Sectoral Wages, Reallocation Frictions and Trade Integration*

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Abstract

The wage in the Goods sector relative to the Service sector varies over time and this change is heterogeneous across countries. I argue that a likely explanation is the existence of idiosyncratic sectoral labor demand shocks in the context of employment reallocation frictions. Aggregate trade integration can generate such idiosyncratic shocks. I then introduce a model of international trade with labor market frictions. If labor cannot fully reallocate after a shock, wages tend to adjust: relative wages tend to increase in sectors in which the country has a comparative advantage and tend to shrink in the rest of the economy. Trade integration thus impacts sectoral relative wages and this impact varies across countries. Using data from 37 countries for the 1995-2014 period, I confirm this relationship. I also show that the link is stronger for High Skill workers, which suggests that High Skill workers face larger reallocation costs. Furthermore, labor market frictions don't seem to be compensated by changes at the intensive labor margin (hours worked) nor factor intensity. These findings can shed light on the distributional consequences of diverse types of policies and shocks.

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1 Introduction

There is a renewed interest on the impact of international trade on sectoral employment reallocation. In particular, the decline of manufacturing employment and industrial policy are being discussed again. One lesson from the growing literature that studies these topics is that frameworks that rely on frictionless labor markets cannot explain all of the variation in the observed sectoral employment (see Gallacher [2019] and references there in).

Labor market frictions and hence sectoral wages matter. What frictions? Any labor market friction that limits wage arbitrage: workers' moving sectoral costs (geographical, psychological, etc), worker's sector-specific human capital, firing and hiring costs, market search frictions, monopsony power, sectoral collective bargaining, etc.

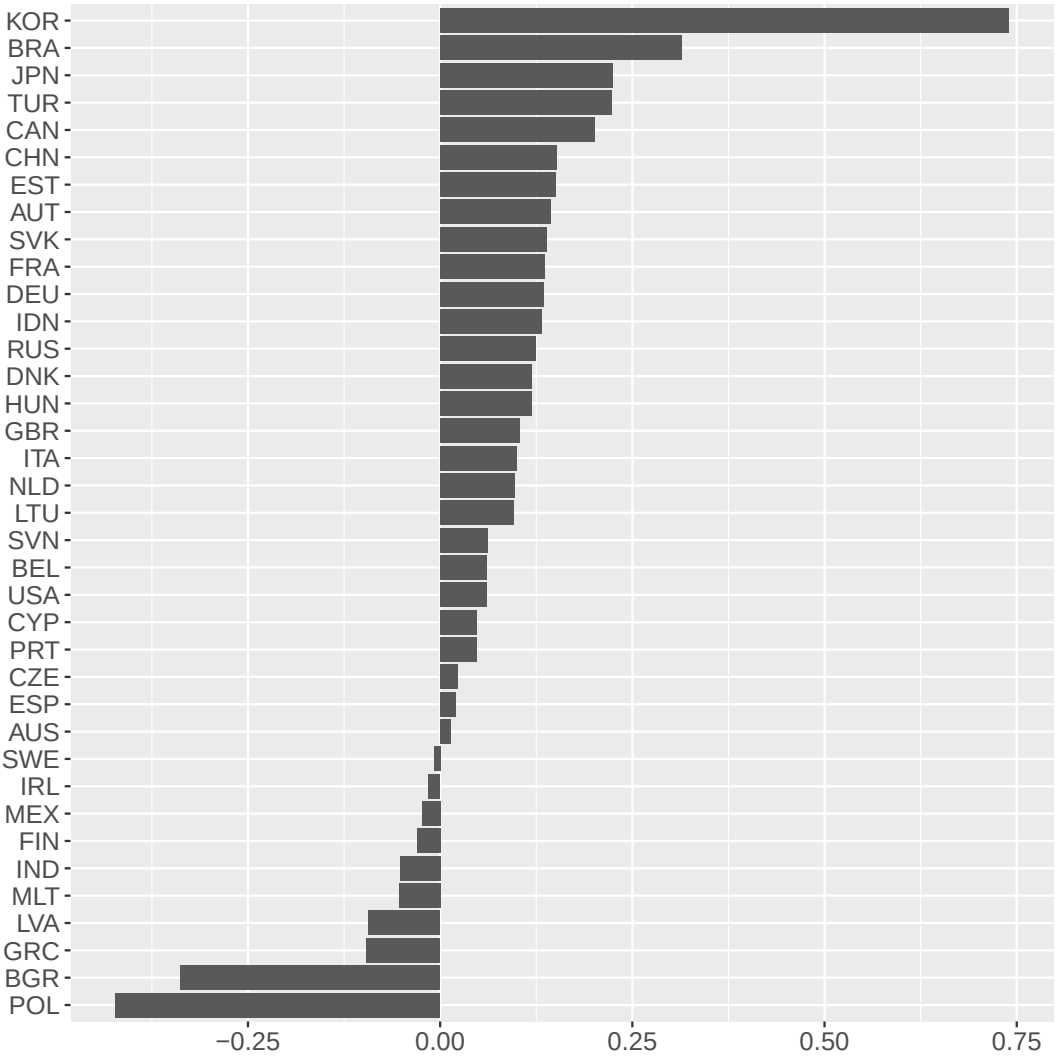
This lack of arbitrage is partially reflected sectoral wage data: for example, in the USA in 2014, a typical worker in the goods sector earned $72K per year while a typical worker in the service sector earned $63K per year. The sectoral relative wages (of the goods sector over service sector) in 2014 was therefore 1.15. This relative wage has been increasing over time (in 1995 was 1.09). Around the world there has also been considerable changes in sectoral relative wages, but with differences in magnitudes and signs, as Figure (1) indicates (Table (A1) in turn shows the data behind this plot).

Why do sectoral relative wages evolve over time? I argue that a likely explanation is the existence of idiosyncratic sectoral labor demand shocks in the context of employment reallocation frictions. I argue that aggregate trade integration con generate such shifts. The intuition is simple: trade liberalization tends to increase labor demand in sectors in which the country has a comparative advantage, and to decrease labor demand in sectors in the rest of sectors. If labor cannot fully reallocate after such shocks, wages tend to adjust: relative wages tend to increase in sectors in which the country has a comparative advantage and tend to shrink in the rest of the economy. Trade integration thus impacts sectoral relative wages and this impact varies across countries.

I introduce a model of international trade with labor market frictions and show that trade integration impacts sectoral relative wages and that this impact varies across countries. In particular, countries with a comparative advantage in the goods (service) sectors tend to experience increasing relative wages in the goods (service) sector. Using the Revealed Comparative Advantage Index, I confirm this relationship in the data.

Previous papers tend to focus on one country. I however study cross-country evidence. I show that employment reallocation frictions shed light on the empirical relevance of the Ricardian model of international trade.

Figure 1: Sectoral Relative Wage Evolution



Source: WIOD. See Appendix (5) for a discussion of the data source and aggregation.

Note: Percentage point change in wage of goods sector over wage of service sector between 1995 and 2014, $\triangle \frac{w_G^i}{w_S^i} = \frac{w^i_{2014,G}}{w^i_{2014,S}} - \frac{w^i_{1995,G}}{w^i_{1995,S}}$. I classify Agriculture and Manufacturing as goods, and all other sectors as services, as described in Appendix (5.2). I classify countries in three groups according to their level of GDP per capita in 2014. See Appendix (5) for more details.

1.1 Contribution to the Literature

This paper is related to the two main research agendas:

1. The first one is the literature on employment reallocation frictions and inter-industry wage inequality. Two papers are particularly relevant: first, Lee and Wolpin [2006] who focus on structural change in the USA under worker's direct psychic or monetary costs of switching sectors. Second, Helwege [1992], who studies labor demand sector specific shifts under worker mobility inhibited by a number of factors that may severely limit arbitrage opportunities.

2. The second one is the literature studying the impact of international trade under sectoral employment reallocation frictions. Artuç et al. [2010], Artuc et al. [2017] and Cosar [2013] study the cases of USA, Argentina and Brazil, respectively.[1] Focusing on geographical mobility costs and local labor markets, David et al. [2013] study the "China Shock" in the USA.[2] In turn, Dix-Carneiro [2014] focuses on Brazil.

2 A Model of International Trade with Employment Reallocation Frictions

Countries produce the same goods using different technologies and labor is the only factor of production. The model is the basic Ricardian model of trade (Ricardo [1817]), augmented with employment reallocation frictions. The frictionless case thus resembles the textbook version of the Ricardian model as exposed in Allen and Arkolakis [2015].

There are two countries, $i = H, F$ ("home" and "foreign") and two sectors, $\omega = G, S$ ("goods" and "services"). I assume that both sectors are tradable.[3]

Firms: The production technologies in the two countries $i = H, F$ are different for the two sectors $\omega = G, S$ and given by

$$y^i_\omega = z^i_\omega l^i_\omega \tag{1}$$

[1] As pointed out by Cosar [2013], previous theoretical research of trade under sectoral reallocation frictions include Mayer [1974], Davidson et al. [1988] and Hosios [1990]. Theoretically, trade models under such frictions are related to the Ricardo-Viner Specific Factor Model (as exposed in for instance Krugman et al. [2017]).

[2] Other papers studying this topic include Caliendo et al. [2019] -using a general equilibrium approach-, and Eriksson et al. [2019] -using a longer term historical perspective-.

[3] Service trade is on the rise and currently represents around 20% of world exports. See Mattoo et al. [2008] and Francois and Hoekman [2010] for a detailed discussion on service trade.

where y^i_ω is output, l^i_ω is labor and z^i_ω is country-sector specific productivity. Each country is endowed with $\bar{l}^i$ units of labor, where $l^i_G + l^i_S = \bar{l}^i$.

I assume that home has a comparative advantage in the production of services

$$\frac{z^F_S}{z^F_G} < \frac{z^H_S}{z^H_G} \tag{2}$$

Households: There is a representative consumer in each country with Cobb-Douglas preferences. The consumer's problem is

$$\max U^i = \alpha \log c^i_G + (1-\alpha) \log c^i_S$$
$$\text{s.t.} p^i_G c^i_G + p^i_S c^i_S \leq w^i_G l^i_G + w^i_S l^i_S$$

where c^i_ω is consumption, w^i_ω is sector specific wage, and $0 < \alpha < 1$. Consumer optimization yields demand functions:

$$c^i_G = \alpha \frac{w^i_G l^i_G + w^i_S l^i_S}{p^i_G} \tag{3}$$

$$c^i_S = (1-\alpha) \frac{w^i_G l^i_G + w^i_S l^i_S}{p^i_S} \tag{4}$$

Autarky Equilibrium; frictionless case

Firms' profits are $\pi^i_\omega = p^i_\omega z^i_\omega l^i_\omega - w^i_\omega l^i_\omega$. Profit maximization implies:

$$w^i_\omega = p^i_\omega z^i_\omega \tag{5}$$

Assuming equal wages across sectors, $w^i_G = w^i_S = w^i$ and using equation (5) yields relative prices

$$\frac{p^i_G}{p^i_S} = \frac{z^i_S}{z^i_G} \tag{6}$$

Using the goods market clearing condition is $y^i_G = c^i_G$ together with the production function and demand function (3), yields $z^i_G l^i_G = \alpha \frac{w^i \bar{l}^i}{p^i_G}$, so $\frac{l^i_G}{\bar{l}^i} = \alpha \frac{w^i}{z^i_G p^i_G}$. Using real wage in equilibrium then yields the equilibrium employment share in the goods sector:

$$\frac{l_G^i}{\bar{l}^i} = \alpha$$

And using labor endowment condition we can solve for equilibrium employment in the service sector:

$$\frac{l_S^i}{\bar{l}^i} = 1 - \alpha$$

Wages in the sectors are equal (since there are no frictions, workers fully abitrage wages), so the relative wage is equal to one,

$$\frac{w_G^i}{w_S^i} = 1$$

Free Trade Equilibrium (Home diversifies); frictionless case

If home diversifies, relative prices are home's autarky equilibrium prices[4]:

$$\frac{p_G}{p_S} = \frac{z_S^H}{z_G^H}$$

Using the service market clearing condition, $y_S^S = c_S^H + c_S^F$, together with production and demands functions yields:

$$z_S^H l_S^H = (1-\alpha)\frac{w^H \bar{l^H}}{p_S} + (1-\alpha)\frac{w^F \bar{l^F}}{p_S}$$

Using equilibrium prices we can solve for the service employment share in Home:

$$\frac{l_S^H}{\bar{l^H}} = (1-\alpha) + (1-\alpha)\frac{z_G^F}{z_G^H}\frac{\bar{l^F}}{\bar{l^H}}$$

which is larger than the autarky equilibrium since $(1-\alpha)\frac{z_G^F}{z_G^H}\frac{\bar{l^F}}{\bar{l^H}} > 0$.

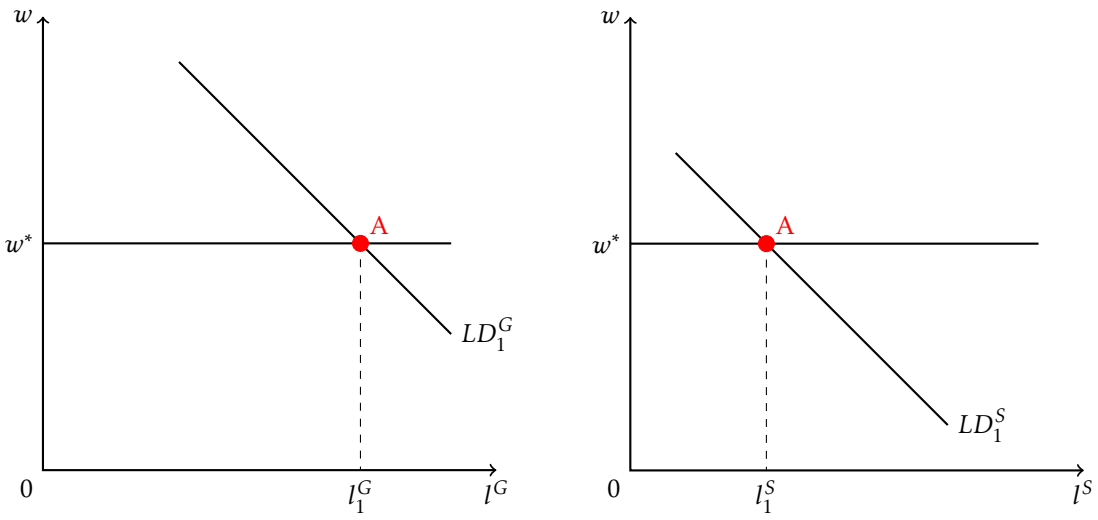
The goods sector employment share in Home if therefore:

$$\frac{l_G^H}{\bar{l^H}} = \alpha - (1-\alpha)\frac{z_G^F}{z_G^H}\frac{\bar{l^F}}{\bar{l^H}}$$

Thus, in the Home economy following trade liberalization the service employment increases while goods sector employment shrinks.

[4]For ease of exposition here I only focus on the home economy in the equilibrium where home diversifies. The case of the foreign economy in the case where Foreign economy diversifies is similar but the goods sector expand while the service sector shrinks after trade liberalization. The cases of the economy that specializes are more straightforward but less empirically interesting: all labor reallocates to the sector in which the country has a comparative advantage.

Figure 2: Autarky, frictionless labor markets



Note: Goods Sector (Left) and Service Sector (Right) labor markets in Home economy.

2.1 Graphical Analysis

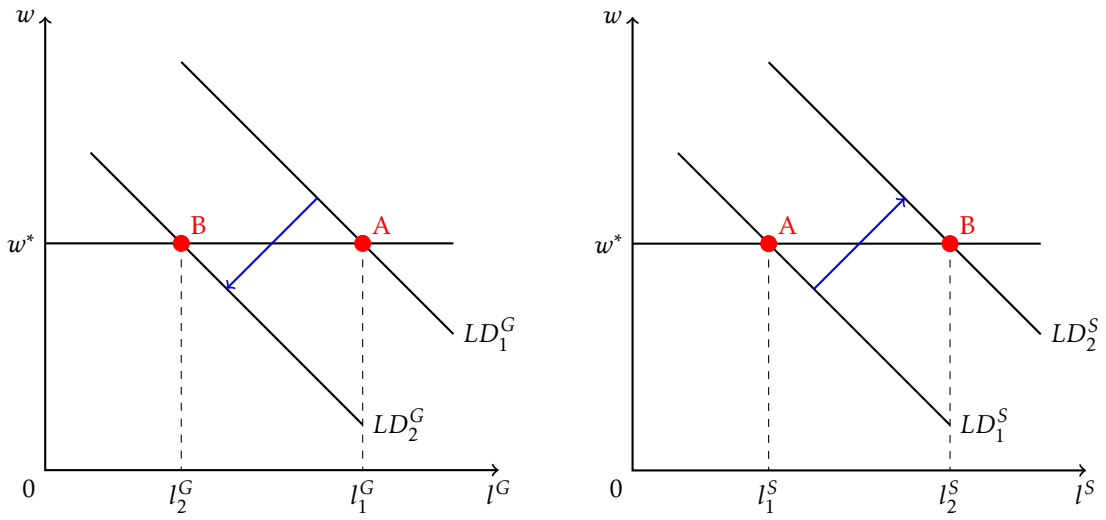
What happens when the economy opens up to trade and there are reallocation frictions? To tackle this I use the previous cases as frictionless benchmarks and proceed with a graphical analysis.

In Figure (2) we can see the frictionless equilibrium autarky equilibrium. Labor demand is downward sloping in labor markets in both the Goods sector (depicted in the left side) and the Service sector (depicted in in the right side): quantity demanded of labor decreases with wage. Wage, in turn, is determined by productivity and is equal across sectors: a difference of wages would incentive workers to switch jobs. So lack of wage differentials is a no-arbitrage condition and it is as if sector specific labor supply curves were perfectly elastic.

What happens when the economy opens up to trade? In Figure (3) we can see the impact of trade integration under frictionless labor markets in the Home economy. Since Home has a comparative advantage in the Service sector, trade integration tends to reduce labor demand in the goods sector and increase labor demand in the service sector. Wages are still given by productivity (since Home diversifies in equilibrium, wages do not change in Home after trade integration). Labor markets go from point A to B in both markets: workers move from the Goods sector to the Service sector.

What happens to the economy if it opens to trade under frictions to employment reallocation? To understand this case, it is useful to consider the extreme case of reallocation friction: segmented labor markets. Figure (4) depicts such an experiment. In this context, employment cannot (for whatever reason) switch at all between sectors, regardless of the size of labor demand shock. If quantities cannot vary, labor

Figure 3: Trade Integration, frictionless labor markets



Note: Goods Sector (Left) and Service Sector (Right) labor markets in Home economy.

demand shifts would then tend to impact prices: wages in the Goods sector would tend to fall while the wages in the Service sector would tend to increase. Since workers cannot switch between sectors, wage differentials are possible in equilibrium. Labor markets go from point A to C in both markets:

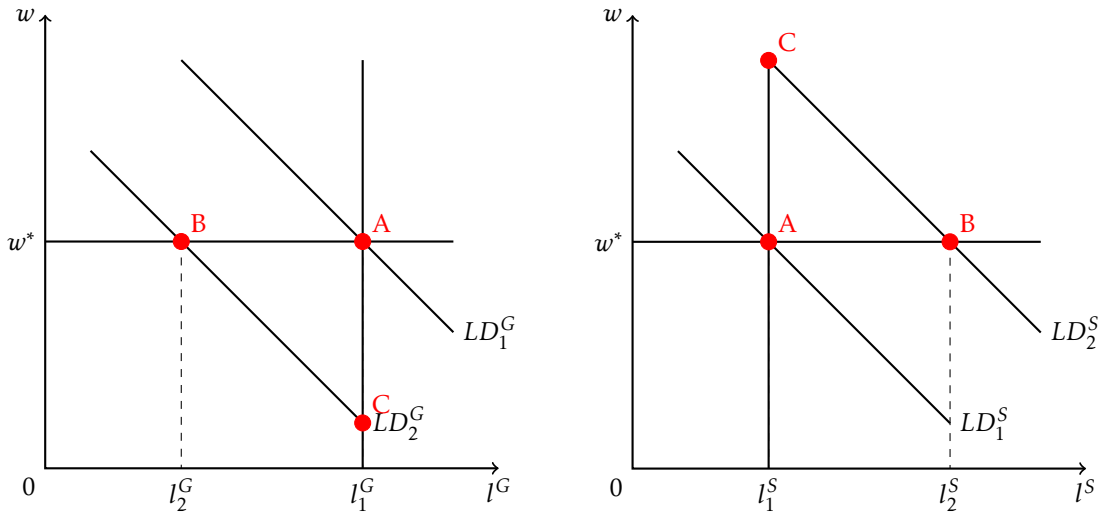
A more realistic scenario however is one of partial reallocation friction: some workers can reallocate across sectors, but not as much as in the frictionless case. In such a context, depicted in Figure (5), both quantities and prices adjust: employment and wages decline in the Goods sector, while both variables increase in the Service sector.

2.2 Heterogeneous Impact of Trade Across Countries

For ease of exposition, here I have focused on the Home economy (recall that this is the equilibrium in which Home diversifies, see Footnote (4) for details). The impact on the Foreign economy would be opposite. In particular, under partial reallocation friction, in the Foreign economy relative wages tend to increase in the goods sector following trade liberalization.

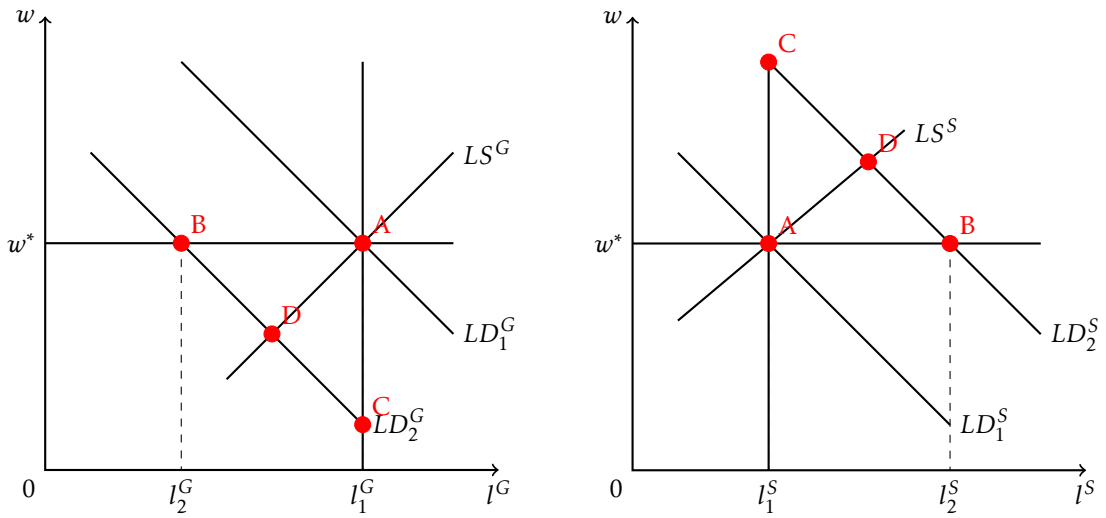
More generally, relative sectoral wages tend to increase in the sector in which the country has a comparative advantage. Trade integration therefore has a heterogeneous impact on sectoral relative wages across countries. For some intuition, if China has a comparative advantage in the goods sector, then we expect $\Delta \frac{w_{G,t}^{CHN}}{w_{S,t}^{CHN}} > 0$. If on the other hand USA has a comparative advantage in service sector, we would expect $\Delta \frac{w_{G,t}^{USA}}{w_{S,t}^{USA}} < 0$.

Figure 4: Trade integration, full employment reallocation friction (segmented markets): goods sector (left) and service sector (right)



Note: Goods Sector (Left) and Service Sector (Right) labor markets in Home economy.

Figure 5: Labor markets with Frictions: goods sector (left) and service sector (right)



Note: Goods Sector (Left) and Service Sector (Right) labor markets in Home economy.

3 Empirical Analysis

3.1 Empirical Measure of Comparative Advantage

The empirical measure of comparative advantage I use is the Revealed Comparative Advantage (RCA), following Balassa [1965] and Barattieri [2014]. The RCA is an index of relative export specialization: Given two sectors $\omega = G, S$ ("goods" and "services"), the RCA for the goods sector is for country i is

$$RCA^i_{Goods,t} = \frac{\frac{EXP^i_{Goods,t}}{\sum_\omega EXP^i_{\omega,t}}}{\frac{EXP^{WLD}_{Goods,t}}{\sum_\omega EXP^{WLD}_{\omega,t}}}$$

where $EXP^i_{\omega,t}$ are sector $\omega = \{G, S\}$ exports from country i at time t.

3.2 Correlation

Recall that the theory presented in the previous section predicts that in countries with a comparative advantage in the Goods sector ($RCA^i_{Goods,t} > 1$) we expect the relative wages in the goods sector to increase more than in countries with a comparative advantage in the Service sector ($RCA^i_{Goods,t} < 1$).

Figure (6) provides evidence supporting this mechanism: the wage of the Goods sector (relative to the Service sector) tends to increase more in countries with a comparative advantage in the goods sector.

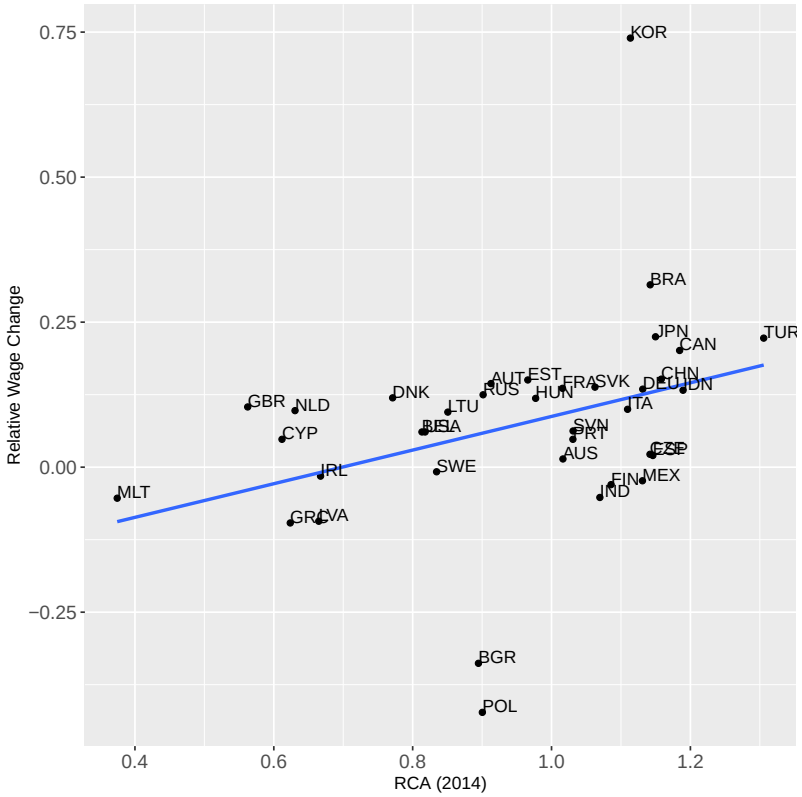
This relationship is statistically significant, as I show next with a regression analysis. I run the following linear regression:

$$\triangle \frac{w^i_{G,\tau,\nu}}{w^i_{S,\tau,\nu}} = \beta_0 + \beta_1 RCA^i_{Goods,t} + \varepsilon^i \tag{7}$$

where $\triangle \frac{w^i_{G,\tau,\nu}}{w^i_{S,\tau,\nu}} = \frac{w^i_{G,\tau}}{w^i_{S,\tau}} - \frac{w^i_{G,\nu}}{w^i_{S,\nu}}$. As in Figure (6), I first run the regression for the 1995-2014 difference ($\tau = 2014, \nu = 1995$) and I use the 1995 and 2014 for the RCA ($t = 1995, 2014$). I report the results in Table (1). As can be observed, the coefficient on the RCA is positive and statistically significant. Since there are outliers, I present both OLS and Robust Linear estimates. RCA is positive and statistically significant for all specifications, except the case of RCA of year 1995 and OLS (the relationship remains when controlling for GDP per capita growth rate, as I checked for as well.)

What about different time windows? I repeat the Robust Linear regression (7) for different combinations of years (starting in 1995 and finishing in different year). I report the coefficient and 90% confidence interval ($\hat{\beta}_1 \pm 1.645 \times SE$). Figure (7) reports such estimates and confidence intervals, for each end year. As can be observed, estimates for $\hat{\beta}_1$ are always positive but only statistically different from zero for a subset

Figure 6: Sectoral Relative Wage Evolution and RCA

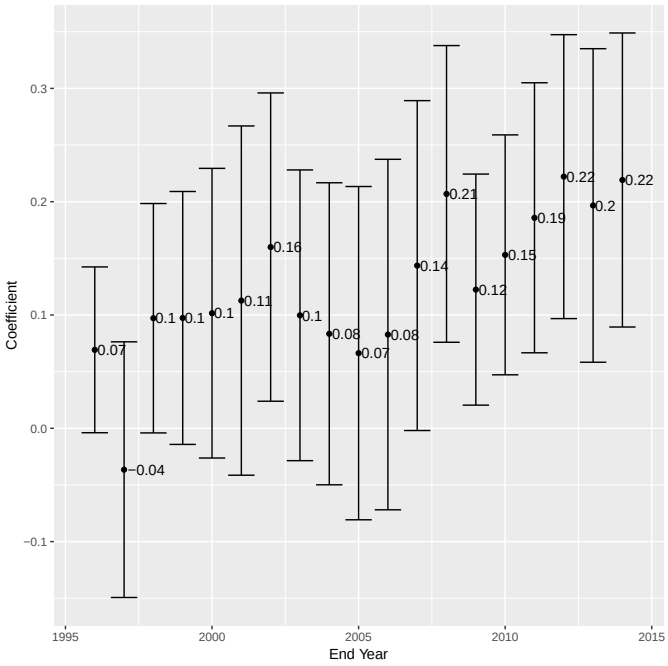


Source: WIOD.

Table 1: Sectoral Relative Wage Change (1995-2014) and Revealed Comparative Advantage

	Dependent variable:			
	$\triangle \frac{w^i_{G,t}}{w^i_{S,t}}$			
	OLS		*robust linear*	
	(1)	(2)	(3)	(4)
$RCA^i_{Goods,2014}$	0.290**		0.219***	
	(0.131)		(0.079)	
$RCA^i_{Goods,1995}$		0.323		0.274**
		(0.221)		(0.135)
Constant	−0.203	−0.240	−0.134*	−0.191
	(0.127)	(0.214)	(0.076)	(0.131)
Observations	37	37	37	37
R^2	0.123	0.058		
Adjusted R^2	0.098	0.031		
Note:			*p<0.1; **p<0.05; ***p<0.01	

Figure 7: Sectoral Relative Wage Evolution and RCA



Source: WIOD.

of years: 2002 and all years after 2007 (recall that these are the end years, the initial year is always 1995). The regressions seem to indicate that the relationship between relative wages and RCA is a long run one.

The changes in sectoral wages could be explained by changes in the composition of the worker type: if a sector becomes more high-skill intensive, the average wage in that sector increases even absence of differences in skill specific wages across sector. However, skill specific wages have indeed evolved as well as indicated in Figure (8), where the skill specific relationship of sectoral relative wage changes and RCA can be observed.[5]

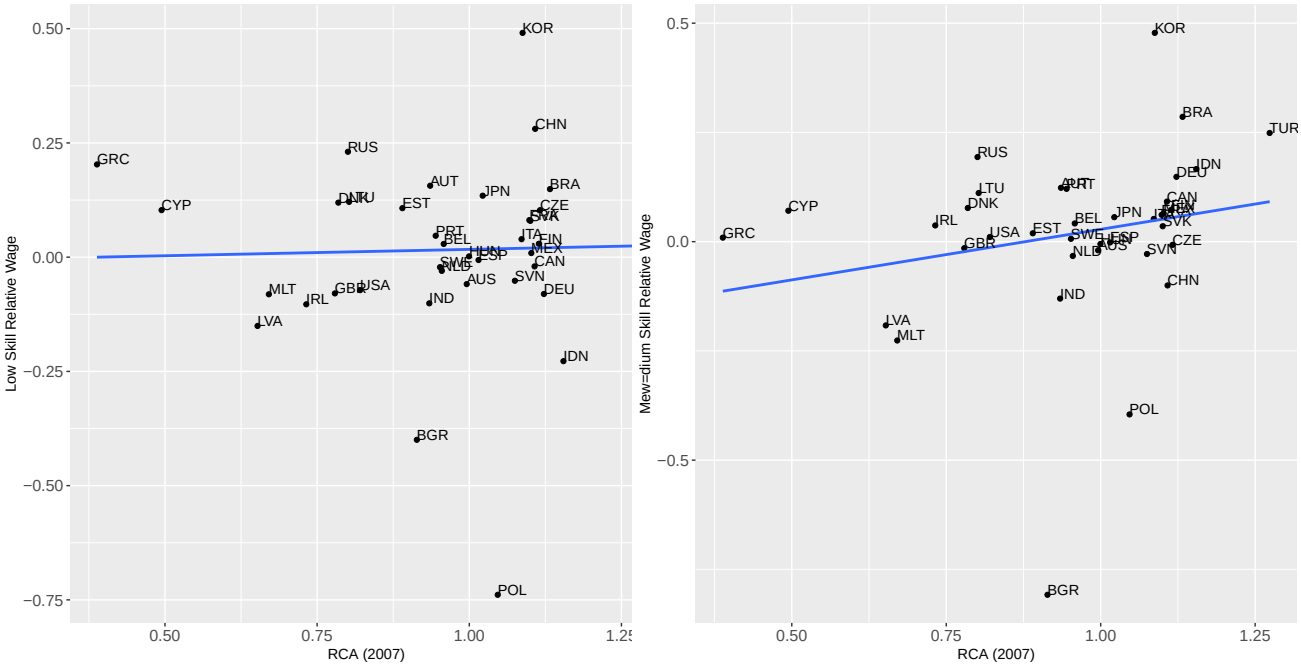
Figures (8a), (8b) and (8c) show respectively the low skill (junior high school or less), medium skill (senior high school) and high skill (university) cases. Table (2) shows the regression results: coefficients on all skill categories are positive, but only statistically significant for High Skill. The average wage case is not statistically significant (recall the 2007 was within the period of no significance results). However, for the case of high-skill workers the RCA in 2007 is statistically significant in explaining part of the variation of high-skill relative sectoral wages. This might suggest that High Skill workers face higher reallocation costs.

[5]Only the 2013 release of WIOD has skill specific data and hence I now use data for 1995-2007 instead of the full 1995-2014 as before

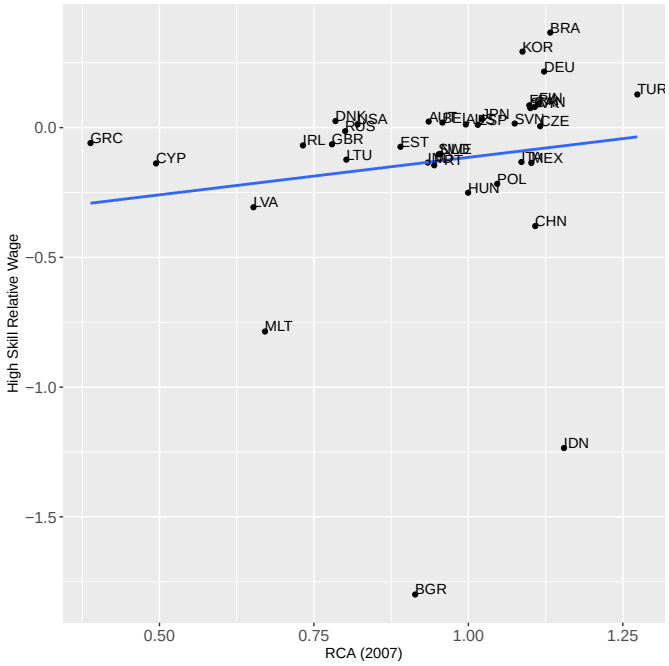
Figure 8: Changes, 1995-2007: Relative Wages by Skill and RCA

(a) Low Skill

(b) Medium Skill



(c) High Skill



Source: WIOD.

Table 2: Sectoral Relative Wage Change (1995-2007) and Skill Intensity

	Dependent variable:							
	Average	Low	Medium	High	Average	Low	Medium	High
	OLS	*OLS*	*OLS*	*OLS*	*robust linear*	*robust linear*	*robust linear*	*robust linear*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$RCA_{i,j}$	0.107	0.028	0.231	0.289	0.103	0.028	0.182	0.290**
	(0.131)	(0.178)	(0.174)	(0.344)	(0.096)	(0.131)	(0.116)	(0.138)
Constant	−0.089	−0.011	−0.203	−0.403	−0.068	0.003	−0.137	−0.322**
	(0.127)	(0.173)	(0.168)	(0.333)	(0.093)	(0.127)	(0.112)	(0.134)
Observations	37	37	37	37	37	37	37	37
R^2	0.019	0.001	0.048	0.020				
Adjusted R^2	−0.009	−0.028	0.021	−0.008				
Note:								*p<0.1; **p<0.05; ***p<0.01

3.3 Margins of Adjustment

Allowing for more factors of productions gives extra margins of adjustment that can "compensate" labor market frictions. Consider for example the following Cobb-Douglas production function:

$$y^i_\omega = z^i_\omega \left[\left(h^i_\omega l^i_\omega \right)^{\alpha^i_\omega} \left(k^i_\omega \right)^{1-\alpha^i_\omega} \right]^{\beta^i_\omega} \left[x^i_\omega \right]^{1-\beta^i_\omega}$$

Where for each new variable and parameter a margin of adjustment can potentially operate:

- Hours $h^i_{j\omega}$: hours worked should increase in sector with positive shocks. In other words, firms can adjust the intensive margin of employment, if it is costly to adjust the the extensive one.
- Labor intensity α^i_ω: labor intensity should decrease in sectors with positive shocks (assuming capital reallocation is less costly that labor reallocation).
- Value-added share β^i_ω should decline in sectors with positive shocks (intermediate input use increases).
- Skill Intensity: high skill intensity should increase in sectors with positive shocks.

In Table (3) I show that the intensive margin (hours), labor intensity and the intermediate input intensity do not seem to be compensating the the labor market friction, since they are not correlated with comparative advantage. Furthermore, Table (4) reports the skill intensity: sectors don't seem to be strategically adjusting the composition of employment either

Table 3: Sectoral Relative Margins Change (1995-2014) and Revealed Comparative Advantage

	Dependent variable:		
	Hours	Labor Share	Value Added Share
	(1)	(2)	(3)
$RCA^{i}_{Goods,2014}$	0.060	0.0005	−0.125
	(0.061)	(0.217)	(0.082)
Constant	−0.010	−0.093	0.069
	(0.059)	(0.210)	(0.079)
Observations	36	37	37
R^2	0.027	0.00000	0.063
Adjusted R^2	−0.001	−0.029	0.036
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4: Sectoral Relative Hours Change (1995-2007) and RCA (2007)

	Dependent variable:			
	Average	Low	Medium	High
	(1)	(2)	(3)	(4)
$RCA_{i,j}$	−0.001	0.055	0.130	−0.0002
	(0.035)	(0.239)	(0.080)	(0.029)
Constant	0.004	−0.356	−0.212***	−0.021
	(0.034)	(0.231)	(0.077)	(0.028)
Observations	37	37	37	37
Note:				*p<0.1; **p<0.05; ***p<0.01

3.4 Back to Comparative Advantage

Comparative advantage determines part of evolution of relative wages. Comparative advantage in turn is explained by relative productivity. In the simple Ricardian model presented with one factor of production, this was pinned down by relative labor productivity. In a more realistic case with multiple factors of production, as discussed previously, comparative advantage can be driven by factor endowments (Hecksher-Ohlin type comparative advantage). In particular:

- High skill endowment: service sector tends to be high skill intensive, as seen in Figure (A1). Countries with high skill endowment should have comparative advantage in the service sector. However, sectoral wages are not correlated high-skill endowment, as seen in column 1 of Table (5).
- Capital endowment: Measuring capital intensity is less straightforward, mainly because measurements of capital tend to be problematic. If we measure capital intensity as the ratio of the capital stock to value added, then the service sector tends to be capital intensive, as Figure (A2) shows. Alternatively, we can proxy capital intensity with the capital income share. Since the labor income share is observed, the we can compute the capital income share residually. This is also problematic because there are profits as well so capital income would be overestimated. In Figure (A3) I show this residual "capital income share". These measures show different stories. For the case of the USA, for example, the service sector is capital intensive in the first measure but labor intensive in the second measure. Either way, sectoral wages are not correlated with capital endowment, as seen in Column 3 of Table (5).
- Intermediate input endowment (input-output structure sophistication): The goods sector tends is intermediate input intensive, as seen in Figure (A4). Countries with high intermediate input endowment (or input-output "complexity") should have comparative advantage in the goods sector. However, sectoral wages are negatively correlated with intermediate input endowment, as seen in column 4 of Table (5).

3.5 RCA Dynamics

In Figure (A5) I plot the RCA for all countries and years. The red dashed line is equal to one: the RCA tends to be above or below unity across countries, but in some cases RCA actually reverses throughout this period. Future research could explore the evolution of comparative advantage and it's endogenous nature.

Table 5: Sectoral Relative Wage Change (1995-2007) and Alternative Comparative Advantage

	Dependent variable:			
	$\Delta \frac{w^i_{G,t}}{w^i_{S,t}}$			
	(1)	(2)	(3)	(4)
$RCA^i_{Goods,2007}$	0.144			
	(0.088)			
High Skill Endowment		0.204		
		(0.164)		
Capital Endowment (K/VA)			−0.010	
			(0.017)	
Intermediate Input Endowment (I/VA)				−0.125**
				(0.061)
Constant	−0.093	−0.003	0.081	0.180***
	(0.086)	(0.040)	(0.062)	(0.068)
Observations	37	37	37	37
Note:				*p<0.1; **p<0.05; ***p<0.01

4 Conclusion

By using data for 37 countries in the 1995-2014 period, in this paper I showed that that sectoral relative wage variation can be partially explained by comparative advantage. I have argued that this is consistent with the existence of labor market frictions.

This paper leaves many open question: For example, I have not directly measured these the labor market frictions: micro-data can shed light on this. Also relevant is the impact of unemployment, since these reallocation frictions imply that it takes time to switch jobs. I leave for future work the exploration of comparative advantage on micro relative wage data and unemployment.

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5 Data Source

5.1 Service Trade Data

The World Trade Organization (WTO) defines in its General Agreement on Trade in Services (GATS), services trade to span the following four modes of supply:

- Mode 1 - Cross-border: services supplied from the territory of one country into the territory of another,
- Mode 2 - Consumption abroad: services supplied in the territory of a nation to the consumers of another,
- Mode 3 - Commercial presence: services supplied through any type of business or professional establishment of one country in the territory of another (i.e. FDI), and
- Mode 4 - Presence of natural persons: services supplied by nationals of a country in the territory of another.

As described in Dietzenbacher et al. [2013], in the data set collected for the WIOD, only data on cross-border services trade in the GATS mode 1 has been used: "The WIOTs are constructed on a territorial basis meaning that they include all activities that take place on the territory of the country, either by residents or non-residents, so mode 3 and 4 are not considered as part of imports and exports. Mode 2 activities are already covered by the items 'purchases of non-residents on domestic territory' and 'foreign purchases of residents' in the national SUTs and are not split further by the country of supply...There is ample space for further improvements in the measurement of services trade. The WIOD database for trade in services should be seen in this light as the best currently available approximation to a comprehensive picture of global trade flows in Mode 1 services."

The service trade flows used throughout my paper are thus in Mode 1 only.

5.2 Aggregation

I use both the 2013 and 2016 releases of WIOD. The different releases of WIOD differ in coverage of years, countries and sectors:

- The 2013 release of WIOD covers 40 countries for the period from 1995 to 2011. Data for 35 sectors are classified according to the International Standard Industrial Classification revision 3 (ISIC Rev. 3).
- The 2016 release of WIOD covers 43 countries for the period from 2000 to 2014. Data for 56 sectors are classified according to the International Standard Industrial Classification revision 4 (ISIC Rev. 4).

Throughout the paper, I focus on two aggregation criteria:

1. Goods sector: for the 2013 release of WIOD, I classify sectors 1 to 16 as Goods (following Kehoe et al. [2018]). I classify the rest as Services.[6] I follow the same criteria for the 2016 release of WIOD, so I classify sectors 1 to 22 as Goods and 23 to 56 as Services.
2. Manufacturing sector: for the 2013 release of WIOD, I classify sectors 1 to 3 as Agriculture, 4 to 16 as Manufacturing and 17 to 35 as Services (following Uy et al. [2013]).[7]. I follow the same criteria for the 2016 release of WIOD, so I classify sectors 1 to 5 as Agriculture, 6 to 22 as Manufacturing, and 23 to 56 as Services.

Table (A2)-(A4) summarizes this sector classification for the 2013 and 2016 release of of WIOD.

[6] Different from Kehoe et al. [2018], I include Construction as a Service while they take Construction as a third sector. See their online appendix at http://users.econ.umn.edu/ tkehoe/publications.html

[7] Uy et al. [2013] use sources different from WIOD. The classification criteria they follow (which I apply to the WIOD sectors) is: "Unless otherwise noted, the sectors are defined by the International Standard Industrial Classification, revision 3 (ISIC III) definitions: Agriculture corresponds to ISIC divisions 1-5 (agriculture, forestry, hunting, and fishing), 10-14 (mining and quarry), 15-16 (food, beverages and tobacco-FBT); Manufacturing corresponds to divisions 17-37 (total manufacturing less FBT); Services corresponds to divisions 40-99 (utilities, construction, wholesale and retail trade, transport, government, financial, professional, and personal services such as education, health care, and real estate services)." See their online appendix at https://www.sciencedirect.com/science/article/pii/S030439321300086X

5.3 WIOD 2013 and 2016 releases merge

Since the sectors in the 2013 and 2016 releases of WIOD are different, I merge as follows: for each release, I aggregate by the sector classification described in the previous paragraph. I then merge by using 1995-2007 data from the 2013 release and 2008-2014 data from the 2016 release. I merge by using the 2013 release data until 2007, and then use the growth rates implied by the 2014 release to construct the remaining years until 2014. In other words, I shift the 2016 release data to match the level of the variables in 2007 given by the 2013 release values.

6 Figure and Tables

Table A1: Sectoral Relative Wages, 1995 and 2014

Country	Relative Wage 1995	Relative Wage 2014	Relative Wage Change	Percentual Change
KOR	0.87	1.61	0.74	84.59
BRA	0.47	0.78	0.31	67.04
JPN	0.79	1.02	0.22	28.35
TUR	0.70	0.92	0.22	31.99
CAN	1.17	1.38	0.20	17.12
CHN	0.72	0.87	0.15	21.11
EST	0.76	0.91	0.15	19.72
AUT	0.91	1.06	0.14	15.81
SVK	0.90	1.04	0.14	15.26
FRA	0.91	1.04	0.14	14.96
DEU	1.20	1.34	0.13	11.18
IDN	0.48	0.61	0.13	27.56
RUS	0.57	0.69	0.12	22.00
DNK	0.94	1.06	0.12	12.74
HUN	0.80	0.91	0.12	14.92
GBR	1.37	1.47	0.10	7.58
ITA	0.91	1.01	0.10	10.93
NLD	1.17	1.26	0.10	8.35
LTU	0.70	0.79	0.09	13.65
SVN	0.89	0.95	0.06	7.03
BEL	1.11	1.17	0.06	5.45
USA	1.09	1.15	0.06	5.58
CYP	0.72	0.77	0.05	6.68
PRT	0.64	0.69	0.05	7.54
CZE	0.89	0.91	0.02	2.49
ESP	0.89	0.91	0.02	2.26
AUS	1.10	1.12	0.01	1.28
SWE	1.10	1.09	-0.01	-0.72
IRL	0.90	0.89	-0.02	-1.71
MEX	0.61	0.58	-0.02	-3.86
FIN	1.03	1.00	-0.03	-2.92
IND	0.29	0.24	-0.05	-17.88
MLT	1.16	1.11	-0.05	-4.59
LVA	0.78	0.69	-0.09	-11.95
GRC	0.67	0.57	-0.10	-14.34
BGR	1.09	0.75	-0.34	-31.13
POL	1.45	1.03	-0.42	-29.17

Table A2: Sectors in WIOD 2013 Release

	Sector	Classification 1	Classification 2
1	Agriculture, Hunting, Forestry and Fishing	Goods	Agriculture
2	Mining and Quarrying	Goods	Agriculture
3	Food, Beverages and Tobacco	Goods	Agriculture
4	Textiles and Textile Products	Goods	Manufacturing
5	Leather, Leather and Footwear	Goods	Manufacturing
6	Wood and Products of Wood and Cork	Goods	Manufacturing
7	Pulp, Paper, Paper , Printing and Publishing	Goods	Manufacturing
8	Coke, Refined Petroleum and Nuclear Fuel	Goods	Manufacturing
9	Chemicals and Chemical Products	Goods	Manufacturing
10	Rubber and Plastics	Goods	Manufacturing
11	Other Non-Metallic Mineral	Goods	Manufacturing
12	Basic Metals and Fabricated Metal	Goods	Manufacturing
13	Machinery, Nec	Goods	Manufacturing
14	Electrical and Optical Equipment	Goods	Manufacturing
15	Transport Equipment	Goods	Manufacturing
16	Manufacturing, Nec; Recycling	Goods	Manufacturing
17	Electricity, Gas and Water Supply	Services	Services
18	Construction	Services	Services
19	Sale, Maintenance and Repair of Motor Vehicles and...	Services	Services
20	Wholesale Trade and Commission Trade, Except of Mo...	Services	Services
21	Retail Trade, Except of Motor Vehicles and Motorcy...	Services	Services
22	Hotels and Restaurants	Services	Services
23	Inland Transport	Services	Services
24	Water Transport	Services	Services
25	Air Transport	Services	Services
26	Other Supporting and Auxiliary Transport Activitie...	Services	Services
27	Post and Telecommunications	Services	Services
28	Financial Intermediation	Services	Services
29	Real Estate Activities	Services	Services
30	Renting of M and Eq and Other Business Activities	Services	Services
31	Public Admin and Defence; Compulsory Social Securi...	Services	Services
32	Education	Services	Services
33	Health and Social Work	Services	Services
34	Other Community, Social and Personal Services	Services	Services
35	Private Households with Employed Persons	Services	Services

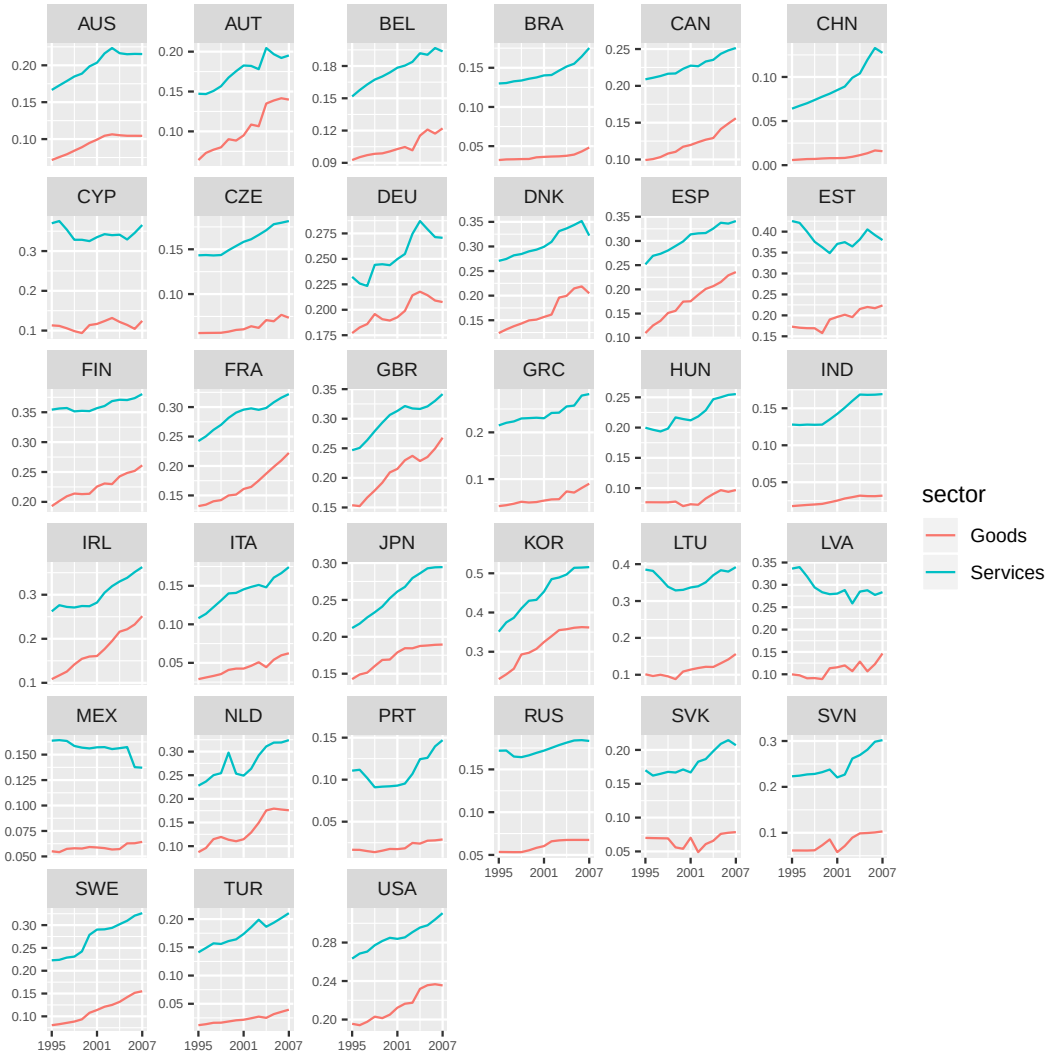
Table A3: Sectors in WIOD 2016 Release (Agricultue and Manufacturing Sectors)

	Sector	Classification 1	Classification 2
1	Crop and animal production, hunting and related se...	Goods	Agriculture
2	Forestry and logging	Goods	Agriculture
3	Fishing and aquaculture	Goods	Agriculture
4	Mining and quarrying	Goods	Agriculture
5	Manufacture of food products, beverages and tobacc...	Goods	Agriculture
6	Manufacture of textiles, wearing apparel and leath...	Goods	Manufacturing
7	Manufacture of wood and of products of wood and co...	Goods	Manufacturing
8	Manufacture of paper and paper products	Goods	Manufacturing
9	Printing and reproduction of recorded media	Goods	Manufacturing
10	Manufacture of coke and refined petroleum products...	Goods	Manufacturing
11	Manufacture of chemicals and chemical products	Goods	Manufacturing
12	Manufacture of basic pharmaceutical products and p...	Goods	Manufacturing
13	Manufacture of rubber and plastic products	Goods	Manufacturing
14	Manufacture of other non-metallic mineral products...	Goods	Manufacturing
15	Manufacture of basic metals	Goods	Manufacturing
16	Manufacture of fabricated metal products, except m...	Goods	Manufacturing
17	Manufacture of computer, electronic and optical pr...	Goods	Manufacturing
18	Manufacture of electrical equipment	Goods	Manufacturing
19	Manufacture of machinery and equipment n.e.c.	Goods	Manufacturing
20	Manufacture of motor vehicles, trailers and semi-t...	Goods	Manufacturing
21	Manufacture of other transport equipment	Goods	Manufacturing
22	Manufacture of furniture; other manufacturing	Goods	Manufacturing

Table A4: Sectors in WIOD 2016 Release (Service Sectors)

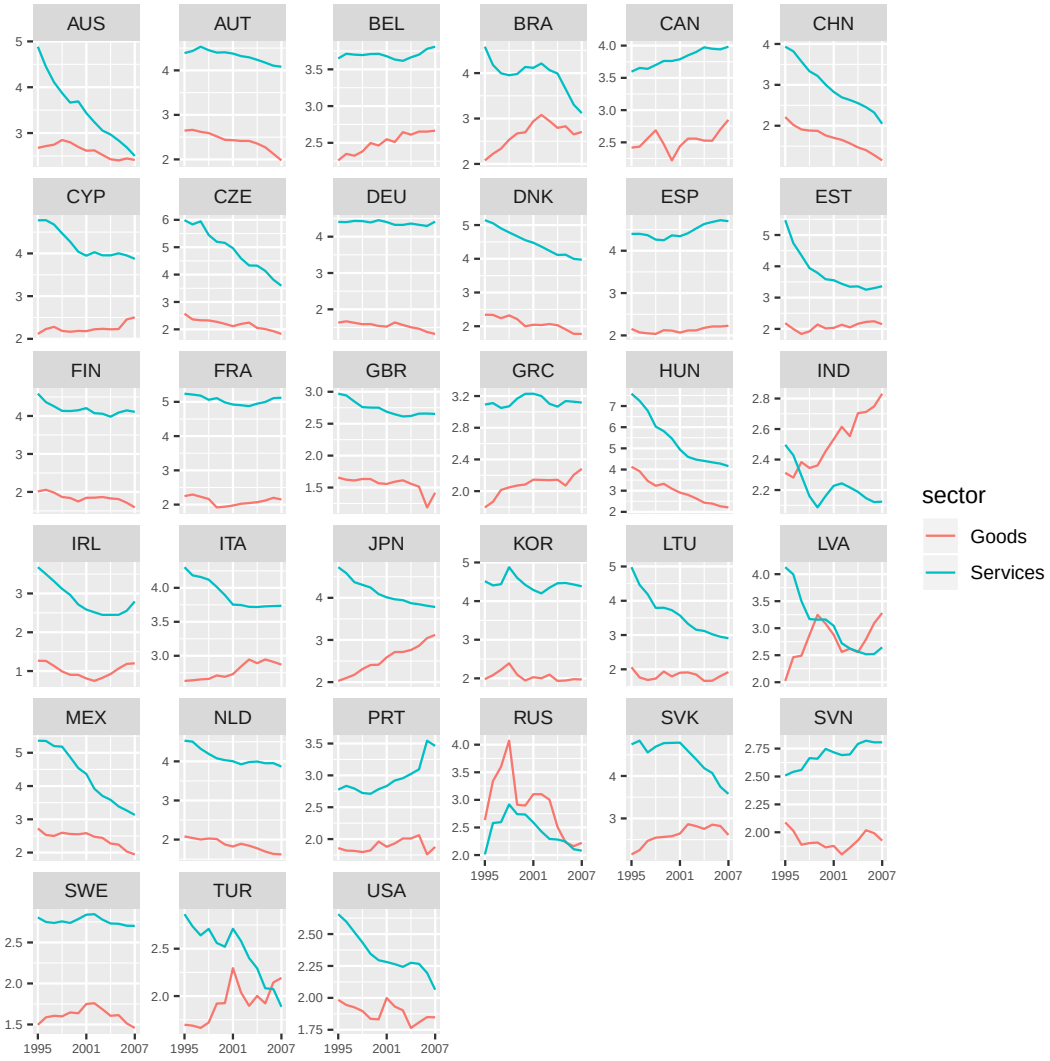
	Sector	Classification 1	Classification 2
23	Repair and installation of machinery and equipment...	Services	Services
24	Electricity, gas, steam and air conditioning suppl...	Services	Services
25	Water collection, treatment and supply	Services	Services
26	Sewerage; waste collection, treatment and disposal...	Services	Services
27	Construction	Services	Services
28	Wholesale and retail trade and repair of motor veh...	Services	Services
29	Wholesale trade, except of motor vehicles and moto...	Services	Services
30	Retail trade, except of motor vehicles and motorcy...	Services	Services
31	Land transport and transport via pipelines	Services	Services
32	Water transport	Services	Services
33	Air transport	Services	Services
34	Warehousing and support activities for transportat...	Services	Services
35	Postal and courier activities	Services	Services
36	Accommodation and food service activities	Services	Services
37	Publishing activities	Services	Services
38	Motion picture, video and television programme pro...	Services	Services
39	Telecommunications	Services	Services
40	Computer programming, consultancy and related acti...	Services	Services
41	Financial service activities, except insurance and...	Services	Services
42	Insurance, reinsurance and pension funding, except...	Services	Services
43	Activities auxiliary to financial services and ins...	Services	Services
44	Real estate activities	Services	Services
45	Legal and accounting activities; activities of hea...	Services	Services
46	Architectural and engineering activities; technica...	Services	Services
47	Scientific research and development	Services	Services
48	Advertising and market research	Services	Services
49	Other professional, scientific and technical activ...	Services	Services
50	Administrative and support service activities	Services	Services
51	Public administration and defence; compulsory soci...	Services	Services
52	Education	Services	Services
53	Human health and social work activities	Services	Services
54	Other service activities	Services	Services
55	Activities of households as employers; undifferent...	Services	Services
56	Activities of extraterritorial organizations and b...	Services	Services

Figure A1: High Skill Intensity



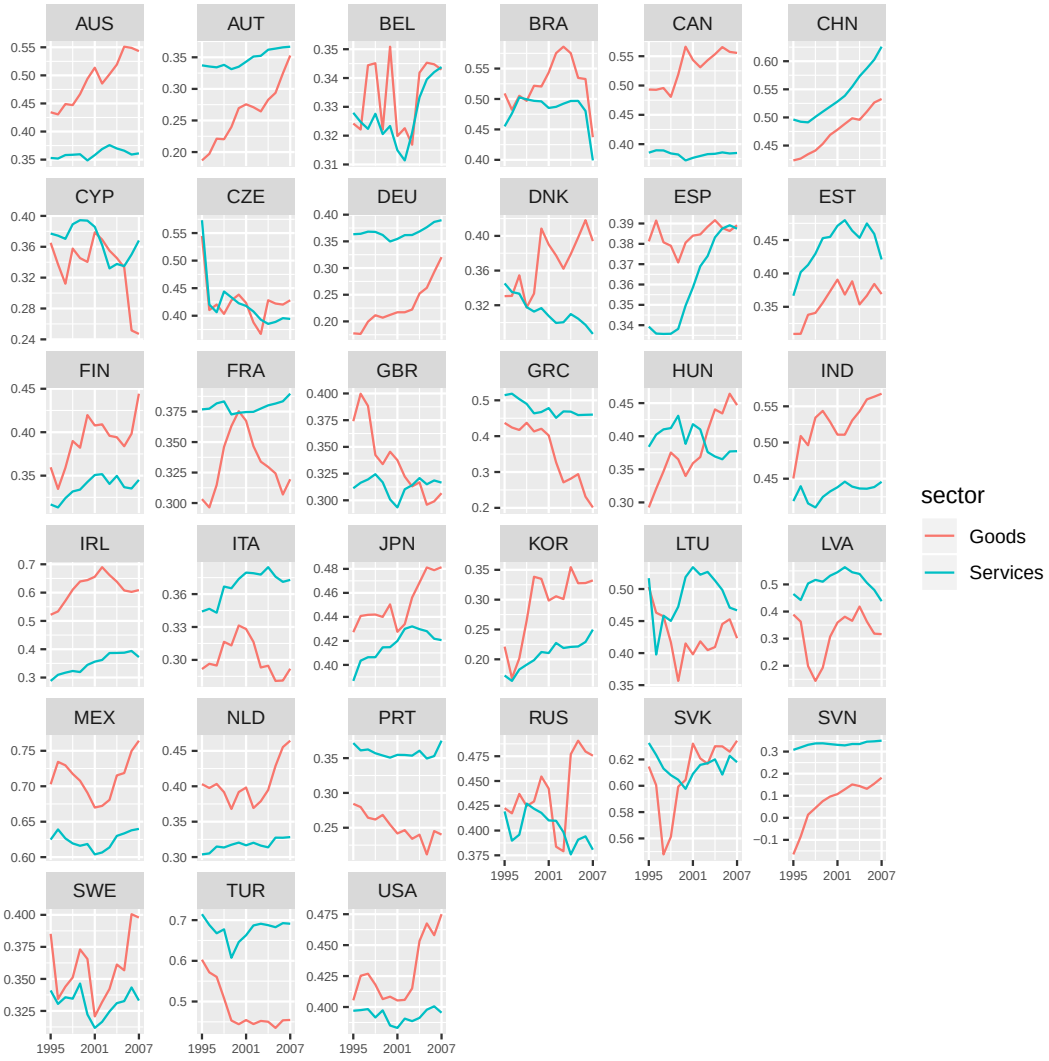
Source: WIOD.

Figure A2: Capital Intensity (Capital to Value Added Ratio)



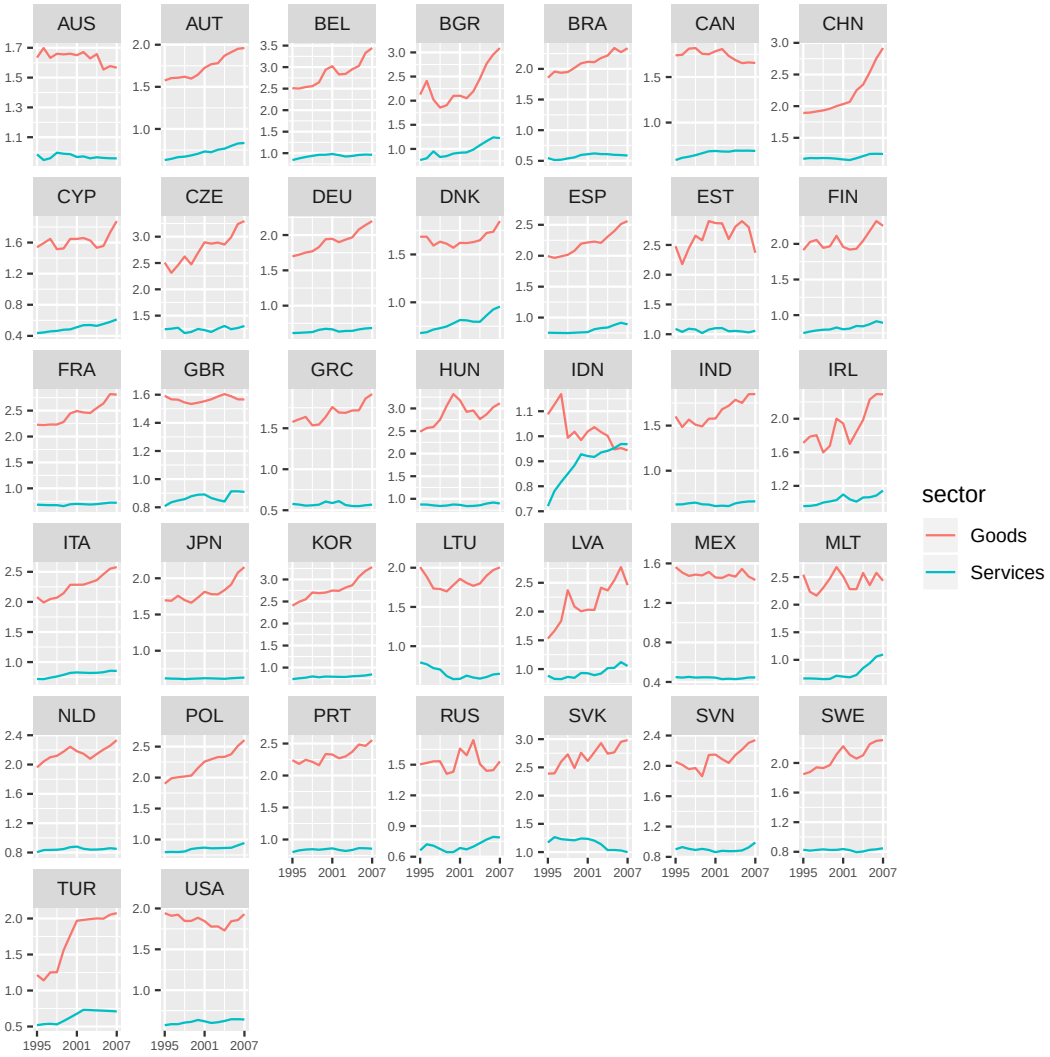
Source: WIOD.

Figure A3: Capital Intensity (Residual Capital Income Share)



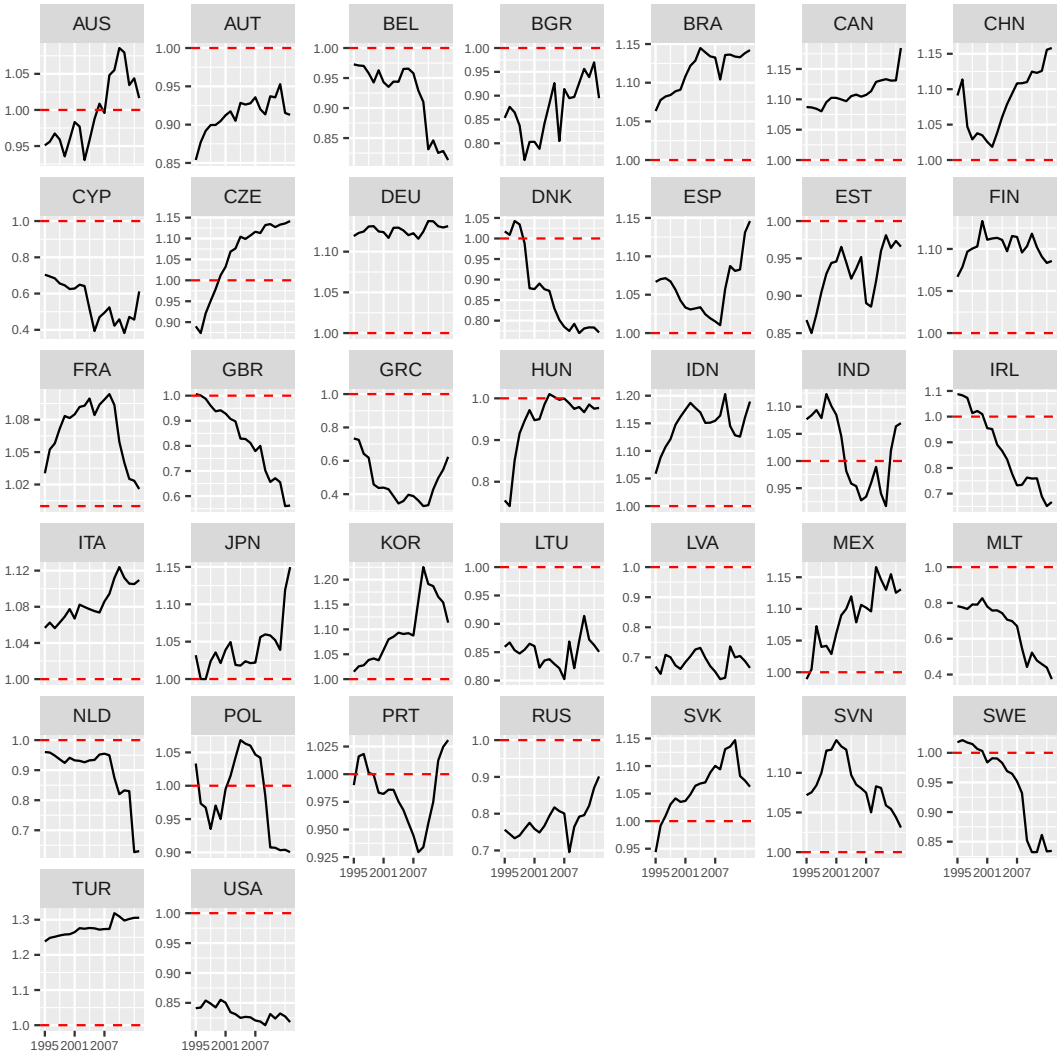
Source: WIOD.

Figure A4: Intermediate Input Intensity (Intermediate Inputs to Value Added Ratio)



Source: WIOD.

Figure A5: Goods Sector Revealed Comparative Advantage



Source: WIOD.