAP	NEER_EA	NEER_12	OPEN	COR	REL PRICE	PMR	EPL	URR	BARCENT	EPL&VOL	AR(1)
Full	-0.12	-0.36	0.10	0.00	-0.07	0.38	0.10	-0.45	-1.04	0.82	1.14	-0.12	0.18
<i>t-stat</i>	-5.55	-7.73	6.81	2.90	-3.78	11.23	2.80	-3.94	-2.81	1.81	2.71	-3.07	3.89
Austria	-0.11	-0.40	0.10	0.01	-0.05	0.36	0.03	-0.50	-1.29	1.04	1.08	-0.13	0.16
<i>t-stat</i>	-4.82	-7.50	6.90	2.73	-2.78	8.00	0.42	-3.76	-2.73	1.81	2.53	-2.85	3.04
Belgium	-0.13	-0.37	0.08	0.00	-0.06	0.40	0.12	-0.51	-0.89	0.80	0.15	-0.20	0.17
<i>t-stat</i>	-5.22	-7.65	4.59	0.60	-3.17	10.20	2.93	-3.36	-2.45	1.56	0.20	-2.32	3.63
Germany	-0.11	-0.36	0.09	0.00	-0.07	0.39	0.09	-0.64	-1.11	0.71	1.06	-0.19	0.13
<i>t-stat</i>	-4.60	-7.94	5.68	-0.03	-3.86	11.06	2.46	-4.41	-2.93	1.51	1.32	-1.73	2.92
Greece	-0.11	-0.39	0.08	0.02	-0.06	0.38	0.10	-0.37	-0.83	0.98	0.96	-0.25	0.20
<i>t-stat</i>	-4.59	-5.68	3.87	5.13	-2.51	9.65	2.00	-2.43	-1.77	1.84	1.47	-3.22	3.90
Spain	-0.11	-0.39	0.13	0.02	-0.06	0.40	0.08	-0.46	-1.10	1.00	0.98	-0.14	0.14
<i>t-stat</i>	-4.81	-8.09	6.39	2.79	-3.43	11.25	2.03	-3.04	-2.24	2.20	1.79	-1.56	3.20
Finland	-0.11	-0.34	0.10	-0.01	-0.08	0.34	0.11	-0.27	-0.96	0.39	1.59	-0.06	0.17
<i>t-stat</i>	-5.16	-6.07	6.83	-3.52	-3.92	9.71	3.21	-2.26	-3.01	0.80	3.16	-1.10	3.67
France	-0.10	-0.35	0.11	0.03	-0.06	0.39	0.08	-0.58	-1.32	0.79	1.19	-0.17	0.10
<i>t-stat</i>	-4.32	-7.42	6.73	3.63	-3.65	10.93	2.16	-4.10	-3.23	1.90	1.89	-1.79	2.32
Ireland	-0.12	-0.32	0.09	-0.01	-0.11	0.32	0.10	-0.18	-1.08	0.54	-1.04	-0.22	0.09
<i>t-stat</i>	-4.96	-7.78	5.10	-1.99	-5.84	7.85	2.36	-1.24	-2.59	1.32	-1.16	-3.28	1.65
Italy	-0.12	-0.36	0.09	0.01	-0.07	0.39	0.10	-0.63	-1.10	0.87	1.04	-0.25	0.14
<i>t-stat</i>	-4.82	-7.32	5.69	1.25	-3.63	11.71	2.77	-4.85	-2.91	1.74	1.38	-2.43	3.01
Netherland	-0.11	-0.38	0.10	-0.02	-0.05	0.38	0.14	-0.55	-1.16	0.78	1.27	-0.21	0.12
<i>t-stat</i>	-4.85	-8.90	6.65	-3.82	-2.78	11.95	4.81	-3.58	-3.31	1.62	2.14	-2.13	2.88
Portugal	-0.10	-0.36	0.05	0.00	-0.08	0.42	0.11	-0.75	-0.97	0.53	1.35	0.12	0.11
<i>t-stat</i>	-4.95	-7.44	1.92	-1.30	-3.94	11.93	2.93	-5.48	-3.19	1.34	1.91	1.60	2.30

Note: The first row corresponds to the results for the full sample presented in Table 1. The results for the sub-samples are obtained by dropping one country at a time from the original estimation.

Table 2 shows the sign and significance of the coefficients are generally robust to changes in the country sample. The magnitude of the coefficients and the t-statistics display little variation for the lagged level of the endogenous variable, the unemployment gap, the intra-area NEER, the degree of openness, the capital-output ratio, the relative prices of intermediates, and the indicators of product market regulation, employment protection legislation and the replacement rate of unemployment benefits. The coefficient for the extra-area NEER is more unstable: it is not significantly different from zero when Belgium, Germany, Finland, Italy or Portugal is excluded and changes sign when Ireland or the Netherlands is left out of the sample. The coefficient for the interaction term between employment protection legislation and the volatility of output is not significant in nearly half of the cases when the sample is reduced and the coefficient for bargaining centralization remains significant only when Finland, the Netherlands or Portugal is dropped from the sample.

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