Economic Integration and the Non-tradable Sector: the European Experience

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Abstract:

Since the introduction of the Euro, macroeconomic imbalances widened among Member States. This divergence took the form of strong differences in the dynamics of the non-tradable sectors between the core and the periphery. Adapting a model of structural change for a small open economy with a tradable and a non-tradable sector, this article shows that economic integration results in a relative expansion of the non-tradable sector in total employment. To do so, the model revisits the traditional Balassa-Samuelson and Baumol's effects to incorporate the effect of financial integration –a collapse in the interest rate– on the dynamics of the non-tradable sector. Using a novel data set for 12 countries of the Euro area, this article then documents the expansion of the non-tradable sector over 1996-2007 in the Euro area periphery (+4.8p.p.) –significant even when excluding the housing sector from the sample (+2.8p.p.). This expansion happened simultaneoulsy to (i) faster productivity growth in the tradable sector than in the non-tradable sector (ii) declining long-term nominal interest rates. A quantification of these effects shows that, in Portugal over 1996-2007, economic integration can explain up to 90% of the expansion of the non-tradable sector. This broad effect of economic integration accounts for much more than the sole Balassa-Samuelson effect (about 13%).

Key words: structural change, non-tradable sector, unbalanced growth, macroeconomic imbalances, Euro area.

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1. Introduction

Greece, Ireland, Portugal and Spain –the so-called "periphery"– have accumulated large current account deficits since the Euro's inception. First interpreted as good imbalances, current account deficits were supposed to reflect a catch-up and convergence process of the poorest countries of the area.[1] The single currency was expected to make balance of payments irrelevant between the member states.[2] This view was called into question in the aftermath of the 2008-2009 recession and the idea that current accounts deficits reflected a convergence process was challenged by both economists and policymakers. Debates emerged to reassess the mechanisms behind the accumulation of current account deficits in the Euro area periphery. They focused on the observation that countries which accumulated the largest deficits were countries with low aggregate TFP growth. This article focuses on the nature of these imbalances and their origins. More specifically, it asks whether economic integration –through the single market but also through monetary and financial integration– could have fostered uneven growth rates across different sectors depending on their exposure to international trade.

Economic integration has had two main dimensions (Blanchard and Giavazzi, 2002): financial and monetary integration, and tradable market integration (the single European market). Tradable market integration led to fast productivity growth in the tradable sector of the periphery. Financial and monetary integration resulted in the convergence of nominal interest rates among the Eurozone countries, hence to a steep decline in the risk premia of countries in the periphery. Extending the baseline multi-sector model of Ngai and Pissarides (2007) to a small open economy composed of a tradable sector and a non-tradable sector, I show that market and financial integration contributes greatly to the expansion of the share of the non-tradable sector in total employment. This reallocation of ressources into the non-tradable sector –the sector with the lowest TFP growth– reduces aggregate TFP growth.

Two mechanisms are at play to explain the effect of economic integration on the share of the non-tradable sector in total employment: a relative (non-tradable to tradable) price effect –*revisited Balassa-Samuelson effect*, and the fact that consumption grows faster than output –*unbalanced growth effect*. Faster productivity growth in the tradable than in the non-tradable sector leads to a relative price increase (Balassa-Samuelson effect). Similarly, a collapse in the cost of capital leads to a relative price increase as it benefits less the labor-intensive non-tradable sector (Acemoglu and Guerrieri, 2008). As long as there is a small (below one) elasticity of substitution between traded and non-traded goods, both effects lead to the expansion of the share of employment in the non-tradable sector (Baumol's effect).[3] Financial integration also fosters a demand boom, *i.e.* temporary unbalanced growth. Tradable goods can be imported, but non-tradable goods must be produced domestically: it results in an increase in the share of employment of the non-tradable sector, and an accumulation of current account deficits.

Using a novel data set for 12 countries of the Euro area, I then document the dynamics of the non-tradable sector over 1995-2014. The share of the non-tradable sector in employment rose steeply in the 'periphery' of the Euro area over 1995-2007 (+4.8p.p.). During the same period, this share remained stable in the so-called 'core' countries.[4] The increase in peripheral countries is significant even if the housing sector is

[1] In their seminal article of 2002, Blanchard and Giavazzi showed that financial integration and lower interest rates along with goods markets integration would lead both to a decrease in saving and an increase in investment in poorer countries, and so, to large current account deficits. Deficits would be reduced as countries would converge.

[2] Ingram pointed out in 1973 that "the traditional concept of a deficit or a surplus in a member nation's balance of payments becomes 'blurred'" (Ingram, 1973, p.15).

[3] Baumol (1967) suggests that fast productivity growth in manufacturing activities fuels an increase in wages. This cost increase cannot be offset in services activities since it faces slower productivity growth. It thus leads to a relative (service to manufacturing) price increase. As long as the relative output of service and manufacturing activities are maintained, an ever increasing proportion of the labor force must be channeled into these activities and the rate of growth of the economy must be slowed correspondingly.

[4] The periphery includes the four countries of the EA12 (countries which adopted the euro in 2001 and before) with the lowest GDP per capita (at purchasing power standards) in 1995. It includes: Greece, Ireland, Portugal, Spain. Core countries are: Austria, Belgium, Finland, France, Germany, Italy, Luxembourg, the Netherlands. Discussion on the composition of the tradable

excluded from the sample. This expansion happened simultaneoulsy to (i) faster productivity growth in the tradable sector than in the non-tradable sector, (ii) declining long-term interest rates. Finally, an illustrative calibration of the model is undertaken to investigate whether the dynamics generated by the model are broadly consistent with the patterns in European data. A simple growth accounting exercise conludes that, in Portugal for example, the standard Balassa-Samuelson effect accounts for 13% of the increase in the share of the non-tradable sector in total employment over 1995-2007. However, when reassessing its broader effects –both the revisited Balassa-Samuelson and unbalanced growth effects–, economic integration can explain up to 90% of the expansion of the non-tradable sector.

The contribution of this article if threefold. First, it proposes a theoretical analysis of the effects of a collapse in the interest rate and different TFP growth rates across sectors on the dynamics of the non-tradable sector. Second, it builds a new database to analyze the dynamics of the non-tradable sector and the different dimensions of economic integration for 12 countries of the Euro area. Third, it quantifies the contributions of economic integration on the dynamics of the non-tradable sector for the 12 countries of the Euro area over 1995-2014.

This articles relates to previous analyses of defective growth patterns. Patterns of defective growth have already been examined for the US by Hlatshwayo and Spence (2014). The authors argue that three main elements explain the American defective growth pattern prior to the 2007 financial crisis: an outsized domestic demand, accommodative capital inflows, and the lack of structural flexibility and resource mobility to accompany technological and structural change. This resulted in a shift of factors of production to the non-tradable sector of the economy, crowding out the US tradable sector, dampening its scope and competitiveness. The impact of EMU on catching-up economies can relate to these three elements: the compression of bond spreads in the Euro area periphery following monetary integration fostered demand booms, monetary and financial integration fueled substantial increase in private leverage in the peripheral countries, the single market integration acted as a catalyst for structural change. In Europe also it resulted in a relative expansion of the non-tradable sector (Giavazzi and Spaventa, 2011). These patterns are all the more defective that they are good predictors of financial crises. Gourinchas and Obstfeld (2012) show that domestic credit expansion and real currency appreciation are the most robust and significant predictors of financial crises, regardless of whether a country is emerging or advanced. Kalantzis (2015) shows how –in a small open economy– the deepening of financial openness resulting in capital inflows, followed by an expansion in the relative size of the nontradable sector, increases the financial fragility of the economy.

They are two different approaches of the mechanisms through which economic integration can affect the dynamics of the non-tradable sector. The first one extends the standard Balassa-Samuelson effect. This effect is at play to explain the shift of factors of production to the non-tradable sector (Gregorio et al., 1994). However, Estrada et al. (2013) suggest that productivity growth in the tradable sector cannot be the sole explanation of the dynamics of the relative price in the periphery. The Balassa-Samuelson framework have been extended to include differences in labor and product-market regulations (in the non-tradable sectors particularly[5]) across countries. Differences in regulations could also have contributed to maintain persistent inflation differentials across countries (Bénassy-Quéré and Coulibaly, 2014), and could have been a driver of the inter-sectoral misallocation of factors of production (Epifani and Gancia, 2011). These extensions of the Balassa-Samulson effect document an increasing relative price of non-tradables, and thereby could explain the relative expansion of the non-tradables sector. In a standard model of the technological explanation of structural change, ressources reallocate to the sector with the fastest growing relative price (Baumol, 1967; Ngai and Pissarides, 2007).

and non-tradable sector is presented in Section 3. The tradable sector includes the manufacturing, mining and agricultural activities, as well as six service sectors for which a large part of the output is internationally traded.

[5] In a Speech given at the Annual Hyman P. Minsky Conference on April 10, 2014, Peter Praet –Member of the Executive Board of the ECB– already stated that the incomplete market integration in goods and services, and a general lack of competitive processes in the non-tradable sector, allowed some firms in so-called catching-up economies to extract excessive rents and distort capital allocation.

A second view focuses rather on the impact of monetary integration on the expansion of the non-tradable sector. Financial integration is modeled through a real interest rate decrease[6] and a subsequent capital inflow in the European periphery. This lower cost of capital fueled a demand boom and the subsequent expansion of the non-tradable sector (Fagan and Gaspar, 2007; Benigno and Fornaro, 2014), and more specifically an increase in house prices (Ferrero, 2015), causing a degradation of current account deficits (Geerolf and Grjebine, 2013). Financial friction could also explain the distorted allocation of capital inflows following financial integration, in favor of the non-tradable sector (Reis, 2013; Gopinath et al., 2015), or once again more specifically in favor of the housing sector (Adam et al., 2012).

This article departs from previous analyses in three ways: it synthesizes the effects of the different dimensions of economic integration on resource allocation in a model of structural change; it documents patterns of defective growth and the different dimensions of economic integration for 12 countries of the Euro area; it quantifies the contribution of economic integration to the building-up of imbalances.

The remainder of the article is organized as follows. Section 2 develops the theoretical framework that is able to investigate the impact of economic integration on the dynamics of the non-tradable sector in a small open economy. Section 3 presents novel data on the dynamics of non-tradable sectors and the different dimensions of economic integration in the Euro area since 1995. Section 3 quantifies the contribution of economic integration on the dynamics of the share of the non-tradable sector in total employment. Section 4 concludes.

2. A two-sector small open economy model

This section presents a model to investigate the impact of economic integration on the dynamics of the non-tradable sector in a small open economy. It is assumed that this economy is part of a group of countries trading goods and assets among themselves. For convenience, this group of countries is referred to as 'the world'. Appendix 1 contains proofs of the main conclusions.

2.1. Set-up

The model extends the baseline multi-sector model of Ngai and Pissarides (2007) to a small open economy. The two sectors considered in the economy here are not the manufacturing and services sectors, but the tradable sector (T) and the non-tradable sector (N). Two reasons motivate this choice.

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

Second, analyzing the tradable versus non-tradable sector allows us to distinguish sectors depending on their exposure to international competition. A small economy is a price-taker in the tradable sector. On the opposite, non-tradable activities face only domestic competition. Traditionally, economists use the shortcut of labeling the industry as tradable and services as non-tradable. Analyzing the dynamics of the tradable versus non-tradable sectors would then be equivalent to analyzing industry versus service sectors. However, the share of services in total world trade is increasing steeply, and especially in the Euro area. In Greece, services represented more than 50% of the value of total exports in 2013. Moreover, recent studies have shown the recent servitization of the economies, *i.e.* the fact that the divide between manufacturing and service activities is becoming more and more blurry (Bernard and Fort, 2015).

[6]See Hale and Obstfeld (2016) for a discussion on the effect of monetary integration the suppression of bond yields in the European periphery up to 2007.

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

Labor is not mobile across countries: the labor force is exogenous and grows at the rate ν. Conversely, capital is mobile and the country can borrow or lend unlimited amounts on the international capital market. As in Blanchard and Giavazzi (2002), the nominal rate of interest 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 stemming from the country's borrowing cost premium due to the currency risk or other types of uncertainty (uncertainty regarding financial regulations, or credit risk for example). This wedge falls as economies integrate. Total financial wealth is composed of domestic capital K_t minus the level of foreign debt F_t.

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

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

where $\beta \in]0,1[$ is the discount factor, 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 labor, is:

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

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 receives the wage ω_t and 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[7]). Borrowing and lending take place *via* one-period foreign bonds. Let f_t be the per capita value of the bonds borrowed at the end of the period $t-1$ at the exogenous interest rate R_t (a negative f means a positive asset holding). $R_t f_t$ 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:

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

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

$$p_t = [\gamma + (1-\gamma)(p_t^N)^{(1-\theta)}]^{\frac{1}{1-\theta}} \tag{2}$$

Standard first order conditions yield the intra-temporal allocation of real consumption:

$$\frac{c_t^T}{c_t^N} = \frac{\gamma}{1-\gamma}(p_t^N)^{\theta} \tag{3}$$

[7]For simplicity, there is no FDI in the model. Blanchard and Giavazzi (2002) show, however, that investment outflows to other EU countries amount to only 15 percent of total outflows.

and the inter-temporal Euler equation:

$$\frac{c_{t+1}}{c_t} = \beta(1+r)(1+x_{t+1})\frac{p_t}{p_{t+1}} \tag{4}$$

Proposition 1 : *the growth rate of consumption is a positive function of the wedge x_{t+1}.*

The higher the wedge, the more impatient is the country. The country reaches the world steady state only when x has converged to zero.

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

$$n_t^T + n_t^N = 1; \quad k_t^T n_t^T + k_t^N n_t^N = k_t \tag{5}$$

where n_t^j is the share of sector j in total employment, k_t the aggregate capital-to-labor ratio, and k_t^j the capital-labor 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 $\alpha^j \in]0,1[$ the capital intensity of sector j, and A_t^j the sector-specific TFP. This production function can be written in units per labor: $y_t^j = A_t^j n_t^j (k_t^j)^{\alpha^j}$.

Firms are equity-financed and seek to maximize the present discounted value of dividends. Dividend (expressed in terms of tradables) in each period equals revenues net of wages and capital expenditures: $D_t^j = p_t^j Y_t^j - \omega_t L_t^j - q_t I_t^j$ where q_t is the price of investment goods and I_t^j represents gross investment. If the firm has market power, then price p_t^j depends on its choice of output: $p_t^j(Y_t^j)$.[8]

With perfect foresight, the firms' programme at time t is:

$$\max_{p_t^j} \sum_{s=t}^{\infty} R_{t,s}^{-1}(p_s^j Y_s^j - \omega_s L_s^j - q_s I_s^j)$$
$$\text{where} \quad R_{t,s} = (1+r)^{s-t}\frac{\prod_{\tau=t}^{s}(1+x_\tau)}{(1+x_t)}$$

$R_{t,s}$ is the discount factor.[9] 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.[10]

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:

$$\begin{aligned} U_t &= q_{t-1}(1+r)(1+x_t) - q_t(1-\delta) \\ &= q_{t-1}\left[(R_t - 1) + \delta\,(1+\hat{q}_{t-1}) - \hat{q}_{t-1}\right] \end{aligned} \tag{6}$$

With $\hat{z}$ the growth rate of variable z. Since the tradable price is the numeraire, first order conditions in the tradable sector yield the equation for the wage:

$$\omega_t = \left[U_t^{-\alpha^T}\frac{A_t^T}{\mu_t^T}(1-\alpha^T)^{1-\alpha^T}(\alpha^T)^{\alpha^T}\right]^{\frac{1}{1-\alpha^T}} \tag{7}$$

[8] This assumption departs from the basic Balassa-Samuelson set-up since firms in each sector have market power to fix their prices. In the traditional Balassa-Samuelson framework, the tradable price follows the law of one price. One would need this assumption to compare price levels across countries. Here the focus is rather on differences in price and employment dynamics, and hence there is no need to make any assumption on the level of the tradable price.

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

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

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.[11]

The equation for the relative price of the non-tradable good, which depends only on technological conditions, is:

$$p_t^N = \frac{(A_t^T/\mu_t^T)^{\frac{1-\alpha^N}{1-\alpha^T}}}{(A_t^N/\mu_t^N)} U_t^{\frac{\alpha^N-\alpha^T}{1-\alpha^T}} \frac{[(1-\alpha^T)^{1-\alpha^T}(\alpha^T)^{\alpha^T}]^{\frac{1-\alpha^N}{1-\alpha^T}}}{(1-\alpha^N)^{1-\alpha^N}(\alpha^N)^{\alpha^N}} \tag{8}$$

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

This section studies implications of trade and financial oppenness on structural change. I assume that the non-tradable sector is more labor-intensive than the tradable sector: $\alpha^N < \alpha^T$. This assumption will be discussed in the empirical section (Section 3).

Proposition 2 : *The relative price of non-tradable goods increases* $\left(\hat{p}_t^N > 0\right)$ *if :*
(1) Balassa-Samuelson effect: productivity (real factor payments) grows faster in the tradable than in the non-tradable sector;
(2) Financial integration: the user cost of capital decreases.

Proof: Rewriting equations 8, we get the growth rate of p_t^N:

$$\hat{p}_t^N = \underbrace{\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{a}_t^T - \hat{a}_t^N}_{\text{Balassa-Samuelson effect}} + \underbrace{\left(\frac{\alpha^N-\alpha^T}{1-\alpha^T}\right)\hat{U}_t}_{\substack{\text{effect of} \\ \text{financial integration}}}$$

where $a_t^j = \frac{A_t^j}{\mu_t^j}$, with $j = N, T$, is productivity, or, in the case where firms have market power with $\mu_t^j \neq 1$, real factor payments[12]. Given that $0 < \alpha^N < \alpha^T < 1$, we get a positive impact of $\left(\hat{a}_t^T - \hat{a}_t^N\right)$ 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 growth 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 labor-intensive.

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 labor intensive, this rise in wages will increase its marginal cost, and hence the relative price, of the non-tradable good: because the non-tradable sector is relatively more labor intensive, this rise in wages will not be compensated by the fall in the interest rate in this sector.

Considering that trade integration involves upward convergence in the productivity of the tradable sector and that financial and monetary integration involves a downward convergence of the interest rate (fall in the wedge x_t), the relative price of the non-tradable good increases through the two channels mentionned in Proposition 2.

[11] With the markup $\mu_t^j = \left(1 + \left(\partial p_t^j/\partial Y_t^j\right)\left(p_t^j/Y_t^j\right)\right)^{-1}$. This markup derives from the case where firms have a market power, then firms set their price as a markup over maginal costs. We then get, as in Fernald and Neiman (2011), that value added in each sector can be decomposed into the labor and capital shares in cost, and a profit share. In that case, measures of TFP can diverge from true technology growth A_t^j if they do not account for the profit share. See model Appendix for a discussion of this bias.

[12] In the case where firms make profits ($\mu_t^j \neq 1$), and these profits evolve over time, we have $\hat{A}_t^j - \hat{\mu}_t^j = (1-\alpha^j)(\hat{\omega}_t - \hat{p}_t^j) + \alpha^j(\hat{U}_t - \hat{p}_t^j)$. If there are no profit, then productivity equals real factor payments.

To recover the share of the non-tradable sector in total employment, we combine the first-order conditions in the tradable and non-tradable sector and the constraint that all non-tradable output must be consumed in each period. Let us denote by n_t^N the share of the non-tradable sector in total employment, and by $\tilde{n}_t^N$ the following function of n_t^N:

$$\tilde{n}_t^N = \frac{n_t^N / s_t^{L,N}}{n_t^N / s_t^{L,N} + n_t^T / s_t^{L,T}} \tag{9}$$

where $s_t^{L,j} = \frac{1-\alpha^j}{\mu_t^j} \quad \forall j \in \{T, N\}$ is the sectoral share of labor in income, $\tilde{n}_t^N$ is a positive function of n_t^N. The expression for the share of the non-tradable sector in total employment is then:

$$\tilde{n}_t^N = (1-\gamma) \left(\frac{p_t^N}{p_t} \right)^{1-\theta} \frac{p_t c_t}{p_t y_t} \tag{10}$$

where y_t is the aggregate output per capita in terms of tradables. The two first terms on the right side represent the employment needed to satisfy the consumption demand for the non-tradable good. The third product is the consumption rate.

Differentiating equation 10, we get the dynamics of $\tilde{n}_t^N$ which satisfies:

$$\begin{aligned}
\hat{\tilde{n}}_t^N &= (1-\theta) \left(\hat{p}_t^N - \hat{p}_t \right) + \hat{\chi}_t \\
\hat{\tilde{n}}_t^N &= (1-\theta)(1-\psi_t) \hat{p}_t^N + \hat{\chi}_t \\
\hat{\tilde{n}}_t^N &= (1-\theta)(1-\psi_t) \Bigg[\underbrace{\left(\frac{1-\alpha^N}{1-\alpha^T} \right) \hat{a}_t^T - \hat{a}_t^N}_{\text{Balassa-Samuelson effect}} + \underbrace{\left(\frac{\alpha^N - \alpha^T}{1-\alpha^T} \right) \hat{U}_t}_{\substack{\text{effect of} \\ \text{financial integration}}} \Bigg] + \underbrace{\hat{\chi}_t}_{\substack{\text{effect of} \\ \text{financial integration}}}
\end{aligned} \tag{11}$$

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

The properties of structural change follow immediately from equation 11. There are three drivers of structural change.

The first is differences in observed sectoral TFP growth rates (i.e., $\hat{a}_t^T \neq \hat{a}_t^N$). If productivity grows faster in the tradable sector than in the non-tradable sector, then the relative price increases (Balassa-Samuelson effect). With $\theta < 1$, consumption demands are too inelastic to match all the output change due to TFP growth, so employment has to move into the slow-growing non-tradable sector (Baumol's effect). Only if $\theta = 1$, then the employment share is constant while the relative price changes. With constant employment shares, the faster-growing tradable sector produces relatively more output over time. The aggregate price changes in this case are such that consumption demands exactly match all the output changes due to the different TFP growth rates.

The second driver is the effect of financial integration on relative prices. Financial integration fosters a relative price increase, and if $\theta < 1$ it leads to an expansion of the non-tradable sector (see proposition 2). In this latter case, consumption demands are too inelastic to match all the output change due to the cheaper capital cost benefitting the capital-intensive tradable sector, so employment has to move into the labor-intensive non-tradable sector.

Finally, the third driver is the effect of financial integration on the consumption rate $p_t c_t / p_t y_t$: if this ratio temporarily increases, the non-tradable sector expands. An increase in this ratio means that the investment rate is falling or that the country accumulates a current account deficit. Labor moves out of the tradable sector and into the non-tradable sector. This is the case when the country is impatient enough (the country is impatient if $\beta(1+r)(1+x_{t+1}) > 1$, see Appendix for a discussion on this effect). An anticipated fall in the wedge x_{t+1} fuels consumption growth in the current period, 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.

Proposition 3: *With differences in TFP and capital intensities across sectors, there are 3 drivers of structural change:*
(1) the Balassa-Samuelson effect (i.e. $\hat{a}_t^T > \hat{a}_t^N$) if $\theta \neq 1$. This effect leads to an expansion of the non-tradable sector if $\theta < 1$;
(2) financial integration, through its effect on the relative price (i.e. $\hat{U}_t < 0$ with $\theta \neq 1$). This effect is at play even if the economy is on a balanced growth path (i.e., $\hat{c}_t = \hat{y}_t$). Financial integration leads to an expansion of the non-tradable sector if $\theta < 1$ and $\alpha^N < \alpha^T$;
(3) financial integration, by fueling a temporary demand boom with $\hat{c}_t > \hat{y}_t$. Then the share of the non-tradable sector expands and the current account deteriorates. This effect is at play even if $\theta \neq 1$.

If there are no differences in capital intensities across sectors and no markups, equation 10 becomes:

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

The expression of structural change then reduces to the expression found in Ngai and Pissarides (2007):

$$\hat{n}_t^N = \underbrace{(1-\theta)(1-\psi_t)(\hat{A}_t^T - \hat{A}_t^N)}_{\text{Balassa-Samuelson effect}} + \underbrace{\hat{\chi}_t}_{\substack{\text{effect of} \\ \text{financial integration}}} \tag{12}$$

Proposition 4: *Absent differences in capital intensities across sectors and with no markups, there are only 2 drivers of structural change:*
(1) the Balassa-Samuelson effect (i.e. $\hat{A}_T > \hat{A}_N$) if $\theta \neq 1$. This effect leads to an expansion of the non-tradable sector if $\theta < 1$;
(2) financial integration, by fueling a temporary demand boom with $\hat{c}_t > \hat{y}_t$.

Economic integration affects both temporarily and permanently the dynamics of the non-tradable sector. In this section was first incorporated a Balassa-Samuelson effect in a model of structural change of a small open borrowing economy. It results that the Balassa-Samuelson effect, by inducing a relative price increase in the long-run, leads –as long as TFP grows faster in the tradable sector– to a reallocation of labor into the slow-growing non-tradable sector. This effect holds as long as there is a low (below one) elasticity of substitution between tradable and non-tradable goods. A similar effect arises if there is financial integration and the non-tradable sector is labor intensive: financial integration, by lowering the user cost of capital, benefits the capital-intensive sector. However, if consumption demands are too inelastic to match all the output change due to the cheaper capital cost, employment has to move into the labor-intensive non-tradable sector. On top of these two long-run effects, financial integration can also fuel a transitory expansion of the non-tradable sector: financial integration fuels foreign capital inflows into the catching-up economy, and fuels a temporary demand-boom. 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.

3. Empirical Evidence

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

3.1. Data

The data are constucted in two steps: first I build indicators to document sector dynamics 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 is detailled in Appendix 2.

In the first step, using Eurostat National Accounts data, a set of sector-level indicators describing sector dynamics is built for 24 European countries[13] for up to 1975-2015 in 19 sectors of the Nace revision 2 classification. Growth accounting indicators are constructed using EU-KLEMS methodology (O'Mahony and Timmer, 2009). This database covers a wider set of countries than EU KLEMS in its 2016 update but with less information on employment structure[14]. This dataset differs also from EU KLEMS since it allows for the existence of profits to distinguish the share of labor, capital and profits in gross value added. The existence of profits –if not accounted for in the measure of inputs and their revenue shares– can biais the measure of TFP (Fernald and Neiman, 2011). Contrary to EU KLEMS, I do not make the assumption that labor and capital compensations sum exactly to the value added, therefore I cannot deduce capital compensations from gross value added minus labor compensations but rather need to estimate capital compensations. To estimate capital compensations, information on the user cost of capital and capital stock are needed. User costs of capital are constructed using data on investment prices and depreciation rate (both sector and asset specific), and a proxy of rental rates: the long-term nominal interest rates (benchmark central government bonds of 10 years, identical across sectors).[15] Capital compensations are the product of user costs of capital and capital stocks at the country-year-sector-asset level. The profit share is ultimately deduced as the residual of the labor share and the capital share.

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

The tradability of each sector depends on its openness ratio –the ratio of total trade (imports + exports) to total production. A sector is considered as tradable if its openness ratio is greater than 10%, on average for the total area (24 countries) and over 1995-2014. Table 1 reports the openness ratio by sector on average for the 24 countries. Unsurprisingly, mining and quarrying, manufacturing and agriculture activities are found tradable. Concerning services, six industries are considered tradable. The non-tradable sector accounts for 43% of total production, 52% of GVA (Gross Value Added, at current prices) and 51% of employment on average for the area over 1995-2014. On average over 1995-2014, the share of the non-tradable sector is the largest in Denmark (57% of total employment, 56% of GVA, 47% of production) and smallest in Slovenia (40% of total employment, 49% of GVA, 41% of production).

Inevitably, the threshold of 10% is arbitrary. One possibility could be to apply different tradability criteria for different countries, but applying the same criterion for all countries leads to more clearcut results.[16]

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

[14]EU KLEMS uses various micro-data sources to get information on employment structure of the workforce, and use this information to build indicators of labor services used as labor input for the measure of TFP. Here I rather use an indicator of the volume of hours worked as labor input for the measure of TFP.

[15]Since EU KLEMS ultimately deduces capital compensations from substracting labor compensations from gross value added, their rental rate is endogenous and do not correspond to the nominal interest rate as it incorporates also the dynamics of profits.

[16]At country-level, tradability could be affected by market regulations or market structure, which should not matter for the

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

Sector		Openness ratio (%)		
		1995	2014-1995, change in p.p.	1995-2014, average
Tradable sector				
B	Mining and quarrying	124.5	120.0	196.0
C	Manufacturing	74.6	42.8	99.0
I	Accommodation and food service activities	77.3	4.7	81.9
A	Agriculture, forestry and fishing	34.0	18.2	43.9
H	Transportation and storage	30.4	-1.4	33.1
N	Administrative and support service activities	19.5	-4.3	24.1
M	Professional, scientific and technical activities	11.9	15.5	19.1
J	Information and communication	7.3	19.5	14.9
K	Financial and insurance activities	8.5	10.3	14.7
Non-tradable sector				
D	Electricity, gas, steam and air conditioning supply	2.7	1.3	4.3
R	Arts, entertainment and recreation	3.5	1.7	4.2
G	Wholesale and retail trade	2.4	-0.2	3.8
O	Public administration and defence	3.2	-1.4	2.4
F	Construction	2.9	-0.7	2.4
S	Other service activities	1.1	0.8	1.8
E	Water supply and waste management	0.0	0.6	0.3
P	Education	0.0	0.2	0.1
Q	Human health and social work activities	0.0	0.1	0.1
L	Real estate activities	0.0	0.0	0.0

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.

Moreover, the use of a threshold has the virtues of being based on the sample data and is easily subjectable to sensitivity checks. Using a threshold of 15% would exclude financial and insurance activities and information and communication from the tradable sector. Using a threshold of 20% would also exclude professional, scientific and technical activities from the tradable sector. Appendix 2 discusses further the choice of the indicator and the choice of the 10% threshold.

3.2. Stylized facts

The dynamics of the non-tradable sector Figure 1 displays the share of the non-tradable sector in total hours worked over 1995 to 2014 in Euro area countries: core countries (Austria, Belgium, Germany, Finland, France, Italy, Luxembourg, Netherlands) and the periphery (Greece, Spain, Ireland, Portugal).[17]

The share of the non-tradable sector (Figure 1a) rose steeply in the periphery over 1995-2007 (+4.8p.p.), while it declined slightly in core countries (-0.3p.p.). These shares started declining after the 2008 global financial crisis in the periphery but not in core countries. The increase in the non-tradable share before 2008 in the periphery is significant even when excluding the construction and real estate sectors from the sample (see Figure 1b).

The share of the non-tradable sector in hours worked increased most in Ireland and Greece, while it decreased in Germany (see Figure 2). The housing bubbles contributed greatly to the dynamics of the non-tradable sectors as the construction sector was the fastest growing sector in most catching-up countries over 1995-2007 (except for Portugal). However, the housing sector (construction and real estate) does not explain the bulk of the non-tradable sector (except for Spain), and other sectors played an important role (wholesale and retail trade more particularly is one of the most dynamic sectors over the period in the periphery).

Productivity growth The theoretical model shows that labor reallocates in sectors where productivity grows relatively slowly. Figure 3a shows the change in (unbiased) TFP in the tradable relative to the non-tradable sector for each group of countries: core countries (black) and the periphery (green). TFP increased faster in tradable than non-tradable sectors in all groups of countries over 1995-2007. The increase was steeper for the periphery (+20.9% vs. 13.9% in core countries). This effect should thus play in favor of a faster expansion of the non-tradable sector in periphery than in core countries.

Long-term interest rate The theoretical framework also shows that financial and monetary integration contributes to the expansion of the non-tradable sector, as long as the non-tradable sector is more labor-intensive. The dataset shows that labor compensations represent on average 77% of GVA in the non-tradable sector (excluding construction and real estate activities), while the share is 67% in the tradable sector. The evidence is robust when correcting factor shares by the profit share (shares are then resp. of 80% and 74%).

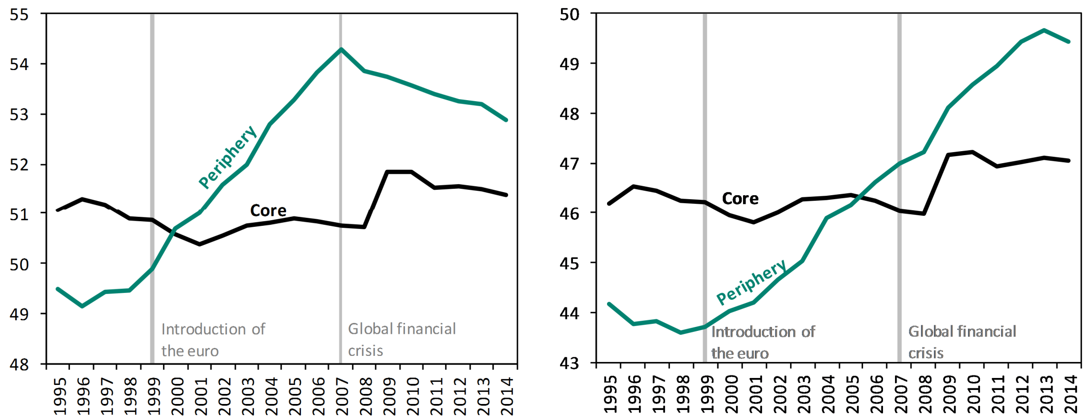
Financial and monetary integration led to a convergence of nominal interest rates among Euro area countries to about 4% around the mid-2000s. This downward convergence induced a strong decline in the risk premia of peripheral economies, with interest rates declining by 7.6 p.p. on average over 1995-2007, while interest rates declined by only 3.9 p.p. on average in core countries. Interest rate increased again after the 2008 global financial crisis and more particularly the 2011 Euro area crisis. These dynamics are largely reflected in long-term interest rates deflated by the price of tradables (deflator of GVA in the tradable sector, see Figure 3a).

EA11 since tradable sectors are well integrated in Europe (Estrada et al., 2013).

[17] The 12 core and peripheral countries of the Euro area all adopted the Euro in 1999 or 2001 for Greece. These 12 countries were classified as periphery if they were in their GDP per capita, in pucharsing power standard, was in the bottom third in 1995, they are else considered as core countries.

Figure 1 – Share of the non-tradable sector in total hours worked, by country group, 1995-2014, in %

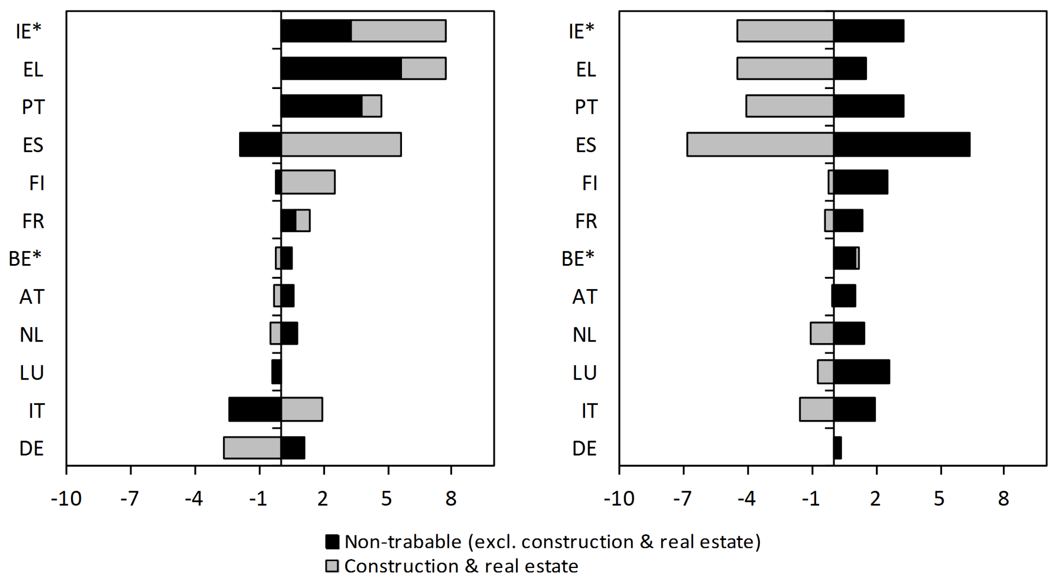
(a) Total economy **(b)** Excluding construction and real estate



Source: author's calculations using Eurostat and BACI.
Note: a threshold of 10% is used for the measure of tradability. Averages over countries weighted by the number of hours worked. The periphery includes the four countries of the EA12 (countries which adopted the euro in 2001 and before) with the lowest GDP per capita (at purchasing power standards) in 1995. The rest of the EA12 are considered as core countries. The periphery includes: EL; ES; IE; PT. The core countries are: AT; BE; DE; FI; FR; IT; LU; NL.

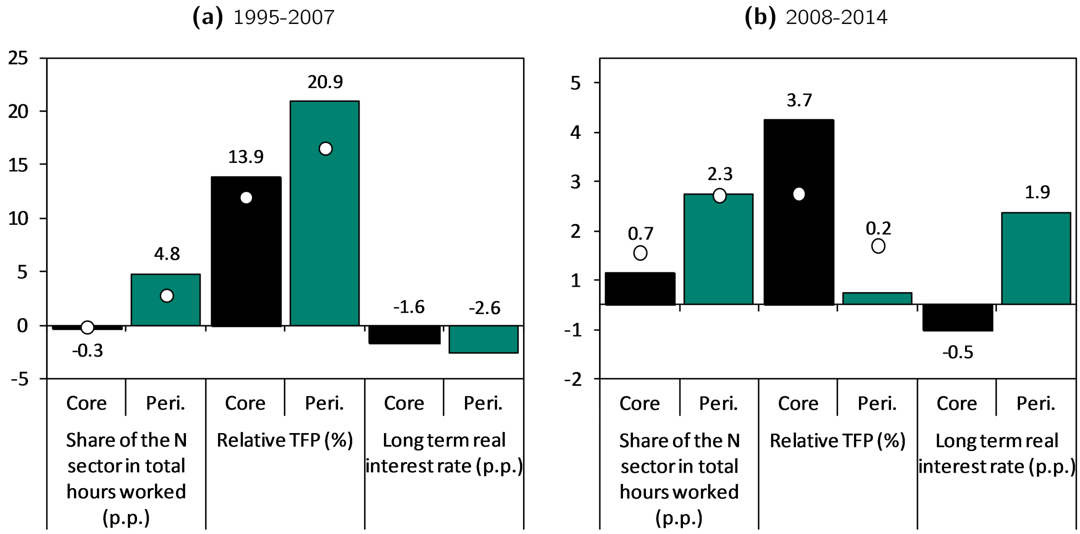
Figure 2 – Change in the share of the non-tradable sector in total hours worked (p.p.)

(a) 2007-1995 **(b)** 2014-2008



Source: author's calculations using Eurostat and BACI.
*For Belgium and Ireland, data start only in 1999. Note: a threshold of 10% is used for the measure of tradability.

Figure 3 – Change in the share of the non-tradable sector in total employment, relative (T/N) TFP and nominal long-term interest rates, total economy (dots: excl. construction & real estate)



Source: author's calculations using Eurostat and BACI.
Note: The measure of TFP is unbiased. Initial year for the periphery: 1997. A threshold of 10% is used for the measure of tradability. The periphery includes: EL; ES; IE; PT. The core countries are: AT; BE; DE; FI; FR; IT; LU; NL.

In total, the rising share of the non-tradable sector in peripheral countries before the crisis is concomitant to the two following stylized facts (Figure 3a): a steep rise in the TFP in the tradable sector relative to the non-tradable sector, a collapse in the long-term interest rates.

4. Quantification

This section assesses the contribution of financial and market integration on the dynamics of the non-tradable sector over 1995-2014 for the 11 core and periphery countries of the Euro area using a growth accounting exercise. Section I emphasized that both the change in relative (T/N) TFP and the fall in long term interest rates are drivers of the share of the non-tradable sector in total employment. These two effects –fast tradable productivity and fall in the interest rate– have already been shown to be important drivers of relative prices in the long-run. Indeed, Piton (2016) shows that the impact of a -1% differential in the real interest rate increases the non-tradable price by 0.86% to 1.52% relative to the Euro area. In Greece, the fall in the real interest rate over 1995-2008 could explain almost half of the non-tradable price increase relative to the EA average, and together with the Balassa-Samuelson (BS) effect, account up to 80% of its variations. We here focus on the dynamics of the share of non-tradable employment rather than on relative prices.

To confront the data with the model, an illustrative calibration is undertaken to investigate whether the dynamics generated by the model are broadly consistent with the patterns in European data. Whether we focus on equation (11) or equation (12), the first important parameter for our calibration is the elasticity of substitution between the two sectors. The model suggests a way of evaluating the elasticity. In particular, it provides a relationship between prices and quantities:

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

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

$$\log(\psi_t) = \log(1-\gamma) + (1-\theta)\left[\log\left(\frac{p_t^N}{p_t}\right)\right] \tag{13}$$

To estimate the parameter θ, once again the share of non-tradable consumption in total consumption $\psi_t = \frac{p_t^N c_t^N}{p_t c_t}$ is needed. Eurostat does not provide data on total final expenditure on consumption per industry but only for the total economy. To get a proxy of non-tradable consumption, I use the assumption made in the model that all non-tradable production must be consumed in each period. A strong limitation with this assumption is that the non-tradable sector includes the real estate and construction activities, which are largely used for investment and not only for consumption. I exclude this sector in the following.[18]. 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 current account in the tradable sector.[19] These two approaches of tradable consumption give very similar measures (they differ by +/- 5%). Finally, non-tradable consumption represents 48% of total consumption on average for the 12 EA countries over 1995-2014.

The elasticity of substitution θ can now be estimated using equation (13). I assume this parameter to be the same for the 12 countries in the sample. Then the estimating relationship will not only include an idiosyncratic error term but also 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 and use smoothed variables for the estimation. This simple regression yields an estimate of $\theta \backsimeq 0.81$ and a two standard error confidence interval of [0.66; 0.97]. I chose $\theta = 0.81$ for the benchmark estimation. This estimate is close to the one used in Acemoglu and Guerrieri (2008): they find an elasticity of substitution of 0.76 between capital-intensive and labor-intensive goods.

Equipped with an estimate of θ, I can measure the contribution of financial and market integration on the dynamics of the non-tradable sector. To do so, I first decompose the change in the share of the non-tradable sector in total employment into a the effect of the construction and real estate sector (H), and the effect of the change of the share of the non-tradable sector in total employment excluding construction and real estate from the sample ($N-H$):

$$(n_t^N \hat{+} n_t^H) = n^N(\hat{n}_t^{N-H} + (1 \hat{-} n_t^H)) + \underbrace{n^H \hat{n}_t^H}_{\text{Construction and real estate}}$$

$$\text{with} \quad n_t^N + n_t^H + n_t^T = 1 \quad \text{and} \quad n_t^{N-H} + n_t^T = 1$$

Then, using equation (12), I decompose further the change of the share of the non-tradable sector in total employment excluding construction and real estate ($\hat{n}_t^{N-H}$), into a traditional Balassa-Samuelson effect, the additional impact of the revisited Balassa-Samuelson effect, and the effect of unbalanced growth. The revisited Balassa-Samuelson effect includes both the effect of the declining interest rate on relative prices, and the effect of correcting biased TFP. Finally, the unbalanced growth effect relies in the fact that the

[18]Investment in dwellings and other buildings and structures (assets $N111$ and $N112$ in the AN_F6 classification) is an important share of total investment. When measuring the ratio of this latter investment to GVA in the construction and real estate sectors, investment represents a little more than 90% of total GVA on average over 1995-2014 for the 12 countries. I thus make the strong assumption that all production in these two sectors are used for investment only, and do not retrench housing consumption from final expenditure net of taxes less subsidies on products.

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

economy is not on a balanced growth path so $\hat{\chi}_t \neq 0$. Rewriting equation (12), we get a decomposition of $\hat{n}_t^{N-H}$:

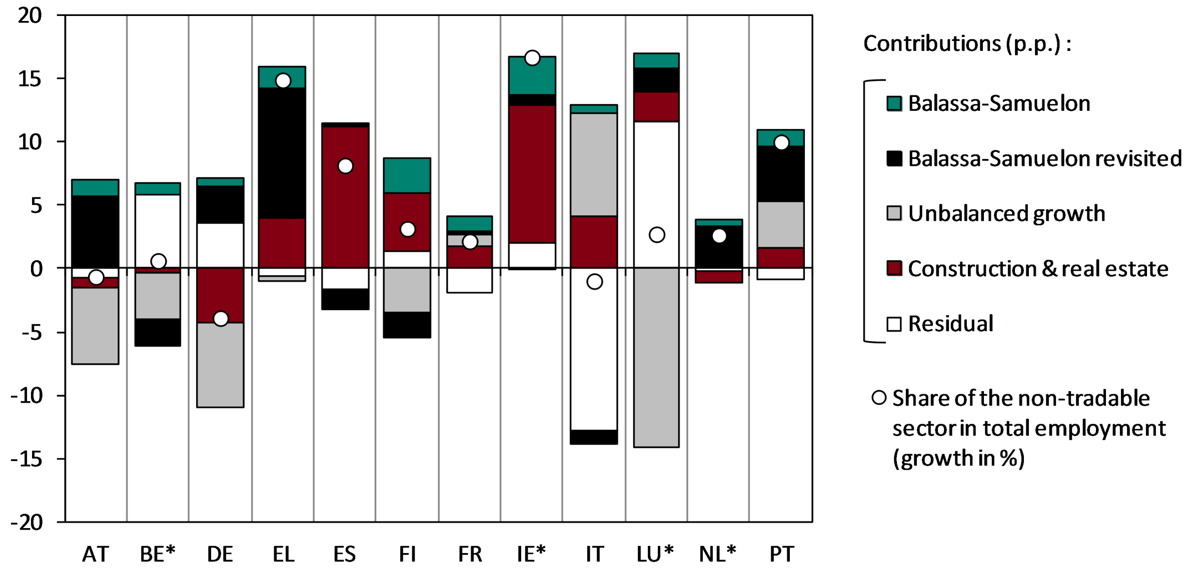
$$
\begin{aligned}
\hat{n}_t^{N-H} =& \left[\left(\frac{1-n^{N-H}}{1-\tilde{n}^{N-H}}\right)\hat{\tilde{n}}_t^{N-H} + (1-n^{N-H})(\hat{s}_t^{L,N-H} - \hat{s}_t^{L,T})\right] \\
=& \underbrace{(1-\theta)(1-\psi)(T\hat{F}P^T - T\hat{F}P_t^{N-H})}_{\text{Standard Balassa-Samuelson effect}} + \underbrace{\hat{\chi}_t}_{\text{Unbalanced growth effect}} \\
& \underbrace{\begin{aligned} &+ \left(\frac{1-n^{N-H}}{1-\tilde{n}^{N-H}}\right)\left((1-\theta)(1-\psi)\left[\left(\frac{1-\alpha^{N-H}}{1-\alpha^T}\right)\hat{a}_t^T - \hat{a}_t^{N-H} + \left(\frac{\alpha^N-\alpha^T}{1-\alpha^T}\right)\hat{U}_t\right] + \hat{\chi}_t\right) \\ &- \left[(1-\theta)(1-\psi)(T\hat{F}P^T - T\hat{F}P_t^{N-H}) + \hat{\chi}_t\right] + (1-n^{N-H})(\hat{s}_t^{L,N-H} - \hat{s}_t^{L,T})\end{aligned}}_{\text{Additional contribution of the the Balassa-Samuelson effect revisited}}
\end{aligned}
$$

I compute these effects for two sub-periods: 1996-2007 (since growth rates are needed, there is no data for 1995) and 2008-2014. For variable with no time subscripts, I use their average over the period. I use the change over the period in the standard primal measure of TFP (biased as it does not account for the dynamics of profits, see Appendix for a discussion on the measures of TFP) to measure the standard Balassa-Samuelson effect.

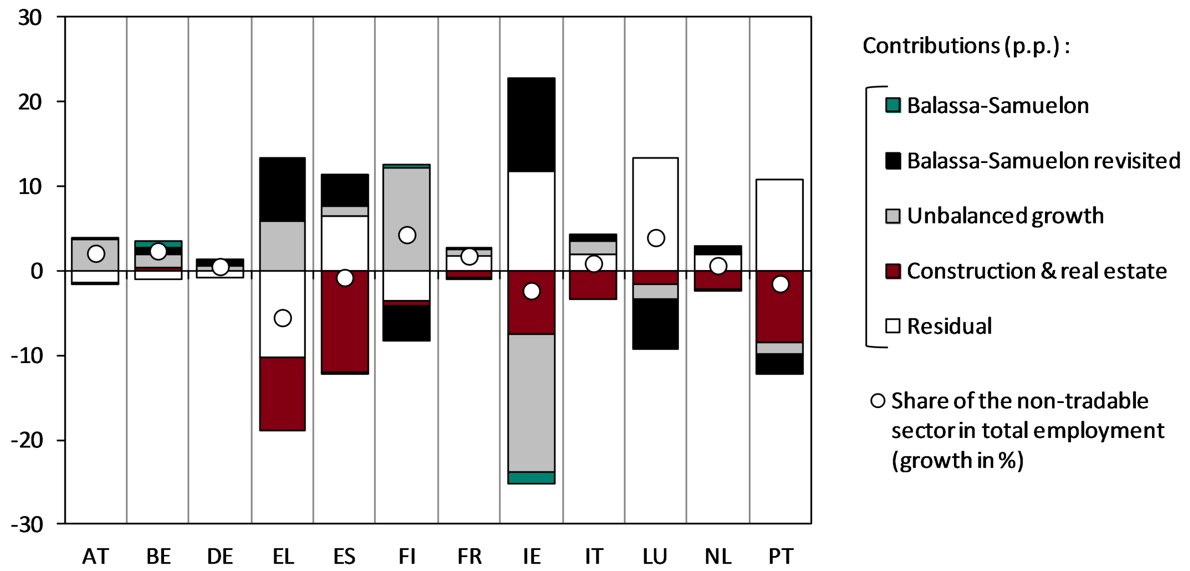
The contributions of each effect for each country over the two sub-periods are summarized in Figure 4. Unsurprisingly, between 1996 and 2007, most of the increase in the non-tradable sector in Spain is due to the housing bubble. In Ireland the housing sector also played an important role: 65% of the increase in the share of the non-tradable sector is due to the housing bubble and more than 25% is due to economic integration. In Germany, employment grew 5% less in the non-tradable sector than in the total economy, and this is entirely due to the dynamics of the housing sector and the declining consumption rate. In Greece and Portugal, economic integration can explain up to resp. 80% and 90% of the change in the share of the non-tradable sector in total employment. Economic integration had a much larger impact than the sole standard Balassa-Samuelson effect (which explain resp. 11% and 13%). Surprisingly, in Greece, the unbalanced growth effect did not play any role, and even acted slightly negatively on the share of the non-tradable sector. Since the 2008 global financial crisis, the non-tradable sector shrinked in every peripheral countries (Greece, Spain, Ireland, Portugal). But this readjusment is mostly due to the fall in the consumption rate and the collapse of the housing sector rather than TFP dynamics.

Figure 4 – Contribution (in p.p.) of the Balassa-Samuelson, Balassa-Samuelson revisited and unbalanced growth effects to the change (in %) in the share of the non-tradable sector in total employment

(a) 1995-2007



(b) 2008-2014



Source: author's calculations using Eurostat and BACI.
*: data start in 1998 for Ireland, 1999 for Belgium, 2001 for the Netherlands and Luxembourg. Note: a threshold of 10% is used for the measure of tradability.

5. Conclusion

Adapting a model of structural change for a small open economy with a tradable and a non-tradable sector, this article shows that not only market integration but also financial and monetary integration affects the dynamics of the non-tradable sector. Market and financial integration lead to a relative price increase which can result in a relative expansion of the non-tradable sector. Financial integration also fosters a temporary demand boom in peripheral economies, leading to an expansion of the non-tradable sector and an accumulation of current account deficits.

Using a novel data set for 12 countries of the Euro area, this article then documents the dynamics of the non-tradable sector in the Euro area: the share of employment in the non-tradable sector increased by +4.8 p.p. in the periphery from the Euro inception up to the 2008 global financial crisis, while it remained stable in core countries. The expansion in the periphery is significant even when excluding the housing sector from the sample (+2.8p.p.), and it happened simultaneoulsy to (i) faster productivity growth in the tradable sector than in the non-tradable sector (ii) declining long-term nominal interest rates.

Finally, this article quantifies the effects of economic integration for 12 countries of the Euro area over 1996-2014. Over 1996-2007, in Portugal, economic integration can explain up to 90% of the expansion of the non-tradable sector. Since the 2008 global financial crisis, the non-tradable sector shrinked in every peripheral countries (Greece, Spain, Ireland, Portugal). But this readjusment is mostly due to the fall in the consumption rate and the collapse of the housing sector rather than TFP dynamics.

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APPENDIX 1 - Theoretical model: proofs and derivations

This Appendix details the theoritecal model and derives the expressions and relationships in Section2.

The representative household has the following programme:

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

The budget constraint is expressed in units per capita:

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

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:

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

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:

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

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:

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

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:

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

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

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

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

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

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

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

$$n_t^N = s_t^{L,N} \left(\frac{n_t^N}{s_t^{L,N}} + \frac{n_t^T}{s_t^{L,T}} \right) (1-\gamma) \left(\frac{p_t^N}{p_t} \right)^{1-\theta} \frac{p_t c_t}{p_t y_t}$$

$$\Rightarrow \tilde{n}_t^N = (1-\gamma) \left(\frac{p_t^N}{p_t} \right)^{1-\theta} \chi_t \quad \text{with} \quad \tilde{n}_t^N = \frac{n_t^N / s_{L,t}^N}{n_t^N / s_{L,t}^N + n_t^T / s_{L,t}^T} \quad \text{and} \quad \chi_t = \frac{p_t c_t}{p_t y_t}$$

Proof of proposition 3: differentiating this expression, we get the dynamics of $\tilde{n}_t^N$ which satisfies

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

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

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

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

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

The dynamics of χ_t:

We have: $\hat{\chi}_t = \widehat{p_t c_t} - \widehat{p_t y_t}$. Replacing $\widehat{p_t c_t}$ using the Euler equation, and replacing $\widehat{p_t y_t}$ using the FOCs in the tradable and non-tradable sector, we get:

$$\begin{aligned}
\hat{\chi}_t =& x_{t+1} - (\hat{\omega}_t - \hat{s}_t^{L,T}) \\
&+ \left(\frac{1-\tilde{n}_t^N}{1-n_t^N} - 1\right)\left[(1-\theta)\left(\hat{p}_t^N - \hat{p}_t\right) + x_{t+1} - (\hat{\omega}_t - \hat{s}_t^{L,T})\right] \\
&+ \left(\frac{1-\tilde{n}_t^N}{1-n_t^N}\right)(\hat{s}_t^{L,N} - \hat{s}_t^{L,T})n_t^N
\end{aligned}$$

$\hat{\chi}_t > 0$ if the wedge is big enough, *i.e.* the country is impatient enough and x_{t+1} is still high enough so that consumption grows more than the increase in real wealth $(\hat{\omega}_t - \hat{s}_t^{L,T})$. This effect is reinforced if the non-tradable sector has a larger labor share than the tradable sector $(s_t^{L,N} > s_t^{L,T})$, meaning that $\left(\frac{1-\tilde{n}_t^N}{1-n_t^N} > 1\right)$. And it is futhermore reinforced if the labor share in the non-tradable sector increases more than in the tradable sector $(\hat{s}_t^{L,N} - \hat{s}_t^{L,T} > 1)$.

Proof of proposition 4: absent differences in capital intensities across sectors, we have $s_t^{L,N} = s_t^{L,T} = s_t^L$ and the dynamics of $\tilde{n}_t^N$ reduces to

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

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

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

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

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

When allowing for the existence of profits, these usual primal and dual measures of TFP diverge from true technology and real factor payments. Since $s_t^{L,j} = \frac{1-\alpha^j}{\mu_t^j}$, we get than primal TFP diverges from true technology:

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

And dual TFP diverges from real factor payments:

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

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

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

APPENDIX 2 - Data

Appendix A. Growth accounting for the tradable and non-tradable sector: Data sources, methodology and discussion

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

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

1. Growth accounting at the 19-industry level

Eurostat provides harmonized National Accounts data for all 28 EU Member States following the SNA 2010 system of accounts.[20] It contains series of gross value added and production, compensation of employees and employment, investment and capital stock for up to 64 industries. The coverage widely differs depending on the period, country, indicator and industry considered. A breakdown in 21 industries (20 + total) of the NACE rev.2 classification is chosen to obtain the most 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 19 sectors.

1.1. Output and Gross Value Added

Eurostat provides information on output and gross value added at basic prices in its "nama_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 labor, 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 labor, capital services and profits) is created using information on taxes less subsidies on production. On average, the tax rate is 1.30%, with the largest rate in Sweden. The real estate sector faces the biggest rate (3.70% on average) while the agriculture, forestry and fishing sector benefits the most from subsidies (corresponding to a rate of -12.63%).

1.2. Employment and labor compensation

Eurostat provides information on compensation of employees in its "nama_a64" dataset and information on hours worked (EMP) and its decomposition for employees and self-employed in its "nama_a64_e" dataset. To obtain an indicator of total labor compensation ($LABCOMP$), earnings of self-employed (mixed income) is needed.

Mixed income are estimated assuming the average earning by hour worked for self-employed is the same than for employees. Self-employed represent, on average, 20.27% of total employment, with the highest share in Greece (39.39%) and the lowest share in Luxembourg (6.58%).

[20] 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

1.3. Capital stocks and capital compensations

Eurostat provides information on net fixed capital stocks ($NFCS$)[21] by asset and industry (in the ESA AN_F6 classification) when provided by countries in its "nama_10_nfa_st" dataset and information on investment by asset and industry in its "nama_10_nfa_fl" dataset.

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

$$NFCS_{c,j,n,t} = (1 - \delta_{j,n})NFCS_{c,j,n,t-1} + GFCF_{c,j,n,t} \tag{14}$$

with c the country, j the industry, n the asset, and t the year. To estimate NFCS series, information on constant depreciation rates and initial stocks of capital are needed.

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

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

Asset type (AN_F6)		average	min	max
N111	Dwellings	0.028	-3.618	7.095
N112	Other buildings and structures	0.046	-30.848	5.663
N1131	Transport equipments	0.173	-1.944	3.229
N11321	Computer hardware	0.324	-1.326	15.000
N11322	Telecommunications equipment	0.186	-10.447	4.045
N11O	Other machinery and equipment and weapons systems	0.122	-11.587	1.322
N115	Cultivated biological resources	0.060	-1.954	9.347
N1171	Research and development	0.199	-0.575	1.587
N1173	Computer software and databases	0.380	-28.753	21.154
N117-N1171-N1173	Intellectual property products	0.087	-270.344	6.619

Source: author's calculations using Eurostat.
Note: implicit rates are recoverd using data from countries reporting both capital stocks and investment.

When NFCS series are missing for the entire period, an estimate of an initial stock of capital is needed. Following Harberger (1978), the initial stock can be estimated using its steady state level:

$$NFCS_{c,j,n,0} = \frac{GFCF_{c,j,n,0}}{g + \delta_{j,n}} \tag{15}$$

with g the growth rate of capital stock measured with long time series.

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

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

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

	Reported	Estimated	Missing series*
AT	1995-2015		
BE	1995-2015		
CZ	1995-2015		
DE	1995-2015 (9)		
DK	1975-2015		
EE	2001-2014 (9)	1995-1999 (9)	
EL	1995-2014		
ES		1970-2014 (EU KLEMS data)	
FI	1980-2015		
FR	1978-2015		
HU	1995-2014 (9)		
IE	1995-2014 (7)		N11O and N117
IT	1995-2014		
LT	2000-2014 (8)		
LU	2000-2015		
LV	1995-2012 (8)	1995-2012 (2)	
NL	1999-2015		
NO	1975-2014		
PL	2000-2014 (7)		
PT	2000-2014 (5)	1995-1999 (7) et 2000-2014 (2)	
SE	1993-2014		
SI	2000-2014	1995-1999	
SK	2004-2015		
UK		1997-2014 (EU KLEMS data)	

*Data which are not available for any sector.
Note: numbers in parenthesis correspond to the detail of assets available, if different than 10 (the most disagregated level). Last data update: February 2017.

Estimating user costs of capital To estimate capital compensations, NFCS in volume are necessary but also user costs of capital. Capital compensations ($CAPCOMP$) are the product of user costs and constant price NFCS.

In the absence of taxation, user costs evolve according to (see equation 6):

$$U_{c,j,n,t} = q_{c,j,n,t-1}\left[i_{c,t} + \delta_{j,n}\left(1 + \hat{q}_{c,j,n,t-1}\right) - \hat{q}_{c,j,n,t-1}\right]$$

with $i_{c,t}$ the country nominal interest rate at year t[22], $q_{c,j,n,t-1}$ the investment price at the country-sector-asset level[23], at time $t-1$ and and $\hat{q}_{c,j,n,t-1}$ the investment price inflation between $t-1$ and t. We use, on contrary to EU-KLEMS, an ex-ante measure for the nominal interest rate since capital services do not equalize gross operating surpluses in the presence of monopolistic competition. We use the long-term (risk-free) interest rate given by Ameco, corresponding to central government benchmark bonds of 10 years.

1.4. Coverage of the industry-level dataset

The coverage of the final dataset is reported in Table A.3. Using information on labor compensation (measured with hours worked), capital services and gross value added at factor costs we can deduce the shares of labor, capital and profits in total gross value added.

1.5. Measuring productivity

TFP at the country-level is usually measured as:

$$\Delta lnTFP^{primal}_{c,t} = \Delta lnY_{c,t} - \bar{s}^L_{c,t}\Delta lnL_{c,t} - \bar{s}^K_{c,t}\Delta lnK_{c,t}$$

where the contribution of each input is defined as the input's volume growth rate ($L_{c,t}$ is the number of hours worked and $K_{c,t}$ the stock of capital at 2010 prices) weighted by the two period average revenue share of the input ($s^L_{c,t}$ is the share of labor compensations in total value added, and $s^K_{c,t} = 1 - s^L_{c,t}$). Unlike EU-KLEMS, this measure uses information on the volume of inputs rather than on an index of input services since we do not have here more detailled information on the composition of labor.

When allowing for the existence of profits, the measure of unbiased TFP (true technology) becomes:

$$\Delta lnTFP^{primal,unbiased}_{c,t} = \Delta lnY_{c,t} - \frac{\bar{s}^L_{c,t}}{\bar{s}^L_{c,t} + \bar{s}^{K^*}_{c,t}}\Delta lnL_{c,t} - \frac{\bar{s}^{K^*}_{c,t}}{\bar{s}^L_{c,t} + \bar{s}^{K^*}_{c,t}}\Delta lnK_{c,t}$$

the contribution of each input is still defined as the input's volume growth rate ($L_{c,t}$ is the number of hours worked and $K_{c,t}$ the stock of capital at 2010 prices) weighted by the two period average cost share (rather than revenue share) of the input. The revenue share of capital and labor compensations in total value added do not sum to one, but to one minus the profit share: $s^L_{c,t} + s^{K*}_{c,t} + s^{\pi}_{c,t} = 1$ (where $s^{K*}_{c,t}$ is the share of capital compensations in total value added, measured with an ex-ante rate of return). The cost shares sum to 1 minus the profit share: $s^L_{c,t} + s^{K*}_{c,t} = 1 - s^{\pi}_{c,t}$. The weight is then the cost share of the input.

Figure A.1 shows, for France and Spain, the measures of $TFP^{primal,unbiased}$ using an ex ante rate of return (here the long-term nominal interest rate), TFP^{primal} using an ex post measure of rate of return (based on EU-KLEMS methodology), and the $TFP^{primal,EUK}$ measure given by EU-KLEMS in its latest release (using factor services rather than factor volumes). Using factor volumes rather than services change significantly the dynamics of TFP. Also, taking into account the existence of profits changes the dynamics of TFP for Spain, but not for France.

[22]To find equation 6, we can rewrite $i_{c,t} = R_{c,t} - 1 = r_{EA16} + x_{c,t}(1 + r_{EA16})$.
[23]As in EU-KLEMS, we take a 5-year moving average of this price.

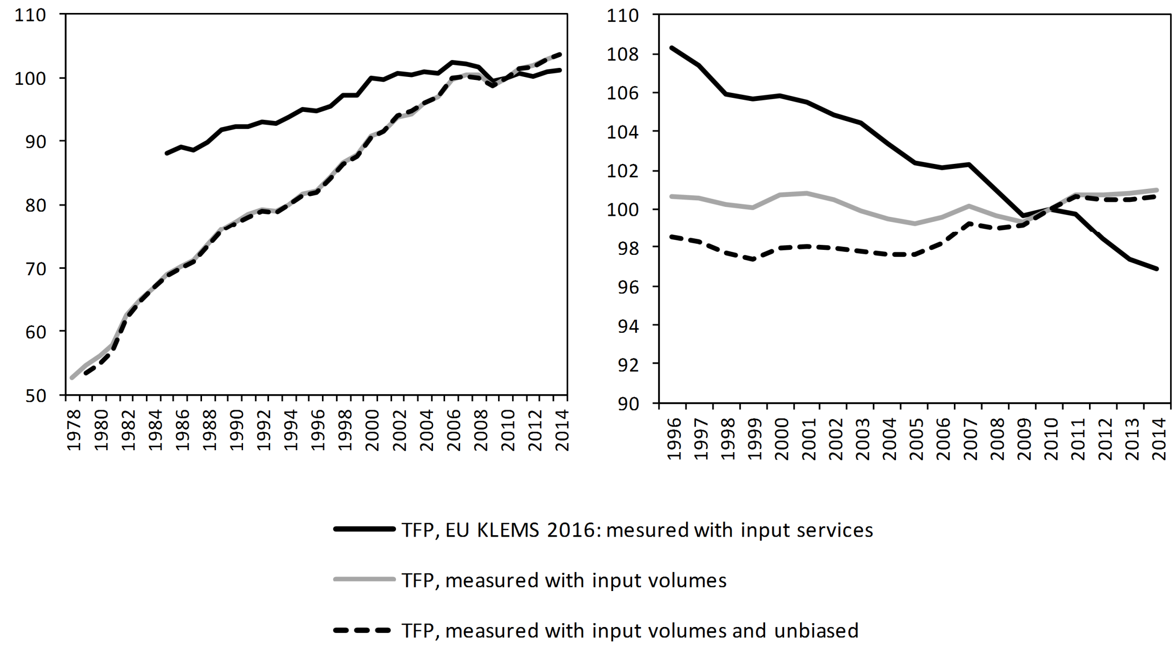
Table A.3 – Coverage of the dataset at the 19-industry level

	GVAFC	LABCOMP	CAPCOMP	GVAFC	EMP	NFCS
	current price			2010 prices	hours worked	2010 prices
AT	1995-2015	1995-2015	1996-2015	1995-2015	1995-2015	1995-2015
BE	1995-2015	1999-2015	1997-2015	1995-2015	1999-2015	1995-2015
CZ	1995-2015	1995-2015	2001-2015	1996-2014	1995-2015	1995-2015
DE	1995-2015	1995-2015	1996-2015	1995-2015	1995-2015	1995-2015
DK	1975-2015	1975-2015	1976-2015	1975-2015	1975-2015	1975-2015
EE	1995-2015	2000-2015 (7)	2001-2010	1995-2015	2000-2015	1995-2014
EL	1995-2015	1995-2015	1996-2014	1996-2015	1995-2015	1995-2014
ES	1995-2015	1995-2015	1978-2014	1996-2015	1995-2015	1970-2014
FI	1980-2015	1980-2015 (18)	1981-2015	1980-2015	1980-2015	1980-2015
FR	1978-2014	1978-2014	1979-2014	1978-2014	1975-2014	1978-2014
HU	1995-2015	2010-2015	1999-2015	1996-2015	2010-2015	1995-2014
IE	1995-2015	1998-2015	1996-2014	1996-2015	1998-2014	1995-2014
IT	1995-2015	1995-2015	1996-2014	1996-2015	1995-2015	1995-2014
LT	1995-2015	1995-2015 (18)	2001-2014	1996-2015	1995-2015	2000-2014
LU	1995-2015	1995-2015	2001-2015	2001-2015	1995-2015	2000-2015
LV	1995-2015	2000-2015	2001-2012	1995-2015	2000-2015	1995-2012
NL	1995-2015	1995-2015	2000-2015	1996-2015	1995-2015	1999-2015
NO	1975-2015	1975-2015	1985-2010	1976-2014	1975-2015	1975-2014
PL	2003-2015	1993-2015	2001-2014	2003-2015	2000-2015	2000-2014
PT	1995-2015	1995-2015	1996-2014	1996-2015	1995-2015	1994-2014
SE	1993-2014	1993-2014	1994-2014	1994-2014	1993-2015	1993-2014
SI	1995-2015	1995-2015	2003-2014	1996-2015	1995-2015	1995-2014
SK	1995-2015	1995-2015	2005-2015	1995-2015	1995-2015	2004-2015
UK	1995-2014	1995-2014	1998-2014	1996-2014	1995-2015	1997-2014

Source: author's calculations using Eurostat and Ameco.
Note: numbers in parenthesis correspond to the number of sectors for which data is available, when different than 19.

Figure A.1 – Different measures of TFP for France and Spain, indices 2010=100

(a) France, 1978-2014 **(b)** Spain, 1996-2015



Source: author's calculations using Eurostat, Ameco and EU-KLEMS 2016 release.
Note: the black line is the measure of TFP provided by EU KLEMS, using capital services. The green lines are measures using input volumes rather than services. The green dotted line uses an ex ante rate of return for capital and therefore is an unbiaised measure of TFP corrected for the dynamics of profits.

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 19 sectors defined above, I build a tradability indicator using the extent to which a good or a service is actually traded with a foreign country, like most of the empirical literature (see, for instance, Gregorio et al., 1994; Mian and Sufi, 2014).

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

We define an openness ratio for each sector –the ratio of total trade (imports + exports) to total production. The openness ratio tends to increase in each sector between 1995 and 2014, as well as for the total economy (from 30% in 1995 to 42% in 2014 for total area). The most opened country is Estonia (87%) and the less openned is Italy (26%).

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

Inevitably, the threshold of 10% is arbitrary. Figure A.2 shows the share of the non-tradable sector in total hours worked in the 24 countries depending on the threshold used to classify each of the 19 sectors as tradable or non-tradable. The black measures the tradability indicator using the average openness ratio for the 24 countries. The grey area represents the measures of the tradability indicator using the sector-level openness ratio of the most opened (Estonia) and the less opened (Italy) countries.

The black line shows that, using the 10% threshold, the non-tradable sector represents about 51% of total hours worked; using a lower threshold, lower than 3%, the non-tradable sector represents less than one third of total hours worked; using a larger threshold, between 15% to 19%, the non-tradable sector represents a little more than 55% of total hours worked; using a threshold over 20%, the non-tradable sector represents more than 60% of total hours worked. Using the 10% threshold, but applying this ratio not to the average openness of the area composed of 24 countries but rather to the most opened country, a larger share of the economy is tradable: the non-tradable sector represents only about 40% of total hours worked. On the contrary, using the 10% threshold, but applying this ratio to the least opened country, the non-tradable sector represents more than 60% of total hours worked.

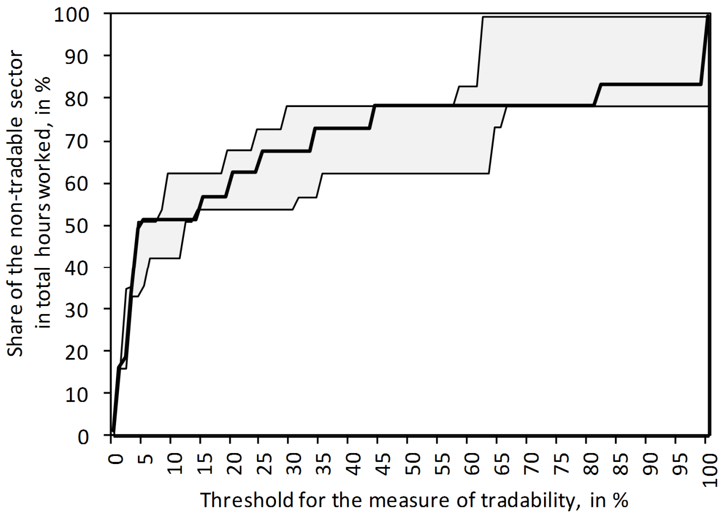
Finally, this tradability indicator is compared to other indicators used in the literature. Using data for 14 OECD countries and 20 sectors, Gregorio et al. (1994) define a sector as tradable if the 14 countries' total exports represent more than 10% of the sector's total production. Mian and Sufi (2014)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

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

Sector		Average 1995-2014, 24 countries		
		Openness ratio: trade to production, in %	Mian & Sufi, 2014: trade per worker, in euros	Gregorio et al., 1994: exports to production, in %
B	Mining and quarrying	196.0	631,975	68.9
C	Manufacturing	99.0	168,903	50.6
I	Accommodation and food service activities	81.9	48,092	41.4
A	Agriculture, forestry and fishing	43.9	18,961	18.8
H	Transportation and storage	33.1	36,761	17.0
N	Administrative and support service activities	24.1	15,371	11.7
M	Professional, scientific and technical activities	19.1	19,460	9.3
J	Information and communication	14.9	25,560	8.7
K	Financial and insurance activities	14.7	27,348	9.1
D	Electricity, gas, steam and air conditioning supply	4.3	18,486	2.1
R	Arts, entertainment and recreation	4.2	3,052	2.5
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	3.8	2,542	2.2
O	Public administration and defence; compulsory social security	2.4	1,644	1.3
F	Construction	2.4	2,524	1.4
S	Other service activities	1.8	909	0.8
E	Water supply; sewerage, waste management and remediation activities	0.3	486	0.2
P	Education	0.1	66	0.1
Q	Human health and social work activities	0.1	34	0.0
L	Real estate activities	0.0	0	0.0

Source: author's calculations using Eurostat and BACI.
Note: grey cells are non service activities.

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



Source: author's calculations using Eurostat and BACI.
Note: The black line measures the tradability indicator using the average openness ratio for the 24 countries. The grey area represents the measures of the tradability indicator using the most and least opened countries.