Online Appendix for "Economic Integration and Unit Labour Costs"

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The Appendix is divided into the following sections:

A1. Data: describes the data sources and definitions used throughout the paper.

A2. Additional details on measurement choices:

- **Growth accounts with profits:** describes the measurement of profits and total factor productivity (TFP) adjusted for profits. It then compares this adjusted TFP measure with the standard KLEMS measure of TFP unadjusted for profits.
- **Defining the tradability of a sector:** discusses the threshold used to classify industries into tradable and non-tradable sectors. It then compares this baseline definition to alternative measures and discusses implications for productivity and capital intensity measures.
- **Country classification:** discusses the definition of country groups.

A3. Additional details on empirical facts:

- **Empirical evidence for the Balassa-Samuelson model:** presents regressions of relative prices on sectoral productivity.
- **Sub-sector contributions to ULC growth:** describes the contribution of tradable and non-tradable sub-sectors' to sectoral ULC growth.

A4. Additional details on the model:

- **Detailed model and extensions:** provides more details on the model and expressions presented in Section 2 and details the role of terms of trade and their relation to a labour wedge that could explain the positive residual in the final decomposition of unit labour costs.
- **Calibration:** provides more details on how I calibrate the model, and in particular capital intensities.
- **Quantitative results:** provides additional tables with results by country of the periphery.

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A1. Data

Industry accounts I use the 2019 vintage of EU KLEMS[1]. EU KLEMS sources data for its Statistical module from Eurostat Industry Accounts. These harmonized accounts follow the 2008 System of National Accounts (SNA) enabling comparisons across all 28 EU Member States. These data contain series of gross value added at basic prices, production, compensation of employees and employment, investment and capital stock for up to 64 industries in the Nace rev.2 classification. Data coverage for capital stocks differs depending on country, period and asset, see Table A.1 below.

EU KLEMS Growth account module then builds on these industry accounts to create growth accounting indicators such as TFP, capital and labour services series. These EU KLEMS-created growth accounts will be discussed more extensively in Appendix A.2.

Trade data For data on trade in goods, I use OECD BTDIxE Bilateral Trade in Goods by Industry and End-use dataset, that offers values of imports and exports at the industry level using the ISIC Rev.4 classification. For trade in services, Eurostat provides data on bilateral service exports and imports for European countries in the BPM5 classification over 1984-2013 and in the BPM6 classification over 2010-2016.

Both trade and industry accounts data are converted into the 19-level NACE revision 2 classification below, and I focus in the paper on market sectors only (see Table A.2). Following accounting conventions, non-market sector output is measured using data on inputs –meaning that by construction TFP is close to zero in these sectors. I thus exclude all non-market sectors, i.e. public administration, health, education and other non-market services, but also the real estate sector which is mostly composed of rental income, and agriculture which revenue is driven by European subsidies. See Table A.2 for a definition of market sectors.

Additional data: opportunity cost of capital and GDP Data on risk-free rates are Eurostat Maastricht criterion interet rate. As for the capital risk premium, I use data on debt-to-equity ratio from Eurostat balance sheets by institutional sector (nasa_10_bf dataset) and on dividend yields from the Jordà-Schularick-Taylor Macrohistory Database (Òscar Jordà et al., 2017, 2019).

Finally, I use National Accounts data for GDP per capital at PPP and final consumption expenditure-to-GDP ratio. I download these data directly from Eurostat National Accounts.

[1] Available at euklems.eu.

Table A.1 – Capital data coverage, by asset and country

Country	Asset						
	Dwellings	Other buildings	Transport equipment	Other machinery	ICT	Cultivated assets	IPP
Austria	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017
Belgium	1996-2017	1996-2017	1996-2017	1996-2017	1996-2017	1996-2017	1996-2017
Cyprus	1996-2016	1996-2016	1996-2016		1996-2016	1996-2016	
Germany	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017
Greece	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016	1995-2016
Spain	1996-2016	1996-2016	1996-2016	1996-2016	1996-2016	1996-2016	1996-2016
Finland	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017
France	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017
Ireland	1995-2016	1995-2016	1995-2016			1995-2016	
Italy	1996-2017	1996-2017	1996-2017	1996-2017	1996-2017	1996-2017	1996-2017
Luxembourg	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017
Netherlands	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017	1995-2017
Portugal	2000-2016	2000-2016	2000-2016			2000-2016	
Slovenia	1995-2017	2000-2017	2000-2017	2000-2017	2000-2017	2000-2017	2000-2017
Slovakia	2000-2017	2000-2017	2000-2017	2000-2017	2000-2017	2000-2017	2000-2017

Source: Eurostat and EU KLEMS 2019 vintage. Note: ICT is Information and Communication Technology; IPP is Intellectual Property Products. All dwellings are included in the Real Estate sector (sector L). As I focus on the market sector for TFP dynamics, excluding the Real Estate sector, dwellings are excluded from the capital stock in measures of TFP.

Table A.2 – Industry classification

Sector code	Sector description	Market sector
A	Agriculture, forestry and fishing	-
B	Mining and quarrying	✓
C	Manufacturing	✓
D-E	Electricity, gas and water supply	✓
F	Construction	✓
G	Wholesale and retail trade	✓
H	Transport and storage	✓
I	Accomodation and food service activities	✓
J	Accomodation and food service activities	✓
K	Financial and insurance activities	✓
L	Real estate activities	-
M-N	Other business activities	✓
O	Public administration and defence	-
P	Education	-
Q	Health and social work	-
R-S	Arts, recreation and other services	✓
T	Activities of households as employers	-
U	Activities of extraterritorial organizations	-

A2. Additional details on measurement choices:

A2.1. Growth accounts with profits

To build two-sector growth accounts I use KLEMS growth accounting methodology (see O'Mahony and Timmer, 2009) but allow for the existence of profits to obtain indicators on the share of labour, capital and profits in gross value added, and the consequent unbiased measure of TFP.

Measuring profits Capital compensations are the product of capital stocks and user costs of capital. User costs of capital are given in equation (18) of the paper:

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

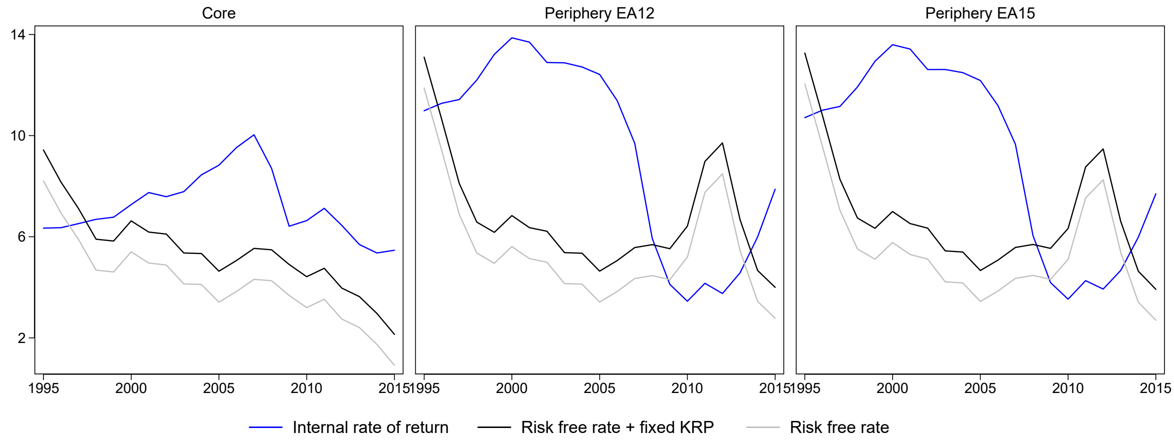
User costs depend on investment prices, depreciation rates and a return to capital. Data on investment prices and depreciation rates are from EU KLEMS 2019 vintage. Assumptions on the rental rate determine the existence of profits.

Assuming no profit in the equilibrium, EU KLEMS uses an 'internal rental rate' (IRR). This rate is inferred from the ratio of total gross operating surplus (capital compensation if profits are null) to the net capital stock. By comparison, I do allow for the existence of profits and cannot infer the rate of return. I build an 'ex-ante' measures of a rental rate, based on exogenous information on capital costs. Using this rate, I am able to distinguish, in the gross operating surplus, the cost of capital from profits. Profits are deduced as the residual when labour and capital compensations are retrenched from gross value added, as in Barkai (2020) or Gutiérrez (2018).

Different types of 'ex-ante' rental rates can be used. I use a long-term (risk-free) interest rate, corresponding to central government benchmark bonds of 10 years plus a capital risk-premium. To proxy the capital risk premium (KRP) I use data on equity yields from Òscar Jordà et al. (2019). Unlike the debt cost of capital, which is observable in market data, the equity cost of capital is unobserved. The classic Gordon model allows us to convert dividend yields ratios into a rough measure of the equity risk premium (ERP). This result is based on the assumption that the rate of growth of future dividends is constant and equal to the risk-free rate. Then, assuming that the corporate structure remains constant over time, the (levered) equity risk premium is related to the (un-levered) risk premium as follows: $ERP = (1 + d)KRP$, with d the debt-to-equity ratio measured using Eurostat data (Caballero et al., 2017). As I only have data for a subset of countries, I assume this capital risk premium is fixed over time and take its average where available (1.2%).

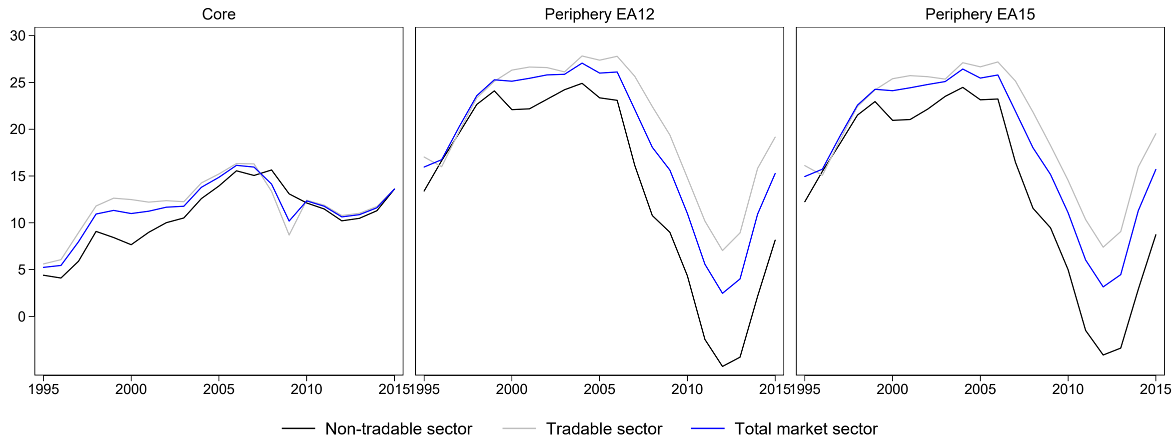
The three different rental rates are presented in Figure A.1 for the core and periphery over 1995-2015: the internal rate of return, the risk-free rate and the risk-free rate plus KRP. EU KLEMS internal rates of return, including profits, are much higher than the 'ex-ante' rental rates and behave in a significant different way, suggesting that profits have not remained stable. This is confirmed in Figure A.2 showing profit shares by country group.

Figure A.1 – Rental rate, by country group, 1995-2015, in %



Source: author's calculations using EU KLEMS, Eurostat and Jordà-Schularick-Taylor Macro-history Database. Averages over country groups are weighted by GDP in euros. See Table A.6 for more details on country groups.

Figure A.2 – Profit shares, by country group and sector, 1995-2015, in %



Source: author's calculations using EU KLEMS, Eurostat and Jordà-Schularick-Taylor Macro-history Database. Averages over country groups are weighted by GDP in euros. See Table A.6 for more details on country groups.

Measuring TFP adjusted for profits When allowing for the existence of profits, usual Solow-residuals can diverge from true technology (Fernald and Neiman, 2011; Comin et al., 2020). When there are no profits, *i.e.* when $\mu_t^j = 1$ and $LS_t^j = 1 - \alpha^j$, then usual measures of TFP equal true technology and also real factor payments. The usual Solow residual can be written as:

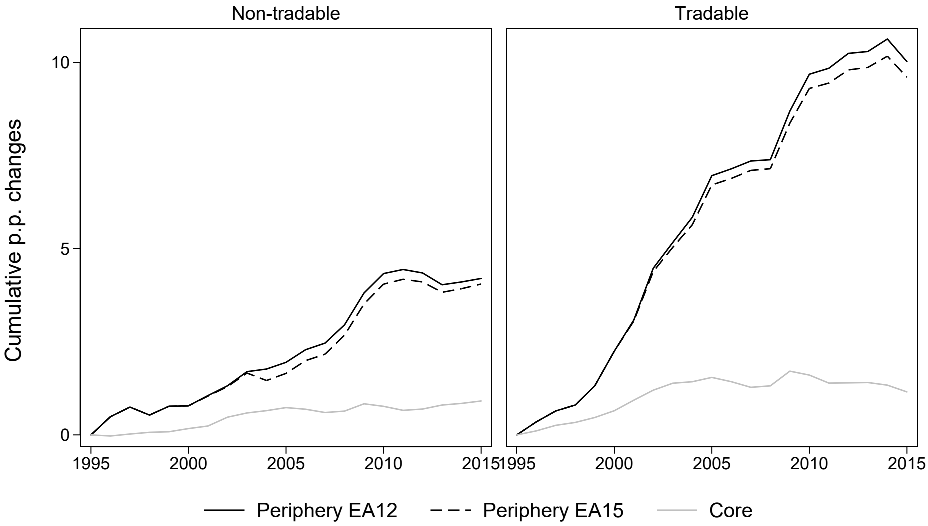
$$T\hat{F}P^j_t = \hat{A}^j_t = \hat{Y}^j_t - LS^j_t\hat{L}^j_t - (1 - LS^j_t)\hat{K}^j_t$$

When allowing for the existence of profits, this measure diverges from true technology (A). Since $LS^j_t = \frac{1-\alpha^j}{\mu^j_t}$, we get:

$$\begin{aligned} T\hat{F}P^j_t &= \hat{Y}^j_t - LS^j_t\hat{L}^j_t - (1 - LS^j_t)\hat{K}^j_t \\ &= \hat{A}^j_t + \underbrace{LS^j_t(\mu^j_t - 1)(\hat{L}^j_t - \hat{K}^j_t)}_{\text{bias}} \end{aligned}$$

This bias has been increasing over time, especially in non-tradable sectors in the periphery, as evidenced in Figure A.3.

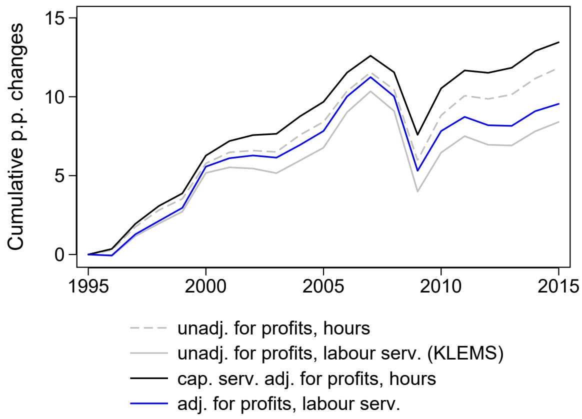
Figure A.3 – Contribution of the profit adjustment to Total Factor Productivity measure, by country group and sector, 1995-2015



Note: this adjustment leads to a 10p.p. upward adjustment in tradable TFP growth over 1995-2015 in the periphery, and a 5p.p. adjustment to non-tradable productivity growth. By contrast, this adjustment affects only little TFP growth in core countries. Averages over country groups are weighted by GDP in euros. See Table A.6 for more details on country groups.

Coverage The coverage of the final dataset is reported in Table A.3. It is worth noting that data on labour services is very limited –especially in the periphery where it most often starts in 2008. Yet, using labour services –and controlling for labour 'quality', leads

Figure A.4 – Adjusted Total Factor Productivity



Note: this figure includes only country-year observations where all four series are available (see Table A.3 for the coverage). Averages over country groups are weighted by GDP in euros. See Table A.6 for more details on country groups.

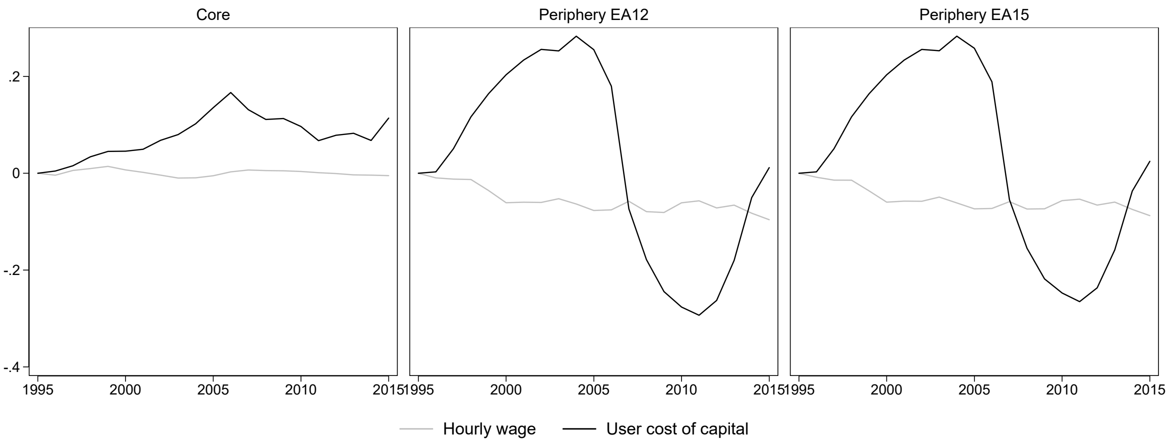
to a downward bias in TFP (see Figure A.4). However, Figure A.5 shows that, even if leading to a downward adjustment to aggregate TFP, hourly wages evolve closely in both sectors suggesting that the labour service adjustment will affect similarly both sectors of the economy –contrary to the capital services adjustment as user costs evolved in very different ways in both sectors.

Table A.3 – Coverage of TFP series

Country	unadj. for profits, hours	unadj. for profits, labour serv.	adj. for profits, hours	adj. for profits, labour serv.
Austria	1995-2015	1995-2015	1995-2015	1995-2015
Belgium	1999-2015	1999-2015	1999-2015	1999-2015
Cyprus	2000-2015	2008-2015	2000-2015	2008-2015
Germany	1995-2015	1995-2015	1995-2015	1995-2015
Greece	1995-2015	2008-2015	1995-2015	2008-2015
Spain	1995-2015	1995-2015	1995-2015	1995-2015
Finland	1995-2015	1995-2015	1995-2015	1995-2015
France	1995-2015	1995-2015	1995-2015	1995-2015
Ireland	1995-2014	2008-2014	1995-2014	2008-2014
Italy	1995-2015	1995-2015	1995-2015	1995-2015
Luxembourg	1995-2015	2008-2015	1995-2015	2008-2015
Netherlands	1995-2015	1995-2015	1995-2015	1995-2015
Portugal	2000-2015	2008-2015	2000-2015	2008-2015
Slovenia	2000-2015	2008-2015	2001-2015	2008-2015
Slovakia	2000-2015	2000-2015	2000-2015	2000-2015

Source: author's calculations using EU KLEMS, Eurostat and Jordà-Schularick-Taylor Macrohistory Database. Last data update: January 2021.

Figure A.5 – Hourly wage and user cost dispersion, tradable vs. non-tradable sector, by country group, 1995-2015



Note: Cumulative p.p. change of the tradable - non-tradable growth. Dispersion in user costs increased much more than dispersion in hourly wages. Averages over country groups are weighted by GDP in euros. See Table A.6 for more details on country groups.

A2.2. 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 market 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). I define an openness ratio for each sector –the ratio of total trade (imports + exports) to total production.

Discussion on the choice of the threshold If this ratio is bigger than 10%, on average for the total area and over 1995-2015 (average weighted by GDP in euros), then the sector is considered as tradable. Table 1 in section 1 of the article reports the openness ratio by sector on average for the 21 countries for which I have data on trade and production (EU15 + Czech Republic, Denmark, Lithuania, Latvia, Sweden, United Kingdom).

Inevitably, the threshold of 10% is arbitrary. This tradability indicator is compared to other indicators used in the literature. Using data for 14 OECD countries and 20 sectors, Gregorio et al. (1994) define a sector as tradable if the 14 countries' total exports represent more than 10% of the sector's total production. Mian and Sufi (2014) use US data for about 300 sectors and define a sector as tradable if total trade (imports plus exports) per worker represent more than $10,000. Both these indicators are constructed using the sample of 24 countries over 1995-2015. Using the openness ratio with a 10% threshold, the export to production ratio with a 5% threshold or trade per worker with a €10,000 threshold give very similar results (Table A.4). Using the same indicator as Gregorio et al. (1994) would be the same than using the 20% threshold.

One could worry that import and export sectors are significantly different across countries, with the periphery exporting services and core countries manufacturing goods. Table A.5 shows tradability indicators, using alternatively total trade or only exports to production, by country group, and compare it to the benchmark openness ratio (average for the 21 countries I mentionned). We can see that sector rankings are very similar across countries. Using a 10% threshold for total trade or a 5% threshold for exports lead to very similar classifications in the core and periphery.

Table A.4 – Three different tradability indicators

Sector code	Average 1995-2015, 21 countries		
	Openness ratio: trade to production, in %	Mian & Sufi, 2014: trade per worker, in euros	Gregorio et al., 1994: exports to production, in %
B	542.71	1,494,960.75	79.96
C	100.42	219,606.20	51.25
I	95.41	54,994.91	36.52
H	34.58	44,842.67	17.36
M_N	16.79	15,726.05	8.50
J	16.05	34,068.74	8.91
K	11.78	29,041.25	7.38
F	2.98	3,388.05	1.73
G	2.86	2,480.36	1.00
D_E	2.62	9,578.24	1.36
R_S	0.79	589.96	0.39
TOTAL	38.27	44,420.11	19.41

Source: author's calculations using Eurostat EU KLEMS and OECD. The 21 countries are EU15 + Czech Republic, Denmark, Lithuania, Latvia, Sweden, United Kingdom. Averages across countries are weighted by GDP in euros.

Table A.5 – Tradability indicators, by country groups

Sector code	Openness ratio	Core EA17		Periphery EA15	
		Imports + Exports	Exports	Imports + Exports	Exports
B	542.71	403.56	30.30	429.88	22.96
C	100.42	110.62	57.27	141.26	42.62
I	95.41	119.04	53.82	147.60	66.16
H	34.58	45.43	22.91	44.33	23.79
M_N	16.79	23.66	10.03	16.40	8.01
J	16.05	29.70	15.77	23.63	12.70
K	11.78	8.44	4.50	12.05	4.66
F	2.98	4.42	2.42	2.17	1.76
G	2.86	2.85	1.28	1.36	0.66
D_E	2.62	4.29	1.79	1.78	0.41
R_S	0.79	0.88	0.36	2.44	0.95
TOTAL	38.27	46.00	23.67	53.46	25.12

Source: author's calculations using Eurostat EU KLEMS and OECD. The Openness ratio is the benchmark measure from Table A.4. Other indicators use alternatively total trade and only exports to production. Averages over 1995-2015 and over country groups, countries being weighted by their GDP in euros. See Table A.6 for more details on country groups.

A2.3. Country classification

In the paper, I focus on two EA aggregates: EA12 and EA15. The periphery includes the four EA12 Member States with the lowest GDP per capita (at purchasing power standards) in 1995: Greece, Ireland, Portugal and Spain, as well as three new Member States in the EA15: Cyprus, Slovenia and Slovakia. Core countries are Austria, Belgium, Germany, Finland, France, Italy, Luxembourg and the Netherlands. Group averages weighted by GDP (in euros).

Note that the sample, described in Table A.3, includes periods before the official inception of the euro. This is not an issue for EA12 as intra-zone exchange rate fluctuations over this period were very small. This is more worrying for the 3 additional Member States of the EA15 that have joined the euro in later years. For this reason, I always present results for the two sub-samples of the periphery: including only EA12 countries or EA15 as well.

Table A.6 – Country classification

EA aggregate	Country group	Country name	Euro adoption date	GDP per capita in PPP, 1995
EA12	Core	Luxembourg	1999	33.3
EA12	Core	Austria	1999	19.9
EA12	Core	Germany	1999	19.9
EA12	Core	Netherlands	1999	19.7
EA12	Core	Belgium	1999	18.9
EA12	Core	Italy	1999	18.8
EA12	Core	France	1999	17.5
EA12	Core	Finland	1999	16.5
EA12	Periphery	Ireland	1999	16.0
EA12	Periphery	Spain	1999	13.7
EA12	Periphery	Greece	2001	13.0
EA12	Periphery	Portugal	1999	12.1
EA15	Periphery	Cyprus	2008	14.4
EA15	Periphery	Slovenia	2007	11.5
EA15	Periphery	Slovakia	2009	7.3

Source: GDP per capita in PPP from Eurostat.

A3. Additional details on empirical facts:

Table A.7 – RER-RULC regressions

	RER 1995-2008, EA12			RER 1995-2015, EA15				RULC 1995-2015, EA15
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(2d)	(3)
RTFP	0.18	0.35	0.49	0.18	0.16	0.07	0.13	0.17
	(0.07)	(0.07)	(0.05)	(0.06)	(0.06)	(0.03)	(0.02)	(0.06)
RMarkups					-0.07		0.28	-0.48
					(0.04)		(0.03)	(0.08)
RULC						0.58	0.71	
						(0.03)	(0.04)	
$\overline{R}^2$	0.57	0.59	0.69	0.35	0.36	0.74	0.81	0.66
N	159	159	159	284	284	284	284	284

Notes: This table shows panel regressions with countries as cross-sections. All estimates are reported along with panel corrected standard errors (Beck and Katz, 1995) in parentheses under the assumption of period correlation (cross-sectional clustering). The estimate of the constant is not reported.
Dependant variable: log real exchange rate expressed as EU12 average relative to country i (an increase is a depreciation), measured using GVA deflators, in columns 1 and 2. $RULC$ is defined as a ratio of nominal total labour compensations for the economy relative to real GVA, expressed as EU12 relative to country i, in column 3. $RTFP_{i,t}$ is the log of TFP index of traded relative to non-traded sector in EU12 relative to country i. Column (1a) uses TFP data for the manuf. vs. service sector, and TFP is unadjusted for profits. Columns (1b) uses the new tradable vs. non-tradable classification, but TFP is still unadjusted for profits. Columns (1c) and the following use TFP data with adjusted N/T classification and profits. $RMarkups$ is defined as average markups in EU12 relative to country i.
Columns (1a) to (2a) show that, if adjusting TFP for the new N/T classification and for profits, the Balassa-Samuelson is well-alive both in the EA12 and the EA15. The coefficient increases as we adjust TFP. Columns (2b-3) are discussed in Appendix A4.2.

Table A.8 – Change in unit labour costs, sector relative to total economy and sector contributions, p.p.

(a) 1995-2015

		Core		Periphery	
Sector code	Sector	$\Delta ULC_k - \Delta ULC$	Contrib.	$\Delta ULC_k - \Delta ULC$	Contrib.
B	Mining and quarrying	32.7	-0.3	-9.6	-0.2
C	Manufacturing	-17.0	-0.5	-32.5	0.1
H	Transportation and storage	-13.3	0.9	-8.4	2.8
I	Accommodation and food service activities	28.2	3.0	69.8	13.6
J	Information and communication	-37.3	3.0	-39.7	2.6
K	Financial and insurance activities	2.6	0.7	-35.2	1.3
M_N	Other business service activities	40.2	16.4	35.8	19.3
Tradable		0.3	16.3	-5.5	22.9
D_E	Utilities and waste management	7.8	1.0	15.6	2.5
F	Construction	26.5	5.4	21.1	10.8
G	Wholesale and retail trade	-7.1	16.2	16.6	40.5
R_S	Arts, entertainment, etc.	23.2	7.0	-0.8	10.0
Non-tradable		6.6	6.7	18.9	22.0
Total (ΔULC, in %)		23.0	-	44.9	-

(b) 1995-2008

		Core		Periphery	
Sector code	Sector	$\Delta ULC_k - \Delta ULC$	Contrib.	$\Delta ULC_k - \Delta ULC$	Contrib.
B	Mining and quarrying	21.7	-0.3	-11.5	0.0
C	Manufacturing	-10.8	-2.2	-23.4	3.7
H	Transportation and storage	-15.2	0.1	-9.5	3.5
I	Accommodation and food service activities	18.8	1.1	64.0	12.7
J	Information and communication	-25.5	2.1	-44.0	1.6
K	Financial and insurance activities	13.5	0.5	-57.8	1.8
M_N	Other business service activities	28.7	10.1	24.7	15.6
Tradable		0.1	8.6	-8.1	20.5
D_E	Utilities and waste management	-2.9	0.1	-7.9	1.3
F	Construction	20.2	2.9	38.8	26.5
G	Wholesale and retail trade	-4.3	8.9	13.7	32.1
R_S	Arts, entertainment, etc.	14.4	3.8	-5.9	6.2
Non-tradable		4.5	2.5	19.1	26.5
Total (ΔULC, in %)		11.2	-	47.0	-

A4. Additional details on the model:

A4.1. Detailed model and extensions

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

$$\max_{p_t^j} \sum_{s=t}^{\infty} R_{t,s}^{-1}(p_s^j y_s^j - \omega_s - q_s i_s^j) \quad \text{where} \quad R_{t,s} = \frac{\prod_{\tau=t}^{s} R_\tau}{R_t}$$

$$\text{subject to} \quad y_t^j = A_t^j k_t^{j\alpha^j} n_t^j \quad \text{with} \quad i_s^j = k_{s+1}^j - (1-\delta)k_s^j \quad \text{and given } k_t^j.$$

First-order conditions are given by:

$$\omega_t = \frac{(1-\alpha^j)}{\mu_t^j}\frac{p_t^j y_t^j}{n_t^j} \quad \text{and} \quad U_t = \frac{\alpha^j}{\mu_t^j}\frac{p_t^j y_t^j}{k_t^j n_t^j} \quad \text{with} \quad \mu_t^j = \left(1 + \left(\partial p_t^j / \partial Y_t^j\right)\left(p_t^j / Y_t^j\right)\right)^{-1}$$
$$\text{and} \quad U_t = q_{t-1}(1 + r + x_t(f_t, f)) - q_t(1-\delta)$$

with x_t a function of the gap between net foreign liabilities f_t and their steady-state level f. In steady state, $x = 0$. 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:

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

The representative household has the following programme:

$$V_t = \sum_{s=t}^{\infty} \beta^{s-t} \ln(c_s) \quad \text{where} \quad c_t = [\gamma^{\frac{1}{\theta}} c_t^{T\,\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} c_t^{N\,\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}}$$
$$\text{subject to} \quad p_t c_t = \omega_t + d_t + f_{t+1} - (R_t - 1)f_t$$
$$\text{with} \quad p_t c_t = c_t^T + p_t^N c_t^N \quad \text{and} \quad \lim_{T\to\infty} R_{t,t+T} f_{t+T+1} = 0$$

First-order conditions are the following:

$$\frac{c_t^T}{c_t^N} = \frac{\gamma}{1-\gamma}(p_t^N)^\theta \quad \text{and} \quad \frac{p_{t+1}c_{t+1}}{p_t c_t} = \beta(1 + r + x_{t+1})$$

with $\beta = R^{-1}$. The consumption price index p_t (expressed in terms of the tradable good) is a function of the relative price of the non-traded goods p_t^N:

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

Consumption shares are given by:

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

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:

$$\hat{p}_t \equiv (1-\gamma)\hat{p}_t^N$$

Equilibrium In equilibrium, the share of the non-tradable sector in total employment and total output is given by:

$$n_t^N = \frac{LS_t^N}{LS_t} s_t^N \quad \text{with} \quad s_t^N = (1-\gamma)\left(\frac{p_t^N}{p_t}\right)^{1-\theta} \chi_t$$

In steady state, because of the No-Ponzi condition and because $\beta = R^{-1}$, we have $\hat{\chi} = 0$, implying that:

$$\Omega = \frac{n^N - s^N}{1-s^N} \quad \text{with} \quad s^N = (1-\gamma)$$
$$\text{and} \quad n^N = \frac{(1-\alpha_N)/\mu_N}{((1-\alpha_N)/\mu_N)(1-\gamma) + ((1-\alpha_T)/\mu_T)\gamma}(1-\gamma)$$

A4.2. Terms of trade

Let us here assume that traded goods are different across countries and this difference reflects export specialization. Terms of trade thus capture export specialization (i.e. differences in the composition exported traded goods across countries) but not a difference in traded goods' consumer prices across countries (countries consume similar traded goods baskets, with similar prices because of the law of one price).

Equations for the Foreign country are symmetric to the domestic economy and denoted with a star. Aggregate consumption is still given by:

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

However, traded consumption is decomposed into the consumption of Home and Foreign traded goods:

$$c_t^T = [\omega^{\frac{1}{\psi}} c_t^{H\,\frac{\psi-1}{\psi}} + (1-\omega)^{\frac{1}{\psi}} c_t^{F\,\frac{\psi-1}{\psi}}]^{\frac{\psi}{\psi-1}}$$

with ψ the elasticity of substitution between the two goods and ω the share of Home consumption goods in the consumption basket. The corresponding price index is:

$$p_t^T = [\omega p_t^{H(1-\psi)} + (1-\omega) p_t^{F(1-\psi)}]^{\frac{1}{(1-\psi)}}$$

And symmetrically, the Foreign price index is:

$$p_t^{T*} = [\omega p_t^{F(1-\psi)} + (1-\omega) p_t^{H(1-\psi)}]^{\frac{1}{(1-\psi)}}$$

Changes in the real exchange rate are now given by:

$$\begin{aligned}
&\widehat{RER}_t = \widehat{p}_t - \widehat{p^*}_t = (1-\gamma)\left(\widehat{p^N}_t - \widehat{p^T}_t - (\widehat{p^{N*}}_t - \widehat{p^{T*}}_t)\right) + \widehat{p^T}_t - \widehat{p^{T*}}_t \\
&\text{with} \quad \widehat{p^T}_t - \widehat{p^{T*}}_t = (2\omega - 1)\tau \\
&\text{and} \quad \widehat{p^N}_t - \widehat{p^T}_t - (\widehat{p^{N*}}_t - \widehat{p^{T*}}_t) = \widehat{p^N}_t - \widehat{p^H}_t - (\widehat{p^{N*}}_t - \widehat{p^F}_t) + 2(1-\omega)\tau
\end{aligned}$$

with $\tau = p_t^H - p_t^F$, the terms of trade of the domestic country, and the change in the relative price of home non-traded to traded goods is given by equation 11:

$$H = \widehat{p^N}_t - \widehat{p^H}_t = \left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{A}_t^T - \hat{A}_t^N - \left[\left(\frac{1-\alpha^N}{1-\alpha^T}\right)\hat{\mu}_t^T - \hat{\mu}_t^N\right] - \left(\frac{\alpha^T-\alpha^N}{1-\alpha^T}\right)\hat{U}_t$$

such that the real exchange is given by:

$$\widehat{RER}_t = (1-\gamma)(H - H^*) + (1 - 2\gamma(1-\omega))\,\tau$$

The real exchange rate now depends on the terms of trade, the sign depending on the share of Home consumption goods in the consumption basket. Assuming the Country consumes the 'world' tradable good, and that the Home tradable price reflects only export specialization ($\omega = 0$), RER is an increase function of the terms of trade and the expression reduces to:

$$\widehat{RER}_t = (1-\gamma)(H - H^*) + (1-2\gamma)\tau$$

In this special case with $\omega = 0$, $RULC$ are now given by:

$$\widehat{RULC}_t = (1 - \gamma + \Omega(1-\theta)\gamma)\left(H - H^*\right) - \left(\widehat{\mu}_t - \widehat{\mu^*}_t\right) + \Omega\left(\hat{\chi}_t - \hat{\chi}^*_t\right) + (1-2\gamma)\tau$$

In the main paper, I assume terms of trade are only affected by a product-market wedge: $\tau = p_t^H - p_t^F = \widehat{\mu^T}_t - \widehat{\mu^{T*}}_t$. Assuming no differences in labour shares across sectors, such that $\alpha_N = \alpha_T = \alpha$ and $\mu^N = \mu^T = \mu$, the expression reduces to:

$$\widehat{RULC}_t = (1-\gamma)\left[(\hat{A}_t^T - \hat{A}_t^{T*}) - (\hat{A}_t^N - \hat{A}_t^{N*})\right] - \left(\widehat{\mu}_t - \widehat{\mu^*}_t\right) + (1-2\gamma)\tau$$

To get a similar expression to Berka et al. (2018), I use similar assumptions: no differences in labour shares across sectors, and $\omega = 0.5$ (thereby assuming differences in the baskets of traded goods consumed across countries). I get as in their equation (H3):

$$\widehat{RER}_t = (1-\gamma)\widehat{RULC}_t + (1-\gamma)(1+\gamma)\left(\widehat{\mu}_t - \widehat{\mu^*}_t\right) + (1-\gamma)\gamma\left[(\hat{A}_t^T - \hat{A}_t^{T*}) - (\hat{A}_t^N - \hat{A}_t^{N*})\right]$$

In this equation, $RULC$ will capture any effect on RER beyond the direct effects of productivity and markups (through terms of trade). This equation motivates the empirical specification in Table A.7 columns (2b-d). Interestingly, the net effect of markups on RER is null (2b), but the effect through terms of trade, that is when simultaneously controlling for $RULC$, is positive and significant (2d). This suggests that the indirect negative effect of markups through $RULC$ is stronger than the positive direct terms of trade effect, consistent with my assumptions in the model that the contributions of markups to $RULC$ through terms of trade is minor.

What is missing in my model is then any terms of trade effect beyond the one of markups. These effects are significant as evidenced by the fact that $RULC$ still has a positive coefficient in Table A.7. Berka et al. (2018) have already showed that these effects could capture the role of a labour wedge from the household-side. I thus assume that the positive residual from the results presented in Section 3 reflects this additional labour wedge effect.

A4.3. Calibration

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

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

$$\widehat{RULC}_t = RPROD_t = (1-\gamma)\left[\hat{A}_t^T - \hat{A}_t^{T*} - (\hat{A}_t^N - \hat{A}_t^{N*})\right] \quad (1)$$

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

$$\hat{A}_t^j = \Delta lnA_t^j = \Delta lnY_t^j - \overline{LS}_t^j \Delta lnL_t^j - \overline{CS}_t^j \Delta lnK_t^j$$

I do not adjust productivity for profits, and take the standard Solow-residual (using hours and not labour services because of data limitations). I define the tradable sector as manufacturing (sector B) and mining activities (sector C), and consider all services as non-tradables.

Calibration (ii) I then focus on the full specification from equation (21), with differences in capital intensity and sector-specific time-varying markups. I set $\alpha_N = 0.20$ and $\alpha_T = 0.25$, their average value in the data (see Table A.9). Similarly, steady states values of profits are set to their average value in the data ($\mu^N = 1.1$ and $\mu^T = 1.2$, implying a steady state labour share of $LS = 69\%$).

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

In this case, productivity in sector $j = T, N$ is given by:

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

This time, I do adjust productivity for profits, and take the new tradable sector definition (including services).

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

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

I take the same productivity measure as in calibration (ii).

Capital intensities are set to their average value in the data for the 15 EA countries over 1995-2015. They are very close among country groups and differ by +/-5p.p. across sectors (see Table A.9).

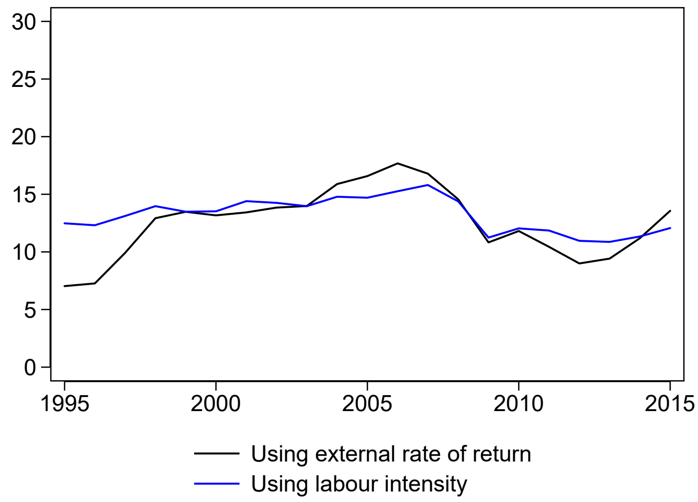
Table A.9 – Labour shares and capital intensities, by sector and group of countries, average over 1995-2015, in %

Country group	LS^N	LS^T	α^N	α^T
EA15	66.4	60.8	20.6	26.1
Core	69.5	63.5	20.0	26.1
Periphery EA12	63.5	56.5	18.6	23.3
Periphery EA15	62.9	57.6	21.6	26.1

This figure shows labour shares in output and capital shares in costs (capital intensity). Averages over country groups are weighted by GDP in euros. See Table A.6 for more details on country groups.

One important assumption using a Cobb-Douglas production function is that labour intensity, i.e. labour shares in total costs, are constant. One can estimate a counterfactual profit share using this assumption. We know that the labour share is a function of labour intensity and the profit share: $LS_t = (1-\alpha)(1-PS_t)$. Taking the estimate $\alpha = 0.22$, and taking the labour share as given, we can estimate the profit share PS_t. This counterfactual profit share is presented Figure A.6. This profit share evolves closely with the observed profit share.

Figure A.6 – Alternative estimates of profit shares: testing the Cobb-douglas production function assumption



Average across countries weighted by their GDP in euros. This Figure shows an inferred profit share from the assumption of constant labour intensity and taking the observed labour shares. This profit share evolves closely with the observed profit share.

A4.4. Quantitative results

Table A.10 – *RULC* decomposition and comparison with observed *RULC*, by country

(a) Periphery EA12

Period	Contribution of:	Greece	Ireland	Portugal	Spain
1995-2008	*RPROD*	8.0	23.3	14.5	0.7
	RCOMP	13.2	17.7	11.1	4.9
	RMISALLOC	0.5	8.3	2.8	3.0
	Residual (Obs. - Est.)	28.6	-20.0	-10.9	27.7
	Observed *RULC*	50.3	29.3	17.5	36.3
1995-2015	*RPROD*	6.3	28.5	1.6	0.5
	RCOMP	32.6	0.4	9.5	8.4
	RMISALLOC	1.1	-7.1	3.0	2.4
	Residual (Obs. - Est.)	17.1	-27.8	-9.4	11.6
	Observed *RULC*	57.0	-6.0	4.7	22.9

(b) Periphery EA15

Period	Contribution of:	Cyprus	Slovakia	Slovenia
1995-2008	*RPROD*	4.0	46.1	14.4
	RCOMP	12.1	-37.5	2.9
	RMISALLOC	-0.4	-0.5	1.4
	Residual (Obs. - Est.)	-4.8	56.7	46.6
	Observed *RULC*	11.0	64.9	65.3

This Tables shows a decomposition of relative unit labour costs using equation (22) in the paper, under calibration (iii) –with no differences in sectoral labour shares. The gap between the observed *RULC* in the data and its estimated counterpart from the model is referred to as the 'residual'.

In Portugal, sectoral productivity (*RPROD*) contributed by 15p.p. to the 29% growth in unit labour costs, so explained half (15/29=50%) of the ULC growth pre-crisis. In Greece, the residual explains most (29/50=60%) of the growth in ULC, suggesting that the labour market wedge might have played a big role in Greece.

References

Barkai, S. (2020). Declining Labor and Capital Shares. *Journal of Finance*, 75(5):2421–2463.

Beck, N. and Katz, J. (1995). What to do (and not to do) with time-series cross-section data. *American Political Science Review*, 89(3):634–647.

Berka, M., Devereux, M. B., and Engel, C. (2018). Real exchange rates and sectoral productivity in the eurozone. *American Economic Review*, 108(6):1543–81.

Caballero, R. J., Farhi, E., and Gourinchas, P.-O. (2017). Rents, technical change, and risk premia accounting for secular trends in interest rates, returns on capital, earning yields, and factor shares. *American Economic Review*, 107(5):614–20.

Comin, D. A., Gonzalez, J. Q., Schmitz, T. G., and Trigari, A. (2020). Measuring TFP: The Role of Profits, Adjustment Costs, and Capacity Utilization. NBER Working Papers 28008, National Bureau of Economic Research, Inc.

Fernald, J. and Neiman, B. (2011). Growth accounting with misallocation: Or, doing less with more in Singapore. *American Economic Journal: Macroeconomics*, 3(2):29–74.

Gregorio, J. D., Giovannini, A., and Wolf, H. C. (1994). International evidence on tradables and nontradables inflation. *European Economic Review*, 38(6):1225–1244.

Gutiérrez, G. (2018). Investigating Global Labor and Profit Shares. Technical report.

Mian, A. and Sufi, A. (2014). What explains the 2007-2009 drop in employment? *Econometrica*, 82(6):2197–2223.

O'Mahony, M. and Timmer, M. P. (2009). Output, Input and Productivity Measures at the Industry Level: The EU KLEMS Database. *Economic Journal*, 119(538):F374–F403.

Òscar Jordà, Knoll, K., Kuvshinov, D., Schularick, M., and Taylor, A. M. (2019). The Rate of Return on Everything, 1870-2015. *The Quarterly Journal of Economics*, 134(3):1225–1298.

Òscar Jordà, Schularick, M., and Taylor, A. M. (2017). Macrofinancial History and the New Business Cycle Facts. *NBER Macroeconomics Annual*, 31(1):213–263.