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ABSTRACT

Real Unit Labour Costs in Eurozone Countries: Drivers and Clusters*

We examine the trajectories of the real unit labour costs (RULCs) in a selection of Eurozone economies. Strong asymmetries in the convergence process of the RULCs and its components – real wages, capital intensity, and technology – are uncovered through decomposition and cluster analyses. In the last three decades, the PIIGS (Portugal, Ireland, Italy, Greece, and Spain) succeeded in reducing their RULCs by more than their northern partners. With the exception of Ireland, however, technological progress was weak; it was through capital intensification that periphery economies gained efficiency and competitiveness. Cluster heterogeneity, and lack of robustness in cluster composition, is a reflection of the difficulties in achieving real convergence and, by extension, nominal convergence. We conclude by outlining technology as the key convergence factor, and call for a renewed attention to real convergence indicators to strengthen the process of European integration.

JEL Classification: F43, F62, O47, O52

Keywords: real unit labour costs, Eurozone, real wages, capital intensity, technology

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1 Introduction

Nominal convergence versus real convergence. Can the former last in the absence of the latter? Even if the Great Recession provides a negative answer, any state in the European Union (EU) desiring to join the Economic and Monetary Union (EMU) is still subject to meet the Maastricht criteria. These criteria, which were designed to ensure nominal convergence,[1] entailed the implicit assumption that real convergence would naturally follow. This presumption has miserably failed. Not only have these countries lacked real convergence (in per capita GDP or unemployment rates), but "the strengthened financial and real connections across the EMU countries, instead of facilitating convergence (...) have magnified and mutually reinforced imbalances" (Croci and Farina, 2012, p. 647).

Although it has become standard to refer to this slump as a 'sovereign-debt crisis', our view is that the rise in public deficits and debts, more than a governments' fail in the management of national fiscal policies, is the consequence of differences in competitiveness that generate real divergence and, therefore, growing account imbalances.[2] Our claim is that these imbalances, which were exacerbated with the EMU, were already present in latent form. This is contrary to Sinn's claim that "the lack of competitiveness was brought about by the euro itself" (Sinn, 2014, p. 1). They reflected, indeed, a structural situation to which we implicitly refer when we divide the Eurozone into Core and Periphery economies acknowledging that the first group is far more competitive than the second one.[3] Ultimately, this is what explains the real divergence we have witnessed since the inception of the euro, and it is also at the root of the differential intensity of the Great Recession in the Eurozone, once the sovereign-debt problem joined in in 2010.

In this paper we take the real unit labour cost (RULC) as a relevant indicator of competitiveness and, as such, as a driver of real convergence. We examine to what extent our hypothesis of latent divergence forces holds by clustering the RULC according

[1] That is, convergence in prices: inflation (the price of goods and services), interest rates (the price of money), and exchange rate stability (the price of currencies), apart from the commitment to keep public sector accounts fairly balanced.

[2] The current euro crisis is considered by many observers as a crisis of government deficits and debt. Nevertheless, even a casual look at the data raises many doubts regarding this point of view (Hein, Truger and van Treeck, 2012). The ratio of gross government debt to GDP was only 25% in Ireland and 36% in Spain, whereas Portugal used to have a smaller debt burden than Germany. This ratio was far below 60%, the reference value of the Stability and Growth Pact (SGP) in all three countries. Nobody would have suspected any risk of government default in these countries.

[3] By Periphery countries we mean Greece, Ireland, Italy, Spain, and Portugal, while the Core economies are Austria, Belgium, Finland, France, the Netherlands, and Sweden. Germany is not be considered, since disaggregated data is only available 1991 onwards due to the unification process.

to its performance in a selection of 11 Eurozone economies. This variable is defined as

$$RULC = \frac{\text{Real compensation per employee}}{\text{Real labour productivity}}, \tag{1}$$

which allows our analysis to be performed on the RULC as a whole, but also on its two main components.[4]

To have a first glance of the recent evolution in RULC, Table 1 shows the cumulated evolution of the RULCs between 1979 and 2012. The first noticeable feature is the fall in all economies, which ranges from 5% to 25%. This is a reflection of the systematic effort undertaken by these economies to become more competitive in a context of growing market pressures (acceleration in the globalization process and deeper European integration).

It is also interesting to observe that the most intensive reductions have taken place in the Eurozone periphery. Ireland takes the lead, with a fall of 25 percentage points (pp) that is followed by some Club-Med countries –Greece, Portugal and Spain–, with a fall around 20 pp. Then we find Italy (-15 pp.), which comes after Sweden.[5] Thus, maybe surprisingly, the sometimes called PIIG economies, appear as those that have undergone the most intensive effort in controlling their RULCs. At the other extreme we observe continental European economies such as Finland and Belgium, with falls below 10 pp.[6]

Table 1. RULC in selected Eurozone economies.

	1979	**2012**	$\Delta\nabla$		**1979**	**2012**	$\Delta\nabla$
Ireland	100.0	74.7	-25.3	Austria	100.0	87.1	-12.9
Spain	100.0	78.8	-21.2	Netherlands	100.0	87.7	-12.3
Portugal	100.0	80.0	-20.0	France	100.0	89.0	-11.0
Greece	100.0	81.8	-18.2	Finland	100.0	92.1	-7.9
Sweden	100.0	83.0	-17.0	Belgium	100.0	95.2	-4.8
Italy	100.0	85.1	-14.9				

Source: Ameco Database.

Given these differences, dating back to the 1980s, we do not support the idea that the inception of the Euro brought, inherently to the new monetary union, the development

[4] The RULCs can also be conceived as the Unit Labour Costs (ULC) deflated by prices (P):

$$RULC = \frac{ULC}{P} \text{ where } ULC = \frac{\text{Nominal compensation per employee}}{\text{Real labour productivity}}.$$

[5] For a comprehensive analysis of the structural changes undergone by the Swedish economy see Freeman *et al.* (2010).

[6] Germany shows a fall of less than 12 pp, very close to the fall experienced by the Netherlands.

of unprecedented external imbalances. We rather see these imbalances as a reflection of a latent structural problem that was exacerbated in the context of a single currency and the impossibility of securing competitive gains through the prevailing, and convenient, management of the exchange rate.

Our hypothesis is that the root of these imbalances is related to the specificities of the growth model in the periphery and core European countries. This hypothesis gets some initial support from a descriptive analysis showing that the periphery economies have mainly relied on capital intensification to counterbalance their otherwise smaller increase in wages. Increases in capital intensity are recognized to boost efficiency, but we argue that this is an inferior strategy than the one followed by the core economies, much more based on technological progress.

To check the validity of our hypothesis, our first target is to evaluate the existence of clusters in the RULCs of some Eurozone economies. The second target is to assess whether these clusters are driven by some of the components in which the RULCs can be decomposed. These are real wages, capital intensity, and technology, the latter two being the drivers of labour productivity and economic growth.

For the clusters to be examined, we first decompose the RULCs into these three components and compute their simulated trajectories when either one or two of the components take their actual values. This provides a first picture of the evolution of the Eurozone economies, in terms of the path followed by their RULCs. Three groups emerge. One with the Club-Med countries, which we classify as capital-intensity driven economies; another one with technology-driven economies such as Belgium, Finland, Ireland, the Netherlands, and Sweden; and a third one with balanced-growth driven economies, where capital intensity and technology have similar explanatory weights. Here we find Austria and France.

To evaluate the existence of clusters, we follow the methodology proposed by Phillips and Sul (2007, 2009) in which different convergence paths can be distinguished among heterogenous economies involved in a convergence process. As explained in Section 4, this heterogeneity is modelled through a nonlinear time varying factor model, which provides flexibility in idiosyncratic behaviour over time –convergence is a dynamic process– and across section –since we examine a group of 11 economies.

We find these features particularly appealing to examine the convergence process of the RULCs in the Eurozone. The main reason is that, although economies with different economic size and structure may appear to follow a similar development path, they may converge at different speeds and, therefore, may actually be at different stages of that same path. Moreover, although Phillips and Sul's (2007, 2009) modelling allows for idiosyncratic behaviour, it also retains some commonality across the panel. In particular, it allows to check the convergence to a constant of the heterogeneous time varying idiosyncratic components, in which case panel convergence holds.

The cluster analysis involves the actual series of the RULCs and all the simulated scenarios in which these costs are decomposed, each of them accounting for the influence of one, two or three of the RULCs components. We find a wide heterogeneity of clusters both in number –different scenarios deliver a different number of clusters– and composition –the composition of the clusters is not robust across simulations.

Given these results –the expected outcome after years of economic integration was, ex-ante, convergence to a single cluster in all major macroeconomic dimensions–, we question the strategy, originally endorsed by the Maastricht Treaty, of securing nominal convergence without considering real convergence indicators. Rather, we suggest to consider both simultaneously in order to safeguard, or at least strengthen, today's hurt process of European integration.

The rest of the paper is structured as follows. In Section 2, we present a decomposition of the RULCs, which is applied to a broad selection of Eurozone economies in Section 3. In Section 4, we explain the methodology we use for the cluster analysis. Section 5 presents our findings before discussing their major implications in Section 6. Section 7 concludes.

2 Analytical decomposition

To study its evolution over time, the real unit labour costs (RULC) can be decomposed in its relevant constituents.

We start by re-writing equation (1) as

$$RULC_t = \frac{\text{Total real employment compensation}}{\text{Real output}} \text{ or } \frac{w_t}{y_t}, \tag{2}$$

where w_t denotes real wages or, in other words, the nominal wages deflated by prices (W_t/P_t). In turn, y_t is real output or the nominal output also deflected by prices (Y_t/P_t). Under the assumption of a production function with capital K_t, labour L_t, and technology A_t as production factors, (nominal) output per employee Y_t/L_t can be expressed as:

$$(Y_t/L_t) = P_t * K_t^{(1-\alpha_t)} * A_t, \tag{3}$$

where α_t is the time-varying labour income share.

Inserting (3) in (2) and differentiating, the growth rate of real unit labor costs $\frac{\Delta(RULC_t)}{RULC_{t-1}}$ can be decomposed as a function of the trajectories of real wages, capital intensity, and technological progress.

$$\frac{\Delta\left(RULC_t\right)}{RULC_{t-1}} \approx \left(\frac{\Delta(W_t)}{W_{t-1}} - \frac{\Delta(P_t)}{P_{t-1}}\right) - (1-\alpha_t) * \frac{\Delta(K_t)}{K_{t-1}} - \frac{\Delta(A_t)}{A_{t-1}}. \tag{4}$$

The first term in equation (4) accounts for the rise in the $RULC$s arising from increases in real compensation per employee. The second and third terms account, respectively, for the fall in the $RULC_t$ resulting from growing capital intensity and quicker technological progress. It is important to note that these two terms $-(1-\alpha_t) * \frac{\Delta(K_t)}{K_{t-1}}$ and $\frac{\Delta(A_t)}{A_{t-1}}$– are the driving forces of labour productivity, as written in equation (1), and, hence, of economic growth.

Following this decomposition, Table 2 shows the three simulated scenarios that can be computed (we call them Simulations 1, 4 and 7, because new scenarios in between are added below, in Table 7). In Simulation 1, the RULCs only respond to changes in real wages (there is no progress in either capital deepening nor in technological change). In Simulation 4, they respond to real wages and capital intensity (and there is no technological progress). In Simulation 7, the three components are taken into account and the resulting simulation can be interpretted as the overall fit of our decomposition to the actual data.

Table 2. Simulated RULCs.

	$\frac{\Delta w_t}{w_{t-1}}$	$(1-\alpha_t)\frac{\Delta K_t}{K_{t-1}}$	$\frac{\Delta A_t}{A_{t-1}}$	Outcome
Simulation 1	✓	–	–	$RULC_{1t}$ in the absence of capital intensity and TFP.
Simulation 4	✓	✓	–	$RULC_{4t}$ in the absence of TFP.
Simulation 7	✓	✓	✓	$RULC_{7t}$ accounted for by the three components (overall fit).

Note: See Table 7, where more scenarios are defined.

3 Empirical decomposition

3.1 Data

We use annual data obtained from the macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs (DG ECFIN). Our sample period runs from 1980 to 2012. Table 3 presents the variables used, together with the corresponding codes in the Ameco Database.

Figure A1 in the Appendix compares the actual growth rates of the RULCs with those obtained from the decomposition proposed in equation (4). One relevant feature of this decomposition is the existence of non-negligible differences between the actual and the simulated trajectories of the RULCs in the 1960s and the 1970s. In levels, these differences end up producing significant discrepancies which would blur the picture obtained with the decomposition analysis. This is the reason why we have excluded these two decades and decided to depart in 1979 and focus on the changes occurred in the 1980s, 1990s, and 2000s. On one side, this still give us enough degrees of freedom to safely conduct the cluster exercise. On the other side, this restricts the analysis to the aftermath of the oil price shocks and excludes noise from the structural break that these shocks caused on all advanced economies.

Table 3. Definitions and codes.

Variable	Notation	Code
Real unit labour cost	$RULC$	QLCD
Nominal compensation per employee	W	HWCDW
Labour income share	α	ALCD
Net capital stock at constant prices per person employed	K	RKNDE
Total Factor Productivity	A	ZVGDF
Price deflator for Gross Domestic Product at market prices	P	PVGD

Note: the Codes correspond to Ameco Database variables.

3.2 Evolution by components

Table 4 shows the evolution of the RULCs (as in Table 1) and each of its components up to 2012 departing from an index value 100 corresponding to 1979. As we know from Table 1, the RULCs have fallen relatively more in the periphery economies than in the non-periphery ones. They have fallen by 19.9 percent, on average, in Greece, Ireland, Italy, Portugal, and Spain, which is almost twofold the 10.6 percent fall achieved, on average, by the others.

The larger reduction in the overall RULC index in the periphery coincides with a smaller increase in wages (44.5% vs. 51.7%, respectively, each of the two areas) and a substantial larger increase in the capital intensity component (37.7 vs. 20.8 percent). In contrast, the evolution of the TFP component in the Core economies has been much more dynamic, showing an average increase of 38.9 percent, in clear contrast with the 17.8 percent rise observed in the Mediterranean ones. Ireland is excluded from this last calculation, as it has been a clear exception with an important cumulative growth both in capital intensity and, especially, in TFP with a 89.6 percent increase.

Beyond the identification of these two groups, a further crucial result is that in none of these economies wages have progressed much beyond their *sustainable* growth. By sustainable growth we mean one that is consistent with the progress of technology.

Indeed, following any standard growth model, the reference wage growth would be set according to technological change so as to ensure a long-run balanced growth path. Denoting γ_a as the growth rate of technology, γ_k as the growth rate of capital accumulation (per employee), and γ_w the growth rate of wages, a balanced growth path would satisfy:

$$\gamma_w = \gamma_k = \gamma_a. \tag{5}$$

On this account it is worthwhile noting that the evolution of the periphery economies since the end of the 1970s is, in general, closer to the above standard theoretical rule. With the exception of Portugal, wages in these countries have evolved closer to the levels granted by technological progress than in most non-periphery countries. But this is not the only significant trait. It can also be observed that capital intensity has also progressed more, relative to technology, in the periphery (with the exception of Ireland) than in the non-periphery economies.

Table 4. RULCs and components: index 100 = 1979 and values in 2012.

	1979	Values in 2012					
		$\frac{\Delta RULC_t}{RULC_{t-1}}$	$\frac{\Delta w_t}{w_{t-1}}$ (I)	$(1-\alpha_t)\frac{\Delta K_t}{K_{t-1}}$ (II)	$\frac{\Delta A_t}{A_{t-1}}$ (III)	$\frac{(I)}{(III)}$	$\frac{(II)}{(III)}$
Periphery							
Greece	100.0	81.8	104.7	129.5	100.2	104%	129%
Ireland	100.0	74.7	197.2	138.6	189.6	104%	73%
Italy	100.0	85.1	122.7	125.5	116.5	105%	108%
Portugal	100.0	80.0	169.5	154.9	137.6	123%	113%
Spain	100.0	78.8	128.3	139.8	116.9	110%	120%
Average	**100.0**	**80.1**	**144.5**	**137.7**	**132.2**	**109%**	**109%**
Non-periphery							
Austria	100.0	87.1	152.4	129.7	133.9	114%	97%
Belgium	100.0	95.2	148.3	118.0	129.4	115%	91%
Finland	100.0	92.1	182.3	120.4	159.8	114%	75%
France	100.0	89.0	137.9	126.7	122.9	112%	103%
Netherlands	100.0	87.7	136.3	115.6	132.8	103%	87%
Sweden	100.0	83.0	153.9	123.5	149.4	103%	83%
Average	**100.0**	**89.4**	**151.7**	**120.8**	**138.9**	**109%**	**88%**

Source: Own decomposition based on official European Commission data (Ameco Database).

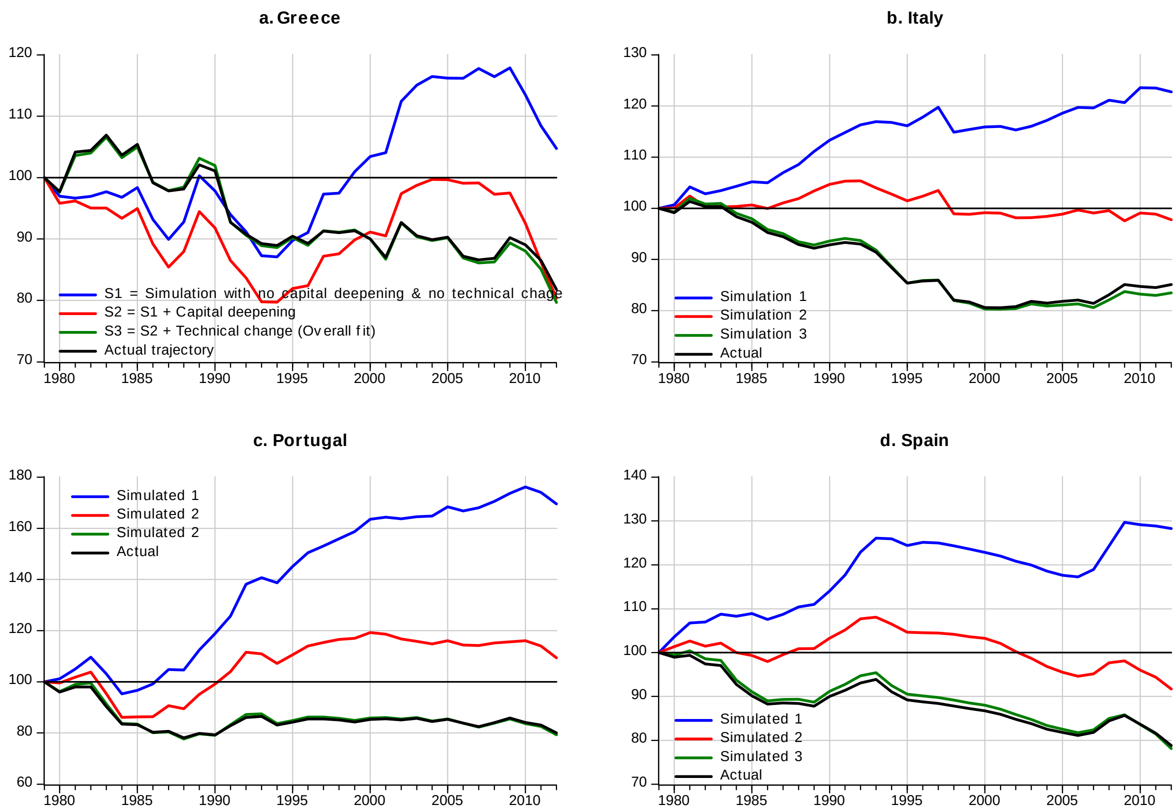
From these results, we draw the following preliminary conclusions. First, the relative trajectories of wages and capital intensity uncover the two channels by which the periphery countries have succeeded in reducing the RULCs by far more than the non-periphery ones. Second, we hypothesize that the problem underlying the lack of real convergence is not originated in the labour market but, rather, in the different speed of technological progress, which is what effectively leads wage setting and the capital accumulation process.

In addition, because the evaluation of these ratios is silent on the relative magnitude of each component's influence on the RULCs, we next look at the detailed contribution of each of these components to the evolution of the RULCs.

3.3 Scenarios

Figures 1, 2 and 3 group the 11 Eurozone economies considered according to the intensity at which the growth drivers –capital intensity and technological progress– have counterbalanced the rise in the RULCs stemming from real wage growth.

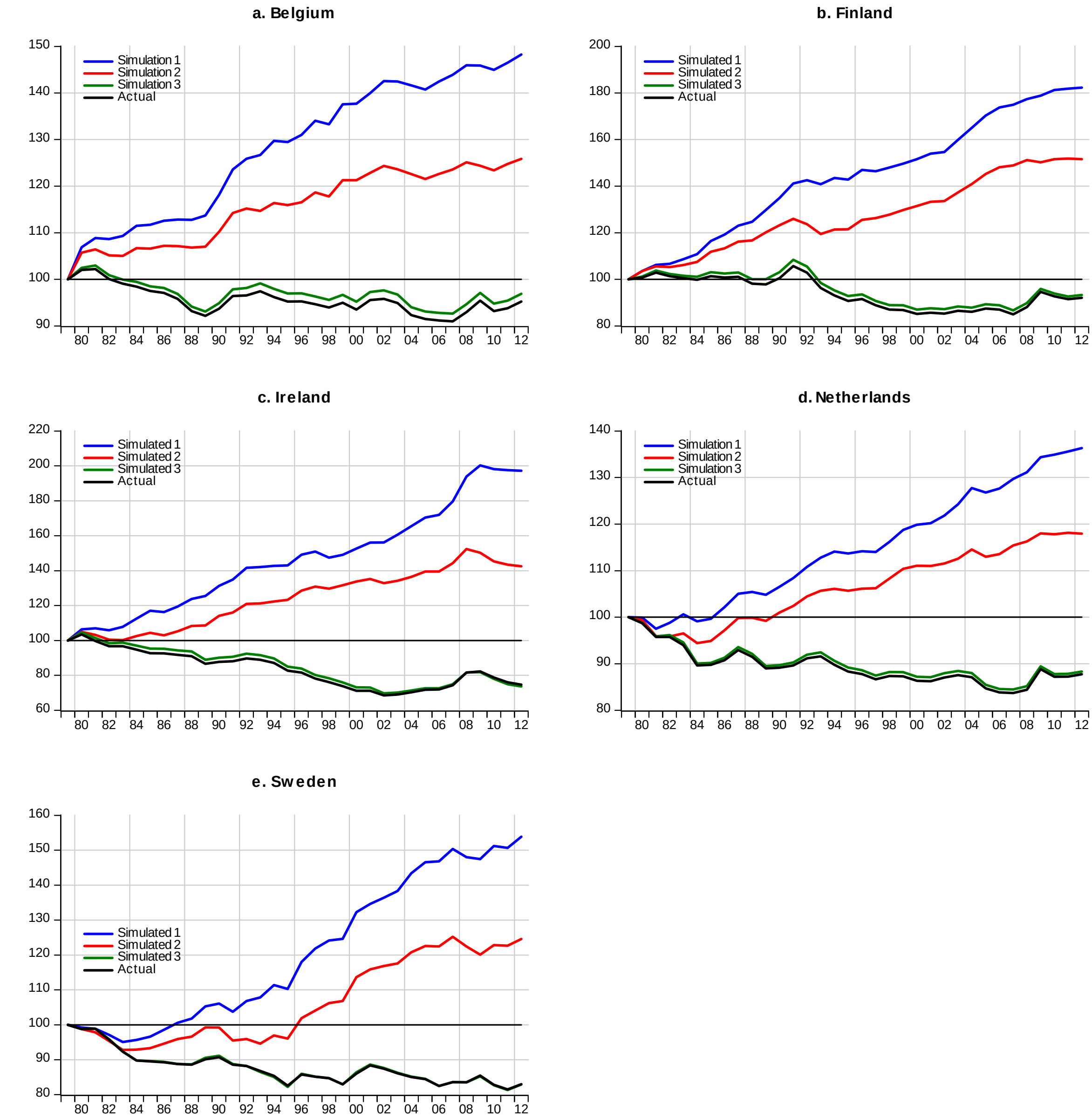
Figure 1. Capital-intensity driven economies.



Source: Own decomposition based on official European Commission data (Ameco Database).

The black line depicts the actual trajectory, which is closely tracked by the line in green resulting from Simulation 7 in Table 2 (i.e., the one with the three components providing the overall fit of the decomposition). This is an indication that the decomposition analysis provides a faithful account of the incidence of each component in the aggregate evolution of the RULCs.

Figure 2. Technology driven economies.



Source: Own decomposition based on official European Commission data (Ameco Database).

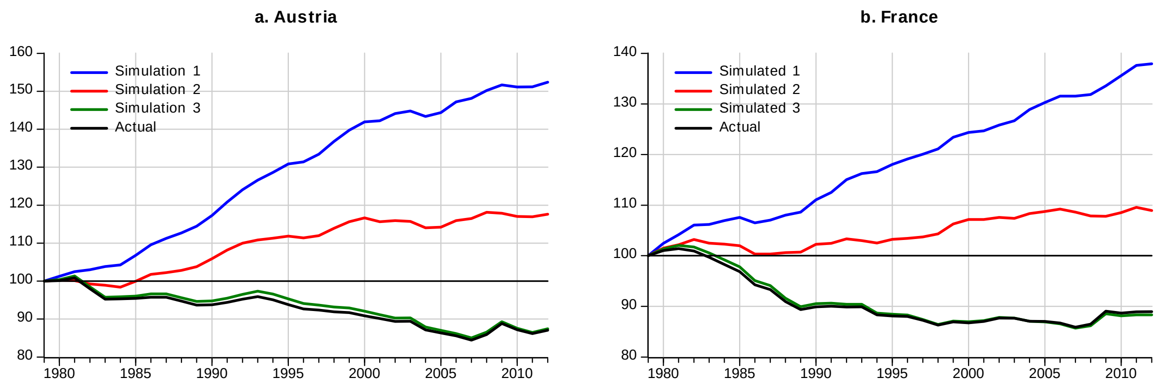
The blue line accounts for the upward effect that the growth in real wages exert, while the red line incorporates (on top of the effect of the growth in real wages) the downward influence of capital intensity. In this way, the distance in 2012 between the blue and the red lines is an indication of the cumulated counterbalancing effect of capital intensity on the RULCs since 1979, while the distance between the red and green lines is an indication of the incidence of technological progress.

As it is the case for the countries plotted in Figure 1, proximity of the red and green lines is an indication that technological progress has been weak in last decades. This is the reason why these economies are grouped under the label of capital intensity driven economies.

In turn, in the economies plotted in Figure 2, the cumulative impact of technological progress is much wider and explain a much larger proportion than capital intensity of the shift from the RULCs when real wages are the only driving force to the actual lower value they take in 2012. These are, therefore, the group of technology driven economies with regard to the path followed by their RULCs.

Then in Figure 3 we have the two balanced driven economies in the sense that neither capital intensity nor technological progress dominate in explaining the downward trajectory of the RULCs once accounted for the rise in real wages.

Figure 3. Balanced driven economies.



Source: Own decomposition based on official European Commission data (Ameco Database).

Table 5 provides more detailed information on the precise values of the RULCs under the scenarios considered. The first block of columns provides the final values taken by the RULCs under the different scenarios considered in Table 2 and plotted in Figures 1 to 3 (we call them A, B, and C). Note that the value in C, resulting from simulation 7, is very close to the actual values of the RULCs in 2012 (in first column of Table 4).

The second block exploits this information to obtain the change in the RULCs due to the evolution of real wages (=A-100, where 100 is the departing index value), of capital intensity (=B-A), and technological progress (=C-B). It can be observed that, with the exception of Portugal, the Club-Med economies experienced relatively mild increases in the RULCs in response to real wages –below 30 percentage points. On the contrary, in the rest of economies this value was above 30 percentage points. This contrasted patterns is a reflection of differences in the progress of labour productivity.

Table 5. RULCs and components.

	Simulations			Changes explained by:			% growth drivers*	
	S1	S4	S7	w_t	$(1-\alpha_t)K_t$	A_t		
	(A)	(B)	(C)	(A-100)	(B-A)	(C-B)	$\frac{\text{(B-A)}}{\text{(A-C)}}$	$\frac{\text{(C-B)}}{\text{(A-C)}}$
Capital-intensity driven gains in RULCs								
Greece	104.7	80.3	79.7	4.7	-24.4	-0.7	97.4	2.6
Italy	122.7	97.8	83.5	22.7	-25.0	-14.3	63.6	36.4
Portugal	169.5	109.4	79.3	69.5	-60.1	-30.1	66.7	33.3
Spain	128.3	91.7	78.1	28.3	-36.6	-13.6	73.0	27.0
Technology driven gains in RULCs								
Belgium	148.3	125.8	96.9	48.3	-22.4	-28.9	43.7	56.3
Finland	182.3	151.6	93.2	82.3	-30.7	-58.3	34.5	65.5
Ireland	197.2	142.5	73.6	97.2	-54.7	-68.9	44.3	55.7
Netherlands	136.3	118.0	88.3	36.3	-18.3	-29.7	38.2	61.8
Sweden	153.9	124.6	82.8	53.9	-29.3	-41.7	41.2	58.8
Balanced driven gains in RULCs								
Austria	152.4	117.6	87.4	52.4	-34.8	-30.2	53.5	46.5
France	137.9	109.0	88.3	37.9	-29.0	-20.6	58.4	41.6

Notes: S1, S4 and S7 correspond to Simulations 1, 4, and 7, as defined in Table 2; *: indicates the relative share of capital intensity and technological progress on the overall downward impact of these growth drivers on RULCs.
Source: Own decomposition based on official European Commission data (Ameco Database).

The sources of these differences can be assessed by looking at the contributions of the two growth drivers, capital intensity and technological change.[7] On this account, no clear pattern can be perceived when looking at the role played by capital intensity in percentage point changes. In particular, with the exception of Portugal, the rest of the Club-Med countries have values between -24 and -37 pp, whereas (with the exception of Ireland), the rest of economies have values between -18 and -35. There is, therefore, a

[7]Note that the addition of the values in the second block of columns gives essentially the same information than Simulation 7 (the C column). In the case of Greece, for example, 4.7-(-24.4)-(-0.7)=-20.3, which is the fall in the RULC explained by our decomposition analysis (from 100 to 79.7, which is the value in the C column).

relatively homogeneous impact of the progress in capital accumulation on the reduction of the RULCs in the late decades across Eurozone countries.

The main difference, in this context, can be found in the contribution of technological progress to the fall of these costs, which has been very poor in the Club-Med economies (bar Portugal), but large in the other ones (bar France, which is in between the two groups and, on this respect, resembles its Mediterranean neighbours). This can be easily seen through the third block of columns in Table 5, where information is provided on the relative share of capital intensity and technological progress in explaining the overall downward contribution of these growth drivers to the fall of the RULCs.

In the Club-Med economies, the fall in RULCs have been mainly driven by progress in capital intensity which accounts, at least, for 66.3% of the fall as in Italy. This leaves technological progress to account, on average in Italy, Portugal, and Spain, for a third of the fall in the RULCs. Greece is an extreme case where the contribution of TFP has been almost non-existent.

Belgium, Finland, Ireland, the Netherlands, and Sweden have in common a contribution of TFP which is explains at least 55% of the fall, and reaches two thirds in Ireland. This the group of economies with technology driven gains in RULCs.

Finally, Austria and France take an intermediate position with a balanced contribution of the growth drivers to the fall in RULCs. The capital intensity share is around 55%, and thus significantly lower than in the Club-Med economies, while the share of technological progress is around 45%, and thus significantly lower than in the Nordic and Continental European countries.

From this analysis, we conclude that differences in the speed of technological progress is a major determinant of the unlike evolution of the RULCs in the Eurozone countries. Note that this conclusion is endorsed by the prediction, from any standard neoclassical growth model, that technology is the key growth driver and, hence, the critical factor allowing for capital accumulation and wage growth in the long-run. To confirm this finding, we now turn to a cluster analysis seeking to classify these economies into significantly homogeneous groups according to the individual and joint influence of the RULCs components.

4 Cluster analysis

The panel data model by Phillips and Sul (2007) has been proposed to represent the behavior of economies in transition allowing for different convergence paths with heterogeneous individuals. Heterogeneity is formulated as a nonlinear time varying factor model which provides flexibility in idiosyncratic behaviour over time and across section. These features of the model are very appealing in the case of convergence in the euro zone. Countries with different economic size and structure may appear to follow a similar development path but at different speeds so that they are currently at different stages on that path. The effect on technological and capital accumulation caused by the different economic policies in different countries may also be important to explain different speed of convergence. The model allows for idiosyncratic behaviour and also retains some commonality across the panel meaning that when the heterogeneous time varying idiosyncratic components converge over time to a constant, panel convergence holds.

The starting point of the test is a simple factor model:

$$X_{it} = \delta_i \mu_t + \varepsilon_{it} \tag{6}$$

where δ_i measures the idiosyncratic distance between some common factor μ_t and the systematic part of X_{it}. This model seeks to capture the evolution on the individual X_{it} in relation to μ_t by means of its two idiosyncratic elements, that is, the systematic element δ_i and the error ε_{it}. Phillips and Sul (2007) modified this initial model by allowing the systematic idiosyncratic element to evolve over time, thereby accommodating heterogeneous agent behavior and evolution within that behavior by means of a time-varying factor-loading coefficient δ_{it}. Furthermore, they allow δ_{it} to have a random component, which absorbs ε_t in equation (6) and allows for possible convergence behavior in δ_{it} over time in relation to the common factor μ_t. The new model has the following time varying representation:

$$X_{it} = \delta_{it} \mu_t. \tag{7}$$

The time varying representation in (7) can be used to separate common from idiosyncratic components in the traditional decomposition of panel data:

$$X_{it} = g_{it} + a_{it}, \tag{8}$$

where g_{it} embodies systematic components, including permanent components that give rise to cross section dependence, and a_{it} represents a transitory component. Transformation of equation (8) to equation (7) is given by:

$$X_{it} = \left(\frac{g_{it} + a_{it}}{\mu_t} \right) = \delta_{it} \mu_t \tag{9}$$

for all i and t. In this way, X_{it} is decomposed in a single common component μ_t and a idiosyncratic one δ_{it}, both being time-varying.

The simple econometric representation in (7) can be used to analyze growth convergence by testing whether the factor loadings δ_{it} converge. Phillips and Sul (2009) proposed a modification of the neoclassical growth model so that technological growth rates differ across and over time and are endogenously determined. To account for temporal and transitional heterogeneity, Phillips and Sul (2009) introduced time-heterogeneous technology by allowing technological progress, A_{it}, to follow a path of the form $A_{it} = A_0 e^{x_{it}t}$. Under this heterogeneous technology the individual transition path of log per capita real income, $log\ y_{it}$, evolves as:

$$\log y_{it} = \log \tilde{y}_i^* + \log A_{i0} + [\log \tilde{y}_{i0} - \log \tilde{y}_i^*]e^{-\beta_{it}t} + x_{it}t \tag{10}$$

where $\tilde{y}_0$ and $\tilde{y}_i^*$ denote initial and steady-state levels of effective log per capita real income and β_{it} is a time-varying speed of adjustment.

Equation (10) can be expressed in the form of equation (7):

$$\log y_{it} = \log \tilde{y}_i^* + \log A_{i0} + [\log \tilde{y}_{i0} - \log \tilde{y}_i^*]e^{-\beta_{it}t} + x_{it}t = a_{it} + x_{it}t = \delta_{it}\mu_t \tag{11}$$

where x_{it} is presumed to have some elements that are common across countries so that countries share a common growth component, μ_t. This common component can represent commonly available world technology such as the industrial and scientific revolutions and internet technology. Thus, the dynamic factor formulation $\delta_{it}\mu_t$ involves the growth component μ_t that is common across countries and individual transition factors δ_{it} which measures the transition path of an economy to a common steady-state growth path determined by μ_t. During transition, δ_{it} depends on the speed of convergence parameter β_{it}, the rate of technological progress parameter x_{it} and the initial technical endowment and steady state levels through the parameter a_{it} (Phillips and Sul, 2009, p. 1158).

Phillips and Sul (2007) proposed to model the transition elements δ_{it} by the construction of a relative measure of the transition coefficients:

$$h_{it} = \frac{X_{it}}{\frac{1}{N}\sum_{i=1}^{N} X_{it}} = \frac{\delta_{it}}{\frac{1}{N}\sum_{i=1}^{N} \delta_{it}}, \tag{12}$$

which measures the loading coefficient δ_{it} in relation to the panel. The variable h_{it} is called the relative transition path, and traces out an individual trajectory for each i relative to the panel average. So, h_{it} measures region i's relative departure from the common steady-state growth path μ. When there is a common limiting transition behavior across regions, we have $h_{it} = h_t$ across i, and when there is ultimate growth convergence then $h_{it} \longrightarrow 1$ for all i as $t \longrightarrow \infty$.

Next, Phillips and Sul (2007) construct the cross-sectional mean square transition differential H_1/H_t where:

$$H_{it} = \frac{1}{N}\sum_{i=1}^{N}\left(\hat{h}_{it} - 1\right)^2 \tag{13}$$

and measures the distance of the panel from the common limit.

To formulate a null hypothesis of growth convergence, the authors proposed a semi-parametric model for the time-varying behavior of δ_{it} as follows:

$$\delta_{it} = \delta_i + \sigma_i \xi_{it} L\left(t\right)^{-1} t^{-\alpha} \tag{14}$$

where δ_i is fixed, $\sigma_i > 0$, ξ_{it} is i.i.d. $(0, 1)$ across i but is weakly dependent on t, and $L(t)$ is a slowly varying function for which $L(t)$ tends to infinity as t also goes to infinity. Following Phillips and Sul (2007) the $L(t)$ function is assumed to be $\log t$. In turn, ξ_{it} introduces time-varying and region-specific components to the model. The size of α determines the behavior (convergence or divergence) of δ_{it}. This formulation ensures convergence of the parameter of interest for all $\alpha \geq 0$, which is the null hypothesis of interest since $\delta_{it} = \delta_i$ as $t \longrightarrow \infty$. Furthermore, if this hypothesis holds and $\delta_i = \delta_j$ for $i \neq j$, the specification in (14) still allows for transitional periods in which $\delta_{it} \neq \delta_{jt}$, thereby incorporating the interesting possibility of transitional heterogeneity or even transitional divergence across i. Thus, the null hypothesis of convergence can be written as:

$$H_0 : \delta_{it} = \delta \text{ and } \alpha \geq 0, \tag{15}$$

while the alternative is either:

$$H_A : \delta_{it} = \delta \text{ for all } i \text{ with } \alpha < 0, \tag{16}$$

or

$$H_A : \delta_{it} \neq \delta \text{ for some } i \text{ with } \alpha \geq 0, \text{ or } \alpha \leq 0 \tag{17}$$

The alternative hypothesis includes divergence, as in (16) and (17), but can also consider club convergence. For example, if there are two convergent clubs, the alternative is:

$$H_A : \delta_{it} \rightarrow \{ \begin{array}{c} \delta_1 \text{ and } \alpha \geq 0, \text{ if } i \in G_1 \\ \delta_2 \text{ and } \alpha \geq 0, \text{if } i \in G_2 \end{array}, \tag{18}$$

where G stands for an specific club.

Phillips and Sul (2007) show that these hypotheses can be statistically tested by means of the following '$\log t$' regression model:

$$\log(H_1/H_t) - 2log\left[\log\left(t\right)\right] = a + b\log\left(t\right) + u_t \tag{19}$$

for $t = [rT], [rT]+1, ..., T$ with some $r > 0$. Phillips and Sul (2007) suggest $r = 0.3$ based on their simulation experiments.

The key parameter of the convergence test b is related with α. Indeed, Phillips and Sul (2007) showed that the fitted value of $\log t$ is $\tilde{b} = 2\tilde{\alpha}$ where $\tilde{\alpha}$ is the estimated value of α under the null. In this method, rejection of the null for the whole panel does not imply that there is not convergence, since it is possible to test, by means of an algorithm, whether there are clubs or clusters of convergence. Hence, it is possible to test the hypothesis of convergence for different group of countries, and identify commonalities within a panel of countries.

The regression test of convergence in (19) is made up of three stages (Phillips and Sul, 2007, p.1788). In the first step, the cross-sectional variance (H_1/H_t) ratio is constructed, and then in the second step the conventional robust t statistic, $t\tilde{b}$, for the coefficient $\hat{b}$ is computed using (19). Finally, in the third step, an autocorrelation and heteroskedasticity robust one-side t test of the inequality null hypothesis $\alpha \geq 0$ is applied using the estimated coefficient $\hat{b}$ and HAC standard errors. At the 5\% percent level, the null hypothesis of convergence is rejected if the statistic has a value below -1.65.

However, the novel aspect of this approach is that convergence patterns within groups can be examined using $\log t$ regressions, that is, the existence of club convergence and then clustering. This fact is particularly relevant since the rejection of the null of convergence does not necessarily imply divergence, since different scenarios can be met, such as separate points of equilibrium or steady-state growth paths, as well as convergence clusters and divergent regions in the full panel. The existence of club convergence raises an important concern, that is, how to identify the regions that belong to each cluster. In this regard, Phillip and Sul (2007) suggested the following method.

In the first step, individuals in the panel must be ordered according to the last third observations in the panel. In the second step, the so-called 'core group', G_k, should be identified by selecting the first k highest individuals in the panel to form the subgroup G_k for some $N > k \geq 2$, and then the $\log t$ regression is run and the convergence test statistic $t_k(G_k)$ is obtained for this subgroup. Then, the core group size k^* is chosen by maximizing t_k over k according to the criterion:

$$k^* = \arg\max \{t_k\}, \text{ subject to } \min \{t_k\} > -1.65.$$

The latter condition ensures that the null hypothesis of convergence is supported for each k. The rule for classifying the groups of regions into clubs is straightforward. For example, if all the regions belong to the same group, then the size of the club will be N. In contrast, if there are regions that do not belong to that group, the clusters will have a size lower than N. More formally, this implies that if the condition $\min \{t_k\} > -1.65$ is not held for $k = 2$, then the highest individual in G_k can be dropped from each subgroup and new subgroups are created. This process is repeated as many times as necessary until the condition is satisfied. If at the end of this process there are subgroups that have been created (said to be club convergent), but there are others that do not satisfy the condition, then it is said that those individuals diverge.

The convergence approach by Phillips and Sul (2007) presents clear advantages. First, it is a test for relative convergence as it measures convergence to some cross-sectional average in contrast to the concept of level convergence analyzed by Bernard and Durlauf (1995). Second, this approach outperforms the standard panel unit root tests since in the latter case $X_{it} - X_{jt}$ may retain nonstationary characteristics even though the convergence condition holds, in other words, panel unit root test may classify the difference between gradually converging series as non-stationary. As a further problem, a mixture of stationary and non-stationary series in the panel may bias results. Moreover, test results are sometimes not particularly robust. In contrast, the Phillips and Sul (2007) test does not depend on particular assumption concerning trend stationarity or stochastic nonstationarity of the variables to be tested.

5 Clusters in the RULCs and its components

Our cluster analysis involves the evaluation of several scenarios. The first one is the analysis on the actual trajectory of the RULCs, which is followed by the analysis on the seven simulated trajectories of the RULCs presented in Table 6. In Simulations 1, 2 and 3, the RULCs only respond to changes in one of the components. These are, respectively, real wages (there is no progress in either capital deepening nor in technical change), capital intensity (there is no growth in real wages nor in TFP), and technological change (real wages and capital intensity do not change). In simulations 4, 5 and 6, RULCs respond to two out of the three components. As noted before, in the first of these, real wages and capital intensity (but not technological progress) are taken into account, in the second one (Simulation 5) real wages and TFP (but not capital intensity) are considered, whereas Simulation 6 assumes no growth in real wages. Simulation 7 takes into account the influence of the three components and accounts for the overall fit of the decomposition.

Detailed information on the results of the cluster analysis for each of these scenarios is presented in Appendix 2. Table 7 summarizes the outcome of this analysis when applied to the scenarios described in Table 6. Regarding the actual values of the RULCs, our results uncover the existence of two groups, one comprising Austria, Belgium, Finland, France, and the Netherlands belonging to the continental Europe, and another one comprising the so-called PIIGS (Portugal, Ireland, Italy, Greece, and Spain) plus Sweden. The PIIGS group is characterised by structural difficulties to compete internationally, and a regular use of the exchange rate –in the pre-EMU era– to compensate for their positive inflation differentials with respect to their main trade partners. Interesting enough, this was also the case of Sweden up to 1990 (see Freeman *et al.*, 2010).

Note that these results are consistent with our decomposition analysis. The first cluster includes three economies with technology-driven gains in the RULCs, plus the group with balanced driven gains, while the second cluster incorporates the four countries characterized by capital-intensity driven gains. This second cluster includes, in addition, Ireland and Sweden.

Table 6. RULCs: actual and simulated.

	$\frac{\Delta RULC}{RULC_{t-1}}$	$\frac{\Delta w_t}{w_{t-1}}$	$(1-\alpha_t)\frac{\Delta K_t}{K_{t-1}}$	$\frac{\Delta A_t}{A_{t-1}}$	**Outcome**
Actual	✓	–	–	–	Clusters on actual aggregate data.
Simulation 1	–	✓	–	–	$RULC_{1t}$ in the absence of capital intensity and TFP.
Simulation 2	–	–	✓	–	$RULC_{2t}$ in the absence of real wages and TFP.
Simulation 3	–	–	–	✓	$RULC_{3t}$ in the absence of real wages and capital intensity.
Simulation 4	–	✓	✓	–	$RULC_{4t}$ in the absence of TFP.
Simulation 5	–	✓	–	✓	$RULC_{5t}$ in the absence of capital intensity.
Simulation 6	–	–	✓	✓	$RULC_{6t}$ in the absence of real real wages.
Simulation 7	–	✓	✓	✓	$RULC_{7t}$ accounted for by the three components (overall fit).

Regarding Simulation 1, the first group identified in the cluster analysis puts together Finland, Ireland, and Portugal. This should come as no surprise since these are the economies that during the 1980s, 1990s and 2000s have experienced, by far as shown in Table 2, the largest growth in real wages. The second and third groups comprise, respectively, Austria, Belgium and Sweden and, then, France and the Netherlands, while the last one gathers Greece, Italy and Spain together.

Table 7. Clusters.

	Actual	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5	Sim 6	Sim 7
Group 1	AU BE FI FR NT	FI IR PO	BE FI NT	FR GR IT SP	FI IR	BE PO	AU BE FR GR IT NT PO SP	AU BE FI FR NT
Group 2	GR IR IT PO SP SW	AU BE SW	GR IT SW	AU BE NT PO	AU BE NT PO SW	AU FR FI GR IR IT NT SP SW	FI IR SW	GR IR IT PO SP SW
Group 3		FR NT	AU FR	FI IR SW	FR GR IT SP			
Group 4		GR IT SP	IR PO SP					

The classification in terms of capital intensity (Simulation 2) delivers groups that are not as different, from one another, than those obtained from simulations 1 and 3. The reason is that, for real wages and TFP, there is much more dispersion in the evolution of the countries, than for capital intensity (see Table 2).[8] In any case, the most remarkable feature regarding capital intensity, is that group 3 clearly identifies Austria and France as conforming a group themselves, while group 1 comprises only technology-driven economies (Belgium, Finland and the Netherlands).

The cluster analysis performed when TFP is the only variable allowed to affect the evolution of the RULCs (Simulation 3) provides useful complementary information

[8]More precisely, note that for real wages and TFP the countries with the smallest and biggest growths are Greece and Ireland, with differences around 90 percentage points. In contrast, for capital intensity the divergence across economies is in the much narrow range of 40 percentage points (between 115.6 in 2012 in the Netherlands and 154.9 in Portugal).

which exploits wider differentials in the performance of the economies. Looking at the clusters, it is worthwhile pointing out that the first group does fully coincide with one of the clusters obtained from Simulation 4. The second and third ones, in turn, provide a very close match. The only difference is that Sweden moves from the second group (when both capital intensity and TFP are allowed to vary) to the third one (when only TFP changes).

We interpret this close match as evidence that TFP is the strongest driver of labour productivity and, as such, growth policies deserve great attention from policy makers. This idea is consistent with the recent finding by Wierts *et al.* (2014) that the effect of the real exchange rate on exports in the Eurozone becomes smaller the higher the share of high technology exports in total exports. Following this, specialisation in high tech sectors pushes productivity and makes these economies less dependant of the real effective exchange rate which, in the absence of national currencies, is the relevant variable to assess price competitiveness.

The contrast between the results under Simulations 1 and 3 virtually vanish in Simulation 5, in which the RULCs are evaluated considering changes in wages (like in Simulation 1) *and* TFP (as in Simulation 3). The first club joins Belgium and Portugal, while a second one contains the rest of the economies although, in any case, we must state that the differences between the two clubs are of minor order (recall that Belgium and Portugal are the two countries where the ratio between wages and technology growth has been the largest –even though very close to next economies in this ranking in the Belgian case).

Simulation 6 examines the clusters when both capital intensity and technology, but not wages, drive the evolution of the RULCs. This implies that the two sources of labour productivity are considered together. Since wages are fixed as a function of productivity, the less clubs we find, the more homogeneous will be wage growth in the Eurozone.

This sixth scenario is the only one in which we find two clear clusters. On top of this being the number of clusters obtained for the actual evolution of the RULCs, these clubs have a salient feature. The first one contains the members of cluster 1 and 2 under Simulation 3 (when technology was absent), while the second one exactly matches club 3 in Simulation 3. In other words, as opposed to capital intensity, technology seems to be the fundamental driving force in the clustering of the countries and, therefore, in the real convergence process.

This result is consistent with the predictions of standard growth theory. It introduces some caveats, however, in the design of (common) economic policy towards which we turn next.

6 RULCs, economic convergence and external imbalances

External imbalances are currently an issue of great concern. No so long ago, however, they were mainly seen as a temporary counterpart of economic convergence.

In a seminal paper, Feldstein and Horioka (1980) argued that increased financial integration should lead to a loosening of the relation between domestic savings and investment, as international capital markets could be used to finance savings-investment imbalances. Accordingly, increasing current account imbalances should not be seen as an issue of concern, but rather as the natural consequence of an improved international (re)allocation of capital and, thus, as the resulting economic convergence across countries.

The theory of intertemporal utility maximization provides a theoretical framework to this line of thought. In the presence of integrated real and financial markets, less developed countries attract foreign investment because of their higher expected productivity of invested capital. At the same time, these economies should consume more and save less in anticipation of higher income growth in the future. As a result, these countries run current account deficits. Thus, diverging current accounts should be interpreted as the consequence of a convergence process among countries with different levels of economic development. If this is the case, external imbalances should be temporary and would not require government intervention. They would be automatically offset by changes in exchange rates, private investment and savings across countries (Clarida, 2007, and Blanchard, 2007).

In spite of this rationalization, external imbalances are a recurrent feature of the world economies with an outcome not always in line with the optimistic theoretical prediction. Belke and Schnabl (2013) point to four waves of global imbalances. The first one, between Japan and the US since the early 1980s, led to the Japanese 'lost decade'; the second one, between China and a group of East Asian economies, on one side, and the US on the other, lead to the East Asian crisis; the third one was due to the fast increase in the prices of oil and other raw materials, and caused large current account deficits in the US and Europe (bar the northern European oil producers); the fourth one has taken place in the Eurozone and has even threatened the European integration process itself.

Moreover, the literature in this field is far from reaching a consensus. Departing from the above theoretical framework, Blanchard and Giavazzi (2002) concluded that domestic investment and savings decisions in the Eurozone are decoupled in the sense that southern lower-income countries can extensively borrow from northern higher-income countries leading to economic convergence between these groups. Similar conclusions are reached by Ahearne *et al.* (2007), who argued that capital flows within the euro zone were moving as predicted by neoclassical theory and were strongly supportive of the convergence hypothesis. On the contrary, Arghyrou and Chortareas (2008) and Jaumotte and Sodsriwiboon (2010) expressed concern about the sustainability of the observed current account deficits in the southern Eurozone countries. Belke and Dreger (2013) acknowledge that these deficits may be understood to be in line with the intertemporal approach of the current account, but they also claim that catching up does not offer a full explanation, and point to relative government debt and competitiveness as more relevant factors.

The study with the closest view to our analysis is the one by Holinski *et al.* (2012), who argued that growing current account imbalances within the Eurozone reflect an ongoing process of economic divergence rather than the expected convergence. The difference between this study an ours lies in the roots of this divergence. Holinski *et al.* (2012) concluded that the increasing current account deficits in the Periphery are driven mainly by the decline in transfers and the increase in net factor payments. Excess borrowing increases net foreign debt and subsequent interest payments, bringing these countries to an unsustainable net foreign debt position. Our claim is that the ultimate cause of this situation lies in the structural lack of real convergence experienced by these economies in spite of the economic integration process.

In any case, the lack of full consistency between the economic convergence theory and the growing external imbalances in the Eurozone is a research area that will deserve further attention from the profession.

Our analysis has taken into account more than three decades of the recent economic history. Those in which the European integration process consolidated along the European Free Trade Association (EFTA) set up in 1960 with Austria, Portugal, and Sweden, and also Finland since 1961, among other countries, and the European Economic Community (EEC) with Belgium, France, Italy and the Netherlands since the 1950s, and also Ireland (since 1973), Greece (1981), and Spain (1986), to which the EFTA economies joined subsequently.

In a globalised world with deep economic integration, one could have expected a strong enough process of economic convergence so as to deliver a unique cluster. Beyond that, one could even envisage a situation in which this club would be the same for all the scenarios considered, with technology leading the convergence in all major macro variables.

It is clear, however, that the Eurozone economies are actually far from such theoretical prediction. Although we have verified that wages have grown in a sustainable manner all around following technological progress, their evolution is very heterogeneous as a reflect of the variety of technological experiences. This is what we observe when clustering systematically the RULCs so as to account for the incidence of one or two of the components that determine their trajectory.

The actual path of the RULCs delivers two clusters which, in broad-brush terms coincide with the periphery and non-periphery Eurozone groups that have characterised the Sovereign-Debt crisis in 2010-2013. However, when these economies are examined according to the incidence of wages, capital intensity and technology on the RULCs, a wide variety of clusters emerge. Four in the first two simulations in which only wages or capital intensity affect the RULCs (with a different country-composition of these four clusters), but three when only technology is allowed to change. Three in the absence, only, of TFP changes, but two in the absence of capital intensity and real wages influences (although these two are different among them, and also relative to the two clubs resulting from the aggregate analysis).

Beyond the detailed interpretation of these results provided in Section 5, there is an all-encompassing crucial question: How is Europe supposed to be successful in achieving nominal convergence (the one led by the Maastricht criteria in the 1990s), in the absence of real convergence?

We believe that with lots of difficulties. The crucial role played by the growing external imbalances in the onset of the Sovereign-Debt crisis is eloquent on this respect.[9] Figure 4 plots the evolution of current account balances as percent of GDP and provides intuitive support to the findings in Table 7. Figures 4a and 4b are revealing in showing, on one side, the difficulties of the Periphery countries in avoiding current account deficits and, on the other side, the more comfortable situation of the Core economies.

We were initially told that the European and Monetary Union would further facilitate economic integration (further with respect to the common market) by converging nominally as a stepping stone towards real convergence. In this way, growth, technological and, ultimately, welfare gaps would be reduced and eventually closed. Taking a short-run perspective, the recent evolution of growth, unemployment, and welfare has been certainly unlike within Europe. And taking a 30 years long-run perspective, we have shown wide disparities in the evolution of the RULCs, one key variable representative of the serious lack of real convergence.

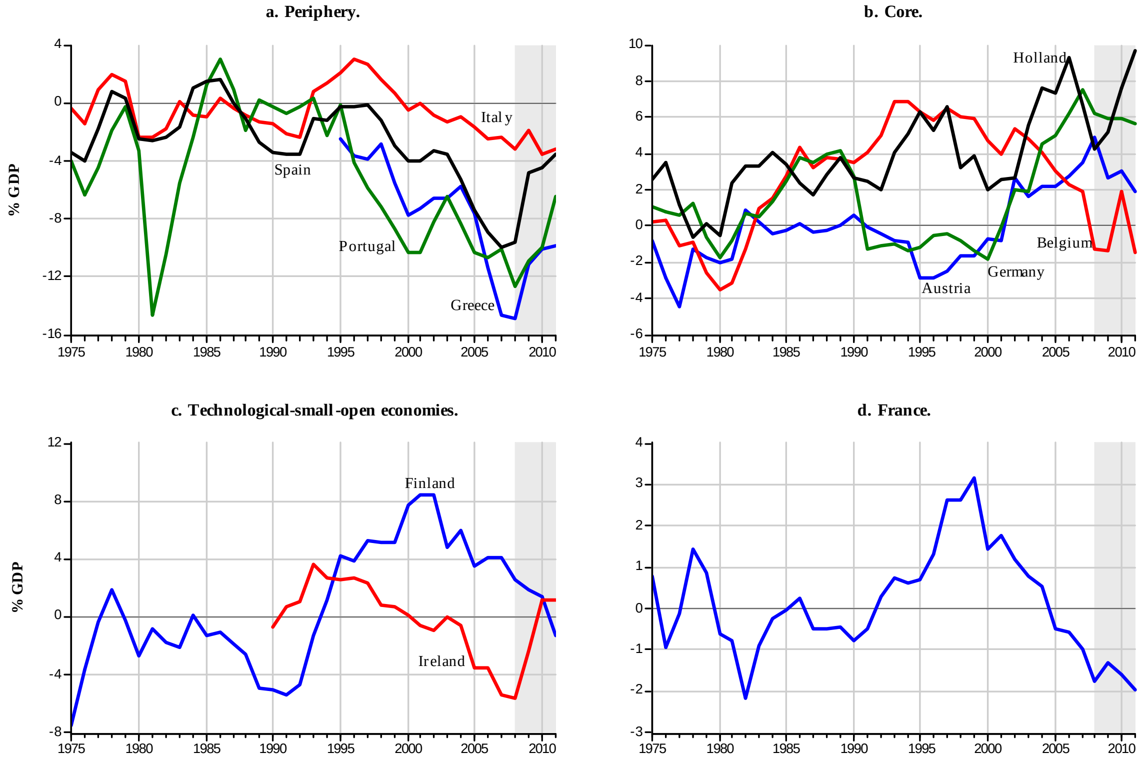
Under this perspective, policy coordination at the European level (call it Maastricht Treaty, Stability and Growth Pact, or Fiscal Compact) and national coordination of European policies is more than ever a major challenge. Because this issue is much beyond the scope of this particular analysis, let us focus on one particular example. Would it be useful to embark on a process of unification of labour market legislation so as to foster a Single European Labour Market?[10] Our results call for a very cautious

[9]There has been much discussion on the role played by external imbalances in the current crisis, both at the European level (Croci and Farina, 2012) and at the global level (Willett, 2012).

[10]Recall that the European Commissioner for Employment, László Andor, pointed in May 2013 to

approach to this avenue. Although there is, of course, scope for changes in legislation in all economies, the performance of the labour market cannot be isolated from the economic performance of the countries. This is the reason why the prominent target should be to foster technological convergence. Of course along the lines of the EU programme Horizon 2020 seeking to enhance research and innovation, but going beyond that to incorporate, in parallel, much more national coordination of industrial policies. This has been, up to now, a relatively neglected area in the European process of economic integration.

Figure 4. Current account balance.



Source: OECD Economic Outlook 92 (December 2012).

7 Conclusion

Were the Eurozone economies hiding structural differences in competitiveness through a skillful management of the exchange rate? Could this strategy no longer be hidden –and thus maintained– with the single currency, and then materialized in the form of unprecedented external imbalances? The results of this paper point to positive answers to these questions.

We have shown that the RULCs have fallen almost twice as much in the Periphery than in the non-Periphery countries over the period 1979-2012. This is the outcome

the establishment of a Single European Labour Market as a "part of the EU's recovery strategy" and that some institutions (European Policy Centre, Institute for the Study of Labor) are devoting energy to asses the potential costs and benefits of pursuing seriously this route.

of a less expansionary wage growth process mainly counterbalanced through capital intensity gains. On the contrary, Core Eurozone economies have experienced larger rates of wage growth sustained through a much more dynamic process of technological progress.

Which one is the best strategy? Although capital accumulation boosts growth and productivity, technology is the right way to ensure stable long-run economic growth. This would explain why, in spite of the PIIGS effort to reduce their RULCs, they were unable to converge to the Core Eurozone economies.

Last decades have witnessed a period of most intensive economic integration within Europe. Real convergence, however, has not been achieved as ex-ante expected. Instead of finding a single cluster or, at least, a robust configuration of clubs within the Eurozone, we have uncovered a variety of statistically significant clusters with, on top, wide country-variation in their composition.

Cluster heterogeneity, and lack of robustness in cluster composition, would have been such unexpected outcomes had the architects of the Economic and Monetary Union (EMU) been asked in 1989 Madrid's summit whether this process would result, 25 years later, into significant real convergence.

On the contrary, there was a quick and intensive deterioration of the current account balance in the PIGS since the mid 1990s, which accelerated since the inception of the euro, and had a positive counterpart in the Core group current accounts. Our results lead us to think that the EMU has not been the cause of the external imbalances, and the resulting sovereign-debt crisis, in a context of closed financial markets. Rather, it has boosted some structural divergencies that were already present in the growth model of these economies.

Since these divergencies can be ascribed mainly to different technological levels, rather than to a wrong wage behaviour in the Periphery, internal devaluation policies are not the solution to surpass the current situation in the Eurozone. These policies have forced rebalancing of the external deficits, but they do not help convergence. And the reason is the same we have heard many times when economies embark in external devaluations: these are not genuine competitive gains, it is technology what matters.

Hence, looking retrospectively, the definition of the Maastricht criteria should have been probably more balanced towards the inclusion of some real convergence indicators to be fulfilled before joining the EMU. The extensive battery of indicators considered in the macroeconomic imbalance procedure (MIP) constitute a response to this void.[11]

[11] 3 year backward moving average of the current account balance as percent of GDP, with thresholds of +6% and -4%; net international investment position as percent of GDP, with a threshold of -35%; 5 years percentage change of export market shares measured in values, with a threshold of -6%; 3 years percentage change in nominal unit labour cost, with thresholds of +9% for euroarea countries and +12% for non-euroarea countries; 3 years percentage change of the real effective exchange rates based on HICP/CPI deflators, relative to 41 other industrial countries, with thresholds of -/+5% for

We cannot abstain, however, to point out that this new set of indicative thresholds are formulated as a surveillance mechanism, and not as convergence targets.[12] We wonder, in the current context, whether some real convergence indicators should also be targeted to safeguard, or at least strengthen, the process of European integration.

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euroarea countries and -/+11% for non-euroarea countries; private sector debt (consolidated) in % of GDP with a threshold of 133%; private sector credit flow in % of GDP with a threshold of 15%; year-on-year changes in house prices relative to a Eurostat consumption deflator, with a threshold of 6%; general government sector debt in % of GDP with a threshold of 60%; 3-year backward moving average of unemployment rate, with a threshold of 10%; year-on-year changes in total financial sector liabilities, with a threshold of 16.5%.

[12] Moreover, De Grauwe (2012) has recently remarked that although "the key idea in the MIP is symmetry, i.e. imbalances between surplus and deficit countries should be treated and corrected symmetrically (...) the MIP is unlikely to work symmetrically for the same reason the EMS did not" [De Grauwe (2012), p. 5].

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APPENDIX 1

Figure A1. Growth rates of the RULCs. Actual and simulated.

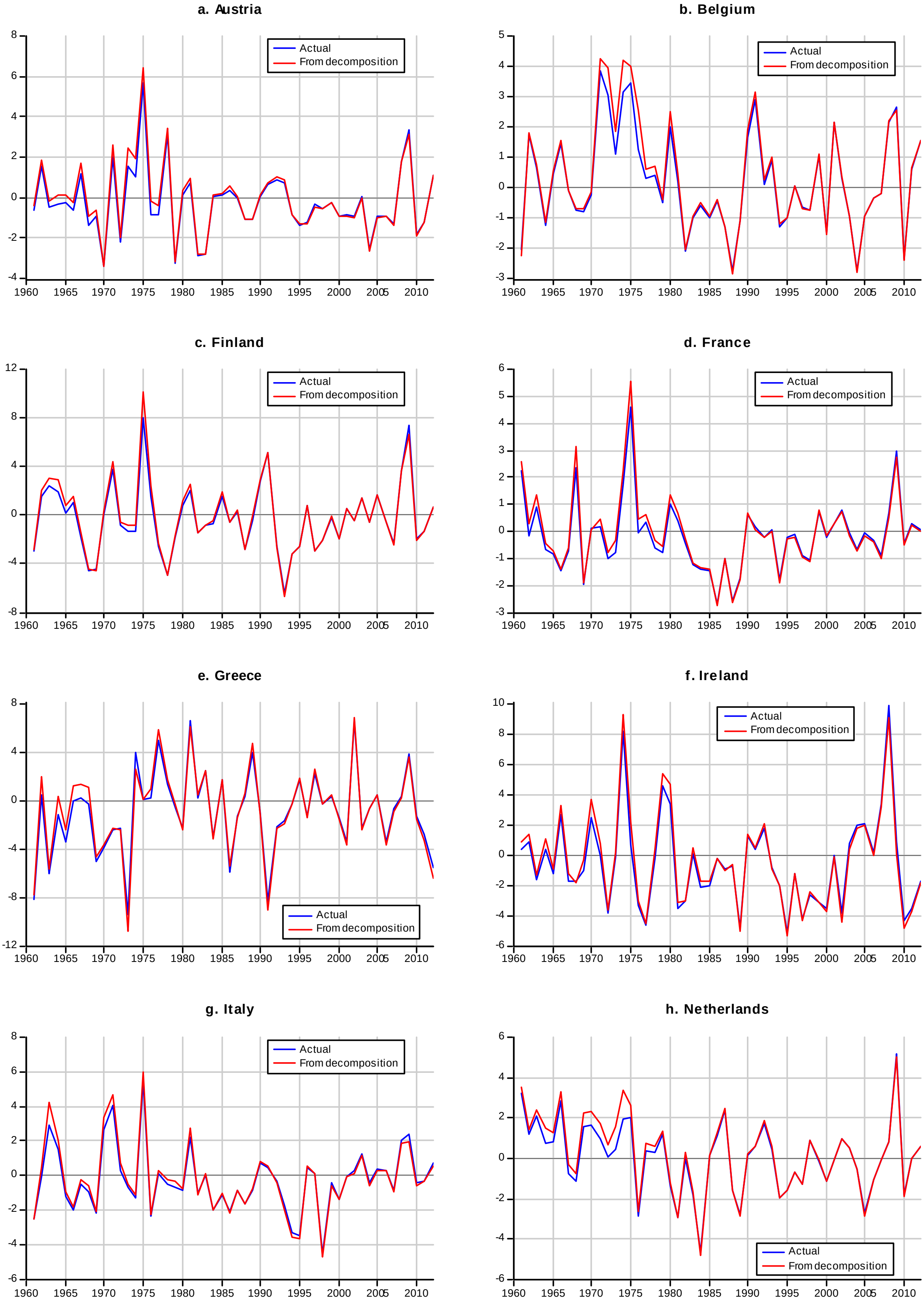
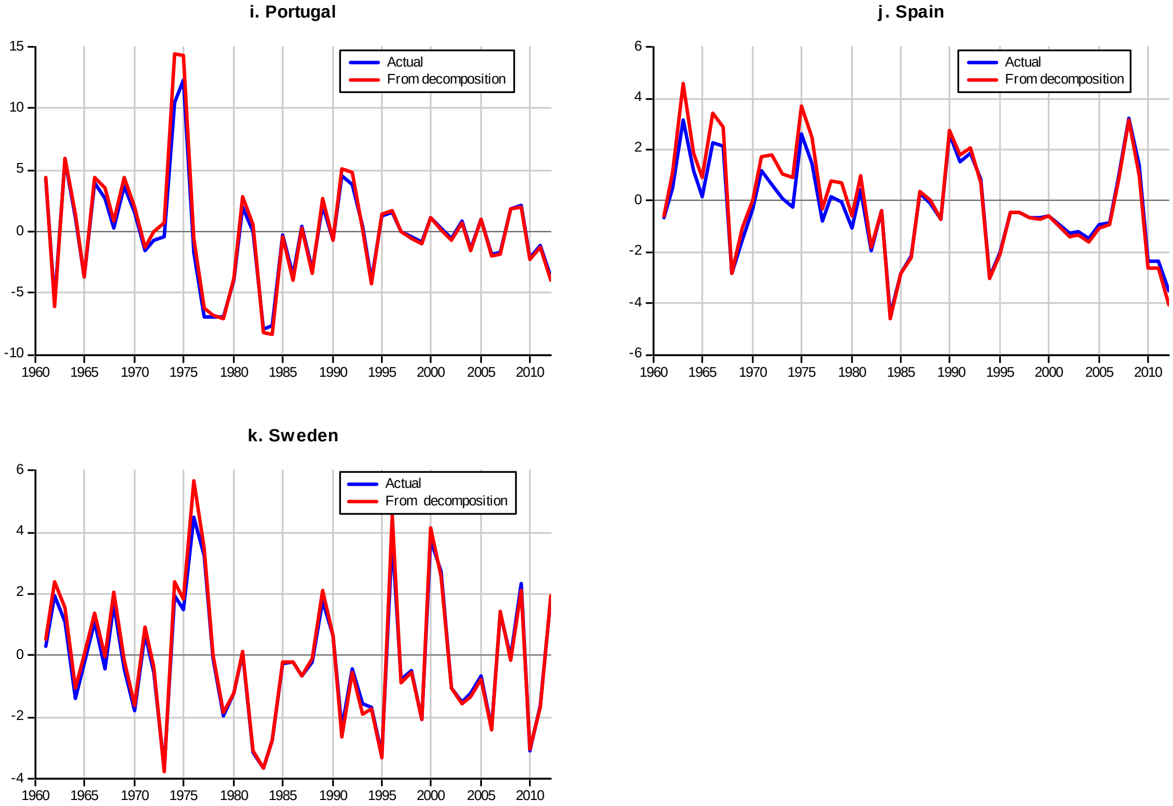


Figure A1. ... continuation



Note: Simulation based on the scenario 'Simulation 7' (as explained in Tables 2 and 6), which is conducted for period 1960-2012.

Source: Decomposition based on official European Commission data (Ameco Database).

APPENDIX 2

Table A2.1. Cluster analysis on the actual RULCs.

Overall convergence test:

	$b-coef$	$t-stat$
constant	-0.158	-0.100
$\log t$	-0.832	-1.587

Sub-club convergence:

FIRST CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-0.448	-0.533
$\log t$	-0.386	-1.380

Countries: Austria, Belgium, France, Finland, Netherlands.

SECOND CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-2.002	-0.483
$\log t$	-0.158	-0.114

Countries: Greece, Ireland, Italy, Portugal, Spain, Sweden.

Note: Since t-stat>-1.65, the second club is indeed a convergent club.

Table A2.2. Cluster analysis on the RULCs from Simulation 1.

Overall convergence test:

	$b-coef$	$t-stat$
constant	0.070	0.180
$\log t$	-1.750	-12.772

Sub-club convergence:

FIRST CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-4.798	-2.178
$\log t$	0.862	1.113

Countries: Ireland, Portugal, Finland.

SUB CLUB CONVERGENCE:

	$b-coef$	$t-stat$
constant	-0.128	-0.167
$\log t$	-1.446	-5.370

Note: Since t-stat<-1.65, we repeat the clustering procedures

SECOND CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-5.486	-2.606
$\log t$	1.228	1.661

Countries: Austria, Belgium, Sweden. Since t-stat<-1.65, we repeat the clustering procedures

SUB CLUB CONVERGENCE:

	$b-coef$	$t-stat$
constant	-1.950	-1.508
$\log t$	-0.750	-1.650

Note: Since t-stat<-1.65, we repeat the clustering procedures

THIRD CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-4.958	-2.313
$\log t$	1.071	1.423

Countries: France, Netherlands.

FOURTH CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-5.021	-1.906
$\log t$	0.614	0.664

Countries: Greece, Spain, Italy.
Note: Since t-stat>-1.65, the fourth club is indeed a convergent club.

Note: Simulation 1 allows variations in wages, while capital intensity and TFP are fixed.

Table A2.3. Cluster analysis on the RULCs from Simulation 2.

Overall convergence test:

	$b-coef$	$t-stat$
constant	1.278	8.413
$\log t$	-1.644	-30.469

Sub-club convergence:

FIRST CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-5.894	-12.890
$\log t$	0.771	4.749

Countries: Belgium, Finland, Netherlands.

SUB CLUB CONVERGENCE:

	$b-coef$	$t-stat$
constant	0.664	7.248
$\log t$	-1.358	-41.757

Note: Since t-stat<-1.65, we repeat the clustering procedures

SECOND CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-4.368	-1.950
$\log t$	0.567	0.713

Countries: Greece, Italy, Sweden.

Since t-stat<-1.65, we repeat the clustering procedures

SUB CLUB CONVERGENCE:

	$b-coef$	$t-stat$
constant	-0.836	-3.560
$\log t$	-0.928	-11.133

Note: Since t-stat<-1.65, we repeat the clustering procedures

THIRD CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-4.470	-2.862
$\log t$	0.322	0.581

Countries: Austria, France.

FOURTH CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-4.359	-6.101
$\log t$	0.185	0.729

Countries: Ireland, Portugal, Spain.

Note: Since t-stat>-1.65, the fourth club is indeed a convergent club.

Note: Simulation 2 allows variations in capital intensity, while wages and TFP are fixed.

Table A2.4. Cluster analysis on the RULCs from Simulation 3.

Overall convergence test:					
	$b-coef$	$t-stat$			
constant	-0.636	-2.560			
$\log t$	-1.045	-11.859			
Sub-club convergence:					
First convergence club:			Sub club convergence:		
	$b-coef$	$t-stat$		$b-coef$	$t-stat$
constant	-2.795	-1.435	constant	-2.298	-3.475
$\log t$	0.625	0.904	$\log t$	-0.713	-3.039
Countries: Greece, France, Spain, Italy.			Note: Since t-stat<-1.65, we repeat the clustering procedures		
Second convergence club:			Third convergence club:		
	$b-coef$	$t-stat$		$b-coef$	$t-stat$
constant	-6.167	-4.609	constant	-4.968	-6.289
$\log t$	1.703	3.587	$\log t$	0.352	1.255
Countries: Austria, Belgium, Netherlands. Portugal.			Countries: Finland, Ireland, Sweden. Note: Since t-stat>-1.65, the fourth club is indeed a convergent club.		

Note: Simulation 3 allows variations in TFP, while wages and capital intensity are fixed.

Table A2.5. Cluster analysis on the RULCs from Simulation 4.

Overall convergence test:					
	$b-coef$	$t-stat$			
constant	1.659	3.796			
$\log t$	-1.798	-11.591			
Sub-club convergence:					
First convergence club:			Sub club convergence:		
	$b-coef$	$t-stat$		$b-coef$	$t-stat$
constant	4.760	0.530	constant	-0.212	-0.324
$\log t$	-1.151	-0.361	$\log t$	-1.273	-5.498
Countries: Finland, Ireland.			Note: Since t-stat<-1.65, we repeat the clustering procedures		
Second convergence club:			Third convergence club:		
	$b-coef$	$t-stat$		$b-coef$	$t-stat$
constant	-1.667	-1.980	constant	-0.759	-0.405
$\log t$	0.049	0.164	$\log t$	-0.768	-1.154
Countries: Austria, Belgium, Netherlands, Portugal, Sweden.			Countries: France, Greece, Italy, Spain. Note: Since t-stat>-1.65, the third club is indeed a convergent club.		

Note: Simulation 4 allows variations in wages and capital intensity, while TFP is fixed.

Table A2.6. Cluster analysis on the RULCs from Simulation 5.

Overall convergence test:

	$b-coef$	$t-stat$
constant	-1.286	-3.535
$\log t$	-1.058	-8.765

Sub-club convergence:

FIRST CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	12.514	5.716
$\log t$	-5.339	-7.353

Countries: Belgium, Portugal.

SECOND CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-3.971	-7.645
$\log t$	-0.007	-0.040

Note: Since t-stat>-1.65, the second club is indeed a convergent club.

Countries: Austria, Finland, France, Greece, Ireland, Italy, Netherlands, Spain, Sweden.

Note: Simulation 5 allows variations in wages and TFP, while capital intensity is fixed.

Table A2.7. Cluster analysis on the RULCs from Simulation 6.

Overall convergence test:

	$b-coef$	$t-stat$
constant	-0.500	-2.384
$\log t$	-1.488	-21.611

Sub-club convergence:

FIRST CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-4.278	-6.242
$\log t$	0.283	1.260

Countries: Austria, Belgium, France, Greece, Italy, Netherlands, Portugal, Spain.

SECOND CONVERGENCE CLUB:

	$b-coef$	$t-stat$
constant	-6.562	-9.263
$\log t$	0.835	3.592

Countries: Finland, Ireland, Sweden.

Note: Since t-stat>-1.65, the second club is indeed a convergent club.

SUB CLUB CONVERGENCE:

	$b-coef$	$t-stat$
constant	-0.720	-1.107
$\log t$	-1.417	-6.644

Note: Since t-stat<-1.65, we repeat the clustering procedures

Note: Simulation 6 allows variations in capital intensity and TFP, while wages are fixed.

Table A2.8. Cluster analysis on the RULCs from Simulation 7.

Overall convergence test:

	$b - coef$	$t - stat$
constant	-0.642	-0.585
$\log t$	-1.144	-3.172

Sub-club convergence:

FIRST CONVERGENCE CLUB:

	$b - coef$	$t - stat$
constant	-1.962	-2.797
$\log t$	-0.282	-1.221

Countries: Austria, Belgium, France, Finland, Netherlands.

SECOND CONVERGENCE CLUB:

	$b - coef$	$t - stat$
constant	-0.633	-0.215
$\log t$	-1.206	-1.245

Countries: Greece, Ireland, Italy, Portugal, Spain, Sweden.

Note: Since t-stat>-1.65, the second club is indeed a convergent club.

Note: Simulation 7 allows variations in wages, capital intensity, and TFP. It provides the overall fit.