Economic Integration and Unit Labour Costs

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Abstract:

Unit labour costs (ULCs) have increased much faster in the periphery than in core Eurozone countries since 1995. This divergence was pointed as a key amplifying factor in the Euro's 2010 crisis; but there is no consensus to date on its cause. This paper investigates the drivers of ULCs divergence. It shows that faster tradable productivity growth in the periphery –i.e. real convergence– fueled a sectoral shift towards non-tradable sectors, and an increase in ULCs. This fact bears important implications and suggests that any effort towards further real convergence in Europe could be associated with a resurgence of such imbalances. (JEL: E65, F41, F45, O33, O41, O47, O52.)

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Introduction

Unit labour costs, the ratio of total labour compensations to real GDP, reflect how wages evolve relative to labour productivity. These costs have increased substantially in the so-called periphery relative to core Eurozone countries since the mid-1990s (Figure 1). Different explanations were put forward to explain this wage-productivity disconnect in the periphery such as poor labour market regulations (Berka et al., 2018), or capital misallocation (Reis, 2013; Gopinath et al., 2017). Yet, no consensus emerged on what caused such imbalances to rise.

Whatever the cause, this divergence was said to have played a key role in the Euro's 2010 crisis. High ULCs, reflecting low competitiveness in the periphery, was pointed as having amplified the 2010 banking and sovereign crises (Shambaugh, 2012). In response, the European Commission put much focus on correcting[1] and preventing ULCs divergence[2].

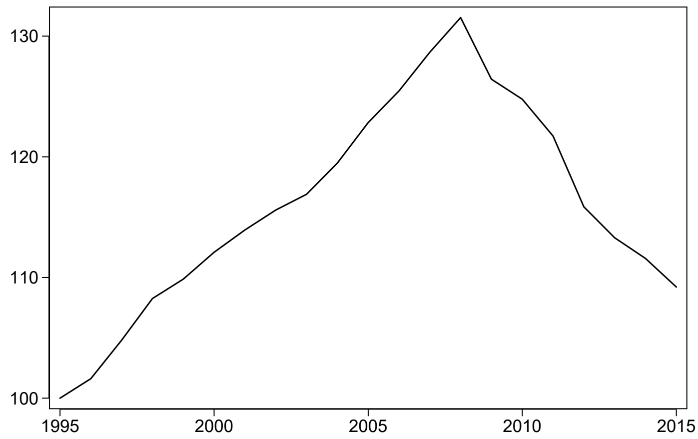
Identifying the main drivers of these rising imbalances is however essential to design policies to correct or prevent them from rising again in the future. Whether diverging ULCs reflect differences in product/market regulations or whether they result from real convergence has different implications. In the latter case, any effort towards real convergence in Europe would be associated with a resurgence of such imbalances if not prevented.

This paper aims at shedding light on the drivers of ULCs divergence in the Eurozone. It starts by documenting how ULCs divergence was driven by a shift of resources towards the non-tradable sector. It then uses a two-sector model to show how any shock affecting the marginal product of labour in the tradable relative to the non-tradable sector, such

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

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

Figure 1 – Nominal unit labour costs (total labour costs to real output) in the periphery, deviation from core countries, 1995-2015 (index 1995=100)



Source: author's calculations using Eurostat.
Note: the periphery includes the four countries of the EA12 (countries that adopted the euro in 2001 and before) with the lowest GDP per capita (at purchasing power standards) in 1995: Greece, Ireland, Portugal and Spain. 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 1999 for Belgium and 1998 for Ireland.

as faster productivity growth, can drive this shift and result in rising ULCs. The paper then identifies various sectoral shocks in the data, and measures their contributions to diverging ULCs in the Eurozone. Results shows that faster tradable productivity growth, and thereby real convergence, is an important cause of increasing ULCs in the periphery relative to the core.

The result that ULCs divergence originates in the non-tradable sector stems from two important stylized facts that the paper highlights using a novel dataset. The first one is that the increase in unit labour costs is driven by the non-tradable sector: the non-tradable sector experienced fast relative (to tradable) price increase and weighted more and more in total costs as it expanded as a share of employment. The second one is that the periphery experienced faster productivity growth in the tradable sector than in the non-tradable sector pre-crisis, a sign of real convergence. The observation of real convergence differs from previous papers, and this can be explained by the definition of the tradable/non-tradable sector. This paper defines a sector as tradable depending on its exposure to international trade, as in De Gregorio et al. (1994), and includes thereby a number of service sectors in the tradable sector. By contrast, previous papers analyzing patterns of convergence/divergence among euro area countries typically classify the manufacturing sector as tradable and services as non-tradable (see, for instance, Estrada et al., 2013).

The paper then presents a 2-sector open economy model where unit labour costs are endogenous to various standard effects in the academic literature on economic integration. It uses results from 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).

In the model, as long as economic integration boosts productivity in the tradable sector of the periphery, the relative price of non-tradables increases (the well-known Balassa-Samuelson effect). As for financial integration, by lowering the user cost of capital, it benefits more the capital-intensive tradable sector, inducing a relative price increase in the non-tradable sector (as suggested by the Stolper-Samuelson theorem). If traded and non-traded goods are complements, those long-run price effects lead to the expansion of the share of employment in the non-tradable sector. On top of these 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. All of these shocks result in a relative (non-tradable to tradable) price increase, and fuels resources to shift to the non-tradable sector –both effects contributing to an increase in aggregate ULCs. The full version of the model developed in the Appendix also expresses ULCs as a function of mark-ups, capital misallocation and distortionary public spendings, all put forward in previous papers as potential determinants of macroeconomic imbalances (see, among others, Reis, 2013; Gopinath et al., 2017; Bunnermeier and Reis, 2019; Sinn, 2014).

The theoretical framework provides an accounting decomposition of unit labour costs growth into various sectoral shocks that can be easily identified in the data. For realistic parameter values, the model generates dynamics of unit labour costs that are consistent with the data. The quantification exercise shows that, before the global financial crisis, the two main drivers of increasing ULCs in Greece and Portugal are this Balassa-Samsuelson effect as well as the collapse of the interest rate. This result suggests that rising ULCs do not necessarily reflects 'competitiveness losses', as it could be associated with productivity growth and catching-up processes. It also shows that any effort towards further real convergence in the future might lead macroeconomic imbalances to rise again. If not prevented, this shift of resources towards non-tradable sectors could contribute to the financial fragility of catching-up economies (Kalantzis, 2015).

The remainder of the paper is organized as follows. Section 1 describes the novel dataset and documents five stylized facts characterizing the periphery since the mid-1990s. Section 2 develops the theoretical framework and presents the accounting decomposition of the growth in ULCs. Section 3 quantifies the contribution of economic integration on the divergences of ULCs in the Euro area. Section 4 concludes.

1. Empirical Evidence

This section presents a novel database built to document the sectoral origins of ULCs dynamics as well as key facts about the dynamics of the tradable and non-tradable sectors in Europe. Sources include national account data at the industry level as well as data on trade in goods and services. The final 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. Data are available for up to 24 countries and cover up to the years 1975-2017, but the coverage differs widely across countries. This paper focuses on a subset of 12 euro area countries over 1995-2015.[3]

1.1. Data

Data are constucted in two steps: first I build growth accounting indicators at the most disagregated 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 and the main descriptive statistics are presented in detail in Appendix 1.

Growth accounting indicators The first step uses Eurostat National Accounts data to build growth accounting indicators for 17 industries. The main divergence from EU KLEMS is that capital compensations are distinguished from profits; in EU KLEMS, and all non-labour income is attributed to capital. I thus distinguish the share of labour, capital and profits (reflecting monopoly power) in gross value added, as in Barkai (2016).[4]

To get a measure of profits, I estimate capital compensations using information on the user cost of capital and capital stocks. I then ultimately deduce the profit share as the residual after measuring the labour and capital shares. User costs of capital are constructed using the standard Hall and Jorgenson (1967) formula, requiring data on investment prices

[3] The 12 countries are: AT: Austria; BE: Belgium; DE: Germany; EL: Greece; ES: Spain; FI: Finland; FR: France; IE: Ireland; IT: Italy; LU: Luxembourg; NL: Netherlands; PT: Portugal.
[4] See (Basu, 2019) for a literature review and discussion of this type of estimates< of markups.

Table 1 – Sector classification and openness ratio, average over the full sample

Sector		Openness ratio (%)		
		1995	2015-1995, change in p.p.	1995-2015, average
Tradable sector				
B	Mining and quarrying	114.76	107.90	192.60
C	Manufacturing	71.66	44.49	96.24
I	Accommodation and food service activities	75.86	8.32	82.80
A	Agriculture, forestry and fishing	31.46	22.35	42.04
H	Transportation and storage	29.87	0.64	33.54
M-N	Professional, scientific and technical, administrative and support service activities	14.14	12.66	21.84
J	Information and communication	6.87	21.72	15.85
K	Financial and insurance activities	7.93	12.86	15.31
Non-tradable sector				
R	Arts, entertainment and recreation	3.47	2.52	4.32
G	Wholesale and retail trade; repair of motor vehicles	2.30	0.43	3.76
D-E	Electricity, gas, water supply	1.83	1.38	3.03
F	Construction	3.20	-0.85	2.41
O	Public admin. and defence	2.95	-1.17	2.34
S	Other service activities	1.15	0.91	1.81
P	Education	0.00	0.19	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
Total		28.87	13.11	36.71

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.

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).[5] 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).[6] 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 4%, while the risk-free rate to an average share of 10%.[7]

Defining the tradability of a sector In a second step, I classify sectors as tradable or not. Economists traditionally use the shortcut of labeling the industry as tradable and services as non-tradable. However, services represent a growing share of total world trade, especially in the Euro area. In Greece, services represented more than half of the value of total exports in recent years.[8] 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

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

[6]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.

[7]The existence of profits –if not accounted for in the measure of inputs and their revenue shares– can also bias the measure of TFP (Fernald and Neiman, 2011).

[8]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).

sector allows me to address both issues: taking into account the importance of services in export performance and overcoming the growing complexity of activities.

I build an openness ratio –ratio of total trade (imports + exports) to total production– using data on production (Eurostat National Accounts), data on trade in services (Eurostat Balance of Payments) and data on trade in goods (BACI). A sector is considered tradable if its openness ratio is greater than 10%, on average for the full sample.[9]

Table 1 reports the resulting classification. Unsurprisingly, mining and quarrying, manufacturing and agriculture activities are found tradable. Concerning services, five industries are considered tradable. The non-tradable sector accounts for 48% of total gross value added (38% if we exclude construction and real estate from the sample) and 51% of employment (resp. 51%) on average. 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 20% would exclude financial and insurance activities and information and communication from the tradable sector. Appendix 1 discusses further the choice of the indicator and the choice of the 10% threshold.

1.2. Key stylized facts characterizing the periphery (relative to the core)

In the following, the periphery includes the four countries of the EA12 (countries that adopted the euro in 2001 and before) with the lowest GDP per capita (at purchasing power standards) in 1995: Greece, Ireland, Portugal and Spain. Core countries are Austria, Belgium, Germany, Finland, France, Italy, Luxembourg and the Netherlands.

[9] The full sample includes 24 countries over 1995-2015. It consists of the EU28 excluding Bulgaria, Croatia, Cyprus, Romania, Malta due to poor data quality but including also Norway.

Fact 1: increasing unit labour costs The first fact, already discussed in the introduction, is the large increase in unit labour costs in the periphery relative to core countries in the pre-crisis period. Unit labour costs increased by 30% more in the periphery than in core countries from 1995 up to the onset of the global financial crisis (Figure 2).

Fact 2: stable profit shares If reflecting a growing "competitiveness gap" between the periphery and the core countries, increasing unit labour costs should be parallel to worsened profitability, at least in the tradable sector of the periphery.

Figure 3 shows profit shares in the periphery and core countries, for the total economy and the tradable sector. Profit shares follow the very same dynamic in the tradable sector than in the total economy. They remained relatively stable in both the core and periphery since the 2000s.[10] They are in 2015 at the same level than in 1995 in the periphery. Profit shares could thus hardly explain such faster increase in unit labour costs in the periphery.[11]

Fact 3: increasing share of the (non-housing) non-tradable sector The loss in aggregate competitiveness does not reflect a loss in the competitiveness of the tradable/ export-led sectors, but an increase in the share of the less competitive non-tradable sector. Indeed, an important point to note from Figure 2 is that the increase in unit labour costs was mostly driven by the non-tradable sector (grey line). And not only the non-tradable sector experiences faster growth in ULCs, but it also increased in size –reinforcing its contribution to the growth in aggregate unit labour costs.

Figure 4 displays the share of the non-tradable sector in total hours worked in the two groups of countries.[12] The share of the non-tradable sector rose steeply in the periphery

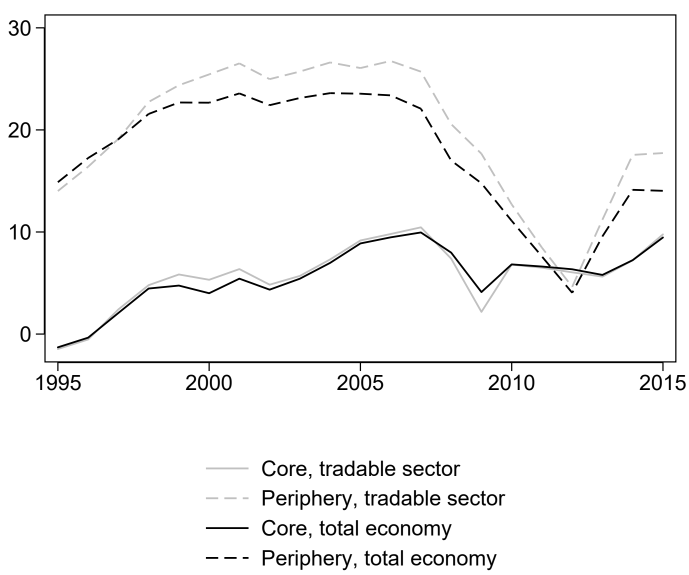
[10]This fact is in line with recent evidence from Gutierrez and Philippon (2018).

[11]The stability of the profit share is robust to the choice of the rental rate. This simply results from the fact that the different rental rates follow similar dynamics (see Figure A.1 in Appendix.)

[12]The 12 core and peripheral countries of the euro area all adopted the Euro in 1999 or 2001 for Greece.

Figure 2 – Nominal unit labour cost in the periphery, in deviation from core countries, index 1995=100

Figure 3 – Profit shares, in %



Source: author's calculations using Eurostat and BACI.
Note: Unit labour costs in deviation from the core average for the total economy. A risk-free rate is used for the measure of the profit share. A threshold of 10% is used for the measure of tradability. See section 1.1 for more details on the data construction. Core countries: Austria, Belgium, Germany, Finland, France, Italy, Luxembourg, Netherlands. Periphery: Greece, Spain, Ireland, Portugal. Data start in 1998 for Ireland. Averages over countries are weighted by GDP at PPP.

from 1995 up to 2007 (+4.7p.p.), while it declined slightly in core countries (-0.3p.p.). These shares started declining after the global financial crisis in the periphery but not in core countries. The increase in the share of the non-tradable sector before 2008 in the periphery is sizable even when excluding the construction and real estate sectors from the sample (see dotted lines in Figure 4, core: -0.2p.p., periphery: +3.2p.p.).

The share of the non-tradable sector in hours worked increased most in Ireland and Greece, while it decreased in Germany (see Figure 5). Housing bubbles contributed greatly to the dynamics of the non-tradable sectors as the construction sector was among the fastest growing sector in peripheral countries over 1995-2007. 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 such as wholesale and retail trade, human health and social work activities. Since the global financial crisis, the share of the construction sector collapsed in every peripheral economies, and the increase in the share of the non-tradable sector comes mostly from the health, public administration and education sectors (see Table A.5 in Appendix).

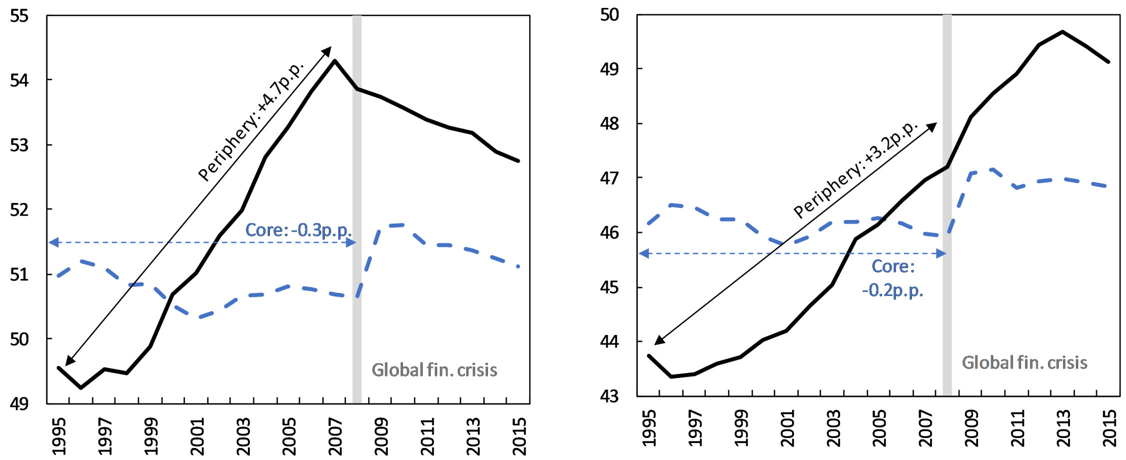
Fact 4: falling interest rates Financial integration was already put forward as one potential driver for the expansion of the non-tradable sector (see, for example, Reis, 2013). Together with the creation of the monetary union, financial integration have led to a convergence of nominal long-term interest rates. Peripheral economies thus faced large decreases in their interest rates.[13] Long-term nominal interest rates converged among euro area countries to about 4% around the mid-2000s. In peripheral economies, interest rates declined by 7.6 p.p. on average over 1995-2007, while interest rates declined by

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.

[13]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.

Figure 4 – Share of the non-tradable sector in hours worked, by country group, 1995-2015, in %

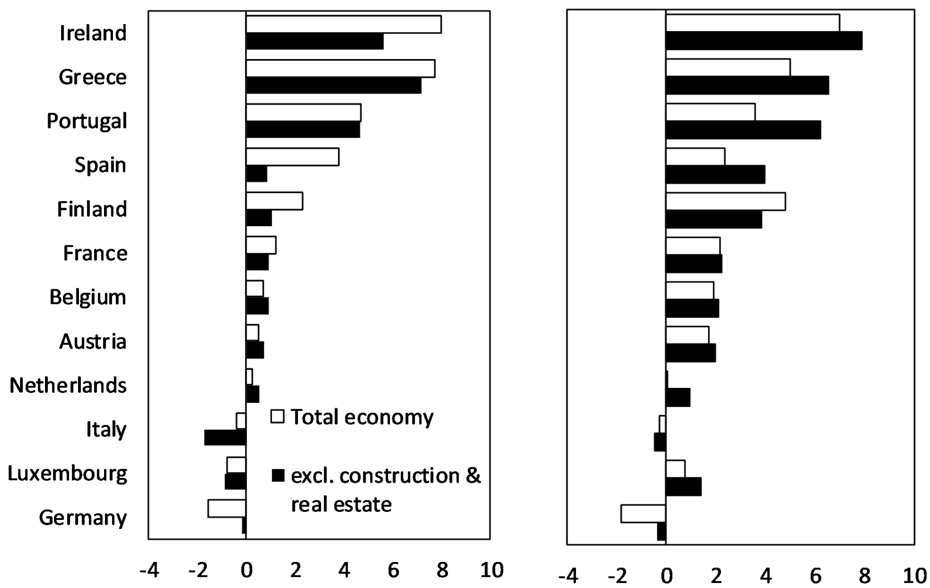
(a) Total economy **(b)** Excl. construction and real estate



Source: author's calculations using Eurostat and BACI.
Note: a threshold of 10% is used for the measure of tradability. 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. Averages over countries are weighted by the number of hours worked.

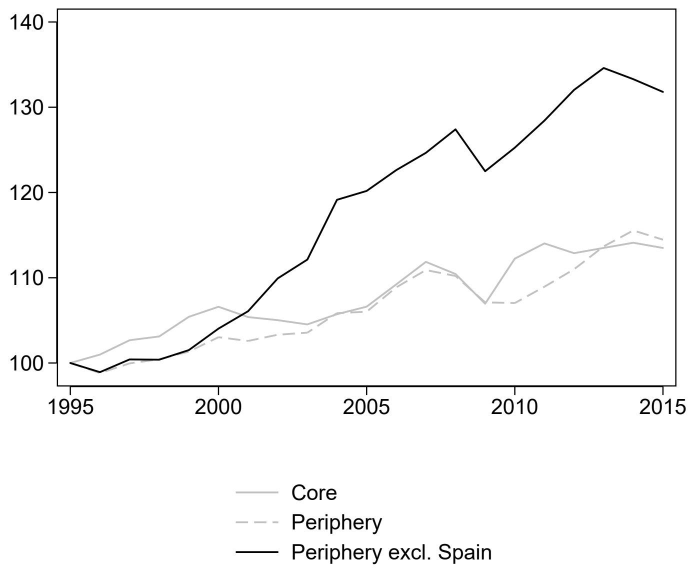
Figure 5 – Change in the share of the non-tradable sector in hours worked (p.p.)

(a) 1995-2007 **(b)** 1995-2015



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.

Figure 6 – Relative (tradable vs. non-tradable) TFP, index 1995=100



Source: author's calculations using Eurostat and BACI.
Note: relative (tradable vs. non-tradable) total factor productivity growth. A threshold of 10% is used for the measure of tradability. Core countries: Austria, Belgium, Germany, Finland, France, Italy, Luxembourg, Netherlands. Periphery: Greece, Spain, Ireland, Portugal. Data start in 1998 for Ireland. Averages over countries are weighted by GDP at PPP.

only 3.7 p.p. on average in core countries. If looking at the rate including a capital risk premium, it declined respectively about 9.4 p.p. and 3.7 p.p. Interest rate increased again after the 2008 global financial crisis and more particularly the 2011 euro area crisis (see Figure A.1 in Appendix).

Fact 5: faster productivity growth in the tradable (vs. non-tradable) sector A novel and important fact stemming from this database concerns TFP. Figure 6 displays the change in TFP in the tradable relative to the non-tradable sector for each country group. TFP increased faster in tradable than non-tradable sectors everywhere over 1995-2007.

Two important points are worth noting. First, the relative increase was steeper for the periphery than for the core countries, but Spain is again an outlier. So, outside of Spain, a Balassa-Samuelson effect could be at play to explain the dynamics of the non-tradable sector in the periphery. Second, in the periphery before the financial crisis, TFP grew most in tradable services. This suggests that the Balassa-Samuelson effect could be significantly underestimated if measured using the standard manufacturing vs. services classification (see Figure A.3 in Appendix).[14]

In total, the increase in aggregate ULCs in peripheral countries before the crisis is concomitant to the following stylized facts: (i) a stable profit share, (ii) an increasing contribution of the non-tradable sector to this rise, (iii) a falling interest rate relative to the core (iv) a faster rise in the TFP in the tradable sector than in the non-tradable sector, and more so than in core countries.

2. Decomposing Unit Labour Costs

To what extent is the rise in ULCs related to economic integration? To answer this question, this section presents a model built 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 2 contains the full version of the model, only the main results are presented here.

2.1. A two-sector small open economy

The model has two key ingredients: it features a small open economy, and includes two sectors –the tradable sector (T) and the non-tradable sector (N). Economic integration

[14]The Balassa-Samuselon effect is robust to various definitions of TFP: whether TFP is adjusted or not for profits, and whether profits are measured using risk-free rates or adding a capital risk premium.

takes the form of two exogenous effects in this economy, in line with the empirical evidence: (i) fast tradable productivity growth, (ii) a decreasing interest rate spread. Extensions to the model include as well sector-specific markups, different returns to capital across sector as a proxy for capital misallocation, and a public sector to model the effects of distortionary public spending.

The implications of different total factor productivity (TFP) growth across sectors for resource reallocation 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 adapt this closed economy framework to a small open economy. I consider that the economy is composed of a tradable and a non-tradable sector, rather a manufacturing vs. service sector.

By analogy to Ngai and Pissarides (2007), structural change hereafter refers to a change in the share of the non-tradable sector in hours worked. I 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.

Labour is not mobile across countries: the labour force is exogenous and grows at the rate ν. Conversly, 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:

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

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

Production functions are Cobb-Douglas: $Y_t^j = A_t^j (K_t^j)^{\alpha^j} (L_t^j)^{(1-\alpha^j)}$ with α^j the capital intensity of sector j, and A_t^j the sector-specific technology. This production function can be written in units per labour: $y_t^j = A_t^j n_t^j (k_t^j)^{\alpha^j}$. Firms are equity-financed and seek to maximize the present discounted value of dividends. Dividends (expressed in terms of tradables) in each period equal revenues net of wages and capital expenditures: $D_t^j = p_t^j Y_t^j - \omega_t L_t^j - q_t I_t^j$ where q_t is the price of investment goods[15] and I_t^j represents gross investment.[16] The representative firm has market power, so its price p_t^j depends on its

[15]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.

[16]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, I assume that investment decisions are made by firms. One could imagine an economy where firms rent capital from consumers who directly own it and make investment decisions. Results would carry through.

choice of output: $p_t^j(Y_t^j)$. With perfect foresight, the firms' programme at time t is:

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

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

$R_{t,s}$ is the discount factor.[17] The firm's programme is subject to initial capital K_0^j, the production function, and the constraint that capital input depends on investment and depreciation δ.[18] 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:

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

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

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

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

In each sector j the markup is $\mu_t^j = \left(1 + \left(\partial p_t^j / \partial Y_t^j\right)\left(p_t^j / Y_t^j\right)\right)^{-1}$, as in Fernald and Neiman (2011). This markup derives from the fact that firms have a market power.[19] Value added in each sector can then be decomposed into labour compensations, capital compensations

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

[18] 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.

[19] 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).

and profits. It results that 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:

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

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.

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:

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

where β is the rate of time preference, ν 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:

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

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 ω_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:

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

With $\gamma \in [0,1]$ the share of the non-tradable good, and $\theta > 0$ the elasticity of substitution between the two goods[20]. The consumption price index p_t is a function of the relative price of the non-traded good p_t^N:

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

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

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

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

and the inter-temporal Euler equation:

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

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 is consistent with what is observed in data, as evidenced in Section 3.

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

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

with $\hat{z} = \frac{z_{t'}}{z_t} - 1$ denoting 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 $\left(\hat{A}_t^T - \hat{A}_t^N\right)$, a negative impact of $\left(\hat{\mu}_t^T - \hat{\mu}_t^N\right)$ and a negative impact of $\hat{U}_t$ on $\hat{p}_t^N$.

Changes in the relative price reflects the typical Balassa-Samuelson effect, i.e. a positive link between faster productivity growth in the tradable sector and the relative price of the non-tradable good. This effect stems from the fact that productivity gains in the tradable sector leads to a wage increase, which ensures that the marginal cost of tradables remains constant. However, it increases the marginal cost, and hence the relative price of the non-tradable good –the more so that the non-tradable sector is labour-intensive. 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 Stopler-Samuelson theorem: a decrease in the user cost of capital decreases the relative price of the product that uses capital intensively.[21]

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

$$s_t^N = f^+(n_t^N) = (1-\gamma)\left(\frac{p_t^N}{p_t}\right)^{1-\theta}\chi_t \tag{13}$$

where $\chi_t = \frac{p_t c_t}{p_t y_t}$ is the consumption rate. The two first terms on the right hand side represent the employment needed to satisfy the relative demand for the non-tradable good. The third product is the consumption rate. Replacing p_t using equation 9, and differentiating equation 13, we get the dynamics of s_t^N which satisfies:

$$\hat{s}_t^N = (1-\theta)(1-\psi_t)\hat{p}_t^N + \underbrace{\hat{\chi}_t}_{\substack{\text{demand-boom}\\ \text{effect}}} \tag{14}$$

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

[21] 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).

The properties of structural change follow immediately from equation 14. There are four drivers of structural change: the three supply-side drivers of the relative price from equation 12, and a fourth driver deriving from the fact that the composition of output also depends on demand factors.

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. Labour 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.[22]

Absent differences in capital intensities across sectors ($\alpha_N = \alpha^T$) and with perfect competition (μ^T=μ^N=1), the expression of structural change reduces to the expression found

[22]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).

in Ngai and Pissarides (2007):

$$\hat{n}_t^N = \underbrace{(1-\theta)(1-\psi_t)(\hat{A}_t^T - \hat{A}_t^N)}_{\text{productivity effect}} + \underbrace{\hat{\chi}_t}_{\substack{\text{demand-boom} \\ \text{effect}}} \tag{15}$$

2.3. Implications for real unit labour costs

Let us now define real unit labour costs (ULC) as the ratio of real wages (in terms of the tradable good) to labour productivity. 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:

$$ULC_t = \frac{w_t L_t}{Y_t} = \frac{y_t^N}{y_t} ULC_t^N + \frac{y_t^T}{y_t} ULC_t^T \quad \text{with} \quad ULC_t^j = \frac{w_t n_t^j}{y_t^j}, \quad j = N, T \tag{16}$$

Using firms' FOCs in each sector, we get that:

$$ULC_t^N = p_t^N LS_t^N = p_t^N \frac{(1-\alpha^N)}{\mu_t^N} \quad \text{and} \quad ULC_t^T = LS_t^T = \frac{(1-\alpha^T)}{\mu_t^T} \tag{17}$$

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.[23]

Differentiating and combining equations 16 and 17, as well as replacing the expression for the relative price and share of the non-tradable sector, real unit labour costs can be decomposed into the effect of productivity ($PROD_t$), the effect of competition ($COMP_t$),

[23] This result derives from the fact that wage earners do not get a share in the markup, as is typically the case in the the literature (see Barkai, 2016, for example). 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.

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

$$\begin{aligned}
\widehat{ULC}_t =& PROD_t + COMP_t + FIN_t + DEM_t \qquad (18)\\
\text{with } PROD_t =& \left[\psi_t + \Omega_t(1-\theta)(1-\psi_t)\right]\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{A}_t^T - \hat{A}_t^N\right]\\
COMP_t =& -\left[\psi_t + \Omega_t(1-\theta)(1-\psi_t)\right]\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{\mu}_t^T - \hat{\mu}_t^N\right] - \hat{\mu}_t^T(1-n_t^N) - \hat{\mu}_t^N n_t^N\\
FIN_t =& \left[\psi_t + \Omega_t(1-\theta)(1-\psi_t)\right]\left(\frac{\alpha^N-\alpha^T}{1-\alpha^T}\right)\hat{U}_t\\
DEM_t =& \Omega_t\hat{\chi}_t
\end{aligned}$$

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.

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 ULCs is productivity. Productivity has a positive effect on ULCs by increasing the relative price (thereby reducing the competitiveness of the non-tradable 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 ULCs 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 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 ULCs. 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 ULCs in both sectors; on the opposite, increasing markups decrease ULCs 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 to the labour-intensive non-tradable sector, where the labour share–and so ULCs–are higher (composition effect).

The divergence of nominal ULCs The model provides a decomposition of real ULCs, that is of ULCs in terms of the tradable good. I focus rather on nominal ULCs ($nULC$) 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) ULCs growth from core countries should be equivalent to deviations in nominal ULCs growth (the same deflator should apply for all countries).[24]

[24] 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).

3. Quantification

This section brings the accounting decomposition of unit labour costs proposed in equation 18 to the data. It also considers two additional effects on top of those identified in the previous section: the effect of capital misallocation (described in Appendix 2.3) and distortionary public spending (described in Appendix 2.4). Both effects affect the relative price, and thereby ULCs. The full version of ULCs decmposition is shown in equation 20 in Appendix.

Calibration Two important parameters must be calibrated. The first important parameter is the share of non-tradable consumption in total consumption: ψ_t. Since there is no input/output structure involved in the model, ψ_t corresponds to a 'theoretical' non-tradable consumption and can be measured using value added data (Herrendorf et al., 2014).[25] Non-tradable consumption represents 48% of total consumption on average for the 12 EA countries over 1995-2015.

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

[25] 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 thus exclude this sector. With these assumptions, tradable consumption can be deduced by retrenching non-tradable gross value added from total final expenditure net of taxes less subsidies on products. Tradable consumption should also be equal to gross value added minus total investment and minus the tradable balance in the tradable sector. These two approaches of tradable consumption give very similar measures (they differ by +/- 5%).

the estimate is very low and close to zero.[26]

Equipped with an estimate of θ and a measure of ψ_t, and given the dynamics of productivity, markups, user costs, and public vs. private wages, I can quantify the contribution of economic integration and policy intervention to the dynamics of aggregate ULCs. I compute these effects for the overall period 1995-2015. For variables in level, I use their average over the period.

Results In a first step, I compare results for four different decompositions of ULCs (see Appendix 3 for a detailed discussion on these four decompositions):

(i) I first look at the most basic decomposition where ULCs are endogenous to the productivity and demand-boom effects. In this decomposition, there is no markup, no differences across sectors, no capital misallocation nor any policy intervention (equation 21 in Appendix).

(ii) I then account for policy intervention as well as for markups (equation 24 in Appendix).

(iii) I then introduce misallocation, but only across sectors (equation 25 in Appendix).

(iv) Finally, I introduce misallocation across and within sectors and get the full

[26]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: $\log(\psi_t) = \log(1-\gamma) + (1-\theta)\left[\log\left(\frac{p_t^N}{p_t}\right)\right]$. As in Acemoglu and Guerrieri (2008), the elasticity of substitution θ can be estimated using this equation. The estimating relationship will include an idiosyncratic error term and country fixed effects (assuming that way that the parameter γ 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]. 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 I run the regressions in first difference ($\theta \simeq 0.70$).

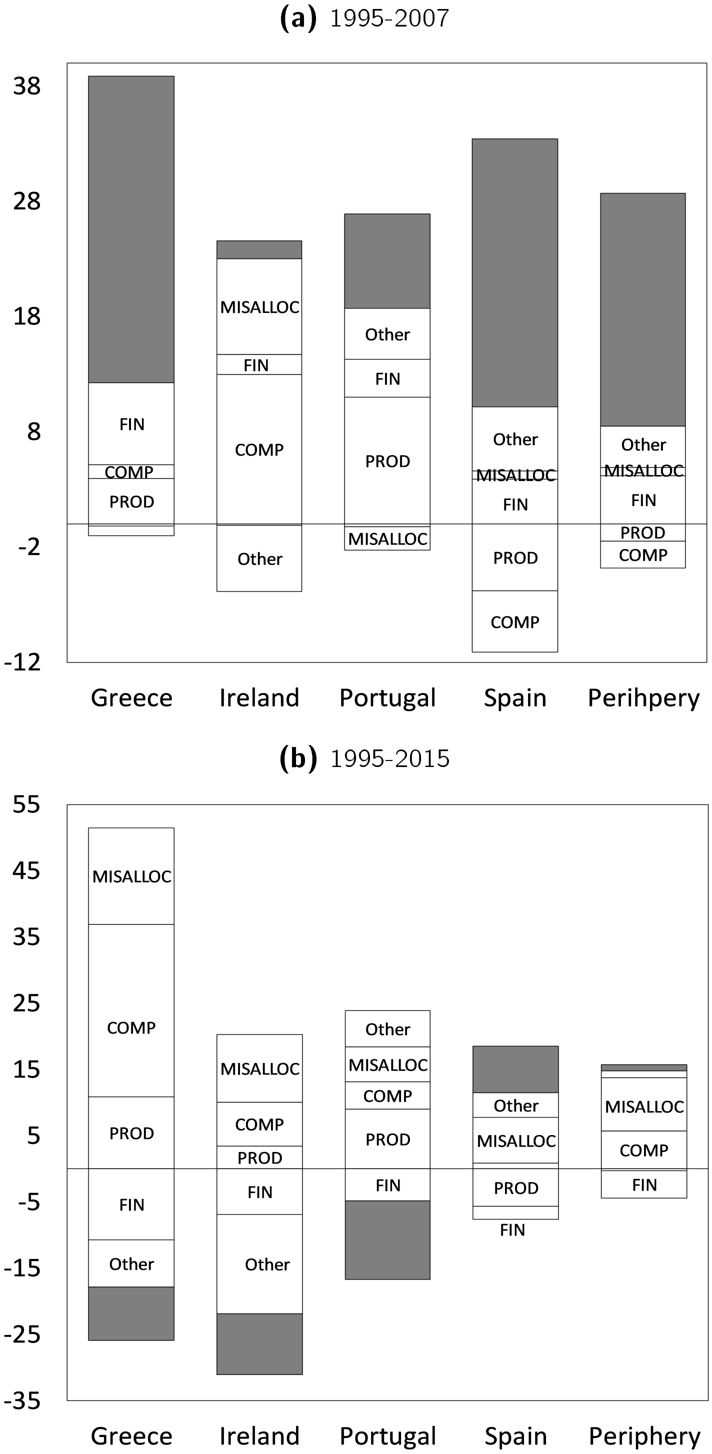
decomposition (equation 20 in Appendix).

Decompositions (ii), (iii), (iv) are driven using the two alternative rental rates (alternatively the risk-free rate and the risk-free rate plus a capital risk premium). Results are presented in Table 2. It shows the contribution of each effect of economic integration and policy intervention to aggregate ULCs growth in the periphery relative to core countries. The observed contribution of the construction and real estate sector to ULCs growth is also displayed. The gap between the observed ULCs growth rate and the estimated ULCs growth rate is shown as the residual. Since the model does not include labour market frictions, this residual can partly be interpreted as reflecting such frictions (Berka et al., 2018, assume all non-productivity-related movements in ULCs reflect a labour market wedge).

Considering only the productivity and demand effects result in a large residual. This residual shrinks when we take into account the overall effects of economic integration, as well as capital misallocation. We can also see that policy intervention does not contribute significantly to the growth in unit labour costs. The strong divergence in unit labour costs between the core and the periphery over 1995-2015 is mostly explained by supply-side effects.

Productivity seems to contribute negatively to the increase in aggregate ULC in the full decomposition (decomposition iv, including misallocation across and within sectors). 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 7 and Table A.6 in Appendix), we can see that this is the case only in Spain. In every other peripheral economies, the Balassa-Samuelson effect was indeed at play.

Figure 7 – Decomposition of nominal ULCs in the periphery (deviation from core countries), by country, 1995-2015, change in % and contributions in p.p.



Source: author's calculations. Decomposition of the growth in unit labour costs as given in equation 20 of the Appendix. It includes misallocation across and within sectors and uses the risk-free rate. Only the name of the main drivers are shown on the Figure, for more details see Table A.6 in Appendix.

Table 2 – Decomposition of nominal ULCs in the periphery (deviation from core countries) under different assumptions, 1995-2015, change in % and contributions in p.p.

		Risk-free rate			Risk-free rate + capital risk premium		
	No profit, no differences across sectors	No misalloc.	Misalloc. across sectors	Misalloc. across and within sectors	No misalloc.	Misalloc. across sectors	Misalloc. across and within sectors
Unit labour costs	11.34	11.34	11.34	11.34	11.34	11.34	11.34
Contribution of:							
Productivity effect	1.32	2.06	0.45	-0.31	2.94	1.02	0.19
Competition effect	-	6.03	5.71	5.71	6.51	6.34	6.34
Financial effect	-	-1.03	-4.07	-4.07	-1.42	-4.49	-4.49
Misallocation effect	-	-	7.29	8.11	-	7.3	8.34
Wage gap effect	-	-1.48	-1.48	-1.48	-1.48	-1.48	-1.48
Demand effect	-0.23	-0.24	-0.24	-0.24	-0.23	-0.23	-0.23
Residual	7.53	3.27	0.95	0.89	2.29	0.16	-0.05
Housing sector	2.72	2.73	2.73	2.73	2.72	2.72	2.72

Source: author's calculations.

Before the global financial crisis, in Greece and Portugal, the two main drivers are: the productivity which explains on average a little less than on third of ULCs growth relative to core countries; the financial effect explaining a little more than 15% on average. Ireland is the country where competition matters most, and could contribute to more than two-third of the growth in ULCs.[27] In Spain, the demand boom effect is the biggest contributor up to the global financial crisis. A symmetric exercise can be driven for core countries relative to the periphery (Table A.7 in Appendix). Estimates fit well the data, especially in Germany over 1995-2015. It results that the competition effect is the biggest driver of decreasing German ULCs.

4. Concluding Remarks

This paper investigates the drivers of ULCs divergence among Eurozone Member States. It shows that faster tradable productivity growth in the periphery, and thereby real con-

[27]However, due to poor data quality for capital stocks, results for Ireland should be interpreted with caution.

vergence, fueled a sectoral shift towards non-tradable sectors, and an increase in ULCs. This fact bears important implications as it suggests that any effort towards real convergence among Member States in the future could be associated with a resurgence of such imbalances if not prevented. Yet, the fact that rising ULCs in the periphery might be associated with tradable productivity gains also questions the idea that such imbalances are necessarily a 'bad' outcome, and calls for further research on whether we should worry about ULCs divergence depending on its source.

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Online appendix for "Economic Integration and Unit Labour Costs"

Appendix 1. Growth accounting for the tradable and non-tradable sector

This section describes the data source and the methodology used to build a set of growth accounting indicators for the tradable and non-tradable sectors in European countries. It builds on 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 17 industries in the NACE revision 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 17 sectors as tradable or non-tradable.

Appendix 1.1. Growth accounting at the 17-industry level

Eurostat provides harmonized National Accounts data by industry for all 28 EU Member States following the 2008 System of National Accounts (SNA).[28] 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

[28] 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

the period, country, indicator and industry considered. A breakdown in 20 industries (19 + total) of the NACE rev.2 classification is chosen to obtain the most detailled 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 17 sectors. Similarly, we focus on 24 countries that have a good data coverage.

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 ($GVAFC$, corresponding to the sum of compensation paid to labour, capital services and profits) is created using information on taxes less subsidies on production.

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 ($LABCOMP$), labour compensations of self-employed are needed.

Labour compensations of self-employed are estimated assuming the average earning by hour worked for self-employed is the same than for employees. Self-employed represent, on average, 20% of total hours worked, with the highest share in Greece (39%) and the lowest share in Luxembourg (6%).

Capital stocks Eurostat provides information on net fixed capital stocks ($NFCS$)[29] 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. When available, we use EU KLEMS to fill missing values. See Table A.1 for the overage of NFCS series by country in Eurostat and EU KLEMS.[30]

Capital compensations and rental rates Capital compensations are the product of capital stocks and user costs of capital. User costs of capital are given in equation Appendix 2.3. They depend on investment prices, depreciation rates and a return to capital. Eurostat provides data on investment prices, and depreciation rates are from KLEMS. Concerning rental rates, I use three different measures.

The first one is what is often called the 'internal' measure and is the one adopted by KLEMS. KLEMS 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. An 'internal' rental rate can then be inferred.

The two other rates are 'ex-ante' measures of rental rates, based exogenous information on capital costs. Using these rates, we are able to distinguish, in the gross operating surplus, the cost of capital from profits. Profits are deduced as the residual when labour

[29] 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.

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

Table A.1 – Availability of NFCS series (2010 prices)

	Eurostat	EU KLEMS
Austria	1995-2016 (7)	1995-2015 (7)
Belgium	1996-2016 (7)	-
Czech Republic	1995-2017 (7)	1995-2015 (7)
Germany	1995-2016 (7)	1995-2015 (7)
Denmark	1975-2015 (7)	1995-2015 (7)
Estonia	2000-2004 (6) - 2005-2015 (7)	2000-2014 (17)
Greece	1995-2015 (7)	1995-2014 (4)
Spain	-	1995-2015 (7)
Finland	1982-2015 (7)	1995-2015 (17)
France	1978-2016 (7)	1995-2015 (7)
Hungary	1996-2015 (7)	1995-2014 (6)
Ireland	1995-2014 (5)	1995-2014 (4)
Italy	1996-2015 (7)	1995-2014 (7)
Lithuania	1995-2015 (7)	2000-2014 (6)
Luxembourg	1995-2016 (7)	1995-2015 (7)
Latvia	1995-2012 (7) - 2013-2015 (6)	1995-2014 (7)
Netherlands	2000-2016 (7)	2000-2015 (7)
Norway	1975-2015 (7)	-
Poland	2000-2015 (6)	2000-2014 (4)
Portugal	2000-2015 (5)	2000-2014 (4)
Sweden	1994-2015 (7)	1995-2014 (7)
Slovenia	2000-2016 (7)	2000-2015 (7)
Slovakia	2004-2015 (7)	2004-2015 (7)
United Kingdom	1996-2016 (7)	1997-2015 (7)

Note: numbers in parenthesis correspond to the number of assets available. The maximum is 7 (the most disagregated level). Last data update: July 2018.

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 (Caballero et al., 2017).

The three different rental rates are presented in Figure A.1 for the core and periphery over 1995-2015. An additional rate is presented corresponding to the cost of borrowing indicator for non-financial corporations provided by the ECB.

Coverage The coverage of the final dataset is reported in Table A.2.

Appendix 1.2. Defining the tradability of a sector

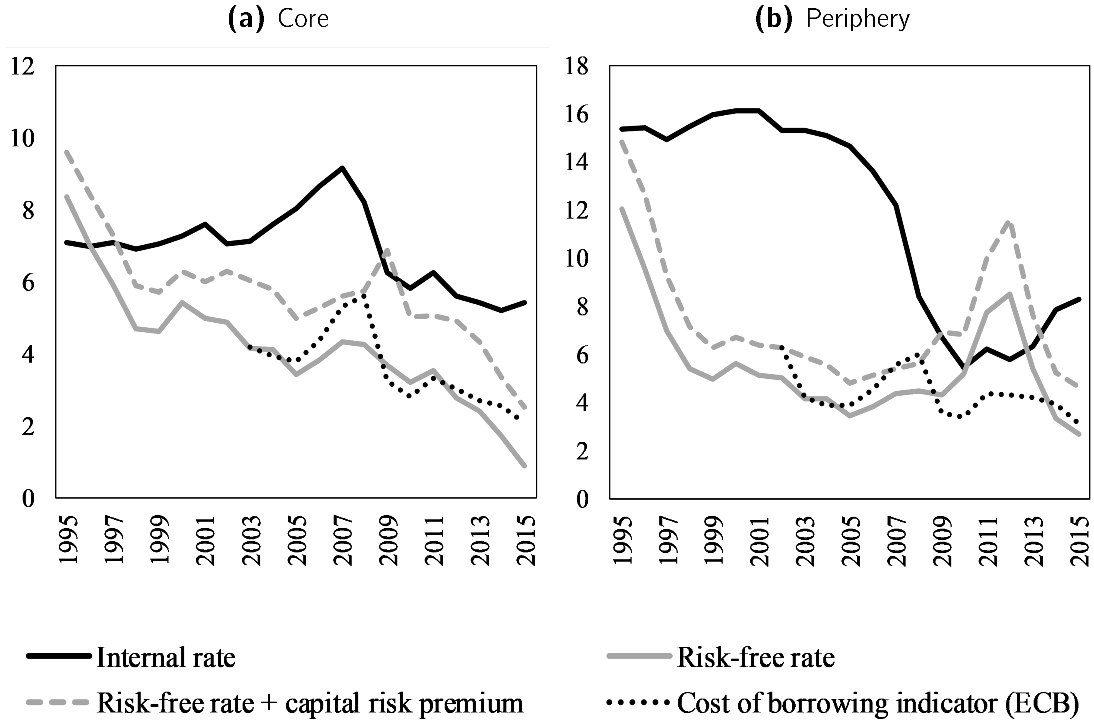
Most studies label the manufacturing sector as tradable and consider services sectors as non-tradable. However, services represent an increasing share of advanced economies' exports. To reassess the tradability of each of the 17 sectors defined above, I build a tradability indicator using the extent 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.,

Table A.2 – Coverage of the dataset at the 17-industry level

	GVAFC	LABCOMP	CAPCOMP	GVAFC	EMP	NFCS
	current price			2010 prices	hours worked	2010 prices
Austria	1995-2016	1995-2016	1996-2016	1995-2016	1995-2016	1995-2016
Belgium	1995-2016	1999-2016	1997-2016	1995-2016	1999-2016	1996-2016
Czech Republic	1995-2017	1995-2017	2001-2016	1995-2017	1995-2017	1995-2017
Germany	1995-2016	1995-2016	1996-2016	1995-2016	1995-2016	1995-2016
Denmark	1975-2017	1975-2017	1996-2015	1975-2017	1975-2017	1995-2015
Estonia	1995-2016	2000-2016	2001-2010	1995-2016	2000-2016	2000-2015
Greece	1995-2016	1995-2016	1996-2015	1995-2016	1995-2016	1995-2015
Spain	1995-2016	1995-2016	1996-2015	1995-2016	1995-2016	1995-2015
Finland	1980-2016	1980-2016	1983-2016	1980-2016	1980-2016	1982-2016
France	1978-2015	1978-2015	1979-2016	1978-2016	1975-2016	1978-2016
Hungary	1995-2016	2010-2016	1999-2014	1995-2016	2010-2016	1995-2014
Ireland	1995-2016	1998-2016	1996-2014	1995-2016	1998-2016	1995-2014
Italy	1995-2016	1995-2016	1997-2015	1995-2016	1995-2016	1996-2015
Lithuania	1995-2016	1995-2016	2001-2015	1995-2016	1995-2016	1995-2015
Luxembourg	1995-2016	1995-2016	1996-2016	1995-2016	1995-2016	1995-2016
Latvia	1995-2016	2000-2016	2001-2014	1995-2016	2000-2016	1995-2014
Netherlands	1995-2016	1995-2016	2001-2016	1995-2016	1995-2017	2000-2016
Norway	1975-2015	1975-2015	1985-2010	1975-2015	1975-2015	1975-2015
Poland	1995-2016	2000-2016	2001-2015	1995-2016	2000-2016	2000-2015
Portugal	1995-2016	1995-2016	2001-2015	1995-2016	1995-2016	2000-2015
Sweden	1993-2015	1993-2014	1995-2015	1993-2016	1993-2016	1994-2015
Slovenia	1995-2016	1995-2016	2002-2016	1995-2016	1995-2016	2000-2016
Slovakia	1995-2016	1995-2016	2005-2015	1995-2016	1995-2016	2004-2015
United Kingdom	1995-2015	1995-2015	1997-2015	1995-2015	1995-2017	1996-2016

Source: author's calculations using Eurostat and EU KLEMS. Last data update: July 2018.

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



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

1994; Mian and Sufi, 2014).

Eurostat national accounts data 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 2016 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 2010-2016. All databases are converted into the 17-level NACE revision 2 classification for the 24 countries presented in Table A.2 over 1995-2015 (data quality is too poor for 2016, too much data are missing before 1995).

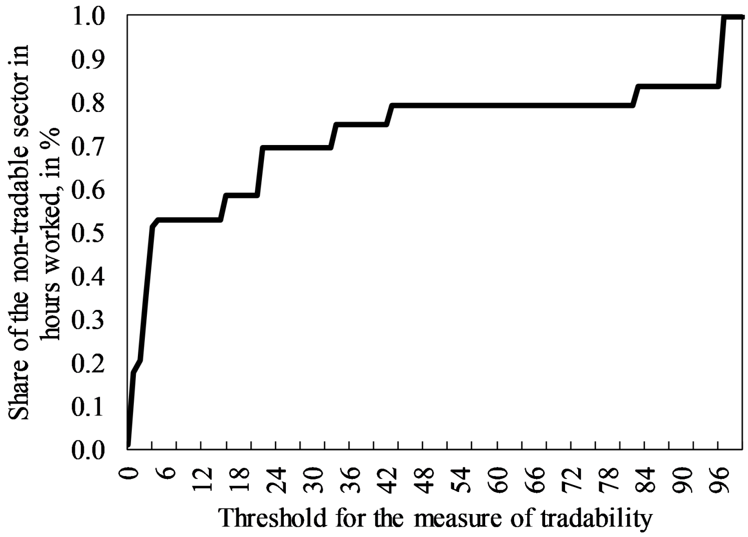
We define an openness ratio for each sector –the ratio of total trade (imports + exports) to total production. The openness ratio tends to increase in each sector between 1995 and 2015, as well as for the total economy (from 29% in 1995 to 42% in 2015 for total area). The most opened country is Estonia (87%) and the least 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 1995-2015 (average weighted by production in current prices), then the sector is considered as tradable. Table 1 in section 1 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 17 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 half 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, 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 1995-2015. 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.3). Using the same indicator as Gregorio et al. (1994) would be the same than using the 20% threshold.

Figure A.2 – Share of the non-tradable sector in total hours worked depending on the threshold used for the measure of tradability, average 1995-2015



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.

Table A.3 – Three different tradability indicators
average 1995-2015, 24 countries

Sector code	Sector name	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	192.60	576987.44	61.41
C	Manufacturing	96.24	165080.28	49.43
I	Accommodation and food service activities	82.80	48598.83	42.12
A	Agriculture, forestry and fishing	42.04	18320.80	18.30
H	Transportation and storage	33.54	37269.89	17.27
M-N	Professional, scientific and technical, administrative and support service activities	21.84	18097.21	10.54
J	Information and communication	15.85	27119.19	9.29
K	Financial and insurance activities	15.31	27954.94	9.49
R	Arts, entertainment and recreation	4.32	3112.46	2.54
G	Wholesale and retail trade; repair of motor vehicles	3.76	2547.08	2.12
D-E	Electricity, gas, water supply	3.03	8899.44	1.55
F	Construction	2.41	2533.24	1.42
O	Public administration and defence	2.34	1626.35	1.29
S	Other service activities	1.81	929.19	0.83
P	Education	0.15	70.34	0.09
Q	Human health and social work activities	0.07	38.10	0.03
L	Real estate activities	0.00	0.00	0.00
TOTAL	Total	36.71	36952.74	18.52

Source: author's calculations using Eurostat and BACI.

Appendix 2. Theoretical model: proofs and derivations

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

Appendix 2.1. Detailed baseline model

The representative household has the following programme:

$$V_t = \sum_{s=t}^{\infty} [\beta(1+\nu)]^{s-t} \ln(c_s)$$
$$\text{where} \quad c_t = [\gamma^{\frac{1}{\theta}} {c_t^T}^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} {c_t^N}^{\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}}$$
$$\text{subject to} \quad p_t c_t = \omega_t + d_t + (1+\nu) f_{t+1} - R_t f_t$$
$$\text{with} \quad p_t c_t = c_t^T + p_t^N c_t^N$$

The budget constraint is expressed in units per capita:

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

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):

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

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:

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

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:

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

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 ψ_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 $\theta \to 0$, 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 $\theta \to \infty$, 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 $p_t = \left[\gamma + (1-\gamma)(p_t^N)^{1-\theta}\right]^{\frac{1}{1-\theta}}$, 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:

$$\max_{p_t^j} \sum_{s=t}^{\infty} R_{t,s}^{-1}(p_s^j Y_s^j - \omega_s L_s^j - q_s I_s^j)$$
$$\text{where} \quad R_{t,s} = (1+r)^{s-t}\frac{\prod_{\tau=t}^{s}(1+x_\tau)}{(1+x_t)}$$
$$\text{subject to} \quad Y_t^j = A_t^j (K_t^j)^{\alpha^j}(L_t^j)^{(1-\alpha^j)}$$
$$\text{with} \quad I_s^j = K_{s+1}^j - (1-\delta)K_s^j \quad \text{and given } K_t^j.$$

Replacing Y_s^j with the production function and I_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:

$$\frac{\partial D_t^j}{\partial L_t^j} = \frac{\partial p_t^j}{\partial Y_t^j}\frac{\partial Y_t^j}{\partial L_t^j}Y_t^j + p_t^j\frac{\partial Y_t^j}{\partial L_t^j} - \omega_t = 0$$

$$\Rightarrow \omega_t = \frac{(1-\alpha^j)}{\mu_t^j}\frac{p_t^j Y_t^j}{L_t^j} = \frac{(1-\alpha^j)}{\mu_t^j}\frac{p_t^j y_t^j}{n_t^j}$$

$$\frac{\partial D_t^j}{\partial K_t^j} = \left(\frac{\partial p_t^j}{\partial Y_t^j}\frac{\partial Y_t^j}{\partial K_t^j}Y_t^j + p_t^j\frac{\partial Y_t^j}{\partial K_t^j} + q_t(1-\delta)\right) - R_{t-1,1}^{-1}q_{t-1} = 0$$

$$\Rightarrow U_t = q_{t-1}(1+r)(1+x_t) - q_t(1-\delta) = \frac{\alpha^j}{\mu_t^j}\frac{p_t^j Y_t^j}{K_t^j} = \frac{\alpha^j}{\mu_t^j}\frac{p_t^j y_t^j}{k_t^j n_t^j}$$

$$\text{with} \quad \mu_t^j = \left(1 + \left(\partial p_t^j/\partial Y_t^j\right)\left(p_t^j/Y_t^j\right)\right)^{-1}$$

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:

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

Drivers of structural change The FOCs in the non-tradable sector yield 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, $p_t y_t = y_t^T + p_t^N y_t^N = \omega_t \left(\frac{n_t^N}{LS_t^N} + \frac{n_t^T}{LS_t^T}\right)$:

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

Differentiating this expression, we get the dynamics of s_t^N which satisfies

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

Replacing $\hat{p}_t$ as a function of ψ_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, we get:

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

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

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

Real Unit Labour Costs Real unit labour costs (ULC) is the ratio of real wages (in terms of the tradable good) to labour productivity. 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:

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

Using firms' FOCs in each sector, and replacing the relative price, we easily get that:

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

Differentiating the expression for aggregate ULC, we get:

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

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 relative price, this expression gives provides the decomposition of real unit labour costs growth into the effect of productivity ($PROD_t$), the effect of competition ($COMP_t$), the effect of financial integration (FIN_t), and the effect of the demand-boom (DEM_t):

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

Appendix 2.2. 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:

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

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:

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

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^{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: $U_t^{biased} = \frac{U_t K_t + \pi_t}{K_t} = U_t + \frac{PS_t}{k_t}$.

Appendix 2.3. Model extension 1: Heterogeneous returns to capital

So far, it has been assumed that firms in both sectors face the same marginal cost of capital, implying that capital is homogenous and moves freely across sectors. However, the recent literature has emphasized the role of financial frictions and heterogenous 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 returns to capital across firms. In this section we aim at measuring the contribution of 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, 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.[31] Each asset k receives a different price U_t^k but moves freely across sectors and receives the same price everywhere. Differences in user costs reflect differences in the price of assets as well as differences in depreciation rates across assets:

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

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

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

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

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

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

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

with $\phi_t^k = \frac{U_t^k K_t^k}{\sum_k U_t^k K_t^k}$ the share of asset k in total capital compensations, $\phi_t^{k,j} = \frac{U_t^k K_t^{k,j}}{\sum_k U_t^k K_t^{k,j}}$ the share of asset k in capital compensations of sector j, $\phi_t^{k,j,i} = \frac{U_t^k K_t^{k,j,i}}{\sum_k U_t^k K_t^{k,j,i}}$ the share of asset k in capital compensations of sub-sector i. An increasing reallocation term indicates a change in the composition of capital with an increasing share of assets with a high user cost of capital. Since user costs of capital are higher for technological assets (ICT equipment and IPP), whereas the user cost of buildings and structures is low, an increasing 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:[32]

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

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

Misallocation here reflects 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 $\hat{\zeta}_t^T < 0$. This effect could reflect financial frictions, as there is evidence in the literature that such frictions 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).

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

$$\hat{p}_t^N = \underbrace{\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{A^*}_t^T - \hat{A^*}_t^N}_{\text{productivity effect}} - \underbrace{\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{\mu}_t^T - \hat{\mu}_t^N\right]}_{\text{competition effect}} + \underbrace{\left(\frac{\alpha^N-\alpha^T}{1-\alpha^T}\right)\hat{U}_t}_{\substack{\text{effect of}\\ \text{financial integration}}}$$
$$- \underbrace{\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\alpha^T\hat{\zeta}_t^T - \alpha^N\hat{\zeta}_t^N\right]}_{\substack{\text{effect of}\\ \text{misallocation}}} \tag{19}$$
$$\text{with} \quad \hat{\zeta}_t^j = \hat{U}_t^j - \hat{U}_t, \quad j = T, N$$

The misallocation effect reinforces the effect of financial integration and of productivity

[32] 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.

on the relative price. It affects unit labour costs through this relative price effect.

Appendix 2.4. Model extension 2: Distortionary public spending

I now consider the effects of public spending benefiting the expansion of the non-tradable sector.[33] 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 be modeled through two exogenous effects in the model. First, an increase in the (public) consumption of non-tradable goods. Second, a diverging wage dynamics between a public and private 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 14 of the paper becomes:

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

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

Increased wage gap between the public and private sector So far, we focused exclusively on the private sector. 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 mar-

[33]The government is financed through lump-sum taxes.

ket economy, wages are still defined by equation 4 of the paper (ω_t). However, in the non-market sector, wages ω_t^g are set by the public administration. The government sets civil servant wages with a wedge z_t over market economy wages. We have $1+\tau_t = \frac{\omega_t^g}{\omega_t}$.[34] If the government increases wages in the public sector relatively to the market economy, it increases wages in the non-tradable sector (including the public sector) relative to the tradable sector (only private).

Equation 19 becomes:

$$\hat{p}_t^N = \underbrace{\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{A^*}_t^T - \hat{A^*}_t^N}_{\text{productivity effect}} - \underbrace{\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{\mu}_t^T - \hat{\mu}_t^N\right]}_{\text{competition effect}} + \underbrace{\left(\frac{\alpha^N-\alpha^T}{1-\alpha^T}\right)\hat{U}_t}_{\substack{\text{effect of}\\ \text{financial integration}}}$$
$$- \underbrace{\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\alpha^T\hat{\zeta}_t^T - \alpha^N\hat{\zeta}_t^N\right]}_{\substack{\text{effect of}\\ \text{misallocation}}} + \underbrace{\sigma_t\widehat{(1+\tau_t)}}_{\substack{\text{effect of}\\ \text{wage gap}}}$$
$$\text{with} \quad \widehat{(1+\tau_t)} = \hat{\omega}_t^G - \hat{\omega}_t$$

Appendix 2.5. Full decomposition of unit labour costs

Replacing $\hat{p}_t^N$ and χ_t^* in the equation of ULCs (equation 18) of the paper, we can now identify: (i) the effect of capital misallocation through the revised $PROD$ effect and the new $MISALLOC$ effect, (ii) the effects of policy intervention, through the revision of the

[34] This is equivalent to assuming that workers in the public sector receive a subsidy τ_t. Production in the non-tradable sector is now a Cobb-Douglas function of market and non-market production, and the relative price is now: $p_t^{N(1-\sigma_t)}p_t^{G\sigma_t}$.

DEM effect and the addition of a new $WAGE$ effect on ULC:

$$
\begin{aligned}
\widehat{ULC}_t =& PROD_t + COMP_t + FIN_t + MISALLOC_t + WAGE_t + DEM_t \qquad (20)\\
\text{with } PROD_t &= [\psi_t + (1-\sigma_t)\Omega_t(1-\theta)(1-\psi_t)] \left[\left(\frac{1-\alpha^N}{1-\alpha^T} \right) \hat{A^*}_t^T - \hat{A^*}_t^N \right] \\
COMP_t &= -[\psi_t + (1-\sigma_t)\Omega_t(1-\theta)(1-\psi_t)] \left[\left(\frac{1-\alpha^N}{1-\alpha^T} \right) \hat{\mu}_t^T - \hat{\mu}_t^N \right] \\
&\quad - \hat{\mu}_t^T(1-n_t^N) - \hat{\mu}_t^N n_t^N \\
FIN_t &= [\psi_t + (1-\sigma_t)\Omega_t(1-\theta)(1-\psi_t)] \left(\frac{\alpha^N - \alpha^T}{1-\alpha^T} \right) \hat{U}_t \\
MISALLOC_t &= -[\psi_t + (1-\sigma_t)\Omega_t(1-\theta)(1-\psi_t)] \left[\left(\frac{1-\alpha^N}{1-\alpha^T} \right) \alpha^T \hat{\zeta}_t^T - \alpha^N \hat{\zeta}_t^N \right] \\
WAGE_t &= [\psi_t + (1-\sigma_t)\Omega_t(1-\theta)(1-\psi_t)]\, \sigma_t(\widehat{1+\tau_t}) \\
DEM_t &= \Omega_t \hat{\chi^*}_t
\end{aligned}
$$

Appendix 3. Calibrating four decompositions of unit labour costs

Four different set of assumptions are considered in the growth accounting exercise to provide four decompositions of ULCs:

(i) I first look at the most basic decomposition –looking only at standard long-run drivers of structural change as in Ngai and Pissarides (2007). The decomposition only includes only two effects: the productivity and demand boom effects. In this decomposition, there is no profit, no differences across sectors, no capital misallocation nor any policy intervention.

(ii) I then account for policy intervention as well as for profits. However, I assume that there is no capital misallocation.

(iii) I then introduce misallocation, but only across sectors.

(iv) Finally, I introduce misallocation across and within sectors and get the full decomposition as described in equation 20 in the Appendix. This decomposition is the "baseline" one.

I then consider two alternative rental rates for the exercise based on decompositions (ii) to (iv). I end up with seven different decompositions summarized in Table 2.

Decomposition (i) In this decomposition, unit labour costs are a function of productivity and the demand effect:

$$\widehat{ULC}_t = PROD_t + DEM_t \tag{21}$$

$$PROD_t = [\psi_t + (1-\sigma_t)\Omega_t(1-\theta)(1-\psi_t)]\left[\hat{A}_t^T - \hat{A}_t^N\right] \tag{22}$$

$$DEM_t = \Omega_t \hat{\chi}_t \tag{23}$$

Table A.4 – Capital intensities in the tradable (T) and the non-tradable sectors (N)

	No profit		Profit, but no misalloc.		Profit, with misalloc.	
Labour share:	N	T	N	T	N	T
Adj. for self-employed	23.69	33.19	23.85	21.80	20.59	26.96
Not adj.	34.44	45.97	26.24	25.19	22.73	30.92

Note: this table shows capital intensities (the share of capital compensation in total factor costs) in the tradable and the non-tradable sector depending on different set of assumptions and the measure of the labour share. The first line shows data for factor costs measured using a labour share adjusted for self-employed, the second line for factor costs measured using a labour share that is not adjusted. The first two columns assume that there is no profit, so the capital intensity is simply one minus the labour share of total income. Columns 2 and 3 assume that there are profits but no misallocation (decomposition ii), and columns 4 and 5 assume that there are profits and misallocation (assumptions iv). The data cover only the market economy as defined in EU KLEMS (excluding sectors L, O, P, Q, T in the nace rev. 2 classification).

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 $CS_t^j = 1 - LS_t^j$. χ_t is the private consumption rate (total consumption rate minus public consumption).

Decomposition (ii) Unit labour costs are decomposed as follows:

$$\begin{aligned}
\widehat{ULC}_t =& PROD_t + COMP_t + FIN_t + WAGE_t + DEM_t \qquad (24)\\
\text{with } PROD_t &= [\psi_t + (1-\sigma_t)\Omega_t(1-\theta)(1-\psi_t)]\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{A^*}_t^T - \hat{A^*}_t^N\right]\\
COMP_t &= -[\psi_t + (1-\sigma_t)\Omega_t(1-\theta)(1-\psi_t)]\left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{\mu}_t^T - \hat{\mu}_t^N\right]\\
&\quad - \hat{\mu}_t^T(1-n_t^N) - \hat{\mu}_t^N n_t^N\\
FIN_t &= [\psi_t + (1-\sigma_t)\Omega_t(1-\theta)(1-\psi_t)]\left(\frac{\alpha^N-\alpha^T}{1-\alpha^T}\right)\hat{U}_t\\
WAGE_t &= [\psi_t + (1-\sigma_t)\Omega_t(1-\theta)(1-\psi_t)]\,\sigma_t(\widehat{1+\tau_t})\\
DEM_t &= \Omega_t\hat{\chi^*}_t
\end{aligned}$$

Productivity in sector j is now by:

$$\hat{A}_t^j = \Delta lnA_t^j = \Delta lnY_t^j - \overline{(1-\alpha^j)}\Delta lnL_t^j - \overline{\alpha^j}\Delta lnK_t^j$$

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 (1995-2015), provided in Table A.4.

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):

$$CS_t^j = U_t K_t^j$$
$$U_t = [r_t + \delta_t]$$

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

Decomposition (iii) Unit labour costs are decomposed as follows:

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

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 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 $K{*}_t^j$. 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 (1995-2015).

Here, the capital share is the product of the usercost of capital at the tradable/non-tradable sector and of capital services. The user cost of capital is given by:

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

with $\phi_t^k = \frac{U_t^k K_t^k}{\sum_k U_t^k K_t^k}$ the share of asset k in total capital compensations and $\phi_t^{k,j} = \frac{U_t^k K_t^{k,j}}{\sum_k U_t^k K_t^{k,j}}$ the share of asset k in capital compensations of sector j..

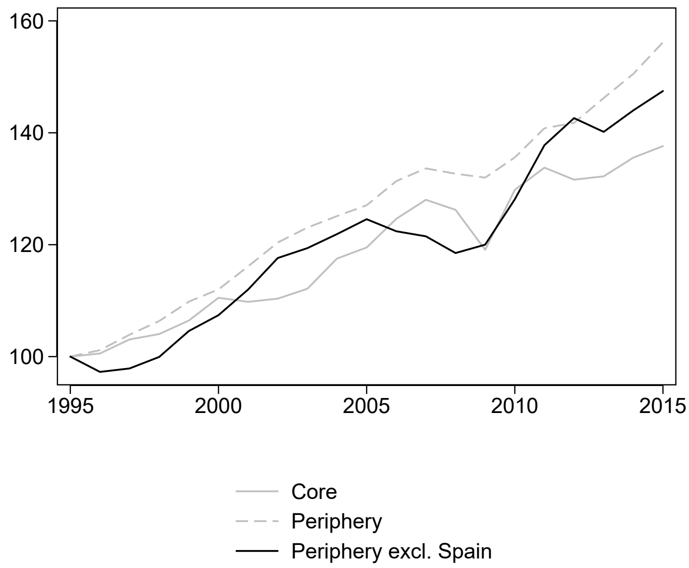
Decomposition (iv) This decomposition is similar to the previous one. However, user costs of capital are now measured by:

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

with $\phi_t^k = \frac{U_t^k K_t^k}{\sum_k U_t^k K_t^k}$ the share of asset k in total capital compensations, $\phi_t^{k,j} = \frac{U_t^k K_t^{k,j}}{\sum_k U_t^k K_t^{k,j}}$ the share of asset k in capital compensations of sector j, $\phi_t^{k,j,i} = \frac{U_t^k K_t^{k,j,i}}{\sum_k U_t^k K_t^{k,j,i}}$ the share of asset k in capital compensations of sub-sector i.

Appendix 4. Additional tables and figures

Figure A.3 – Relative (manuf vs. services) TFP, index 1995=100



Source: author's calculations using Eurostat and BACI.
Note: Core countries: Austria, Belgium, Germany, Finland, France, Italy, Luxembourg, Netherlands. Periphery: Greece, Spain, Ireland, Portugal. Data start in 1998 for Ireland. Averages over countries are weighted by GDP at PPP.

Table A.5 – Contribution of each sub-sector to the change in the share of the tradable and non-tradable sector in total hours worked, p.p., 1995-2007 and 2008-2015

Sector		Greece		Spain		Ireland		Portugal		Periphery		Core	
		95-07	08-15	95-07	08-15	95-07	08-15	95-07	08-15	95-07	08-15	95-07	08-15
Non-tradable sector		7.73	-2.86	3.76	-0.65	8.00	-0.80	4.67	-1.00	4.82	-1.11	-0.57	0.46
D-E	Electricity, gas, water supply	-0.28	-0.00	-0.09	0.28	0.25	-0.23	-0.22	0.15	-0.14	0.18	-0.16	0.08
F	Construction	1.98	-4.26	4.97	-6.47	4.93	-4.11	0.70	-4.14	3.82	-5.54	-0.41	-0.65
G	Wholesale and retail trad	2.11	-0.21	-0.10	0.58	0.02	1.26	1.53	0.15	0.34	0.37	-0.96	-0.42
L	Real estate activities	0.09	0.03	0.68	0.06	0.20	0.23	0.18	0.07	0.46	0.07	0.14	-0.05
O	Public administration and defence	1.25	0.25	-1.43	1.45	0.16	1.25	0.24	0.14	-0.71	1.00	-1.07	-0.30
P	Education	1.33	0.20	-0.70	1.27	0.29	-0.28	0.28	0.66	-0.10	0.90	0.26	0.22
Q	Human health and social work activities	1.05	0.46	0.12	1.14	2.34	1.76	1.15	1.58	0.76	1.17	1.23	1.40
R	Arts, entertainment and recreation	0.23	0.10	0.06	0.36	0.03	-0.53	0.25	0.18	0.20	0.23	0.30	0.10
S	Other service activities	-0.02	0.59	0.25	0.68	-0.22	-0.14	0.57	0.21	0.18	0.52	0.08	0.06
Tradable sector		-7.73	2.86	-3.76	0.65	-8.00	0.80	-4.67	1.00	-4.82	1.11	-2.26	-0.46
A	Agriculture, forestry and fishing	-6.93	1.78	-4.10	0.12	-4.09	0.50	-3.64	-1.53	-5.03	0.12	-1.60	-0.37
B	Mining and quarrying	-0.06	0.02	-0.04	-0.10	0.18	-0.35	-0.05	-0.08	-0.03	-0.09	-0.13	-0.02
C	Manufacturing	-1.08	-2.27	-3.67	-1.86	-6.29	-0.90	-5.32	-0.58	-3.48	-1.60	-5.74	-1.43
H	Transportation and storage	-2.77	0.05	-0.69	-0.07	-0.07	0.06	0.32	0.34	-0.88	0.01	-0.16	-0.11
I	Accommodation and food service activities	0.37	1.76	1.11	0.84	-0.12	0.99	1.70	0.45	1.01	0.93	0.45	0.22
J	Information and communication	0.44	0.17	0.34	0.49	-0.25	0.34	0.21	0.50	0.47	0.43	0.58	0.10
K	Financial and insurance activities	0.13	-0.33	-0.67	-0.03	0.65	-0.34	-0.36	0.12	-0.26	-0.08	-0.23	-0.08
M-N	Business services	2.18	1.68	3.95	1.26	1.98	0.49	2.47	1.79	3.39	1.39	4.57	1.24

Source: author's calculations using Eurostat and BACI. Note: for the measurement of the tradability of each sector, the 10% threshold is used. Data start in 1999 for Belgium and 1998 for Ireland.

Table A.6 – Decomposition of nominal ULCs in the periphery (deviation from core countries), by country, 1995-2015, change in % and contributions in p.p.

	Greece	Ireland	Portugal	Spain	Periphery
Period: 1995-2007					
Unit labour costs	37.84	18.71	24.65	22.29	24.86
Contribution of:					
Productivity effect	3.95	-0.11	10.98	-5.79	-1.48
Competition effect	1.18	12.95	-0.23	-5.36	-2.36
Financial effect	7.15	1.74	3.31	3.91	4.2
Misallocation effect	-0.2	8.34	-2.05	0.71	0.69
Wage gap effect	0.71	-3.98	2.14	-1.28	-0.66
Demand effect	0.63	2.48	3.28	6.36	4.75
Residual	26.6	1.56	8.24	23.26	20.21
Housing sector	-2.18	-4.28	-1.02	0.48	-0.48
Period: 1995-2015					
Unit labour costs	25.58	-10.83	7.25	11	11.34
Contribution of:					
Productivity effect	10.91	3.44	9.01	-5.63	-0.31
Competition effect	25.97	6.65	4.11	0.85	5.71
Financial effect	-10.68	-6.89	-4.79	-1.94	-4.07
Misallocation effect	14.62	10.18	5.27	6.88	8.11
Wage gap effect	-0.57	-5.95	-2.25	-1.07	-1.48
Demand effect	2.37	-7.03	0.97	-0.44	-0.24
Residual	-8.05	-9.28	-11.87	7.09	0.89
Housing sector	-8.99	-1.94	6.81	5.27	2.73

Source: author's calculations. Decomposition of the growth in unit labour costs as given in equation 20 of the paper. It includes misallocation across and within sectors and uses the risk-free rate.

Table A.7 – Decomposition of nominal ULCs in the core (deviation from the periphery), by country, 1995-2015, change in % and contributions in p.p.

	Austria	Belgium	Finland	France	Germany	Italy	Lux.	Nether.	Core
Period: 1995-2007									
Unit labour costs	-32.63	-18.92	-27.73	-21.33	-40.01	-7.74	-8.05	-15.91	-24.86
Contribution of:									
Productivity effect	6.53	3.34	17.07	6.42	-1.08	-1.42	-2.66	0.48	1.48
Competition effect	-6.35	8.37	-10.28	5.5	-2.75	8.37	-2.32	2.33	2.36
Financial effect	-5.27	-4.9	-4.39	-4.91	-5.56	-0.98	-3.77	-4.74	-4.2
Misallocation effect	2.75	1.62	-0.65	-1.38	-0.75	-1.54	2.42	1.64	-0.69
Wage gap effect	-1.06	-0.37	-0.92	0.12	-0.05	2.19	-1.07	0.31	0.48
Demand effect	-0.64	-0.16	-0.35	0.84	-0.26	2.5	-7.48	0.31	0.66
Residual	-24.04	-17.21	-25.18	-25.15	-20.77	-16.48	14.18	-13.55	-20.21
Housing sector	-4.55	-9.61	-3.03	-2.77	-8.79	-0.38	-7.34	-2.7	-4.75
Period: 1995-2015									
Unit labour costs	-15.95	-5.59	-4.12	-9.4	-23.81	3.09	17.76	-6.59	-11.34
Contribution of:									
Productivity effect	7.83	8.7	17.26	7.93	-3.57	-3.53	-7.01	-5.15	0.31
Competition effect	-14.63	-5.87	-5.06	-1.32	-14.19	5.06	-11.95	-8.4	-5.71
Financial effect	3.5	3.1	4.63	2.83	6.03	2.24	11.05	4.67	4.07
Misallocation effect	-5.56	-5.99	-8.17	-6.24	-12.37	-4.61	-7.56	-6.75	-8.11
Wage gap effect	-0.69	0.85	0.21	1.57	1.35	2.33	-0.92	0.93	1.48
Demand effect	-0.7	0.69	4.32	0.47	-1.21	2.27	-9.37	-0.5	0.24
Residual	-5.44	2.5	-16.62	-14.08	6.51	-2.92	53.59	13.95	-0.89
Housing sector	-0.25	-9.57	-0.69	-0.57	-6.37	2.26	-10.06	-5.34	-2.73

Source: author's calculations. Decomposition of the growth in unit labour costs as given in equation 20 of the paper. It includes misallocation across and within sectors and uses the risk-free rate.