Trade-induced structural change and the skill premium*

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Abstract

We study how international trade affects manufacturing employment and the relative wage of unskilled workers when goods and services are traded with different intensities. Manufacturing trade reduces manufacturing prices worldwide, which reduces manufacturing employment if manufactures and services are complements. We document that manufacturing production is unskilled-labor intensive, so that these changes increase the skill-premium. We incorporate this mechanism in a quantitative trade model and show that trade has had a negative impact on manufacturing employment and the relative wage of unskilled workers. The impact on the skill premium was larger in developing countries where manufacturing is particularly unskilled-labor intensive.

Keywords: Skill Premium, Structural Change, Gains From Trade.

JEL Codes: F16, F62, F63

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1 Introduction

Understanding how international trade affects the relative wage of skilled vs unskilled workers is one of the central questions in international economics. Most of the theoretical and empirical literature has focused on the predictions of the Heckscher-Ohlin model, which dictates that trade integration increases the skill premium in skilled-labor abundant countries and decreases it in other countries.[1] As pointed out by Goldberg and Pavcnik (2007), this prediction appears to be at odds with the trade liberalization experiences of developing, unskilled-labor abundant countries.

This paper evaluates an alternative mechanism through which international trade can reduce the relative size of the manufacturing sector and the relative wage of unskilled workers simultaneously in all countries. Rapid growth in manufacturing trade lowers the relative price of manufactured goods worldwide, and, if manufacturing and services are complements, it also reduces the share of manufactured goods in total value added and in total employment.[2] If the production of manufacturing goods is unskilled-labor intensive, increasing manufacturing trade can then raise the skill premium in all countries. We incorporate this mechanism in a quantitative trade model and measure how changes in trade patterns affected the share of employment in the manufacturing sector and the skill premium across countries over the past three decades.

We first document three features of the data that are key for determining the direction and strength of this mechanism. First, we show that for a broad set of countries, the pace of trade integration over the past three decades has been quite uneven across goods-producing (manufacturing, agriculture and mining) and service sectors. While growth in services trade has outpaced growth in goods trade, the share of domestically produced services in total absorption of services has remained roughly constant, whereas the share of domestically produced goods in total absorption of goods has declined dramatically. Second, we document large differences in skill intensities across broad sectors: goods-producing sectors are unskilled-labor intensive, as are some service sectors (such as construction and retail), while other service sectors (such as FIRE and health) are skilled-labor intensive. Third, we show that relative to skilled-labor intensive sectors, unskilled-labor intensive sectors (both goods and services) use more intermediate inputs from goods producing sectors. The first two observations imply that, if goods and services are comple-

[1] See Leamer and Levinsohn (1995) for a survey, and Goldberg and Pavcnik (2007) for a review of the more recent literature.

[2] The effect of relative price changes on the sectoral composition of the economy was first studied by Baumol (1967). Fast growth in manufacturing trade is akin to fast growth in manufacturing productivity, as it allows countries to specialize in the production of manufactured goods in which they have a comparative advantage.

ments, the changes in trade patterns of the past three decades have been skill-biased. The third observation implies that the effect of a decline in the relative price of goods is magnified by the intensive use of goods as intermediate inputs in unskilled-labor intensive sectors.

We quantify the importance of these mechanisms using a multi-country, multi-sector model of trade. In the model, trade patterns shape the allocation of workers across sectors that are traded with different intensities and that employ skilled and unskilled workers in different proportions. Our model extends that of Eaton and Kortum (2002) by allowing for a non-unitary elasticity of substitution across sectors and for aggregate and sectoral trade imbalances, in a context of heterogeneity in workers' skills. When the elasticity of substitution across sectors is less than one, the goods sector shrinks in response to a decline in the share of domestically produced goods in absorption, as this lowers the relative price of goods. In the model as in the data, goods-producing sectors are unskilled labor intensive, so that a decline in employment in these sectors increases the skill premium. In addition, as the relative price of goods declines, so does the relative price of unskilled-labor intensive sectors that use intermediate goods inputs intensively, magnifying the effects of trade on the skill premium. Finally, as in the standard Heckscher-Ohlin model, an increase in the trade deficit in unskilled-labor intensive sectors increases the skill premium. We highlight that, while the Hecksher-Ohlin mechanism affects the skill premium through differences in comparative advantage across tradable sectors, trade also affects the skill premium in the model operates through differences in the degree of tradability in goods vs service sectors.

We show that, as in Eaton and Kortum (2002), sectoral domestic expenditure shares are sufficient statistics for how changes in trade costs, foreign technologies, and foreign factor supplies affect relative prices in our model. The other key statistics needed for determining the impact of trade in the skill premium are sectoral net exports in skilled- vs unskilled-labor intensive sectors, which can be summarized by the ratio of revenues to absorption in each sector. We build on these results to write changes in sectoral revenue shares and the skill premium as functions of changes in sectoral domestic expenditure shares, the ratio of revenues to absorption in each sector, domestic productivities, and domestic labor endowments. We show that the key elasticities that determine the strength of our mechanisms are: (i) the elasticity of substitution across sectors, (ii) the elasticity of substitution across workers, and (iii) the trade elasticity in each sector. We follow Herrendorf, Rogerson and Valentinyi (2013) and estimate the elasticity of substitution across sectors from changes in relative prices and relative expenditures using time series data for the US. We take the remaining key elasticities (ii) and (iii) from the labor and the trade literature respectively.

We use the calibrated model to conduct two counterfactuals to evaluate the quantitative importance of the mechanisms described above. In our first counterfactual, we change a country's domestic expenditure shares and revenue to absorption ratios in each sector from their observed levels in 1977, or the earliest year for which data are available for the country, to those observed in 2005, while keeping domestic technologies and factor endowments fixed. This counterfactual measures, to a first-order approximation, how a country's sectoral revenue shares and skill premium respond to all changes in technologies, endowments, and trade costs over this period, relative to the response to these same changes in primitives, had that country been in autarky.[3] An advantage of this approach is that we can conduct the counterfactual country by country (which means that we only need data for one country at a time), without having to take a stand on the underlying changes in primitives driving the changes in trade patterns in the data. We show that in response to the observed changes in trade patterns, the calibrated model generates substantial changes in sectoral production shares across countries. In the US, over the 1977-2005 period, the counterfactual implies a 20 percent decline in the gross-output share of the goods producing sectors, relative to the 34 percent decline observed in the data. These changes in the structure of the economy in turn affect the skill premium, which increases by 3.7 percent in the US and by 4.5 percent in the average country of our sample. The counterfactual increase in the skill premium is much larger for developing countries where the goods-producing sector is particularly unskilled-labor intensive.

For our second counterfactual exercise, we estimate changes in bilateral trade costs from observed changes in bilateral trade flows between 1995 and 2005 and study how factor prices respond to these changes in trade costs in the calibrated model. This counterfactual isolates the effect of measured changes in trade costs on sectoral revenue shares and the skill premium. We note, however, that estimating these changes in trade costs requires some stronger assumptions, discussed in Section 5. This exercise also requires bilateral trade data to be available simultaneously for every country over the same time period, which means that, since service trade data for some of our countries is only available starting in 1995, we can only conduct the exercise for the much shorter 1995-2007 period. In this counterfactual, the skill premium increases for all countries in the sample, by an average of 2.5 percent. The change is much smaller in some developed countries where the value added share of the manufacturing sector was already small by 1995.

We conduct three alternative calibrations to assess the importance of the features of

[3] A similar interpretation to this type of counterfactual was first given by Burstein, Cravino and Vogel (2013) and Burstein, Morales and Vogel (2015).

the data highlighted above for our results. First, we re-calibrate the model under the assumption that there are no intermediate inputs in production. We show that while the qualitative results remain, the changes in sectoral revenue shares and the skill premium implied by our first counterfactual are only half as large as in our baseline calibration. Second, we repeat the first counterfactual in a two-sector model that does not take into account the substantial heterogeneity in skill and input intensities that we observe across service sectors. We show that, while the counterfactual decline in the share of the goods producing sector is roughly the same as in the baseline three-sector model, the counterfactual increase of the skill premium is about 29 percent smaller. Our last alternative parameterization extends our baseline model to allow for non-homothetic preferences using the generalized CES aggregator used by Comin, Lashkari and Mestieri (2015), and shows that the counterfactual changes in the skill premium are almost identical in the homothetic and the non-homothetic models.[4]

Finally, we use our model to re-evaluate measures of the effects of trade on the skill premium that are based on the factor content of trade (FCT). For a factor of production, the FCT measures the quantity of that factor that is embodied in a country's net exports. Intuitively, an increase in the trade-adjusted supply of a factor should decrease the factor's price. We use data generated by our model to show that factor-content based measures of the skill premium can greatly underestimate the effects of trade on the skill premium.[5] In our context, trade in goods increases the skill premium even if the factors embodied in a country's exports are the same as those embodied in a country's imports.

Our paper is related to two strands of the literature. The first is the literature that uses quantitative models to assess the importance of different channels through which trade affects the skill premium. Recent examples of this literature are Burstein, Cravino and Vogel (2013) and Parro (2013), who measure the effects of capital imports when the production function exhibits capital-skill complementarity, and Burstein and Vogel (2016), who study within-sector factor reallocation across firms with different skill intensities.[6] Our contribution to this literature is to propose and quantify a novel mechanism through which trade can affect the skill premium: by inducing reallocation of labor across sectors

[4] Intuitively, this follows from the fact that the real income gains from trade in our model are relatively small (as is typically the case in the gravity models covered by Arkolakis, Costinot and Rodriguez-Clare (2012)).

[5] Katz and Murphy (1992) argue that the effects of international trade on the US skill premium are small according to FCT measures. Burstein and Vogel (2016) point out that, if exporters and domestic producers use different technologies, measures based on sector-level data underestimate the FCT. We show that in our context the FCT severely understates the effect of trade on the skill premium even when perfectly measured.

[6] In related work, Matsuyama (2007) argues that trade can increase the skill premium if the factor intensities for supplying a good depend on where the good is sold.

that are traded with different intensities. To provide a transparent quantification of this new channel, we abstract from other forces already discussed in the literature.

Our work is also related to the recent literature that studies structural change in open economies. Matsuyama (2009) shows that the growth of manufacturing productivity and the relative size of the manufacturing sector can be decoupled in open economies. Uy, Yi and Zhang (2013) use a two-country growth model featuring a Baumol effect and non-homothetic preferences to study structural change in South Korea, while abstracting from aggregate trade imbalances. Kehoe, Ruhl and Steinberg (2013) build a model of the US and the rest of the world to assess the quantitative impact of U.S. borrowing on goods-sector employment, in a context in which trade costs are fixed. Our contribution to this literature is to study how trade affects the skill premium through structural change, using a parsimonious multi-country model that allows us to incorporate both trade imbalances and trade costs reductions simultaneously in a setting with arbitrarily many countries.

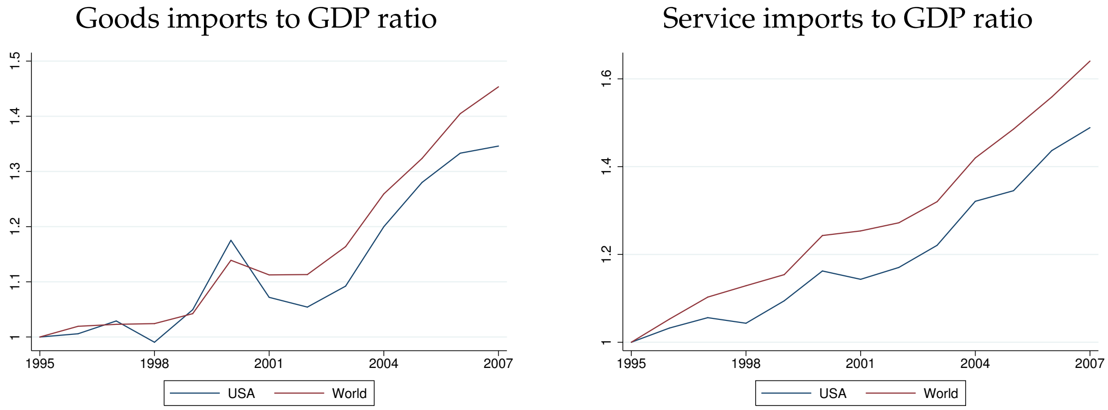
Finally, in a recent paper closely related to ours, Buera, Kaboski and Rogerson (2015) document that increases in GDP per capita are associated with a shift in the composition of value added towards service sectors that are intensive in skilled labor. They find that these compositional changes account for roughly a quarter of the increase in the skill premium due to technical change. Relative to Buera, Kaboski and Rogerson (2015), we document that, compared to service-producing sectors, goods-producing sectors are more tradable and experienced faster trade opening in the past decades. In our multi-country setup, this makes international trade an additional driver of the observed reallocation of labor out of unskilled labor intensive sectors and the increase in the skill premium. We also highlight the role of differences in input intensities across sectors in magnifying the effects of changes in the price of goods on the skill premium.

The rest of the paper is organized as follows. Section 2 reports differences in trade patterns and in skill and input intensities across sectors for a panel of countries. Section 3 introduces our quantitative model and characterizes how trade and net exports shape sectoral revenue shares and the skill premium in our framework. Section 4 shows how we parameterize the model. Section 5 presents our quantitative results, and the last section concludes.

2 Sectoral trade patterns and factor and input intensities

This section documents, for a wide set of countries, three differences across broad sectors that determine the effect of recent changes in trade patterns on real wages and the skill premium. First, we show that the share of expenditures on domestically produced

Figure 1: Imports relative to total GDP (1995=1)



Notes: We classify Agriculture, Manufacturing and Mining as goods, and all other sectors as services. Source: WIOD.

goods relative to total absorption of goods declined dramatically between 1995 and 2007, while the share of expenditures on domestically produced services relative to total absorption of services remained roughly constant. Second, we show that goods sectors are unskilled-labor intensive. Finally, we show that unskilled-labor intensive sectors use more intermediate inputs from goods producing sectors.

2.1 Sectoral changes in trade patterns

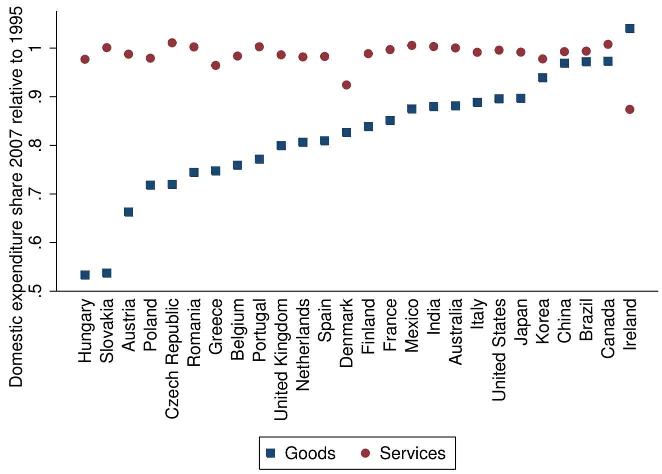
We start by documenting differences in trade patterns across goods sectors and service sectors. Figure 1 uses data from the World Input Output Database (WIOD) to plot imports of goods and services between 1995 and 2007.[7] Both panels in the figure show the dramatic increase in trade relative to GDP over this period. They also show that imports of services have grown slightly faster than imports of goods. For the US, the ratio of service imports to GDP grew about 49 percent, while the ratio of goods imports to GDP only by about 35 percent. Appendix Table A2 shows that this pattern is pervasive for the 40 countries in the WIOD.

We are interested in understanding how changes in trade patterns affected relative prices across sectors. We define the 'domestic expenditure share' of each sector j in country i, denoted by $\pi^j_{ii,t}$, as the ratio of expenditures on domestically produced goods or services relative to total expenditures in that sector.[8] Figure 2 reports domestic expendi-

[7] We classify Agriculture, Mining, and Manufacturing industries as goods-producing sectors, and the remaining industries as services. We provide a detailed account of how we group industries in WIOD into goods and services in Section 4 and in the data Appendix.

[8] The domestic expenditure share equals one minus the share of imports in total absorption. We focus on

Figure 2: Changes in domestic expenditure shares



Notes: We classify agriculture, manufacturing and mining as 'Goods', and all other sectors as 'Services.' 'Domestic expenditure shares 2007 relative to 1995' refers to $\pi^j_{ii,2007}/\pi^j_{ii,1995}$, where $\pi^j_{ii,t} \equiv 1 - Imports^j_t / \left[Output^j_i + Imports^j_i - Exports^j_i\right]$. Source: WIOD.

ture shares in 2007 relative to 1995 for the countries in the WIOD (see Appendix Table A3 for the exact values). The figure reveals that domestic expenditure shares in goods sectors declined dramatically in most countries. In contrast, domestic expenditure shares in service sectors remained roughly constant in every country of our sample with the exception of Denmark and Ireland. In the average country, the domestic expenditure share in goods producing sectors declined by 19 percent, relative to only 2 percent for service sectors. For the US these numbers are roughly 10 and 0 percent respectively. We summarize this finding in the following observation:

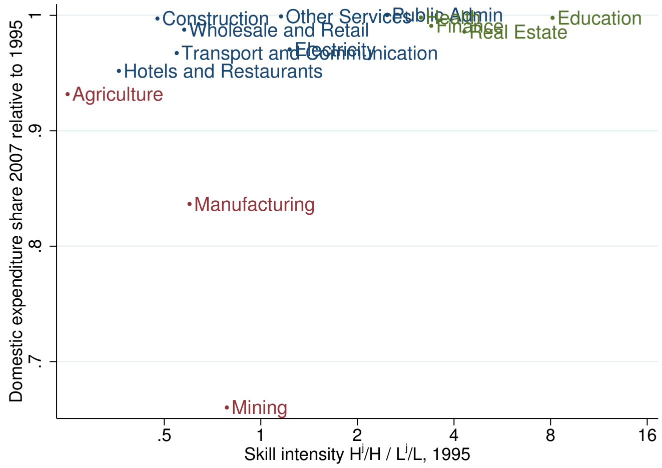
Observation 1 *Between 1995 and 2007, domestic expenditure shares in goods producing sectors declined dramatically, while domestic expenditure shares on service producing sectors remained roughly constant.*

2.2 Sectoral trade patterns and skill intensities

We now report how skill intensities vary across broad sectors using data on employment and educational attainment by sector from KLEMS and IPUMS. We classify workers with complete college education as skilled workers, and workers that have not completed col-

changes in domestic expenditure shares because this is what determines relative price movements in our model (this is a feature shared by most workhorse trade models, see Arkolakis, Costinot and Rodriguez-Clare (2012)).

Figure 3: Skill intensities and tradability across sectors



Notes: 'Domestic expenditure shares 2007 relative to 1995' refers to $\pi^j_{ii,2007}/\pi^j_{ii,1995}$ defined in Figure 2. H^j_i and L^j_i denote the number of unskilled and skilled workers in country i and sector j, and $H_i \equiv \sum_j H^j_i$ and $L_i \equiv \sum_j L^j_i$. The figure reports the average of these measures across the countries in our sample (see the Appendix for a description of the sample). Source: KLEMS, IPUMS, WIOD

lege as unskilled workers.[9] In what follows, we let H^j_i and L^j_i denote skilled and unskilled employment in country i and sector j. We refer to the 'skill intensity' of a sector as the ratio of skilled to unskilled workers in the sector relative to the ratio of skilled to unskilled workers in the overall economy.[10]

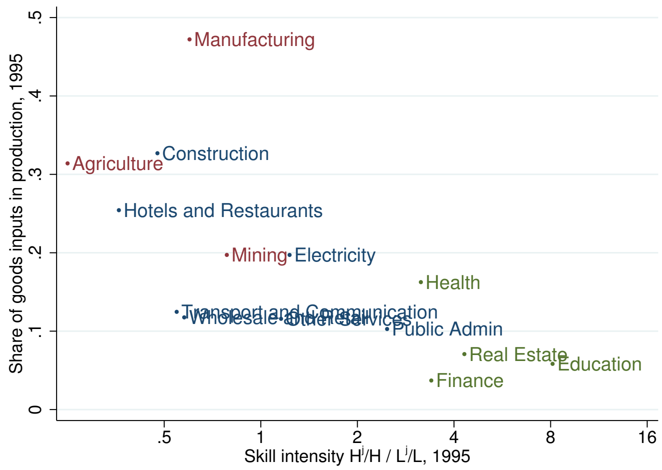
Figure 3 plots the average skill intensities and the 1995-2007 changes in domestic expenditure shares in each one-digit ISIC Rev. 2 sector across countries in our sample. The figure reveals that sectors in which domestic expenditure shares declined the most (Agriculture, Manufacturing and Mining) are unskilled-labor intensive. Among the sectors in which domestic expenditure shares remained roughly constant, some are unskilled-labor intensive (such as Construction, Retail), while some are skilled-labor intensive (such as FIRE and Education). Appendix Figure A.1 shows that this pattern is pervasive across countries. We summarize these findings in the following observation:

Observation 2 *Goods producing sectors (Agriculture, Mining, and Manufacturing) are unskilled-labor intensive,* $L^j_i/H^j_i > L_i/H_i$. *Within the service sectors, Finance and Insurance, Real Estate, Health, and Education are skilled-labor intensive,* $L^j_i/H^j_i < L_i/H_i$, *while the remaining service*

[9] KLEMS sorts workers into 3 educational groups: "Low" (no college), "Medium" (some college), and "High" (college graduate and above). We classify "Low" and "Medium" education as unskilled workers, and classify the workers with "High" education as skilled workers. Appendix E details how we classify industries in KLEMS and IPUMS into sectors.

[10] That is, the skill intensity of a sector is given by $\frac{H^j_i/L^j_i}{H_i/L_i}$, with $H_i \equiv \sum_j H^j_i$ and $L_i \equiv \sum_j L^j_i$

Figure 4: Use of inputs from the goods sector



Notes: 'Share of Goods Inputs in Production' is the share of agriculture, mining and manufacturing inputs in total production of the sector. Skill intensities are defined as in Figure 3. The figure reports the average of these measures across the countries in our sample. Source: KLEMS, IPUMS, WIOD

sectors are unskilled-labor intensive, $L_i^j / H_i^j > L_i / H_i$.

2.3 Skill intensities and intermediate input shares

Finally, we report how the use of intermediate inputs from goods-producing sectors varies across sectors with different skill intensities. In particular, we compute the share of intermediate inputs from goods-producing sectors in total output for each one-digit ISIC Rev. 2 sector using data from the WIOD as described in Appendix E.

Figure 4 plots skill intensities and the share of goods inputs by sector for the average country in our sample. The figure reveals that unskilled-labor intensive sectors use more intermediate inputs from goods-producing sectors. This observation applies to both goods-producing sectors (Agriculture, Manufacturing and Mining) and unskilled-labor intensive service sectors (such as Construction and Hotels and Restaurants). In contrast, skilled-labor intensive service sectors use relatively less inputs from the goods sector. Appendix Figure A.2 documents the finding across countries, which is summarized in the following observation:

Observation 3 *Unskilled-labor intensive sectors use relatively more intermediate inputs from goods producing sectors than skilled-labor intensive sectors.*

2.4 Summary

The data in this section show that the sectors that experienced the sharpest declines in the domestic expenditure shares between 1995 and 2007 are unskilled-labor intensive. In addition, unskilled-labor intensive sectors use relatively more highly-traded intermediate inputs than skilled-labor intensive sectors. In the following section, we present a quantitive trade model in which these differences across sectors shape how trade affects the composition of output across sectors and the skill premium.

3 Model

3.1 Setup

Preliminaries: We consider a world economy featuring I countries indexed by i and J sectors indexed by j. Each country is endowed with H_i and L_i efficiency units of skilled and unskilled labor, respectively. The final output of each sector can be used for consumption or as an intermediate input in the production of any sector. Within each sector j, there are K^j industries indexed by k.[11] Heterogeneous producers use skilled and unskilled labor to produce intermediate varieties in each of the industries. Producers differ in terms of their productivity and the sector in which they produce. All labor and goods markets are perfectly competitive.

Preferences: The utility of the representative household is given by

$$C_i = \left[\sum_j \bar{\phi}_i^{j\frac{1}{\rho}} \left[C_i^j \right]^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}, \tag{1}$$

where C_i^j denotes consumption of the final good from sector j, $\bar{\phi}_i^j$ controls the weight of each sector in the aggregate consumption bundle, and ρ is the elasticity of substitution

[11] While differentiating across industries within sectors is not crucial for the direction of our mechanisms, the quantitative effect of trade on relative prices does depend on the level of disaggregation at which trade elasticities and the domestic expenditure shares are computed. Costinot and Rodriguez-clare (2014) and Ossa (2015) show that the real wage gains from trade for the average country get larger as one moves from a one-sector to a multi-sector model. Following the recent literature on international trade and real wages (see for example, Costinot and Rodriguez-clare (2014), Caliendo and Parro (2015), Ossa (2015) and Levchenko and Zhang (2016)) we allow for multiple industries within sectors of our model, though we assume that all industries within a given sector have identical factor intensities.

across sectors. The household's budget constraint is given by

$$s_i H_i + w_i L_i = \sum_j P_i^j C_i^j + NX_i.$$

Here, w_i and s_i denote the wages of unskilled and skilled workers respectively. The skill premium in country i is defined as s_i / w_i. NX_i are net transfers from country i to the rest of the world. Note that if $NX_i < 0$ the country is running a trade deficit.

Sectoral output: Each sector j combines the production of its K^j industries according to a Cobb-Douglas aggregator:

$$Y_i^j = \prod_{k=1}^{K^j} Y_i^j(k)^{\sigma_i^j(k)}.$$

Final output from each sector is non-tradable and can be used for consumption or as intermediates

$$Y_i^j = C_i^j + X_i^j, \tag{2}$$

where X_i^j denotes the quantity of the final good from sector j that is used as intermediate inputs by any of the sectors.

Industrial output: Industry k combines a continuum of intermediate varieties, indexed by $\omega \in [0,1]$, according to a CES production function with country- and industry-specific elasticity of substitution $\eta_i^j(k) > 1$,

$$Y_i^j(k) = \left[\int_0^1 q_i^j(\omega, k)^{\frac{\eta_i^j(k)-1}{\eta_i^j(k)}} d\omega \right]^{\frac{\eta_i^j(k)}{\eta_i^j(k)-1}},$$

where $q_i^j(\omega, k)$ is consumption of intermediate variety (ω, k) from sector j in country i. Each intermediate variety (ω, k) is potentially produced in every country.

Production of intermediate varieties: Producers of intermediate variety (ω, k) in country i, sector j produce according to the following constant returns to scale production function

$$q_i^j(\omega, k) = A_i^j(k) \, z_i^j(\omega, k) \, m_i^j(\omega, k)^{1-\beta_i^j} \, va_i^j(\omega, k)^{\beta_i^j}, \tag{3}$$

where

$$m_i^j(\omega,k) \equiv \left[\sum_{l=1}^{J}\left[\bar{\alpha}_i^{lj}\right]^{\frac{1}{\rho}} x_i^{lj}(\omega,k)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}},$$

and

$$va_i^j(\omega,k) \equiv \left[\left[\bar{\mu}_i^j\right]^{\frac{1}{\gamma}} l_i^j(\omega,k)^{\frac{\gamma-1}{\gamma}} + \left[1-\bar{\mu}_i^j\right]^{\frac{1}{\gamma}} h_i^j(\omega,k)^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}}.$$

Producers from industry k in sector j combine value added, $va_i^j(\omega,k)$, and a sector-specific intermediate input bundle, $m_i^j(\omega,k)$, according to a Cobb-Douglas aggregator, with a constant share of value added in gross output β^j that is common for all industries k within each sector j. The intermediate input bundle $m_i^j(\omega,k)$ aggregates inputs from all sectors, where $x_i^{lj}(\omega,k)$ denotes the use of inputs from sector l in the production of sector j; the parameter $\bar{\alpha}_i^{lj}$ controls the share of inputs from sector l on total input expenditures in sector j, and is common across industries within sectors. The elasticity of substitution across inputs from different sectors is the same as the elasticity of substitution across sectors in the consumption bundle, which is given by ρ. Value added combines unskilled labor, l, and skilled labor, h, with a constant elasticity of substitution γ, and the shares, $\bar{\mu}_i^j$ are sector but not industry specific.

The productivity of country i producers of variety (ω,k) is given by the product of a country-industry specific term, $A_i^j(k)$, shared by all industry k producers in the country, and a country-intermediate-variety specific productivity, $z_i^j(\omega,k)$. Note that, up to the productivity terms $A_i^j(k)\,z_i^j(\omega,k)$, the parameters of the production function are common across all industries K^j within each sector j. The country-intermediate-variety specific productivity is equal to $z_i^j(\omega,k) = u^{-\theta^j(k)}$, where u is an i.i.d random variable that is exponentially distributed with mean and variance 1. A higher value of $\theta^j(k)$ increases the dispersion of productivities across producers within industry k.

International trade Only intermediate varieties can be traded internationally. Delivering a unit of intermediate variety (ω,k) from country i to country n requires producing $\tau_{in}^j(k) \geq 1$ of the good. We assume that trading domestically is costless, $\tau_{ii}^j(k) = 1$.

Equilibrium To construct prices, we first define the unit cost of producers of intermediate variety (ω,k) producing in country i and selling in country n, $c_{in}^j(\omega,k)$,

$$c_{in}^{j}(\omega,k)=\frac{c_i^j\tau_{in}^j(k)}{A_i^j(k)\,z_i^j(\omega,k)}.$$

Here c_i^j is the unit cost of producing industry k intermediate inputs for the domestic market for an intermediate producer with productivity $A_i^j(k)\,z_i^j(\omega,k)=1$, and is given by:

$$c_i^j \;=\; \bar{\beta}_i^j\left[v_i^j\right]^{\beta_i^j}\left[b_i^j\right]^{1-\beta_i^j},$$

where $\bar{\beta}_i^j$ is a constant, and v_i^j and b_i^j are the unit costs of the labor and input bundles in sector j in country i. These costs are common across all industries in each sector j since production functions are identical across industries within sectors. The price of the intermediate variety (ω,k) in country n is given by

$$p_n^j(\omega,k)=min_i\left\{c_{in}^j(\omega,k)\right\},$$

where we have used the fact that good (ω,k) is perfectly substitutable across all potential source countries that can supply it to country n. The price index of sector j output in country n is

$$P_n^j(k)=\left[\int_0^1 p_n^j(\omega,k)^{1-\eta_n^j(k)}\,d\omega\right]^{\frac{1}{1-\eta_n^j(k)}},$$

and the share of country n's expenditure in industry k's goods produced in country i is

$$\pi_{in}^j(k)=\left[\int_0^1 p_n^j(\omega,k)^{1-\eta_n^j(k)}\,\mathbb{I}_{in}^j(\omega,k)\,d\omega\right]/\,P_n^j(k)^{1-\eta_n^j(k)}; \tag{4}$$

where $\mathbb{I}_{in}^j(\omega,k)$ is an indicator variable that equals one if country n purchases intermediate variety (ω,k) from country i, and equals zero otherwise. Under the assumption of exponentially distributed productivities, Eaton and Kortum (2002) show that in equilibrium:

$$\pi_{in}^j(k)=\left[\tau_{in}^j(k)\,c_i^j/\,A_i^j(k)\right]^{-1/\theta^j(k)}/\sum_{i'}\left[\tau_{i'n}^j(k)\,c_{i'}^j/\,A_{i'}^j(k)\right]^{-1/\theta^j(k)}. \tag{5}$$

A competitive equilibrium is a set of prices and quantities such that all markets clear. Each producer satisfies worldwide demand for its output. Sectoral output must satisfy the resource constraints (2). The demand for unskilled and skilled labor across producers must equal the endowments L_i and H_i, respectively. The total demand for intermediate inputs from each sector must equal X_i^j. The household's budget constraints must be satisfied. We fully characterize the equilibrium in Appendix A.1.

3.2 International trade, structural change and the skill premium

We now examine the central forces shaping the composition of output across sectors, real wages, and the skill premium in our model. Cost minimization implies that producers set the ratio of the marginal product of skilled labor to unskilled labor equal to the skill premium. Equation (3) implies that

$$\frac{s_i}{w_i} = \frac{\sum_j \beta_i^j \left[1-\mu_i^j\right] r_i^j}{\sum_j \beta_i^j \mu_i^j r_i^j} \frac{L_i}{H_i}, \tag{6}$$

where $\mu_i^j \equiv \frac{w_i L_i^j}{w_i L_i^j + s_i H_i^j}$ is the share of unskilled labor in sector j's value added, and r_i^j is the share of sector j in aggregate revenues.[12] From equation (6), changes in country i's skill premium are fully determined by changes in country i's endowments of skilled and unskilled labor and by changes in sectoral revenue shares. Given μ_i^j's, an increase in the size of the skilled labor intensive sectors (i.e. an increase in r_i^j in sectors where μ_i^j is low) increases the skill premium.

Changes in the skill premium will in turn affect the factor shares μ_i^j's. To better understand these forces we substitute for the μ_i^j's and take a first-order approximation to equation (6) in Appendix B, which yields:

$$\tilde{s}_i - \tilde{w}_i = \frac{1}{\bar{\gamma}} \left[\left[\tilde{H}_i - \tilde{L}_i\right] - \sum_j \left[\frac{H_i^j}{H_i} - \frac{L_i^j}{L_i} \right] \tilde{r}_i^j \right], \tag{7}$$

where variables with a tilde denote log changes, and $\bar{\gamma}_i \equiv [1-\gamma]\chi_i - 1 < 0$, with $\chi_i \equiv \sum_j \frac{\mu_i^j}{\mu_i} \frac{H_i^j}{H_i}$ and $\mu_i \equiv \frac{w_i L_i}{w_i L_i + s_i H_i}$. Equation (7) shows that the skill premium will increase when the relative supply of unskilled labor increases ($\tilde{L}_i > \tilde{H}_i$), or when the skilled labor intensive sectors grow ($\tilde{r}_i^j > 0$ in sectors where $\frac{H_i^j}{H_i} > \frac{L_i^j}{L_i}$). The direct effects of these changes in the skill premium are magnified or mitigated depending on whether the elasticity of substitution between skilled and unskilled labor is greater than 1 (which determines the value of $\bar{\gamma}_i$). If γ is greater than 1, a change in H_i/L_i or r_i^j's that increases the skill premium is mitigated by an increase in the share of unskilled labor in value added,

[12] Formally, $r_i^j \equiv \sum_n \pi_{in} P_n^j Y_n^j / \sum_j \sum_n \pi_{in} P_n^j Y_n^j$.

μ_i^j's, while the reverse is true when γ is smaller than 1.

Note that the sectoral revenue shares, r_i^j's, are endogenous, and potentially depend on the entire matrix of trade costs (between each pair of countries and in each sector), changes in net transfers to each country, changes in each country-sector specific productivities, and changes in labor endowments in each country. We can show, however, that there is a set of sufficient statistics that fully determine the equilibrium change in the skill premium. Appendix A.3 presents a set of 16 equations from which, given changes in these sufficient statistics, the change in the skill premium (and the real wages of skilled and unskilled workers) can be calculated for any country i. In particular, given values of the elasticities of substitution (γ and ρ), the dispersion of productivities in each industry $\theta^j(k)$, and factor shares in the initial equilibrium, the change in country i's skill premium depends only on changes in: (i) a weighted average of the industry-level domestic expenditure shares in each sector, given by $\pi_{ii}^j \equiv \prod_{k=1}^{K_j} \pi_{ii}^j(k)^{\sigma_i^j(k)\theta^j(k)}$; (ii) the ratio of revenues to absorption in each sector, $\lambda_i^j \equiv \frac{R_i^j}{Y_i^j}$, (iii) domestic technologies, $A_i^j(k)$ for all j; and (iv) domestic labor endowments, H_i and L_i. Importantly, conditional on $(i)-(iv)$, changes in trade costs, transfers, changes in other countries' technologies and endowments, and changes in all other trade shares do not affect country i's skill premium. That is, international trade costs, foreign technologies, transfers and foreign endowments only affect country i's skill premium through π_{ii}^j and λ_i^j. Moreover, given changes in π_{ii}^j and λ_i^j, we do not need to compute the multi-country general equilibrium model to calculate the change in country i's skill premium.

3.2.1 Trade and structural change

We start by showing how changes in prices and transfers shape changes in the revenue shares by log-linearizing the equilibrium equations. To facilitate the exposition, we focus on a special case of the model in which there are no intermediate inputs, $\beta_i^j = 1$ (we relax this assumption for the quantitive exercises of Section 5). Appendix B shows that in this case, to a first-order approximation, changes in sectoral revenue shares are given by:

$$\tilde{r}_i^j = [1-\rho]\left[\tilde{P}_i^j - \sum_l r_i^l \tilde{P}_i^l\right] + \left[\tilde{\lambda}_i^j - \sum_l r_i^l \tilde{\lambda}_i^l\right]. \tag{8}$$

The first term in equation (8) captures the effect of price changes on sectoral revenue shares. If the elasticity of substitution across sectors is less than 1 ($\rho < 1$), sector j's revenue share is increasing in its price relative to the gross output deflator (given by $\tilde{P}_i^R \equiv \sum_l r_i^l \tilde{P}_i^l$). The second term captures the effect of changes in sectoral trade deficits or surpluses, measured by changes in revenue to absorption ratios. Other things equal, a reduction in the ratio of revenues to absorption in a sector $\left(\tilde{\lambda}_i^j < 0\right)$ reduces the sector's share in gross output.

3.2.2 Trade and the skill premium

We now provide a first-order approximation for how changes in factor supplies, domestic expenditure shares, and net transfers affect the skill premium. To facilitate exposition, in this section we continue to abstract from intermediate inputs ($\beta_i^j = 1$). The change in the skill premium is given by:

$$\tilde{s}_i - \tilde{w}_i \;\; = \;\; \frac{1}{\Gamma_i}\left[\tilde{H}_i - \tilde{L}_i\right] + \sum_j \xi_{i,\pi}^j \left[\tilde{\pi}_{ii}^j - \tilde{A}_i^j\right] + \sum_j \xi_{i,\lambda}^j \tilde{\lambda}_i^j \qquad (9)$$

where $\Gamma_i \equiv \; -\left[\chi_i \gamma + \left[1-\chi_i\right]\rho\right]$ is the aggregate elasticity of substitution between skilled- and unskilled labor,[13] and $\xi_{i,\pi}^j = \frac{\rho-1}{\Gamma_i}\left[\frac{H_i^j}{H_i} - \frac{L_i^j}{L_i}\right]$ and $\xi_{i,\lambda}^j = -\frac{1}{\Gamma_i}\left[\frac{H_i^j}{H_i} - \frac{L_i^j}{L_i}\right]$ denote the elasticity of the skill premium to domestic expenditure shares and to the ratio of revenues to absorption respectively.

Equation (9) decomposes the change in the skill premium into three components. The first component depends on the growth of skilled labor relative to unskilled labor and captures the relative supply effect already present in equation (7). All else equal, an increase in the relative supply of skilled labor reduces the skill premium with an elasticity of $1/\left|\Gamma_i\right|$. If there are no differences in skill intensities across sectors, $\frac{H_i^j}{H_i} = \frac{L_i^j}{L_i}$, then $\xi_{i,\pi}^j = 0$. In this case changes in trade patterns do not affect the skill premium. More generally, note that the elasticity $\xi_{i,\pi}^j$ is negative if $\rho < 1$ and $\frac{H_i^j}{H_i} < \frac{L_i^j}{L_i}$, which indicates that increased trade in sector j (reflected in a decline in the domestic expenditure share π_{ii}^j) results in an increase in the skill premium. Finally, the last term in equation (9) shows how changes in sectoral deficits affect sectoral revenue shares directly and indirectly, as explained in equation (8) above. If $\frac{H_i^j}{H_i} < \frac{L_i^j}{L_i}$, the elasticity $\xi_{i,\lambda}^j$ is negative, so that an increase in the revenue to absorption ratio in sector j ($\tilde{\lambda}_{ii}^j > 0$) reduces the skill premium.

[13] That is, $\Gamma_i \equiv -\frac{dlog\left[H_i/L_i\right]}{dlog\left[s_i/w_i\right]}$. In the case of no intermediate inputs, this is just a weighted average of the elasticity of substitution across workers within sectors, γ, and the elasticity of substitution across sectors, ρ, employing skilled and unskilled workers with different intensities.

3.2.3 Real wages

Finally, we show how changes in domestic expenditure shares and the revenue to absorption ratio shape changes in real wages for skilled and unskilled workers. Real wages of skilled and unskilled workers are simply s_i/P_i^C and w_i/P_i^C respectively, where P_i^C is the consumption price index associated with the bundle in equation (1). We show in Appendix B that changes in real skilled and unskilled wages are, to a first-order approximation, given by:

$$\widetilde{s_i/P_i^C} = \frac{\bar{\mu}_i}{\Gamma_i}\left[\tilde{H}_i - \tilde{L}_i\right] + \sum_j \left[\bar{\mu}_i \xi_{i,\pi}^j - \phi_i^j\right]\left[\tilde{\pi}_{ii}^j - \tilde{A}_i^j\right] + \bar{\mu}_i \sum_j \xi_{i,\lambda}^j \tilde{\lambda}_i^j \tag{10}$$

$$\widetilde{w_i/P_i^C} = \frac{\bar{\mu}_i - 1}{\Gamma_i}\left[\tilde{H}_i - \tilde{L}_i\right] + \sum_j \left[\left[\bar{\mu}_i - 1\right]\xi_{i,\pi}^j - \phi_i^j\right]\left[\tilde{\pi}_{ii}^j - \tilde{A}_i^j\right] + \left[\bar{\mu}_i - 1\right] \sum_j \xi_{i,\lambda}^j \tilde{\lambda}_i^j \tag{11}$$

where $\bar{\mu}_i \equiv \sum_j \phi_i^j \mu_i^j$ is a weighted average of the sectoral factor shares, with weights given by the share of sector j in total consumption, $\phi_i^j \equiv \frac{P_i^j C_i^j}{\sum_j P_i^j C_i^j}$.

Equations (10) and (11) show how real wages respond to small changes in trade patterns and transfers in our model when we abstract from intermediate inputs. Note that, as established in the previous section, if $\rho < 1$ and $\frac{H_i^G}{H_i} < \frac{L_i^G}{L_i}$, then $\xi_{i,\pi}^G < 0$ and $\xi_{i,\lambda}^G < 0$. In this case, real wages increase for skilled workers in response to an increase in trade in the goods sector, since $\bar{\mu}_i \xi_{i,\pi}^G - \phi_i^G < 0$, but may increase or decrease for unskilled workers, depending on whether $\bar{\mu}_i \xi_{i,\pi}^G - \phi_i^G < \xi_{i,\pi}^G$. In contrast, a decline in the ratio of revenues to absorption ratio in sector G unambiguously increases real wages for skilled workers and reduces real wages for unskilled workers, because a decline in $\tilde{\lambda}_{ii}^j$ reduces the size of the sector j without directly affecting the aggregate price index. In the following sections, we calibrate the model and conduct two counterfactual exercises to quantify the impact of international trade on structural change, real wages, and the skill premium.

4 Data and parameterization

To conduct the counterfactual exercises of the next section we need data on trade flows and we need to assign values to our model's parameters. In what follows, we first describe our data sources and discuss how we map them to the model. We then compute the sectoral factor intensities, which according to equation (9) determine whether changes in trade patterns are skilled biased. Next, we show how we pick values for the parameters and input shares in the model. Finally, we describe how we construct changes in domestic expenditure shares and revenues to absorption ratios.

4.1 Taking the model to sectoral data

We take the model to the data focusing on 3 sectors motivated by our observations from Section 2: a goods-producing sector, $j = G$; and two service sectors, one that is skilled labor intensive, $j = F$, and one that is unskilled labor intensive, $j = S$. We start by briefly discussing how we aggregate industries to match the sectors in the model. We combine input-output data from the OECD (ranging from 1977 to 1990, depending on the country) and the WIOD (1995 to 2011), with data on employment and compensation from KLEMS and IPUMS. Combining these datasets, we are left with 26 countries for which data on both input-output tables and the sectoral factor intensities used in the following section are available. We classify the sectors of the I-O tables into the three sectors of our model as follows: i) goods G (including Agriculture, Mining, and Manufacturing), ii) skilled-labor intensive services F (including Finance and Insurance, Real Estate, Health, and Education), and iii) unskilled-labor intensive services S (including the remaining services).[14]

Trade data We use the IO tables from the OECD and the WIOD to compute bilateral trade shares and revenue to absorption ratios by sector. The trade shares $\pi_{in}^{j}(k)$ are the spending of country n in imports from country i relative to total absorption in industry k in sector j, where absorption is defined as gross output plus imports minus exports. The domestic expenditure shares, $\pi_{ii}^{j}(k)$, are gross output minus exports divided by absorption in each industry k (as in Section 2). To calculate the revenue to absorption ratios, λ_i^j, we measure revenues as gross output; in this case, we measure both revenues and absorption at the level of the broad sector j. Table A4 presents our sample and the changes in π_{ii}^{j}'s and λ_i^j's used in our quantitative exercises.

4.2 Parameterization

According to equations (A.17)-(A.22), the key moments and parameters that determine how changes in trade patterns affect the skill premium are: (i) the sectoral factor intensities H_i^j/H_i and L_i^j/L_i in the initial equilibrium, (ii) the share of unskilled labor in total labor payments in the initial equilibrium, μ_i, (iii) the industrial shares in aggregate absorption in the goods sector, $\sigma_i^j(k)$, (iv) the sectoral value added shares, β_i^j, (v) the shares

[14]That is, Utilities, Construction, Wholesale and Retail Trade, Hotels and Restaurants, Transport and Communications, and Other Community, Social and personal Services. See Appendix E for details on how the aggregation works for each dataset.

of inputs from each sector that are used in the sectoral input bundles, α_i^{lj}, (vi) the trade elasticities $\theta_i^j(k)$, (vii) the elasticity of substitution between skilled and unskilled labor, γ, and (viii) the elasticity of substitution across sectors, ρ. We describe how we assign these values below.[15]

Factor and input shares We follow the skill classification described in Section 2 and use data from KLEMS and IPUMS to compute the sectoral skill intensities H_i^j/H_i and L_i^j/L_i, which we report in Appendix Table A5. We measure the share of unskilled labor in total labor payments, μ_i, directly from KLEMS data as the ratio of labor compensation to unskilled workers relative to total labor compensation.[16] We use data from Input-Output tables (WIOD or OECD IO) to compute $\sigma_i^G(k)$ as industry k's share in total absorption in the goods sector in the initial year. We calculate the sectoral value added shares, β_i^j, as the ratio of value added to gross output in each sector, using also the Input-Output Tables. We construct the input shares in each sector's input bundle, α_i^{lj}, as the share of expenditures in intermediate inputs from sector l relative total input expenditures by sector j. The resulting value added and input shares are reported Appendix Table A6.

Elasticities Finally, we calibrate the trade elasticities, $1/\theta^j(k)$, and the elasticities of substitution across workers and across sectors, γ and ρ. The first two elasticities are taken directly from the literature. We take the industry-level trade elasticities $1/\theta^j(k)$ from Caliendo and Parro (2015), listed in Appendix Table A1. We set $\gamma = 1.51$, to match an aggregate elasticity of substitution between skilled and unskilled workers of $\Gamma = 1.42$ in the US, following Katz and Murphy (1992).

While an extensive literature has studied how low elasticities of substitution across sectors can shape structural change, there are three important differences between the structural parameter ρ in our model and most estimates of the elasticity of substitution across sectors in this literature.[17] First, while the structural transformation literature typically breaks sectors into agriculture, manufacturing and services, the sectoral breakdown in our model is across goods, low- and high-skilled services. Second, while the elasticity is typically estimated from consumption data, the parameter ρ in our model simultane-

[15] From these, one can infer other initial shares, such as ϕ_i^j and μ_i^j.

[16] We assign the cross-country average μ_i to the countries for which labor compensation data is not available (see Appendix E for details).

[17] For example, Buera, Kaboski and Rogerson (2015) use an elasticity of 0.2. Kehoe, Ruhl and Steinberg (2013) use an elasticity 0.5 in the consumption bundle, and a Leontieff input bundle . Comin, Lashkari and Mestieri (2015) estimate an elasticity around 0.65 . Herrendorf, Rogerson and Valentinyi (2013) estimate an elasticity of 0.85 using final consumption expenditure data, and of roughly 0 when using value added expenditure data.

ously governs the elasticity of substitution in the consumption- and in the input-bundles. Finally, the definition of consumption expenditures $P_i^j C_i^j$ in our model cannot be mapped directly to either the 'final-expenditure' nor to the 'value-added' data described in Herrendorf, Rogerson and Valentinyi (2013), a point we discuss in detail below.

With this in mind, we estimate ρ from time series data on prices and expenditure shares in the US in a way that is consistent with our model, following the macro-approach in Herrendorf, Rogerson and Valentinyi (2013) and Comin, Lashkari and Mestieri (2015). For our baseline estimation, we allow for non-homotheticicities in consumption demand using a generalized CES aggregator, as in Comin, Lashkari and Mestieri (2015).[18] In particular, Appendix F derives the following demand system:

$$log\left(\frac{P_i^j C_i^j}{P_i^{j'} C_i^{j'}}\right) = log\left(\frac{\bar{\phi}_i^j}{\bar{\phi}_i^{j'}}\right) + (1-\rho)\, log\left(\frac{P_i^j}{P_i^{j'}}\right) + \left(\epsilon^j - \epsilon^{j'}\right) logC_i, \tag{12}$$

$$log\left(\frac{P_i^j x_i^{jl}}{P_i^{j'} x_i^{j'l}}\right) = log\left(\frac{\bar{\alpha}_i^{jl}}{\bar{\alpha}_i^{j'l}}\right) + (1-\rho)\, log\left(\frac{P_i^j}{P_i^{j'}}\right). \tag{13}$$

Here ϵ^j is a parameter that governs the income elasticity of consumption of goods from sector j, and $P_i^j x_i^{jl}$ denotes expenditures on inputs from sector j by producers in sector $l = S, G, F$.

Herrendorf, Rogerson and Valentinyi (2013) note that elasticity estimates based on final expenditure data are higher than estimates based on value added data, as final expenditures are produced using intermediate inputs that contain value added from multiple sectors. As noted above, the expenditure shares and relative prices in our model cannot be measured directly with either final consumption expenditure data nor with the consumption value-added data constructed by Herrendorf, Rogerson and Valentinyi (2013). On the one hand, data on final consumption expenditures includes distribution margins, but our model does not have a distribution sector (note that consumption in retail, wholesale trade, and transport are all included in the unskilled labor intensive service sector in our parameterization). On the other hand, while consumption value-added data as measured by Herrendorf, Rogerson and Valentinyi (2013) subtracts the input content from consumption expenditures, the value of intermediate inputs is included in the sectoral

[18] We note that this aggregator nests the CES aggregator in our baseline model, so that we can estimate the elasticity of substitution while allowing for non-homotheticicities without loss of generality. Our model can be easily extended to allow for non-homotheticicities as shown in Appendix C. We opted to keep the baseline model homothetic to facilitate exposition, since as shown in the next section, allowing for non-homotheticicities does not affect our main results.

consumption expenditures in our model, $P_i^j C_i^j$.[19] Measuring expenditure shares in a way that is consistent with our model thus requires measuring how the *gross output* of each sector, valued at *producer prices* (i.e. before distribution margins are applied), is used in the economy. Appendix F describes in detail how we construct expenditure shares at producer prices using the Input-Output Use Tables for the US, and how we construct sectoral producer price indexes using the Chain-Type Price Indexes for Gross Output published by the BEA.

Figure A.3 plots the relative prices and relative expenditure shares in consumption and each of the input bundles. Both the price and the expenditure shares of skilled labor intensive services relative to goods rose during this period, which is consistent with an elasticity of substitution smaller than 1. These changes in relative expenditure shares are similar for the consumption and all of the input bundles. In addition, a similar pattern arises also for the relative price and relative expenditure shares of unskilled labor intensive services vs goods. Overall, the strong positive comovements of prices and expenditure shares are indicative of strong complementarities across sectors.

Columns 1 to 4 of Table A7 report the results of estimating equations (12) and (13) for $l = S, G, F$ using iterated feasible generalized nonlinear least square estimation, as Herrendorf, Rogerson and Valentinyi (2013). To deal with the issue that the elasticity of substitution is constrained to be positive, we make the following transformation $\rho = e^{b_0}$ and estimate the unconstrained parameter $b_0 \in (-\infty, +\infty)$. The estimate for ρ is statistically less than 1 in all of the columns, and indicates an elasticity of substitution of 0.59 when estimated of the consumption bundle and of roughly 0 when estimated of the input bundles. The last column simultaneously estimates the 4 equations for the consumption and input bundles, imposing the restriction that the elasticity of substitution should be the same across the equations. The resulting elasticity of substitution suggest a Leontieff aggregator. With these results in mind, we pick a value within the range of our estimates and set $\rho = 0.2$ in our baseline calibration. It is worth noting that the results of our first counterfactual can be easily scaled with the value of ρ using equation (9).

5 Quantitative results

This section quantifies how international trade affects revenue shares, real wages and the skill premium in our model. We conduct two counterfactual exercises to measure these effects, and show how our quantitative results change under alternative parameterizations.

[19] That is, while the value of intermediate inputs is not counted in the consumption value-added data, the sectoral production functions in our model are not value-added production functions.

We then show that measures based on the factor content of trade greatly underestimate the effect of trade on the skill premium in our model.

5.1 Counterfactual 1: Observed changes in trade patterns

Our first counterfactual uses the analytical results from Section 3 and equations (A.17)-(A.22) in the Appendix to calculate how sectoral revenue shares, the skill premium, and the gains from trade for each type of worker change in response to a given change in domestic expenditure shares and revenues to absorption ratios, $\hat{\pi}_{ii}^{j}$ and $\hat{\lambda}_{i}^{j}$. We conduct this counterfactual country by country, using the changes $\hat{\pi}_{ii}^{j}$ and $\hat{\lambda}_{i}^{j}$ observed during the past three decades.[20] Importantly, in this counterfactual, we do not require a balanced panel because we do not need data for other countries $n \neq i$ when solving for the change in the skill premium in country i .

This first exercise quantifies the impact of international trade and trade imbalances on sectoral revenue shares and real wages over a given period in the following specific way.[21] Fix the model's parameters $\left\{\sigma_{i}^{j}(k), \rho, \beta_{i}^{j}, \alpha_{i}^{lj}\right\}$, sectoral factor intensities $\left\{H_{i}^{j}/H_{i},\ L_{i}^{j}/L_{i},\ \mu_{i}^{j}\right\}$, and sectoral revenue shares $\left\{r_{i}^{j}\right\}$. Suppose that between two years the primitives of the model –trade costs, technologies, factor endowments and transfers– change in some unobserved manner. These changes in primitives will cause changes in domestic sectoral expenditure shares, $\left\{\tilde{\pi}_{ii}^{j}\right\}$, revenue to absorption ratios, $\left\{\tilde{\lambda}_{i}^{j}\right\}$, sectoral revenue shares $\left\{\tilde{r}_{i}^{j}\right\}$, factor payments $\{\tilde{s}_{i},\ \tilde{w}_{i}\}$ and prices $\left\{\tilde{P}_{i}^{j}\right\}$. Now consider a counterfactual environment in which country i is in autarky. Suppose that the same changes in the unobserved primitives occur, excluding the changes in trade costs and transfers (which are always set to infinity and zero respectively in this autarky scenario). The changes in primitives will cause changes in country $i's$ sectoral revenue shares, factor payments and prices which we denote by $\left\{\tilde{r}_{i}^{A,j},\ \tilde{s}_{i}^{A},\ \tilde{w}_{i}^{A},\ \tilde{P}_{i}^{A,j}\right\}$. Then, the difference in the change in the skill premium between the environment in which country i trades and the counterfactual environment in which it is in autarky is given by

$$\widetilde{s_i/w_i} - \widetilde{s_i^A/w_i^A} \quad = \quad \xi_{s/w,\pi}^{i}\tilde{\pi}_{ii}^{j} + \xi_{s/w,\lambda}^{i}\tilde{\lambda}_{i}^{j}. \tag{14}$$

Equation (14) answers the question: What are the additional effects of changes in primitives on the skill premium and real wages in an open economy relative to the effects in a

[20] As detailed in the Appendix, in our quantitative exercises we follow Dekle, Eaton and Kortum (2008) and use the "hat algebra" to solve for the exact changes in all the endogenous variables. In what follows, we define $\hat{x} \equiv x_1/x_0$.

[21] The discussion that follows is based on Corollary 1 in Burstein, Cravino and Vogel (2013).

closed economy? From equation (14), we can answer this question (to a first order approximation) using observable changes in domestic sectoral expenditure shares and revenue to absorption ratios, with no need to observe the underlying changes in primitives.

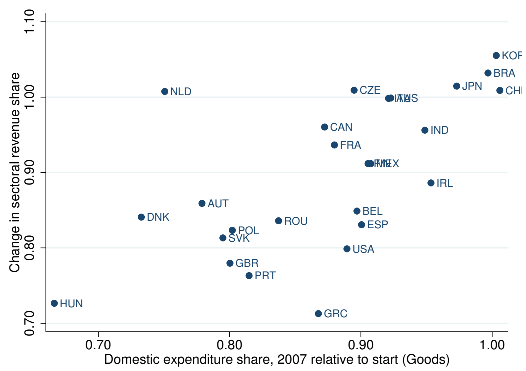
5.1.1 Trade and structural change

We start by evaluating the counterfactual predictions of the model for structural change in response to the changes in π_{ii}^j and λ_i^j reported in Table A4. The predictions are listed in Appendix Table A8 and summarized in Figure 5. Each dot in the figure relates the counterfactual change in sectoral revenue shares, $\hat{r}_i^j$, to the change in the domestic expenditure share in the goods sector. For the average country in our sample, the counterfactual generates approximately a 10% decline in the revenue share of the goods producing sector and a 13% increase in the revenue share of the skilled labor intensive service sector. There is a great deal of heterogeneity in the changes in revenue shares across sectors and countries, ranging from -29% to 6% for goods, and from about -6% to 37% in skilled-labor intensive services. As discussed in Section 3.2, a decline in the domestic expenditure shares in the goods sector is associated with a decline of the revenue share of the goods sector and an increase in the shares of the service sectors. The decline of the goods sector is larger for those countries that experienced a large increase in their goods-trade deficits, such as the US. Note also that, as the domestic expenditure shares in the goods sector decline, the skilled-labor intensive service sector expands faster than the unskilled-labor intensive service sector, because in the model, as in the data, the later uses relatively more intermediate inputs from the goods sector.

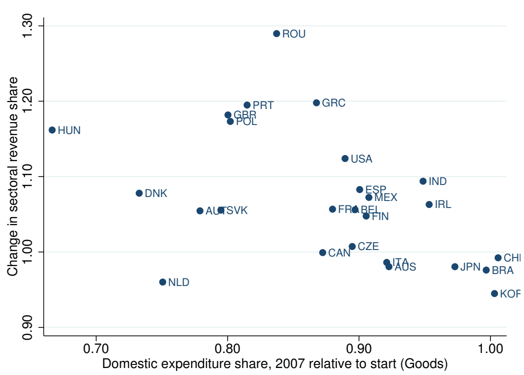
Figure 6 compares the counterfactual changes in revenue shares with the changes observed in the data. The figure suggests that the cross-country experiences on structural transformation of the past three decades are broadly consistent with the results of this counterfactual. The absolute magnitudes of the changes in sectoral revenue shares are larger in the data than in our theory. For instance, in the US, the revenue share of the goods sector declines 21 percent in the counterfactual, relative to the 34 percent decline that is observed in the data. This is not surprising given that the counterfactual abstracts from other forces that could have generated structural change in this period, such as rapid domestic productivity growth in the goods sector. Moreover, a significant fraction of the heterogeneity in the observed changes in revenue shares is not explained by the model, reflecting the reality that countries differ along multiple dimensions in addition to the ones present in our the counterfactual. Note however that, consistent with the data, the model predicts a decline in the size of the goods sector and an increase in the size of the skilled labor intensive service sector in most countries. The unskilled labor intensive ser-

Figure 5: Trade and structural change, Counterfactual 1

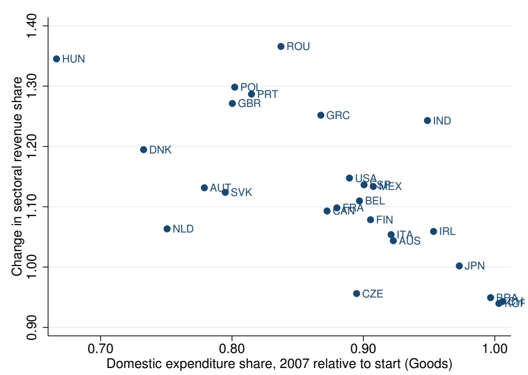
(a) Goods



(b) Unskilled-labor intensive services



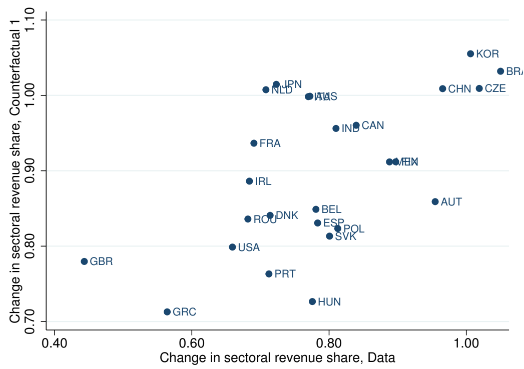
(c) Skilled-labor intensive services



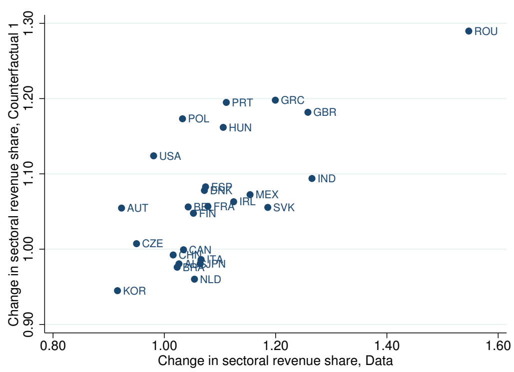
Notes: The figures report the change in sectoral revenue shares in Counterfactual 1 under our baseline calibration. The x-axis reports the weighted change in domestic expenditure shares for each country, $\hat{\pi}_{ii}^{G}$, and the y-axis reports the change in revenue shares, $\hat{r}_{i}^{j}$. The initial and final years to compute these changes are reported in Table A4.

Figure 6: Structural change, Counterfactual 1 vs. data

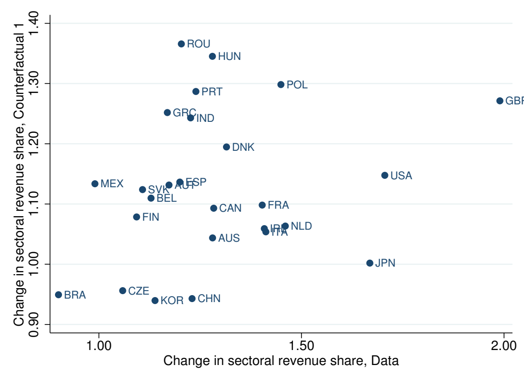
(a) Goods



(b) Unskilled-labor intensive services



(c) Skilled-labor intensive services



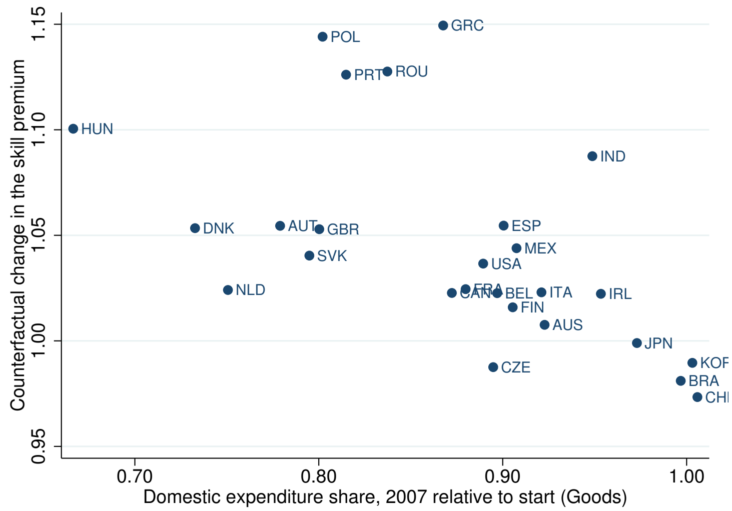
Notes: The figures report the change in sectoral revenue shares, $\hat{r}_i^j$, in Counterfactual 1 and in the data. The initial and final years to compute these changes in the model and in the data are reported in Table A4.

vice sector grows in some countries and shrinks in others, both in the model and in the data. Taken together these results suggest that the impact of trade, as measured in this counterfactual, may be responsible for non-trivial changes in the structure of the economy.

5.1.2 Trade, real wages and the skill premium

We now evaluate the counterfactual predictions for real wages and the skill premium, which are reported in Table A9. The results for the skill premium are summarized in Figure 7. For the average country in our sample, the model generates a 4.5% increase in the skill premium in response to the observed changes in trade patterns. Note that the increase is larger in countries with large declines in domestic expenditure shares, such as Hungary, or with large increases in their trade deficits, such as the US. The change in

Figure 7: Trade and the skill premium, Counterfactual 1



Notes: The figure reports the predicted change in skill premium under Counterfactual 1. The x-axis reports the weighted change in the domestic expenditure share in the goods sector for each country, $\hat{\pi}_{ii}^{G}$, and the y-axis reports the change in skill premium , $\hat{s}_i/\hat{w}_i$.

the skill premium is especially large in developing countries where the good producing sectors are particularly unskilled labor intensive, such as Poland or Greece. For most countries, international factors summarized in these changes either increased the skill premium or had a negligible effect on it. In the US, the model generates a 3.7 percentage point increase in the skill premium in this period.

Columns 2 and 3 in each panel of Table A9 report the predicted changes in real wages for skilled and unskilled workers in our first Counterfactual. Note that, while in most countries the skill premium increases in this counterfactual, unskilled workers gain from trade in all countries with the exception of China.

The role of sectoral net exports vs trade integration We now disentangle the contribution of changes in trade shares from changes in sectoral net exports for the skill premium. The second panel of Appendix Table A9 presents the model's predictions in a counterfactual where changes in the domestic expenditure shares $\hat{\pi}_{ii}^{j}$, while keeping the absorption to revenue ratios constant, $\hat{\lambda}_i^j = 1$. Both the skill premium and the skilled and unskilled real wages increase as a consequence of increased trade integration. The change in domestic expenditure shares accounts for roughly half of the total counterfactual change in the skill premium in the US, and by much more in the average country.

The third panel of Table A9 reports the model's predictions for the skill premium when we feed only the observed changes in the revenues to absorption ratios λ_i^j, while keeping domestic expenditure shares constant, $\hat{\pi}_{ii}^{j} = 1$. These changes mitigate or exacerbate the effects of increased trade integration on the skill premium, depending on whether the country experienced an increase or a decrease in net-exports of goods. In some countries like the US, the effect of these changes is an important factor affecting the skill premium, accounting for about 43 percent of its overall increase. Finally, note that the real wages of unskilled workers decline in countries that experience large goods-trade deficits (such as Spain or the US), while the real wages of skilled workers declines in countries that experience large goods-trade surpluses (such as Netherlands). The magnitude of the changes in real wages, however, is much smaller than in the baseline calibration.

5.2 Counterfactual 2: Changes in trade costs since 1995

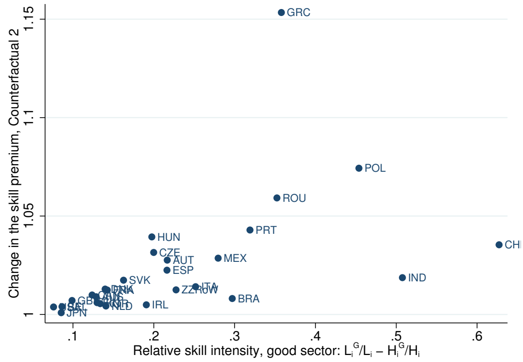
Our second counterfactual directly evaluates the impact of trade costs reductions between 1995 and 2007 on the skill premium. Doing so requires estimating changes in bilateral trade costs from observed changes in the trade flows. We follow the approach in Head and Ries (2001) and infer changes in bilateral trade costs from changes in bilateral expenditure shares. In particular, we write the change in trade costs as a function of observed changes in expenditure shares as:

$$\hat{\tau}_{ni}^{j}(k)\,\hat{\tau}_{in}^{j}(k) = \left(\frac{\hat{\pi}_{in}^{j}(k)\,\hat{\pi}_{ni}^{j}(k)}{\hat{\pi}_{nn}^{j}(k)\,\hat{\pi}_{ii}^{j}(k)}\right)^{-\theta^{j}(k)}. \tag{15}$$

Under the assumption of symmetric trade costs, $\hat{\tau}_{ni}^{j}(k) = \hat{\tau}_{in}^{j}(k)$, equation (15) can be used to back up changes in trade costs between any two periods using data on changes in expenditure shares, $\hat{\pi}_{in}^{j}(k)$, and the trade elasticities $\theta^{j}(k)$. We compute a counterfactual equilibrium implied by these changes in trade costs following the "exact hat algebra" approach of Dekle, Eaton and Kortum (2008). The counterfactual is informative about the change in the skill premium that is attributable to changes in trade costs. It is important to note, however, that this exercise requires more information and assumptions than that used in Counterfactual 1. In particular, instead of country-by-country changes in trade shares and revenue to absorption ratios, the exercise requires data on bilateral trade shares, $\pi_{in}^{j}(k)$, employment shares, H_i^j/H_i and L_i^j/L_i, and compensation shares, μ_i, for every country and sector to be used simultaneously. We are thus limited to evaluate the impact of changes in trade costs since 1995, the first year for which the WIOD provides a full bilateral trade matrix.

Figure 8 reports the resulting changes in the skill premium against the baseline skill

Figure 8: Change in the skill premium, Counterfactual 2



Notes: The figure reports the change in the skill premium in Counterfactual 2 in the y-axis. Relative skill intensity is in the goods sector is given by $\frac{L_i^G}{L_i} - \frac{H_i^G}{H_i}$.

intensity in the goods-producing sector. The skill premium increases for all countries in the sample, by an average of 2.5%. Some middle-income countries experience large increases (up to 15% for Greece), while the effect for most rich countries is relatively small.

To understand the size of the change of the skill premiun inthis counterfactual, consider equation (9) again. The change in the skill premium depends on the sectoral skill intensities in the initial equilibrium and the changes in domestic expenditure shares. Figure 8 reflects this result, showing that skill intensity in 1995 is positively correlated with the changes in the skill premium. But since some rich countries employ small fractions of both types of workers in the goods-producing sector in 1995, in those countries the scope for our mechanism is limited. In addition, Appendix Figure A.5 shows that the counterfactual changes in $\hat{\pi}_{ii}^j$ tend to be smaller than those observed in the data. This is to be expected, as the counterfactual does not take into account changes in relative productivities and relative size across countries.

5.3 Alternative parameterizations

This section evaluates the importance of alternative parameterizations for our quantitative results. First, we evaluate the quantitative importance of incorporating intermediate inputs into the model. Second, we evaluate the importance of the differences in skill and input intensities across the service sectors by simulating a two sector model in which the skilled and unskilled labor intensive services are aggregated into a single sector. Finally, we evaluate how our results change if we allow for non-unitary income elasticities in consumption demand.

No intermediate inputs We start by evaluating the importance of incorporating intermediate inputs for our quantitative results. To do so, we recalibrate the model imposing a share of value added equal to one in each sector, $\beta_i^j = 1$, and re-calculate the change in the skill premium under Counterfactual 1. The resulting changes in the skill premium are compared to those under the baseline parameterization in Figure 9a. The figure shows that the skill premium increases in most countries under the two calibrations. However, the increase in the skill premium is smaller in the model with no intermediates relative to the baseline in all countries, and 2.5% in the average country, which reveals that accounting for intermediate inputs is important for establishing the magnitude of our quantitative results.

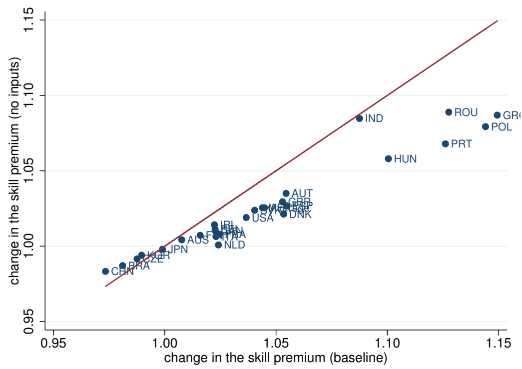
Two sector model We now evaluate the importance of incorporating differences in skill intensities across services in our model by calibrating an economy with just two sectors: goods and services. Note that this is equivalent to a three sector economy in which the two service sectors are identical. Hence, we re-calibrate all the sectoral shares in the service sectors to match the aggregate service shares in each economy. We then conduct Counterfactual 1 in this economy and compare the results to those obtained from our baseline calibration. The resulting changes in the skill premium are reported in Figure 9b. For the average country, the increase in the skill premium is 29% smaller in the two sector model than in our baseline calibration. Note, however, that the two models predict roughly the same decline in the revenue share of the goods sector. The differences in the models arise from the fact that, in the baseline model, sector F grows by more than sector S, since it uses relatively more intermediate inputs from the goods sector. Since sector F uses skilled labor more intensively, this magnifies the increase in the skill premium. This extra effect is not present when the service sectors are identical. We conclude that accounting for the differences in factor intensities across service sectors is important for quantifying the effects of trade integration on structural change and the skill premium.

Non-homothetic Preferences Finally, we extend our baseline model to allow for non-homotheticities in demand. In particular, we assume that consumers aggregate goods from different sectors with the generalized CES aggregator used by Comin, Lashkari and Mestieri (2015). Appendix C shows how the equilibrium conditions of our model are changed with this extension, and discuss how we parameterize the income elasticities of the different sectors following Comin, Lashkari and Mestieri (2015).[22] Figure 9c compares

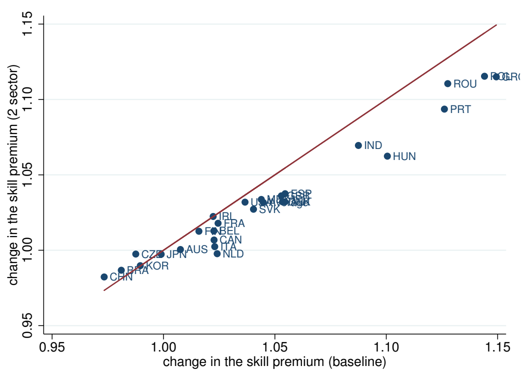
[22] In particular, to give the non-homothetic model the biggest chance to have a differential impact on the skill premium, we calibrate the income elasticities ϵ^j using the values reported in the first column of Table

Figure 9: Change in the skill premium, Counterfactual 1. Baseline vs. alternative parameterizations

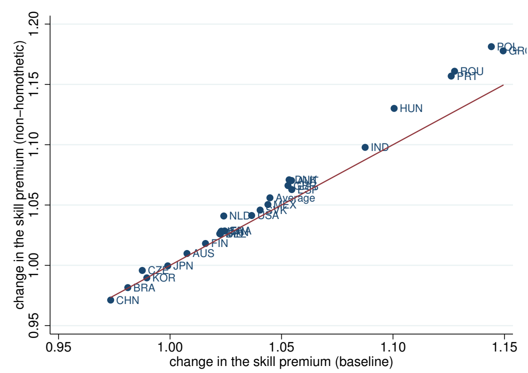
(a) No intermediate inputs



(b) Two sector model



(c) Non-Homothetic demand



Notes: This figure compares the change in the skill premium under alternative parameterizations with the change in the skill premium under our baseline parameterization (x-axis) in Counterfactual 1. The alternative parameterizations are described in Section 5.3.

the results of conducting our Counterfactual 1 in the homothetic vs the non-homothetic models. Since the real income gains from trade are small in our model, the baseline results are not much changed if we restrict preferences to be homothetic. The increase in the skill premium is 24% larger in the average country relative to the homothetic baseline.

5.4 Measuring the skill premium using the factor content of trade

We conclude this section by discussing an alternative approach that has been used in the literature to measure the impact of trade on factor prices: the factor content of trade

A7 (this is the specification that gives the largest differences in the income elasticities across sectors).

(FCT).[23] The FCT of a factor measures the quantity of the factor that is embodied in a country's net exports. Intuitively, an increase in the trade-adjusted supply of a factor should decrease the factor's price. In this section, we measure the FCT in our model and show that it greatly underestimates the effects of trade on the skill premium.

We start by deriving an expression that formally links the FCT to the skill premium. Appendix D shows that we can write the skill premium as:

$$\frac{s_i}{w_i} = \frac{L_i - FCT_i^L}{H_i - FCT_i^H} \times \Phi_i, \tag{16}$$

where $FCT_i^L \equiv \frac{1}{w_i} \sum_j \mu_i^j \beta_i^j \left[R_i^j - Y_i^j\right]$ and $FCT_i^H \equiv \frac{1}{s_i} \sum_j \left(1 - \mu_i^j\right) \beta_i^j \left[R_i^j - Y_i^j\right]$ are the FCT for unskilled- and skilled labor respectively, and we defined $\Phi_i \equiv \frac{\sum_j \left(1-\mu_i^j\right) \beta_i^j Y_i^j}{\sum_j \mu_i^j \beta_i^j Y_i^j}$. Deardorff and Staiger (1988) and Burstein and Vogel (2011) show in a class of models that if factor shares are fixed in each sector and sectoral absorption shares are constant, then Φ_i is constant and changes in the skill premium are proportional to changes in factor supplies and the FCT. Clearly, these conditions are not satisfied in our model, where both sectoral revenue shares and factor intensities change in response to changes in trade patterns.[24]

Figure 10 compares the change in the skill premium in our two counterfactuals to the changes in the skill premium that we measure using equation (16) in the counterfactual data. Both figures show that the change in the FCT greatly underestimates the true change in the skill premium generated by our model. In addition, the FCT based measure of the skill premium moves in the opposite direction than the actual change in the skill premium implied by the model for about a third of the countries in Counterfactual 1, and for about half of the countries in Counterfactual 2.

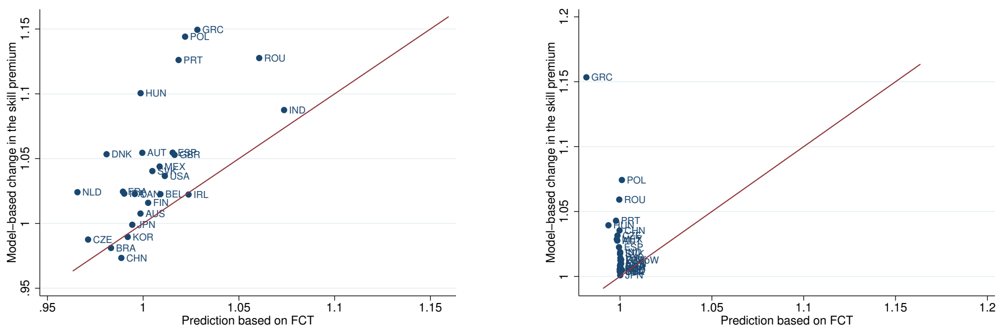
[23] See e.g. Katz and Murphy (1992).

[24] Burstein and Vogel (2016) point out that another issue with the FCT is that it cannot be measure form sectoral data if exporters and domestic firms use different technologies. While the FCT is not a sufficient statistic for the skill premium in their context (the term Φ_i is not constant in their framework), they show that if measured accurately, the FCT does provide a good approximation for the effect of trade on the skill premium. This not the case in our context, even if the FCT is perfectly measured.

Figure 10: Predictions based on the factor content of trade

Counterfactual 1:
Changes in trade patterns 1977-2007

Counterfactual 2:
Changes in trade costs 1995-2007



Notes: This figure compares the change in the skill premium implied by each of our counterfactuals (y-axis) to the change in the skill premium implied by the right hand side of equation (16) (x-axis).

6 Conclusion

Goods-producing sectors are intensive in unskilled labor. In this paper we used a quantitative model to study how increased trade integration in these sectors affects the skill premium by inducing a reallocation of labor towards service sectors in all countries. We showed that the observed changes in trade patterns of the past three decades can generate roughly half of the observed decline in the gross output share of goods-producing sector. These changes can in turn generate sizable increases in the skill premium in all countries (4.5 percent on average). Starting in 1995, changes in trade costs alone generate a 2.5 percent increase in the skill premium in the average country.

Two features of the data are crucial for these quantitative results. Most inputs used by the goods-producing sector are highly tradable, which magnifies the effects of changes in trade costs on the relative price of goods. Second, service sectors that are intensive in unskilled labor also use relatively more goods as inputs, magnifying the reallocation of labor towards the skilled labor intensive sectors.

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ONLINE APPENDIX (NOT FOR PUBLICATION)

Appendix A Equilibrium

This Appendix characterizes the equilibrium of the model, and shows how to solve for the key variables of interest as a function of domestic expenditure shares, $\pi_{ii}^{j}(k)$, and sectoral ratios of revenues to absorption in the each sector, λ_i^j. In addition, we provide the system of equations that we use for computing our counterfactual exercises.

A.1 Equilibrium

An equilibrium is a set of aggregate prices $\{w_i, s_i\}_{i\in I}$, $\left\{P_i^j, c_i^j, v_i^j, b_i^j\right\}_{i\in I, j\in J}$ and $\left\{P_i^j, c_i^j, v_i^j, b_i^j\right\}_{i\in I, j\in J}$, aggregate quantities $\left\{C_i^j, X_i^j, Y_i^j\right\}_{i\in I, j\in J}$ and $\left\{H_i^j, L_i^j\right\}_{i\in I, j\in J}$, and trade shares $\left\{\pi_{in}^{j}(k)\right\}_{i,n\in I, k\in K^j, j\in J}$, such that, given factor supplies $\{H_i, L_i\}_{i\in I}$, technologies $\left\{A_i^j(k)\right\}_{i\in I, k\in K^j, j\in J}$, and net exports $\{NX_i\}_{i\in I}$, the following are satisfied:

i. Households maximize utility subject to their budget constraints. This implies demands:

$$\frac{P_i^j C_i^j}{\sum_j P_i^j C_i^j} \;=\; \bar{\phi}_i^j \left[\frac{P_i^j}{P_i}\right]^{1-\rho}, \tag{A.1}$$

and the budget constraint:

$$w_i L_i + s_i H_i = \sum_j P_i^j C_i^j + NX_i. \tag{A.2}$$

ii. Producers of intermediate varieties minimize costs. Cost minimization implies that the prices of the input bundles are given by:

$$c_i^j \;=\; \bar{\beta}_i^j b_i^{j\,1-\beta_j} v_i^{j\,\beta_j} \tag{A.3}$$

$$v_i^j \;=\; \left[\bar{\mu}_i^j w_i^{1-\gamma} + \left[1-\bar{\mu}_i^j\right] s_i^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \tag{A.4}$$

$$b_i^j \;=\; \left[\sum_{l=1}^{J} \bar{\alpha}_i^{lj} P_i^{l\,1-\rho}\right]^{\frac{1}{1-\rho}}. \tag{A.5}$$

Given these definitions, factor demands are given by:

$$\begin{aligned} w_i l_{in}^j(\omega,k) &= \bar{\mu}_i^j \left[\frac{v_i^j}{w_i}\right]^{\gamma-1} \beta_i^j p_n^j(\omega,k)\, q_{in}^j(\omega,k)\, \mathbb{I}_{in}^j(\omega,k) \\ s_i h_{in}^j(\omega,k) &= \left[1-\bar{\mu}_i^j\right] \left[\frac{v_i^j}{s_i}\right]^{\gamma-1} \beta_i^j p_n^j(\omega,k)\, q_{in}^j(\omega,k)\, \mathbb{I}_{in}^j(\omega,k) \\ P_i^l x_{in}^l(\omega,k) &= \sum_j \bar{\alpha}_i^{lj} \left[\frac{b_i^j}{P_i^l}\right]^{\rho-1} \left[1-\beta_i^j\right] p_n^j(\omega,k)\, q_{in}^j(\omega,k)\, \mathbb{I}_{in}^j(\omega,k). \end{aligned}$$

iii. Cost minimization by producers of final goods. Cost minimization implies that demand for variety (ω, k) is given by:

$$p_i^j(\omega,k)\, q_i^j(\omega,k) = \left[\frac{p_i^j(\omega,k)}{P_i^j(k)}\right]^{1-\eta_i^j(k)} \sigma_i^j(k)\, P_i^j Y_i^j.$$

As shown in Eaton and Kortum (2002) under our same distribution assumptions, price indices for final goods are given by

$$P_i^j = \bar{\sigma}_i^j \left[\prod_{k=1}^{K^j} P_i^j(k)^{\sigma_i^j(k)}\right].$$

where

$$P_i^j(k) = \Xi_i^j(k) \left[\sum_{l=1}^{I} \left[\tau_{li}^j(k) \frac{c_l^j}{A_l^j(k)}\right]^{-1/\theta^j(k)}\right]^{-\theta^j(k)}, \tag{A.6}$$

where $\bar{\sigma}_i^j$ and $\Xi_i^j(k)$ are constants. Trade shares between any pair of countries are given by equation (5).

iv. Aggregate factor market clearing. Integrating factor demands across producers, adding across all destination countries n, substituting for the demand each for variety $q_i^j(\omega,k)$, using equation (4), and adding across industries and across sectors, factor market clearing requires that the total payments to each type of labor in country i equal total demand:

$$w_i L_i^j = \bar{\mu}_i^j \left[\frac{v_i^j}{w_i}\right]^{\gamma-1} \beta_i^j R_i^j \tag{A.7}$$

$$s_i H_i^j = \left[1-\bar{\mu}_i^j\right] \left[\frac{v_i^j}{s_i}\right]^{\gamma-1} \beta_i^j R_i^j, \tag{A.8}$$

where $R_i^j = \sum_n \sum_{k \in K^j} \pi_{in}^j(k) P_n^j(k) Y_n^j(k)$ are aggregate revenues accruing from sales in sector j, and the demand for intermediate inputs in each sector l are given by:

$$P_i^l X_i^l = \sum_j \bar{\alpha}_i^{lj} \left[\frac{b_i^j}{P_i^l} \right]^{\rho-1} \left[1 - \beta_i^j \right] R_i^j. \tag{A.9}$$

v. Labor market clearing.

$$H_i = \sum_j H_i^j \quad ; \quad L_i^j = \sum_j L_i^j. \tag{A.10}$$

vi. Final goods market clearing.

$$Y_i^j = C_i^j + X_i^j. \tag{A.11}$$

Note that, after choosing a numeraire, $(29 \times I - 1 + I \times K^j \times I \times K^j)$ aggregate variables must be determined in equilibrium. Equations (A.1)-(A.11) and (5) give a system of $(29 \times I - 1 + I \times K^j \times I \times K^j)$ independent equations, since the market clearing conditions together with the budget constraints and the definition of revenues make one budget constraint redundant.

A.2 Solving in terms of domestic expenditure shares and revenue to absorption ratios

In this section we show how to solve domestic variables as functions of industrial domestic expenditure shares, $\pi_{ii}^j(k)$, and the ratio of revenues to absorption in each sector, λ_i^j. From equations, (5) and (A.6) we can write the industry-level price indices as functions of domestic expenditure shares:

$$P_i^j(k) = \Xi_i^j(k) \left[c_i^j / A_i^j(k) \right] \pi_{ii}^j(k)^{\theta^j(k)},$$

and the sectoral price indexes as:

$$P_i^j = \bar{\sigma}_i^j \prod_{k=1}^{K^j} \left[\Xi_i^j(k) \left[c_i^j / A_i^j(k) \right] \right] \pi_{ii}^j(k)^{\sigma_j(k)\theta^j(k)}. \tag{A.12}$$

Using equations (A.1), (A.11), and the definition of λ_i^j we can write the factor market clearing equations as:

$$w_i L_i = \sum_j \beta_i^j \bar{\mu}_i^j \left[\frac{v_i^j}{w_i^j}\right]^{\gamma-1} \lambda_i^j \left[P_i^j C_i^j + P_i^j X_i^j\right] \quad (A.13)$$

$$s_i H_i = \sum_j \beta_i^j \left[1-\bar{\mu}_i^j\right] \left[\frac{v_i^j}{s_i^j}\right]^{\gamma-1} \lambda_i^j \left[P_i^j C_i^j + P_i^j X_i^j\right]. \quad (A.14)$$

In combination with equation (A.1) we obtain:

$$\frac{s_i H_i}{w_i L_i} = \frac{\sum_j \beta_i^j \left[1-\bar{\mu}_i^j\right] \left[\frac{v_i^j}{s_i^j}\right]^{\gamma-1} \lambda_i^j \left[\bar{\phi}_i^j \left[P_i^j\right]^{1-\rho} + P_i^j X_i^j / P_i^\rho C_i\right]}{\sum_j \beta_i^j \bar{\mu}_i^j \left[\frac{v_i^j}{w_i^j}\right]^{\gamma-1} \lambda_i^j \left[\bar{\phi}_i^j \left[P_i^j\right]^{1-\rho} + P_i^j X_i^j / P_i^\rho C_i\right]}, \quad (A.15)$$

while intermediate varieties market clearing implies, for each sector l:

$$\frac{P_i^l X_i^l}{P_i^\rho C_i} = \sum_j \bar{\alpha}_i^{lj} \left[\frac{b_i^j}{P_i^l}\right]^{\rho-1} \left[1-\beta_i^j\right] \lambda_i^j \left[\bar{\phi}_i^j P_i^{j1-\rho} + \frac{P_i^j X_i^j}{P_i^\rho C_i}\right]. \quad (A.16)$$

Given values for $\pi_{ii}^j(k)$ and λ_i^j, equations (A.3), (A.5), (A.4), (A.12), (A.15) and (A.16) give a system of 16 equations that can be used to solve for the 13 relative prices in the economy together with $\frac{P_i^j X_i^j}{P_i^\rho C_i}$ for each sector j.

A.3 Solving for price changes

We now combine equations (A.3), (A.4), (A.5), (A.12), and (A.15) to solve for the skill premium as a function of domestic expenditure shares and the ratio of revenues to absorption in each sector. We solve for all the variables in changes following Dekle, Eaton and Kortum (2008). Define $\hat{x} \equiv x_1/x_0$. We can characterize the change in the skill premium as:

$$\left(\frac{\widehat{s}_i}{\widehat{w}_i}\right)^{\gamma}\frac{\widehat{H}_i}{\widehat{L}_i} = \frac{\sum_j \frac{H_i^j}{H_i}\left[\hat{v}_i^j\right]^{\gamma-1}\hat{\lambda}_i^j\left[\left[\hat{P}_i^j\right]^{1-\rho}\left[1-\psi_i^j\right]+\widehat{\frac{P_i^j X_i^j}{P_i^\rho C_i}}\psi_i^j\right]}{\sum_j \frac{L_i^j}{L_i}\left[\hat{v}_i^j\right]^{\gamma-1}\hat{\lambda}_i^j\left[\left[\hat{P}_i^j\right]^{1-\rho}\left[1-\psi_i^j\right]+\widehat{\frac{P_i^j X_i^j}{P_i^\rho C_i}}\psi_i^j\right]} \tag{A.17}$$

$$\hat{P}_i^j = \left[\hat{c}_i^j/\hat{A}_i^j\right]\prod_{k=1}^{K_j}\hat{\pi}_{ii}^j(k)^{\sigma_i^j(k)\theta^j(k)} \tag{A.18}$$

$$\hat{c}_i^j = \left[\hat{b}_i^j\right]^{1-\beta_i^j}\left[\hat{v}_i^j\right]^{\beta_i^j} \tag{A.19}$$

$$\hat{b}_i^j = \left[\sum_l \alpha_i^{lj}\left[\hat{P}_i^l\right]^{1-\rho}\right]^{\frac{1}{1-\rho}} \tag{A.20}$$

$$\hat{v}_i^j = \left[\mu_i^j\hat{w}_i^{1-\gamma}+\left[1-\mu_i^j\right]\hat{s}_i^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \tag{A.21}$$

and

$$\widehat{\frac{P_i^l X_i^l}{P_i^\rho C_i}} = \sum_j \Phi_{lj}\hat{\lambda}_i^j\left[\frac{\hat{b}_i^j}{\hat{P}_i^l}\right]^{\rho-1}\left[\left[\hat{P}_i^j\right]^{1-\rho}\left[1-\psi_i^j\right]+\widehat{\frac{P_i^j X_i^j}{P_i^\rho C_i}}\psi_i^j\right], \tag{A.22}$$

where $\alpha_i^{lj}\equiv\bar{\alpha}_i^{lj}\left[\frac{b_i^j}{P_i^j}\right]^{\rho-1}$ is the share of sector $l's$ inputs in total sector $j's$ input usage, and $\Phi_i^{lj}=\frac{\alpha_i^{lj}\left[1-\beta_i^j\right]r_i^j}{\sum_j\alpha_i^{lj}\left[1-\beta_i^j\right]r_i^j}$, is the share of good l intermediate inputs used by sector j.

Equations (A.17)-(A.22) give a system of 16 equations that can be used to solve for the 13 relative prices in the economy and the 3 auxiliary terms $\widehat{\frac{P_i^l X_i^l}{P_i^\rho C_i}}$ as a function of changes in domestic technologies, $\hat{A}_i^j(k)$, domestic expenditure shares, $\hat{\pi}_{ii}^j(k)$ and sectoral transfers $\hat{\lambda}_i^l$, and of sectoral factor shares μ_i^j, the skilled and unskilled labor shares, shares $\frac{H_i^j}{H_i}$, and $\frac{L_i^j}{L_i}$, the share of value added in each sector, β_i^j, the share of absorption used as intermediate inputs in each sector ψ_i^j, Φ_i^{lj}, and the elasticities of substitution ρ and γ.

Changes in revenue, absorption and value added shares The change in the share of sector j in total revenues is given by:

$$\hat{r}_i^j = \frac{\hat{\lambda}_i^j \left[\left[1-\psi_i^j\right] \left[\hat{P}_i^j\right]^{1-\rho} + \psi_i^j \widehat{\frac{P_i^j X_i^j}{P_i^\rho C_i}} \right]}{\sum_l r_i^l \hat{\lambda}_i^j \left[\left[1-\psi_i^j\right] \left[\hat{P}_i^j\right]^{1-\rho} + \psi_i^j \widehat{\frac{P_i^j X_i^j}{P_i^\rho C_i}} \right]}. \tag{A.23}$$

The change in the share of sector j in total absorption is:

$$\frac{\widehat{Y_i^j}}{Y_i} = \frac{\left[\left[1-\psi_i^j\right] \left[\hat{P}_i^j\right]^{1-\rho} + \psi_i^j \widehat{\frac{P_i^j X_i^j}{P_i^\rho C_i}} \right]}{\sum_j \frac{Y_i^j}{Y_i} \left[\left[1-\psi_i^j\right] \left[\hat{P}_i^j\right]^{1-\rho} + \psi_i^j \widehat{\frac{P_i^j X_i^j}{P_i^\rho C_i}} \right]}.$$

The change in the share of value added in sector j in total value added is given by

$$\frac{\widehat{va_i^j}}{va_i} = \frac{\hat{r}_i^j}{\sum_l \frac{\beta_i^j r_i^l}{\sum_l \beta_i^j r_i^l} \hat{r}_i^j}. \tag{A.24}$$

Appendix B Proofs

In this section we log-linearize the equilibrium conditions around the initial equilibrium and derive equations (8), (9), (10) and (11) in the paper.

Derivation of Equation (7)

We start by deriving equation (7). To a first order approximation, equation (6) can be written as:

$$\tilde{s}_i - \tilde{w}_i = \sum_j \left[\frac{H_i^j}{H_i} - \frac{L_i^j}{L_i} \right] \tilde{r}_i^j - \sum_j \frac{1}{1-\mu_i} \frac{L^j}{L} \tilde{\mu}_i^j - \left[\tilde{H}_i - \tilde{L}_i \right]. \tag{B.1}$$

Log differentiating μ_i^j we obtain:

$$\tilde{\mu}_i^j = -\mu_i^j \frac{s_i H_i^j}{W_i L_i^j} dlog \left[\frac{s_i H_i^j}{W_i L_i^j} \right] = -\mu^j \frac{s_i H^j}{W_i L^j} (1-\gamma) \left[\tilde{s}_i - \tilde{w}_i \right], \tag{B.2}$$

where the second equality follows from the factor demand equations. Substituting in equation (B.1) and solving for we $\tilde{s}_i - \tilde{w}_i$ we obtain equation (6) in the text.

Derivation of Equation (8)

We now differentiate r_i^j to derive equation (8). Multiplying by $P_i^\rho C_i$ and adding $P_i^l C_i^l$ to both sides of equation (A.16) we obtain:

$$R_i^l/\lambda_i^l \quad = \quad P_i^l C_i^l + \sum_j \bar{\alpha}_i^{lj} \left[\frac{b_i^j}{P_i^l}\right]^{\rho-1} \left[1-\beta_i^j\right] \lambda_i^j R_i^l. \tag{B.3}$$

In the special case in which $\beta_i^j = 1$, we can log-differentiate this equation as:

$$\tilde{R}_i^l \quad = \quad [1-\rho]\, \tilde{P}_i^l + \tilde{\lambda}_i^l + \widetilde{P_i^{-\rho} C_i}.$$

so that $\tilde{r}_i^j = \tilde{R}_i^j - \sum_l \tilde{R}_i^l$ coincides with expression (8) in the text.

Derivation of equation (9) We now derive equation (9) in the text in the special version of the model with $\beta_i^j = 1$. Substituting equation (8) into (7) we can write:

$$[\tilde{s}_i - \tilde{w}_i] \quad \bar{\gamma} = \quad \left[\tilde{H}_i - \tilde{L}_i\right] - \sum_j \left[\frac{H_i^j}{H_i} - \frac{L_i^j}{L_i}\right] \left[[1-\rho]\, \tilde{P}_i^j + \tilde{\lambda}_i^j\right]. \tag{B.4}$$

Log-linearizing equations (A.3)-(A.5) in the case of $\beta_i^j = 1$, we obtain:

$$\tilde{P}_i^j \quad = \quad \left[1-\mu_i^j\right] [\tilde{s}_i - \tilde{w}_i] + \tilde{w}_i - \tilde{A}_i^j + \tilde{\pi}_{ii}^j. \tag{B.5}$$

Substituting back in equation (B.4) and solving for $\tilde{s}_i - \tilde{w}_i$ gives the expression in the text.

Derivation of equations (10) **and** (11)

The expression in the text follows from noting that the consumer price index can be written as $\tilde{P_i^C} = \sum \phi_i^j \tilde{P}_i^j$, and using expression (B.5).

Appendix C Non-homothetic preferences

This section characterizes the equilibrium of our model with the generalized CES consumption aggregator given by:

$$\sum_j \left[\bar{\phi}_i^j\right]^{\frac{1}{\rho}} C_i^{\frac{\epsilon^j-\rho}{\rho}} \left[C_i^j\right]^{\frac{\rho-1}{\rho}} \quad = \quad 1. \tag{C.1}$$

Note that in the special case of $\epsilon^j = 1$, for all j, the aggregator collapses to the standard CES aggregator in equation (1), in which there are no income effects. Under these preferences the equilibrium conditions are given by equations (5), (A.2)-(A.11) and by the sectoral consumption demands associated with (C.1), given by:

$$P_i^j C_i^j = \bar{\phi}_i^j \left[\frac{P_i^j}{P_i}\right]^{1-\rho} P_i C_i^{\epsilon^j}. \tag{C.2}$$

Combining these demands with equations (A.13) and (A.14) we obtain

$$\frac{s_i H_i}{w_i L_i} = \frac{\sum_j \beta_i^j \left[1-\bar{\mu}_i^j\right] \left[\frac{v_i^j}{s_i^j}\right]^{\gamma-1} \lambda_i^j \left[\bar{\phi}_i^j \left[P_i^j\right]^{1-\rho} C_i^{\epsilon^j-1} + P_i^j X_i^j / P_i^\rho C_i\right]}{\sum_j \beta_i^j \bar{\mu}_i^j \left[\frac{v_i^j}{w_i^j}\right]^{\gamma-1} \lambda_i^j \left[\bar{\phi}_i^j \left[P_i^j\right]^{1-\rho} C_i^{\epsilon^j-1} + P_i^j X_i^j / P_i^\rho C_i\right]}, \tag{C.3}$$

while intermediate varieties market clearing implies, for each sector l:

$$\frac{P_i^l X_i^l}{P_i^\rho C_i} = \sum_j \bar{\alpha}_i^{lj} \left[\frac{b_i^j}{P_i^l}\right]^{\rho-1} \left[1-\beta_i^j\right] \lambda_i^j \left[\bar{\phi}_i^j P_i^{j\,1-\rho} C_i^{\epsilon^j-1} + \frac{P_i^j X_i^j}{P_i^\rho C_i}\right]. \tag{C.4}$$

We use the hat algebra in the system of equations above to conduct our alternative parameterization exercise in Section (5.3). To give the non-homothetic model the biggest chance to have a differential impact on the skill premium, we calibrate the income elasticities ϵ^j using the values reported in the first column of Table A7 (this is the specification that gives the largest differences in the income elasticities across sectors). Our results in the main body show that even in this parameterization, accounting for non-homotheticities has small effects on our quantitative results.

Appendix D The factor content of trade

This section shows how the skill premium can be written as a function of the factor content of trade in our model. We start by writing equations (A.7) and (A.8), summing over j, as:

$$\begin{aligned} s_i H_i &= \sum_j \left[1-\mu_i^j\right] \beta_i^j R_i^j = \sum_j \left[1-\mu_i^j\right] \beta_i^j Y_i^j + s_i FCT_i^H \\ w_i L_i &= \sum_j \mu_i^j \beta_i^j R_i^j = \sum_j \mu_i^j \beta_i^j Y_i^j + w_i FCT_i^L, \end{aligned}$$

where we defined the skilled- and unskilled-labor content of trade as $FCT_i^H \equiv \frac{1}{s_i} \sum_j \left(1-\mu_i^j\right) \beta_i^j \left[R_i^j - Y_i^j\right]$ and $FCT_i^L \equiv \frac{1}{w_i} \sum_j \mu_i^j \beta_i^j \left[R_i^j - Y_i^j\right]$. Solving for the wages s_i and

w_i and taking ratios we can write the skill premium as:

$$\frac{s_i}{w_i} = \frac{L_i - FCT_i^L}{H_i - FCT_i^H} \times \frac{\sum_j \left(1 - \mu_i^j\right) \beta_i^j Y_i^j}{\sum_j \mu_i^j \beta_i^j Y_i^j}.$$

Deardorff and Staiger (1988) and Burstein and Vogel (2011) show that if factor shares μ_i^j do not change across equilibria, and sectoral absorption shares are a constant fraction of total absorption $Y_i^j = \bar{\kappa}_i^j Y_i$, then the term $\sum_j \left(1 - \mu_i^j\right) \beta_i^j Y_i^j / \sum_j \mu_i^j \beta_i^j Y_i^j$ is constant. This implies that changes in the skill premium are determined by changes in FCT_i^L and FCT_i^H.

Appendix E Data and Parameterization

This section first describes our data sources and then explains how these are combined to parameterize our model.

E.1 Data Sources

We combine four data sources. We use the first two sources, the OECD Input-Output tables and the World Input Output Database, to construct changes in domestic expenditure shares, revenue to absorption ratios, and intermediate input shares β^j and α^{ij}. From 1995 on, we use WIOD to calculate bilateral trade shares $\pi_{ni}^j(k)$. We use the third source, the KLEMS dataset, to calculate employment shares, H_i^j / H_i and L_i^j / L_i, aggregate payments to skilled relative to unskilled labor, $s_i H_i / w_i L_i$, as well as revenue shares, r_i^j, and value added shares. For countries missing in KLEMS, we complement employment shares using census samples from IPUMS International, and we complement revenue and absorption shares using WIOD.

Table A1 provides our own concordance to aggregate industries across datasets and levels of aggregation, and the trade elasticity in each industry and sector. We use different levels of aggregation in the paper, depending on the calculation. The column "Category" lists our most disaggregated industries, which correspond with the index k in the paper. The next column, "One Digit", aggregates the sector G industries that correspond to manufacturing; we use this classification for illustration purposes in Figures 1 and 3. Finally, the column "Sector" classifies industries into goods, unskilled and skilled labor intensive services.

In the following sub-sections, we describe the datasets and their use in detail.

World Input-Output Tables For each year between 1995 and 2011, we observe the input output tables and bilateral trade shares from the World Input-Output Tables Database (WIOD), with industries disaggregated according to ISIC rev 3. These data are available at http://www.wiod.org/new_site/database/niots.htm. Column "WIOD code" in Table A1 lists the original industrial classification of the dataset and how we use it to compute industry and sector aggregates. We exclude "Private Households with Employed Persons (P)" from the calculations.

OECD Input-Output Tables We download the data from http://www.oecd.org/trade/input-outputtables.htm, 1995 edition (ISIC Rev 2). Coverage is sparse until the 1990s. The earliest observations we use are for the year 1977, but the beginning of the sample varies by country. Column "OECD Description" in Table A1 lists all disaggregated industries in this dataset and shows how we aggregate them into the sectors and industries of our model. We exclude the categories "Other producers" , "Statistical discrepancies", and "Private household activities" from the analysis.

One limitation of this dataset is that Education and Health are aggregated into the category "Community, social & personal services." Since we interpret Education as skilled labor intensive and Other services as unskilled labor intensive, we split this category into sectors S and F according to the 1995 share of Education in Education + Other Services for the US, from WIOD.

KLEMS We downloaded data at http://www.euklems.net/, March 08 release: (i) Labour input files and (ii) Country basic files. For Canada we repeat the same steps, but we use separate files (also available in the KLEMS webpage). KLEMS provides yearly data from 1970 to 2005, disaggregated by ISIC Rev. 3 industries. For each year, we observe the share of total hours employed in each industry, corresponding to the hours of each skill type in {Low, Medium, High}, where "High" includes workers with a college degree. We also observe, for each industry, the total hours employed, which allows us to calculate, for each labor type, the total hours of employment. We also observe total compensation for {Low, Medium, High} skills, which we use to compute the ratio sH/wL. Finally, we also obtain data on total revenue and absorption. Column "KLEMS Code" in Table A1 relates the original industrial classification in KLEMS to ours. We drop Private Households with Employed Persons (P).

IPUMS International We download census samples from www.ipums.org and use the number of persons employed by educational attainment to calculate the labor force of each type. We identify industries according to INDGEN (Industry, general recode), and we drop workers in the categories "NIU (not in universe)", "Response suppressed" and "Unknown." The column IPUMS in Table A1 documents the match to other databases. To classify workers between high and low skilled, we use the variable EDATTAIN (Educational attainment, international recode); we drop individuals in the categories "NIU (not in universe)" and "Unknown", and classify individuals with "University completed" as high skilled workers.

E.2 Data construction

In this section, we first list our data sources and then discuss some details on data construction not contained in the main body of the paper.

E.2.1 Sample

Table A4 reports the countries in our sample, together with the initial and final years used for Counterfactual 1. In constructing the sample, we strived to maximize coverage across countries and time. The resulting sample is the largest possible panel for which we could obtain data on both employment shares and input-output data.

We provide next the details of the construction of our variables. In computing trade shares, revenue to absorption ratios, and input shares, we give priority to WIOD data, and use OECD-IO data when the former is not available. In computing sectoral labor intensities, we give priority to KLEMS data, and use IPUMS data when the former is not available. Finally, to calculate revenue and absorption shares across sector, we give priority to KLEMS data, and complement it with WIOD data.

E.2.2 Constructing sectoral changes in trade shares and revenue to absorption ratios

Table A1 shows the correspondence between the classification in the OECD IO data and the classification in the WIOD data. The table also reports the classification we constructed to bridge the different levels of aggregation of these two classifications (which correspond to k in our model), and how we associated industries to the trade elasticities from Caliendo and Parro (2015). The calculation of the sectoral trade shares requires choosing a single elasticity for the "Auto and Other Transport" and "Electrical, Communication and Medical", and "Basic Metals and Metal Products" categories. In these cases, we chose the average elasticity.

E.2.3 Share of intermediate inputs in total revenue $\left(1-\beta^j\right)$ and share of each sector in the intermediate input bundle $\left(\alpha^{lj}\right)$

For each country and sector, we calculate at the beginning of the sample,

$$1-\beta^j = \frac{\text{Sector } j\text{'s Total Intermediate Use}}{\text{Sector } j's \text{ Total Intermediate Use} + \text{Sector } j's \text{ Value Added}},$$

where Sector $j's$ Total Intermediate Use is measured as Total Intermediate Use of G (Imported and Domestic) plus Total Intermediate Use of S and F (both including only domestic intermediate inputs). Sector $j's$ Value added is measured as Sector $j's$ Total Output less **all** inputs purchased by aggregate sector j.

We measure the share of sector l in the intermediate input bundle used in sector j, which we denote by α^{lj}, as

$$\alpha^{lj} = \frac{\text{Sector } j\text{'s Total Intermediate Use of } l}{\text{Sector } j\text{'s Total Intermediate Use}}$$

E.2.4 Low and high skill shares and relative labor compensation

We combine "Low" and "Medium" skill in KLEMS into our L category, and use "High" skill as our H category, for each sector $j = S, T, F$. KLEMS also provides data on shares of labor compensation. We aggregate the labor compensation data, according to the same criteria, to generate $s_i H_i / w_i L_i$.

We use IPUMS data for countries missing from KLEMS. Because IPUMS data are not available for every year, we calculate the employment shares using the closest year to the baseline year, depending on the exercise. For our first counterfactual, we use the year closest to the earliest year for which other data are available. For the second counterfactual, we use the year closest to 1995. Finally, since IPUMS does not contain information about compensation, for these countries we impute sH/wL based on the average for all other countries included in the sample.

Appendix F Estimating the elasticity of substitution across sectors

This section provides details for our estimation of the elasticity ρ in Section E. Equation (12) in the paper follows from taking ratios and logs in the demand functions in equation (C.2) for sectors j and j'. Equation (13) follows from aggregating the input demand functions across producers and industries,

$$P_i^l \sum_k \int x_{in}^{lj}(\omega, k)\, d\omega \;= P_i^l x_{in}^{lj} = \; \bar{\alpha}_i^{lj} \left[\frac{b_i^j}{P_i^l}\right]^{\rho-1} \left[1-\beta_i^j\right] R_i^j,$$

and then taking logs and differences across inputs l.

To estimate equations (12) and (13), we measure expenditure shares in a way that is consistent with our model, which requires measuring how *gross output* of each sector, valued at *producer prices* (i.e. before distribution margins are applied), is used in the economy. We measure expenditure shares at producer prices using the US Input-Output Use Tables for every year in the 1977-2012 period. In particular, we group the sectors in the Input-Output Tables into the sectors of our model following the definitions from Appendix E and compute the share of each sector in total consumption expenditures and in total intermediate inputs used by the goods, unskilled and skilled intensive service sectors. We construct sector specific price indexes from the Chain-Type Price Indexes for Gross Output by NAICS 2-digit Industry published by the BEA. We aggregate these prices using the yearly expenditure shares of the US Input-Output Tables to construct chain-weighted price indexes for the three broad sectors in our model. We compute aggregate consumption expenditures per capita, C_i, from the Input-Output data Chain-Type Price index data. In particular, we aggregate final private consumption at producer prices and aggregate the Chain-Type Price Indexes using the consumption expenditure shares to construct an aggregate price index for consumption at producers prices that is consistent with our other data. We compute $C_{i,t}$ as final consumption divided by the price index, divided by population.

Appendix G Tables and Figures

Figure A.1: Skill and trade intensities across industries by countries

Notes: Each point is a country, one-digit industry pair. 'Domestic expenditure shares 2007 relative to 1995' refers to $\pi^j_{ii,2007}/\pi^j_{ii,1995}$ defined in Figure 2. Skill intensities are defined as in Figure 3. Source: KLEMS, IPUMS, WIOD.

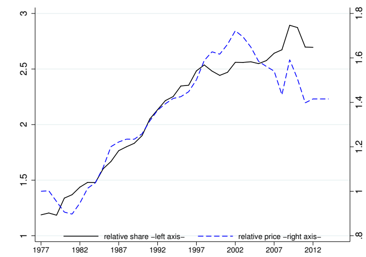
Figure A.2: Intermediate use of inputs from the goods-producing sector, by industries and countries

Notes: Each point is a country-industry pair. Share of goods inputs in production is the share of agriculture, mining and manufacturing inputs in total production of the sector. Skill intensities are defined as in Figure 3. Source: KLEMS, IPUMS, WIOD

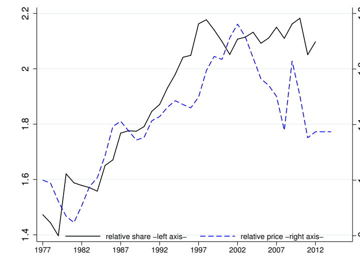
Figure A.3: Relative prices vs. relative expenditure shares

(a) Consumption bundle

Skilled-labor intensive services vs goods

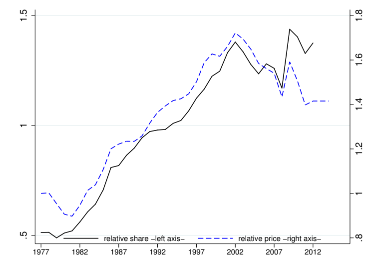


Unskilled-labor intensive vs goods

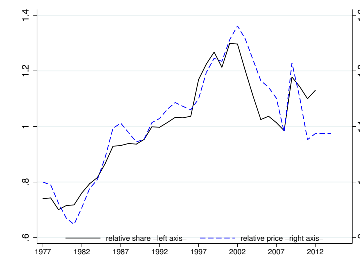


(b) Input bundle used in the unskilled labor intensive service sector

Skilled-labor intensive services vs goods

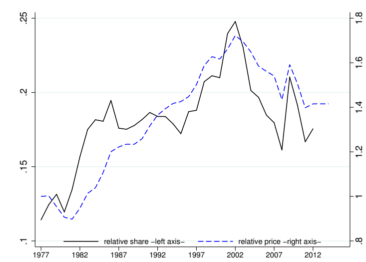


Unskilled-labor intensive vs goods

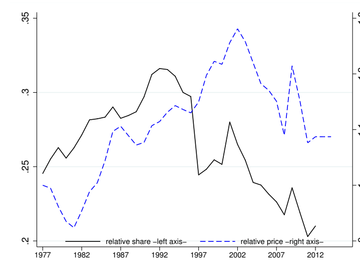


(c) Input bundle used in the goods sector

Skilled-labor intensive services vs goods

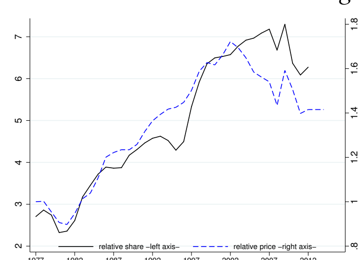


Unskilled-labor intensive vs goods

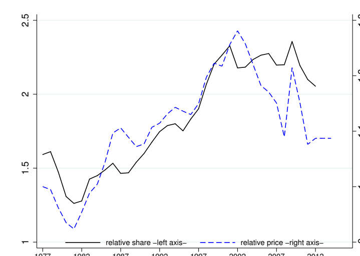


(d) Input bundle used in the skilled labor intensive service sector

Skilled-labor intensive services vs goods



Unskilled-labor intensive services vs goods

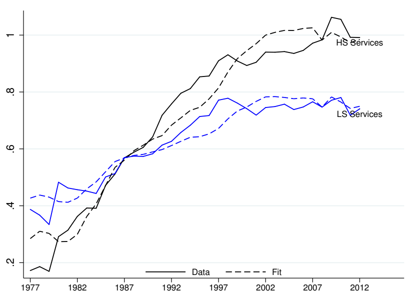


Notes: The figures plots the change in sectoral relative prices, and relative expenditures for (a) consumption, and total inputs in (b) the unskilled-labor intensive service sector, (c) the goods sector, and (d) the skilled- labor service sector. Source: Authors calculations based on data from the USE Input-Output Tables for the US, and the Chain-Type Price Indexes for Gross Output published by the BEA.

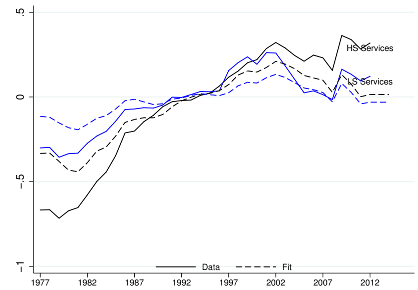
Figure A.4: Actual vs. predicted expenditure shares

(a) Independent estimation

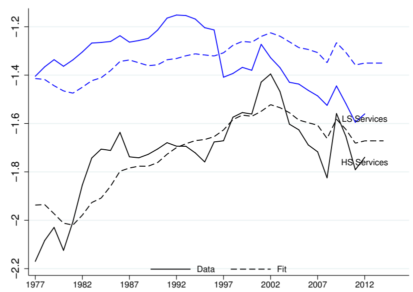
Consumption Bundle



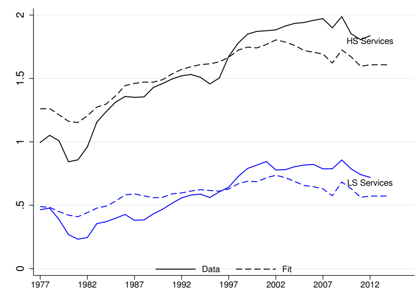
Unskilled-labor intensive services input bundle



Goods input bundle

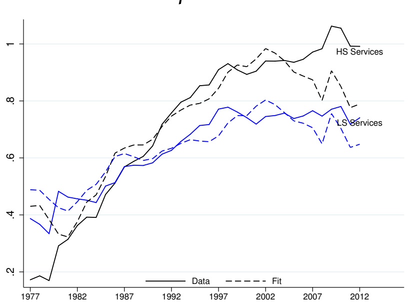


Skilled-labor intensive services input bundle

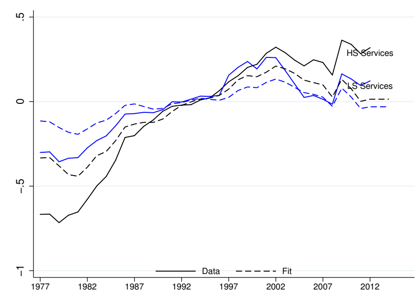


(b) Joint estimation

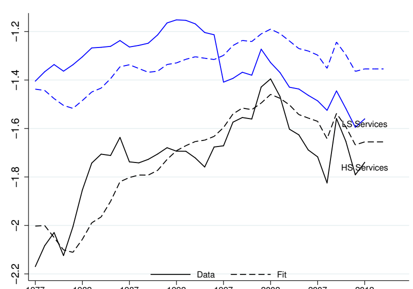
Consumption Bundle



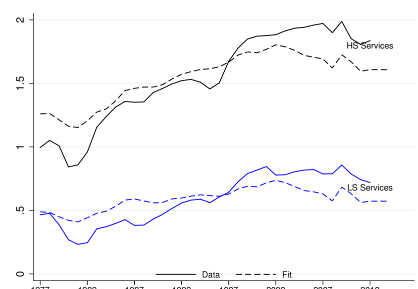
Unskilled-labor intensive services input bundle



Goods input bundle

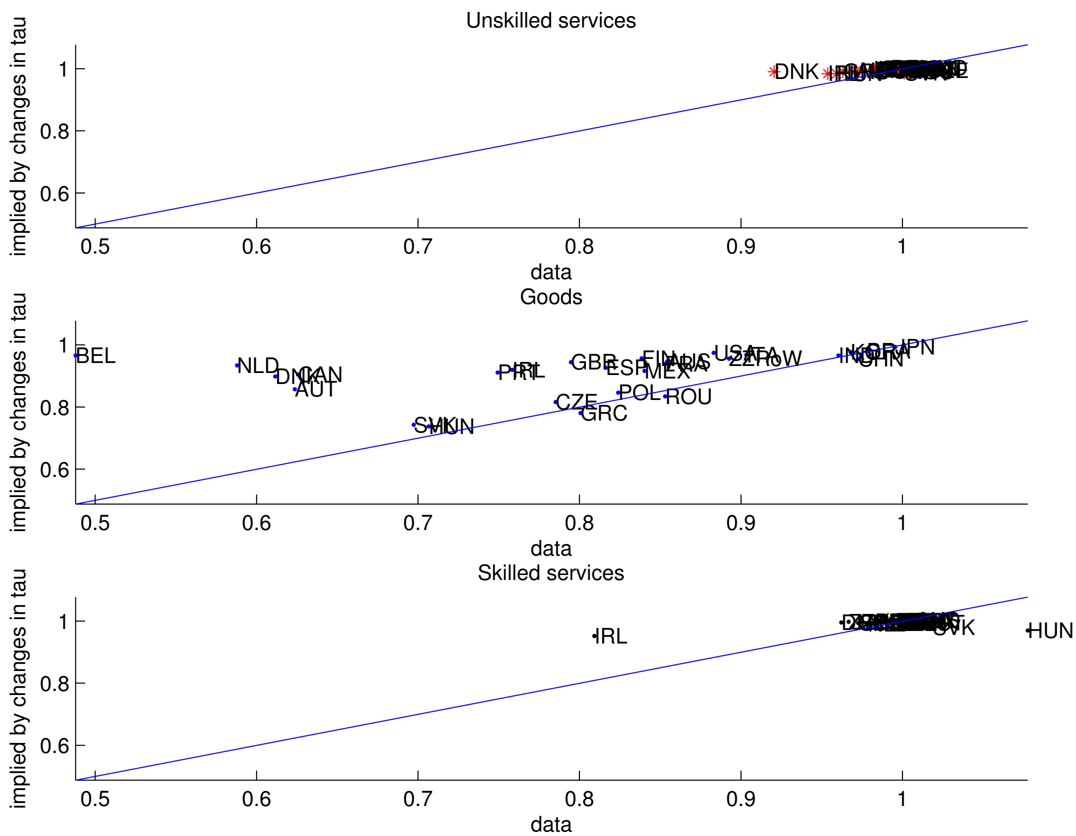


Skilled-labor intensive services input bundle



Notes: The figures report the expenditure shares in the data an the fitted values obtained from estimating equations (12) and (13).

Figure A.5: Changes in domestic expenditure shares, Counterfactual 2.



Notes: The figures reports the changes sectoral domestic expenditure shares in Counterfactual 2 (y-axis) to the changes in sectoral domestic expenditure shares observed between 1995 and 2007.

Table A1: Concordance across datasets and sectoral aggregation

Category	One Digit	Sector	OECD Description	WIOD code	KLEMS code	IPUMS	CP Elasticity	Agg. Elasticity
Agriculture	AtB	G	Agriculture, forestry & fishing	AtB	AtB	10	8.11	8.11
Mining	C	G	Mining & quarrying	C	C	20	15.72	15.72
Food	D	G	Food, beverages & tobacco	15t16	15t16	30	2.55	2.55
Textile	D	G	Textiles, apparel & leather	19	17t19	30	5.56	5.56
Textile	D	G	Textiles, apparel & leather	17t18	17t19	30	5.56	5.56
Wood	D	G	Wood products & furniture	20	20	30	10.83	10.83
Paper	D	G	Paper, paper products & printing	21t22	21t22	30	9.07	9.07
Chemicals	D	G	Industrial chemicals	24	24	30	4.75	4.75
Chemicals	D	G	Drugs & medicines			30	4.75	4.75
Petroleum	D	G	Petroleum & coal products	23	23	30	51.08	51.08
Plastic	D	G	Rubber & plastic products	25	25	30	1.66	1.66
Minerals	D	G	Non-metallic mineral products	26	26	30	2.76	2.76
Basic metals and Metal Products	D	G	Iron & steel	27t28	27t28	30	7.99	6.76
Basic metals and Metal Products	D	G	Non-ferrous metals	27t28	27t28	30	7.99	6.76
Basic metals and Metal Products	D	G	Metal products			30	4.3	6.76
Machinery nec	D	G	Non-electrical machinery	29	29	30	1.52	1.52
Electrical, Communication, Medical	D	G	Office & computing machinery			30	12.79	10.11
Electrical, Communication, Medical	D	G	Electrical apparatus, nec	30t33	30t33	30	10.6	10.11
Electrical, Communication, Medical	D	G	Radio, TV & communication equipment			30	7.07	10.11
Auto and Other Transport	D	G	Shipbuilding & repairing	34t35	34t35	30	.37	.53
Auto and Other Transport	D	G	Other transport	34t35	34t35	30	.37	.53
Auto and Other Transport	D	G	Motor vehicles			30	1.01	.53
Auto and Other Transport	D	G	Aircraft	34t35	34t35	30	.37	.53
Electrical, Communication, Medical	D	G	Professional goods			30	9.98	10.11
Other	D	G	Other manufacturing	36t37	36t37	30	5	5
Electricity	E	S	Electricity, gas & water	E	E	40		
Construction	F	S	Construction	F	F	50		
Wholesale and Retail	G	S	Wholesale & retail trade	51	51	60		
Wholesale and Retail	G	S	Wholesale & retail trade	52	52	60		
Wholesale and Retail	G	S	Wholesale & retail trade	50	50	60		
Hotels and Restaurants	H	S	Restaurants & hotels	H	H	70		
Transport and Communication	I	S	Transport & storage	60	I	80		
Transport and Communication	I	S	Transport & storage	63	I	80		
Transport and Communication	I	S	Transport & storage	62	I	80		
Transport and Communication	I	S	Transport & storage	61	I	80		
Transport and Communication	I	S	Communication	64	I	80		
Finance	J	F	Finance & insurance	J	J	90		
Real Estate	K	F	Real estate & business services	71t74	71t74	111		
Real Estate	K	F	Real estate & business services	70	70	111		
Other Services	O	S	Community, social & personal services	O	O	114		
Education	M	F	Community, social & personal services	M	M	112		
Health	N	F	Community, social & personal services	N	N	113		
Public Admin	L	S	Producers of government services	L	L	100		
Private Households	P	S	Other producers	P	P	120		

Table A2: Changes in goods and service imports relative to total GDP

Country	Goods	Services	Country	Goods	Services
Australia	1.22	1.01	Italy	1.33	1.48
Austria	1.54	1.28	Japan	2.16	2.06
Belgium	1.15	1.31	Korea	1.33	1.85
Bulgaria	2.51	0.78	Lithuania	1.11	0.92
Brazil	1.37	1.45	Luxembourg	0.80	2.60
Canada	0.98	0.91	Latvia	1.37	1.01
China	1.40	1.73	Mexico	1.24	0.71
Cyprus	1.09	1.04	Malta	0.92	1.32
Czech Republic	1.57	0.93	Netherlands	0.99	1.28
Germany	1.75	1.93	Poland	2.14	1.92
Denmark	1.17	3.25	Portugal	1.23	1.05
Spain	1.47	2.04	Romania	1.62	1.24
Estonia	0.93	0.92	Russia	1.10	0.70
Finland	1.43	1.31	Rest of the World	1.22	1.49
France	1.35	1.19	Slovakia	1.71	0.99
Great Britain	0.93	1.68	Sweden	1.26	1.58
Greece	1.42	2.61	Taiwan	1.47	1.22
Hungary	2.00	1.30	United States	1.35	1.49
India	2.14	1.02	World	1.45	1.64
Ireland	0.77	2.32	Average	1.38	1.44

Notes: This table reports imports to total GDP in 2007 relative to 1995 using data from the WIOD. The classification of WIOD industries into Goods and Services is detailed in Section 4.

Table A3: Sectoral changes in domestic-expenditure shares

Country	Goods	Services	Country	Goods	Services
Australia	0.88	1.00	Italy	0.89	0.99
Austria	0.66	0.99	Japan	0.90	0.99
Belgium	0.76	0.98	Korea	0.94	0.98
Bulgaria	0.62	1.06	Lithuania	0.75	1.00
Brazil	0.97	0.99	Luxembourg	0.96	0.79
Canada	0.97	1.01	Latvia	0.68	1.02
China	0.97	0.99	Mexico	0.87	1.01
Cyprus	0.73	1.01	Malta	0.62	1.00
Czech Republic	0.72	1.01	Netherlands	0.81	0.98
Germany	0.75	0.98	Poland	0.72	0.98
Denmark	0.83	0.92	Portugal	0.77	1.00
Spain	0.81	0.98	Romania	0.74	1.00
Estonia	0.72	1.02	Russia	0.97	1.01
Finland	0.84	0.99	Rest of the World	0.89	0.96
France	0.85	1.00	Slovakia	0.54	1.00
Great Britain	0.80	0.99	Sweden	0.83	0.97
Greece	0.75	0.96	Taiwan	0.78	0.99
Hungary	0.53	0.98	United States	0.90	1.00
India	0.88	1.00	World	0.90	0.98
Ireland	1.04	0.87	Average	0.81	0.98

Notes: This Table reports the ratio of the 2007 domestic expenditure shares relative to those in 1995 and 2007. Domestic expenditure shares are computed as the ratio of production minus exports to production plus imports minus exports in each sector using data from the WIOD. The grouping of WIOD industries into Goods and Services is detailed in Section 4.

Table A4: Observed changes in domestic expenditure shares and revenue to absorption ratios

Country	Initial year	Final year	Weighted change in domestic expenditure share	Change in revenue to absorption ratio
Australia	1986	2007	0.92	0.95
Austria	1995	2007	0.78	0.92
Belgium	1995	2007	0.90	1.03
Brazil	1995	2007	1.00	0.95
Canada	1981	2007	0.87	0.93
China	1995	2007	1.01	0.97
Czech Republic	1995	2007	0.89	0.90
Denmark	1980	2007	0.73	0.90
Spain	1995	2007	0.90	1.09
Finland	1995	2007	0.91	1.01
France	1980	2007	0.88	0.97
United Kingdom	1979	2007	0.80	1.09
Greece	1995	2007	0.87	1.25
Hungary	1995	2007	0.67	0.94
India	1995	2007	0.95	1.06
Ireland	1996	2007	0.95	1.05
Italy	1985	2007	0.92	0.95
Japan	1980	2007	0.97	0.96
Korea	1995	2007	1.00	0.96
Mexico	1995	2007	0.91	1.03
Netherlands	1981	2007	0.75	0.82
Poland	1995	2007	0.80	1.06
Portugal	1995	2007	0.81	1.09
Romania	1995	2007	0.84	1.18
Slovakia	1995	2007	0.79	0.99
United States	1977	2007	0.89	1.12
Average			**0.87**	**1.01**

Notes: The weighted change in domestic expenditure shares is defined as $\hat{\pi}_{ii} \equiv \prod_{k=1}^{K_j} \hat{\pi}_{ii}^{j}(k)^{\sigma_i^j(k)\theta^j(k)}$. The change in the revenue to absorption ratio is given by $\hat{\lambda}_i^T$. The first year in the sample is the earliest year for which we have data on input-output flows and employment shares.

Table A5: Sectoral factor intensities

Country	H^S/H	L^S/L	Difference	H^G/H	L^G/L	Difference	H^F/H	L^F/L	Difference
Australia	0.40	0.50	-0.10	0.16	0.27	-0.11	0.45	0.23	0.21
Austria	0.26	0.52	-0.26	0.08	0.30	-0.22	0.66	0.18	0.48
Belgium	0.28	0.50	-0.22	0.14	0.23	-0.09	0.57	0.27	0.30
Brazil	0.35	0.43	-0.08	0.14	0.43	-0.30	0.51	0.13	0.38
Canada	0.41	0.53	-0.13	0.12	0.29	-0.16	0.47	0.18	0.29
China	0.25	0.11	0.14	0.22	0.85	-0.63	0.53	0.04	0.49
Czech Republic	0.33	0.48	-0.14	0.18	0.38	-0.20	0.49	0.14	0.34
Denmark	0.28	0.44	-0.16	0.09	0.28	-0.19	0.62	0.28	0.34
Spain	0.33	0.56	-0.23	0.10	0.31	-0.22	0.57	0.13	0.44
Finland	0.38	0.45	-0.07	0.21	0.34	-0.13	0.41	0.21	0.20
France	0.43	0.52	-0.09	0.16	0.37	-0.21	0.41	0.12	0.29
United Kingdom	0.27	0.46	-0.20	0.21	0.35	-0.14	0.52	0.19	0.33
Greece	0.31	0.50	-0.19	0.06	0.42	-0.36	0.63	0.08	0.55
Hungary	0.34	0.50	-0.16	0.16	0.36	-0.20	0.50	0.14	0.36
India	0.40	0.22	0.18	0.26	0.77	-0.51	0.35	0.02	0.33
Ireland	0.25	0.50	-0.25	0.13	0.32	-0.19	0.62	0.17	0.44
Italy	0.23	0.48	-0.26	0.10	0.38	-0.29	0.68	0.13	0.54
Japan	0.51	0.51	-0.00	0.25	0.37	-0.13	0.25	0.12	0.13
Korea	0.50	0.48	0.02	0.27	0.41	-0.13	0.22	0.11	0.11
Mexico	0.48	0.51	-0.03	0.15	0.43	-0.28	0.37	0.06	0.31
Netherlands	0.25	0.49	-0.24	0.09	0.28	-0.19	0.66	0.23	0.43
Poland	0.32	0.31	0.01	0.06	0.52	-0.45	0.62	0.17	0.45
Portugal	0.30	0.46	-0.16	0.11	0.43	-0.32	0.59	0.11	0.48
Romania	0.29	0.26	0.02	0.31	0.66	-0.35	0.40	0.08	0.33
Slovakia	0.32	0.47	-0.15	0.08	0.24	-0.16	0.60	0.29	0.31
United States	0.37	0.52	-0.15	0.16	0.31	-0.15	0.47	0.17	0.29
Average	**0.34**	**0.45**	**-0.11**	**0.15**	**0.40**	**-0.24**	**0.51**	**0.15**	**0.35**

Notes: H^j/H measures the fraction of total skilled labor employed in sector $j = S, G, F$. L^J/L is defined analogously. Difference measures $H^j/H - L^j/L$ for each sector j.

Table A6: Intermediate input shares

Country	β_i^S	β_i^G	β_i^F	α_i^{SS}	α_i^{GS}	α_i^{FS}	α_i^{SG}	α_i^{GG}	α_i^{FG}	α_i^{SF}	α_i^{GF}	α_i^{FF}
Australia	0.61	0.39	0.69	0.32	0.47	0.21	0.20	0.71	0.09	0.37	0.23	0.40
Austria	0.63	0.41	0.70	0.49	0.35	0.16	0.29	0.64	0.07	0.52	0.19	0.29
Belgium	0.52	0.31	0.66	0.65	0.25	0.09	0.30	0.67	0.03	0.53	0.18	0.29
Brazil	0.64	0.37	0.73	0.49	0.36	0.15	0.25	0.69	0.06	0.53	0.24	0.23
Canada	0.64	0.38	0.74	0.30	0.51	0.19	0.15	0.80	0.05	0.32	0.10	0.58
China	0.43	0.35	0.57	0.27	0.66	0.08	0.15	0.81	0.04	0.32	0.46	0.22
Czech Republic	0.44	0.30	0.56	0.55	0.36	0.09	0.25	0.71	0.03	0.50	0.32	0.18
Denmark	0.67	0.33	0.73	0.29	0.53	0.18	0.13	0.81	0.06	0.45	0.23	0.32
Spain	0.54	0.35	0.70	0.51	0.37	0.12	0.30	0.66	0.04	0.57	0.18	0.25
Finland	0.56	0.37	0.69	0.43	0.43	0.14	0.29	0.69	0.02	0.51	0.28	0.21
France	0.70	0.35	0.72	0.29	0.43	0.28	0.12	0.77	0.11	0.24	0.23	0.53
United Kingdom	0.66	0.36	0.73	0.41	0.49	0.11	0.18	0.75	0.07	0.46	0.30	0.24
Greece	0.61	0.39	0.77	0.42	0.47	0.11	0.26	0.72	0.03	0.67	0.16	0.17
Hungary	0.53	0.31	0.68	0.48	0.43	0.09	0.23	0.74	0.02	0.48	0.34	0.18
India	0.59	0.40	0.80	0.36	0.54	0.10	0.24	0.70	0.06	0.37	0.41	0.23
Ireland	0.49	0.40	0.69	0.61	0.31	0.09	0.26	0.71	0.03	0.46	0.17	0.37
Italy	0.60	0.37	0.73	0.28	0.48	0.25	0.16	0.75	0.10	0.25	0.31	0.44
Japan	0.58	0.31	0.71	0.28	0.51	0.21	0.15	0.78	0.06	0.32	0.36	0.32
Korea	0.55	0.31	0.70	0.33	0.46	0.21	0.13	0.83	0.04	0.47	0.25	0.28
Mexico	0.64	0.40	0.80	0.39	0.42	0.19	0.20	0.74	0.06	0.42	0.27	0.31
Netherlands	0.67	0.35	0.78	0.36	0.50	0.14	0.10	0.84	0.06	0.33	0.27	0.39
Poland	0.54	0.37	0.66	0.52	0.42	0.06	0.28	0.68	0.04	0.50	0.23	0.27
Portugal	0.53	0.33	0.70	0.54	0.35	0.11	0.25	0.71	0.05	0.57	0.22	0.21
Romania	0.49	0.39	0.69	0.39	0.53	0.08	0.19	0.75	0.06	0.31	0.55	0.14
Slovakia	0.43	0.32	0.66	0.56	0.37	0.07	0.27	0.70	0.03	0.46	0.30	0.24
United States	0.64	0.38	0.69	0.34	0.44	0.22	0.17	0.76	0.07	0.33	0.20	0.47
Average	**0.57**	**0.36**	**0.70**	**0.42**	**0.44**	**0.14**	**0.21**	**0.74**	**0.05**	**0.43**	**0.27**	**0.30**

Notes: We calculate β_i^j from Input-Output data as the share of value added in sector j's total revenues. The input share α_i^{lj} is the share of expenditure in inputs produced in sector l, as a fraction of total input expenditure in sector j.

Table A7: Generalized *CES* estimates

	Consumption	Unskilled Services	Skilled Services	Goods	Joint Estimation
ρ	0.597***	0.000	0.237*	0.000	0.000
	(0.099)	(.)	(0.102)	(.)	(.)
$\epsilon^F - \epsilon^G$	0.831***				0.017
	(0.092)				(0.015)
$\epsilon^S - \epsilon^G$	0.429***				0.113***
	(0.037)				(0.017)
# Years	36	36	36	36	36

Notes: The table reports the results of estimating equations (12) and (13). 'Consumption', 'Unskilled Services', 'Skilled Services' and 'Goods' correspond to the results of estimating equations (12), and (13) for $l = S, G, F$ respectively. The last column reports the results to estimating the 4 equations simultaneously.

Table A8: Changes in revenue shares: Counterfactual 1 vs. Data

Country	Counterfactual 1			Data		
	Unskilled services	Goods	Skilled services	Unskilled services	Goods	Skilled services
Australia	0.98	1.00	1.04	1.03	0.77	1.28
Austria	1.05	0.86	1.13	0.92	0.95	1.17
Belgium	1.06	0.85	1.11	1.04	0.78	1.13
Brazil	0.98	1.03	0.95	1.02	1.05	0.90
Canada	1.00	0.96	1.09	1.03	0.84	1.28
China	0.99	1.01	0.94	1.02	0.97	1.23
Czech Republic	1.01	1.01	0.96	0.95	1.02	1.06
Denmark	1.08	0.84	1.19	1.07	0.71	1.32
Spain	1.08	0.83	1.14	1.07	0.78	1.20
Finland	1.05	0.91	1.08	1.05	0.90	1.09
France	1.06	0.94	1.10	1.08	0.69	1.40
United Kingdom	1.18	0.78	1.27	1.26	0.44	1.99
Greece	1.20	0.71	1.25	1.20	0.56	1.17
Hungary	1.16	0.73	1.35	1.11	0.78	1.28
India	1.09	0.96	1.24	1.27	0.81	1.23
Ireland	1.06	0.89	1.06	1.12	0.68	1.41
Italy	0.99	1.00	1.05	1.07	0.77	1.41
Japan	0.98	1.01	1.00	1.06	0.72	1.67
Korea	0.94	1.06	0.94	0.92	1.01	1.14
Mexico	1.07	0.91	1.13	1.15	0.89	0.99
Netherlands	0.96	1.01	1.06	1.05	0.71	1.46
Poland	1.17	0.82	1.30	1.03	0.81	1.45
Portugal	1.19	0.76	1.29	1.11	0.71	1.24
Romania	1.29	0.84	1.37	1.55	0.68	1.20
Slovakia	1.06	0.81	1.12	1.19	0.80	1.11
United States	1.12	0.80	1.15	0.98	0.66	1.71
Average	**1.07**	**0.90**	**1.13**	**1.09**	**0.79**	**1.29**

Notes: The Table reports the change in sectoral revenue shares in Counterfactual 1 under our baseline calibration and the changes observed in the data. The initial and final years to compute these changes are reported in Table A4.

Table A9: Changes in skill premium and gains from trade ratio, Counterfactual 1

Country	Integration and Imbalances			Integration			Imbalances		
	Skill premium	Skilled real wage	Unskilled real wage	Skill premium	Skilled real wage	Unskilled real wage	Skill premium	Skilled real wage	Unskilled real wage
Australia	0.8	6.9	6.1	1.0	7.1	6.1	-0.3	-0.3	0.0
Austria	5.4	22.0	15.8	6.0	22.6	15.6	-1.0	-0.9	0.2
Belgium	2.3	8.9	6.5	1.3	8.1	6.7	1.0	0.8	-0.2
Brazil	-1.9	-1.0	0.9	0.1	0.5	0.4	-2.0	-1.5	0.5
Canada	2.3	11.6	9.1	3.1	12.3	9.0	-1.0	-0.9	0.2
China	-2.7	-3.0	-0.4	-0.7	-1.5	-0.9	-2.0	-1.5	0.5
Czech Republic	-1.2	11.7	13.1	2.5	14.9	12.1	-3.9	-3.1	0.9
Denmark	5.3	38.2	31.2	6.9	40.1	31.1	-2.5	-2.4	0.1
Spain	5.5	12.7	6.8	2.9	10.6	7.6	2.8	2.0	-0.7
Finland	1.6	7.4	5.7	1.3	7.2	5.8	0.3	0.2	-0.1
France	2.5	16.1	13.3	3.3	16.9	13.2	-0.9	-0.8	0.1
United Kingdom	5.3	27.3	20.9	3.6	25.4	21.1	1.8	1.7	-0.1
Greece	14.9	26.7	10.2	7.4	20.8	12.4	8.4	6.1	-2.2
Hungary	10.0	53.0	39.0	9.8	52.7	39.2	-0.7	-0.5	0.2
India	8.7	15.8	6.5	2.8	10.9	8.0	5.7	4.3	-1.3
Ireland	2.2	7.0	4.6	0.4	5.5	5.1	1.9	1.5	-0.5
Italy	2.3	11.4	8.9	3.3	12.4	8.8	-1.1	-1.0	0.1
Japan	-0.1	3.2	3.3	0.4	3.7	3.2	-0.6	-0.4	0.1
Korea	-1.0	-0.4	0.6	-0.1	0.1	0.2	-1.0	-0.5	0.4
Mexico	4.4	12.6	7.9	3.4	11.8	8.2	1.0	0.8	-0.2
Netherlands	2.4	27.2	24.2	6.5	31.8	23.7	-6.4	-5.8	0.6
Poland	14.4	41.7	23.8	11.4	38.7	24.5	3.3	2.7	-0.6
Portugal	12.6	34.8	19.7	9.1	31.7	20.7	4.0	3.0	-1.0
Romania	12.8	41.5	25.4	6.4	35.4	27.2	6.1	4.7	-1.4
Slovakia	4.0	17.6	13.1	3.6	17.3	13.2	0.3	0.2	-0.1
United States	3.7	11.9	8.0	2.2	10.7	8.4	1.6	1.2	-0.4
Average	**4.5**	**17.8**	**12.5**	**3.8**	**17.2**	**12.7**	**0.6**	**0.4**	**-0.2**

Notes: This table reports the predicted change in skill premium and real wages under our baseline calibration. The first panel, "Integration and Imbalances" simulates the model with changes in both domestic expenditure shares, $\hat{\pi}_{ii}^{j}$ and changes in absorption to revenues ratios , $\hat{\lambda}_i^j$. The second panel, "Integration", feeds in the observed changes in domestic expenditure shares, $\hat{\pi}_{ii}^{j}$, while keeping the absorption to revenues ratios constant, $\hat{\lambda}_i^j = 1$. The third panel, "Imbalances", feeds in the observed changes in absorption, $\hat{\lambda}_i^j$, while keeping domestic expenditure shares constant.