NBER WORKING PAPER SERIES

TRADE INDUCED STRUCTURAL CHANGE AND THE SKILL PREMIUM

Javier Cravino
Sebastian Sotelo

Working Paper 23503
http://www.nber.org/papers/w23503

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2017

We thank Rodrigo Adao, Ariel Burstein, Alan Deardorff, Pablo Fajgelbaum, Laurien Gilbert, Sam Kortum, Andrei Levchenko and our discussants Vanessa Alviarez and Marti Mestieri, along with seminar and workshop participants at several institutions for very helpful comments and suggestions. We also thank Sam Haltenhof for superb research assistance. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Trade Induced Structural Change and the Skill Premium
Javier Cravino and Sebastian Sotelo
NBER Working Paper No. 23503
June 2017
JEL No. F16,F62,F63

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.

Javier Cravino
Department of Economics
University of Michigan
611 Tappan Street, Lorch Hall 365B
Ann Arbor, MI 48109
and NBER
jcravino@umich.edu

Sebastian Sotelo
University of Michigan, Ann Arbor
Department of Economics
611 Tappan Ave
Ann Arbor, MI 48109
ssotelo@umich.edu

1 Introduction

What is the impact of international trade on manufacturing employment and wage inequality? Policy makers in developed countries are increasingly concerned that competition from poor countries may be shifting manufacturing jobs overseas and hurting unskilled workers. These concerns are in line with the predictions of the standard Heckscher-Ohlin model, which indicates that, as countries open up to trade, sectors where a country has a comparative advantage will expand at the expense of other sectors, while the skill premium will rise in skilled-labor abundant countries and fall in other countries.[1] Manufacturing employment, however, has been falling both in countries that are net-importers and net-exporters of manufactured goods. Moreover, as noted by Goldberg and Pavcnik (2007), the model's predictions for the skill premium appear 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 manufacturing employment and the skill premium across countries between 1995 and 2007.

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 between 1995 and 2007 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

[1]See Leamer and Levinsohn (1995) for a survey of the early Heckscher-Ohlin literature, 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). Growth in manufacturing trade is akin to growth in manufacturing productivity, as it allows countries to specialize in the production of manufactured goods in which they have a comparative advantage.

(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 complements, the changes in trade patterns between 1995 and 2007 were skill-biased, as they induced reallocation of employment out of unskilled-labor intensive goods and into skilled-labor intensive services (i.e. they induced structural change). 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 imbalances, in a context of heterogeneity in workers' skills. When the elasticity of substitution across sectors is less than one, the goods sector shrinks following 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 net imports in unskilled-labor intensive sectors also increases the skill premium. We highlight that, while the Heckscher-Ohlin mechanism affects the skill premium through sectoral differences in comparative advantage, trade also affects the skill premium in our model through differences in the extent to which goods and services are traded.

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- and unskilled-labor intensive sectors. We build on these results to write changes in sectoral value added shares, employment shares, and the skill premium as functions of changes in sectoral domestic expenditure shares, the ratio of net exports in each sector to economy-wide revenues, 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 the first counterfactual we estimate changes in trade costs between 1995 and 2007 and evaluate how these changes affect employment in the goods sector and the skill premium across countries in our model.[3] We show that, as in the data, the goods sector shrinks in most countries in this counterfactual. The employment share of the goods sector declines by about 8 percent in the average country and by 12 percent in the US, relative to 21 and 25 percent in the data. More importantly, we cannot reject the null hypothesis that the slope of a regression between changes in sectoral employment shares in the data and those in the counterfactual is equal to one, and the same is true when we consider changes in value-added shares. Thus, while the counterfactual misses part of the global decline in the size of the goods sector, the reduction in trade costs substantially contributes to understanding how this decline has differed across countries. The skill premium in this counterfactual increases in almost every country in our sample, by an average of 2.3 percent. Notably, the counterfactual change in the skill premium is larger in developing countries where the goods sector is particularly unskilled labor intensive, such as Turkey, Romania, Portugal or Poland. Finally, we provide evidence for the mechanisms in the model by decomposing changes in the share of skilled workers in employment into within-sector skill upgrading and between-sector labor reallocation, and show that the reduction in trade costs is important for understanding how the contribution of each component varies across countries.

The counterfactual described above isolates the effect of changes in trade costs on wages and sectoral employment, and purposely abstracts from other international forces that may affect these variables, such as productivity growth in foreign countries. A limitation of the exercise is that it requires bilateral trade data to be available simultaneously for every country, and this is only available starting in 1995.[4] This is unfortunate, as much of the changes in the skill premium in some developed countries, such as the US, took place during the 1980's. In our second quantitative exercise, we take a sufficient statistic approach to conduct counterfactuals country by country (so that we only need

[3]In particular, we estimate changes in trade costs over this period following Head and Ries (2001) and use the "hat-algebra" approach developed in Dekle, Eaton and Kortum (2008) to evaluate how these changes in trade costs affect the equilibrium of our model.

[4]The main constraint is that service trade data for some of our countries is only available starting in 1995.

data for one country at a time), without having to take a stand on the underlying changes in primitives driving the observed changes in trade patterns. In particular, we change a country's domestic expenditure shares and sectorial net exports from their observed levels in 1995, or an earlier year for countries where data are available, to those observed in 2007, while keeping domestic technologies and factor endowments fixed. This counterfactual measures, to a first-order approximation, how a country's sectoral employment 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, had that country been in autarky.[5] We show that in the US, in response to the observed changes in trade patterns over the 1977-2007 period, the counterfactual generates a 20 percent decline in the employment share of the goods sectors, relative to the 45 percent decline observed in the data. These changes in turn affect the skill premium, which increases by 3.2 percent in the US between 1977 and 2007 and by 3.8 percent in the average country of our sample between 1995 and 2007.

We repeat this last exercise under three alternative calibrations to assess the importance of the features of 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 employment shares and the skill premium are only half as large as in our baseline calibration. Second, we calibrate 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 27 percent smaller on average. Our last alternative calibration extends our baseline model to allow for non-homothetic preferences using the generalized CES aggregator proposed 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.[6]

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). The FCT measures the quantity of a factor of production 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 FCT based measures of the skill premium

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

[6] 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)).

can greatly underestimate the effects of trade on the skill premium.[7] 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 multi-country quantitative general equilibrium models to assess the importance of different channels through which trade affects the skill premium globally. Recent examples of this literature are Parro (2013) and Burstein, Cravino and Vogel (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.[8] 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 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. Fajgelbaum and Redding (2014) study how changes in trade costs affected structural change and spatial patterns of specialization in Argentina at the end of the 19th century. 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 model that allows us to incorporate both trade imbalances and trade costs reductions simultaneously in a setting with arbitrarily many countries.

Finally, 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 sec-

[7]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.

[8]In other 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. Basco and Mestieri (2013) study how asymmetric globalization patterns across sectors affect wage inequality in a North-South economy. Caron, Fally and Markusen (2014) note that differences in skill intensities across goods with different income elasticities coupled with differences in skill endowments across countries can account for the excessive trade among rich countries.

tors 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 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

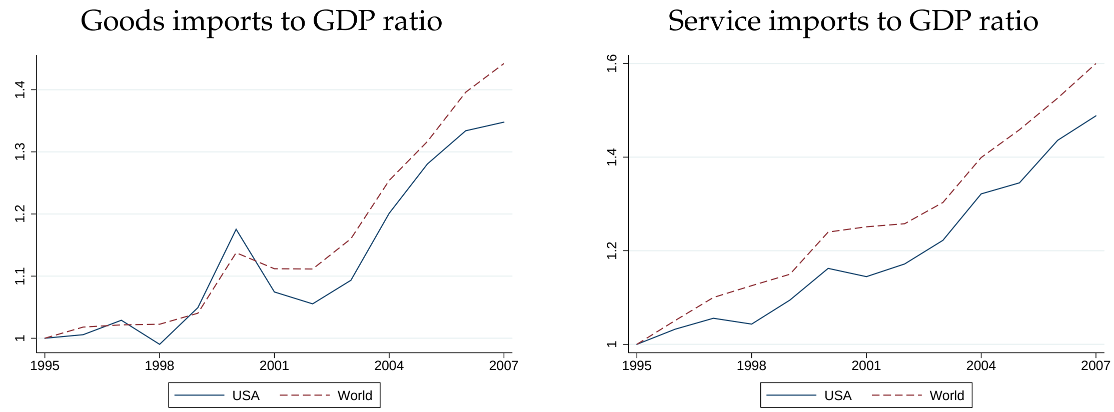
This section documents, for a wide set of countries, three differences across broad sectors that determine the effect of recent changes in trade patterns on real wages and the skill premium. First, we show that the share of expenditures on domestically produced goods relative to total absorption of goods 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.[9] Both panels in the figure show the dramatic increase in trade relative to GDP over this period. They also show that imports

[9] 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.

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.

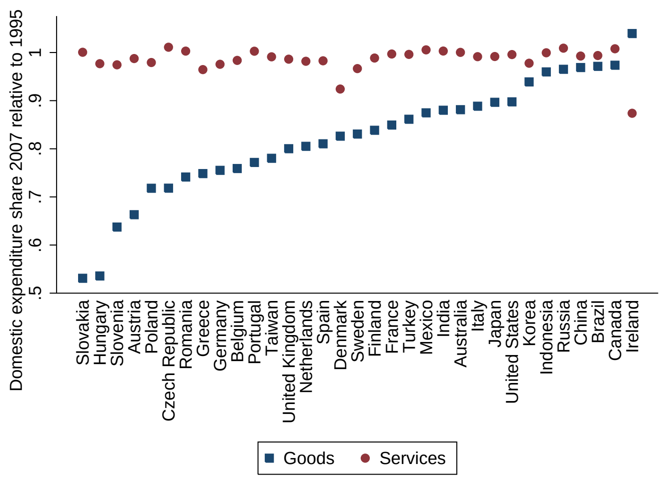
of services have grown slightly faster than imports of goods. For the US, the ratio of service imports to GDP grew about 49 percent, while the ratio of goods imports to GDP only by about 35 percent. Appendix Table A2 shows that this pattern is pervasive for the sample of countries we construct based on 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.[10] Figure 2 reports domestic expenditure shares in 2007 relative to 1995 for the countries in our sample (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 18 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.*

[10]The domestic expenditure share equals one minus the share of imports in total absorption. We focus on changes in domestic expenditure shares because they summarize the effects of trade on relative price movements in our model. This is a feature shared by most workhorse trade models (see Arkolakis, Costinot and Rodriguez-Clare, 2012).

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.

2.2 Sectoral trade patterns and skill intensities

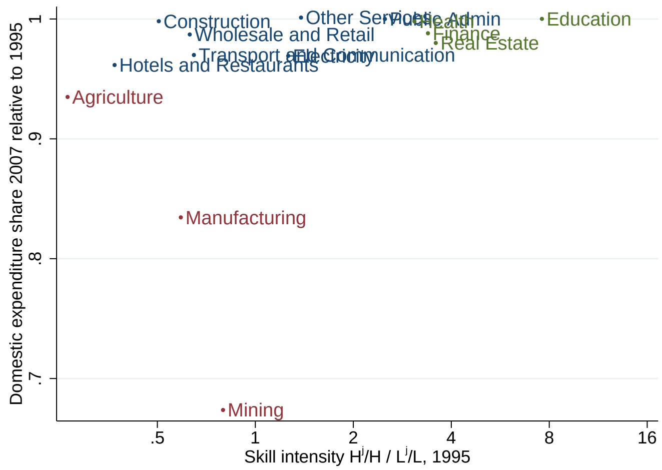
We now report how skill intensities vary across broad sectors using data on employment and educational attainment by sector from the WIOD Socio Economic Accounts. We classify workers with complete college education as skilled workers, and workers that have not completed college as unskilled workers.[11] 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.[12]

Figure 3 plots the average skill intensities and the 1995-2007 changes in domestic expenditure shares in each one-digit ISIC Rev. 3 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 and Retail), while some are skilled-labor intensive (such as FIRE and Education). Appendix Figure A.2 shows that this pattern is pervasive across countries. We summarize these findings in the following observation:

[11] WIOD Socio Economic Accounts 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.

[12] 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 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. Source: WIOD.

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 sectors are unskilled-labor intensive, $L^j_i/H^j_i > L_i/H_i$.*

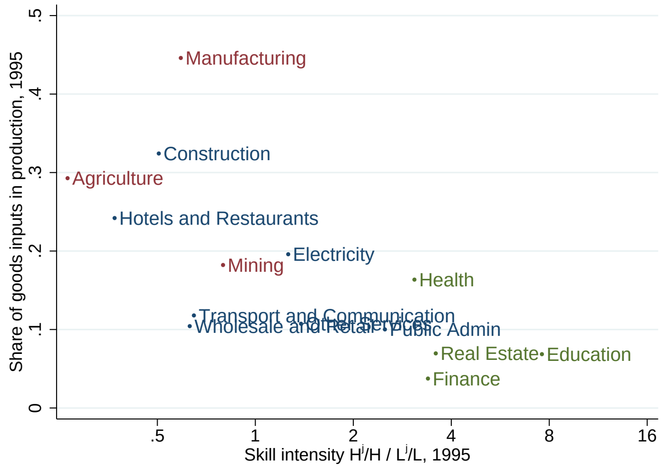
2.3 Skill intensities and intermediate input shares

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. 3 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 fewer inputs from the goods sector. Appendix Figure A.3 documents the finding across countries, which is summarized in the following observation:

Observation 3 *Unskilled-labor intensive sectors use relatively more intermediate inputs from*

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: WIOD.

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 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 value-added and employment 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. 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.[13] 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 across sectors. The household's budget constraint is given by

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

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:

$$Y_i^j = \prod_{k=1}^{K^j} Y_i^j (k)^{\sigma_i^j(k)}. \tag{2}$$

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

$$Y_i^j = C_i^j + X_i^j, \tag{3}$$

[13] While allowing for 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.

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 $\eta_i^j(k) > 1$,

$$Y_i^j(k) = \left[\int_0^1 q_i^j(\omega,k)^{\frac{\eta_i^j(k)-1}{\eta_i^j(k)}} d\omega \right]^{\frac{\eta_i^j(k)}{\eta_i^j(k)-1}}, \tag{4}$$

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, although the industrial output is not traded.[14]

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

$$q_i^j(\omega,k) \quad = \quad A_i^j(k)\, z_i^j(\omega,k)\, m_i^j(\omega,k)^{1-\beta_i^j}\, e_i^j(\omega,k)^{\beta_i^j}, \tag{5}$$

where

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

and

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

Producers from industry k in sector j combine a bundle of skilled and unskilled workers, $e_i^j(\omega,k)$, 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

[14] We follow most of the quantitative trade literature in assuming that there is no value-added in the production of sectorial and industrial output. An interpretation for why this output is not traded is that the aggregation of intermediate varieties may be done by the households or the firms directly, so that the bundles in equations 2 and (4) are not traded in the market.

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 intermediate variety (ω,k) in 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. The employment bundle 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:

$$c_i^j = \bar{\beta}_i^j \left[p_{v,i}^j\right]^{\beta_i^j} \left[p_{b,i}^j\right]^{1-\beta_i^j},$$

where $\bar{\beta}_i^j$ is a constant, and $p_{v,i}^j$ and $p_{b,i}^j$ 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

$$\pi_{in}^j(k) = \left[\int_0^1 p_n^j(\omega, k)^{1-\eta_n^j(k)} \mathbb{I}_{in}^j(\omega, k) d\omega \right] / P_n^j(k)^{1-\eta_n^j(k)}; \quad (6)$$

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:

$$\pi_{in}^j(k) = \left[\tau_{in}^j(k) c_i^j / A_i^j(k) \right]^{-1/\theta^j(k)} / \sum_{i'} \left[\tau_{i'n}^j(k) c_{i'}^j / A_{i'}^j(k) \right]^{-1/\theta^j(k)}. \quad (7)$$

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 (3). 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 A simplified model to illustrate the mechanism

We start by solving a simplified version of our model to clarify the new mechanisms in the paper. Consider a version of the model with two sectors, goods and services, indexed by G and S, with only one industry in each sector. Assume further that the production of goods uses only low-skilled labor, ($\bar{\mu}^G = 1$, and $\beta^G = 1$) that the production of services uses only high-skilled labor ($\bar{\mu}^S = 0$, and $\beta^S = 1$), and that the parameters θ and $\bar{\phi}$ are constant across sectors. Finally, to underscore that the effects of trade on sectorial value-added shares and the skill-premium can go in the same direction in every country, we focus on the case of symmetric countries are symmetric.[15]

In this version of the model, total compensation to high- and to low-skilled workers equals value-added in the service and the goods sectors respectively. In addition, from balanced trade (which follows from symmetry), and the assumption that there are no intermediate inputs ($\beta^j = 1$), sectorial value-added equals sectorial consumption expenditures. That is:

$$\frac{sH}{wL} = \frac{v^S}{v^G} = \frac{P^S C^S}{P^G C^G} \quad = \quad \left[\frac{P^S}{P^G}\right]^{1-\rho}, \tag{8}$$

where v^j denotes the share of sector j in total value added, and the last equality follows from the demand function associated with (1). As shown in Eaton and Kortum (2002) under our same distributional assumptions, price indices for final goods are proportional to the domestic expenditure shares:

$$P^j \propto \frac{c^j}{A^j} \pi_{ii}^{j\,\theta}.$$

If $\mu^G = 1$, $\mu^S = 0$ and $\beta^j = 1$, relative prices are given by:

$$\frac{P^S}{P^G} = \frac{s}{w} \frac{A^G}{A^S} \left[\frac{\pi^S}{\pi^G}\right]^{\theta}, \tag{9}$$

where from the symmetry assumption the domestic expenditure shares depend only on the trade costs, and are given by $\pi^j = \left[1 + [I-1]\left[\tau^j\right]^{-1/\theta}\right]^{-1}$. Equation (9) shows that more trade in goods relative to services ($\pi^G < \pi^S$ or $\tau^G < \tau^S$) results in a lower relative price of goods *in all countries*. Combining equations (8) and (9) we can solve for the skill premium:

$$\frac{s}{w} \quad = \quad \left[\frac{L}{H}\right]^{\frac{1}{\rho}} \left[\frac{A^G}{A^S}\left[\frac{\pi^S}{\pi^G}\right]^{\theta}\right]^{\frac{1-\rho}{\rho}}. \tag{10}$$

Finally, substituting in (8), we can write relative value added shares as:

$$\frac{v^G}{v^S} \quad = \quad \left[\frac{H}{L}\frac{A^S}{A^G}\left[\frac{\pi^G}{\pi^S}\right]^{\theta}\right]^{\frac{1-\rho}{\rho}}. \tag{11}$$

[15]We thus drop the country subscripts in this subsection.

Equations (10) and (11) show that, if goods and services are complements, $\rho < 1$, more trade in goods relative to services ($\pi^G < \pi^S$ or $\tau^G < \tau^S$) is associated with a larger skill premium and a smaller goods sector in terms of value added *in all countries*.[16] The intuition is that more trade in goods reduces goods prices world wide, as shown in equation (9).

3.3 International trade, structural change and the skill premium

We now examine the central forces shaping real wages, the skill premium, and the sectoral composition of value-added and employment in the general model model described in section 3.1, and evaluate what are the key elasticities that determine these forces. We start by relating the skill premium to sectorial value added shares. Competitive factor markets and equation (5) imply that

$$\frac{s_i}{w_i} = \frac{\sum_j \left[1 - \mu_i^j\right] v_i^j}{\sum_j \mu_i^j v_i^j} \frac{L_i}{H_i}, \tag{12}$$

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 v_i^j is the share of sector j in aggregate value-added.[17] From equation (12), 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 value-added shares. Given μ_i^j's, an increase in the size of the skilled labor intensive sectors (i.e. an increase in v_i^j in sectors where μ_i^j is low) increases the skill premium.

Changes in the skill premium will in turn affect factor shares μ_i^j's. To better understand these forces we substitute for μ_i^j and take a first-order approximation to equation (12) in Appendix B, which yields:

$$\tilde{s}_i - \tilde{w}_i = \frac{1}{\bar{\gamma}_i}\left[\tilde{L}_i - \tilde{H}_i\right] + \frac{1}{\bar{\gamma}_i}\sum_j \left[\frac{H_i^j}{H_i} - \frac{L_i^j}{L_i}\right] \tilde{v}_i^j, \tag{13}$$

where variables with a tilde denote log changes, and $\bar{\gamma}_i \equiv \gamma\chi_i + [1 - \chi_i] > 0$, 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 (13) 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

[16] In this example, sectoral employment shares do not depend on trade by construction (as by assumption they are determined by H/L). The general model does not impose this restriction.

[17] Formally, $v_i^j \equiv \beta_i^j \sum_n \pi_{in} P_n^j Y_n^j / \sum_j \beta_i^j \sum_n \pi_{in} P_n^j Y_n^j$.

labor intensive sectors grow ($\tilde{v}_i^j > 0$ 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 v_i^j's that increases the skill premium is mitigated by an increase in the share of unskilled labor in value-added, μ_i^j's, while the reverse is true when γ is smaller than 1.

Note that sectoral value-added shares, v_i^j's, are endogenous, and 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 23 equations from which, given changes in these sufficient statistics, changes in sectorial value-added shares and changes 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 sectorial net exports relative to aggregate revenues, $\lambda_i^j \equiv 1 + \frac{NX_i^j}{R_i}$, with $R_i \equiv \sum_j \sum_n \pi_{in} P_n^j Y_n^j$ and $NX_i^j \equiv \sum_n \pi_{in} P_n^j Y_n^j - \sum_n \pi_{ni} P_i^j Y_i^j$, (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. We highlight that this result does not rely on the approximation. We exploit this property of the model when we conduct Counterfactual 2 in Section 5.

3.3.1 Trade and structural change

We now show how changes in prices and sectorial net exports shape changes in value-added 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, $\beta_i^j = 1$, and make the approximation around $\lambda_i^j = 1$ (we relax these assumptions for the quantitive exercises of Section 5, which do not rely on approximations). Appendix B shows that in this case, first-order changes in sectoral value-added shares are given by:

$$\tilde{v}_i^j = [1-\rho]\left[\tilde{P}_i^j - \sum_j v_i^j \tilde{P}_i^j\right] + \frac{\tilde{\lambda}_i^j}{r_i^j} - \sum_j v_i^j \frac{\tilde{\lambda}_i^j}{r_i^j}, \tag{14}$$

where r_i^j denotes the share of sector j in aggregate revenues.[18] The first term in equation (14) captures the effect of price changes on sectoral value-added shares. If the elasticity of substitution across sectors is less than 1 ($\rho < 1$), sector j's value-added share is increasing in its price relative to the price of the other sectors (summarized in $\sum_j v_i^j \tilde{P}_i^j$). The second term captures the effect of changes in sectoral trade deficits or surpluses. Other things equal, an increase in a sector's net exports relative to aggregate revenues ($\tilde{\lambda}_i^j > 0$) increases the sector's share in value-added.

3.3.2 Trade, the skill premium and real wages

This section provides a first-order approximation for how changes in factor supplies, domestic expenditure shares, and sectorial net exports affect the skill premium. We continue to abstract from intermediate inputs ($\beta_i^j = 1$) and to approximate our results around $\lambda_i^j = 1$ to facilitate exposition. The change in the skill premium is given by:

$$\tilde{s}_i - \tilde{w}_i = \frac{1}{\Gamma_i}\left[\tilde{L}_i - \tilde{H}_i\right] + \sum_j \xi_{\pi,i}^j \left[\tilde{\pi}_{ii}^j - \tilde{A}_i^j\right] + \sum_j \xi_{\lambda,i}^j \tilde{\lambda}_i^j, \tag{15}$$

where $\Gamma_i \equiv \chi_i\gamma + [1-\chi_i]\,\rho$ is the aggregate elasticity of substitution between skilled- and unskilled labor,[19] and the elasticities are given by $\xi_{\pi,i}^j \equiv \frac{1-\rho}{\Gamma_i}\left[\frac{H_i^j}{H_i} - \frac{L_i^j}{L_i}\right]$ and $\xi_{\lambda,i}^j = \frac{1}{r_i^j\Gamma_i}\left[\frac{H_i^j}{H_i} - \frac{L_i^j}{L_i}\right] = \frac{\xi_{\pi,i}^j}{r_i^j[1-\rho]}$.

Equation (15) 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 (13). All else equal, an increase in the relative supply of skilled labor reduces the skill premium with an elasticity of $1/\Gamma_i$. The last two terms show how changes in trade patterns affect the skill premium.

[18]That is, $r_i^j \equiv \sum_n \pi_{in} P_n^j Y_n^j / \sum_j \sum_n \pi_{in} P_n^j Y_n^j$.

[19]That is, $\Gamma_i \equiv -\frac{dlog[H_i/L_i]}{dlog[s_i/w_i]}$. 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.

If there are no differences in skill intensities across sectors, $\frac{H_i^j}{H_i} = \frac{L_i^j}{L_i}$, then $\xi_{\pi,i}^j = \xi_{\lambda,i}^j = 0$. In this case the skill premium is not affected by trade. More generally, the elasticity $\xi_{\pi,i}^j$ is positive if $\frac{H_i^j}{H_i} < \frac{L_i^j}{L_i}$ and $\rho < 1$. In this case, increased trade in unskilled-labor intensive sectors (i.e. a decline in the domestic expenditure share π_{ii}^j in these sectors) results in an increase in the skill premium. Finally, the last term in equation (15) shows how changes in sectoral deficits affect sectoral revenue shares directly and indirectly, as explained in equation (14) above. It shows that a decline in net exports in low skill intensive sectors (that is, $\tilde{\lambda}_i^j < 0$ in sectors where $\frac{H_i^j}{H_i} < \frac{L_i^j}{L_i}$) increases the skill premium.

Real wages We now show how changes in domestic expenditure shares and sectorial net exports 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:

$$\tilde{s}_i - \tilde{P}_i^C = \frac{\mu_i}{\Gamma_i}\left[\tilde{L}_i - \tilde{H}_i\right] + \sum_j \left[\mu_i \xi_{\pi,i}^j - \phi_i^j\right]\left[\tilde{\pi}_{ii}^j - \tilde{A}_i^j\right] + \mu_i \sum_j \xi_{\lambda,i}^j \tilde{\lambda}_i^j \tag{16}$$

$$\tilde{w}_i - \tilde{P}_i^C = \frac{\mu_i - 1}{\Gamma_i}\left[\tilde{L}_i - \tilde{H}_i\right] + \sum_j \left[\mu_i \xi_{\pi,i}^j - \xi_{\pi,i}^j - \phi_i^j\right]\left[\tilde{\pi}_{ii}^j - \tilde{A}_i^j\right] + \left[\mu_i - 1\right] \sum_j \xi_{\lambda,i}^j \tilde{\lambda}_i^j \tag{17}$$

where $\phi_i^j \equiv \frac{P_i^j C_i^j}{\sum_j P_i^j C_i^j}$ is the share of sector j in total consumption. Equations (16) and (17) show how real wages respond to small changes in trade patterns 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 $\xi_{\pi,i}^G < 0$ 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 $\mu_i \xi_{i,\pi}^G - \phi_i^G < 0$, but may increase or decrease for unskilled workers, depending on whether $\mu_i \xi_{i,\pi}^G - \phi_i^G < \xi_{i,\pi}^G$. In contrast, a decline in the ratio of net exports to revenues 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.

3.3.3 Trade and structural change

We conclude this section by relating changes in employment and value-added shares across sectors to changes in trade patters. Appendix B shows that, to a first order approximation, changes in sectorial value-added shares can be written as:

$$\begin{aligned}\tilde{v}_i^j &= [1-\rho]\left[\left[\tilde{\pi}_{ii}^j - \tilde{A}_i^j\right] - \sum_l v_i^l \left[\tilde{\pi}_{ii}^l - \tilde{A}_i^l\right]\right] + \frac{\tilde{\lambda}_i^j}{r_i^j} - \sum_l v_i^l \frac{\tilde{\lambda}_i^j}{r_i^l} \\ &+ [1-\rho]\left[\mu_i - \mu_i^j\right][\tilde{s}_i - \tilde{w}_i]. \end{aligned} \tag{18}$$

In addition, changes in sectorial employment shares are given by:

$$\begin{aligned}\tilde{\omega}_{E,i}^j = [1-\rho]\left[\left[\tilde{\pi}_{ii}^j - \tilde{A}_i^j\right] - \sum_l \omega_{E,i}^l \left[\tilde{\pi}_{ii}^l - \tilde{A}_i^l\right]\right] + \frac{\tilde{\lambda}_i^j}{r_i^j} - \sum_l \omega_{E,i}^l \frac{\tilde{\lambda}_i^l}{r_i^l} \\ + \left[\left[\mu_i^j - \sum_l \omega_{E,i}^l \mu_i^l\right][\rho-\gamma] + \left[\frac{L_i^j}{L_i^j + H_i^j} - \sum_l \omega_{E,i}^l \frac{L_i^l}{L_i^l + H_i^l}\right]\gamma\right][\tilde{s}_i - \tilde{w}_i]. \end{aligned} \tag{19}$$

Equations (18) and (19) state that, if ρ is less than one, sectorial value-added and employment shares are increasing in the sector's domestic expenditure shares and decreasing in the sector's productivity. In addition, sectorial shares are increasing the sectorial net exports, summarize in λ_i^j. 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 (15) 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 net exports to total revenue 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. Our main sample combines input-output data from the WIOD with data on employment and compensations from the WIOD Socio Economic Accounts. We follow Costinot and Rodriguez-clare (2014) and include seven small economies in WIOD into the "Rest of the World" category, so that we are left with a sample of 34 countries.[20] While WIOD data covers the 1995-2011 period, we mainly focus on the 1995-2007 to exclude the great trade collapse and the great recession from our sample.[21] We classify the sectors of the IO 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).[22] Within sector G industries k correspond to the most disaggregated industrial classification available in WIOD (see Table A1).

Trade data We use the IO tables to compute bilateral trade shares and the ratios of sectorial net exports to aggregate revenue ratio. 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. To calculate the net export to revenue ratios, λ_i^j, we measure revenues as gross output, and net exports at the level of the broad sector j.

4.2 Parameterization

According to equations (A.18)-(A.23), 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 of inputs from each sector that are used in the sectoral input bundles, α_i^{lj}, (vi) the trade elasticities $\theta^j(k)$, (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.[23]

[20]Following Costinot and Rodriguez-clare (2014), we include Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Luxembourg, and Malta in the expanded ROW category.

[21]We exclude the trade collapse and the recession as the model is not designed to measure how high frequency shocks affect labor market outcomes.

[22]That is, Utilities, Construction, Wholesale and Retail Trade, Hotels and Restaurants, Transport and Communications, and Other Community, Social and Personal Services.

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

Factor and input shares We follow the skill classification described in Section 2 and use data from WIOD Socio Economic Accounts 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, as the ratio of labor compensation to unskilled workers relative to total labor compensation. We use data from IO tables (WIOD) 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, also using 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) (see 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.[24] First, while the structural transformation literature typically breaks sectors into agriculture, manufacturing and services, the sectoral breakdown in our model is across goods, low-skilled services, and high-skilled services. Second, while the elasticity is typically estimated from consumption data, the parameter ρ in our model simultaneously governs the elasticity of substitution in the consumption- and in the input-bundles. Finally, the definition of consumption expenditures $P_i^jC_i^j$ 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

[24] 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 Leontief 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.

in Herrendorf, Rogerson and Valentinyi (2013) and Comin, Lashkari and Mestieri (2015). For our baseline estimation, we allow for non-homotheticities in consumption demand using a generalized CES aggregator, as in Comin, Lashkari and Mestieri (2015).[25] In particular, Appendix F derives the following demand system:

$$log\left(\frac{P_i^j C_i^j}{P_i^{j'} C_i^{j'}}\right) = log\left(\frac{\bar{\phi}_i^j}{\bar{\phi}_i^{j'}}\right) + (1-\rho)\, log\left(\frac{P_i^j}{P_i^{j'}}\right) + \left(\epsilon^j - \epsilon^{j'}\right) logC_i, \tag{20}$$

$$log\left(\frac{P_i^j x_i^{jl}}{P_i^{j'} x_i^{j'l}}\right) = log\left(\frac{\bar{\alpha}_i^{jl}}{\bar{\alpha}_i^{j'l}}\right) + (1-\rho)\, log\left(\frac{P_i^j}{P_i^{j'}}\right). \tag{21}$$

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 consumption expenditures in our model, $P_i^j C_i^j$.[26] 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

[25]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-homotheticities without loss of generality. Our model can be easily extended to allow for non-homotheticities 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-homotheticities does not affect our main results.

[26]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.

by the BEA.

Figure A.4 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 (20) and (21) for $l = S, G, F$ using iterated feasible generalized nonlinear least square estimation, as Herrendorf, Rogerson and Valentinyi (2013). To constrain the elasticity of substitution to be positive, we make the 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 using the consumption bundle and of roughly 0 when estimated using 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 Leontief 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.

5 Quantitative results

This section quantifies how international trade affects sectorial employment, value-added, real wages and the skill premium in our model. We conduct two counterfactual exercises to measure these effects, compare the implications of the model to the data, provide evidence of the mechanisms in the paper, and show how our quantitative results change under alternative parameterizations. 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: Changes in trade costs between 1995 and 2007

Our first counterfactual directly evaluates the effect of changes in trade costs between 1995 and 2007 on the sectorial composition of the economy and on the skill premium across countries. We begin by measuring changes in bilateral trade costs from changes in bilateral expenditure shares, following the approach in Head and Ries (2001). In particular, we use equation (7) to write the change in trade costs between two periods as

$$\hat{\tau}_{ni}^{j}(k)\,\hat{\tau}_{in}^{j}(k)=\left[\frac{\hat{\pi}_{in}^{j}(k)\,\hat{\pi}_{ni}^{j}(k)}{\hat{\pi}_{nn}^{j}(k)\,\hat{\pi}_{ii}^{j}(k)}\right]^{-\theta^{j}(k)},\tag{22}$$

where a hat over a variable denotes the ratio of the variable between the final and initial year, that is, $\hat{x}\equiv\frac{x_1}{x_0}$. Assuming symmetric trade costs, $\hat{\tau}_{ni}^{j}(k)=\hat{\tau}_{in}^{j}(k)$, and given values for the trade elasticities $\theta^{j}(k)$, we use equation (22) to estimate the changes in trade costs from observed changes in bilateral trade patterns, $\hat{\pi}_{ni}^{j}(k)$. We then follow the "exact hat algebra" approach in Dekle, Eaton and Kortum (2008) to compute the equilibrium response to these changes in trade costs.[27]

5.1.1 Changes in trade shares

We begin by reporting how domestic expenditure shares π_{ii}^{j} change in response to the changes in trade costs we estimate. Figure 5 shows that the counterfactual changes in domestic expenditure shares line up well with those observed in the 1995-2007 data. In the goods sector, regressing the changes in expenditure shares in the data on those generated by the counterfactual generates an R-squared of 0.8 and a slope that is close to 1. The changes in trade costs also do a good job in accounting for the observed changes in domestic expenditure shares in the service sectors for most countries, with the notable exceptions of Hungary and Slovakia, where expenditure shares decline dramatically in the counterfactual equilibrium but increase in the data. We show below that our results are not driven by these two countries. Crucially, in the counterfactual equilibrium as in the data, the decline in domestic expenditure shares is much larger in the goods sector than in the services sectors for all countries with the exception of Ireland.

5.1.2 Structural change

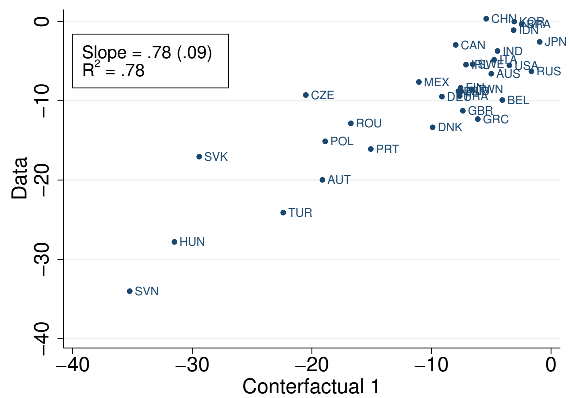
Figures 6 and 7 compare the counterfactual changes in value-added and employment shares to those observed in the data.[28] As explained in Section 3.3, the declines in do-

[27] Appendix A.3 characterizes the changes in the equilibrium of our model as a function of changes in the model's fundamentals (trade cost, endowments, productivities and transfers). Counterfactual 1 is computed by feeding in the changes in trade costs implied by equation (22), and keeping the other fundamentals fixed.

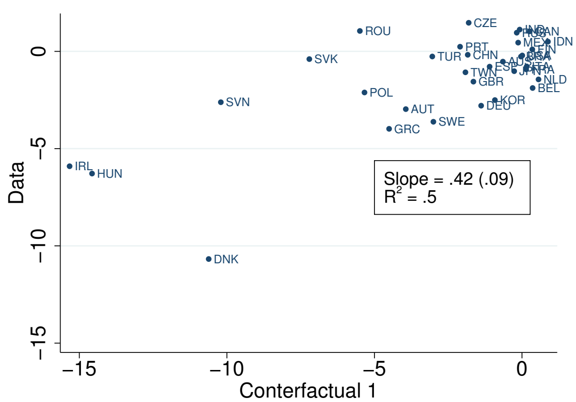
[28] The exact numbers behind this figure are listed in Appendix Table A8.

Figure 5: Changes in domestic expenditure shares, Counterfactual 1

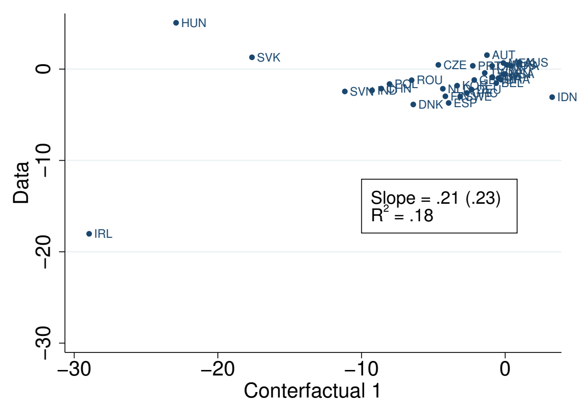
(a) Goods



(b) Unskilled-labor intensive services



(c) Skilled-labor intensive services



Notes: The figure reports the percent change in the domestic expenditure shares in Counterfactual 1 on the x-axis, and the percent change in domestic expenditure shares between 1995-2007 in the WIOD data on the y-axis.

mestic expenditure shares in the goods sector reported in Figure 5 lead to a decline of the goods sector relative to the service sectors. As a result, the counterfactual share of the goods sector in value-added falls in most countries, by 8.5 percent in the average country, and by 12.3 percent in the US. Likewise, the counterfactual share of employment in the goods sector also declines in most countries, by an average of 8.2 percent. The figures reveal a great deal of heterogeneity in these counterfactual changes across sectors and countries, ranging from -20 to 5 percent for goods, and from about -10 to 20 in skilled-labor intensive services. In most countries, skilled-labor intensive services expand faster than unskilled-labor intensive services, because in the model, as in the data, the later uses relatively more intermediate inputs from the goods sector.

Figures 6 and 7 show that, as in the data, the goods sector shrinks in most countries, although the contraction in the data is larger. This is not surprising given that the counterfactual abstracts from other forces that could have generated structural change, such as productivity growth in the goods sector (see equations 18 and 19). More importantly, there is a statistically significant relation between the changes in the counterfactual and those in the data, and we cannot reject the null hypothesis that the slope of a regression between the observed and counterfactual changes in value-added shares is equal to one (this is also true when we consider changes in employment shares). Thus, while the counterfactual misses part of the global decline in employment in the goods sector (which could be attributed to global changes in productivity, A^G), the reduction in trade costs substantially contributes to understanding how the goods-sector decline has differed across countries.[29] Note that an important fraction of the heterogeneity is not captured by the changes in trade costs, reflecting the reality that countries differ along multiple dimensions in addition to the ones emphasized in the counterfactual (such as country-specific changes in productivity, $\tilde{A}_i^j$). Appendix Figure A.1 shows that the model can also account for the global decline in employment in the goods sector in a counterfactual where we change both trade costs and global productivity in the goods sector, A^G, where the change in global productivity is calibrated to match the decline in the goods sector employment share in the US (see Appendix G).

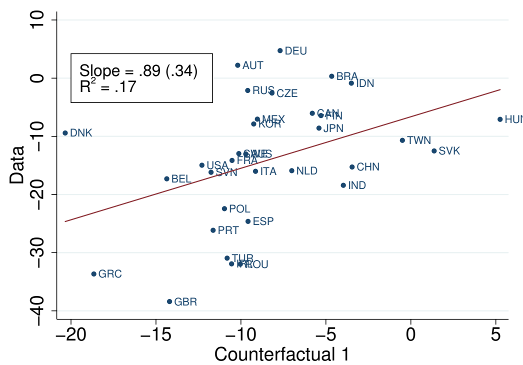
5.1.3 Changes in net exports vs price effects

As discussed in Section 3.3, changes in trade costs affect the equilibrium both through domestic expenditure shares, π_{ii}^j's, and through sectorial net exports, λ_i^j's. In this section

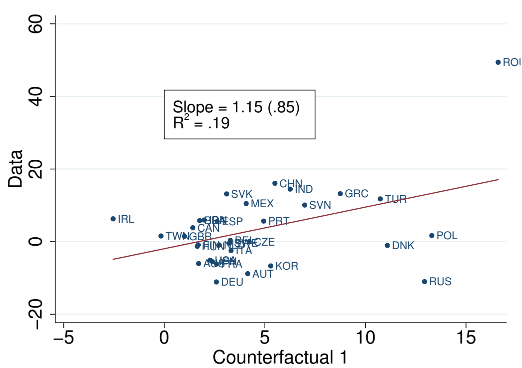
[29]These findings are robust to excluding Hungary and Slovakia from the sample, countries for which our trade costs estimates imply a large counterfactual decline in the domestic expenditure share in skilled services.

Figure 6: Changes in sectorial value-added shares, Counterfactual 1

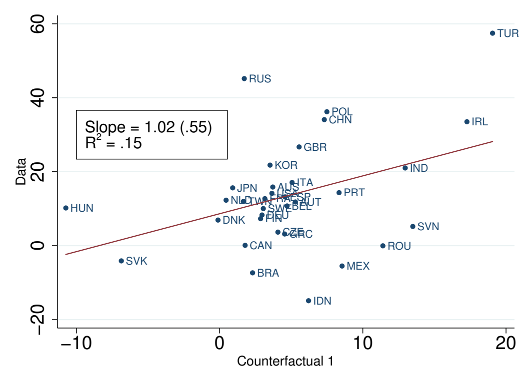
(a) Goods



(b) Unskilled-labor intensive services



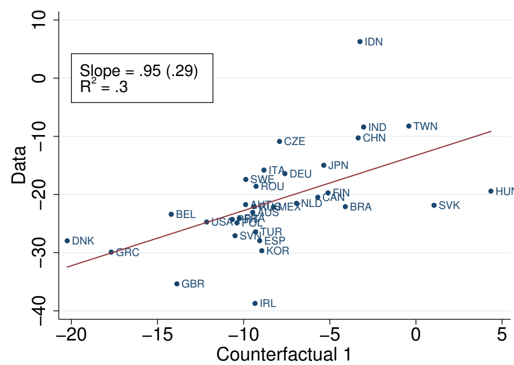
(c) Skilled-labor intensive services



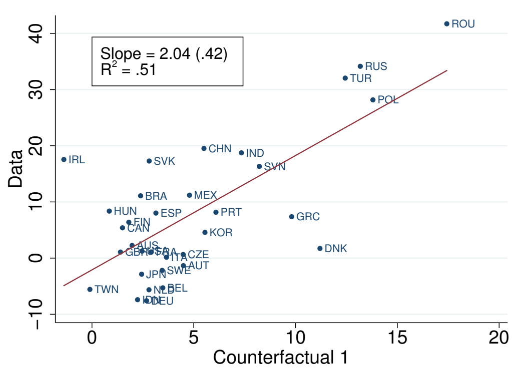
Notes: The x-axis shows the percent change in the sector's share of value-added in Counterfactual 1. The y-axis shows the percent change in the sector's share of value-added between 1995-2007 in the WIOD data.

Figure 7: Changes in sectorial employment shares, Counterfactual 1

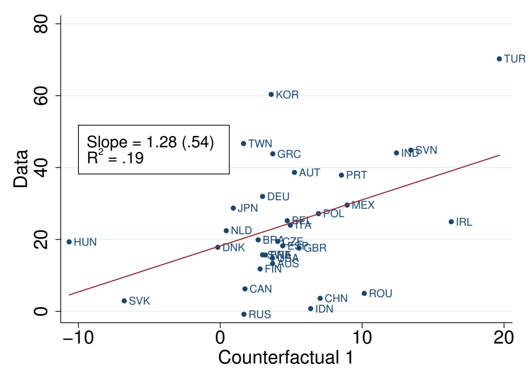
(a) Goods



(b) Unskilled-labor intensive services



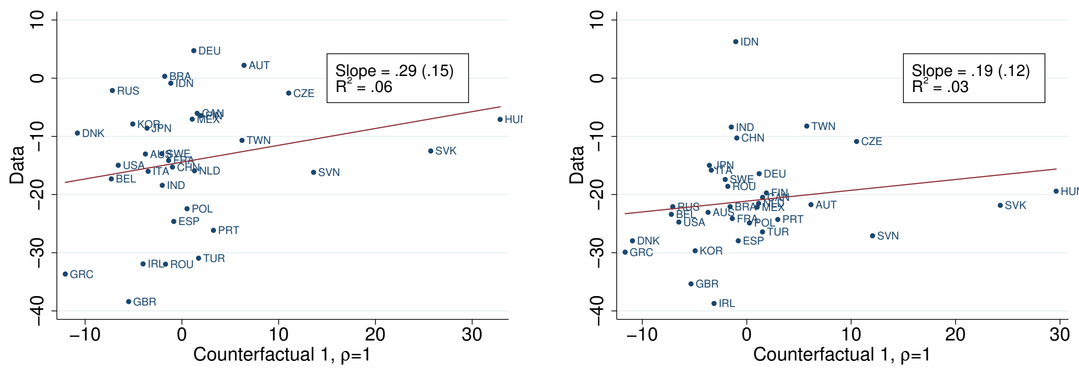
(c) Skilled-labor intensive services



Notes: The x-axis shows the percent change in the sector's share in employment in Counterfactual 1. The y-axis reports the percent change in the sector's share in employment between 1995-2007 in the WIOD data.

Figure 8: Counterfactual change in the goods sector share in value-added and employment, with no price effects

(a) Value-Added (b) Employment



Notes: The x-axes reports the percent change in the goods sector's share in value-added and employment in a version of Counterfactual 1 where we set $\rho = 1$. The y-axes report the percent change in the goods sector share in value-added and employment between 1995-2007 in the WIOD data.

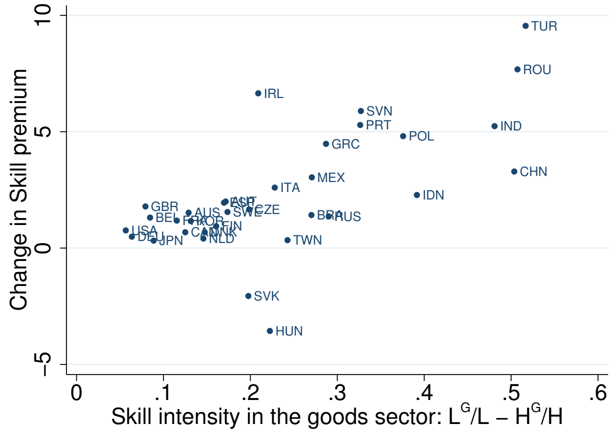
we disentangle the contribution of these two effects to the results presented above. To do so, we re-compute Counterfactual 1 in a calibration where the elasticity of substitution across sectors is set to $\rho = 1$, so that sectorial absorption shares are constant. As noted in equations (18) and (19), in this case trade only affects value-added and employment shares through sectorial net exports, summarized in λ_i^j.

Figure 8 presents the counterfactual changes in the share of the goods sector in value-added and employment in this calibration. The goods sector grows for about half of the countries: on average it increases by 1.1 percent in terms of its share in value-added, and by 0.9 percent in terms of its share in employment. This stands in contrast to the results in Figures 6 and 7, where the goods sector shrinks in most countries. In addition, both the slope and the R-squared of the regression between the counterfactual predictions and the data fall dramatically relative to the baseline calibration. We conclude that price effects play an important role in shaping how the sectorial composition of the economy is affected by trade.

5.1.4 Changes in the skill premium and within-sector skill-upgrading

Figure 9 and Table A9 present the changes in the skill premium and real wages in Counterfactual 1. The figure relates the counterfactual change in the skill premium, $\frac{\hat{s}_i}{\hat{w}_i}$, to the skill intensity in the goods sector in each country, measured by $\frac{L_i^G}{L_i} - \frac{H_i^G}{H_i}$. The reduction in trade costs increases the skill premium for almost all countries in the sample, by an aver-

Figure 9: Change in the skill premium, Counterfactual 1



Notes: The figure reports the percent change in the skill premium in Counterfactual 1 in the y-axis, and the relative skill intensity of the goods sector, given by $\frac{L_i^G}{L_i} - \frac{H_i^G}{H_i}$, in 1995 on the x-axis.

age of 3.2 percent. The notable exceptions are Slovakia and Hungary, countries for which the high-skill intensive sector shrinks in the counterfactual equilibrium. The change in the skill premium is especially large in developing countries where the goods sector is particularly unskilled-labor intensive, such as Turkey, Romania, Portugal or Poland. In the US, the counterfactual generates a modest increase in the skill premium of 0.8 percent. Columns 2 and 3 in first panel of Table A9 report the predicted changes in real wages for skilled and unskilled workers in this Counterfactual. Note that, while in most countries the counterfactual skill premium increases, unskilled workers gain from the reduction in trade costs in all countries.

To understand the size of the change of the skill premium in this counterfactual, consider equation (15) 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 9 reflects this result, showing that skill intensity in 1995 is positively correlated with the counterfactual changes in the skill premium. Since by 1995 the fraction of both types of workers in the goods sectors was already very small in most developed countries, the decline of the goods sector on wages in those countries has a limited effect. Unfortunately, we cannot extend this counterfactual back in time, since bilateral data on service trade for many of our countries is only available starting in 1995. In the next section, we build on the theoretical results from Section 3 and take a sufficient statistic approach for measuring the effects of trade on the skill premium.

5.1.5 Inspecting the mechanisms: within-sector skill upgrading vs between-sector reallocation

We conclude this section by providing additional evidence on the mechanisms through which changes in trade patterns affect the skill premium in the model. As in the Heckscher-Ohlin model, trade affects the skill premium in our model by inducing reallocation of labor from unskilled labor intensive sectors to skilled labor intensive sectors. If trade were the only driver of the observed changes in the skill premium, we should expect to see labor reallocating from unskilled labor intensive sectors to skilled labor intensive sectors, coupled skill downgrading within each sector (due to the rise in the skill premium). A large and influential literature has measured the extent of within-sector skill upgrading and between-sector factor reallocation and argued that, since most of the shift in demand for skilled labor is accounted for by within sector skill upgrading, the increase in the skill premium is likely to be driven by skill biased technical change.[30] While this view is consistent with a version of our model that incorporates global skill biased technical change, we ask instead: can trade account for the observed differences in within-sector skill upgrading across countries? The answer speaks directly to our mechanism, since the model predicts that, other things equal, between reallocation should be larger the larger the change in trade costs in the goods sector (and hence the contribution of within skill upgrading should be smaller).

With this objective in mind, we decompose changes in the share of skilled labor in employment, $H_{E,i} \equiv \frac{H_i}{H_i+L_i}$, into changes in skilled labor shares within each industry, $H^j_{E,i} \equiv \frac{H^j_i}{H^j_i+L^j_i}$, and changes in employment shares $\omega^j_{E,i}$ between industries. That is:

$$\Delta H_{E,i} = \underbrace{\sum_j \Delta H^j_{E,i} \bar{\omega}^j_{E,i}}_{\text{within}} + \underbrace{\sum_j \Delta \omega^j_{E,i} \bar{H}^j_{E,i}}_{\text{between}}, \tag{23}$$

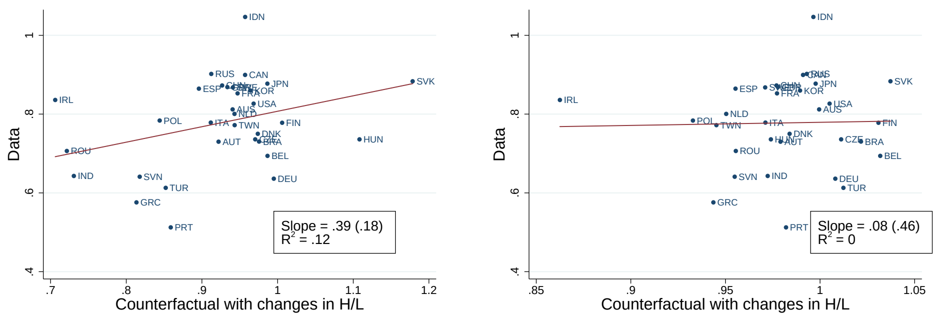
where $\Delta x \equiv x_{t_1} - x_{t_0}$ denotes the change of a variable between periods t_1 and t_0, and $\bar{x} \equiv \frac{x_{t_1}+x_{t_0}}{2}$ is the average value of the variable across periods. We compare the outcomes of this decomposition in the data and in a version of the counterfactual that incorporates changes in factor supplies.

Figure 10 shows the contribution of within-sector reallocation to the change in the

[30] See e.g. Berman, Bound and Griliches (1994), Attanasio, Goldberg and Pavcnik (2004) and Haltiwanger et al. (2004).

Figure 10: Contribution of within sector skill upgrading to changes in the high skilled labor demand

(a) With changes in trade costs (b) Without changes in trade costs



Notes: The first panel reports the observed within contribution, defined in footnote 31 in the y-axis, and the within contribution in a counterfactual that incorporates changes in labor supplies and changes in trade costs in the x-axis. The second panel reports the observed within contribution in the y-axis, and the within contribution in a counterfactual that incorporates changes in labor supplies and but does not incorporate changes in trade costs in the x-axis.

skilled share of total employment.[31] The first panel of the figure shows a positive relation between the contribution of within-sector skill upgrading in the counterfactual and in the data. The second panel shows that, if we simulate the model without changes in trade costs, the correlation between the counterfactual and the data falls dramatically. We conclude that reductions in trade costs are an important factor in accounting for the cross-country variation in the contribution of within-sector skill upgrading.

5.2 Counterfactual 2: Using observed changes in trade patterns as sufficient statistics

Our second counterfactual uses the analytical results from Section 3 and equations (A.18)-(A.23) in the Appendix to calculate how the skill premium and sectoral value-added and employment shares change in response to a given change in domestic expenditure shares and changes in sectorial net exports, $\hat{\pi}^j_{ii}$ and $\hat{\lambda}^j_i$. We conduct this counterfactual country

[31] We define the contribution of within-sector reallocation as the first term in the following expression:

$$1 = \underbrace{\frac{\sum_j \Delta H^j_{E,i} \bar{\omega}^j_{E,i}}{\Delta H_{E,i}}}_{\text{within contribution}} + \underbrace{\frac{\sum_j \Delta \omega^j_{E,i} \bar{H}^j_{E,i}}{\Delta H_{E,i}}}_{\text{between contribution}},$$

which we obtain by dividing both sides of decomposition (23) by the total change in the skill labor share. For this exercise, we simulate changes in the factors supplies along with changes in trade costs, and compute the contribution of within and between reallocation in the model and in the data.

by country, using observed changes in $\hat{\pi}_{ii}^{j}$ and $\hat{\lambda}_{i}^{j}$ between 1995 and 2007. 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 allows us to explore a broader notion of the impact of trade on structural change and the skill premium, as well as to extend time period for a subset of countries for which data on services trade is available prior to 1995.

A disadvantage of this counterfactual relative to our first exercise is that changes in $\hat{\pi}_{ii}^{j}$ and $\hat{\lambda}_{i}^{j}$ depend not only on international factors, but also potentially depend on changes domestic fundamentals. We note however that this 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.[32] 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, $\left\{\tilde{\pi}_{ii}^{j}\right\}$, sectorial net-exports, $\left\{\tilde{\lambda}_i^j\right\}$, sectoral value-added shares $\left\{\tilde{v}_i^j\right\}$, 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 $\left\{\tilde{v}_i^{A,j},\ \tilde{s}_i^A,\ \tilde{w}_i^A,\ \tilde{P}_i^{A,j}\right\}$. 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

$$\widetilde{s_i/w_i} - \widetilde{s_i^A/w_i^A} \quad = \quad \sum_j \xi_{i,\pi}^j \tilde{\pi}_{ii}^j + \sum_j \xi_{i,\lambda}^j \tilde{\lambda}_i^j. \tag{24}$$

Equation (24) 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 closed economy? From equation (24), 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. Table A4 presents the changes in $\pi_{ii}^G$and λ_i^G used to conduct this quantitative exercise.

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

Figure 11: Trade and structural change, Counterfactual 2

(a) Value-added (b) Employment

Notes: The figures report the percent change in the share of value-added and employment in the goods sector in Counterfactual 2. 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 value-added and employment shares, $\hat{\vartheta}_{i}^{G}$ and $\hat{\omega}_{i,E}^{j}$.

5.2.1 Observed changes in trade patterns, structural change and the skill premium

We start by showing the results of the counterfactual when we use the changes in $\hat{\pi}_{ii}^{j}$ and $\hat{\lambda}_{i}^{j}$ we observe between 1995 and 2007 for each country. The predictions of the second counterfactual in response to the changes in π_{ii}^{j} and λ_{i}^{j} are summarized in Figure 11. Dots in the figure relate the counterfactual changes in sectoral value-added shares, $\hat{\vartheta}_{i}^{j}$, to the counterfactual changes in the domestic expenditure shares in the goods sector. For the average country in our sample, the counterfactual share of the goods sector in value-added declines by approximately a 10 percent. Larger declines in the domestic expenditure shares in the goods sector are associated with larger declines of the size of the goods sector. 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.

The counterfactual changes in the skill premium are summarized in Figure 12. For the average country in our sample, the model generates a 3.8 percent 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, Turkey and Slovenia. The change in the skill premium is especially large in developing countries where the good producing sectors are particularly unskilled labor intensive, with the exception of China and Indonesia, where domestic expenditure shares are constant or mildly increase. For most countries, international factors summarized in these changes either increased the skill premium or had a negligible effect on it. For the skill premium, these changes are larger on average than those in the first counterfactual. For

Figure 12: Change in the skill premium, Counterfactual 2

Notes: The figure reports the percent change in the skill premium in Counterfactual 2 in the y-axis, and the relative skill intensity of the goods sector, given by $\frac{L_i^G}{L_i} - \frac{H_i^G}{H_i}$, in 1995.

structural change, the difference depends on the country. The reason is that this counterfactual takes into account all the effects of changes in trade patterns, rather than focusing on those that arise from changes in trade costs. For example, even with constant trade costs, cross-country changes in productivity can increase or decrease net exports. In the next section, we further extend this exercise to go back in time for countries in which data on both IO tables and employment shares are available.

5.2.2 Trade patterns, structural change and the skill premium over longer horizons

We conclude this section by extending the second counterfactual to go further back in time.[33] Given the large reallocation of activity away from the goods sectors in developed countries in the decades before 1995 (e.g. in the US and the UK), our previous exercise might underestimate the role that trade has played in those countries. With the sufficient statistic approach, we can conduct the second counterfactual for individual countries for which the required data are available.

Table 1 reports the results of this exercise. Not surprisingly, for these countries, the decline in domestic expenditure shares is larger over this longer period. As a consequence the associated decline in value-added and employment shares in the goods sector are

[33]We bring in Input-Output data from the OECD, for which the start year ranges from 1977 to 1990, depending on the country. We combine it with data on employment and compensation from KLEMS. We process these data in the same way as described in Section 4. Only 6 countries contain data from both sources.

Table 1: Percent changes in trade patterns, structural change and the skill premium, 1977-2007

Country	Initial Year	Domestic Expenditure share	Value added share	Employment share	Skill Premium	Gains from trade ratio
Australia	1986	-6.32	1.78	1.83	0.49	1.10
Canada	1981	-22.22	-15.61	-15.22	4.38	1.31
Denmark	1980	-30.71	-25.53	-25.26	6.89	1.26
Great Britain	1979	-20.10	-23.89	-23.54	6.59	1.38
Italy	1985	-7.80	-0.77	-0.67	2.02	1.25
Japan	1980	-2.58	1.35	1.33	-0.09	0.97
Netherlands	1981	-34.54	-20.18	-19.75	6.61	1.27
United States	1977	-10.80	-20.09	-19.65	3.14	1.45

Notes: The table reports counterfactual change in Counterfactual 2, starting as indicated in the column "Initial Year". The first three columns refer to the goods-producing sector.

larger than those in Figure 11. In the US, the manufacturing employment share declines by 20 percent in this counterfactual, relative to the 45 percent that we see over this period. In addition, since for these countries the share of employment in the goods sector was larger at the beginning of this sample than in 1995, the elasticity of the skill premium with respect to changes in domestic expenditure shares in the goods sector is larger than in the previous counterfactual (see equation 15). Therefore, the associated increase in the skill-premium is also larger for all countries. Although the increase of 3.1 percent in the US skill premium over this period is now is much larger than before, it is still small relative to the 40 percent estimated by Krueger et al. (2010) for the 1980-2006 period.

5.3 Alternative parameterizations

This section evaluates the importance of our modeling choices 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. Under these alternative calibrations, we perform the same type of sufficient statistic exercise as in Counterfactual 2.

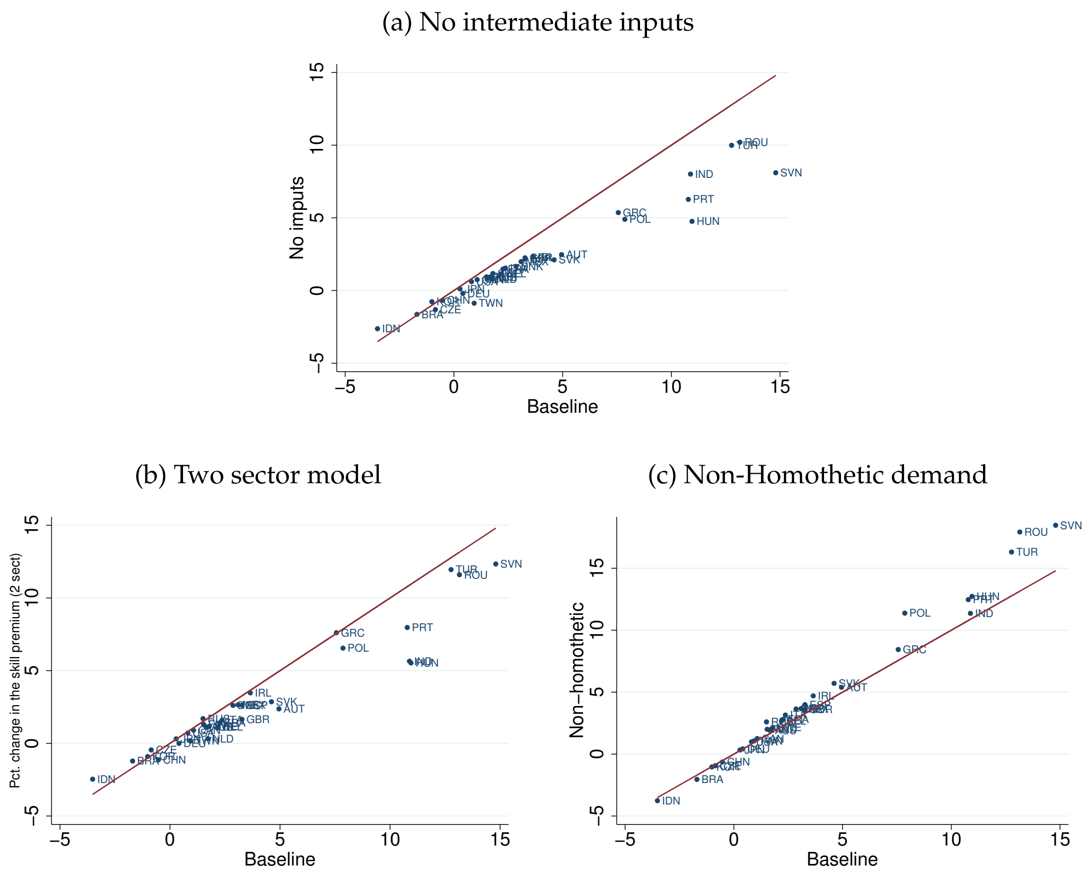
No intermediate inputs We start by evaluating the importance of incorporating intermediate inputs for our quantitative results. To do so, we recalibrate the model imposing that the share of the employment bundle is equal to one in each sector, $\beta_i^j = 1$, and recalculate the change in the skill premium under Counterfactual 2. The resulting changes in the skill premium are compared to those under the baseline parameterization in Figure 13a. 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 about half of that in the baseline calibration for 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 2 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 13b. For the average country, the increase in the skill premium is 29 percent smaller in the two sector model than in our baseline calibration. Note, however, that the two models predict roughly the same decline in the employment 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 discusses how we parameterize the income elasticities of the different sectors following Comin, Lashkari and Mestieri (2015).[34] Figure 13c

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

Figure 13: Change in the skill premium, Counterfactual 2. 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 2. The alternative parameterizations are described in Section 5.3.

compares the results of conducting our Counterfactual 2 in the homothetic vs the non-homothetic model. The figure shows that the restricting preferences to be homothetic does not greatly affect the results for the skill premium.

5.4 Measuring the skill premium using the factor content of trade

We conclude this section by assessing, in the context of our model, an alternative approach that has been used in the literature to measure the impact of trade on factor prices: the factor content of trade (FCT).[35] The FCT measures the quantity of a factor that is em-

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

bodied in a country's net exports. Intuitively, an increase in the trade-adjusted supply of a factor should decrease the factor's price. We first use our model to measure changes in the FCT implied by Counterfactuals 1 and 2. Then we show that these measured changes greatly underestimate the model's predictions for the changes in 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:

$$\frac{s_i}{w_i} = \frac{L_i - FCT_i^L}{H_i - FCT_i^H} \times \Phi_i, \tag{25}$$

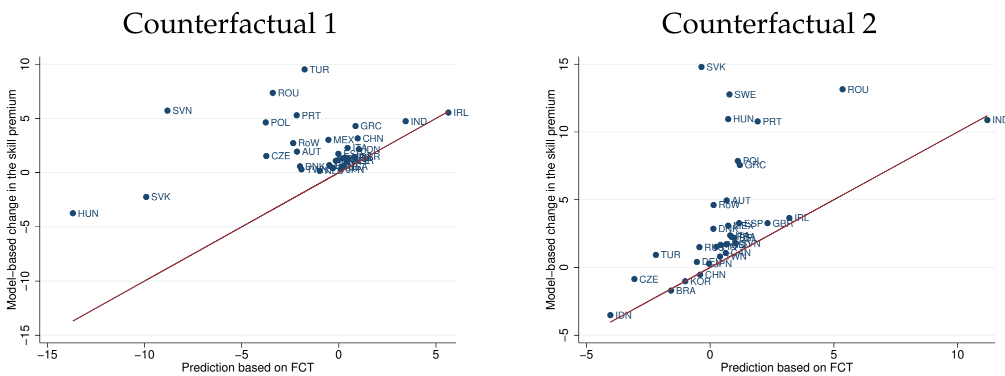
where $FCT_i^L \equiv \frac{1}{w_i} \sum_j \mu_i^j \beta_i^j \left[R_i^j - Y_i^j \right]$ and $FCT_i^H \equiv \frac{1}{s_i} \sum_j \left(1 - \mu_i^j\right) \beta_i^j \left[R_i^j - Y_i^j \right]$ are the FCT for unskilled and skilled labor respectively, and where we defined $\Phi_i \equiv \frac{\sum_j \left(1-\mu_i^j\right) \beta_i^j Y_i^j}{\sum_j \mu_i^j \beta_i^j Y_i^j}$. Deardorff and Staiger (1988) and Burstein and Vogel (2011) show in a class of models that, if factor shares, μ_i^j, are fixed in each sector and sectoral absorption shares, Y_i^j, are constant, then Φ_i is constant and changes in the skill premium are proportional to changes in factor supplies and the FCT, captured by $\left(L_i - FCT_i^L\right) / \left(H_i - FCT_i^H\right)$. In that context, changes in the FCT are sufficient statistics for the effect of trade on the skill premium. Clearly, these conditions are not satisfied in our model, where both sectoral absorption shares and factor shares change in response to changes in trade patterns.[36] The FCT approach, therefore, does not capture all of the effects of trade on the skill premium.

Figure 14 compares the counterfactual change in the skill premium to the changes in the skill premium that we measure from the counterfactual changes in the first term of equation (25).[37] The figures show that the change in the FCT greatly underestimates the counterfactual changes in the skill premium in our model in almost every country. In fact, the FCT-based measure moves in the opposite direction to the counterfactual skill premium for about half the countries in Counterfactual 1, and for about fifteen percent of the countries in Counterfactual 2.

[36] Burstein and Vogel (2016) also note that the FCT cannot be measured from 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 to the effect of trade on the skill premium. This not the case in our context, even if the FCT is perfectly measured.

[37] That is, we use data generated in the counterfactuals to measure how $\left(L_i - FCT_i^L\right) / \left(H_i - FCT_i^H\right)$ changes, while keeping Φ_i constant. See Appendix 3.3 for details.

Figure 14: Predictions based on the factor content of trade



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 (25) (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. Changes in trade costs between 1995 and 2007 generate an 8.5 percent decline in the size of the goods sector in our model, and account well for the cross-country differences in the changes in the size of the goods sector. The observed changes in trade patterns of the past three decades can generate roughly half of the observed decline in the value added share of the goods-producing sector. These changes can in turn generate sizable increases in the skill premium in all countries (2.3 percent on average). The increase in the skill premium is larger in developing countries where the goods sector is particularly unskilled-labor intensive.

References

Arkolakis, Costas, Arnaud Costinot, and Andres Rodriguez-Clare. 2012. "New Trade Models, Same Old Gains?" *American Economic Review*, 102(1): 94–130.

Attanasio, Orazio, Pinelopi Goldberg, and Nina Pavcnik. 2004. "Trade reforms and wage inequality in Colombia." *Journal of Development Economics*, 74(2): 331–366.

Basco, Sergi, and Marti Mestieri. 2013. "Heterogeneous trade costs and wage inequality: A model of two globalizations." *Journal of International Economics*, 89(2): 393–406.

Baumol, William J. 1967. "Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis." *American Economc Review*, 57(3): 415–426.

Berman, Eli, John Bound, and Zvi Griliches. 1994. "Changes in the Demand for Skilled Labor within U. S. Manufacturing: Evidence from the Annual Survey of Manufactures." *The Quarterly Journal of Economics*, 109(2): 367–397.

Buera, Francisco, Joseph Kaboski, and Richard Rogerson. 2015. "Skill Biased Structural Change." *NBER Working Paper No. 21165*.

Burstein, Ariel, and Jonathan Vogel. 2011. "International Trade Patterns, the Skill Premium, and Heterogeneous Firms." Working Paper 2011 1247.

Burstein, Ariel, and Jonathan Vogel. 2016. "International trade, technology, and the skill premium." *Journal of Political Economy*, , (Forthcoming).

Burstein, Ariel, Eduardo Morales, and Jonathan Vogel. 2015. "Accounting for Changes in Between-Group Inequality." National Bureau of Economic Research, Inc NBER Working Papers 20855.

Burstein, Ariel, Javier Cravino, and Jonathan Vogel. 2013. "Importing Skill-Biased Technology." *American Economic Journal: Macroeconomics*, 5(2): 32–71.

Caliendo, Lorenzo, and Fernando Parro. 2015. "Estimates of the Trade and Welfare Effects of NAFTA." 82.

Caron, Justin, Thibault Fally, and James R. Markusen. 2014. "International Trade Puzzles: A Solution Linking Production and Preferences *." *The Quarterly Journal of Economics*, 129(3): 1501.

Comin, Diego A., Danial Lashkari, and Martí Mestieri. 2015. "Structural Change with Long-run Income and Price Effects." National Bureau of Economic Research, Inc NBER Working Papers 21595.

Costinot, Arnaud, and Andres Rodriguez-clare. 2014. "Trade Theory with Numbers: Quantifying the Consequences of Globalization." Vol. 4 of *Handbook of International Economics*, Chapter 4, 197–261. Elsevier.

Deardorff, Alan V., and Robert W. Staiger. 1988. "An interpretation of the factor content of trade." *Journal of International Economics*, 24(1-2): 93–107.

Dekle, Robert, Jonathan Eaton, and Samuel Kortum. 2008. "Global Rebalancing with Gravity: Measuring the Burden of Adjustment." *IMF Staff Papers*, 55(3): 511–540.

Eaton, Jonathan, and Samuel Kortum. 2002. "Technology, Geography, and Trade." *Econometrica*, 70(5): 1741–1779.

Fajgelbaum, Pablo, and Stephen J. Redding. 2014. "External Integration, Structural Transformation and Economic Development: Evidence From Argentina." Centre for Economic Performance, LSE CEP Discussion Papers dp1273.

Goldberg, Pinelopi Koujianou, and Nina Pavcnik. 2007. "Distributional Effects of Globalization in Developing Countries." *Journal of Economic Literature*, 45(1): 39–82.

Haltiwanger, John, Adriana Kugler, Maurice Kugler, Alejandro Micco, and Carmen Pages. 2004. "Effects of tariffs and real exchange rates on job reallocation: evidence from Latin America." Economics Division, School of Social Sciences, University of Southampton Discussion Paper Series In Economics And Econometrics 0410.

Head, Keith, and John Ries. 2001. "Increasing Returns versus National Product Differentiation as an Explanation for the Pattern of U.S.-Canada Trade." *American Economic Review*, 91(4): 858–876.

Herrendorf, Berthold, Richard Rogerson, and Ákos Valentinyi. 2013. "Two Perspectives on Preferences and Structural Transformation." *American Economic Review*, 103(7): 2752–89.

Katz, Lawrence F, and Kevin M Murphy. 1992. "Changes in Relative Wages, 1963-1987: Supply and Demand Factors." *The Quarterly Journal of Economics*, 107(1): 35–78.

Kehoe, Timothy J., Kim J. Ruhl, and Joseph B. Steinberg. 2013. "Global Imbalances and Structural Change in the United States." National Bureau of Economic Research, Inc NBER Working Papers 19339.

Krueger, Dirk, Fabrizio Perri, Luigi Pistaferri, and Giovanni L. Violante. 2010. "Cross Sectional Facts for Macroeconomists." *Review of Economic Dynamics*, 13(1): 1–14.

Leamer, Edward E., and James Levinsohn. 1995. "International trade theory: The evidence." Vol. 3 of *Handbook of International Economics*, Chapter 26, 1339 – 1394. Elsevier.

Levchenko, Andrei A., and Jing Zhang. 2016. "The Evolution of Comparative Advantage: Measurement and Welfare Implications." *Journal of Monetary Economics*, 78: 48–66.

Matsuyama, Kiminori. 2007. "Beyond Icebergs: Towards a Theory of Biased Globalization." *Review of Economic Studies*, 74(1): 237–253.

Matsuyama, Kiminori. 2009. "Structural Change in an Interdependent World: A Global View of Manufacturing Decline." *Journal of the European Economic Association*, 7(2-3): 478–486.

Ossa, Ralph. 2015. "Why trade matters after all." *Journal of International Economics*, –.

Parro, Fernando. 2013. "Capital-Skill Complementarity and the Skill Premium in a Quantitative Model of Trade." *American Economic Journal: Macroeconomics*, 5(2): 72–117.

Uy, Timothy, Kei-Mu Yi, and Jing Zhang. 2013. "Structural change in an open economy." *Journal of Monetary Economics*, 60(6): 667 – 682.

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 ratios of net exports to aggregate revenues in 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 $\{P_i, w_i, s_i\}_{i\in I}$, and $\left\{P_i^j, c_i^j, p_{v,i}^j, p_{b,i}^j\right\}_{i\in I, j\in J}$, 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 $\left\{A_i^j(k)\right\}_{i\in I, k\in K^j, j\in J}$, trade costs $\left\{\tau_{in}^j(k)\right\}_{i,n\in I, k\in K^j, j\in J}$, and net exports $\{NX_i\}_{i\in I}$, the following are satisfied:

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

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

where P_i^C consumption price index in country i, 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:

$$c_i^j = \bar{\beta}_i^j \left[p_{b,i}^j\right]^{1-\beta_j} \left[p_{v,i}^j\right]^{\beta_j} \tag{A.3}$$

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

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

Given these definitions, factor demands are given by:

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

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 distributional assumptions, price indices for final goods are given by

$$
P_i^{j} = \bar{\sigma}_i^{j}\left[\prod_{k=1}^{K^j} P_i^{j}(k)^{\sigma_i^{j}(k)}\right]. \tag{A.6}
$$

where

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

where $\bar{\sigma}_i^{j}$ and $\Xi_i^{j}(k)$ are constants. Trade shares between any pair of countries are given by equation (7).

iv. **Aggregate factor market clearing.** Integrating factor demands across producers, adding across all destination countries n, substituting for the demand for each variety $q_i^{j}(\omega,k)$, using equation (6), 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:

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

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

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:

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

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, $(30 \times I - 1 + I \times I \times (K^S + K^G + K^F))$ aggregate variables must be determined in equilibrium. Equations (A.1)-(A.11) and (7) give a system of $(30 \times I - 1 + I \times I \times (K^S + K^G + K^F))$ 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 sectorial net exports

In this section we show how to solve for domestic variables as functions of industrial domestic expenditure shares, $\pi_{ii}^j(k)$, and net exports relative to aggregate revenues, λ_i^j. From equations, (7) 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.7) and (A.8) we can write

$$\left[\frac{s_i}{w_i}\right]^\gamma \frac{H_i}{L_i} = \frac{\sum_j \left[1-\bar{\mu}_i^j\right]\left[p_{v,i}^j\right]^{\gamma-1}\beta_i^j r_i^j}{\sum_j \bar{\mu}_i^j \left[p_{v,i}^j\right]^{\gamma-1}\beta_i^j r_i^j}, \tag{A.13}$$

where $r_i^j \equiv R_i^j / R_i$ is the share of sector j in aggregate revenues. From the definition of λ_i^j, we can write r_i^j as:

$$r_i^j = \lambda_i^j - 1 + \frac{P_i^j Y_i^j}{R_i}. \tag{A.14}$$

Equation (A.11) implies

$$\frac{P_i^j Y_i^j}{R_i} = \frac{P_i^j C_i^j}{R_i} + \frac{P_i^j X_i^j}{R_i}. \tag{A.15}$$

Combining (A.1), (A.11), and the definition of λ_i^j, we obtain

$$\frac{P_i^j C_i^j}{R_i} = \bar{\phi}_i^j \left[\frac{P_i^j}{P_i}\right]^{1-\rho} \left[4 - \sum_{j=1}^{3} \lambda_i^j - \frac{\sum_j P_i^j X_i^j}{R_i}\right], \tag{A.16}$$

where (A.9) implies:

$$\frac{\sum_j P_i^j X_i^j}{R_i} = \sum_j \bar{\alpha}_i^{lj} \left[\frac{p_{b,i}^j}{P_i^l}\right]^{\rho-1} \left[1-\beta_i^j\right] r_i^j. \tag{A.17}$$

Given values for $\pi_{ii}^j(k)$ and λ_i^j, equations (A.3), (A.5), (A.4), and (A.12), -(A.17) give a system of 23 equations that can be used to solve for the 13 relative prices in the economy together with the sectorial revenue shares r_i^j, the ratios of sectorial absorption to aggregate revenues $\frac{P_i^j Y_i^j}{R_i}$, the ratios of sectorial consumption to revenues $\frac{P_i^j C_i^j}{R_i}$, and the ratio of inputs to revenues in the economy $\frac{\sum_j P_i^j X_i^j}{R_i}$.

A.3 Solving for price changes

We now combine equations (A.3), (A.4), (A.5), (A.12), and (A.13) to solve for changes in sectorial value-added shares and the skill premium as a function of changes in domestic expenditure shares and the ratio of sectorial net exports relative to GDP. 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:

$$\left[\frac{\hat{s}_i}{\hat{w}_i}\right]^{\gamma}\frac{\hat{H}_i}{\hat{L}_i} = \frac{\sum_j \frac{H_i^j}{H_i}\hat{\vartheta}_i^{j\,\gamma-1}\hat{r}_i^j}{\sum_j \frac{L_i^j}{L_i}\hat{\vartheta}_i^{j\,\gamma-1}\hat{r}_i^j} \tag{A.18}$$

$$\hat{P}_i^j = \left[\hat{c}_i^j/\hat{A}_i^j\right]\prod_{k=1}^{K_j}\hat{\pi}_{ii}^j(k)^{\sigma_i^j(k)\theta^j(k)} \tag{A.19}$$

$$\hat{c}_i^j = \left[\hat{p}_{b,i}^j\right]^{1-\beta_i^j}\left[\hat{p}_{v,i}^j\right]^{\beta_i^j} \tag{A.20}$$

$$\hat{p}_{b,i}^j = \left[\sum_l \alpha_i^{lj}\left[\hat{P}_i^l\right]^{1-\rho}\right]^{\frac{1}{1-\rho}} \tag{A.21}$$

$$\hat{p}_{v,i}^j = \left[\mu_i^j\hat{w}_i^{1-\gamma} + \left[1-\mu_i^j\right]\hat{s}_i^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \tag{A.22}$$

and

$$\hat{r}_i^j = \frac{\lambda_i^j}{r_i^j}\hat{\lambda}_i^j - 1 + \frac{Y_i^j}{R_i^j}\frac{\hat{Y}_i^j}{\hat{R}_i}. \tag{A.23}$$

$$\frac{\hat{Y}_i^j}{\hat{R}_i} = \left[1-\psi_i^j\right]\left[\widehat{\frac{P_i^jC_i^j}{R_i}}\right] + \psi_i^j\left[\widehat{\frac{P_i^jX_i^j}{R_i}}\right] \tag{A.24}$$

$$\widehat{\frac{P_i^jC_i^j}{R_i}} = = \left[\widehat{\frac{P_i^j}{P_i}}\right]^{1-\rho}\frac{Y_i}{P_iC_i}\left[\frac{\sum_j\left[r_i^j\hat{r}_i^j + 1 - \lambda_i^j\hat{\lambda}_i^j\right]}{\sum_j\left[r_i^j + 1 - \lambda_i^j\right]} - \sum_l \frac{Y_i^l}{Y_i}\psi_i^l\left[\widehat{\frac{P_i^lX_i^l}{R_i}}\right]\right] \tag{A.25}$$

$$\widehat{\frac{P_i^lX_i^l}{R_i}} = \sum_j \Phi_i^{lj}\left[\widehat{\frac{\hat{p}_{b,i}^j}{P_i^l}}\right]^{\rho-1}\hat{r}_i^j \tag{A.26}$$

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.18)-(A.26) give a system of 25 equations that can be used to solve for the changes in the 13 relative prices in the economy, together with the changes in sectorial revenue shares $\hat{r}_i^j$, the ratios of sectorial absorption to aggregate revenues $\widehat{\frac{P_i^j Y_i^j}{R_i}}$, the ratios of sectorial consumption to revenues $\widehat{\frac{P_i^j C_i^j}{R_i}}$, and the ratio of inputs to revenues in the economy $\widehat{\frac{P_i^l X_i^l}{R_i}}$, 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 value-added and employment shares The change in the share of value-added in sector j in total value-added is given by

$$\hat{v}_i^j = \frac{\hat{r}_i^j}{\sum_l \frac{\beta_i^j r_i^l}{\sum_l \beta_i^j r_i^l} \hat{r}_i^j}. \tag{A.27}$$

Finally, note that we can write the change in the share of skilled and unskilled workers employed in sector j, $\omega_{L,i}^j \equiv \frac{L_i^j}{L_i}$, and $\omega_{H,i}^j \equiv \frac{H_i^j}{H_i}$, as:

$$\widehat{\omega_{L,i}^j} = \frac{\hat{\mu}_i^j \hat{r}_i^l}{\sum_j \omega_{L,i}^l \hat{\mu}_i^j \hat{r}_i^l}$$

$$\widehat{\omega_{H,i}^j} = \frac{\left[\widehat{1-\mu_i^j}\right] \hat{r}_i^l}{\sum_j \omega_{H,i}^j \left[\widehat{1-\mu_i^j}\right] \hat{r}_i^l}$$

with:

$$\hat{\mu}_i^j = \left[\left[1-\mu_i^j\right]\left[\widehat{\frac{s_i}{w_i}}\right]^{1-\gamma} + \mu_i^j\right]^{-1}$$

$$\left[\widehat{1-\mu_i^j}\right] = \left[\mu_i^j \left[\widehat{\frac{s_i}{w_i}}\right]^{\gamma-1} + \left[1-\mu_i^j\right]\right]^{-1}.$$

Changes in total sectorial employment shares, $\omega_{E,i}^j \equiv \frac{L_i^j + H_i^j}{L_i + H_i}$ are given by:

$$\widehat{\omega_{E,i}^j} = \frac{L_i^j}{L_i^j + H_i^j} \widehat{\omega_{L,i}^j} + \frac{H_i^j}{L_i^j + H_i^j} \widehat{\omega_{H,i}^j}.$$

Appendix B Proofs

In this section we log-linearize the equilibrium conditions around the initial equilibrium and derive equations (13), (14), (15), (16), (17), (18) and (19) in the paper.

Derivation of Equation (13)

We start by deriving equation (13). To a first order approximation, equation (12) can be written as:

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

Log-differentiating μ_i^j we obtain:

$$\tilde{\mu}_i^j \;=\; -\mu_i^j \frac{s_i H_i^j}{w_i L_i^j} \left[\widetilde{\frac{s_i H_i^j}{w_i L_i^j}} \right] = -\left[1-\mu_i^j\right] [1-\gamma] \left[\tilde{s}_i - \tilde{w}_i\right], \tag{B.2}$$

where the second equality follows from the factor demand equations. Substituting in equation (B.1) and solving for $\tilde{s}_i - \tilde{w}_i$ we obtain equation (13) in the text.

Derivation of Equation (14)

To derive equation (14), we start by differentiating (A.23) around $\lambda_i^j = 1$.

$$\tilde{r}_i^j = [1-\rho] \left[\tilde{P}_i^j - \tilde{P}_i \right] + \frac{\tilde{\lambda}_i^j}{r_i^j} - \sum_l \tilde{\lambda}_i^l. \tag{B.3}$$

Noting that we can write the value-added shares as $v_i^j = \frac{\beta_i^j r_i^j}{\sum \beta_i^j r_i^j}$ we obtain the changes in these shares as:

$$\tilde{v}_i^j = \tilde{r}_i^j - \sum_j v_i^j \tilde{r}_i^j.$$

Substituting for $\tilde{r}_i^j$ we obtain equation (14) in the text.

Derivation of equation (15)

We now derive equation (15) in the text in the special version of the model with $\beta_i^j = 1$. Substituting equation (14) into (13) we can write:

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

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 (16) and (17)

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).

Derivation of equations (18) and (19)

We start by deriving equation (18). Log-linearizing equation (A.27) and combining with (B.3) we obtain:

$$\tilde{v}_i^j \quad = \quad [1-\rho]\left[\tilde{P}_i^j - \sum_j v_i^j \tilde{P}_i^j\right] + \frac{\tilde{\lambda}_i^j}{r_i^j} - \sum_l \frac{v_i^l}{r_i^l}\tilde{\lambda}_i^l.$$

Substituting with equation (B.5) we obtain equation (18) in the text.

To obtain equation (19), define sectorial employment by $E_i^j \equiv L_i^j + H_i^j$ and note that

$$\omega_{E,i}^j \quad = \quad \tilde{E}_i^j - \sum_l \omega_{E,i}^l \tilde{E}_i^l. \tag{B.6}$$

Log-linearizing sectorial employment we obtain:

$$\tilde{E}_i^j \quad = \frac{L_i^j}{L_i + H_i^j}\tilde{L}_i^j + \frac{H_i^j}{L_i^j + H_i^j}\tilde{H}_i^j \quad ,$$

which can be written as:

$$\tilde{E}_i^j \quad = \frac{L_i^j}{L_i^j + H_i^j}\left[\tilde{L}_i^j + \tilde{w}_i - \tilde{w}_i - \tilde{v}_i^j\right] + \frac{H_i^j}{L_i^j + H_i^j}\left[\tilde{H}_i^j + \tilde{s}_i - \tilde{s}_i - \tilde{v}_i^j\right] + \tilde{v}_i^j \quad .$$

or:

$$\tilde{E}_i^j = \frac{L_i^j}{L_i^j+H_i^j}\left[\tilde{\mu}_i^j - \tilde{w}_i\right] + \frac{H_i^j}{L_i^j+H_i^j}\left[\widetilde{\left[1-\mu_i^j\right]} - \tilde{s}_i\right] + \tilde{v}_i^j \quad . \tag{B.7}$$

Combining equations (B.7), (18), (B.2), noting that $\widetilde{\left[1-\mu_i^j\right]} = -\frac{\mu_i^j}{1-\mu_i^j}\tilde{\mu}_i^j$, and substituting into equation (B.6) gives expression (19) in the text.

Appendix C Non-homothetic preferences

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

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

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 (7), (A.2)-(A.11) and by the sectoral consumption demands associated with (C.1), given by:

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

This implies that equation A.1 is now written as:

$$\frac{P_i^j C_i^j}{R_i} = \bar{\phi}_i^j \left[\frac{P_i^j}{P_i}\right]^{1-\rho} C_i^{\epsilon^j} \left[4 - \sum_{j=1}^{3}\lambda_i^j - \frac{\sum_j P_i^j X_i^j}{R_i}\right], \tag{C.3}$$

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:

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

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.

We next show how we measure changes in the FCT in the model, starting with the expression above in changes:

$$\frac{s_i}{w_i}\frac{\widehat{s_i}}{w_i} = \frac{L\hat{L}}{H\hat{H}} \frac{1-\frac{FCT_i^L \widehat{FCT_i^L}}{L\hat{L}}}{1-\frac{FCT_i^H \widehat{FCT_i^H}}{H\hat{H}}} \Phi_i \hat{\Phi}_i$$

, where Φ_i is defined as in the main body of the paper. We next impose that $\hat{\Phi}_i = 1$, to obtain

$$\frac{\widehat{s_i}}{w_i}^{FC} = \frac{\left(1-\frac{FCT_i^L \widehat{FCT_i^L}}{L\hat{L}}\right) / \left(1-\frac{FCT_i^L}{L}\right)}{\left(1-\frac{FCT_i^H \widehat{FCT_i^H}}{H\hat{H}}\right) / \left(1-\frac{FCT_i^H}{H}\right)}.$$

Now, since

$$\frac{FCT_i^L}{L} = \sum_j \frac{L_i^j}{L}\left[1-\frac{1}{\lambda_i^j}\right] = 1 - \sum_j \frac{L_i^j}{L}\frac{1}{\lambda_i^j}$$

and

$$\frac{FCT_i^L}{L}\frac{\widehat{FCT_i^L}}{L} = \sum_j \frac{L_i^j}{L}\left[\frac{\hat{L}_i^j}{L}\right]\left[1-\frac{1}{\lambda_i^j \hat{\lambda}_i^j}\right] = \left[1-\sum_j \frac{L_i^j}{L}\left[\frac{\hat{L}_i^j}{L}\right]\frac{1}{\lambda_i^j \hat{\lambda}_i^j}\right],$$

we finally obtain

$$\frac{\widehat{s_i}^{FC}}{w_i} = \frac{\left(\sum_j \frac{H_i^j}{H}\frac{1}{\lambda_i^j}\right) \times \left(\sum_j \frac{L_i^j}{L}\left[\frac{\hat{L}_i^j}{L}\right]\frac{1}{\lambda_i^j \hat{\lambda}_i^j}\right)}{\left(\sum_j \frac{L_i^j}{L}\frac{1}{\lambda_i^j}\right) \times \left(\sum_j \frac{H_i^j}{H}\left[\frac{\hat{H}_i^j}{H}\right]\frac{1}{\lambda_i^j \hat{\lambda}_i^j}\right)}.$$

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

Our main sample combines two data sources. We use the IO tables from the World Input Output Database (WIOD) to construct changes in domestic expenditure shares, net export to aggregate revenue ratios, intermediate input shares β^j and α^{ij}, and sectorial value-added shares. We use the Socio Economic Accounts included in the WIOD (SEA) to calculate baseline employment shares, H_i^j/H_i and L_i^j/L_i, aggregate payments to skilled relative to unskilled labor, $s_i H_i / w_i L_i$, and aggregate employment shares.

In Section 5.2.2, to extend our sample backward in time, we also bring in data on IO tables from the OECD IO tables (1995 version) and data on employment and labor compensation from KLEMS. We use these data in the same way as described in the previous paragraph.

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 2007, 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.

The WIOD also extends the labor and compensation data from KLEMS in its own Socio Economic Accounts module. 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.

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, 0.75, 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. We treat these data just as the WIOD SEA data. 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).

E.2 Data construction

In this section, we discuss details on data construction not contained in the main body of the paper.

E.2.1 Sample

Table A2 reports the countries in our main sample, all of them starting in 1995 and ending in 2007. For Section 5.2.2, 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 and the splicing across datasets.

E.2.2 Constructing sectoral changes in trade shares and net exports to total revenue 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,

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

where Sector $j's$ Total Intermediate Use is measured as Total Intermediate Use of S, G, and F (Imported and Domestic). 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

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

Appendix F Estimating the elasticity of substitution across sectors

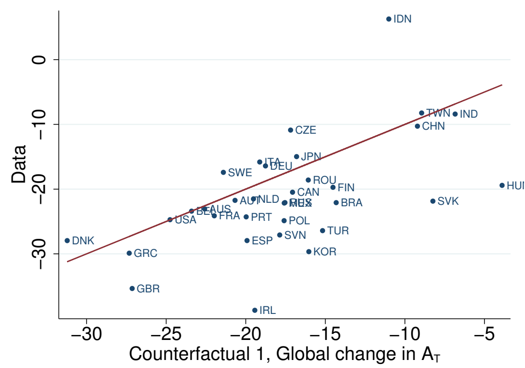
This section provides details for our estimation of the elasticity ρ in Section 4. Equation (20) in the paper follows from taking ratios and logs in the demand functions in equation (C.2) for sectors j and j'. Equation (21) follows from aggregating the input demand functions across producers and industries,

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

and then taking logs and differences across inputs l.

To estimate equations (20) and (21), 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

Figure A.1: Changes in goods employment shares (Counterfactual 1 with global productivity growth)



Notes: The x-axis shows the percent change in the sector's share in employment in a version of Counterfactual 1 that includes productivity growth. The y-axis reports the percent change in the sector's share in employment between 1995-2007 in the WIOD data.

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.

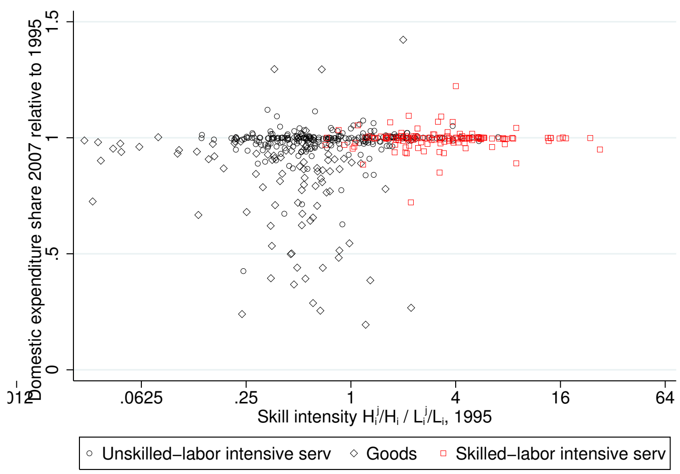
Appendix G Global productivity growth in the goods sector

In this counterfactual we augment Counterfactual 1 with global productivity growth. That is, in addition to declines in trade costs obtained from (22), we assign $\hat{A}_i^G = \hat{A}^G$ to every country i, and we calibrate $\hat{A}^G$ such that the model exactly replicates the decline in the US employment share in the goods sector between 1995 and 2007.

Figure A.1 compares the results of this counterfactual to the data, with a 45-degree line as a reference. The figure shows that once we allow for global productivity change to account for the changes in good employment in the US, then the counterfactual can account quite well for the decline in the share of employment in the goods sector in most countries.

Appendix H Tables and Figures

Figure A.2: 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: WIOD.

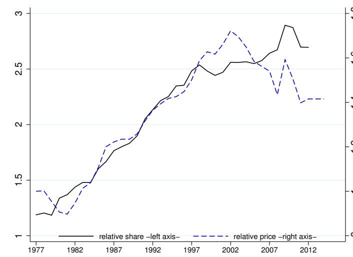
Figure A.3: Intermediate use of inputs from the goods-producing sector, by industries and countries

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: WIOD.

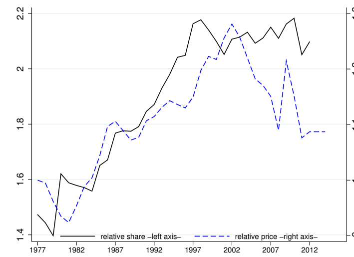
Figure A.4: Relative prices vs. relative expenditure shares

(a) Consumption bundle

Skilled-labor intensive services vs goods

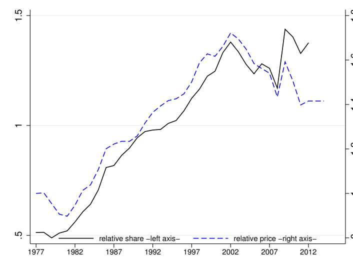


Unskilled-labor intensive vs goods

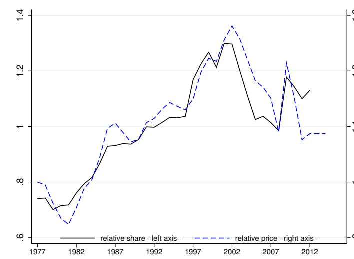


(b) Input bundle used in the unskilled labor intensive service sector

Skilled-labor intensive services vs goods

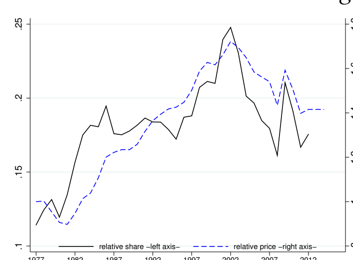


Unskilled-labor intensive vs goods

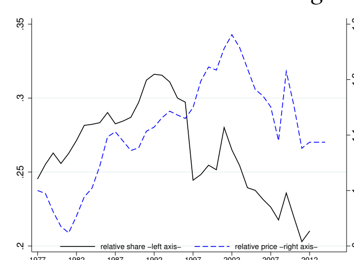


(c) Input bundle used in the goods sector

Skilled-labor intensive services vs goods

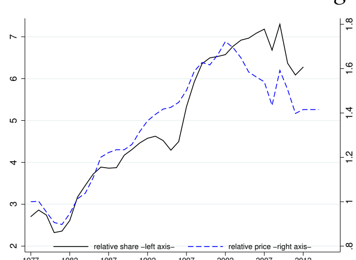


Unskilled-labor intensive vs goods

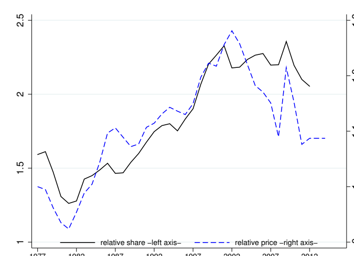


(d) Input bundle used in the skilled labor intensive service sector

Skilled-labor intensive services vs goods



Unskilled-labor intensive services vs goods

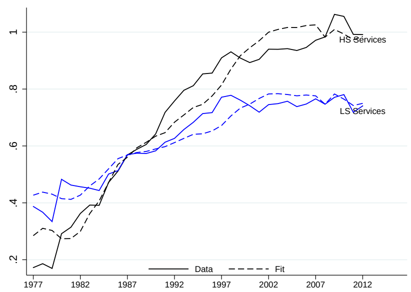


Notes: The figures plots the change in sectoral relative prices, and relative expenditures for (a) consumption, and total inputs in (b) the unskilled-labor intensive service sector, (c) the goods sector, and (d) the skilled- labor service sector. Source: Authors calculations based on data from the USE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

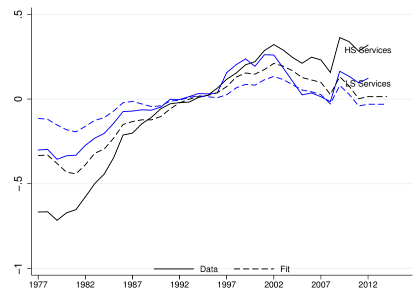
Figure A.5: Actual vs. predicted expenditure shares

(a) Independent estimation

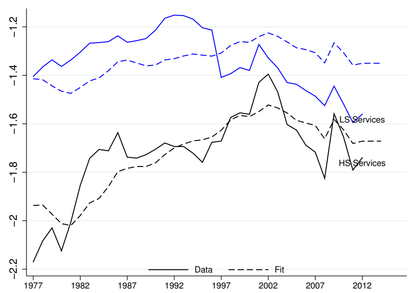
Consumption Bundle



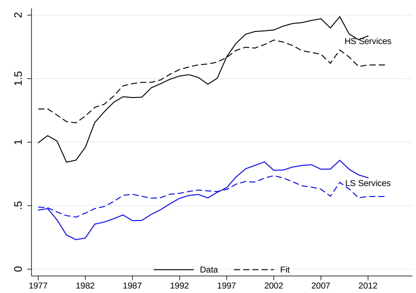
Unskilled-labor intensive services input bundle



Goods input bundle

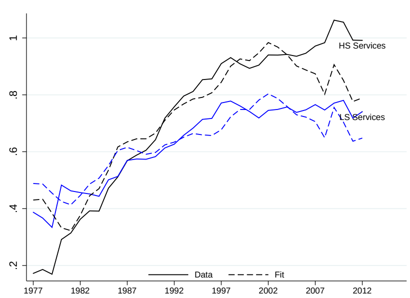


Skilled-labor intensive services input bundle

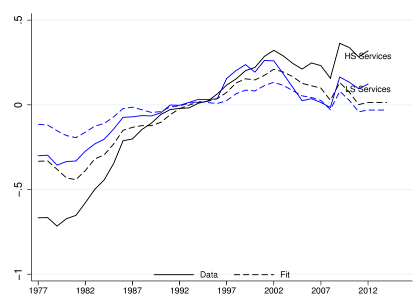


(b) Joint estimation

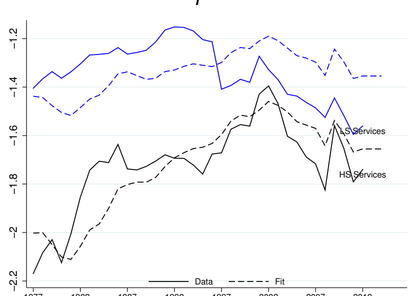
Consumption Bundle



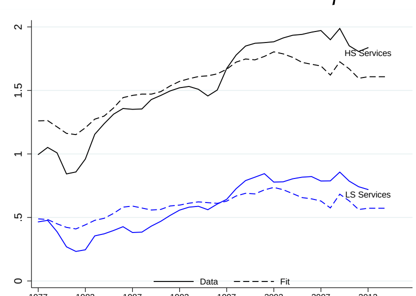
Unskilled-labor intensive services input bundle



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 (20) and (21).

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	52	52	60		
Wholesale and Retail	G	S	Wholesale & retail trade	51	51	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	62	I	80		
Transport and Communication	I	S	Transport & storage	63	I	80		
Transport and Communication	I	S	Transport & storage	61	I	80		
Transport and Communication	I	S	Transport & storage	60	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		
Health	N	F	Community, social & personal services	N	N	113		
Other Services	O	S	Community, social & personal services	O	O	114		
Education	M	F	Community, social & personal services	M	M	112		
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	1.23	1.02	Italy	1.33	1.47
Austria	1.51	1.25	Japan	2.16	2.05
Belgium	1.13	1.29	Korea	1.32	1.83
Brazil	1.35	1.43	Mexico	1.24	0.71
Canada	0.98	0.91	Netherlands	0.97	1.26
China	1.39	1.72	Poland	2.12	1.90
Czech Republic	1.55	0.92	Portugal	1.22	1.04
Germany	1.73	1.91	Romania	1.56	1.18
Denmark	1.15	3.18	Russia	1.07	0.68
Spain	1.44	2.00	Rest of the World	1.22	1.43
Finland	1.42	1.30	Slovakia	1.69	0.99
France	1.33	1.18	Slovenia	1.29	1.71
Great Britain	0.93	1.67	Sweden	1.26	1.59
Greece	1.39	2.57	Turkey	1.62	1.74
Hungary	1.99	1.29	Taiwan	1.47	1.23
Indonesia	1.05	1.18	United States	1.35	1.49
India	2.15	1.03	World	1.44	1.60
Ireland	0.75	2.23	Average	1.39	1.48

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
Brazil	0.97	0.99	Mexico	0.87	1.01
Canada	0.97	1.01	Netherlands	0.81	0.98
China	0.97	0.99	Poland	0.72	0.98
Czech Republic	0.72	1.01	Portugal	0.77	1.00
Germany	0.76	0.98	Romania	0.74	1.00
Denmark	0.83	0.92	Russia	0.97	1.01
Spain	0.81	0.98	Rest of the World	0.89	0.96
Finland	0.84	0.99	Slovakia	0.53	1.00
France	0.85	1.00	Slovenia	0.64	0.97
Great Britain	0.80	0.99	Sweden	0.83	0.97
Greece	0.75	0.96	Turkey	0.86	1.00
Hungary	0.54	0.98	Taiwan	0.78	0.99
Indonesia	0.96	1.00	United States	0.90	1.00
India	0.88	1.00	World	0.90	0.98
Ireland	1.04	0.87	Average	0.82	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 net exports to aggregate revenue ratios

Country	Weighted change in domestic expenditure share	Change in Sectoral Net Exports to Aggregate Revenues ratio
Australia	0.93	1.01
Austria	0.80	0.97
Belgium	0.90	1.01
Brazil	1.00	0.98
Canada	0.97	1.01
China	1.00	0.98
Czech Republic	0.91	0.95
Germany	0.91	0.97
Denmark	0.87	1.02
Spain	0.91	1.03
Finland	0.92	1.01
France	0.91	1.01
Great Britain	0.89	1.03
Greece	0.88	1.05
Hungary	0.72	0.97
Indonesia	0.99	0.97
India	0.96	1.03
Ireland	0.95	1.04
Italy	0.95	1.01
Japan	0.97	1.00
Korea	1.00	0.98
Mexico	0.92	1.01
Netherlands	0.91	0.99
Poland	0.85	1.02
Portugal	0.84	1.02
Romania	0.87	1.07
Russia	0.94	1.00
Slovakia	0.83	0.99
Slovenia	0.66	1.00
Sweden	0.95	1.01
Turkey	0.76	1.01
Taiwan	0.91	0.97
United States	0.94	1.02
Average	**0.90**	**1.00**

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 $\hat{\lambda}_i^T$.

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	0.29	0.53	-0.24	0.11	0.23	-0.13	0.60	0.24	0.37
Austria	0.31	0.50	-0.20	0.17	0.34	-0.17	0.52	0.15	0.37
Belgium	0.29	0.51	-0.22	0.15	0.23	-0.08	0.57	0.26	0.31
Brazil	0.32	0.49	-0.17	0.13	0.40	-0.27	0.55	0.11	0.44
Canada	0.43	0.57	-0.14	0.11	0.24	-0.13	0.45	0.19	0.26
China	0.61	0.31	0.29	0.14	0.64	-0.50	0.25	0.04	0.21
Czech Republic	0.34	0.48	-0.14	0.18	0.38	-0.20	0.48	0.15	0.34
Germany	0.38	0.51	-0.13	0.22	0.28	-0.06	0.40	0.21	0.19
Denmark	0.30	0.48	-0.18	0.12	0.27	-0.15	0.58	0.25	0.33
Spain	0.39	0.57	-0.19	0.14	0.31	-0.17	0.47	0.11	0.36
Finland	0.38	0.44	-0.06	0.19	0.35	-0.16	0.43	0.21	0.22
France	0.28	0.50	-0.23	0.14	0.25	-0.12	0.59	0.24	0.34
Great Britain	0.30	0.53	-0.23	0.12	0.20	-0.08	0.58	0.27	0.31
Greece	0.44	0.56	-0.12	0.09	0.37	-0.29	0.48	0.07	0.41
Hungary	0.33	0.46	-0.13	0.19	0.41	-0.22	0.49	0.13	0.35
Indonesia	0.53	0.41	0.11	0.11	0.50	-0.39	0.36	0.09	0.28
India	0.38	0.23	0.15	0.27	0.75	-0.48	0.35	0.02	0.33
Ireland	0.28	0.46	-0.18	0.18	0.39	-0.21	0.54	0.15	0.39
Italy	0.24	0.50	-0.26	0.11	0.33	-0.23	0.65	0.16	0.49
Japan	0.48	0.54	-0.06	0.20	0.29	-0.09	0.32	0.17	0.15
Korea	0.51	0.49	0.02	0.27	0.40	-0.13	0.22	0.11	0.11
Mexico	0.52	0.45	0.07	0.17	0.44	-0.27	0.30	0.11	0.20
Netherlands	0.30	0.51	-0.21	0.09	0.24	-0.15	0.61	0.25	0.36
Poland	0.32	0.32	-0.01	0.19	0.57	-0.38	0.49	0.11	0.38
Portugal	0.29	0.48	-0.20	0.08	0.41	-0.33	0.63	0.11	0.53
Romania	0.19	0.27	-0.07	0.15	0.65	-0.51	0.66	0.08	0.58
Russia	0.21	0.33	-0.12	0.22	0.51	-0.29	0.57	0.16	0.41
Slovakia	0.29	0.43	-0.14	0.19	0.38	-0.20	0.52	0.18	0.34
Slovenia	0.34	0.35	-0.01	0.21	0.53	-0.33	0.46	0.12	0.34
Sweden	0.31	0.45	-0.14	0.11	0.28	-0.17	0.59	0.27	0.31
Turkey	0.56	0.31	0.24	0.11	0.63	-0.52	0.33	0.06	0.27
Taiwan	0.51	0.49	0.02	0.18	0.42	-0.24	0.31	0.08	0.23
United States	0.41	0.58	-0.16	0.15	0.21	-0.06	0.44	0.22	0.22
Average	**0.36**	**0.46**	**-0.09**	**0.16**	**0.39**	**-0.23**	**0.48**	**0.15**	**0.32**

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	0.46	0.41	0.63	0.40	0.31	0.29	0.32	0.57	0.11	0.34	0.11	0.55
Austria	0.61	0.42	0.68	0.43	0.31	0.26	0.27	0.60	0.13	0.36	0.17	0.48
Belgium	0.51	0.33	0.64	0.52	0.22	0.26	0.28	0.63	0.09	0.24	0.16	0.60
Brazil	0.65	0.41	0.73	0.37	0.35	0.27	0.21	0.69	0.10	0.39	0.23	0.37
Canada	0.59	0.40	0.73	0.39	0.32	0.28	0.26	0.65	0.09	0.46	0.12	0.42
China	0.43	0.35	0.57	0.25	0.65	0.10	0.15	0.81	0.05	0.28	0.45	0.27
Czech Republic	0.43	0.32	0.54	0.51	0.33	0.16	0.24	0.69	0.07	0.37	0.29	0.34
Germany	0.59	0.41	0.70	0.39	0.31	0.30	0.24	0.59	0.17	0.26	0.12	0.62
Denmark	0.56	0.41	0.72	0.49	0.27	0.24	0.30	0.60	0.10	0.42	0.16	0.42
Spain	0.54	0.35	0.69	0.44	0.36	0.20	0.26	0.65	0.09	0.41	0.18	0.41
Finland	0.56	0.38	0.68	0.39	0.40	0.21	0.24	0.65	0.10	0.43	0.26	0.31
France	0.56	0.34	0.68	0.47	0.24	0.29	0.26	0.58	0.15	0.28	0.13	0.59
Great Britain	0.52	0.42	0.66	0.45	0.29	0.26	0.25	0.63	0.13	0.34	0.17	0.49
Greece	0.61	0.39	0.77	0.35	0.45	0.21	0.22	0.70	0.08	0.45	0.15	0.40
Hungary	0.51	0.33	0.66	0.35	0.38	0.27	0.20	0.71	0.09	0.29	0.30	0.42
Indonesia	0.55	0.49	0.72	0.33	0.55	0.12	0.17	0.78	0.06	0.33	0.24	0.43
India	0.60	0.41	0.79	0.35	0.53	0.12	0.25	0.69	0.06	0.34	0.39	0.27
Ireland	0.48	0.37	0.64	0.52	0.29	0.20	0.23	0.64	0.14	0.29	0.15	0.57
Italy	0.53	0.35	0.74	0.44	0.33	0.23	0.29	0.63	0.08	0.29	0.16	0.56
Japan	0.57	0.37	0.70	0.40	0.35	0.25	0.23	0.69	0.08	0.39	0.20	0.42
Korea	0.55	0.33	0.70	0.24	0.45	0.31	0.10	0.81	0.08	0.36	0.24	0.39
Mexico	0.64	0.41	0.79	0.29	0.41	0.30	0.17	0.74	0.09	0.23	0.26	0.51
Netherlands	0.53	0.38	0.65	0.43	0.27	0.30	0.27	0.57	0.16	0.32	0.15	0.53
Poland	0.55	0.39	0.66	0.48	0.41	0.11	0.26	0.67	0.07	0.38	0.22	0.40
Portugal	0.53	0.35	0.68	0.46	0.33	0.21	0.22	0.69	0.10	0.33	0.20	0.47
Romania	0.48	0.39	0.69	0.38	0.51	0.11	0.19	0.72	0.08	0.29	0.53	0.18
Russia	0.62	0.43	0.58	0.50	0.43	0.07	0.33	0.65	0.02	0.51	0.29	0.20
Slovakia	0.42	0.33	0.64	0.53	0.34	0.13	0.27	0.67	0.06	0.39	0.27	0.35
Slovenia	0.49	0.38	0.67	0.45	0.33	0.23	0.22	0.69	0.09	0.30	0.29	0.41
Sweden	0.53	0.40	0.64	0.44	0.28	0.28	0.27	0.61	0.12	0.39	0.17	0.44
Turkey	0.68	0.49	0.72	0.27	0.54	0.19	0.27	0.65	0.08	0.33	0.40	0.27
Taiwan	0.58	0.31	0.73	0.29	0.42	0.29	0.18	0.74	0.08	0.18	0.21	0.61
United States	0.62	0.35	0.66	0.36	0.32	0.32	0.19	0.68	0.13	0.25	0.14	0.61
Average	**0.55**	**0.38**	**0.68**	**0.40**	**0.37**	**0.22**	**0.24**	**0.67**	**0.09**	**0.34**	**0.23**	**0.43**

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 (20) and (21). 'Consumption', 'Unskilled Services', 'Skilled Services' and 'Goods' correspond to the results of estimating equations (20), and (21) for $l = S, G, F$ respectively. The last column reports the results to estimating the 4 equations simultaneously.

Table A8: Changes in value added and employment shares: Counterfactual 1 vs. Data

	Value Added						Employment					
	Counterfactual 1			Data			Counterfactual 1			Data		
Country	Unskilled services	Goods	Skilled services	Unskilled services	Goods	Skilled services	Unskilled services	Goods	Skilled services	Unskilled services	Goods	Skilled services
Australia	1.71	-9.72	3.71	-6.04	-13.03	15.85	1.97	-9.47	3.69	2.25	-23.06	13.32
Austria	4.15	-10.19	5.29	-8.82	2.22	11.81	4.49	-9.89	5.23	-1.34	-21.74	38.66
Belgium	3.28	-14.36	4.71	0.35	-17.30	10.73	3.48	-14.20	4.72	-5.30	-23.40	25.23
Brazil	1.76	-4.66	2.30	5.78	0.33	-7.35	2.39	-4.10	2.67	11.09	-22.09	19.89
Canada	1.42	-5.80	1.78	3.82	-6.04	0.09	1.50	-5.70	1.74	5.39	-20.48	6.25
China	5.50	-3.46	7.31	16.06	-15.27	34.07	5.50	-3.35	7.04	19.53	-10.28	3.63
Czech Republic	4.22	-8.17	4.07	-0.02	-2.56	3.66	4.48	-7.92	4.05	0.64	-10.88	19.46
Germany	2.59	-7.70	2.96	-11.09	4.73	8.28	2.68	-7.61	2.98	-7.59	-16.42	31.97
Denmark	11.09	-20.34	-0.11	-1.05	-9.43	6.92	11.20	-20.24	-0.17	1.71	-27.95	17.83
Spain	2.63	-9.58	4.57	5.56	-24.62	13.18	3.14	-9.07	4.40	8.02	-27.95	18.24
Finland	1.69	-5.29	2.86	-0.87	-6.43	7.29	1.81	-5.10	2.81	6.39	-19.72	11.80
France	2.60	-10.52	3.16	-6.16	-14.14	12.71	2.91	-10.25	3.18	1.10	-24.12	15.68
Great Britain	1.00	-14.20	5.55	1.48	-38.40	26.70	1.40	-13.88	5.55	1.07	-35.35	17.61
Greece	8.75	-18.66	4.54	13.20	-33.66	3.15	9.81	-17.68	3.70	7.37	-29.90	43.83
Hungary	1.64	5.25	-10.74	-1.28	-7.08	10.19	0.85	4.35	-10.65	8.37	-19.42	19.34
Indonesia	1.99	-3.50	6.21	5.96	-0.86	-14.90	2.24	-3.25	6.37	-7.41	6.28	0.76
India	6.26	-3.97	12.96	14.47	-18.42	21.00	7.34	-3.04	12.42	18.74	-8.40	44.07
Ireland	-2.54	-10.55	17.27	6.29	-31.92	33.50	-1.38	-9.34	16.28	17.55	-38.72	24.94
Italy	3.32	-9.14	5.06	-2.45	-16.01	17.08	3.66	-8.82	4.94	0.15	-15.81	23.97
Japan	2.39	-5.41	0.91	-5.51	-8.59	15.63	2.44	-5.35	0.92	-2.87	-14.98	28.73
Korea	5.29	-9.25	3.52	-6.68	-7.88	21.78	5.55	-8.95	3.59	4.58	-29.66	60.36
Mexico	4.07	-9.03	8.55	10.49	-7.04	-5.51	4.79	-8.27	8.94	11.20	-22.15	29.56
Netherlands	2.73	-7.01	0.45	-0.92	-15.91	12.30	2.80	-6.93	0.42	-5.64	-21.52	22.45
Poland	13.30	-10.97	7.49	1.68	-22.44	36.21	13.80	-10.39	6.92	28.17	-24.88	27.19
Portugal	4.94	-11.64	8.34	5.67	-26.15	14.32	6.09	-10.66	8.54	8.17	-24.29	37.89
Romania	16.60	-10.04	11.40	49.39	-31.97	-0.05	17.43	-9.28	10.15	41.71	-18.59	5.00
Russia	12.94	-9.60	1.72	-11.00	-2.12	45.17	13.18	-9.39	1.67	34.14	-22.08	-0.81
Slovakia	3.10	1.37	-6.87	13.14	-12.51	-4.12	2.81	1.05	-6.77	17.28	-21.86	2.92
Slovenia	6.98	-11.76	13.49	10.07	-16.18	5.19	8.22	-10.50	13.43	16.32	-27.09	44.84
Sweden	3.24	-10.12	3.05	-0.39	-12.97	10.02	3.45	-9.88	2.98	-2.18	-17.41	15.73
Turkey	10.74	-10.81	19.06	11.77	-30.94	57.46	12.44	-9.30	19.67	32.04	-26.42	70.25
Taiwan	-0.16	-0.50	1.66	1.56	-10.69	11.96	-0.10	-0.41	1.64	-5.57	-8.23	46.68
United States	2.28	-12.30	3.65	-5.11	-14.97	14.15	2.46	-12.15	3.68	1.24	-24.73	14.80
Average	**4.59**	**-8.53**	**4.84**	**3.31**	**-14.19**	**13.59**	**4.99**	**-8.15**	**4.75**	**8.07**	**-21.01**	**24.30**

Notes: The Table reports the change in sectoral value added and employment shares in Counterfactual 1 under our baseline calibration and the changes observed in the data.

Table A9: Changes in skill premium and gains from trade ratio, Counterfactuals 1 and 2

Country	Counterfactual 1			Counterfactual 2		
	Skill premium	Skilled real wage	Unskilled real wage	Skill premium	Skilled real wage	Unskilled real wage
Australia	1.52	3.72	2.16	1.67	4.64	2.93
Austria	2.00	18.98	16.64	4.95	22.07	16.32
Belgium	1.31	3.46	2.12	2.19	8.29	5.98
Brazil	1.42	2.75	1.31	-1.70	-0.66	1.05
Canada	0.68	4.17	3.47	1.07	1.93	0.85
China	3.29	14.31	10.67	-0.53	-1.02	-0.50
Czech Republic	1.66	28.74	26.64	-0.85	9.89	10.84
Germany	0.49	6.45	5.94	0.41	6.87	6.44
Denmark	0.68	8.32	7.60	2.86	11.64	8.54
Spain	1.95	7.76	5.70	3.27	9.43	5.96
Finland	0.94	5.77	4.79	1.53	6.59	4.98
France	1.18	5.50	4.27	2.26	7.57	5.19
Great Britain	1.79	4.97	3.13	3.27	7.62	4.21
Greece	4.48	9.95	5.24	7.56	18.56	10.23
Hungary	-3.56	47.47	52.91	10.95	48.81	34.12
Indonesia	2.28	4.73	2.40	-3.51	-2.09	1.48
India	5.24	12.35	6.76	10.88	15.55	4.22
Ireland	6.65	16.62	9.34	3.65	9.30	5.45
Italy	2.60	6.23	3.54	2.37	6.31	3.85
Japan	0.32	0.94	0.62	0.28	2.24	1.95
Korea	1.16	4.29	3.10	-1.01	0.00	1.03
Mexico	3.04	13.13	9.79	3.09	9.53	6.25
Netherlands	0.41	4.01	3.58	1.72	5.66	3.88
Poland	4.81	35.42	29.20	7.86	30.56	21.05
Portugal	5.29	22.68	16.51	10.78	28.26	15.78
Romania	7.68	41.70	31.59	13.15	37.16	21.21
Russia	1.36	3.00	1.62	1.50	8.66	7.05
Slovakia	-2.06	38.32	41.23	4.61	23.69	18.25
Slovenia	5.89	66.86	57.58	14.80	70.19	48.26
Sweden	1.55	5.36	3.76	1.79	5.05	3.20
Turkey	9.55	40.66	28.40	12.77	46.61	30.01
Taiwan	0.34	8.17	7.80	0.93	10.63	9.61
United States	0.76	2.52	1.74	0.81	3.86	3.02
Average	**2.32**	**15.13**	**12.46**	**3.80**	**14.35**	**9.78**

Notes: This table reports the predicted change in skill premium and real wages under our baseline calibration, in Counterfactuals 1 and 2.