Economic Integration and Unit Labour Costs

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Abstract:

Unit labour costs (ULC) have increased much faster in the periphery than in core Eurozone countries since 1995. This divergence was pointed as a key amplifying factor in the Euro's 2010 crisis; but there is no consensus to date on its cause. This paper investigates the drivers of ULC divergence. It shows that faster tradable productivity growth in the periphery –i.e. real convergence– contributed to rising real exchange rates and a sectoral shift towards non-tradable sectors, resulting in increasing ULC. This productivity effect explains one-third of the rise in ULC dispersion between 1995 and 2015. This fact bears important implications: it suggests that any effort towards further real convergence in Europe could be associated with a resurgence of ULC divergence, and it questions the use of rising ULC dispersion as an indicator of rising macroeconomic imbalances. (JEL: E65, F41, F45, O33, O41, O47, O52.)

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Introduction

Unit labour costs (ULC), the ratio of total labour compensations to real GDP, reflect how wages evolve relative to labour productivity. These costs have increased substantially in the so-called periphery relative to core Eurozone countries since the mid-1990s (Figure 1). This divergence was first interpreted as reflecting catching-up processes in the periphery (Blanchard and Giavazzi, 2002)[1], but this view was challenged after the 2008-2009 recession and subsequent Euro crisis. ULC divergence was then pointed as a key amplifying factor in the crisis (Shambaugh, 2012), and differences in labour market regulations (Berka et al., 2018) or capital misallocation (Reis, 2013; Gopinath et al., 2017) put forward as key drivers. Even if no consensus emerged yet on the relative contributions of each factor, the European Commission puts much focus on correcting[2] and preventing ULC divergence since 2011.[3]

Identifying the main drivers of increasing ULC divergence is however essential to design policies to correct or prevent them from rising again in the future. Whether diverging ULC reflect differences in product or labour market regulations or whether they result from real convergence (i.e. productivity convergence) has different implications. In the latter case, any effort towards real convergence in Europe would be associated with a resurgence of such ULC dispersion.

This paper aims to shed light on the origins of ULC divergence in the Eurozone. It develops an augmented Balassa-Samuelson model –relating real exchange rates to sectoral productivity– and adapts it to investigate ULC divergence. The framework accounts for various sectoral shocks beyond the effect of real convergence to quantify and compare their relative contributions. Results shows that the productivity channel explains one-third of the increase in ULC in the periphery relative to the Eurozone average between 1995 and 2015; the other biggest (and equally) important driver being a product market wedge.

The paper first documents three novel stylized facts using improved growth accounts for Eurozone countries. Data includes 15 Euro area countries: the 12 Members that adopted the Euro in the early 2000s and three new Member States (Cyprus, Slovakia and Slovenia). The periphery is defined as the four poorest countries of the EA12 in 1995[4] plus the three new Member States. The three facts are, in the periphery: (i) an increase in ULC

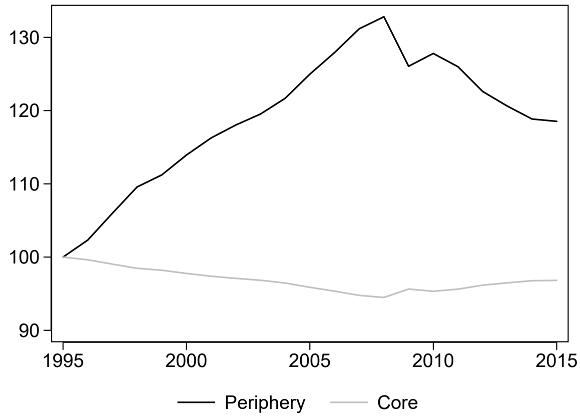
[1] Blanchard and Giavazzi (2002) show that financial integration and lower interest rates along with goods markets integration would lead both to a decrease in saving and an increase in investment in poorer countries, and so, to large current account deficits. Interpreted as good imbalances, these deficits would be reduced as countries converge.

[2] Currency devaluation being unavailable in a fixed exchange-rate regime, policies to adjust these imbalances focus mostly on structural reforms in labour and product markets.

[3] ULC are now closely monitored in Europe. The growth in unit labour costs is considered as 1 of the 5 indicators of "external imbalances and competitiveness losses" in the Macroeconomic Imbalances Surveillance Procedure adopted in 2011. In June 2015, the European Commission also advised the creation of National Productivity Boards in charge of assessing whether wages are evolving in line with productivity.

[4] Poorest in terms of GDP per capita at purchasing power parity. See Appendix A.2. The core includes:

Figure 1 – Unit labour costs (nominal wages to labour productivity), by country group, deviation from Eurozone average, 1995-2015 (index 1995=100)



Note: author's calculations using Eurostat and EU KLEMS. Unit labour costs for the market sector. The periphery includes the four founding Member States with the lowest GDP per capita (at purchasing power standards) in 1995: Greece, Ireland, Portugal and Spain, as well as three new Member States: Cyprus, Slovenia and Slovakia. Core countries are Austria, Belgium, Germany, Finland, France, Italy, Luxembourg and the Netherlands. Group averages weighted by GDP (in euros).

originating in the non-tradable sector; (ii) a strong correlation between real exchange rates and sectoral productivity; (iii) a fall in profit shares relative to the rest of the Eurozone –even pre-crisis.[5] These facts suggest an important contribution of rising real exchange rates to rising ULC in the periphery, and a contribution of sectoral productivity and profit shares to this rise.

Building on these observations, the paper then develops a 2-sector-open-economy model to understand ULC movements. In this model, ULC are a function of the real exchange rate, sectoral reallocations and markups (the theoretical counterpart to profits). Real exchange rates and reallocations are in turn endogenous to various shocks that were emphasized in previous papers as important drivers of macroeconomic divergence in Europe. The model provides an accounting decomposition of unit labour costs growth into the various shocks that can be easily identified in the data. It is the first paper to my knowledge to confront potential candidates of ULC divergence and to quantify their relative importance. The previous literature has been investigating candidate explanations separately and was unable to settle the debate on drivers of ULC divergence in Europe.

The result that sectoral productivity is an important driver of macroeconomic divergence

Austria, Belgium, Germany, Finland, France, Italy, Luxembourg and the Netherlands. The periphery includes Greece, Ireland, Portugal and Spain.

[5] This is consistent with De Loecker and Eeckhout (2017), finding that markups in Europe have increased most in countries classified here as core countries.

in Europe departs from the previous empirical literature on the Balassa-Samuelson model. The Balassa-Samuelson model posits a positive relation between real exchange rates and tradable vs. non-tradable productivity.[6] Previous papers have not been able to find empirical support for a Balassa-Samuelson effect in the Eurozone (see, for instance, Estrada et al., 2013; Berka et al., 2018).[7] I show that, with an improved measure of TFP, the Balassa-Samuelson effect is strong. The first measurement improvement concerns the definition of the tradable sector. My paper defines a sector as tradable depending on its exposure to international trade, as in De Gregorio et al. (1994), and includes thereby a number of service sectors. By contrast, previous papers classify all services as non-tradable. The second improvement concerns the total factor productivity (TFP) measure. TFP measures are biased if profits are not accounted for in their estimate (Fernald and Neiman, 2011; Comin et al., 2020). This is because the contribution of capital inputs is mismeasured when there are profits. I show that this bias affected significantly differences in TFP trends across countries in Europe.

I augment this Balassa-Samuelson model to look at the additional effects of financial integration, sectoral markups and capital misallocation. The intuition is simple: financial integration, by lowering the user cost of capital, benefits more the capital-intensive tradable sector, inducing a relative price increase in the non-tradable sector (as suggested by the Stolper-Samuelson theorem). Different movements in user costs of capital (a proxy for capital misallocation,as in Reis, 2013; Gopinath et al., 2017) or markups across sectors are also translated into relative price movements.

These movements in real exchange rates can fuel a reallocation of resources across sectors if traded and non-traded goods are complements. This is a standard result in the structural change literature (Baumol, 1967; Ngai and Pissarides, 2007; Acemoglu and Guerrieri, 2008). While this literature focuses on drivers of long-term growth, I focus here on convergence dynamics, i.e. deviations from a steady state, assuming countries would converge to the same steady state in the long-run. This way, I study how real and financial convergence can drive temporary macroeconomic imbalances, an idea initially put forward by Blanchard and Giavazzi (2002).

Because my focus is not on long-run growth dynamics, reallocations are also affected by demand effects. Financial integration fuels a transitory demand-boom. The increasing demand for tradables can be satisfied through imports, but the increase in non-tradable consumption requires a shift of productive resources at the expense of the tradable sector. Benigno and Fornaro (2014) suggest that this demand-boom effect is at the center of macroeconomic divergence in Europe. However, their model establishes a negative correlation between economic integration and tradable productivity growth. This is in

[6]Short-run movements in real exchange rate are not related to monetary policy or financial shocks in a group of countries sharing a currency. For this reason, the literature usually focuses on monetary unions to test the Balassa-Samuelson model.

[7]Berka et al. (2018) find empirical support for a Balassa-Samuelson effect only if controlling for unit labour costs –assumed to capture a labour wedge.

contradiction with the stylized fact that tradable productivity growth was strong in the periphery. I find little support for a demand-effect driven by trade deficits compared to relative price effect. This is in line with Kehoe et al. (2018), finding only a little contribution of the trade balance to employment reallocations in the United States since the early 1990s.

Finally, I focus on the role of markups, i.e. a product-market wedge. This departs from Berka et al. (2018), who suggest that it is the labour market wedge, and not product market wedge, that is crucial to understand real exchange rate dynamics in Europe. While I do find that the product market wedge contributed little to real exchange rates movements, I find that this wedge had a direct and significant contribution to movements in unit labour costs.[8]

The result that sectoral productivity is an important driver of ULC dispersion in Europe bears important implications. It suggests that rising ULC do not necessarily reflect 'competitiveness losses', as it could be associated with productivity growth and catching-up processes. It also shows that any effort towards further real convergence in the future might lead ULC dispersion to rise again.

The remainder of the paper is organized as follows. Section 1 describes the novel dataset and documents some stylized facts characterizing the periphery since the mid-1990s. Section 2 develops the theoretical framework and presents an accounting decomposition of the growth in ULC and Section 3 brings this decomposition to the data. Section 4 concludes.

1. Empirical Evidence

1.1. Data

This paper builds new data to document the sectoral origins of ULC dynamics as well as key facts about tradable and non-tradable sectors for 15 countries of the Euro area.[9] The dataset overcomes the traditional shortcut of labeling the industry as tradable and services as non-tradable. It also provides measures of total factor productivity adjusted for profits. Appendix 1 includes more details on data sources and Appendix 2 on measurement.

Growth accounting indicators The dataset uses EU KLEMS industry data[10] to build improved growth accounts. It focuses on non-market sectors only.[11] Whereas KLEMS

[8] I also discuss how the difference between estimated unit labour costs and their observed counterpart in the data can be directly mapped to their labour wedge. This allows me to compare the respective roles of both wedges to diverging ULC dynamics –whereas they assume ULC is a proxy for the labour market wedge only.

[9] The countries are: Austria, Belgium, Cyprus, Germany, Greece, Spain, Finland, France, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovenia and Slovakia.

[10] EU KLEMS takes Industry Accounts from Eurostat.

[11] Following accounting conventions, non-market sector output is measured using data on inputs –meaning that by construction TFP is close to zero in these sectors. I thus exclude all non-market sectors, i.e. public administration, health, education and other non-market services, but also the real estate sector which is

growth accounts are based on the assumption that profits are null (assuming that all non-labour income is attributed to capital), these improved accounts allow for non-zero profits (non-labour income can be attributed to capital or profits –profits reflecting monopoly power).

As in Barkai (2020) or Gutiérrez (2018)[12], I first estimate capital compensations using information on the user cost of capital and capital stocks. I then ultimately deduce the profit share as the residual after measuring the labour and capital shares. User costs of capital are constructed using the standard Hall and Jorgenson (1967) formula, requiring data on investment prices and depreciation rates, and a proxy of rental rates.[13] Rental rates reflect the opportunity cost of capital and are proxied by long-term nominal interest rates (benchmark central government bonds of 10 years, identical across sectors) plus a capital risk premium.[14] Figure A.1 in Appendix draws this rate for the periphery and core countries. On average, profits amount to 10% of GDP.

The existence of profits –if not accounted for in the measure of inputs and their revenue shares– can also bias the measure of TFP (Fernald and Neiman, 2011). This bias is increasing over time, especially in the tradable sector of the periphery, and leads to a 1.5p.p. upward revision in TFP on average (see Figure A.3 and Appendix 2 for a discussion on this adjustment).

Sector tradability Economists traditionally use the shortcut of labeling the industry as tradable and services as non-tradable. However, services represent a growing share of total world trade, especially in the Euro area. In Greece, services represented more than half of the value of total exports in recent years.[15] I build an openness ratio –ratio of total trade (imports + exports) to total production– using data on production (Eurostat National Accounts), data on trade in services (Eurostat Balance of Payments) and data on trade in goods (OECD). A sector is considered tradable if its openness ratio is greater than 10%, on average for the full sample.[16]

Table 1 reports the resulting classification. Unsurprisingly, mining and quarrying as well as manufacturing activities are found tradable. Concerning services, five industries are considered tradable. The non-tradable sector accounts for 35% of total gross value added and 40% of employment on average. Inevitably, the 10% threshold is arbitrary. Interestingly, sectors below this threshold have seen no increase in their openness ratio since 1995, whereas tradable sectors have all experienced a solid increase in trade openness. Yet, from

mostly composed of rental income, and agriculture which revenue is driven by European subsidies.

[12]See Basu (2019) for a literature review and discussion of this class of markup estimation.

[13]Since EU KLEMS ultimately deduces capital compensations from substracting labour compensations from gross value added, their rental rate is endogenous and incorporates the dynamics of profits.

[14]Caballero et al. (2017) show that, while we observed a strong decline in the safe interest rates since the 1980s, there has been a secular increase in the capital risk premia. Using the risk-free rate can lead to underestimate the rental rate of capital, and overstate the role of profits.

[15]In Greece for instance, services represented about 45% of total exports in 1995. This share increased to a little less than 60% in 2015.

[16]The full sample includes 21 countries over 1995-2015 for which trade and production data are available.

Table 1 – Sector classification and openness ratio

Sector		Openness ratio (%)		
		1995	2015-1995, change in p.p.	1995-2015, average
Tradable sector				
B	Mining and quarrying	201.5	538.0	542.6
C	Manufacturing	75.8	48.3	100.4
I	Accommodation and food service activities	23.8	45.8	90.7
H	Transportation and storage	28.7	10.0	34.1
M_N	Other business service activities	9.8	20.9	16.4
J	Information and communication	7.9	23.0	16.1
K	Financial and insurance activities	6.2	14.8	11.6
Non-tradable sector				
F	Construction	2.9	-0.4	2.9
D_E	Utilities and waste management	1.8	0.7	2.6
G	Wholesale and retail trade	1.8	1.5	2.5
R_S	Arts, entertainment, etc.	0.0	1.9	0.5
Total		30.4	15.6	38.3

Note: author's calculations using Eurostat, OECD and EU KLEMS. The openness ratio is the ratio of total trade (imports+exports) to total production for 21 European countries, where countries are weighted using their GDP (in euros). Non-market sectors are excluded.

1995 to 2015, Europe has experienced both rising trade integration and an intensification of global value chains. The fact that trade have not increased as a share of production in non-tradable sectors over this period suggests that the tradability index captures industry rather than country-related characteristics. Appendix 2 discusses further the choice of the indicator and the choice of the 10% threshold and confirms that indicators are similar across country groups.

Country groups The final dataset includes 15 countries of the Euro area and cover up to the years 1995-2015. Countries are classified in the 'core' or the 'periphery' using their GDP per capita (at purchasing power standards) in 1995 (see Table A.6 in Appendix). The periphery includes the four poorest countries of the EA12 (countries that adopted the Euro in 2001 and before, Greece, Ireland, Portugal and Spain), as well as countries that joined the Euro area in 2007 and after (Cyprus, Slovakia and Slovenia). The 'core' includes all remaining countries (Austria, Belgium, Germany, Finland, France, Italy, Luxembourg and the Netherlands).

1.2. Key stylized facts characterizing the periphery

Fact #1: the non-tradable sector, biggest contributor to the rise in unit labour costs The first fact, already discussed in the introduction, is the large increase in unit labour costs (ULC) in the periphery relative to the Euro area average. Unit labour costs increased by 30% more in the periphery from 1995 up to the onset of the global financial crisis (Figure 1), and by 20% more between 1995 and 2015. This implied an absolute increase of about 40% in the periphery between 1995-2015, relative to a 8% increase in core countries.

This increase in the periphery originates mostly in the non-tradable sector. Not only unit labour costs increased much faster in non-tradable sectors than in tradable ones (by 19p.p. more over 1995-2008, see Appendix Table A.8), the non-tradable sector increased in size as well making it the biggest driver to the increase in aggregate unit labour costs pre-crisis.[17] By contrast, the change in ULC in core countries originated mostly in the tradable sector.

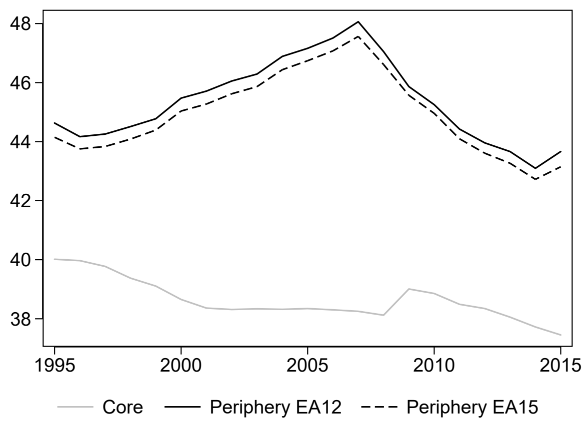
Figure 2 illustrates the shift of ressources to the non-tradable sector in the periphery pre-crisis. It shows the share of the non-tradable sector in total hours worked by country group. This share rose steeply in the periphery from 1995 up to 2008 to then decline until 2015. By contrast, the share declined slightly in core countries over the period. It is worth noting that the real estate is excluded from the market sector, and cannot explain reallocation dynamics in the periphery.

Dispersion in unit labour costs in the Eurozone reflects dispersion in real exchange rates and in labour shares.[18] We study the behaviour of both elements next.

[17]Within the non-tradable sector, the biggest contributor to the rise in ULC was the wholesale and retail sector (sector G). See Appendix Table A.8.

[18]Unit labour costs can be decomposed into the product of the output price and the labour share.

Figure 2 – Share of the (non-housing) non-tradable sector in hours worked, by country group, 1995-2015, in %



Note: author's calculations using Eurostat, OECD and EU KLEMS. See Table 1 for sector classification. This Figure uses the same country classification as in Figure 1. Averages over countries are weighted by the number of hours worked. Non-market sectors (including the real estate sector) are excluded.

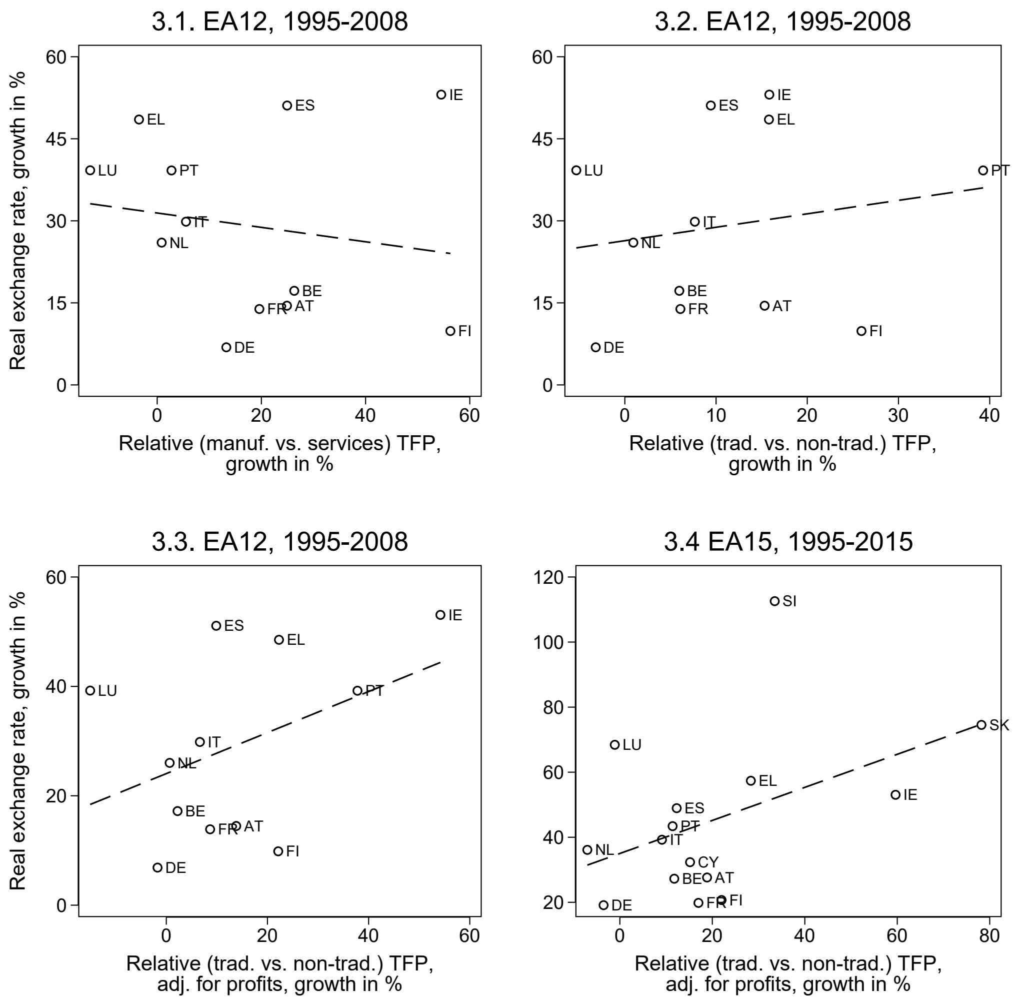
Fact #2: increasing real exchange rates related to faster tradable productivity growth There is already a large evidence of an increase in real exchange rate dispersion in Eurozone countries in the last two decades. The most common approach to understand real exchanges rates is the Balassa-Samuelson model. This model suggests that persistent changes in real exchange rates are positively related to tradable vs. non-tradable productivity growth. Empirical studies usually find little evidence for a Balassa-Samuelson effect (see Berka et al., 2018, for instance). Yet, most studies focus on a definition of tradable sectors excluding services.[19]

Figure 3 shows the growth in real exchange rates over 1995-2008 and 1995-2015 and relates it to tradable vs. non-tradable total factor productivity using different definitions of tradability and total factor productivity. Figure 3.1 confirms that real exchange rate growth is unrelated to manufacturing vs. services TFP growth from KLEMS. When including the most internationally traded service activities in the tradable sector, the Balassa-Samuelson effect is well-alive (Figure 3.2), and even stronger when adjusting TFP for profits (Figure 3.3). The Balassa-Samuelson model holds both for the EA12 over 1995-2007 and the EA15 over 1996-2015 (Figure 3.4).

$ULC = w/LP = pLS$, with w hourly wages, LP labour productivity (real output per hour), p the output deflator and LS the labour share (share of total labour compensation in nominal output). The real exchange rate is the ratio of country i output price and the EA average: $RER = p^i/p^{EA}$.

[19]Using KLEMS data and consumer prices, Berka et al. (2018) for instance find a relation only if controlling for unit labour costs –assuming unit labour costs capture a labour market wedge. Their definition of the tradable sector includes agriculture, mining and manufacturing activities only.

Figure 3 – Real exchange rates and sectoral productivity



Note: author's calculations using Eurostat, OECD and EU KLEMS. The Figure for the EA15 is only displayed over 1995-2015 as European Eastern countries only enter the sample in the mid-2000s. See Appendix 1 for more details on data coverage, and Appendix 2 for more details on TFP measurement.

Table 2 – Profit share changes and within/between decomposition, p.p.

Period	Country group	ΔPS	Within	Between
1995-2008	Core	9.1	5.5	3.6
	Periphery EA12	0.8	0.4	0.4
1995-2015	Core	8.8	8.2	0.6
	Periphery EA12	-1.3	-1.8	0.5
	Periphery EA15	0.4	-0.6	1.0

Source: author's calculations using Eurostat, OECD and EU KLEMS. This Figure uses the same country classification as in Figure 1. Following Melitz and Polanec (2015), the change in the profit share is the sum of within and between effects across the tradable/non-tradable sector, with within effect measured as: $\sum_k \bar{\omega}_{i,k} \Delta PS_{i,k,t}$, and between effect: $\sum_k (P\bar{S}_{i,k} - P\bar{S}_i)\Delta\omega_{i,k,t}$, where $PS_{i,k,t}$ is the profit share in country i and sector k in year t, $\omega_{i,k,t}$ is the sector k's share in country i's gross value added in year t, Δx is the p.p. change in x over 1995-2008 or 1995-1995 and $\bar{x}$ is its average.

These relations are confirmed in a panel regression of real exchange rates on relative tradable productivity growth, including as well country fixed effects (Table A.7 in Appendix). Relative productivity growth always enters with a positive sign and the coefficient always significant at the 5 percent level.

Fact #3: a fall in profits in the periphery relative to core countries Previous studies have already pointed to the heterogeneity in labour share trends across European countries in the last two decades (Gutiérrez and Piton, 2020). This heterogeneity is mirrored in profit share trends. Table 2 shows trends in profit shares by country groups and sub-period. It also shows how much of this aggregate trend is driven by a within-sector change or a reallocation across sectors (between effect), following Melitz and Polanec (2015) decomposition.

This decomposition shows that profits have remained broadly stable in the periphery pre-crisis, and declined slightly post-crisis. By contrast, profits increased substantially in core countries over both periods, in line with previous evidence (De Loecker and Eeckhout, 2017). The rise comes mostly from a within effect, that is an increase in profits in both tradable and non-tradable sectors.[20]

To sum up the main stylized facts characterizing the periphery since 1995: these countries have experienced (i) fast ULC growth coming mostly from the non-tradable sector, (ii) together with a steep rise in real exchanges rates, at least partly driven by a sectoral productivity growth, (ii) and a fall in profits relative to core countries.

[20]Profits have evolved in a similar way in both sectors, see Figure A.2 in Appendix.

2. Decomposing Unit Labour Costs

This section builds a two-sector-small-open-economy model to investigate the impact of economic integration on unit labour costs. It is assumed that this economy is part of a group of countries trading goods and assets among themselves. For convenience, this group of countries is referred to as the 'World'.

2.1. A two-sector small open economy

Firms In each sector, there is a representative firm indexed by $j = T, N$. Firms use homogeneous capital K and labour L, and we have:

$$n_t^T + n_t^N = 1; \quad k_t^T n_t^T + k_t^N n_t^N = k_t \tag{1}$$

where n_t^j is the share of sector j in total employment, k_t the aggregate capital-to-labour ratio, and k_t^j the capital-labour ratio in sector j.

Production functions are Cobb-Douglas: $Y_t^j = A_t^j (K_t^j)^{\alpha^j} (L_t^j)^{(1-\alpha^j)}$ with α^j the capital intensity of sector j, and A_t^j the sector-specific technology. This production function can be written in units per labour: $y_t^j = A_t^j n_t^j (k_t^j)^{\alpha^j}$. Firms are equity-financed and seek to maximize the present discounted value of dividends. Dividends in each period equal revenues net of wages and capital expenditures: $D_t^j = p_t^j Y_t^j - \omega_t L_t^j - q_t I_t^j$ where q_t is the price of investment goods[21] and I_t^j represents gross investment.[22] The representative firm has market power, so its price p_t^j depends on its choice of output: $p_t^j(Y_t^j)$. With perfect foresight, the firms' programme at time t is:

$$\max_{p_t^j} \sum_{s=t}^{\infty} R_{t,s}^{-1} (p_s^j Y_s^j - \omega_s L_s^j - q_s I_s^j) \tag{2}$$

where $R_{t,s}$ is the discount factor.[23] The firm's programme is subject to initial capital K_0^j, the production function, and the constraint that capital input depends on investment and depreciation δ.[24]

The first-order condition for labour yields that the output elasticity is a markup (μ_t^j) over the labour share in output (LS_t^j): $LS_t^j \mu_t^j = 1 - \alpha^j$, where $\mu_t^j = \left(1 + \left(\partial p_t^j / \partial Y_t^j\right)\left(p_t^j / Y_t^j\right)\right)^{-1}$.

[21] Only tradable goods can be invested, with q_t the price of transforming this tradable good into an investment good that can then be used in sector N or T.

[22] Profits differ from dividends and are given by: $\Pi_t^j = p_t^j Y_t^j - \omega_t L_t^j - U_t K_t^j$. Assuming that firms maximize dividends and not profits implies that investment decisions are made by firms. One could imagine an economy where firms rent capital from consumers who directly own it and make investment decisions. Results would carry through.

[23] $R_{t,s} = (\prod_{\tau=t}^{s} R_\tau)/R_t$. We have $R_{t,t} = 1$ and $R_{t,t+1} = R_{t+1}$.

[24] We have $K_{t+1}^j = I_t^j + (1-\delta) K_t^j$ where I_t^j is gross investment in sector j at over period t, and K_t^j is capital input at the begining of time t.

With perfect competition, the price is not affected by the firm's output so $\mu_t^j = 1$.[25] Similarly, the first-order condition for capital implies that the output elasticity is a markup over the capital share in output[26], where capital's cost is calculated with the following user cost of capital:

$$U_t = q_{t-1}R_t - q_t(1-\delta) \quad \text{with} \quad R_t = (1 + r + x_t) \tag{3}$$

As in Blanchard and Giavazzi (2002), the nominal rate of interest in year t is given exogenously and depends on the world interest rate r and a wedge x_t. This wedge x_t could reflect a spread due to the currency risk or cross-border frictions. This wedge falls as economies integrate, and is null as the country converges to a 'world' steady state.[27]

Using the tradable good as the numeraire, first order conditions in the tradable sector yield the equation for the wage ω_t:

$$\omega_t = \left[U_t^{-\alpha^T} \frac{A_t^T}{\mu_t^T} (1-\alpha^T)^{1-\alpha^T} (\alpha^T)^{\alpha^T} \right]^{\frac{1}{1-\alpha^T}} \tag{4}$$

Wages are a decreasing function of the user cost of capital U_t (and thereby a decreasing function of the spread x_t), an increasing function of tradable productivity A_t^T and a decreasing function of a markup μ_t^T.

The representative household The economy is inhabited by a representative household who derives utility V_t at time t from the discounted sum of future consumption:

$$V_t = \sum_{s=t}^{\infty} \beta^{s-t} \ln(c_s) \tag{5}$$

where $\beta = 1/(1+r)$ is the rate of time preference, equal to the world interest rate. $c_s \geq 0$ is consumption per capita at time s. This representative household works, borrows on foreign markets and owns domestic firms. The budget constraint, expressed per unit of labour, is:

$$p_t c_t = \omega_t + d_t + f_{t+1} - (R_t - 1)f_t \tag{6}$$

where c_t is aggregate consumption per capita and p_t the consumer price index in terms of the tradable good. We have $p_t c_t = c_t^T + p_t^N c_t^N$ with c_t^T the consumption of tradables

[25] This monopoly power is usually constant and related to a taste parameter. I here assume that markups are time-varying but take them as exogenous, leaving the question on their determinants open. They could be related to the degree of competition (Blanchard and Giavazzi, 2002; Jaimovich and Floetotto, 2008).

[26] Gross value added in each sector can be decomposed into the shares of labour/capital compensations and profits. It results that standard measures of TFP can diverge from true technology growth if not adjusted for profits, see Appendix A2. This adjustment is a quantitatively significant correction for TFP trends over 1995-2015 in Europe as discussed in the previous Section.

[27] This wedge is increasing in the amount of net foreign liabilities f_t relative to their steady state level f. This assumption ensures stationarity of the model and the independence of its dynamics from the initial conditions (Schmitt-Grohe and Uribe, 2003).

and c_t^N of non-tradables, p_t^N is the relative price of non-tradables. The representative household is endowed with a fixed supply of labour (normalized to be one unit) which he sells at the competitive wage ω_t. He receives the dividends from the firms he owns d_t.[28] Borrowing and lending to foreign countries take place *via* one-period assets. Let f_t be the per capita value of the liabilities at the end of the period $t-1$ (a negative f means a positive asset holding). $(R_t - 1)f_t$ must be reimbursed at the end of period t, possibly by borrowing f_{t+1}. The inter-temporal current account must be balanced ($\lim_{T\to\infty} R_{t,t+T} f_{t+T+1} = 0$).[29]

Aggregate consumption is a CES function of the consumption of both goods:

$$c_t = [\gamma^{\frac{1}{\theta}} c_t^{T\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} c_t^{N\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}} \tag{7}$$

With $\gamma \in [0, 1]$ the share of the non-tradable good, and $\theta > 0$ the elasticity of substitution between the two goods[30]. The consumption price index p_t is a function of the relative price of the non-traded good p_t^N:

$$p_t = [\gamma + (1-\gamma)(p_t^N)^{(1-\theta)}]^{\frac{1}{1-\theta}} \tag{8}$$

Standard first order conditions yield the consumption for each good as a function of aggregate consumption:

$$c_t^T = \gamma \left(\frac{1}{p_t}\right)^{-\theta} c_t \quad \text{and} \quad c_t^N = (1-\gamma)\left(\frac{p_t^N}{p_t}\right)^{-\theta} c_t \tag{9}$$

and the inter-temporal Euler equation:

$$\frac{c_{t+1}}{c_t} = \beta(1 + r + x_{t+1})\frac{p_t}{p_{t+1}} \tag{10}$$

2.2. Economic integration and the dynamics of the non-tradable sector

Using firms' FOCs and writing a log-linear approximation of the relative price of non-tradable goods around the steady state, we get an amended Balassa-Samuelon model:

$$\hat{p}_t^N = \underbrace{\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{A}_t^T - \hat{A}_t^N}_{\text{productivity effect}} - \underbrace{\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{\mu}_t^T - \hat{\mu}_t^N\right]}_{\text{competition effect}} - \underbrace{\left(\frac{\alpha^T-\alpha^N}{1-\alpha^T}\right)\hat{U}_t}_{\substack{\text{effect of}\\ \text{financial integration}}} \tag{11}$$

[28]for simplicity the representative household owns all firms in the domestic economy and there is no foreign direct investment in the model.

[29]Countries can accumulate deficits only when deviating from the steady state, i.e. while converging.

[30]The parameter θ reflects the elasticity of substitution between the tradable and non-tradable goods. Assuming that $\theta < 1$ means that the tradable good and the non-tradable good are complements. However, this elasticity θ differs from the elasticity of substitution among varieties in each sector. Since we assumed each sector faced monopolistic competition, varieties of tradable goods are substitutes, and varieties of non-tradable goods are substitutes.

with $\hat{z}_t$ denoting the growth rate of some variable z between $t-1$ and t. Assuming that the tradable sector is more capital-intensive ($0 < \alpha^N < \alpha^T < 1$), we get a positive impact of $\left(\hat{A}_t^T - \hat{A}_t^N\right)$, a negative impact of $\left(\hat{\mu}_t^T - \hat{\mu}_t^N\right)$ and a negative impact of $\hat{U}_t$ on $\hat{p}_t^N$.

Changes in the relative price reflects the typical Balassa-Samuelson effect, i.e. a positive link between faster productivity growth in the tradable sector and the relative price of the non-tradable good. This effect stems from the fact that productivity gains in the tradable sector leads to a wage increase, which ensures that the marginal cost of tradables remains constant. However, it increases the marginal cost, and hence the relative price of the non-tradable good –the more so that the non-tradable sector is labour-intensive. Similarly, increased competition in the tradable sector, reflected in a decreasing markup (or profits) in this sector relative to the non-tradable sector, also leads to an increase in the relative price of non-tradable goods.

In turn, the impact of a fall in the user cost of capital on the relative price of non-tradables depends on the capital intensity of the tradable relatively to the non-tradable sector $(\alpha^T - \alpha^N)$. Indeed, a fall in the interest rate is matched by a wage increase ensuring that the marginal cost of tradables remains constant. If the non-tradable sector is relatively more labour intensive, this rise in wages will increase the marginal cost, and hence the relative price, of the non-tradable good: because the non-tradable sector is relatively more labour intensive, this rise in wages will not be compensated by the fall in the interest rate in this sector. The underlying logic is the reciprocal to the well-known Stopler-Samuelson theorem: a decrease in the user cost of capital decreases the relative price of the product that uses capital intensively.[31]

In equilibrium, we get that the share of the non-tradable sector in gross value added (s_t^N) follows:

$$s_t^N = f^+(n_t^N) = (1-\gamma)\left(\frac{p_t^N}{p_t}\right)^{1-\theta}\chi_t \tag{12}$$

where $\chi_t = \frac{p_t c_t}{p_t y_t}$ is the consumption rate. The two first terms on the right hand side represent the employment needed to satisfy the relative demand for the non-tradable good. The third product is the consumption rate. Replacing p_t using equation (8), and writing a log-linear approximation of equation (12) around the steady state, we get the dynamics of s_t^N which satisfies:

$$\hat{s}_t^N = (1-\theta)\gamma\hat{p}_t^N + \underbrace{\hat{\chi}_t}_{\text{demand-boom effect}} \tag{13}$$

There are four drivers of this share: the three drivers of the relative price from equation (11), and a fourth driver deriving from the fact that the country can temporarily import capital from abroad and accumulate current account deficits.[32]

[31] This theorem states that a change in relative product prices benefits the factor used intensively in the industry that expands. See Stolper and Samuelson (1941).

[32] Intertemporal current accounts are balanced to respect the no-Ponzi condition.

With $\theta < 1$, thereby assuming that the tradable and non-tradable goods are complements, the increase in the relative price will not be enough to keep the relative spending in non-tradable and tradable goods constant, so employment has to move into the slow-growing less competitive non-tradable sector. This effect is often referred to as a 'Baumol cost disease'.[33] If $\theta = 1$, then the employment share is constant while the relative price changes. With constant employment shares, the faster-growing more competitive tradable sector produces relatively more output over time.

Finally, the fourth driver is the effect of a rising consumption rate $p_t c_t / p_t y_t$. If this ratio temporarily increases, the non-tradable sector expands. An increase in this ratio means that the investment rate is falling or that the country accumulates a current account deficit. Labour moves out of the tradable sector and into the non-tradable sector. This is the case when the anticipated fall in the wedge x_{t+1} fuels consumption growth, increasing the demand for both the non-tradable and tradable goods. However, non-tradable goods must be produced domestically, whereas tradable goods can be imported: the share of the non-tradable sector increases, and the current account balance deteriorates.[34]

Absent differences in capital intensities across sectors ($\alpha^N = \alpha^T$), with perfect competition (μ^T=μ^N=1) and a balanced current account, changes in the share of the non-tradable sector only reflects changes in the relative price: $\hat{n}_t^N = (1-\theta)\gamma(\hat{A}_t^T - \hat{A}_t^N)$.

2.3. Implications for relative unit labour costs

Unit labour costs (ULC) is the ratio of wages to labour productivity. ULC can be written as the product of the price and the aggregate labour share: $ULC_t = p_t LS_t$ with $LS_t = LS_t^N s_t^N + LS_t^T s_t^T$. Writing a log-linear approximation of unit labour costs around the steady state, we get:

$$\widehat{ULC}_t = \widehat{p}_t - \widehat{\mu}_t + \Omega \widehat{s_t^N} \tag{14}$$

with $\Omega_t = \frac{n_t^N - s_t^N}{1 - s_t^N} > 0$, and Ω its steady state value; and with $\widehat{\mu}_t = \widehat{\mu}_t^N n^N + \widehat{\mu}_t n^T$, movements in the aggregate markup.

Let us now assume the 'World' can be represented by a Foreign country. Equations for the Foreign country are symmetric and denoted with a *. Relative ULC ($RULC$) are given by:

$$\widehat{RULC}_t = \widehat{ULC}_t - \widehat{ULC^*}_t = \widehat{RER}_t - \left(\widehat{\mu}_t - \widehat{\mu^*}_t\right) + \Omega\left(\widehat{s_t^N} - \widehat{s_t^{N*}}\right) \tag{15}$$

[33] Baumol (1967) described first this 'cost-disease' showing how in the long term labour reallocates from a progressive manufacturing sector to a stagnant service sector. This effect was then formalized by Ngai and Pissarides (2007).

[34] Since the non-tradable sector expands and is less capital-intensive, the current-account deficit is mostly affected by the consumption rate rather than the investment rate, a conclusion in line with Blanchard and Giavazzi (2002).

with $\widehat{RER}_t = \widehat{p}_t - \widehat{p^*}_t$ the real exchange rate. Relative unit labour costs ($RULC$) are a function of the real exchange rate (RER), relative markups ($\widehat{\mu}_t - \widehat{\mu^*}_t$), and reallocation effects depending on Ω –a function of the steady state difference in labour shares.[35]

Assuming the law of one price holds in the tradable sector of the Euro area[36], and that differences in tradable goods' prices reflect only export specialization[37], the real exchange rate reduces to:

$$\begin{aligned}\widehat{RER}_t = & \underbrace{(1-\gamma)\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)(\hat{A}_t^T - \hat{A}_t^{T*}) - (\hat{A}_t^N - \hat{A}_t^{N*})\right]}_{\text{productivity effect}} \\ & \underbrace{-(1-\gamma)\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)(\hat{\mu}_t^T - \hat{\mu}_t^{T*}) - (\hat{\mu}_t^N - \hat{\mu}_t^{N*})\right] + (1-2\gamma)(\widehat{\mu^T}_t - \widehat{\mu^{T*}}_t)}_{\text{competition effect}} \\ & \underbrace{-(1-\gamma)\left[\left(\frac{\alpha^T-\alpha^N}{1-\alpha^T}\right)(\hat{U}_t - \hat{U}_t^*)\right]}_{\substack{\text{effect of} \\ \text{financial integration}}} \qquad (16)\end{aligned}$$

This equation motivates the main empirical specification for Fact #2 in Section 1. Plugging equation (16) into equation (15) gives the following expression for relative unit labour costs:

$$\begin{aligned}\widehat{RULC}_t &= \left(1 + \Omega(1-\theta)\frac{\gamma}{1-\gamma}\right) RER_t - (\widehat{\mu}_t - \widehat{\mu}_t^*) + \Omega\,(\hat{\chi}_t - \hat{\chi}_t^*) \\ &= RPROD_t + RCOMP_t + RFIN_t + RDEM_t \qquad (17)\end{aligned}$$

[35]See Model Appendix for a full specification of Ω.

[36]The assumption the Law of One Price (LOP) holds for the tradable sector is a common one in the traditional Balassa-Samuelson framework. This hypothesis can hold for the tradable sector in the Euro area, while clearly it is not the case for non-tradable goods. For example, A. Cavallo (2015) show, using data on Zara –a highly tradable industry– before and after the adoption of the Euro in Latvia, that Latvian prices converged almost instantaneously with prices in the rest of the Euro area. The percentage of goods with nearly identical prices in Latvia and Germany increased from 6 percent before to 89 percent after the adoption of the Euro. Other recent work show empirical evidence of a substantial convergence in price levels in the case of tradable goods (see, among others, Estrada et al., 2013).

[37]Terms of trade capture export specialization (i.e. differences in the composition of exported traded goods across countries) but not a difference in traded goods' consumer prices across countries (countries consume similar traded goods baskets, with similar prices because of the LOP). See Appendix A.4 for a discussion of this assumption and more details on how I get to this result.

$$
\begin{aligned}
\text{with } RPROD_t =& [(1-\gamma)+\Omega(1-\theta)\gamma]\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)(\hat{A}_t^T-\hat{A}_t^{T*})-(\hat{A}_t^N-\hat{A}_t^{N*})\right]\\
RCOMP_t =& -[(1-\gamma)+\Omega(1-\theta)\gamma]\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)(\hat{\mu}_t^T-\hat{\mu}_t^{T*})-(\hat{\mu}_t^N-\hat{\mu}_t^{N*})\right.\\
&\left.-(1-2\gamma)(\widehat{\mu^T}_t-\widehat{\mu^{T*}}_t)\right]-(\widehat{\mu}_t-\widehat{\mu^*}_t)\\
RFIN_t =& -[(1-\gamma)+\Omega(1-\theta)\gamma]\left(\frac{\alpha^T-\alpha^N}{1-\alpha^T}\right)(\hat{U}_t-\hat{U^*}_t)\\
RDEM_t =& \Omega(\hat{\chi}_t-\hat{\chi^*}_t)
\end{aligned}
$$

The dynamics of relative unit labour costs have four drivers. The first three drivers, (i) $RPROD$, (ii) $RCOMP$, (iii) $RFIN$, affect $RULC$ through the real exchange rate. $RPROD$ reflects the typical Balassa-Samuelson effect, $RCOMP$ and $RFIN$ its augmented version. These movements in real exchange rates can also fuel a reallocation of resources across sectors if traded and non-traded goods are complements, and thereby amplify the effect of the real exchange rate on $RULC$. A temporary demand-boom, the (iv) $RDEM$ effect, can also lead to a reallocation of resources across sectors, affecting $RULC$.

Two points are worth noting. The first one is that the reallocation effect is at play only if sectors have different labour shares: assuming the non-tradable sector has a higher labour share, an increase in the size of the non-tradable sector will increase the aggregate labour share by a composition effect. Assuming sectors have similar labour shares in steady state ($\Omega = 0$) shuts this reallocation effect. Secondly, the competitiveness effect, (ii) $RCOMP$ does not only affect $RULC$ through the real exchange rate but also directly by affecting the aggregate labour share.

The evidence from Section 1 provides some intuitions on the effects at play in the periphery relative to core countries. Because labour shares levels and trends are very similar across sectors in both groups of countries, $RCOMP$ and $RFIN$ should have a marginal effect on RER, and have little contribution to the reallocation of resources across sectors. Similarly, the $RDEM$ effect should only be marginal. By comparison, faster tradable productivity growth (the $RPROD$ effect) together with the relative fall in aggregate profits ($RCOMP$) should be important drivers of the rise in ULC in the periphery relative to core countries. Section 3 formally takes this decomposition to the data to confirm those intuitions.

2.4. Heterogeneous returns to capital

So far, it has been assumed that firms in both sectors face the same marginal cost of capital, implying that capital is homogeneous and moves freely across sectors. However, the recent literature has emphasized the role of financial frictions and heterogenous returns to capital in capital misallocation, such that that capital inflows have benefited most the non-tradable sector (Reis, 2013), or the least productive firms (Gopinath et al., 2017) by favouring technological adoption for firms with an easier access to credit (Midrigan and

Xu, 2014). We capture this misallocation effect through different changes in the user cost of capital across sectors.

Let us now assume that capital is composed of heterogeneous assets: structures, information and communication technologies (ICT) and other equipment, but also intellectual property products.[38] Each asset k receives a different price U_t^k but moves freely across sectors and receives the same price everywhere. Differences in user costs reflect differences in the price of assets as well as differences in depreciation rates across assets:

$$\begin{aligned} U_t^k &= q_{t-1}^k R_t - q_t^k (1-\delta^k) \\ &= q_{t-1}^k \left[(R_t - 1) + \delta^k \left(1 + \hat{q}_t^k\right) - \hat{q}_t^k \right] \end{aligned} \tag{18}$$

Computer and information equipment or IPP products are short-lived (meaning it has a high depreciation rate δ^k) and their price q_t^k tends to decrease: unit user costs for this type of assets will be high. On the contrary, very low depreciation rates together with strong increases in the price of construction (high capital gains) lead to very low user costs of capital for such assets.

In each sector $j = T, N$, the composition of capital differs: the non-tradable sector uses more buildings, the tradable sector uses more ICT or IPP assets. In turn, in each sub-sector i of sector j, the composition of capital differs. The user cost at the sector-level is a weighted average of user costs at the sub-sector level, which are in turn an average of the user costs of each assets weighted by the share of the asset in total capital compensations of the sub-sector. Given that the share of each type of assets differs in each sub-sector, user costs of capital differs across sectors.

Changes in sectoral user costs, $\hat{U}_t^j$, now reflect the growth in the user cost for the total economy $\hat{U}_t$ plus a reallocation term $\hat{\zeta}_t^j$ reflecting the change in the composition of assets between sectors and within each sector j (between sub-sectors i):

$$\hat{U}_t^j = \hat{U}_t + \hat{\zeta}_t^j \tag{19}$$

$$\text{with} \quad \hat{U}_t = \sum_k \phi_t^k \hat{U}_t^k \quad \text{and} \quad \hat{\zeta}_t^j = \sum_i \sum_k \Bigg[\underbrace{(\phi_t^{k,j,i} - \phi_t^{k,j})}_{\text{realloc. within sector } j} + \underbrace{(\phi_t^{k,j} - \phi_t^{k})}_{\text{realloc. across sectors}} \Bigg] \hat{U}_t^k$$

with $\phi_t^k = \frac{U_t^k K_t^k}{\sum_k U_t^k K_t^k}$ the share of asset k in total capital compensations, $\phi_t^{k,j} = \frac{U_t^k K_t^{k,j}}{\sum_k U_t^k K_t^{k,j}}$ the share of asset k in capital compensations of sector j, $\phi_t^{k,j,i} = \frac{U_t^k K_t^{k,j,i}}{\sum_k U_t^k K_t^{k,j,i}}$ the share of asset k in capital compensations of sub-sector i. An increasing reallocation term indicates a change in the composition of capital with an increasing share of assets with a high user cost of capital. Since user costs of capital are higher for technological assets (ICT equipment and IPP), whereas the user cost of buildings and structures is low, an increasing

[38] I use a classification in 7 assets: cultivated assets, residential structures, dwellings, intellectual property products, ICT equipment, other machinery and transport.

reallocation term indicates that, in sector j, there is a composition shift towards relatively more technological assets.

As in Jorgenson (1995), in EU KLEMS, and most of the literature on growth accounting, to take into account the widely different marginal products from the heterogeneous stock of assets, sectoral capital inputs (K'^j_t) are now defined as a translog quantity index of individual assets:[39]

$$\hat{K'}^j_t = \sum_{k,i \in j} \phi^{k,i,j}_t \hat{K}^{k,i,j}_t = \hat{K}^j_t + \hat{Q}^j_t \tag{20}$$

with Q^j_t an index of composition of capital: an increasing share of assets with a high user cost of capital means an increasing flow of productive services from capital. With this new measure of capital input in each sector, TFP becomes: $\hat{A}^j_t = \hat{Y}^j_t - (1-\alpha^j)\hat{L}^j_t - \alpha^j \hat{K'}^j_t$.[40]

Replacing the new expression of the user costs in equation (17), we get a a fifth driver, capital misallocation ($RMISALLOC$), to the drivers of $RULC$ (the other ones being unchanged):

$$\widehat{RULC}_t = RPROD_t + RCOMP_t + RFIN_t + RMISALLOC_t + RDEM_t \tag{21}$$
$$\text{with } MISALLOC_t = -\left[(1-\gamma) + \Omega(1-\theta)\gamma\right]\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\alpha^T\hat{\zeta}^T_t - \alpha^N\hat{\zeta}^N_t\right]$$

Assuming no differences in labour shares across sectors, such that $\alpha_N = \alpha_T = \alpha$ and $\mu^N = \mu^T = \mu$, the expression reduces to:

$$\begin{aligned} \widehat{RULC}_t &= RPROD_t + RCOMP_t + RMISALLOC_t \\ \text{with } RPROD_t &= (1-\gamma)\left[(\hat{A}^T_t - \hat{A}^{T*}_t) - (\hat{A}^N_t - \hat{A}^{N*}_t)\right] \\ RCOMP_t &= -\left[1-(1-\gamma)(1-2\gamma)\right](\hat{\mu}_t - \widehat{\mu^*}_t) \\ RMISALLOC_t &= -(1-\gamma)\alpha\left[\hat{\zeta}^T_t - \hat{\zeta}^{T*}_t - (\hat{\zeta}^N_t - \hat{\zeta}^{N*}_t)\right] \end{aligned} \tag{22}$$

3. Quantification

This section brings the accounting decomposition of unit labour costs proposed in equation (21) to the data.

Calibration The first parameter to calibrate is the share of tradables in total consumption: γ. Since there are no production networks in the model, γ corresponds to a 'theoretical'

[39] Capital services are a direct measure of the flow of productive services from capital assets rather than a measure of the stock of those assets.

[40] EU KLEMS measures labour services in a similar way to capital services, thereby assuming differences in sector-composition of labour skills. Unfortunately, labour services series are not available before 2008 for most countries. However, this heterogeneity should be translated in an increased dispersion in hourly wages across sectors. I show in the Appendix Figure A.5 that capital returns dispersion is much stronger that the dispersion in hourly wages –suggesting a minor role for labour quality.

tradable consumption and can be measured using value added data (Herrendorf et al., 2014).[41] Tradable consumption represents 48% of total consumption on average for the 15 EA countries over 1995-2015, so I set $\gamma = 0.5$.

The second one is the elasticity of substitution between the two sectors. This elasticity, θ is set to 0.7 which is a standard estimate from previous literature (Berka et al., 2018; Benigno and Thoenissen, 2008). For example, Acemoglu and Guerrieri (2008) find an elasticity of substitution of 0.76 between capital-intensive and labour-intensive goods, using a classification which is very close to my tradable/non-tradable classification. Herrendorf et al. (2014) also find that, using the "consumption in value added" approach, the estimate is very low and close to zero.

I calibrate the functional form of $x_t(f_t, f)$, determining the dynamics of χ_t, so as to reproduce the volatility of the consumption-to-GDP ratio from the data, and take the dynamics of productivity, markups, user costs directly from the data.

Finally, I compare results for three different specifications concerning capital intensities and markups (see Appendix A.4 for a detailed description of the associated $RULC$ expressions and calibration):

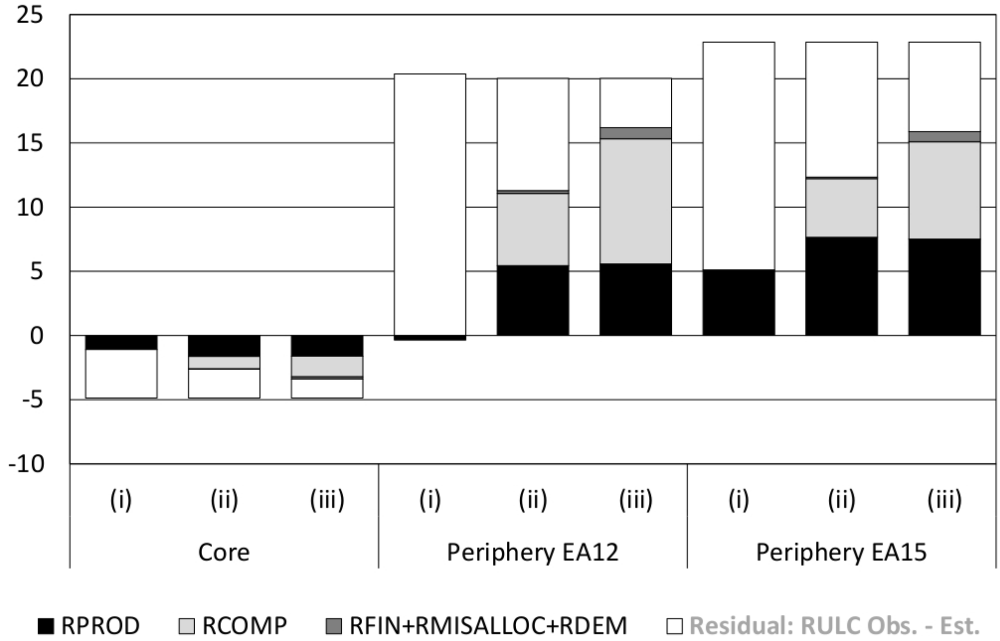
(i) I first focus on the case of perfect competition ($\mu^N = \mu^T = 1$) with similar capital intensities and user costs across sectors, so $RULC$ depends only on the productivity effect $RPROD$ in equation (22). I also assume all services are non-tradables. This decomposition is similar to standard assumptions in previous literature. I set capital intensity to its total economy average, $\alpha_N = \alpha_T = \alpha = 0.22$.

(ii) I then focus on the full specification from equation (21), with differences in capital intensity and sector-specific time-varying markups. Capital intensities are set to their average value in the data for the 15 EA countries over 1995-2015, that is $\alpha_N = 0.20$ and $\alpha_T = 0.25$.[42] Markups' dynamics directly come from the data. Appendix A.4 provides a detailed discussion on the measure of capital intensities and markups.

[41] I use the assumption made in the model that all non-tradable production must be consumed in each period. A strong limitation with this assumption is that the non-tradable sector includes construction activities, which are largely used for investment and not only for consumption. I thus exclude this sector. With these assumptions, tradable consumption can be deduced by retrenching non-tradable gross value added from total final expenditure net of taxes less subsidies on products. Tradable consumption should also be equal to gross value added minus total investment and minus the tradable balance in the tradable sector. These two approaches of tradable consumption give very similar measures (they differ by +/- 5%).

[42] Similarly, steady states values of profits are set to their average value in the data for the 15 EA countries over 1995-2015 ($\mu^N = 1.1$ and $\mu^T = 1.2$, implying a steady state labour share of $LS = 69\%$). These values are needed to calibrate Ω. See Appendix A.4 for a more detailed model solution. While $\mu^T = 1.2$ is standard in the literature, $\mu^N = 1.1$ is less so and usually set to 1.4 (see, for instance, Eggertsson et al., 2014). The higher markup in the literature comes from the different sector classification, and in particular with the inclusion of real estate in the non-tradable sector. Real estate is excluded from the analysis here (see footnote 11).

Figure 4 – ULC decomposition, by country group and calibration choices, deviation from Euroz



Note: Averages over country groups are weighted by GDP in euros. This Figure uses the same country classification as in Figure 1.
It shows a decomposition of relative unit labour costs comparing the three different calibrations. The first one (i) considers *RULC* is a function of sectoral producitivity only, and takes a manuf. vs. services productivity measure unadjusted for profits. Calibration (ii) uses the full model specified in equation (21) of the paper. Finally, calibration (iii) estimates a reduced model with no sector heterogeneity that is summarized in equation (22) of the paper. The gap between the observed *RULC* in the data and its estimated counterpart from the model is referred to as the 'residual'.

(iii) Finally, because differences in capital intensities and profits across sectors are small, I look at the decomposition in equation (22) where sectors have similar labour shares. Assuming labour shares are similar across sectors shuts the reallocation effect (Ω=0) and *RULC* depends only on real exchange rates and markups. In this case I assume as in (i) that $\alpha_N = \alpha_T = \alpha = 0.22$. Markups are still time-varying but similar across sectors in each country; I take markups' dynamics from the data.

Results I first compare results for a decomposition of *RULC* –unit labour costs relative to the EA15 average, over the full period (1995-2015) by country group and calibration choices described above. Results are presented in Figure 4. The gap between the observed *RULC* in the data and its estimated counterpart from the model is referred to as the 'residual' –and shown through the white boxes.

The first estimation results use calibration (i), the standard one in previous literature, with perfect competition, no differences in capital intensities across sectors, and using the standard sector classification considering all services as non-tradables. *RULC* are only affected by changes in real exchange rates; real exchange rates depend only on sectoral productivities. This specification results in a very large residual, with a contribution of productivity (in black) close to zero in the periphery. This is consistent with the empirical fact shown in Section 1, that there is no evidence for a Balassa-Samuelson effect if measuring sectoral productivity differences using manufacturing vs. service productivities. This observation was already put forward in Berka et al. (2018). The authors attribute all residual to the effects of terms of trade, and show how terms of trade dynamics are related to a labour market wedge. They conclude that *RULC* is a good proxy for the labour market wedge. Appendix 4.2 shows how terms of trade could indeed drive the residual.[43]

However, this residual shrinks when I use the new measure of tradable vs. non-tradable productivity –including internationally traded services in the tradable sector and adjusting it for profits. The contribution of the productivity effect is about one-third of the total change in observed *RULC* in each country group. This number remains unchanged whether we account or not for differences across sectors in capital intensities and markups (in calibration (ii) or (ii)). This is again consistent with evidence in Section 1 that the Balassa-Samuelson effect is well-alive if including services in the traded sector and adjusting the measure of TFP for profits.

The contribution of markups ranges from 20% to 50% of the total change in observed *RULC*, and is a third on average. This contribution is related to movements in profit shares over the period: markups are positively related to profits ($\mu_t = 1/(1 - PS_t)$). As relative profits fall in the periphery ($\widehat{\mu}_t - \widehat{\mu^*}_t < 0$), the share of labour increases resulting in increasing *RULC*. The 8p.p. relative fall in the profit share shown in Section 1 maps one-to-one to the 8p.p. positive contribution to the rise in ULC in calibration (iii). In calibration (ii), as I allow for sector-specific markups, this fall is slightly compensated by the fact that relative profits declined less in the tradable sector than in the non-tradable sector in the periphery (see Figure A.2 in Appendix), pushing down on the rise in real exchange rates.

The contributions of the three other effects (financial integration, demand-boom and misallocation) are small (less than 5% of the total change in observed *RULC*); the bulk of it being the misallocation effect. This misallocation effect reflect difference in user costs of capital across sectors, with a faster increase in user costs in the non-tradable than in the non-tradable sector ($\alpha^T \hat{\zeta}_t^T - \alpha^N \hat{\zeta}_t^N < 0$) in the periphery (see Appendix Figure A.5). This increase contributes to rising real exchange rates, and thereby to rising *RULC*. This fact confirms previous evidence showing how financial frictions –proxied by differences in user costs across sectors– have contributed to the expansion of the non-tradable sector

[43]Another element that could explain the positive contribution of the residual is production networks. If non-tradable services are used in the production of tradable goods, an increase in non-tradable prices could also drive an increase in tradable prices, reinforcing the increase in real exchange rates and thereby in *RULC*.

Table 3 – *RULC* decomposition and comparison with observed *RULC*, by period and country group

Period	Contribution of:	Core	Periphery EA12	Periphery EA15
1995-2008	*RPROD*	-1.3	5.6	-
	RCOMP	-1.8	8.1	-
	RMISALLOC	-0.7	3.2	-
	Residual (Obs. - Est.)	-4.2	18.6	-
	Observed *RULC*	-7.9	35.6	-
1995-2015	*RPROD*	-1.6	5.6	7.5
	RCOMP	-1.6	9.8	7.6
	RMISALLOC	-0.2	0.9	0.8
	Residual (Obs. - Est.)	-1.5	3.8	7.0
	Observed *RULC*	-4.9	20.0	22.8

Note: Averages over country groups are weighted by GDP in euros. This Table uses the same country classification as in Figure 1.
It shows a decomposition of relative unit labour costs using equation (22) in the paper, under calibration (iii) –with no differences in sectoral labour shares. The gap between the observed *RULC* in the data and its estimated counterpart from the model is referred to as the 'residual'. In the periphery of the EA15, sectoral productivity (*RPROD*) contributed by 7.5p.p. to the 23% growth in unit labour costs, so explained about a third (7.5/23=33%) of the ULC growth pre-crisis.

(Reis, 2013).

The small contribution of the financial effect can be surprising given the strong decline in interest rates in the periphery over 1995-2015.[44] However, this effects depends on the difference in capital intensities between the tradable and non-tradable sector ($\alpha^T - \alpha^N$); the difference is small ($0.25-0.20 = 0.05$) such that the contribution is not significant. As for the demand effect, the consumption-to-GDP ratio affects *RULC* only by reallocating ressources to the non-tradable sector. This effect depends on Ω, which also depends on sector heterogeneity, this time in labour shares (capital intensities and steady state markups) across sectors. Once again, sector heterogeneity is small ($\Omega = 0.1$), so the demand effect contributed only little to the change in *RULC*. For both effects, the level of heterogeneity would have to be substantially different from the data for them to become significant.

Table 3 presents results in more details for each country group over the two sub-periods. This table focuses on specification (iii), abstracting from reallocation effects (i.e. sector

[44] Together with the creation of the monetary union, financial integration have led to a convergence of nominal long-term interest rates among euro area countries to about 4% around the mid-2000s. In peripheral economies, interest rates declined by 7.6 p.p. on average over 1995-2008, while interest rates declined by only 3.7 p.p. on average in core countries. See Figure A.1 in Appendix.

heterogeneity) as their contribution is small. In this case, $RULC$ only depend on real exchange rates and aggregate markups. These results confirm that, over 1995-2015, in each country group, sectoral productivity and markups contribute each to about one-third of the rise in ULC, and the residual (the labour wegde) to the last third. Pre-crisis, both the misallocation effect and the residual have stronger contributions, respectively 50% and 8% of the total change in $RULC$ in the periphery. The productivity and competition effects are still significant (they explain respectively about 20% of the change in $RULC$).

Finally, Table A.10 in Appendix presents results by country. It is worth noting that there is a lot of heterogeneity in the respective contributions among countries, with the productivity effect contributing most to ULC growth in Portugal and Ireland, and the residual being the largest in Greece and Spain pre-crisis.

4. Concluding Remarks

This paper investigates the drivers of ULC divergence among Eurozone Member States. It shows that faster tradable productivity growth in the periphery, and thereby real convergence, contributed to a increasing real exchange rates and unit labour costs. This effect explains one-third of the ULC increase in the periphery between 1995 and 2015. Over the period, the other most (and equally) important determinant of ULC is a product market wedge.

The previous literature has focused primarily on labour markets or financial frictions to understand dynamics in ULC. European policy-makers have associated rising ULC with rising macroeconomic imbalance and monitor ULC in the European Macroeconomic Imbalances Procedure.[45] Understanding how they are related to productivity is therefore important. If faster productivity growth leads to a rise in ULC, any effort towards real convergence among Member States in the future could be associated with a resurgence ULC divergence. Yet, the fact that rising ULCs in the periphery might be associated with tradable productivity gains questions the idea that such imbalances are necessarily a 'bad' outcome. This conclusion calls for further research on implications of ULC divergence depending on its source.

[45]The macroeconomic imbalance procedure (MIP) "aims to identify, prevent and address the emergence of potentially harmful macroeconomic imbalances that could adversely affect economic stability in a particular EU country, the euro area, or the EU as a whole." It was introduced in 2011. Under the MIP, when a country is found to have an excessive imbalance, it is subject to enhanced monitoring and can also face sanctions. The growth in unit labour costs is considered excessive when the 3-year percentage change in nominal unit labour cost exceeds 9%. See https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/macroeconomic-imbalances-procedure/dealing-macroeconomic-imbalances_en (accessed last on January 30, 2021).

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