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## Do Unit Labor Costs Matter? A Decomposition Exercise on European Data

Sophie Piton

### Highlights

- Since the introduction of the Euro, unit labour costs increased by much faster in the periphery than in core countries. This paper asks why this happened. Is it the result of distortionary public spending, or the consequence of economic integration?
- It builds a model of a small open economy with a tradable and a non-tradable sector. This model provides a decomposition of unit labour costs growth into various effects of economic integration (both trade and financial integration) and policy intervention.
- Using a novel dataset, the contribution of each effect of economic integration and policy intervention are quantified for 12 countries of the Euro area from 1995 to 2014.
- Results show that trade and financial integration is a significant driver of unit labor costs divergence. On the contrary, distortionary public spending plays a minor role.



## ■ Abstract

From the introduction of the Euro up to the 2008 global financial crisis, macroeconomic imbalances widened among Member States. This divergence took the form of strong differences in the dynamics of unit labour costs. This paper asks why this happened. Is it the result of distortionary public spending, or the consequence of economic integration? To answer this question, this paper builds a theoretical framework that is able to provide a decomposition of unit labour costs growth into various effects of economic integration and policy intervention. Using a novel dataset, it then measures the contribution of each effect to the dynamics of unit labour costs in 12 countries of the Euro area from 1995 to 2014. Results show that trade and financial integration are significant drivers of unit labour costs divergence. Before the global financial crisis, in Greece and Portugal for example, trade and financial integration explain up to 30% of the increase in unit labour costs relative to core countries. On the contrary, distortionary public spending plays a minor role. These results suggest that, in peripheral economies, increasing unit labour costs reflect more the process of real convergence than fiscal profligacy.

## ■ Keywords

Economic Integration, Productivity, Structural Change, Non-tradable Sector, Macroeconomic Imbalances, Capital Flows, Growth Accounting, Euro Area.

## ■ JEL

E32, E65, F41, F45, O33, O41, O47, O52.

## Working Paper ■



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CEPII  
20, avenue de Séur  
TSA 10726  
75334 Paris Cedex 07  
+33 1 53 68 55 00  
[www.cepii.fr](http://www.cepii.fr)  
Press contact: [presse@cepii.fr](mailto:presse@cepii.fr)

RESEARCH AND EXPERTISE  
ON THE WORLD ECONOMY



## Do Unit Labor Costs Matter? A Decomposition Exercise on European Data

Sophie Piton\*  
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\*Paris School of Economics – University Paris 1 Panthéon Sorbonne & CEPII. Email: [sophie.piton@psemail.eu](mailto:sophie.piton@psemail.eu). Website: <https://sites.google.com/site/sophiepiton>.

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## 1. Introduction

From the introduction of the Euro in 1999 up to the 2008 global financial crisis, macroeconomic imbalances widened among Member States. These imbalances were first interpreted as reflecting a catch-up and convergence process of the poorest countries of the area.<sup>1</sup> Both economists and policymakers challenged this view in the aftermath of the 2008 recession. Imbalances were then pointed out as reflecting a broader competitiveness problem in the 'sinful periphery' compared to the 'virtuous core', due in particular to distortionary public spending.<sup>2</sup> And this eroding competitiveness could have participated to the Euro crisis ([Shambaugh, 2012](#)). Since then, the dynamics of unit labour costs has been the subject of considerable attention. In December 2011, the 'six pack' introduced a new surveillance procedure of macroeconomic imbalances at the European level.<sup>3</sup> In this procedure, the growth in unit labour costs is considered as an early warning of "macroeconomic imbalances and competitiveness losses".<sup>4</sup> In June 2015 the European Commission advised the creation of National Productivity Boards in charge of assessing whether wages are evolving in line with productivity.

Figure 1 shows unit labour costs (ULCs, reflecting how wages evolve relative to labour productivity) in the periphery relative to core countries, from 1995 to 2014. ULCs increased by 26% more in the periphery than in core countries from 1995 up to the global financial crisis of 2007.<sup>5</sup> What are the main contributors behind this increase in the periphery: is it distortionary policy intervention, or the consequence of economic integration? To answer, this paper provides a decomposition of unit labour costs growth into various effects of economic integration, and measures each effect using a novel dataset. This is, to my knowledge, the first paper to confront and quantify various views on the reasons for diverging competitiveness since the adoption of the Euro. Results show that trade and financial integration are significant drivers of the divergence in unit labour costs. This result is robust even when taking into account the effect of distortionary public spending that could have reduced competitiveness, and which play only little role. These results suggest that, in peripheral economies, increasing unit labour costs reflect more the process of real convergence than fiscal profligacy.

This paper starts by building a model of a small open economy composed of a tradable and a non-tradable sector. Economic integration takes the form of three exogenous shocks in this peripheral economy: fast tradable productivity growth, increased competition in the tradable sector, and a decreasing interest rate spread. Four channels are identified through which economic integration leads to an expansion of the non-tradable sector and an increase in unit labour costs in the periphery relative to core countries. The first three ones are long-run price effects and depend only on technological conditions: the productivity (i), competition (ii) and financial integration (iii) effects. The fourth effect is the temporary effect of the demand-boom (iv) on the size of the non-tradable sector.

<sup>1</sup>In their seminal paper of 2002, [Blanchard and Giavazzi](#) showed 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. Deficits would be reduced as countries would converge, so there was no need to worry about them. As such, Ingram had already pointed out in 1973 that "the traditional concept of a deficit or a surplus in a member nation's balance of payments becomes 'blurred'" ([Ingram, 1973](#), p.15).

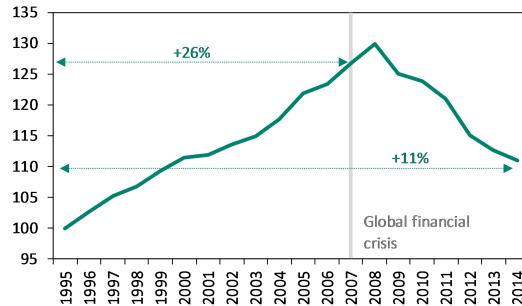
<sup>2</sup>See, for instance, [Sinn \(2014b,a\)](#). In 2014, Hans Werner Sinn argued that the "The lack of competitiveness was brought about by the euro itself. The announcement of irrevocable commitment to it at the Madrid Summit of December 1995, three years before its actual introduction in 1999, caused interest rates to converge, making cheap credit available to southern Europe and Ireland. [...] In Greece and Portugal, the government sectors used the credit to raise public sector wages and hire more public employees, while in Spain and Ireland investors borrowed to buy real estate and build houses." ([Sinn, 2014a](#), p.1-2).

<sup>3</sup>The six pack (a legislative package of five regulations and one directive entered into force in December 2011) introduces a new surveillance mechanism for the prevention and correction of macroeconomic imbalances. This Macroeconomic Imbalance Procedure (MIP) is composed of both a preventive arm and a corrective arm.

<sup>4</sup>Unit labour costs are part of a scoreboard of indicators. The growth in unit labour costs is considered excessive when the 3-year percentage change in nominal unit labour cost exceeds 9% for euro area countries and 12% for non-euro area countries. A description of the scoreboard is available here: [https://ec.europa.eu/info/sites/info/files/swp\\_scoreboard\\_08\\_11\\_2011\\_en.pdf](https://ec.europa.eu/info/sites/info/files/swp_scoreboard_08_11_2011_en.pdf) (accessed last on April 23, 2018).

<sup>5</sup>Unit labour costs were initially lower in peripheral economies than in core countries: in 1995, they were 20% lower in peripheral economies (OECD).

**Figure 1** – Nominal unit labour costs (total labour costs to real output) in the periphery, deviation from core countries, 1995-2014 (index 1995=100)



Source: author's calculations using Eurostat.

Note: the periphery includes the four countries of the EA12 (countries which adopted the euro in 2001 and before) with the lowest GDP per capita (at purchasing power standards) in 1995: Greece, Spain, Ireland and Portugal. Core countries are Austria, Belgium, Germany, Finland, France, Italy, Luxembourg and the Netherlands. Group averages weighted by gross value added at current prices. Data start in 1997 for Belgium and 1998 for Ireland.

As long as real integration boosts productivity in the tradable sector of peripheral economies, the relative price of non-tradables increases. This productivity effect, also well-known as Balassa-Samuelson effect, is reinforced if tradable market integration also increases competition in the tradable sector (the competition effect). 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 (financial integration effect). If there is a small elasticity of substitution between traded and non-traded goods—that is traded and non-traded goods are complements—those three long-run effects lead to the expansion of the share of employment in the non-tradable sector.<sup>6</sup> On top of these three long-run effects, financial integration can also fuel a transitory demand-boom. The increasing demand for tradable can be satisfied through imports, but the increase in non-tradable consumption requires a shift of productive resources toward this sector at the expenses of the tradable sector.

Two extensions to the model are then presented. A first one explores the effects of financial integration in presence of financial frictions. Financial frictions are modeled through heterogeneous user costs of capital across sectors, and within sectors among sub-sectors. If the less efficient non-tradable sectors benefits more from the capital inflows than the tradable sectors, financial integration reinforces the increase in the relative price and size of the non-tradable sector. This extension thus presents a fifth effect, the misallocation effect, capturing misallocation of capital across the non-tradable and tradable sector, within the non-tradable sector, and within the tradable sector. The second extension explores the effects of distortionary public spending (a sixth effect). Distortionary public spending takes two form: increased government expenditures on non-tradables, and increased civil servant wages leading to an increased wage gap between the tradable and non-tradable sector. Both forms reinforce the increase in the relative price and size of the non-tradable sector.

Using a novel dataset for 12 countries of the Euro area, I then provide new stylized facts on the dynamics of the non-tradable sector and the main dimensions of economic integration from 1995 to 2014. The share of the non-tradable sector in employment rose steeply in the 'periphery' of the Euro area over 1995-2007 (+4.8p.p.), while this share remained stable in the so-called 'core' countries.<sup>7</sup> The increase in peripheral

<sup>6</sup>Baumol (1967) suggests that fast productivity growth in manufacturing activities fuels an increase in wages. This cost increase cannot be offset in services activities since this sector faces slower productivity growth. It thus leads to a relative (service to manufacturing) price increase. As long as the relative output of service and manufacturing activities are maintained, an increasing proportion of the labour force must be channeled into these activities.

<sup>7</sup>Discussion on the composition of the tradable and non-tradable sector is presented in Section 3. The tradable sector includes

countries is significant even when the housing sector (construction and real estate) is excluded from the sample. This expansion happened simultaneously to a steep rise in TFP in the tradable sector relative to the non-tradable sector, increasing markups and profit shares in both sectors of the economy –but less in peripheral than in core countries, a collapse in the long-term interest rate, rising user costs of capital in the non-tradable relative to the tradable sector, an increased share of the public sector and a relative increase in civil servant wages.

For realistic parameter values, the model generates dynamics of unit labour costs that are consistent with the European data. It is mostly supply-side effects of economic integration that are at play to explain the strong divergence in unit labour costs between the core and the periphery over 1995–2014. This is robust even when taking into account the effect of policy interventions that could have led to a rising demand for non-tradables or increased wages in the non-tradable sector relative to the tradable sector. Overall, before the global financial crisis, in Greece and Portugal for example, the biggest driver is productivity which explains resp. 30% and 22% of ULCs growth relative to core countries (excl. construction and real estate). Competition comes next explaining resp. 12% and 25%, followed by misallocation (resp. 8% and 6%) and financial integration (resp. 2% and 1%).

This paper relates to the work by [Blanchard and Giavazzi \(2002\)](#) which synthesizes both the real and financial effects of economic integration on the current account in a single framework. However, the authors develop a model of a small open economy with a single sector only, and do not look at the potential implications for the dynamics of the non-tradable sector and unit labour costs. There is already a large literature on the real effects of economic integration on the dynamics of the non-tradable price building on the standard Balassa-Samuelson effect. More particularly, [De Gregorio et al. \(1994\)](#) show that faster growth of total factor productivity in the tradable goods sector is the main contributor to higher non-tradables inflation in OECD countries over 1970–1985. [Estrada et al. \(2013\)](#) challenge this idea and suggest that the Balassa-Samuelson effect cannot be the sole explanation for the dynamics of the relative price in the periphery since the Euro's inception. However, the authors proxy the Balassa-Samuelson effect by the productivity of manufacturing relative to service activities. This paper shows that some service activities are now highly tradable with strong productivity growth rates. When excluding these activities from the tradable sector, the Balassa-Samuelson is underestimated. The Balassa-Samuelson framework have also been extended to include differences in labour and product-market regulations (in the non-tradable sectors particularly) across countries ([Bénassy-Quéré and Coulibaly, 2014](#)). There is also a growing literature on the effects of financial and monetary integration on the relative price of non-tradables. Financial integration decreased real interest rates<sup>8</sup> and fueled capital inflows in the European periphery. This have resulted in a demand-boom and subsequently in an expansion of the non-tradable sector ([Fagan and Gaspar, 2007; Benigno and Fornaro, 2014](#)), and more specifically an increase in house prices ([Ferrero, 2015](#)), causing a deepening of current account deficits ([Geerolf and Grjebine, 2013](#)). In this paper I build on these analyses and synthesize both real and financial integration in a model of a small open economy composed of two sectors to derive implications for the dynamics of the non-tradable sector and unit labour costs.

To do so, I use previous results of multi-sector models of structural change in which resources reallocate to the sector with the fastest growing relative price, whether this relative price is driven by differences in productivity across sectors ([Baumol, 1967; Ngai and Pissarides, 2007](#)), or because sectors benefit differently from capital deepening due to their differences in capital intensity ([Acemoglu and Guerrieri, 2008](#)). These models focus on the shift of employment from manufacturing to services activities in closed economies. This paper extends this theoretical framework to an open economy, and analyses rather the shift of employment from the tradable to the non-tradable sector.

Recent analyzes of the divergence in productivity dynamics among Member States focus on the role of financial frictions, i.e. unequal access to capital across sectors. Financial frictions could explain the distorted

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the manufacturing, mining and agricultural activities, as well as six service sectors for which a large part of the output is internationally traded.

<sup>8</sup>See [Hale and Obstfeld \(2016\)](#) for a discussion on the effect of monetary integration the suppression of bond yields in the European periphery up to 2007.

allocation of capital inflows following financial integration, in favor of the non-tradable sector ([Reis, 2013](#)), or in favor of the housing sector ([Adam et al., 2012](#)). Financial frictions could have led to a growing misallocation of inputs within sectors among firms reducing aggregate TFP ([Gopinath et al., 2017](#)). This issue is addressed into an extension to the model allowing for heterogeneous user costs of capital across sectors, and across sub-sectors within the non-tradable and the tradable sector.

Finally, this paper helps understanding better previous analyses of defective growth patterns –episodes of growth that display elements known to precede financial crises ([Hlatshwayo and Spence, 2014](#)). Domestic credit expansion and real currency appreciation are the most robust and significant predictors of financial crises, regardless of whether a country is emerging or advanced ([Gourinchas and Obstfeld, 2012](#)). And [Kalantzis \(2015\)](#) shows how capital inflows, followed by an expansion in the relative size of the nontradable sector, increases the financial fragility of the economy. Focusing more specifically on explaining the 2010 Eurozone crisis ([Martin and Philippon, 2017](#)), or the Greek crisis ([Gourinchas et al., 2016](#)), the authors find that financial integration as well as excessive government spending increased substantially the level of debt in the periphery in the pre-crisis period. Confronted with sudden stops in 2010, severe macroeconomic adjustments were then inevitable. And focused on Spain, [Arellano et al. \(2018\)](#) show that these large and persistent declines in economic activity affect disproportionately more the non-tradable sector. This paper complements this analysis by bringing more light on the quality of growth before the crisis. Was it only the reflection of speculative bubbles, as suggested by [Fernández-Villaverde et al. \(2013\)](#), or did it reflect real convergence? This paper proposes a single framework allowing to disentangle both effects. It quantifies the dynamics of competitiveness stemming from real convergence.

To sum-up, the first contribution of this paper is to build a model of structural change for an open economy that is able to incorporate the different effects of trade and financial integration. In contrast with the existing literature that studies each effect separately, this framework encapsulates the various effects and provides a simple decomposition of unit labour costs into each of them. Using a new dataset for 12 European countries from 1995 to 2014, I am able to quantify the contribution of each effect. The construction of this dataset is the second contribution of this paper. This dataset provides detailed growth and productivity accounts for the tradable and non-tradable sectors. It overcomes the traditional shortcut of labeling the industry as tradable and services as non-tradable. It also provides alternative measures of total factor productivity and profit shares, and helps understand the biases that arise with standard ones.

The remainder of the paper is organized as follows. Section 2 develops the theoretical framework. Section 3 presents novel data on the dynamics of non-tradable sectors and the different dimensions of economic integration in the Euro area since 1995. Section 3 quantifies the contribution of economic integration on the divergence of ULCs in the Euro area. Section 4 concludes.

## 2. A two-sector small open economy model

This section presents a model to investigate the impact of economic integration (both trade and financial/monetary integration) on the dynamics of the non-tradable sector and aggregate unit labour costs in a small open economy. 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'. Appendix 1 contains proofs of the main conclusions.

### 2.1. Set-up

The model has two key ingredients: it focuses on a small open economy, and it includes two sectors – the tradable sector (T) and the non-tradable sector (N). Economic integration takes the form of three exogenous effects in this economy: (i) fast tradable productivity growth, (ii) increased competition in the tradable sector, (iii) a decreasing interest rate spread.<sup>9</sup>

<sup>9</sup>See [Blanchard and Giavazzi \(2002\)](#), or [Hale and Obstfeld \(2016\)](#) for a discussion on the effects of financial and monetary integration on the decreasing interest rate spread in the Eurozone. As for the effects of economic integration on the tradable

The implications of different sectoral total factor productivity (TFP) growth rates on sectoral dynamics have already been analyzed in technology-driven models of structural change. Ngai and Pissarides (2007) show that a low (below one) elasticity of substitution across final goods leads to shifts of employment shares to sectors with low TFP growth in a closed economy. They thus give theoretical ground to Baumol's cost-disease effect stating that in the long term labour reallocates from the progressive manufacturing sector to the stagnant service sector. I here extend Ngai and Pissarides (2007) framework to analyze the effects of various forms of economic integration on sectoral dynamics, and more specifically on the dynamics of the non-tradable sector. I first adapt this closed economy framework to a small open economy. I then consider that the economy is composed of a tradable and a non-tradable sector, rather a manufacturing vs. service sector. Two reasons motivate this choice.

First, analyzing the sectoral dynamics in terms of tradable versus non-tradable sectors allows to derive implications for the dynamics of exports and imports and thereby for the current account. As is outlined in Blanchard (2007), the dynamics of large imbalances imply significant inter-sectoral shifts in economic activity: during a deficit phase, the non-tradable sector expands and the tradable sector shrinks in relative terms; conversely, current account rebalancing requires a relative contraction of the nontradable sector and the expansion of the tradable sector.

Second, economists traditionally use the shortcut of labeling the industry as tradable and services as non-tradable. Analyzing the dynamics of the tradable versus non-tradable sectors would then be equivalent to analyzing industry versus service sectors. 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.<sup>10</sup> Moreover, recent studies have shown the growing servitization of the economies, casting doubt on the relevance of opposing manufacturing and service activities (Bernard and Fort, 2015). Analyzing the tradable versus non-tradable sector allows us to address both issues: taking into account the importance of services in export performance and overcoming the growing complexity of activities.

By analogy to Ngai and Pissarides (2007), structural change hereafter refers to a change in the share in total employment of the non-tradable sector. We assume that non-tradable goods can only be consumed domestically, whereas tradable goods can be consumed, invested or traded. The tradable good is used as the numeraire. There are two inputs for production: labour and capital. Both are perfectly mobile across sectors.

Labor is not mobile across countries: the labour force is exogenous and grows at the rate  $\nu$ . Conversely, capital is mobile and the country can borrow or lend unlimited amounts on the international capital market. 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  $x_t$ :  $R_t = (1 + r)(1 + x_t)$ . This wedge  $x_t$  could reflect a spread due to the currency risk or cross-border frictions. This wedge falls as economies integrate. Total financial wealth at the beginning of year  $t$  is composed of domestic capital  $K_t$  minus the level of foreign debt  $F_t$ .

**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:

$$n_t^T + n_t^N = 1; \quad k_t^T n_t^T + k_t^N n_t^N = k_t \quad (1)$$

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  $j$ .

sector, the intuition follows standard results of models of heterogeneous firms in which the market size and trade affect the toughness of competition and the selection of producers. TFP and markups respond to the size of a market and the extent of its integration through trade. Larger, more integrated markets exhibit higher productivity and lower markups (Melitz and Ottaviano, 2008). Poorer countries have initially lower TFP and higher markups; economic integration is likely to lead to a relatively faster increase in TFP and a faster decrease in markups in the tradable sectors of these countries.

<sup>10</sup>In Greece, services represented about 36% of total exports in 1995. This share increased to a little less than 50% in 2014. In Ireland also this share increased from 13% in 1995 to a little less than 50% in 2014 (Eurostat).

Production functions are Cobb-Douglas:  $Y_t^j = A_t^j (K_t^j)^{\alpha^j} (L_t^j)^{1-\alpha^j}$  with  $\alpha^j \in ]0, 1[$  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. Dividend (expressed in terms of tradables) in each period equals 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<sup>11</sup> and  $I_t^j$  represents gross investment.<sup>12</sup> 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:

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

where  $R_{t,s} = (1+r)^{s-t} \frac{\prod_{\tau=t}^s (1+x_\tau)}{(1+x_t)}$

$R_{t,s}$  is the discount factor.<sup>13</sup> 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  $\delta$ .<sup>14</sup>

The user cost of capital at time  $t$  (the same in both sectors,  $U_t$ ) is a function of the price of investment goods, the interest rate and the depreciation rate:

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

Since the tradable good is the numeraire, first order conditions in the tradable sector yield the equation for the wage  $\omega_t$ :

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

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  $\mu_t^T$ .

As in [Fernald and Neiman \(2011\)](#), in each sector  $j$  the markup is  $\mu_t^j = \left( 1 + \left( \partial p_t^j / \partial Y_t^j \right) \left( p_t^j / Y_t^j \right) \right)^{-1}$ . This markup derives from the fact that firms have a market power.<sup>15</sup> The value added in each sector can then be decomposed into the labour and capital shares in cost, and a profit share, and standard measures of TFP can diverge from true technology growth  $A_t^j$ . See model Appendix for a discussion of this bias.

The relative price of the non-tradable good depends only on technological conditions. Its expression is given by:

$$p_t^N = \frac{(A_t^T / \mu_t^T)^{\frac{1-\alpha^N}{1-\alpha^T}}}{(A_t^N / \mu_t^N)} U_t^{\frac{\alpha^N - \alpha^T}{1-\alpha^T}} \frac{[(1-\alpha^T)^{1-\alpha^T} (\alpha^T)^{\alpha^T}]^{\frac{1-\alpha^N}{1-\alpha^T}}}{(1-\alpha^N)^{1-\alpha^N} (\alpha^N)^{\alpha^N}} \quad (5)$$

While the demand side have no effect on the relative price of non-tradables, it does alter the composition of output and the allocation of inputs.

<sup>11</sup>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.

<sup>12</sup>Dividends and profits differ. Profits are:  $\Pi_t^j = p_t^j Y_t^j - \omega_t L_t^j - U_t K_t^j$ , with  $U_t$  the user cost of capital (see equation 3). By assuming that firms maximize dividends rather than profits, we assume that it is firms that make investment decisions. One could imagine an economy where firms rent capital from consumers who directly own it and make investment decisions. Results would carry through.

<sup>13</sup>We have  $R_{t,t} = 1$  and  $R_{t,t+1} = R_{t+1} = (1+r)(1+x_{t+1})$ . If  $x_t = x$  is constant, then  $R_{t,s} = [(1+r)(1+x)]^{s-t}$ .

<sup>14</sup>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  $t$ .

<sup>15</sup>This monopoly power is usually related to a taste parameter. Here, it rather reflects entry barriers or any competition policy affecting the substitutability of varieties of goods within each sector, as in [Blanchard and Giavazzi \(2002\)](#).

**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:

$$V_t = \sum_{s=t}^{\infty} [\beta(1 + \nu)]^{s-t} \ln(c_s) \quad (6)$$

where  $\beta \in ]0, 1[$  is the rate of time preference,  $\nu$  the growth rate of the labour force, and  $c_s \geq 0$  is consumption per capita at time  $s$ . This representative household works, borrows on foreign markets and owns domestic firms. The budget constraint, expressed in terms of tradables and per unit of labour, is:

$$p_t c_t = \omega_t + d_t + f_{t+1} - (R_t - \nu)f_t \quad (7)$$

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 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  $\omega_t$ . He receives the dividends from the firms he owns  $d_t$  (for simplicity the representative household owns all firms in the domestic economy and there is no foreign direct investment in the model). 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).  $(R_t - \nu)f_t$  must be reimbursed at the end of period  $t$ , possibly by borrowing  $f_{t+1}$ .

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

$$c_t = [\gamma^{\frac{1}{\theta}} c_t^T^{\frac{\theta-1}{\theta}} + (1 - \gamma)^{\frac{1}{\theta}} c_t^N^{\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}} \quad (8)$$

With  $\gamma \in [0, 1]$  the share of the non-tradable good, and  $\theta > 0$  the elasticity of substitution between the two goods<sup>16</sup>. The consumption price index  $p_t$  is a function of the relative price of the non-traded good  $p_t^N$ :

$$p_t = [\gamma + (1 - \gamma)(p_t^N)^{(1-\theta)}]^{\frac{1}{1-\theta}} \quad (9)$$

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

$$c_t^T = \gamma \left( \frac{1}{p_t} \right)^{-\theta} c_t \quad \text{and} \quad c_t^N = (1 - \gamma) \left( \frac{p_t^N}{p_t} \right)^{-\theta} c_t \quad (10)$$

and the inter-temporal Euler equation:

$$\frac{c_{t+1}}{c_t} = \beta(1 + r)(1 + x_{t+1}) \frac{p_t}{p_{t+1}} \quad (11)$$

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

This section studies the implications of economic integration on structural change –through both tradable and financial market integration. I assume that the non-tradable sector is more labour-intensive than the tradable sector:  $\alpha^N < \alpha^T$ . This assumption will be discussed in Section 3.

**Proposition 1:** *The relative price of non-tradable goods increases ( $\hat{p}_t^N > 0$ ) if:*

*(1) productivity grows faster in the tradable than in the non-tradable sector (productivity effect);*

<sup>16</sup>The parameter  $\theta$  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  $\theta$  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.

- (2) profits (or the markup) decrease in the tradable relative to the non-tradable sector (competition effect);  
 (3) the user cost of capital decreases (effect of financial integration), and the non-tradable sector is relatively labour-intensive ( $\alpha^N < \alpha^T$ ).

*Proof:* Rewriting equation 5, we get the growth rate of  $p_t^N$ :

$$\hat{p}_t^N = \underbrace{\left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}_t^T - \hat{A}_t^N}_{\text{productivity effect}} - \underbrace{\left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right]}_{\text{competition effect}} + \underbrace{\left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t}_{\text{effect of financial integration}} \quad (12)$$

$\hat{z} = \frac{z_t'}{z_t} - 1$  denotes the percent rate of change of some variable  $z$  between  $t$  and  $t'$ . Given that  $0 < \alpha^N < \alpha^T < 1$ , we get a positive impact of  $(\hat{A}_t^T - \hat{A}_t^N)$ , a negative impact of  $(\hat{\mu}_t^T - \hat{\mu}_t^N)$  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 growth in productivity 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. The effect of 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 non-tradable relatively to the tradable sector ( $\alpha^N - \alpha^T$ ). 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 Stolper-Samuelson theorem: a decrease in the user cost of capital decreases the relative price of the product that uses capital intensively.<sup>17</sup>

As argued by [Blanchard and Giavazzi \(2002\)](#), tradable market integration should have led to an upward convergence in productivity in the tradable sector and resulted in a downward pressure on markups (increased competition) in the tradable sector; in turn, financial and monetary integration involved a downward convergence of the interest rate (fall in the wedge  $x_t$ ). Overall, these effects of economic integration should have led to an increase in the relative price of the non-tradable good through the three channels mentioned in Proposition 1.

To recover the share of the non-tradable sector in total employment, we combine the first-order conditions in the tradable and non-tradable sector, the constraint that all non-tradable output must be consumed in each period, and the expression of non-tradable consumption as a function of aggregate consumption. With  $n_t^N$  the share of the non-tradable sector in total employment, and  $s_t^N$  the share of the non-tradable sector in total nominal gross value added,  $s_t^N$  is the following positive function of  $n_t^N$ :

$$s_t^N = \frac{n_t^N / LS_t^N}{n_t^N / LS_t^N + n_t^T / LS_t^T} \quad (13)$$

where  $LS_t^j = \frac{1 - \alpha^j}{\mu_t^j} \quad \forall j \in \{T, N\}$  is the sectoral share of labour in income. If  $\mu_t^j = 1$  (perfect competition), then  $LS_t^j = 1 - \alpha^j$ , and the share of payments to labour in total revenue is the same as the share of payments

<sup>17</sup>This theorem states that a change in relative product prices benefits the factor used intensively in the industry that expands. See [Stolper and Samuelson \(1941\)](#).

to labour in total costs. With markups, the share of payments to labour in total revenue is a function of the share of payments to labour in total costs and the markup  $\mu_t^j$ . The expression for the share of the non-tradable sector is then (see Appendix 1 for more details):

$$s_t^N = f^+(n_t^N) = (1 - \gamma) \left( \frac{p_t^N}{p_t} \right)^{1-\theta} \chi_t \quad (14)$$

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.

Differentiating equation 14, we get the dynamics of  $s_t^N$  which satisfies:

$$\begin{aligned} \dot{s}_t^N &= (1 - \theta) (\hat{p}_t^N - \hat{p}_t) + \hat{\chi}_t = (1 - \theta)(1 - \psi_t) \hat{p}_t^N + \hat{\chi}_t \\ &= (1 - \theta)(1 - \psi_t) \underbrace{\left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}_t^T - \hat{A}_t^N \right]}_{\text{productivity effect}} - \underbrace{\left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N}_{\text{competition effect}} + \underbrace{\left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t}_{\substack{\text{effect of} \\ \text{financial integration}}} + \underbrace{\hat{\chi}_t}_{\text{demand-boom effect}} \end{aligned} \quad (15)$$

where  $\psi_t = (1 - \gamma) \left( \frac{p_t^N}{p_t} \right)^{1-\theta}$ ,  $\psi_t \in ]0, 1[$  is the share of non-tradables in aggregate nominal consumption.

The properties of structural change follow immediately from equation 15. There are four drivers of structural change: the same three supply-side drivers as for the relative price, and a fourth driver deriving from the fact that the composition of output also depends on demand factors.

Increased goods and financial market integration fuel an increase in the relative price through the three effects described above: productivity, competition or financial integration effects. 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 (The Baumol cost disease). 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. Labor moves out of the tradable sector and into the non-tradable sector. This is the case when the country is impatient enough or if 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.<sup>18</sup>

**Proposition 2:** *There are 4 drivers of structural change:*

- (1) *the productivity effect ( $\hat{A}_t^T > \hat{A}_t^N$ );*
- (2) *the competition effect ( $\hat{\mu}_t^T < \hat{\mu}_t^N$ );*
- (3) *the effect of financial integration ( $\hat{U}_t < 0$  with  $\alpha^N < \alpha^T$ )*

$\Rightarrow$  *these three long-run price effects are at play as long as  $\theta \neq 1$ , and lead to an expansion of the non-tradable sector if  $\theta < 1$ . They are at play even if the economy is on a balanced growth path (i.e.,  $\hat{c}_t = \hat{y}_t$ ).*

- (4) *the demand-boom effect if  $\hat{c}_t > \hat{y}_t$ . Then the share of the non-tradable sector expands and the current account deteriorates. This effect is at play even if  $\theta = 1$ .*

<sup>18</sup>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 \(2002\)](#).

Absent differences in capital intensities across sectors ( $\alpha_N = \alpha^T$ ) and with perfect competition ( $\mu^T = \mu^N = 1$ ), the expression of structural change reduces to the expression found in [Ngai and Pissarides \(2007\)](#):

$$\hat{n}_t^N = \underbrace{(1 - \theta)(1 - \psi_t)(\hat{A}_t^T - \hat{A}_t^N)}_{\text{productivity effect}} + \underbrace{\hat{\chi}_t}_{\text{demand-boom effect}} \quad (16)$$

**Proposition 3:** With  $\alpha_N = \alpha^T$  and  $\mu^T = \mu^N = 1$ , there are only 2 drivers of structural change:

- (1) the productivity effect ( $\hat{A}_T > \hat{A}_N$ ) if  $\theta \neq 1$ . This effect leads to an expansion of the non-tradable sector if  $\theta < 1$ ;
- (2) the demand-boom effect with  $\hat{c}_t > \hat{y}_t$ .

### 2.3. Decomposing real unit labour costs

Let us now define real unit labour costs (ULC) as real wages in terms of the tradable good corrected for labour productivity. Real ULC is an indicator of cost competitiveness, and as long as the law of one price holds in tradable sector, divergence in real ULC reflects divergence in nominal ULC. Aggregate unit labour costs expressed in terms of the tradable good are an average of labour costs in the tradable and the non-tradable sector:

$$ULC_t = \frac{w_t L_t}{Y_t} = \frac{w_t}{y_t} = \frac{y_t^N}{y_t} ULC_t^N + \frac{y_t^T}{y_t} ULC_t^T \quad \text{with} \quad ULC_t^j = \frac{w_t n_t^j}{y_t^j}, \quad j = N, T \quad (17)$$

Using firms' FOCs in each sector, and replacing the relative price by its expression given in proposition 1, we easily get that:

$$ULC_t^N = p_t^N LS_t^N = p_t^N \frac{(1 - \alpha^N)}{\mu_t^N} \quad \text{and} \quad ULC_t^T = LS_t^T = \frac{(1 - \alpha^T)}{\mu_t^T} \quad (18)$$

In each sector, real unit labour costs are a positive function of the share of labour in income  $LS_t^j = \frac{(1 - \alpha^j)}{\mu_t^j}$ : the higher the markups (or profits), the less do labour compensations weight in real output.<sup>19</sup>

Differentiating equation 17, and using equations 18, we get that the dynamics of aggregate unit labour costs expressed in terms of the tradable good are a function of the relative price, the share of the non-tradable sector, and markups in the tradable and non-tradable sectors:

$$\begin{aligned} \widehat{ULC}_t &= \sum_{j=T,N} n_t^j \left[ \widehat{ULC}_t^j + \hat{s}_t^j - (\hat{\rho}_t^j - \hat{\rho}_t) \right] \\ &= (1 - n_t^N) \left[ \widehat{ULC}_t^T - \frac{s_t^N}{1 - s_t^N} \hat{s}_t^N + \hat{\rho}_t \right] + n_t^N \left[ \widehat{ULC}_t^N + \hat{s}_t^N - (p_t^N - \hat{\rho}_t) \right] \\ &= [\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \hat{\rho}_t^N + \Omega_t \hat{\chi}_t - \hat{\mu}_t^T (1 - n_t^N) - \hat{\mu}_t^N n_t^N \end{aligned} \quad (19)$$

with  $\Omega_t = \frac{n_t^N - s_t^N}{1 - s_t^N}$ ,  $\Omega_t > 0$  if the non-tradable sector is more labour intensive than the tradable sector.

Replacing the dynamics of the non-tradable price and the dynamics of the share of the non-tradable sector, real unit labour costs can be decomposed into the effect of productivity ( $PROD_t$ ), the effect of competition

<sup>19</sup>This result derives from the fact that wage earners do not get a share in the markup. In [Blanchard and Giavazzi \(2003\)](#), the authors show that it is the bargaining power of workers which determines the distribution of rents between workers and firms. Assuming that part of this rent is then redistributed to workers would reduce the negative effect of competition on real ULC.

( $COMP_t$ ), the effect of financial integration ( $FIN_t$ ), and the effect of the demand-boom ( $DEM_t$ ):

$$\widehat{ULC}_t = PROD_t + COMP_t + FIN_t + DEM_t \quad (20)$$

$$\begin{aligned} \text{with } PROD_t &= [\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}_t^T - \hat{A}_t^N \right] \\ COMP_t &= -[\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right] - \hat{\mu}_t^T(1 - n_t^N) - \hat{\mu}_t^N n_t^N \\ FIN_t &= [\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t \\ DEM_t &= \Omega_t \hat{\chi}_t \end{aligned}$$

Like for structural change, the dynamics of real unit labour costs (unit labour costs expressed in terms of the tradable good) have four drivers. The first three drivers are relative price/costs effects: the productivity, competition and financial integration effects. The fourth one is the effect of the demand-boom on the size of the non-tradable sector.

The first driver of ULC is once again productivity. Productivity has a positive effect on ULC by increasing the relative price (thereby reducing the competitiveness of this sector) but also through a composition effect (by increasing the relative size of the non-tradable sector, if  $\theta < 1$ ). The second driver is the effect of financial integration: similarly to the effect of productivity, it affects aggregate ULC by increasing costs in the non-tradable sector, and by increasing the size of this sector (if  $\theta < 1$  and  $\alpha^N < \alpha^T$ ).

The third driver of aggregate ULC is the effect of competition. If markups decrease in the tradable relative to the non-tradable sector, the relative non-tradable price but also the size of the non-tradable sector increase, inducing, as explained above, an increase in aggregate ULC. However, the overall effect of competition depends on the effect of a change in markups on the labour share in each sector: decreasing markups will mechanically increase the share of labour in income, increasing real ULC in both sectors; on the opposite, increasing markups decrease ULC in both sectors.

Finally, the fourth driver is the effect of a rising consumption rate  $\chi_t = p_t c_t / p_t y_t$ . If this ratio temporarily increases, the non-tradable sector expands: resources reallocate in the labour-intensive non-tradable sector, where the labour share—and so ULC—are higher (composition effect).

**Proposition 4:** *There are four drivers of aggregate real unit labour costs, that is ULC expressed in terms of the tradable good:*

- (1) *the productivity effect ( $\hat{A}_t^T > \hat{A}_t^N$ )*
- (2) *the effect of financial integration ( $\hat{U}_t < 0$  and  $\alpha^N < \alpha^T$ )*  
⇒ *these two effects increase aggregate real ULC by increasing relative costs in the non-tradable sector, and by increasing the size the non-tradable sector, if  $\theta < 1$ ;*
- (3) *the competition effect (i.e.  $\hat{\mu}_t^T < \hat{\mu}_t^N$ ) fuels an increase in real ULC in the non-tradable sector by increasing the relative price and size of the non-tradable sector (if  $\theta < 1$  and  $\alpha^N < \alpha^T$ ). It also affects ULC in each sector by affecting the share of labour in income: decreasing (increasing) markups will mechanically increase (decrease) the share of labour in income;*
- (4) *the demand-boom effect ( $\hat{c}_t > \hat{y}_t$ ), only through the increasing size of the non-tradable sector (composition effect).*

## 2.4. Extension 1: heterogeneous returns to capital and misallocation

So far, it has been assumed that firms in both sectors face the same marginal cost of capital, implying that capital is homogenous and moves freely across sectors. However, the recent literature has emphasized the role of financial frictions and heterogeneous returns to capital across the tradable and non-tradable sector,

and also across firms within each sector. These distortions could partly explain why capital flows from abroad have benefited most the non-tradable sector (Reis, 2013), or induced low productivity growth in each sector by benefiting firms that were not necessarily more productive (Gopinath et al., 2017) and precluding credit-constrained firms from adopting more efficient technologies (Midrigan and Xu, 2014). Gopinath et al. (2017) use data for manufacturing firms in Spain between 1999 and 2012 and document a significant increase in misallocation, measured by the dispersion of the return to capital across firms. In this section we aim at measuring the contribution of the three types of misallocation: (i) across the tradable and the non-tradable sector, (ii) among sub-sectors of the tradable sector, and (iii) among sub-sectors of the non-tradable sector. We measure misallocation by the dispersion of returns to capital across sectors, as in Gopinath et al. (2017), and give some intuitions as for why these returns differ 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 (IPP, see Table A.1 in Appendix for a detailed classification of assets). 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:

$$\begin{aligned} U_t^k &= q_{t-1}^k R_t - q_t^k (1 - \delta^k) \\ &= q_{t-1}^k [(R_t - 1) + \delta^k (1 + \hat{q}_t^k) - \hat{q}_t^k] \end{aligned} \quad (21)$$

Computer and information equipment or IPP products are short-lived (meaning it has a high depreciation rate  $\delta^k$ ) 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 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  $i$ ):

$$\begin{aligned} \hat{U}_t^j &= \hat{U}_t + \hat{\zeta}_t^j \quad (22) \\ \text{with } \hat{U}_t &= \sum_k \phi_t^k \hat{U}_t^k \quad \text{and} \quad \hat{\zeta}_t^j = \sum_i \sum_k \left[ \underbrace{(\phi_t^{k,j,i} - \phi_t^{j,k})}_{\text{realloc. within sector } j} + \underbrace{(\phi_t^{j,k} - \phi_t^k)}_{\text{realloc. across sectors}} \right] \hat{U}_t^k \end{aligned}$$

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,  $\phi_t^{k,j} = \sum_i \frac{U_t^k K_t^{k,j,i}}{\sum_k U_t^k K_t^{k,j,i}}$  the share of asset  $k$  in capital compensations of 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 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 ( $K_t^{*j}$ ) are now defined as a translog quantity index of individual assets:<sup>20</sup>

$$\hat{K}_t^{*j} = \sum_{k,i} \phi_t^{k,i,j} \hat{K}_t^{k,i,j} = \hat{K}_t^j + \hat{Q}_t^j \quad (23)$$

with  $Q_t^j$  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:  $\hat{A}_t^{*j} = \hat{Y}_t^j - (1 - \alpha^j) \hat{L}_t^j - \alpha^j \hat{K}_t^{*j}$ .

As will be shown Section 3, user costs of capital are lower in the non-tradable sector than in the tradable sector, reflecting a larger share of residential assets in the non-tradable than in the tradable sector. However, these user costs increased faster in the non-tradable than in the tradable sector in the periphery over 1995-2007: the non-tradable sector invested relatively more in technological assets than the tradable sector over the period. This could be explained by the presence of financial frictions. Analyzing the case of Portugal, [Reis \(2013\)](#) suggests that because the credit market are underdeveloped in the periphery, banks were unwilling to use capital inflows following monetary integration to extend credit to existing productive firms since they were already operating at their collateral constraint. Instead the new funds flew into new, inefficient firms, in the non-tradable sector. Non-tradable firms, owning more residential assets, might also have benefited from an increase in the collateral value of housing, allowing them to invest relatively more ([Chaney et al., 2012](#)). Financial frictions also alter the decisions of technological adoption and allow firms which have an easier access to credit to adopt more efficient technologies ([Midrigan and Xu, 2014](#)).

These effects could have altered the relative allocative efficiency of capital across sectors: it could have eased a composition shift towards more technological assets in the less efficient non-tradable sector  $\hat{\zeta}_t^N > 0$ , while slowing the pace of technological adoption in the more efficient tradable sector  $\hat{\zeta}_t^T < 0$ . All in all, the increase in the user cost of capital in the non-tradable relative to the tradable sector have resulted in a misallocation of capital: technological assets were allocated to the less efficient sector. This misallocation effect reinforces the effect of financial integration and of productivity on the relative price (see Proposition 5).

**Proposition 5:** If the user cost of capital increases in the N sector relative to the T sector ( $\hat{\zeta}_t^N > \hat{\zeta}_t^T$ ):

- (1) it reinforces the increase in the relative price of non-tradable goods following financial integration (a fifth effect, the misallocation effect);
- (2) there is an upward correction of the relative TFP growth in the tradable sector.

*Proof:* Replacing the new expression of the user costs in equation 12, we get:

$$\hat{p}_t^N = \underbrace{\left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}_t^{*T} - \hat{A}_t^{*N}}_{\text{productivity effect}} - \underbrace{\left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right]}_{\text{competition effect}} + \underbrace{\left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t}_{\text{effect of financial integration}} - \underbrace{\left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \alpha^T \hat{\zeta}_t^T - \alpha^N \hat{\zeta}_t^N \right]}_{\text{effect of misallocation}} \quad (24)$$

$$\text{with } \hat{\zeta}_t^j = \hat{U}_t^j - \hat{U}_t, \quad j = T, N$$

Replacing  $\hat{p}_t^N$  in the equation of ULCs (equation 19), we get that ULCs can now be decomposed into five

<sup>20</sup>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.

effects and isolate the effect of misallocation ( $MISALLOC_t$ ):

$$\begin{aligned}\widehat{ULC}_t &= PROD_t + COMP_t + FIN_t + MISALLOC_t + DEM_t \quad (25) \\ \text{with } PROD_t &= [\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}^{*T}_t - \hat{A}^N_t \right] \\ COMP_t &= -[\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right] - \hat{\mu}_t^T(1 - n_t^N) - \hat{\mu}_t^N n_t^N \\ FIN_t &= [\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t \\ MISALLOC_t &= -[\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \alpha^T \hat{\zeta}_t^T - \alpha^N \hat{\zeta}_t^N \right] \\ DEM_t &= \Omega_t \hat{X}_t\end{aligned}$$

## 2.5. Extension 2: distortionary public spending

I now consider the effects of public spending benefiting the expansion of the non-tradable sector.<sup>21</sup> Decreased bond spreads in the run up to the monetary union might have reduced the expenditure on debt servicing costs (Lane, 2006), allowing governments to increase public expenditures on non-tradable goods (expenditures on health or education for example) and increase civil servant wages. These effects will have two implications in the model. First, it might increase the effect of the consumption rate on the size of the non-tradable sector. Second, it might lead to diverging wage dynamics between the tradable and the non-tradable sector.

**Increased government expenditures on non-tradables** Consider that non-tradable output can be consumed either by households or the general government, so the new market equilibrium for non-tradable goods is:  $p_t^N(c_t^N + g_t) = p_t^N y_t^N$ . We now get that the dynamics of the share of the non-tradable sector depends on the dynamics of both private and public non-tradable consumption. Equation 15 becomes:

$$\hat{s}_t^N = \left[ (1 - \theta)(1 - \psi_t) \hat{p}_t^N + \hat{\chi}_t^h \right] (1 - \sigma_t) + \hat{\chi}_t^g \sigma_t = (1 - \sigma_t)(1 - \theta)(1 - \psi_t) \hat{p}_t^N + \hat{\chi}_t \quad (26)$$

with  $\chi^* = \chi^h + \chi^g$ , the total consumption rate –the sum of private ( $\chi^h$ ) and public ( $\chi^g$ ) consumption rates, and  $\sigma_t$  the share of public services in total non-tradable output.

**Increased wage gap between the tradable and non-tradable sector** So far, it has been assumed that workers earned the same wage in both sectors. Let us now assume that workers in the non-market economy (public sector) earn a different wage than workers in the market economy. In the market economy, and so in the tradable sector, wages are still defined by equation 4 ( $\omega_t^T = \omega_t$ ). However, in the non-tradable sector, wages are a weighted average:

$$\omega_t^N = (1 - \sigma_t)\omega_t + \sigma_t\omega_t^g \quad (27)$$

with  $\omega_t^g$  the average wage in the non-market economy set by the public administration. Consider that the government increases wages in the public sector relatively to the market economy, leading to increasing wages in the non-tradable sector relative to the tradable sector. This takes the form of an increase in the

<sup>21</sup>The government is financed through lump-sum taxes.

wedge  $\tau_t = \frac{\omega_t^N}{\omega_t^T}$ .<sup>22</sup> Equation 24 becomes:

$$\hat{\rho}_t^N = \underbrace{\left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}^{*T}_t - \hat{A}^{*N}_t}_{\text{productivity effect}} - \underbrace{\left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right]}_{\text{competition effect}} + \underbrace{\left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t}_{\text{effect of financial integration}} - \underbrace{\left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \alpha^T \hat{\zeta}_t^T - \alpha^N \hat{\zeta}_t^N \right]}_{\text{effect of misallocation}} + \underbrace{(1 - \alpha^N) \hat{\tau}_t}_{\text{effect of wage gap}}$$
(28)

$$\text{with } \hat{\tau}_t = \hat{\omega}_t^N - \hat{\omega}_t^T$$

Replacing  $\hat{\rho}_t^N$  and  $\chi_t^*$  in the equation of ULCs (equation 25), we can now identify the effects of policy intervention, through the revision of the *DEM* effect and the addition of a new *WAGE* effect on ULC:

$$\widehat{ULC}_t = PROD_t + COMP_t + FIN_t + MISALLOC_t + WAGE_t + DEM_t$$
(29)

$$\begin{aligned} \text{with } PROD_t &= [\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}^{*T}_t - \hat{A}^{*N}_t \right] \\ COMP_t &= -[\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right] - \hat{\mu}_t^T(1 - n_t^N) - \hat{\mu}_t^N n_t^N \\ FIN_t &= [\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] \left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t \\ MISALLOC_t &= -[\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \alpha^T \hat{\zeta}_t^T - \alpha^N \hat{\zeta}_t^N \right] \\ WAGE_t &= [\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] (1 - \alpha^N) \hat{\tau}_t \\ DEM_t &= \Omega_t \hat{\chi}_t^* \end{aligned}$$

### 3. Empirical Evidence

This section presents a novel database that documents the dynamics of the tradable and non-tradable sectors and the main dimensions of economic integration in Europe. The database uses national account data at the industry level as well as data on trade in goods and services to build a series of indicators of growth and productivity for the tradable and non-tradable sectors of European countries. Data are available for up to 24 countries and cover up to the years 1975-2015, but the coverage differs widely across countries. This paper focuses on a subset of 12 Euro area countries over 1995-2014.

#### 3.1. Data

The data are constructed in two steps: first I build indicators to document sector dynamics at the most disaggregated level available; then I classify each sector as tradable or non-tradable and aggregate the data in these two sectors. The construction of the database is detailed in Appendix 2.

In the first step, using Eurostat National Accounts data, a set of sector-level indicators describing sector dynamics is built for 24 European countries for up to 1975-2015 in 19 sectors of the Nace revision 2 classification.<sup>23</sup> Growth accounting indicators are constructed using EU-KLEMS methodology ([O'Mahony and Timmer, 2009](#)). This database covers a wider set of countries than EU KLEMS in its 2016 update but

<sup>22</sup>Imagine the government sets civil servant wages with a wedge  $z_t$  over market economy wages. We have  $\tau_t = (1 - \sigma_t) + \sigma_t z_t$ .

<sup>23</sup>The 24 countries are countries of the EU28 excluding Bulgaria, Croatia, Cyprus, Romania, Malta due to poor data quality but including also Norway. Countries are thus: AT: Austria; BE: Belgium; CZ: Czech Republic; DE: Germany; DK: Denmark; EE: Estonia; EL: Greece; ES: Spain; FI: Finland; FR: France; HU: Hungary; IE: Ireland; IT: Italy; LT: Lithuania; LU: Luxembourg; LV: Latvia; NL: Netherlands; NO: Norway; PL: Poland; PT: Portugal; SE: Sweden; SI: Slovenia; SK: Slovakia; UK: United Kingdom.

with less information on employment structure.<sup>24</sup> This dataset differs also from EU KLEMS since I want to distinguish the rental income of capital from profits. I thus distinguish the share of labour, capital (the rental income of capital net of depreciation and capital gains or losses) and profits (reflecting monopoly power) in gross value added.<sup>25</sup> The existence of profits –if not accounted for in the measure of inputs and their revenue shares– can bias the measure of TFP ([Fernald and Neiman, 2011](#)). To distinguish the rental income of capital from profits, I estimate capital compensations net of profits using information on the user cost of capital and capital stocks. I then ultimately deduce the profit share as the residual of the labour share and this 'net' capital share.

User costs of capital are constructed using data on investment prices and depreciation rates, and a proxy of rental rates. Rental rates reflect the opportunity cost of capital and are proxied by the long-term nominal interest rates (benchmark central government bonds of 10 years, identical across sectors).<sup>26</sup> However, [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. For robustness checks, an alternative rental rate is used, which adds a proxy of capital risk premium (KRP) to the risk-free long-term nominal interest rate using financial markets data (Datastream).<sup>27</sup> Figure A.1 in Appendix draws this rate for the periphery and core countries. Using the risk-free rate plus KRP leads to an average profit share of 7%, while the risk-free rate leads to an average profit share of 12%. See Appendix 2 for a more detailed discussion on the measure of profits at the industry-level.

In the following, three different assumptions will be considered in the growth accounting exercise: (a) no markup and sectors have the same technology (same labour intensity across sectors); (b) markups and differences in technology across sectors; (c) same as b, plus differences in capital composition across sectors leading to differences in user costs across sectors. I then consider two alternative rental rates for the exercise based on assumptions b and c. I end up with five different measures of TFP, markup and user costs. Details on how each indicator is measured depending on the scenario is provided in Appendix 2.

A tradability indicator is built to classify each sector as tradable or non-tradable. To do so, I use data on production provided in Eurostat national accounts. Data on trade in services come from Eurostat balance of payments for each European countries in the BPM5 classification over 1984-2013 and in the BPM6 classification over 2010-2014 (data for 2015 are not declared for all countries and items). Finally, data on trade in goods come from BACI, CEPII's database based on COMTRADE which provides a harmonized world trade matrix for values at the 6-digit level of the Harmonized System of 1992 (5 699 products) for 253 countries over 1989 to 2015. All databases are converted into the NACE revision 2 classification.

The tradability of each sector depends on its openness ratio –the ratio of total trade (imports + exports) to total production. A sector is considered as tradable if its openness ratio is greater than 10%, on average for the total area (24 countries) and over 1995-2014. Table 1 reports the openness ratio by sector on average for the 24 countries. Unsurprisingly, mining and quarrying, manufacturing and agriculture activities are found tradable. Concerning services, six industries are considered tradable. The non-tradable sector accounts for 43% of total production (34% if we exclude construction and real estate from the sample), 52% of GVA

<sup>24</sup>EU KLEMS uses various micro-data sources to get information on employment structure of the workforce. They build indicators of labour services and consider them as labour input for the measure of TFP. Here I rather use an indicator of the volume of hours worked as labour input for the measure of TFP.

<sup>25</sup>As in [Fernald and Neiman \(2011\)](#) or [Blanchard and Giavazzi \(2003\)](#), profits reflect monopoly power. These profits could be reinvested or redistributed to capital owners or workers. Here we assume that they are entirely redistributed to capital owners, so the overall product of capital adds up rental income and profits, net of depreciation and capital gains or losses.

<sup>26</sup>Since EU KLEMS ultimately deduces capital compensations from subtracting labour compensations from gross value added, their rental rate is endogenous and incorporates also the dynamics of profits.

<sup>27</sup>The classic Gordon model allows us to convert dividend yields ratios into a rough measure of the equity risk premium (ERP). This result is based on the assumption that the rate of growth of future dividends is constant and equal to the risk-free rate. Then, assuming that the corporate structure remains constant over time, the (levered) equity risk premium is related to the (un-levered) risk premium as follows:  $ERP = (1 + d)KRP$ , with  $d$  the debt-to-equity ratio measured using Eurostat data.

(Gross Value Added, at current prices, resp. 43%) and 51% of employment (resp. 46%) on average for the area over 1995–2014. On average over 1995–2014, the share of the non-tradable sector is the largest in Denmark (57% of total employment, 56% of GVA, 47% of production) and smallest in Slovenia (40% of total employment, 49% of GVA, 41% of production).

Inevitably, the threshold of 10% is arbitrary. One possibility could be to apply different tradability criteria for different countries, but applying the same criterion for all countries leads to more clearcut results. Moreover, the use of a threshold has the virtues of being based on the sample data and is easily subjectable to sensitivity checks. Using a threshold of 15% would exclude financial and insurance activities and information and communication from the tradable sector. Using a threshold of 20% would also exclude professional, scientific and technical activities from the tradable sector as well as information and communication. Appendix 2 discusses further the choice of the indicator and the choice of the 10% threshold.

### 3.2. Stylized facts

**The dynamics of the non-tradable sector** Figure 2 displays the share of the non-tradable sector in total hours worked over 1995 to 2014 in Euro area countries: core countries (Austria, Belgium, Germany, Finland, France, Italy, Luxembourg, Netherlands) and the periphery (Greece, Spain, Ireland, Portugal).<sup>28</sup>

The share of the non-tradable sector rose steeply in the periphery over 1995–2007 (+4.8 p.p.), while it declined slightly in core countries (-0.5 p.p.). These shares started declining after the 2008 global financial crisis in the periphery but not in core countries. The increase in the non-tradable share before 2008 in the periphery is sizeable even when excluding the construction and real estate sectors from the sample (see dotted lines in Figure 2, core: -0.3 p.p., periphery: +2.8 p.p.).

The share of the non-tradable sector in hours worked increased most in Ireland and Greece, while it decreased in Germany (see Figure 3). Housing bubbles contributed greatly to the dynamics of the non-tradable sectors as the construction sector was the fastest growing sector in most peripheral countries over 1995–2007 (except for Portugal). However, the housing sector (construction and real estate) does not explain the bulk of the non-tradable sector (except for Spain), and other sectors played an important role (wholesale and retail trade are among the most dynamic sectors over the period in the periphery).

**Financial integration** The theoretical framework shows that declining interest rates contribute to an increase in the relative price, the expansion of the non-tradable sector, and an increase in aggregate ULC as long as the non-tradable sector is more labour-intensive. The dataset shows that labour compensations represent on average 77% of GVA in the non-tradable sector (excluding construction and real estate activities), while the share is 67% in the tradable sector. The evidence is robust when correcting factor shares for the profit share and measuring the share of labour in total factor costs, i.e. labour intensity  $\alpha$ .

Financial integration deepened with the creation of the monetary union, which eliminated the exchange rate risk within the Euro area. It has led to a decrease in the wedge  $x$  within the Euro area and a convergence of nominal long-term interest rates, resulting in large decreases in the interest rate of peripheral economies. Long-term nominal interest rates converged among Euro area countries to about 4% around the mid-2000s. In peripheral economies, interest rates declined by 7.7 p.p. on average over 1995–2007, while interest rates declined by only 2.9 p.p. on average in core countries. Interest rate increased again after the 2008 global financial crisis and more particularly the 2011 Euro area crisis. Table 2 reports the average annual growth rate of the interest rate over the two sub-periods 1995–2007 and 2008–2014. Interest rates declined by 8.4%

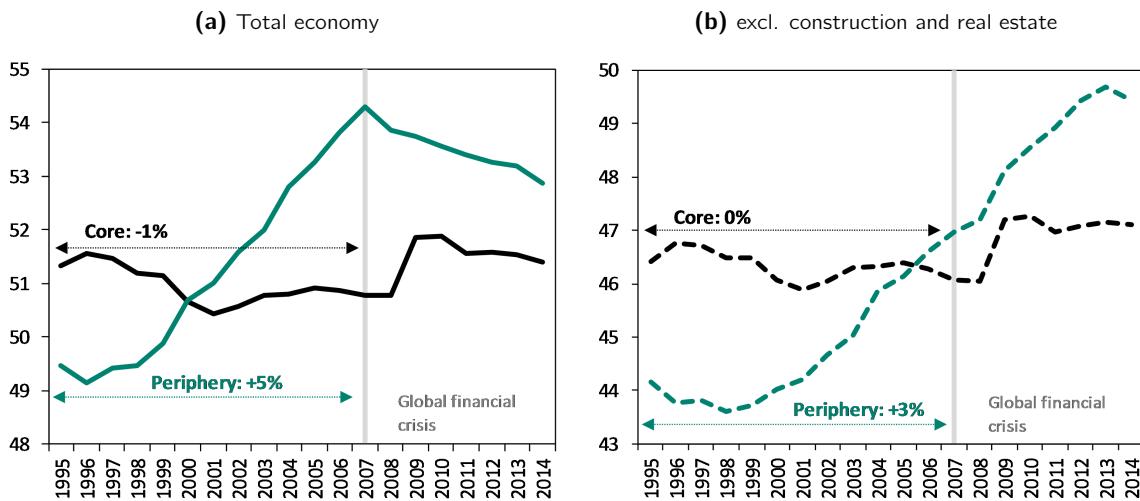
<sup>28</sup>The 12 core and peripheral countries of the Euro area all adopted the Euro in 1999 or 2001 for Greece. These 12 countries are considered as periphery if their GDP per capita, in purchasing power standard, was in the bottom third in 1995; they are else considered as core countries.

**Table 1** – Openness ratio by sector, on average for the 24 countries

Sector	Openness ratio (%)			
	1995	2014-1995, change in p.p.	1995-2014, average	
<i>Tradable sector</i>				
B	Mining and quarrying	118.99	121.11	192.34
C	Manufacturing	71.97	41.04	95.17
I	Accommodation and food service activities	75.74	8.47	82.49
A	Agriculture, forestry and fishing	32.59	17.26	41.90
H	Transportation and storage	29.75	0.40	33.83
N	Administrative and support service activities	17.84	-1.98	24.30
M	Professional, scientific and technical activities	11.70	17.19	19.68
J	Information and communication	6.83	21.01	15.06
K	Financial and insurance activities	7.75	12.78	14.95
<i>Non-tradable sector</i>				
R	Arts, entertainment and recreation	3.49	1.75	4.20
D	Electricity, gas, steam and air conditioning supply	2.64	1.24	4.19
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	2.36	-0.02	3.85
F	Construction	2.86	-0.61	2.39
O	Public administration and defence; compulsory social security	2.97	-1.13	2.38
S	Other service activities	1.12	0.84	1.78
E	Water supply; sewerage, waste management and remediation activities	0.01	0.61	0.29
P	Education	0.00	0.16	0.15
Q	Human health and social work activities	0.02	0.12	0.07
L	Real estate activities	0.00	0.00	0.00

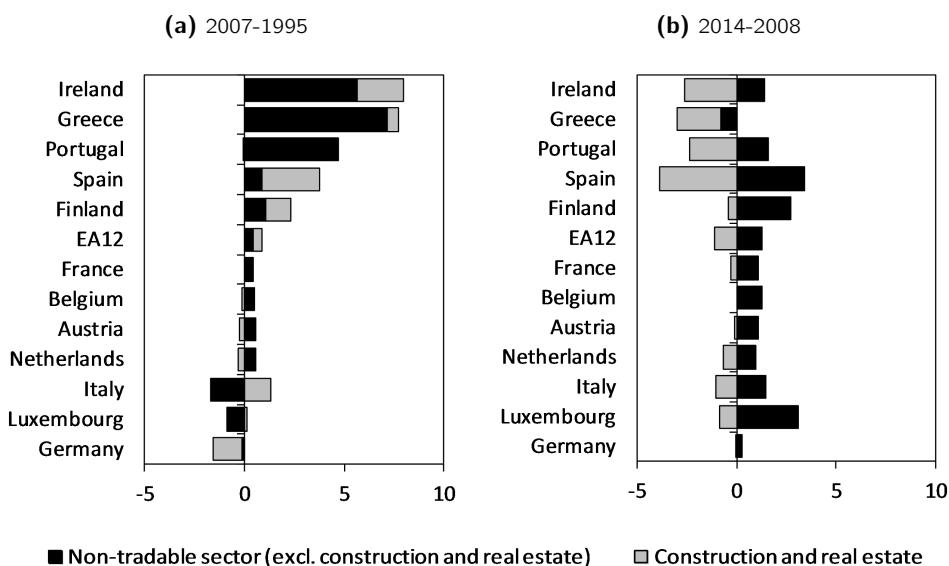
Source: author's calculations using Eurostat and BACI.

Note: the openness ratio is the ratio of total trade (imports+exports) to total production. Grey cells are non service activities.

**Figure 2** – Share of the non-tradable sector in total hours worked, by country group, 1995-2014, in %

Source: author's calculations using Eurostat and BACI.

Note: a threshold of 10% is used for the measure of tradability. Averages over countries weighted by the number of hours worked. Core countries: Austria, Belgium, Germany, Finland, France, Italy, Luxembourg, Netherlands. Periphery: Greece, Spain, Ireland, Portugal. Data start in 1999 for Belgium and 1998 for Ireland.

**Figure 3** – Change in the share of the non-tradable sector in total hours worked (p.p.)

Source: author's calculations using Eurostat and BACI.

Note: a threshold of 10% is used for the measure of tradability. Data start in 1999 for Belgium and 1998 for Ireland.

on average per year in the periphery over the first sub-period, whereas they declined by 5.2% on average in core countries. This faster decline is also found in other measures of the rental rate of capital (Table A.5 in Appendix): the rate including a capital risk premium declined by 8.0% on average in the periphery over 1995–2007, 4p.p. more than in core countries.

**Productivity convergence** The theoretical model also shows that labour reallocates to sectors where productivity grows relatively slowly. Economic integration in Europe with the single European market should have fostered productivity convergence in the tradable sector of Member States, and fast productivity growth in tradable sectors of the periphery. Table 2 displays the change in TFP in the tradable relative to the non-tradable sector for each country of the EA12 –depending on the assumption made (a), (b), (c). TFP increased faster in tradable than non-tradable sectors everywhere over 1995–2007 (except for Spain and Luxembourg in scenario (c)). This is true whether we assume there are markups (assumption b) and correct TFP or not for differences in user costs of capital among sectors (assumption c), and with any measure of the rental rate (Table A.5 in Appendix). The difference and relative increase was steeper for the periphery than for the EA12 average, except for Spain.

**Competition** At odds with the theoretical intuitions, markups have increased everywhere, with the two alternative measures of rental rate that I use. However, they increased less in the periphery than in core countries. And in the periphery, they increased less in non-tradable sectors than in tradable sectors. Table 2 shows the growth rate of markups in the tradable relative to the non-tradable sector. For every measure of markups (whether we correct or not for differences in the user costs of capital across sectors, and with an alternative measure of the rental rate in Table A.5 in Appendix), it seems that markups increased faster in the tradable sector than in the non-tradable sector in the periphery, while markups increased faster in the non-tradable sector than in the tradable sector in core countries, except in Ireland.<sup>29</sup>

When looking at the dynamics of markups more precisely, it seems that on average markups increased by 5% over 1995–2007 in the tradable sectors of the periphery and core countries. Whereas dynamics of markups are very similar in the tradable sector, they differ more in the non-tradable sector: in the periphery, they increased by 1% on average, while they increased by more than 8% in core countries. Whatever the measure used, markups increased in every core and periphery countries except for Ireland, where markups decreased in both sectors. Overall, over 1995–2007, markups increased in every countries, but with no particular pattern for the dynamics of relative (T/N) markups. This result is at odds with what we would expect from integrating tradable markets. Recent papers have pointed out increasing markups in the US since the 1980s, both using firm level data ([Loecker and Eeckhout, 2017](#)) or national account data ([Barkai, 2016](#)). This seems to be true also in Europe.

**Misallocation** Misallocation between the tradable and non-tradable sector is measured by the difference in user costs of capital between the two sectors. Given that both sectors face the same exogenous rental rate, differences in user costs of capital reflect differences in investment prices and depreciation rates, which result from differences in the composition of capital across sub-sectors.

Capital in the non-tradable sector includes much more residential assets than in the tradable sector. On average, over 1995–2014, and for the 12 countries in the dataset, residential assets represent 78% of the volume of total assets in the non-tradable sector, while it represents 48% of the volume of total assets in the tradable sector.<sup>30</sup> Since the residential assets have a lower user cost of capital<sup>31</sup>, the average user cost

<sup>29</sup>Eurostat data quality concerning the capital stock and user costs is poor for Ireland, so these numbers should be interpreted with caution.

<sup>30</sup>These numbers reflect the share of residential assets (assets N111 and N112) in total assets at constant 2010 prices. See Table A.1 in Appendix for a detailed classification of assets.

<sup>31</sup>User costs of capital for residential assets (assets N111 and N112) are 70% lower than the user cost of capital of equipments

**Table 2** – Contributors to the dynamics of unit labour costs, 1995-2007 and 2008-2014  
*Rental rate: risk-free rate.*

Unit labour costs (ULC, %)	ULC excl. constr. & real est. (%)	nominal rental rate (p.p.)	relative (T-N, p.p.)							consumption rate (in %)	
			TFP			markup		usercost	wage		
			(a)	(b)	(c)	(b)	(c)	(c)			
<b>Period: 1995-2007</b>											
EA12	15.32	14.37	-3.21	8.67	9.42	7.62	-1.05	-2.90	13.18	-0.83	-1.35
Peri.	36.78	33.65	-6.09	6.84	9.14	6.06	2.31	3.29	-5.29	-4.79	-1.19
EL	41.39	39.79	-8.94	22.90	31.19	26.16	10.49	9.32	-8.61	-2.66	2.70
ES	40.31	36.79	-6.90	0.68	1.67	-0.51	2.14	4.19	1.83	-7.12	-3.98
IE	15.84	14.73	-0.27	9.61	12.36	9.43	-5.94	-2.97	-42.27	-0.57	5.56
PT	31.64*	26.90	-3.75	20.98	23.27	17.08**	1.81	-2.99	-5.80	2.15	3.75
Core	10.73	10.25	-2.60	9.07	9.48	7.95	-1.76	-4.22	17.12	0.02	-1.38
AT	4.48	3.19	-1.82	19.17	19.36	18.48	3.98	3.80	6.06	1.97	-4.63
BE	10.65	10.58	-0.24	8.23	8.00	7.29	-5.98	-6.01	-2.20	-0.27	0.29
DE	-2.80	-1.88	-2.08	4.87	5.39	4.04	-3.09	-8.97	30.54	2.53	-4.07
FI	12.83	7.03	-4.50	32.87	34.02	33.37	-9.83	-6.61	5.97	3.39	-2.21
FR	17.42	15.57	-3.31	16.10	17.85	14.43	-3.95	-5.85	21.53	0.82	-0.51
IT	28.86	27.67	-4.38	7.58	7.02	5.62	1.44	0.87	7.28	-5.66	3.21
LU	10.19	9.92	-0.04	0.98	0.49	-0.51	-0.44	3.51	-13.02	-0.56	-6.34
NL	13.23	12.67	-0.29	6.93	6.79	7.28	2.37	5.13	-7.00	-0.09	-1.85
<b>Period: 2008-2014</b>											
EA12	7.60	7.99	-2.14	1.73	2.00	1.83	-1.37	0.64	-2.00	0.54	1.52
Peri.	-4.82	-1.20	-1.05	1.24	2.11	1.47	-1.42	-2.15	4.32	2.81	1.38
EL	-4.33	2.37	2.02	2.95	4.62	2.22	7.57	4.87	-4.00	-10.77	2.67
ES	-4.01	-0.83	-1.65	2.24	2.47	2.05	-2.68	-2.60	-1.51	4.09	3.47
IE	-9.77	-4.58	-1.51	-4.18	-0.61	-1.34	4.96	-0.55	57.18	7.18	-9.14
PT	-5.17	-4.23	-0.73	-1.26	-0.34	0.02	-11.27	-9.59	-4.78	7.27	-1.82
Core	10.25	9.95	-2.38	1.84	1.98	1.91	-1.37	1.23	-3.35	0.06	1.55
AT	12.87	11.81	-2.73	0.64	0.82	0.68	-1.85	-0.60	-0.53	2.01	2.51
BE	8.84	8.86	-2.17	6.79	6.89	6.49	5.97	5.54	0.53	-0.90	2.34
DE	12.39	12.31	-2.68	1.62	1.65	1.99	0.06	3.14	6.33	-1.45	0.71
FI	17.65	19.35	-2.84	3.67	3.74	3.79	-10.45	-5.53	-7.23	-2.14	11.51
FR	9.13	8.43	-2.56	3.61	4.10	3.09	-3.42	0.75	-21.15	1.17	2.01
IT	7.91	7.18	-1.70	1.45	1.55	1.71	-2.42	-1.04	-6.18	2.58	1.32
LU	9.17	9.66	-2.13	0.37	2.59	1.58	-5.29	-3.39	1.02	-0.77	-1.95
NL	6.99	7.33	-2.22	-2.75	-2.83	-3.01	-2.28	-0.34	-3.47	-1.81	1.91

Source: author's calculations using Eurostat, BACI and Ameco. A threshold of 10% is used for the measure of tradability. Group averages are weighted by country total gross value added at current prices.

\*: In Portugal, unit labour costs in the total economy increased by 31.64% between 1995 and 2007. \*\*: a 17.08p.p. increase in relative TFP means that TFP in the T sector grew 17.08p.p. faster than TFP in the N sector in Portugal over 1995-2007.

of capital in the non-tradable sector is almost 30% lower than the user cost of capital in the tradable sector.

Column 10 in Table 2 and column 7 in Table A.5 in Appendix show a similar pattern whatever the measure used: user costs of capital increased in the non-tradable sector compared to the tradable sector in the periphery over 1995–2007, whereas the opposite happened in core countries. Increasing user costs of capital are more often associated with a compositional shift to technological assets. It suggests that the pace of adoption of new technologies was faster in the non-tradable than the tradable sector in the periphery. This is reflected in a significant change in the composition of capital in the non-tradable sector of the periphery over 1995–2007. In Spain, for example, the share of ICT and IPP in total assets increased almost 3 times faster than in the tradable sector (even if this share remained much lower, at 6%, compared to 14% in the tradable sector in 2007). In Greece, the share of ICT and IPP in total assets increased almost 2 times faster than in the tradable sector.

**Public spending** On average, the public sector represents 20% of the non-tradable sector, so the dynamics of the non-tradable sector might reflect changes in general government policies. Indeed, decreased interest rate spreads in the run up to the monetary union might have fueled private consumption but also sharply reduced debt servicing costs ([Lane, 2006](#)), allowing governments to increase public expenditure and civil servant wages. Table 2 shows the change in the (public and private) consumption rate, as well as the wage gap between the tradable and non-tradable sector. The consumption rate decreased in almost every country except in Portugal and Italy over 1995–2007 –there is therefore no evidence of a large demand-boom. However, wages increased faster in the non-tradable than in tradable sectors in most core and peripheral economies.

In total, the rising share of the non-tradable sector and the increase in aggregate ULC in peripheral countries before the crisis is concomitant to the five following stylized facts (Figure 3): (i) a collapse in the long-term interest rates, (ii) a steep rise in the TFP in the tradable sector relative to the non-tradable sector, (iii) increased markups and profit shares in both sectors of the economy, (iv) rising user costs of capital in the non-tradable relative to the tradable sector, (v) an increased share of the public sector and a relative increase in civil servant wages.

#### 4. Quantification

This section assesses the contribution of economic integration –through both tradable and financial market integration– on the dynamics of aggregate ULC over 1995–2014 for the 12 core and periphery countries of the Euro area using a growth accounting exercise. To confront the data with the model, an illustrative calibration is undertaken to investigate whether the dynamics generated by the model are broadly consistent with the patterns in European data. Looking at equation (20), the first important parameter for our calibration is the elasticity of substitution between the two sectors. The model suggests a way of evaluating the elasticity. In particular, it provides a relationship between prices and quantities:

$$\psi_t = \frac{p_t^N c_t^N}{p_t c_t} = (1 - \gamma) \left( \frac{p_t^N}{p_t} \right)^{1-\theta}$$

Expressing all variables in their logarithm, we obtain the following relationship:

$$\log(\psi_t) = \log(1 - \gamma) + (1 - \theta) \left[ \log \left( \frac{p_t^N}{p_t} \right) \right] \quad (30)$$

---

(assets N1131 and N11O), and 80% lower than the user cost of capital of ICT (assets N1132) and IPP (assets N117 and N115).

To estimate the parameter  $\theta$ , the share of non-tradable consumption in total consumption  $\psi_t = \frac{p_t^N c_t^N}{p_t c_t}$  is needed. To get a proxy of non-tradable consumption consistent with production measures<sup>32</sup>, 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 the real estate and construction activities, which are largely used for investment and not only for consumption. I exclude this sector in the following.<sup>33</sup> 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.<sup>34</sup> These two approaches of tradable consumption give very similar measures (they differ by +/- 5%). Non-tradable consumption represents 48% of total consumption on average for the 12 EA countries over 1995-2014.

The elasticity of substitution  $\theta$  can now be estimated using equation (30). The estimating relationship will include an idiosyncratic error term and country fixed effects (assuming that way that the parameter  $\gamma$  differs across countries). Since the focus of the relative price effect is on medium-run frequencies (rather than business cycle fluctuations), I use the Hodrick-Prescott filter to smooth both the independent and the dependent variables. This simple regression yields an estimate of  $\theta \simeq 0.76$  and a two standard error confidence interval of [0.56; 0.97].<sup>35</sup> I chose  $\theta = 0.76$  for the benchmark estimation. This estimate is very close to the one used by [Acemoglu and Guerrieri \(2008\)](#) (they find an elasticity of substitution of 0.76 between capital-intensive and labour-intensive goods).<sup>36</sup>

Equipped with an estimate of  $\theta$ , I can first measure the contribution of economic integration to the dynamics of aggregate ULC. Similarly to the stylized facts, I will drive this decomposition using three assumptions leading to different measures of TFP, markup and user costs. I will also look at the effects of policy intervention in a last scenario. I thus have four scenarios, corresponding each to a different equation for the estimated aggregate ULC:

- (a):  $\widehat{ULC}_t = PROD_t + DEM_t$ , productivity is measured assuming no markup and the same technology in both sectors, and there is no policy intervention.
- (b):  $\widehat{ULC}_t = PROD_t + COMPET_t + FIN_t + DEM_t$  (equation 20), there are markups and different technologies across sectors, but still no policy intervention.
- (c):  $\widehat{ULC}_t = PROD_t + COMPET_t + FIN_t + MISALLOC_t + DEM_t$  (equation 25), assumption b plus differences in user costs across sectors.<sup>37</sup>

<sup>32</sup>Since there is no input/output structure involved in the model, I have to measure a 'theoretical' non-tradable consumption using value added data not consistent with final expenditure data. For more details on this consumption in value added approach, see [Herrendorf et al. \(2014\)](#).

<sup>33</sup>Investment in dwellings and other buildings and structures (assets N111 and N112 in the ANF6 classification) is an important share of total investment. When measuring the ratio of this latter investment to GVA in the construction and real estate sectors, investment represents a little more than 90% of total GVA on average over 1995-2014 for the 12 countries. I thus make the assumption that all production in these two sectors are used for investment only, and do not retrench housing consumption from final expenditure net of taxes less subsidies on products.

<sup>34</sup>Rewriting the budget constraint in level rather than in per capita, and replacing dividends by its expression given in the firms' section, we get that:  $p_t C_t = p_t Y_t - q_t I_t + F_{t+1} - R_t F_t$ . Since all non-tradable production is consumed in each period, we easily get:  $C_t^T = Y_t^T - q_t I_t + F_{t+1} - R_t F_t$ , so tradable consumption should equalize tradable gross value added minus total investment (gross fixed capital formation excluding investment in dwellings and other buildings and structures) and minus the trade balance in this sector.

<sup>35</sup>A smoothing weight of 1,600 is used. Results are very similar with a smoothing weight of 10: the elasticity of substitution is  $\theta \simeq 0.75$ , with a two standard error confidence interval of [0.49; 1.01]. Results are also very close using a lagged relative price ( $\theta \simeq 0.85$ ), or if we run the regressions in first difference ( $\theta \simeq 0.70$ ).

<sup>36</sup>[Herrendorf et al. \(2014\)](#) also find that, using the consumption in value added approach, the estimate is very low and close to zero.

<sup>37</sup>In the financial integration effect, for option (b), I make the assumption that changes in the user cost of capital reflects only changes in the interest rate ( $\hat{U}_t \equiv \hat{R}_t$ ). I assume thereby that changes in investment prices are not significant. I drop this assumption in option (c) and (d), and include the effects of changes in user costs due to changes in investment prices in the misallocation effect.

(d):  $\widehat{ULC}_t = PROD_t + COMPET_t + FIN_t + MISALLOC_t + WAGE_t + DEM_t$  (equation 29),  
assumption c plus policy intervention.

These equations provide a decomposition of real ULC, that is of ULC in terms of the tradable good. I focus rather on nominal ULC ( $nULC$ ) and on their growth in the periphery  $p$  relative to core countries  $c$ :

$$\Delta \widehat{nULC}_t^{p-c} = (\widehat{ULC}_t^p + p_t^{T,p}) - (\widehat{ULC}_t^c + p_t^{T,c})$$

Assuming the law of one price holds in the tradable sector of the Euro area ( $p_t^T = p_t^{T,p} = p_t^{T,c}$ ), deviations in real (expressed in terms of the tradable good) ULC growth from core countries should be equivalent to deviations in nominal ULC growth (the same deflator should apply for all countries).<sup>38</sup> I compute these effects for the overall period 1995-2014. For variables in level, I use their average over the period.

Figure 4 shows the contribution of each effect of economic integration and policy intervention to aggregate ULC growth in the periphery relative to core countries. The observed contribution of the construction and real estate sector to ULC growth is also displayed. This decomposition exercise is driven for each scenario, using the two alternative rental rates. The gap between the observed ULC growth rate and the estimated ULC growth rate is shown as the residual. We can see that considering only the productivity effect of economic integration results in a large residual. This residual shrinks when we take into account the overall effects of economic integration, as well as the effects of economic integration on capital misallocation. We can also see that policy intervention does not reduce significantly the residual compared to scenario (c). The strong divergence in unit labour costs between the core and the periphery over 1995-2014 is mostly explained by supply-side effects.

Productivity seems to contribute negatively to the increase in aggregate ULC. This result is all the more surprising that one could think that this effect was at play to explain at least partly increases in relative prices in the periphery relative to core countries before the crisis. However, when doing the same decomposition exercise but detailing the results for each country (Figure 5), we can see that this is the case only in Spain. In every other peripheral economies, the Balassa-Samuelson effect was indeed at play. The demand effect does not contribute significantly to the increase in aggregate ULC in any country, nor does the wage gap between both sectors. The effect of financial integration is very small. Competition plays a significant role everywhere, and so does capital misallocation.

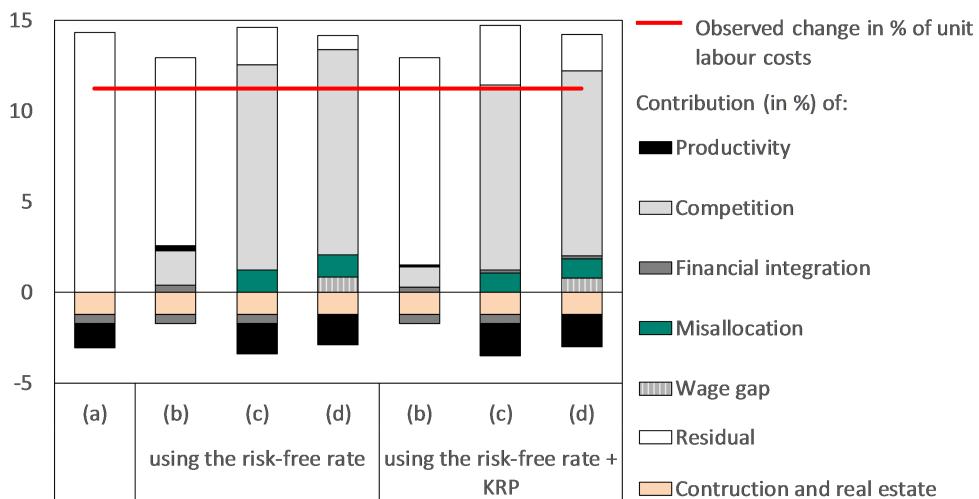
Overall, before the global financial crisis, in Greece and Portugal the biggest driver is productivity which explains resp. 30% and 22% of ULC growth relative to core countries (excl. construction and real estate). Competition comes next explaining resp. 12% and 25%, followed by misallocation (resp. 8% and 6%) and financial integration (resp. 2% and 1%). The demand and wage gap effects are very small (they explain up to 4% in Greece and contribute negatively to ULC in Portugal). Ireland is the country where misallocation matters most. However, due to poor data quality, results for Ireland should be interpreted with caution. A symmetric exercise can be driven for core countries relative to the periphery (Figure A.3 in Appendix). Estimates fit well the data, especially in Germany over 1995-2014. We can see that the competition effect explains most of the decreasing German unit labour costs.

## 5. Concluding remarks

By adapting a model of structural change for a small open economy with a tradable and a non-tradable sector, this article shows that trade and financial integration affects the dynamics of the non-tradable

<sup>38</sup>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](#)).

**Figure 4** – Estimated contribution of the effects of economic integration and policy intervention to nominal unit labour costs in the periphery (deviation from core countries)  
*Decomposition for assumptions (a) to (d) with two alternative rental rates. Period: 1995-2014, in %.*

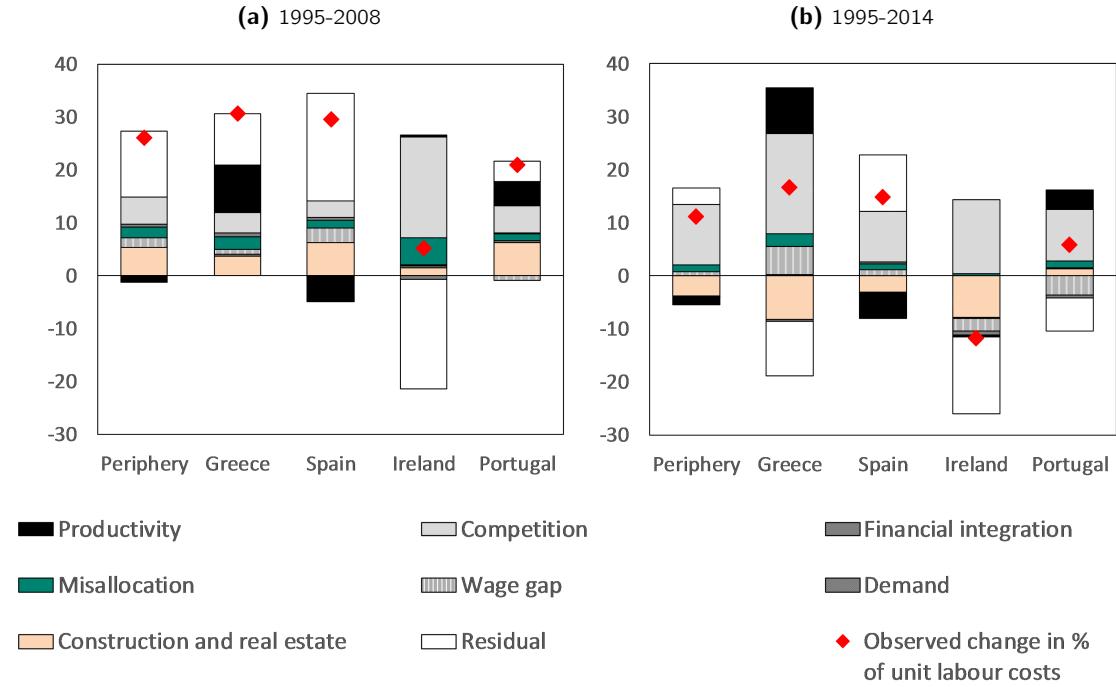


Effect of:	Assumption:						
		Rental rate:					
		risk-free rate			risk-free rate + KRP		
Effect of:	(a)	(b)	(c)	(d)	(b)	(c)	(d)
Productivity	-1.37	0.28	-1.62	-1.61	0.09	-1.77	-1.76
Competition		1.92	11.33	11.33	1.14	10.20	10.20
Financial integration		0.39	-0.05	-0.05	0.27	0.18	0.18
Misallocation			1.24	1.24		1.05	1.04
Wage gap					0.80		1.04
Demand	-0.48	-0.48	-0.48	0.01	-0.48	-0.48	0.01
Observed change in nominal ULC (%)							11.24
of which, contribution of construction & real estate sector:							-1.23

Source: author's calculations using Eurostat, BACI and Ameco. A threshold of 10% is used for the measure of tradability.

Note: ULC grew 11.24p.p. faster in the periphery than in core countries over 1995-2014. The construction and real estate sector contributed by -1.23p.p. to this growth rate. With assumptions (d) and using the risk-free rate only, the estimates suggest that productivity contributed negatively (by -1.61p.p.) to this growth, competition by 11.33p.p., financial integration by -0.05, misallocation by 1.24p.p., and faster wage increase in the non-tradable sector by 0.80p.p. The demand-boom effect was null.

**Figure 5** – Nominal unit labour costs in the periphery, deviation from core countries, and decomposition into the effects of economic integration and policy intervention (in %)  
*Decomposition for assumptions (d) using the risk-free rate.*



Source: author's calculations using Eurostat, BACI and Ameco. A threshold of 10% is used for the measure of tradability.

sector, and thereby the dynamics of aggregate unit labour costs. I identify various channels through which economic integration affects the share of the non-tradable sector and thereby unit labour costs in a catching-up economy. The first one is the effect of productivity convergence: by inducing a relative price increase in the long-run (Balassa-Samuelson effect), faster TFP growth in the tradable relative to the non-tradable sector induces a reallocation of labour into the slow-growing non-tradable sector. This effect is reinforced if tradable market integration fosters an increase in tradable market competition. A similar effect arises if there is financial integration and the non-tradable sector is relatively more labour intensive. On top of these three long-run effects, financial integration can also fuel a transitory expansion of the non-tradable sector through a temporary demand-boom. Finally, in the presence of financial frictions, financial integration may benefit more the non-tradable sector which then adopts relatively more efficient technologies than the tradable sector. This misallocation effect reinforces the increase in the relative price of non-tradable goods. These five effects, leading to an increase in the relative price and size of the non-tradable sector, increases aggregate real ULC. They can only be reinforced by public spending expansion (increased public demand for non-tradable goods and increase civil servant wages).

Using a novel data set for 12 countries of the Euro area, this article then documents the dynamics of the non-tradable sector in the Euro area: the share of employment in the non-tradable sector increased by +4.8 p.p. in the periphery from the Euro inception up to the 2008 global financial crisis, while it remained stable in core countries. The expansion in the periphery is significant even when excluding the housing sector from the sample (+2.8 p.p.). Parallel to this, aggregate ULC increased 35% faster in the periphery than in core countries. These trends happened simultaneously to (i) a collapse in the long-term interest rates, (ii) a steep rise in the TFP in the tradable sector relative to the non-tradable sector, (iv) increased markups and profit shares in both sectors of the economy –but less in peripheral than in core countries, (v) increasing misallocation between the tradable and non-tradable sector, i.e. rising user costs of capital in the non-tradable relative to the tradable sector, (vi) an increased share of the public sector and a relative

increase in civil servant wages.

Finally, this article quantifies the effects of economic integration for 12 countries of the Euro area over 1995-2014. It is mostly supply-side effects of economic integration that are at play to explain the strong divergence in unit labour costs between the core and the periphery over 1995-2014. This result is robust even when taking into account the effect of public spending. Overall, before the global financial crisis, in Greece and Portugal for example, the biggest driver is productivity which explains resp. 30% and 22% of ULC growth relative to core countries (excl. construction and real estate). Competition comes next explaining resp. 12% and 25%, followed by misallocation (resp. 8% and 6%) and financial integration (resp. 2% and 1%).

Unit labour costs were pointed out as one of the main cause behind diverging competitiveness performances between a 'virtuous core' and a 'sinful periphery'. In June 2015, the Five Presidents' Report advised the creation of National Productivity Boards in charge of assessing whether wages are evolving in line with productivity. In light of this recommendation, decomposing the dynamics of ULC is a first order question. In catching-up economies –the poorest countries of the area– the effects of economic integration on the dynamics of the non-tradable sector and ULC should not be neglected. As [Blanchard and Giavazzi \(2002\)](#) already argued, poorer countries should run larger current account deficits while catching-up. This article suggests that they should also have an increasing relative price and size of the non-tradable sector, and increasing ULC relative to the Euro area. These results suggest that National Productivity Boards have differentiated objectives among Member States, supporting real convergence since "convergence [towards the highest levels of prosperity] is at the heart of our Economic Union."<sup>39</sup>

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<sup>39</sup>the Five Presidents' Report on [Completing Europe's Economic and Monetary Union](#), June 2015, p.7.

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## Appendix 1 - Theoretical model: proofs and derivations

This Appendix details the theoretical model and derives the expressions and relationships in Section 2.

**The representative household** has the following programme:

$$V_t = \sum_{s=t}^{\infty} [\beta(1+\nu)]^{s-t} \ln(c_s)$$

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

subject to  $p_t c_t = \omega_t + d_t + (1+\nu)f_{t+1} - R_t f_t$

with  $p_t c_t = c_t^T + p_t^N c_t^N$

The budget constraint is expressed in units per capita:

$$\begin{aligned} p_t C_t &= \omega_t L_t + D_t + F_{t+1} - R_t F_t \\ \Leftrightarrow p_t c_t &= \omega_t + d_t + \frac{F_{t+1}}{L_t} - R_t f_t \\ \text{with } c_t &= \frac{C_t}{L_t}; d_t = \frac{D_t}{L_t}; f_t = \frac{F_t}{L_t} \\ \text{we also have: } \frac{F_{t+1}}{L_t} &= \frac{F_{t+1} L_{t+1}}{L_{t+1} L_t} = f_{t+1}(1+\nu) \end{aligned}$$

This is a standard intertemporal optimization problem. Replacing  $c_s$  in the utility function by its expression given in the budget constraint, and deriving with respect to  $f_{t+1}$ ,  $c_t^T$  and  $c_t^N$  we get the following first order conditions (FOCs):

$$\begin{aligned} \text{Intra-temporal allocation of consumption: } \frac{c_t^T}{c_t^N} &= \frac{\gamma}{1-\gamma} (p_t^N)^\theta \\ \text{Euler equation: } \frac{p_{t+1} c_{t+1}}{p_t c_t} &= \beta(1+r)(1+x_{t+1}) \end{aligned}$$

The consumption price index  $p_t$  is a function of the relative price of the non-traded goods  $p_t^N$ . It is the minimum expenditure  $z_t$  such that  $c_t = 1$  given  $p_t^N$ . From the FOC, we get:

$$\begin{aligned} z_t &= \frac{\gamma}{1-\gamma} (p_t^N)^\theta c_t^N + p_t^N c_t^N \\ \Leftrightarrow z_t &= \frac{1}{1-\gamma} (p_t^N)^\theta c_t^N [\gamma + (1-\gamma)(p_t^N)^{1-\theta}] \\ \Rightarrow c_t^N &= \frac{(1-\gamma)(p_t^N)^{-\theta} z_t}{\gamma + (1-\gamma)(p_t^N)^{1-\theta}} \end{aligned}$$

Symmetrically, we have the tradable consumption:

$$c_t^T = \frac{\gamma z_t}{\gamma + (1-\gamma)(p_t^N)^{1-\theta}}$$

Replacing  $c_t^N$  and  $c_t^T$  in the expression of  $c_t$ , we get:

$$c_t = [\gamma^{\frac{1}{\theta}} \left( \frac{\gamma z_t}{\gamma + (1-\gamma)(p_t^N)^{1-\theta}} \right)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} \left( \frac{(1-\gamma)(p_t^N)^{-\theta} z_t}{\gamma + (1-\gamma)(p_t^N)^{1-\theta}} \right)^{\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}}$$

$p_t$  is the minimum expenditure  $z_t$  such that  $c_t = 1$  given  $p_t^N$ :

$$\begin{aligned} 1 &= \left[ \gamma^{\frac{1}{\theta}} \left( \frac{\gamma p_t}{\gamma + (1-\gamma)(p_t^N)^{1-\theta}} \right)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} \left( \frac{(1-\gamma)(p_t^N)^{-\theta} p_t}{\gamma + (1-\gamma)(p_t^N)^{1-\theta}} \right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \\ &\Leftrightarrow 1 = p_t \left[ \gamma + (1-\gamma)(p_t^N)^{1-\theta} \right]^{\frac{1}{\theta-1}} \\ &\Rightarrow p_t = \left[ \gamma + (1-\gamma)(p_t^N)^{1-\theta} \right]^{\frac{1}{1-\theta}} \end{aligned}$$

We can deduce:

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

We define  $\psi_t$  the share of non-tradables in total nominal consumption:

$$\psi_t = \frac{p_t^N c_t^N}{p_t c_t} = (1-\gamma) \left( \frac{p_t^N}{p_t} \right)^{1-\theta}$$

If  $\theta = 1$ , then the aggregator  $c_t$  is a Cobb-Douglas of tradable and non-tradable goods, and  $p_t = (p_t^N)^{1-\gamma}$ . An increase in the relative price will lead to a fall in the relative consumption of the same proportion. If  $\theta \rightarrow 0$ , then the tradable and non-tradable goods are perfect complements. An increase in the relative price will lead to a fall the relative consumption, but of a smaller proportion: consumption demand are too inelastic to match all the price change. If  $\theta \rightarrow \infty$ , then the tradable and non-tradable goods are perfect substitutes. An increase in the relative price will lead to a fall the relative consumption, but in a larger proportion: consumption demand are very elastic to the change in prices.

With  $p_t = [\gamma + (1-\gamma)(p_t^N)^{1-\theta}]^{\frac{1}{1-\theta}}$ , the growth rate of the consumption price index is:

$$\begin{aligned} \hat{p}_t &= (1-\gamma) \left( \frac{p_t^N}{p_t} \right)^{1-\theta} \hat{p}_t^N = \psi_t \hat{p}_t^N \\ &\equiv (1-\gamma) \hat{p}_t^N \quad \text{if the starting point is one at which } p_t^N = 1. \end{aligned}$$

**Firms** are equity-financed and seek to maximize the present discounted value of dividends. With perfect foresight, the firms' programme in sector  $j$  at time  $t$  is:

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

where  $R_{t,s} = (1+r)^{s-t} \frac{\prod_{\tau=t}^s (1+x_\tau)}{(1+x_t)}$

subject to  $Y_t^j = A_t^j (K_t^j)^{\alpha^j} (L_t^j)^{(1-\alpha^j)}$

with  $l_s^j = K_{s+1}^j - (1-\delta) K_s^j$  and given  $K_t^j$ .

Replacing  $Y_s^j$  with the production function and  $l_s^j$  with the law of motion of capital in the expression for dividends, and deriving this expression with regards to  $L_t^j$  and  $K_t^j$ , we get the usual FOCs:

$$\begin{aligned} \frac{\partial D_t^j}{\partial L_t^j} &= \frac{\partial p_t^j}{\partial Y_t^j} \frac{\partial Y_t^j}{\partial L_t^j} + p_t^j \frac{\partial Y_t^j}{\partial L_t^j} - \omega_t = 0 \\ \Rightarrow \omega_t &= \frac{(1-\alpha^j)}{\mu_t^j} \frac{p_t^j Y_t^j}{L_t^j} = \frac{(1-\alpha^j)}{\mu_t^j} \frac{p_t^j y_t^j}{n_t^j} \\ \frac{\partial D_t^j}{\partial K_t^j} &= \left( \frac{\partial p_t^j}{\partial Y_t^j} \frac{\partial Y_t^j}{\partial K_t^j} Y_t^j + p_t^j \frac{\partial Y_t^j}{\partial K_t^j} + q_t(1-\delta) \right) - R_{t-1,1}^{-1} q_{t-1} = 0 \\ \Rightarrow U_t &= q_{t-1}(1+r)(1+x_t) - q_t(1-\delta) = \frac{\alpha^j}{\mu_t^j} \frac{p_t^j Y_t^j}{K_t^j} = \frac{\alpha^j}{\mu_t^j} \frac{p_t^j y_t^j}{k_t^j n_t^j} \\ \text{with } \mu_t^j &= \left( 1 + \left( \frac{\partial p_t^j}{\partial Y_t^j} \right) \left( \frac{p_t^j}{Y_t^j} \right) \right)^{-1} \end{aligned}$$

We can deduce:

$$k_t^j = \frac{\alpha^j}{1-\alpha^j} \frac{\omega_t}{U_t} \quad \text{and} \quad k_t = \sum_j n_t^j k_t^j = \frac{\omega_t}{U_t} \left[ \frac{\alpha^T}{1-\alpha^T} + n_t^N \left( \frac{\alpha^N}{1-\alpha^N} - \frac{\alpha^T}{1-\alpha^T} \right) \right]$$

And also:

$$p_t^j y_t^j = \mu_t^j \left( \omega_t n_t^j + U_t k_t^j n_t^j \right) = \frac{\omega_t n_t^j}{LS_t^j} \quad \text{with} \quad LS_t^j = \frac{1-\alpha^j}{\mu_t^j}$$

Since the tradable price is the numeraire,  $p_t^T = 1$ , replacing  $k_t^T$  in the FOCs in the tradable sector gives the equation for the wage:

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

Replacing the expression for the wage in the FOCs for the non-tradable sector gives the expression for the relative price:

$$\begin{aligned} p_t^N &= w_t^{1-\alpha^N} U_t^{\alpha^N} \frac{A_t^T}{\mu_t^T} (1-\alpha^N)^{-(1-\alpha^N)} (\alpha^N)^{-\alpha^N} \\ \Leftrightarrow p_t^N &= \frac{(A_t^T / \mu_t^T)^{\frac{1-\alpha^N}{1-\alpha^T}}}{(A_t^N / \mu_t^N)^{\frac{1-\alpha^N}{1-\alpha^T}}} U_t^{\frac{\alpha^N - \alpha^T}{1-\alpha^T}} \frac{[(1-\alpha^T)^{1-\alpha^T} (\alpha^T)^{\alpha^T}]^{\frac{1-\alpha^N}{1-\alpha^T}}}{(1-\alpha^N)^{1-\alpha^N} (\alpha^N)^{\alpha^N}} \end{aligned}$$

The FOCs in the non-tradable sector yield also the expression for the share of the non-tradable sector in total employment:

$$n_t^N = \frac{(1 - \alpha^N)}{\mu_t^N} \frac{p_t^N y_t^N}{\omega_t}$$

Since, in each period, all non-tradable production must be consumed, we can replace  $y_t^N = c_t^N$  and  $c_t^N$  by its expression as a fraction of total consumption:

$$n_t^N = \frac{(1 - \alpha^N)}{\mu_t^N} \frac{p_t^N (1 - \gamma) \left( \frac{p_t^N}{p_t} \right)^{-\theta} c_t}{\omega_t} = \frac{(1 - \alpha^N)}{\mu_t^N} \frac{p_t y_t}{\omega_t} (1 - \gamma) \left( \frac{p_t^N}{p_t} \right)^{1-\theta} \frac{p_t c_t}{p_t y_t}$$

We can replace the expression for the nominal output,  $p_t y_t = y_t^T + p_t^N y_t^N = \omega_t \left( \frac{n_t^N}{LS_t^N} + \frac{n_t^T}{LS_t^T} \right)$ :

$$\begin{aligned} n_t^N &= LS_t^N \left( \frac{n_t^N}{LS_t^N} + \frac{n_t^T}{LS_t^T} \right) (1 - \gamma) \left( \frac{p_t^N}{p_t} \right)^{1-\theta} \frac{p_t c_t}{p_t y_t} \\ \Rightarrow s_t^N &= (1 - \gamma) \left( \frac{p_t^N}{p_t} \right)^{1-\theta} \chi_t \quad \text{with} \quad s_t^N = \frac{n_t^N / LS_t^N}{n_t^N / LS_t^N + n_t^T / LS_t^T} \quad \text{and} \quad \chi_t = \frac{p_t c_t}{p_t y_t} \end{aligned}$$

**Proof of proposition 3:** differentiating this expression, we get the dynamics of  $s_t^N$  which satisfies

$$\hat{s}_t^N = (1 - \theta) (\hat{p}_t^N - \hat{p}_t) + \hat{\chi}_t$$

Replacing  $\hat{p}_t$  as a function of  $\psi_t$  and  $\hat{p}_t^N$ , we get:

$$\hat{s}_t^N = (1 - \theta) (1 - \psi_t) \hat{p}_t^N + \hat{\chi}_t$$

Replacing  $\hat{p}_t^N$  by its expression given in Proposition 2, we get:

$$\hat{s}_t^N = (1 - \theta) (1 - \psi_t) \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}_t^T - \hat{A}_t^N - \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right] + \left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t \right] + \hat{\chi}_t$$

**Proof of proposition 4:** with perfect competition and absent differences in capital intensities across sectors, we have  $LS_t^N = LS_t^T = LS_t$  and the dynamics of  $s_t^N$  reduces to

$$\hat{s}_t^N = \hat{n}_t^N = (1 - \theta) (1 - \psi_t) (\hat{A}_t^T - \hat{A}_t^N) + \hat{\chi}_t$$

**Biased and unbiased TFP measures** When allowing for the existence of profits, usual measures of TFP can be biased and diverge from true technology (Fernald and Neiman, 2011). Indeed, when there are no profits, i.e. when  $\mu_t^j = 1$  and  $LS_t^j = 1 - \alpha^j$ , then usual measures of TFP equal true technology and also real factor payments. From the FOCs and the production function, we get:

$$TFP_t^j = \hat{A}_t^j = \hat{Y}_t^j - LS_t^j \hat{L}_t^j - (1 - LS_t^j) \hat{K}_t^j$$

and from the equation of the price with  $\mu_t^j = 1$ , we get:

$$T\hat{F}P_t^j = \hat{A}_t^j = LS_t^j(\hat{\omega}_t - \hat{p}_t^j) + (1 - LS_t^j)(\hat{U}_t - \hat{p}_t^j)$$

When allowing for the existence of profits, these usual measures of TFP diverge from true technology and real factor payments if profits are not accounted for and the assumption that  $LS_t^j \equiv 1 - \alpha^j$  is made. Since  $LS_t^j = \frac{1-\alpha^j}{\mu_t^j}$ , we get TFP diverges from true technology:

$$\begin{aligned} T\hat{F}P_t^j &= \hat{Y}_t^j - LS_t^j \hat{L}_t^j - (1 - LS_t^j) \hat{K}_t^j \\ &= \hat{A}_t^j + \underbrace{LS_t^j(\mu_t^j - 1)(\hat{L}_t^j - \hat{K}_t^j)}_{\text{bias}} \end{aligned}$$

TFP also diverges from real factor payments:

$$\begin{aligned} T\hat{F}P_t^j &= LS_t^j(\hat{\omega}_t - \hat{p}_t^j) + (1 - LS_t^j)(\hat{U}_t - \hat{p}_t^j) \\ &= \underbrace{\hat{A}_t^j - \hat{\mu}_t^j}_{\text{real factor payments}} + \underbrace{LS_t^j(\mu_t^j - 1)(\hat{L}_t^j - \hat{K}_t^j) + (1 - LS_t^j)(\hat{U}_t^{\text{biased}} - \hat{U}_t)}_{\text{bias}} \end{aligned}$$

With  $\hat{A}_t^j - \hat{\mu}_t^j$  the change in real factor payments:

$$\hat{A}_t^j - \hat{\mu}_t^j = (1 - \alpha^j)(\hat{\omega}_t - \hat{p}_t^j) + \alpha^j(\hat{U}_t - \hat{p}_t^j)$$

And with  $U_t^{\text{biased}}$  the biased return to capital deduced from the observation of capital compensations, assuming capital and labour compensations sum to the gross value added (assuming thereby that there is no profit). The biased user cost of capital includes the profit share  $PS_t$ , we have:  $U_t^{\text{biased}} = \frac{U_t K_t + \pi_t}{K_t} = U_t + \frac{PS_t}{k_t}$ .

## Appendix 2 - Growth accounting for the tradable and non-tradable sector: data sources, methodology and discussion

This section describes the data source and the methodology used to improve the coverage and build a set of indicators to document the dynamics of the tradable and non-tradable sectors for European countries. It builds on EU KLEMS growth accounting methodology (see O'Mahony and Timmer, 2009) but allows the existence of profits to obtain indicators on the share of labour, capital and profits in gross value added, and the consequent unbiased measure of TFP.

This appendix first describes the construction of a dataset for 19 industries in the NACE rev.2 classification—the most detailed industry breakdown available if one wants a good coverage across countries and time—including indicators on gross value added and its decomposition in labour, capital and profits. It then documents the construction of a tradability indicator to classify each of the 19 sectors as tradable or non-tradable.

### Growth accounting at the 19-industry level

Eurostat provides harmonized National Accounts data for all 28 EU Member States following the SNA 2010 system of accounts.<sup>40</sup> It contains series of gross value added and production, compensation of employees and employment, investment and capital stock for up to 64 industries. The coverage widely differs depending on the period, country, indicator and industry considered. A breakdown in 21 industries (20 + total) of the NACE rev.2 classification is chosen to obtain the most detailed information available but with a good coverage across countries over time. However, as data for activities of extraterritorial organizations and bodies and activities of households as employers (sectors T and U) are missing for most countries, these sectors are excluded leading to a classification in 19 sectors.

**Output and Gross Value Added** Eurostat provides information on output and gross value added at basic prices in its "nama\_10\_a64" dataset. Both series are provided in current and constant prices. GDP is composed of gross value added at basic prices minus taxes less subsidies on products. In turn, gross value added at basic prices is composed of output minus intermediate consumption. It is also the sum of compensation paid to labour, capital services and profits minus taxes net of subsidies on production.

An indicator of gross value added at factor prices (*GV AFC*, corresponding to the sum of compensation paid to labour, capital services and profits) is created using information on taxes less subsidies on production. On average, the tax rate is 1.28%, with the largest rate in Sweden. The real estate sector faces the biggest rate (3.66% on average) while the agriculture, forestry and fishing sector benefits the most from subsidies (corresponding to a rate of -11.93%).

**Employment and labour compensation** Eurostat provides information on compensation of employees in its "nama\_10\_a64" dataset and information on hours worked (*EMP*) and its decomposition for employees and self-employed in its "nama\_10\_a64\_e" dataset. To obtain an indicator of total labour compensation (*LABCOMP*), earnings of self-employed (mixed income) is needed.

Mixed income are estimated assuming the average earning by hour worked for self-employed is the same than for employees. Self-employed represent, on average, 19.87% of total hours worked, with the highest share in Greece (38.97%) and the lowest share in Luxembourg (6.40%).

<sup>40</sup>All databases are available for download on the bulk download facility: <http://ec.europa.eu/eurostat/estat-navtree-portlet-prod/BulkDownloadListing>. See a description of the databases available here: [http://ec.europa.eu/eurostat/cache/metadata/en/nama10\\_esms.htm](http://ec.europa.eu/eurostat/cache/metadata/en/nama10_esms.htm)

**Capital stocks and capital compensations** Eurostat provides information on net fixed capital stocks (*NFCS*)<sup>41</sup> by asset and industry (in the ESA AN\_F6 classification) when provided by countries in its "nama\_10\_nfa\_st" dataset and information on investment by asset and industry in its "nama\_10\_nfa\_fl" dataset.

**Improving the coverage of NFCS** When available, series of NFCS in current and constant replacement costs are used to obtain constant price series of NFCS. For observations (at the country, year, asset, industry level) for which NFCS is not available but gross fixed capital formation (*GFCF*) is, the Perpetual Inventory Method (PIM) with geometric rates is used to estimate NFCS series. In the PIM, assuming a constant depreciation rate  $\delta$ , capital stock (NFCS) evolves according to:

$$NFCS_{c,j,n,t} = (1 - \delta_{j,n})NFCS_{c,j,n,t-1} + GFCF_{c,j,n,t} \quad (31)$$

with  $c$  the country,  $j$  the industry,  $n$  the asset, and  $t$  the year. To estimate NFCS series, information on constant depreciation rates is needed.

We could use data from countries reporting both investment and NFCS series to recover "implicit" rates of depreciation. However, these rates fluctuate substantially from year to year or form an industry to another (see Table A.1). We thus use the same rates as in EU KLEMS.

**Table A.1** – "Implicit" depreciation rates: average, minimum and maximum over industries and EU KLEMS average rates

Asset type (AN_F6)	Implicit rates			EU KLEMS average
	average	min	max	
N111 Dwellings	0.03	-0.02	0.07	0.01
N112 Other buildings and structures	0.05	0.03	0.08	0.03
N1131 Transport equipments	0.17	0.05	0.22	0.18
N11321 Computer hardware	0.29	0.12	0.41	0.31
N11322 Telecommunications equipment	0.17	0.01	0.21	0.12
N11O Other machinery and equipment and weapons systems	0.11	0.05	0.16	0.13
N115 Cultivated biological resources	0.06	-0.07	0.10	0.18
N1171 Research and development	0.20	0.15	0.24	0.20
N1173 Computer software and databases	0.37	0.21	0.41	0.31
N1172 Intellectual property products (N117-N1171-N1173)	-1.70	-188.57	0.34	0.13

Source: author's calculations using Eurostat and EU KLEMS.

Note: implicit rates are recovered using data from countries reporting both capital stocks and investment.

Finally, when neither stock or investment data were available, or if the quality of the data was too poor, we used EU KLEMS stock data if available. See Table A.2 for the final coverage of NFCS series by country.

### Three different scenarios

Three different assumptions are considered in the growth accounting exercise:

<sup>41</sup>The NFCS is the stock of assets surviving from past periods, and corrected for depreciation. The net stock is valued as if capital goods (used or new) were all acquired on the date to which the balance-sheet relates. It reflects the wealth of the owner of the asset at a particular point in time. See [OECD \(2009\)](#) for more details.

**Table A.2** – Availability of NFCS series (2010 prices)

	Reported	Estimated	Missing series*
AT	1995-2015		
BE	1996-2015		
CZ	1995-2015		
DE	1995-2015 (9)		
DK	1975-2015		
EE	2000-2014	1995-1999	
EL	1995-2014		
ES		1970-2014 (EU KLEMS data)	
FI	1980-2015		
FR	1978-2015		
HU	1995-2014 (9)		
IE	1995-2014 (7)		N115, N117, N11O
IT	1995-2015		
LT	2000-2014 (9)		
LU	1995-2015		
LV	1995-2014		
NL	2000-2015		
NO	1975-2014		
PL	2000-2014 (7)	1995-1999 (7)	N11O (1995-1999)
PT	2000-2014 (7)	1995-1999 (7)	N117 (1995-1999)
SE	1993-2014		
SI	2000-2015	1995-1999	
SK	2004-2015	1995-2003	N117 (1995-2003), N1132 (1995-1999)
UK	1995-2014		

\*Data which are not available for any sector.

Note: numbers in parenthesis correspond to the detail of assets available, if different than 10 (the most disaggregated level). Last data update: June 2017.

- (a) no markup and sectors have the same technology (same labour intensity across sectors);
- (b) markups and differences in technology across sectors;
- (c) same as b, plus differences in capital composition across sectors leading to differences in user costs across sectors.

I then consider two alternative rental rates for the exercise based on assumptions b and c. I end up with five different measures of TFP, markup and user costs.

**Scenario (a)** In this scenario, unit labour costs are a function of productivity and the demand effect:

$$\begin{aligned}\widehat{ULC}_t &= PROD_t + DEM_t \\ PROD_t &= [\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] [\hat{A}_t^T - \hat{A}_t^N] \\ DEM_t &= \Omega_t \hat{\chi}_t\end{aligned}$$

And the productivity in sector  $j = T, N$  is given by:

$$\hat{A}_t^j = \Delta \ln A_t^j = \Delta \ln Y_t^j - \overline{LS}_t^j \Delta \ln L_t^j - \overline{CS}_t^j \Delta \ln K_t^j$$

the contribution of each input still defined as the input's volume growth rate ( $L_t^j$  is the number of hours worked and  $K_t^j$  the stock of capital at 2010 prices) weighted by the two period average factor share in revenue, with  $CS_t^j = 1 - LS_t^j$ .  $\chi_t$  is the private consumption rate (total consumption rate minus public consumption).

**Scenario (b)** In this scenario, unit labour costs are a function of productivity, competition, financial integration and the demand effect:

$$\begin{aligned}\widehat{ULC}_t &= PROD_t + COMP_t + FIN_t + DEM_t \\ \text{with } PROD_t &= [\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}_t^T - \hat{A}_t^N \right] \\ COMP_t &= -[\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right] - \hat{\mu}_t^T(1 - n_t^N) - \hat{\mu}_t^N n_t^N \\ FIN_t &= [\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t \\ DEM_t &= \Omega_t \hat{\chi}_t\end{aligned}$$

Productivity in sector  $j$  is now by:

$$\hat{A}_t^j = \Delta \ln A_t^j = \Delta \ln Y_t^j - \overline{(1 - \alpha^j)} \Delta \ln L_t^j - \overline{\alpha^j} \Delta \ln K_t^j$$

the contribution of each input still defined as the input's volume growth rate ( $L_t^j$  is the number of hours worked and  $K_t^j$  the stock of capital at 2010 prices) weighted by the average factor share in total costs:  $1 - \alpha^j = \frac{LS_t^j}{1 - PS_t^j}$  and  $\overline{(1 - \alpha^j)}$  its average for each group of countries, over the entire period (1995-2014).

The markup is given by  $\mu_t^j = \frac{1}{1 - PS_t^j}$  with  $PS_t^j$  the profit share, defined as  $PS_t^j = 1 - LS_t^j - CS_t^j$ . To get a measure of this profit share, we thus need a measure of the capital share. The capital share is the product of the usercost of capital and of the stock of capital at 2010 prices. In the absence of taxation and of an investment price, assuming that there is a single depreciation rate for the total economy, user costs evolve according to (see equation 3):

$$\begin{aligned}CS_t^j &= U_t K_t^j \\ U_t &= [r_t + \delta_t]\end{aligned}$$

with  $r_t$  the rental rate (risk-free rate or risk-free rate + KRP) and  $\delta_t$  EU KLEMS depreciation rate.

**Scenario (c)** In this scenario, unit labour costs are decomposed as follows:

$$\widehat{ULC}_t = PROD_t + COMP_t + FIN_t + MISALLOC_t + DEM_t$$

with  $PROD_t = [\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}^{*T}_t - \hat{A}^N_t \right]$

$$COMP_t = -[\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right] - \hat{\mu}_t^T(1 - n_t^N) - \hat{\mu}_t^N n_t^N$$

$$FIN_t = [\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t$$

$$MISALLOC_t = -[\psi_t + \Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \alpha^T \hat{\zeta}_t^T - \alpha^N \hat{\zeta}_t^N \right]$$

$$DEM_t = \Omega_t \hat{\chi}_t$$

Productivity in sector  $j$  is now by:

$$\hat{A}_t^j = \Delta \ln A_t^j = \Delta \ln Y_t^j - \overline{(1 - \alpha^j)} \Delta \ln L_t^j - \overline{\alpha^j} \Delta \ln K^j_t$$

the contribution of labour is still defined as the input's volume growth rate ( $L_t^j$  is the number of hours worked) but the contribution of capital is defined as capital services' growth rate  $K^j_t$ . Both are still weighted by the average factor share in total costs:  $1 - \alpha^j = \frac{LS_t^j}{1 - PS_t^j}$  and  $\overline{(1 - \alpha^j)}$  its average for each group of countries, over the entire period (1995–2014).

Here, the capital share is the product of the usercost of capital and of capital services, as defined in equation 21 and equation 23.

**Scenario (d) in the decomposition exercise** To decompose unit labour costs, a fourth scenario is presented. In this scenario, the same measures of productivity, markups, usercosts, and misallocation as in scenario (c) are used. But this scenario includes a wage gap effect, and includes public consumption in the demand effect:

$$\widehat{ULC}_t = PROD_t + COMP_t + FIN_t + MISALLOC_t + WAGE_t + DEM_t$$

with  $PROD_t = [\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{A}^{*T}_t - \hat{A}^N_t \right]$

$$COMP_t = -[\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right] - \hat{\mu}_t^T(1 - n_t^N) - \hat{\mu}_t^N n_t^N$$

$$FIN_t = [\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] \left( \frac{\alpha^N - \alpha^T}{1 - \alpha^T} \right) \hat{U}_t$$

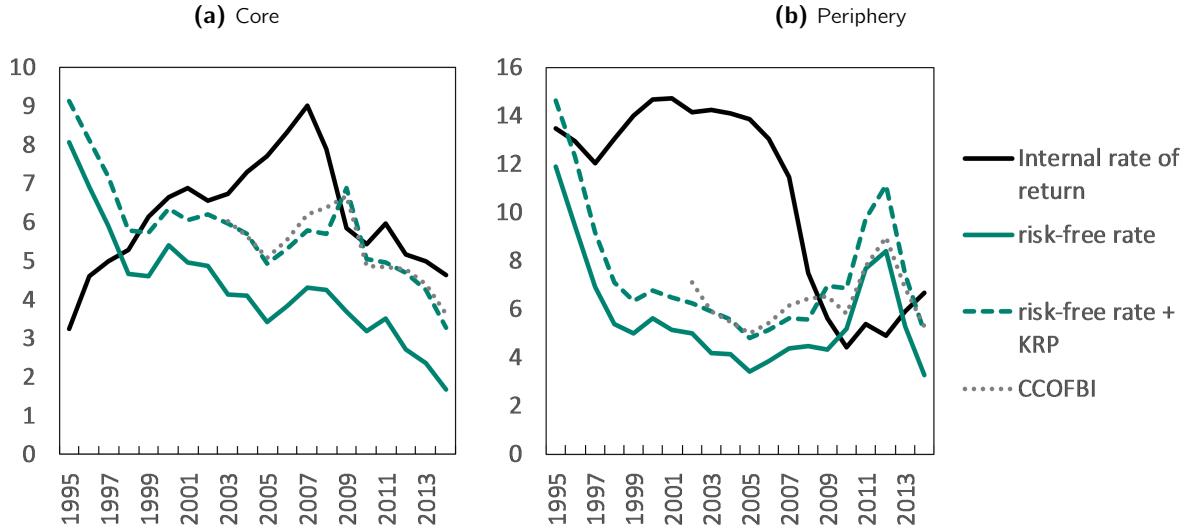
$$MISALLOC_t = -[\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] \left[ \left( \frac{1 - \alpha^N}{1 - \alpha^T} \right) \alpha^T \hat{\zeta}_t^T - \alpha^N \hat{\zeta}_t^N \right]$$

$$WAGE_t = [\psi_t + (1 - \sigma_t)\Omega_t(1 - \theta)(1 - \psi_t)] (1 - \alpha^N) \hat{\tau}_t$$

$$DEM_t = \Omega_t \hat{\chi}^*_t$$

$\hat{\tau}_t$  is measured as the gap in the growth rate of average hourly wages in the tradable and the non-tradable sector.

**The different measures of the rental rate** For robustness, I use three different measures for the rental rate. The first one, used in scenario (a), is what is often called the 'internal' measure and is the one adopted

**Figure A.1** – Different rental rate, core and periphery of the EA, 1995-2014.

Source: author's calculations using Eurostat, Ameco, ECB and Datastream.

by EU-KLEMS. It assumes that there is no profit, so capital compensations correspond exactly to the gross operating surplus, and are obtained as gross value added minus labour compensations. Given the stock of capital, an 'internal' rental rate can be inferred (i). The two other rates are used alternatively in scenarii (b), (c) and (d). It corresponds to a second type of measure, 'exogenous' measures of rental rates, using exogenous information on rental rates. That way, I can distinguish, in the gross operating surplus, the cost of capital (consumption of fixed capital + interests and charges payable) from current profits before distribution. In that case, the 'cost of capital' is estimated so we get a measure of capital compensations, and current profits are deduced as the residual when labour and capital compensations are retrenched from gross value added. Different types of 'ex-ante' rental rates can be used. I use two different measures: (ii) the long-term (risk-free) interest rate given by Ameco, corresponding to central government benchmark bonds of 10 years, and (iii) the risk-free rate plus a capital risk-premium.

To proxy the capital risk premium (KRP) I use financial markets data (Datastream). Unlike the debt cost of capital, which is observable in market data, the equity cost of capital is unobserved. The classic Gordon model allows us to convert dividend yields ratios into a rough measure of the equity risk premium (ERP). This result is based on the assumption that the rate of growth of future dividends is constant and equal to the risk-free rate. Then, assuming that the corporate structure remains constant over time, the (levered) equity risk premium is related to the (un-levered) risk premium as follows:  $ERP = (1 + d)KRP$ , with  $d$  the debt-to-equity ratio measured using Eurostat data (see [Caballero et al., 2017](#), who do the same with US data).

The three different rental rates are presented in Figure A.1 for the core and periphery over 1995-2014. An additional rate, the CCOFBI, is presented corresponding to the cost of borrowing indicator for non-financial corporations provided by the ECB. For both groups of countries, the three exogenous measures decline over 1995-2007, while the internal rate increases. This can be interpreted as reflecting an increase in the profit share in both groups of countries. The 'ex-post' average cost of capital is higher but evolves very closely to the risk-free rate + KRP in core countries. Its level is much closer to the other exogenous measures but its variations are more chaotic in the periphery. Finally, adding the KRP does not change significantly the dynamics of the risk-free rate.

Depending on the rental rate used, the average profit share changes. Using the risk-free rate provides the

highest profit shares in all countries, ranging from 0.54% in Germany to 26.46% in Ireland. The very high share in Ireland might be explained by the underestimate of the capital stock, since some assets are not reported.

The coverage of the final dataset is reported in Table A.3.

### Defining the tradability of a sector

Most studies label the manufacturing sector as tradable and consider services sectors as non-tradable. However, services represent an increasing share of advanced economies' exports. To reassess the tradability of each of the 19 sectors defined above, I build a tradability indicator using the extent to which a good or a service is actually traded with a foreign country, like most of the empirical literature (see, for instance, [Gregorio et al., 1994](#); [Mian and Sufi, 2014](#)).

Eurostat's data for national accounts provides detailed information on production in current prices. For data on trade in goods, BACI, CEPII's database based on COMTRADE, provides a harmonized world trade matrix for values at the 6-digit level of the Harmonized System of 1992. Data are available from 1989 to 2015 for 253 countries and 5 699 products. Finally, for trade in services, Eurostat provides data on bilateral services exports and imports for European countries in the BPM5 classification over 1984-2013 and in the BPM6 classification over 2010-2014. All databases are converted into the 19-level NACE revision 2 classification for the 24 countries presented in Table A.3 over 1995-2014 (data quality is too poor for 2015, too much data are missing before 1995).

We define an openness ratio for each sector –the ratio of total trade (imports + exports) to total production. The openness ratio tends to increase in each sector between 1995 and 2014, as well as for the total economy (from 29% in 1995 to 41% in 2014 for total area). The most opened country is Estonia (88%) and the less opened is Italy (26%).

**Discussion on the choice of the threshold** If this ratio is bigger than 10%, on average for the total area and over 1995-2014 (average weighted by production in current prices), then the sector is considered as tradable. Table 1 in section 3 of the article reports the openness ratio by sector on average for the 24 countries.

Inevitably, the threshold of 10% is arbitrary. Figure A.2 shows the share of the non-tradable sector in total hours worked in the 24 countries depending on the threshold used to classify each of the 19 sectors as tradable or non-tradable. It shows the tradability indicator using the average openness ratio for the 24 countries. Using the 10% threshold, the non-tradable sector represents about 51% of total hours worked; using a lower threshold, lower than 3%, the non-tradable sector represents less than one third of total hours worked; using a larger threshold, between 15% to 19%, the non-tradable sector represents a little more than 55% of total hours worked; using a threshold over 20%, the non-tradable sector represents more than 60% of total hours worked.

Finally, this tradability indicator is compared to other indicators used in the literature. Using data for 14 OECD countries and 20 sectors, [Gregorio et al. \(1994\)](#) define a sector as tradable if the 14 countries' total exports represent more than 10% of the sector's total production. [Mian and Sufi \(2014\)](#) use US data for about 300 sectors and define a sector as tradable if total trade (imports plus exports) per worker represent more than \$10,000. Both these indicators are constructed using the sample of 24 countries over 1995-2014. Using the openness ratio with a 10% threshold, the export to production ratio with a 10% threshold or trade per worker with a €10,000 threshold give very similar results (Table A.4). Using the same indicator as [Mian and Sufi \(2014\)](#) would lead to the inclusion of utilities in the tradable sector. Using the same indicator as [Gregorio et al. \(1994\)](#) would be the same than using the 20% threshold.

**Table A.3 – Coverage of the dataset at the 19-industry level**

	GVAFC	LABCOMP	CAPCOMP	GVAFC	EMP	NFCS
	current price			2010 prices	hours worked	2010 prices
AT	1995-2015	1995-2015	1995-2015	1995-2015	1995-2015	1995-2015
BE	1995-2015	1999-2015	1996-2015	1995-2015	1999-2015	1995-2015
CZ	1995-2015	1995-2015	2001-2016	1995-2014	1995-2015	1995-2016
DE	1995-2015	1995-2015	1995-2015	1995-2015	1995-2015	1995-2015
DK	1975-2015	1975-2015	1975-2015	1975-2015	1975-2015	1975-2015
EE	1995-2015	2000-2015 (7)	1998-2010	1995-2015	2000-2015	1995-2014
EL	1995-2015	1995-2015	1995-2014	1995-2015	1995-2015	1995-2014
ES	1995-2015	1995-2015	1978-2014	1995-2015	1995-2015	1970-2014
FI	1980-2015	1980-2015 (18)	1980-2016	1980-2015	1980-2015	1980-2015
FR	1975-2015	1975-2015	1978-2016	1975-2015	1975-2015	1978-2015
HU	1995-2015	2010-2015	1999-2014	1995-2015	2010-2015	1995-2014
IE	1995-2015	1998-2015	1995-2014	1995-2015	1998-2015	1995-2014
IT	1995-2015	1995-2015	1996-2014	1995-2015	1995-2015	1995-2014
LT	1995-2015	1995-2015 (18)	2001-2014	1995-2015	1995-2015	1999-2014
LU	1995-2015	1995-2015	1995-2015	1995-2015	1995-2015	1995-2015
LV	1995-2015	2000-2015	2001-2013	1995-2015	2000-2015	1995-2012
NL	1995-2015	1995-2015	1999-2015	1995-2015	1995-2015	1999-2015
NO	1975-2014	1975-2014	1985-2010	1975-2014	1975-2014	1975-2014
PL	2003-2015	2003-2015	1999-2014	2003-2015	2000-2015	1995-2014
PT	1995-2015	1995-2015	1996-2014	1995-2015	1995-2015	1995-2014
SE	1993-2014	1993-2015	1994-2014	1993-2014	1993-2015	1993-2014
SI	1995-2015	1995-2015	2002-2014	1995-2015	1995-2015	1995-2014
SK	1995-2015	1995-2015	2000-2015	1995-2015	1995-2015	1995-2015
UK	1995-2014	1995-2014	1996-2015	1995-2014	1995-2016	1995-2015

Source: author's calculations using Eurostat and Ameco.

Note: numbers in parenthesis correspond to the number of sectors for which data is available, when different than 19. Last data update: June 2017.

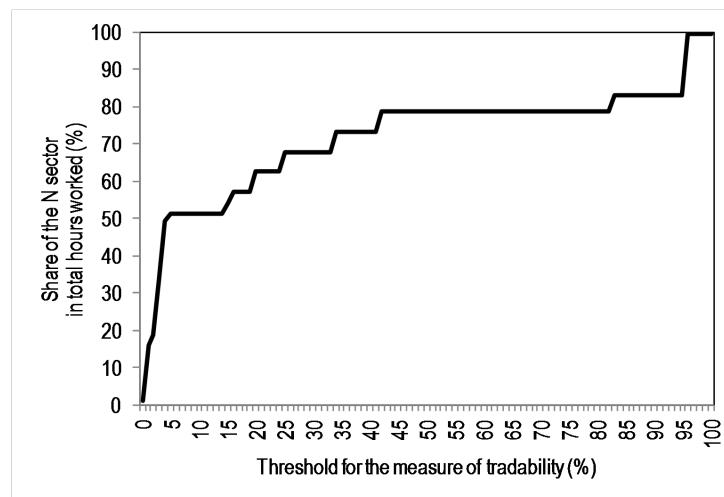
**Table A.4 – Three different tradability indicators  
2014-1995 average, 24 countries**

Sector	Average 1995-2014, 24 countries		
	Openness ratio: trade to production, in %	Mian & Sufi, 2014: trade per worker, in euros	Gregorio et al., 1994: exports to production, in %
B Mining and quarrying	192.34	569,222.56	61.41
C Manufacturing	95.17	160,233.06	48.91
I Accommodation and food service activities	82.49	48,279.50	41.83
A Agriculture, forestry and fishing	41.90	17,831.61	18.26
H Transportation and storage	33.83	37,000.18	17.36
N Administrative and support service activities	24.30	15,453.83	11.77
M Professional, scientific and technical activities	19.68	19,800.85	9.60
J Information and communication	15.06	25,553.96	8.77
K Financial and insurance activities	14.95	26,830.58	9.23
R Arts, entertainment and recreation	4.20	2,976.88	2.47
D Electricity, gas, steam and air conditioning supply	4.19	18,075.38	2.12
G Wholesale and retail trade; repair of motor vehicles and motorcycles	3.85	2,555.30	2.23
F Construction	2.39	2,503.49	1.41
O Public administration and defence; compulsory social security	2.38	1,626.48	1.31
S Other service activities	1.78	904.35	0.83
E Water supply; sewerage, waste management and remediation activities	0.29	466.67	0.18
P Education	0.15	68.08	0.10
Q Human health and social work activities	0.07	34.71	0.02
L Real estate activities	0.00	0.00	0.00
<b>TOTAL</b>	<b>36.48</b>	<b>36,814.62</b>	<b>18.43</b>

Source: author's calculations using Eurostat and BACI.

Note: grey cells are non service activities.

**Figure A.2** – Share of the non-tradable sector in total hours worked depending on the threshold used for the measure of tradability



Source: author's calculations using Eurostat and BACI. Weighted average of the share of the 24 European countries in the dataset, weight: total hours worked.

### Appendix 3 - Additional tables and figures

**Table A.5** – Contributors to the dynamics of unit labour costs using the alternative rental rate: (risk-free rate + KRP)

	relative (T-N, p.p.)									
	TFP		markup		usercost	TFP		markup		usercost
	(b)	(c)	(b)	(c)	(c)	(b)	(c)	(b)	(c)	(c)
	<b>1995-2007</b>					<b>2008-2014</b>				
EA12	9.35	7.58	-1.11	-2.75	9.63	1.93	1.78	-1.29	0.83	-3.72
Peri.	8.80	5.72	1.71	2.66	-5.81	1.94	1.40	-1.36	-1.99	2.91
EL	29.84	24.86	9.11	7.78	-7.31	4.83	2.50	7.59	4.81	-2.40
ES	1.55	-0.65	1.71	3.78	-0.54	2.27	1.91	-2.68	-2.41	-3.38
IE	12.17	9.46	-6.09	-2.99	-34.85	-0.97	-1.31	4.88	-0.75	53.72
PT	22.67	16.42	0.67	-4.41	-5.62	-0.52	-0.16	-10.69	-9.00	-5.04
Core	9.47	7.98	-1.71	-3.91	12.92	1.93	1.86	-1.27	1.44	-5.14
AT	19.08	18.21	3.75	3.63	4.62	0.54	0.40	-2.06	-0.61	-4.20
BE	7.91	7.23	-6.47	-6.45	-3.21	7.16	6.79	6.41	5.99	1.04
DE	5.38	4.06	-2.97	-8.53	26.45	1.66	1.99	0.28	3.66	0.29
FI	33.74	33.05	-8.85	-5.01	-2.73	3.87	3.97	-9.75	-4.87	-9.67
FR	17.61	14.25	-4.07	-5.60	13.57	3.99	3.04	-3.43	0.74	-18.92
IT	7.30	5.96	1.63	1.24	3.77	1.34	1.49	-2.50	-1.16	-4.83
LU	0.70	-0.28	-0.56	3.36	-11.29	2.33	1.39	-4.04	-1.57	-9.14
NL	6.78	7.25	2.42	5.21	-7.58	-2.80	-2.96	-2.31	-0.44	-2.87

Source: author's calculations using Eurostat, BACI, Ameco and Datastream. A threshold of 10% is used for the measure of tradability. Group averages are weighted by country total gross value added at current prices..

**Table A.6** – Estimated contribution of the effects of economic integration and policy intervention to nominal unit labour costs in the periphery (deviation from core countries)

*Decomposition for assumptions (d) with the risk-free rate.*

	Periphery	Greece	Spain	Ireland	Portugal
<b>Period: 1995-2007</b>					
Observed change in % of unit labour costs	26.04	30.65	29.57	5.10	20.90
Construction and real estate	5.35	3.74	6.18	1.45	6.34
<i>Estimated effects</i>					
Productivity	-1.31	9.12	-4.72	0.30	4.53
Competition	5.15	3.78	3.03	19.11	5.21
Financial integration	0.42	0.74	0.58	-0.63	0.18
Misallocation	2.00	2.32	1.55	5.03	1.24
Wage gap	1.86	1.03	2.77	0.22	-0.83
Demand	0.02	0.25	-0.14	0.42	0.32
<b>Period: 1995-2014</b>					
Observed change in % of unit labour costs	11.23	16.69	14.97	-11.69	5.86
Construction and real estate	-3.76	-8.27	-3.02	-7.83	1.41
<i>Estimated effects</i>					
Productivity	-1.61	8.72	-4.86	-0.24	3.68
Competition	11.33	18.91	9.60	13.99	9.67
Financial integration	-0.04	-0.36	0.20	-0.73	-0.46
Misallocation	1.23	2.31	1.15	0.34	1.32
Wage gap	0.79	5.26	1.20	-2.48	-3.65
Demand	0.01	0.31	-0.03	-0.14	0.11

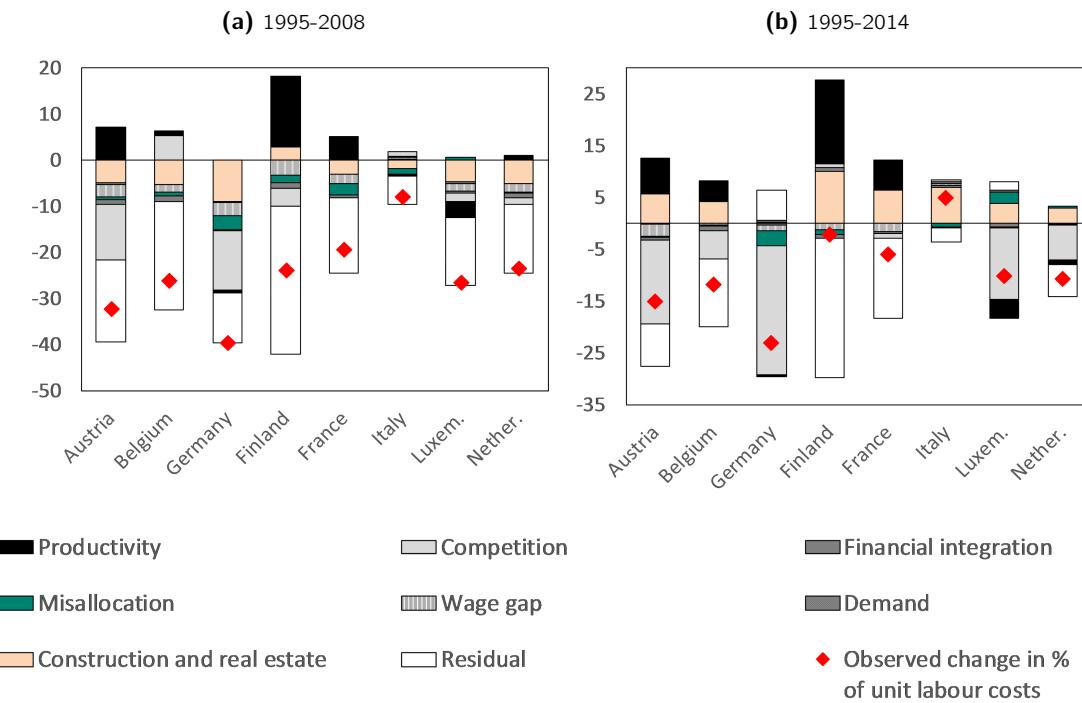
Source: author's calculations using Eurostat, BACI and Ameco. A threshold of 10% is used for the measure of tradability. Group averages are weighted by country total gross value added at current prices.

**Table A.7** – Estimated contribution of the effects of economic integration and policy intervention to nominal unit labour costs in core countries (deviation from the periphery)  
*Decomposition for assumptions (d) with the risk-free rate.*

	Austria	Belgium	Germany	Finland	France	Italy	Luxem.	Nether.
<b>Period: 1995-2007</b>								
Observed change in % of unit labour costs	-32.30	-26.13	-39.58	-23.94	-19.35	-7.92	-26.59	-23.55
Construction and real estate	-4.97	-5.26	-9.03	2.86	-3.00	-1.86	-4.68	-5.00
<i>Estimated effects</i>								
Productivity	7.13	0.84	-0.59	15.27	4.86	-0.34	-3.44	0.94
Competition	-11.99	5.31	-12.85	-3.98	0.23	0.97	-1.82	-1.41
Financial integration	-1.01	-1.31	-0.30	-1.27	-0.61	0.11	-0.41	-0.95
Misallocation	-0.75	-0.71	-2.97	-1.53	-2.43	-1.25	0.65	-0.25
Wage gap	-2.63	-1.75	-2.85	-3.19	-2.18	0.37	-1.63	-1.82
Demand	-0.24	0.09	-0.20	-0.07	0.03	0.29	-0.36	-0.05
<b>Period: 2008-2014</b>								
Observed change in % of unit labour costs	-15.11	-11.79	-23.04	-2.08	-6.00	4.87	-10.15	-10.76
Construction and real estate	5.66	4.22	0.27	10.11	6.44	6.93	3.83	2.87
<i>Estimated effects</i>								
Productivity	6.90	3.86	-0.31	16.15	5.72	-0.22	-3.65	-0.93
Competition	-16.33	-5.40	-24.93	0.80	-0.91	0.35	-13.70	-6.66
Financial integration	-0.40	-0.85	0.38	-0.65	-0.35	0.30	0.44	-0.36
Misallocation	-0.21	-0.28	-2.78	-0.90	-0.04	-0.70	2.15	0.43
Wage gap	-2.36	-0.29	-1.22	-1.26	-1.55	0.49	-0.18	-0.02
Demand	-0.17	0.16	-0.25	0.61	0.08	0.29	-0.71	-0.03

Source: author's calculations using Eurostat, BACI and Ameco. A threshold of 10% is used for the measure of tradability. Group averages are weighted by country total gross value added at current prices. Data start in 1996 in Austria, Germany, Greece, Italy, Luxembourg, and Portugal in 1998 in Ireland, in 1999 in Belgium and in 2000 in the Netherlands.

**Figure A.3** – Nominal unit labour costs in the core, deviation from the periphery, and decomposition into the effects of economic integration and policy intervention (in %)  
*Decomposition for assumptions (d) using the risk-free rate.*



Source: author's calculations using Eurostat, BACI and Ameco. A threshold of 10% is used for the measure of tradability.