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Abstract

This paper investigates both aggregate and distributional impacts of the trade integration of China, India, and Central and Eastern Europe in a quantitative multi-country multi-sector model, comparing outcomes with and without factor market frictions. Under perfect within-country factor mobility, the gains to the rest of the world from trade integration of emerging giants are 0.37%, ranging from −0.37% for Honduras to 2.28% for Sri Lanka. Reallocation of factors across sectors contributes relatively little to the aggregate gains, but has large distributional effects. The aggregate gains to the rest of the world are only 0.065 percentage points lower when neither capital nor labor can move across sectors within a country. On the other hand, the distributional effects of the emerging giants' trade integration are an order of magnitude larger, with changes in real factor returns ranging from −5% to 5% across sectors in most countries. The workers and capital owners in emerging giants' comparative advantage sectors such as Textiles and Wearing Apparel experience greatest losses, while factor owners in Printing and Medical, Precision and Optical Instruments normally gain the most.

JEL Classifications: F11, F15, F16

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1 Introduction

The biggest event in world trade in te last 20 years is the rapid integration of emerging giants: China, India, and Central and Eastern European countries (CEECs). Their export growth since 1990 has been nothing short of spectacular: 12-fold in China, 8-fold in CEECs, and 6-fold in India. Together, these countries now account for 20% of world trade, up from 6% in 1990 (Figure 1). The rise of emerging giants raises two important questions. First, what is the aggregate welfare impact of emerging giants' trade integration on economies around the world, and what are the distributional impacts across sectors within a country? And second, how do factor market frictions affect these outcomes?

While the increased global trade integration should benefit the world as a whole, the gains to individual countries and sectors are likely to vary. When it comes to the aggregate gains, some countries – those with comparative advantages similar to the emerging giants – may lose from the giants' integration into global trade. For instance, there is some evidence that the growing importance of China has reduced export demand for a number of emerging market countries (Hanson and Robertson 2010), and it has been conjectured that the rise of China has been partly responsible for slower than expected economic growth in Mexico (Hanson 2010).

At the same time, trade integration of emerging giants will create both winners and losers within a country even if the aggregate gains are positive. There is a great deal of evidence that factor market reallocations in response to trade liberalization are far from frictionless (Artuç 2009, Artuç, Chaudhuri and McLaren 2010, Dix-Carneiro 2011). OECD (2005) provides evidence that developed country workers displaced by import competition experienced longer unemployment spells and larger income losses compared to workers losing jobs for other reasons. Autor, Dorn and Hanson (2012a) and Autor, Dorn, Hanson and Song (2012b) find a large differential impact of Chinese imports to the U.S. across local labor markets and individual workers. Relatedly, International Monetary Fund (2005) shows that the rise of emerging market exports contributed to the fall in the labor share of GDP in the OECD countries.

Not surprisingly, these developments led to a great deal of discussion about the optimal policies to address trade-induced labor market adjustments (OECD 2005, 2012), as well as concrete policy responses. In the U.S., the Trade Adjustment Assistance program was expanded significantly in 2009 (GAO 2012). At the same time, there were legislative proposals to raise tariffs on Chinese imports in retaliation for China's alleged currency manipulation (*New York Times* 2011).

This paper develops the first comprehensive global-scale quantitative welfare assessment of both aggregate and distributional effects of the emerging giants' trade integration. A model-based assessment is crucial for the following reasons. First and foremost, evaluating the impact of emerging giants on other countries requires finding the counterfactual equilibrium that would obtain in the absence of trade with the emerging giants. If a country cannot trade with the emerging giants, its trade with all of its other trading partners will change, which would in turn change the trade of its trading partners with other partners, and so on. The impact of emerging giants on each country depends on the magnitude and nature of that adjustment. A fully specified model allows us to calculate the counterfactual production allocations and trade flows, and the resulting counterfactual welfare. A regression estimation-based exercise cannot adequately capture the notion of a general equilibrium counterfactual and the associated complex changes in production and trade flows. Second, a fully specified model enables us to make statements about welfare. Computing welfare changes requires accounting for changes not just in (relative) factor prices, but goods prices as well, since gains from trade will be reaped partly through reductions in the latter. While our approach takes those into account, doing so is generally inaccessible to empirical work, in which relative factor prices or relative incomes are normally the objects of analysis. And third, we adopt an explicitly global perspective and analyze the impact of emerging giants on a wide variety of countries. In contrast to one-country studies such as Autor et al. (2012a), this allows us to detect and quantify some general patterns in the worldwide results.

Our analysis extends the large-scale quantitative model of the world economy recently developed by Levchenko and Zhang (2011, 2012). We build a multi-sector Ricardian-Heckscher-Ohlin model that incorporates a number of realistic features, such as multiple factors of production, an explicit non-traded sector, the full specification of input-output linkages between the sectors, and both inter- and intra-industry trade. The model is estimated using data on production and trade to yield sector-level productivities for 19 manufacturing sectors and a sample of 75 countries that includes China, India, all major CEECs, as well as virtually all of the other important economies in the world. Having estimated and solved for the long-run equilibrium of the model, we simulate the trade opening of the emerging giants under two extreme sets of assumptions: perfect within-country factor mobility and no factor mobility across sectors. This exercise allows us to isolate the impact of factor market frictions. In addition, we focus separately on frictions in the labor and capital markets, to identify which ones are more important for reaping the full gains from trade.

The main results can be summarized as follows. First, the gains to the rest of the world from integration of emerging giants under perfect factor mobility are 0.37%, ranging from -0.37% for Honduras to 2.28% for Sri Lanka. Second, reallocation of factors across sectors contributes relatively little to these gains: the welfare gains to the rest of the world are only about 0.065 percentage points lower in the fixed-factors version of the model in which neither capital nor labor can move across sectors within a country. Thus the aggregate gains from trade with emerging giants come largely from intra-industry trade.

Third, there are strong complementarities between reallocation of labor and capital across sectors. Versions of the model with immobile labor but mobile capital, or with immobile capital but mobile labor produce welfare changes that are quite close to the outcome when both factors are immobile. This suggests that to reap the full benefits of sectoral reallocation due to globalization, it is essential that both labor and capital markets function smoothly. Just one inflexible factor market, be it rigid labor markets (as in continental Europe), or poor capital markets (as in much of the developing world) will, quantitatively, negate the benefits of reallocation in the other factor markets.

Fourth, with imperfect factor mobility the distributional consequences of the emerging giants' integration are an order of magnitude greater than the aggregate consequences. While the aggregate gains to the rest of the world tend to amount to a fraction of a percent, in a typical country changes in real wages and returns to capital range from -5% to 5% across sectors. As a group, emerging giants' comparative advantage is in light manufacturing industries such as Textiles and Wearing Apparel, and their comparative disadvantage is in high-tech manufacturing industries such as Printing and Medical, Precision and Optical Instruments. Not surprisingly, in the rest of the world the workers and capital owners in light manufacturing experience greatest losses, while factor owners in high-tech sectors normally gain the most. Controlling for country and sector fixed effects, sectors with higher productivity tend to benefit the most/lose the least from trade opening.

Methodologically, our work builds on recent quantitative welfare assessments of trade integration in multi-sector Ricardian models (Shikher 2011, Caliendo and Parro 2010, Costinot, Donaldson and Komunjer 2012). A number of studies analyze the long-run aggregate impact of some of the emerging giant countries on welfare around the world (Coleman 2007, Hsieh and Ossa 2011, Levchenko and Zhang 2012, di Giovanni, Levchenko and Zhang 2013). This paper is the first to quantitatively explore the consequences of factor market frictions in this type of framework. In addition, because the trade integration of these emerging giant countries has been concurrent, we consider their joint global welfare impact.

Our work is also related to the Computable General Equilibrium (CGE) assessments of trade integration of the major emerging markets: see, e.g., Francois and Wignaraja (2008) and Ghosh and Rao (2010) for China, and Baldwin, Francois and Portes (1997), Brown, Deardorff, Djankov and Stern (1997), Hertel, Brockmeier and Swaminathan (1997), and Baourakis, Lakatos and Xepapadeas (2008) for Eastern Europe. Unlike the traditional CGE approach, our quantitative framework is based on Eaton and Kortum (2002)'s Ricardian model of trade with endogenous specialization both within and across sectors, which enables us to relate our findings to comparative advantage. Our global general equilibrium approach complements recent micro-level studies of the impact of trade with emerging markets in developed countries, such as Autor et al. (2012a), Bloom, Draca and Van Reenen (2011), and Hummels, Jorgensen, Munch and Xiang (2011).

Before moving on to the description of the model and the results, we outline some limitations of our analysis. Our model features fixed labor supply, and thus cannot be used to explore the role of emerging giants in the phenomenon of workers permanently leaving the labor force and the resulting reduction in aggregate employment. We conjecture that allowing for the possibility of workers leaving the labor force would reduce the labor supply in the import-competing industries, which would mitigate the adverse wage impact on the active workers. On the other hand the welfare impact on those leaving the labor force would then depend on their utility from not working. Similarly for capital, our analysis ignores the endogenous response of either domestic capital accumulation or cross-border capital flows to the opening of emerging giants. We do not have a working model of cross-border capital mobility that can be adapted to a large-scale cross-sectional quantitative model like ours, and developing such a model is beyond the scope of the paper. Our current framework also cannot be used to evaluate the role emerging giants may have played in the permanent de-industrialization process observed in a number of advanced economies. To capture this effect, the model would need to be augmented to incorporate tradeable services. Unfortunately, the data required for estimating the model with tradeable services are not currently available.

Finally, any exploration of the distributional effects of trade liberalization will depend on the level of sectoral disaggregation used in the analysis. In the immobile-factor equilibrium, our exercise by construction assumes that factors are specific to the sector at the level of disaggregation we employ (19 tradeable sectors and 1 non-tradeable).[1] Outcomes would differ if in reality factors were specific to much more narrowly defined activities. For instance, one of the sectors in our analysis is textiles, and thus our assumption is that a textile worker's skills are deployable in all types of textiles. However, if the skills of workers in cotton textiles were very different from the skills of workers in wool textiles, and cotton and wool sectors experienced very different trade shocks, then our analysis would likely understate the distributional impact of the trade shocks.

The rest of the paper is organized as follows. Section 2 lays out the quantitative framework and discusses the details of calibration and estimation. Section 3 discusses the main results, and Section 4 concludes.

[1]Our choice of the level of disaggregation is dictated by two considerations. The first is data availability: we require domestic output data, which are not available at much finer levels of disaggregation for as large a sample of countries as we would like. The second is conceptual: to make our framework tractable, we impose an Eaton and Kortum (2002) structure within each sector. That is, within each sector there is a continuum of varieties that can be produced in all countries but with different productivities. This ensures interior trade shares in each country and sector, and makes a large-scale quantitative analysis possible. Making sectors much more disaggregated will strain the assumption that there is still a continuum of varieties in each sector and all trade shares are interior.

2 Quantitative Framework

2.1 The Environment

The world is comprised of N countries, indexed by n and i. There are J tradeable sectors, plus one nontradeable sector $J+1$. Utility over these sectors in country n is given by

$$U_n = \left(\sum_{j=1}^{J} \omega_j^{\frac{1}{\eta}} \left(Y_n^j\right)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}\xi_n} \left(Y_n^{J+1}\right)^{1-\xi_n}, \tag{1}$$

where ξ_n denotes the Cobb-Douglas weight for the tradeable sector composite good, η is the elasticity of substitution between the tradeable sectors, ω_j is the taste parameter for tradeable sector j, Y_n^{J+1} is the nontradeable-sector composite good, and Y_n^j is the composite good in tradeable sector j.

Each sector j aggregates a continuum of varieties $q \in [0,1]$ unique to each sector using a CES production function:

$$Q_n^j = \left[\int_0^1 Q_n^j(q)^{\frac{\varepsilon-1}{\varepsilon}} dq \right]^{\frac{\varepsilon}{\varepsilon-1}},$$

where ε denotes the elasticity of substitution across varieties q, Q_n^j is the total output of sector j in country n, and $Q_n^j(q)$ is the amount of variety q that is used in production in sector j and country n. Producing one unit of good q in sector j in country n requires $\frac{1}{z_n^j(q)}$ input bundles.

Production uses labor (L), capital (K), and intermediate inputs from other sectors. The cost of an input bundle is:

$$c_n^j = \left((w_n^j)^{\alpha_j} (r_n^j)^{1-\alpha_j} \right)^{\beta_j} \left(\prod_{k=1}^{J+1} \left(p_n^k\right)^{\gamma_{k,j}} \right)^{1-\beta_j},$$

where w_n^j is the wage of workers in sector j, r_n^j is the return to capital installed in sector j, and p_n^k is the price of intermediate input from sector k. The value-added based labor intensity is given by α_j, and the share of value added in total output by β_j. Both vary by sector. The shares of inputs from other sectors, $\gamma_{k,j}$ vary by output industry j as well as input industry k.

Following Eaton and Kortum (2002, henceforth EK), productivity $z_n^j(q)$ for each $q \in [0,1]$ in each sector j is random, and drawn from the Fréchet distribution with cdf:

$$F_n^j(z) = e^{-T_n^j z^{-\theta}}.$$

In this distribution, the absolute advantage term T_n^j varies by both country and sector, with higher values of T_n^j implying higher average productivity draws in sector j in country n. The parameter θ captures dispersion, with larger values of θ implying smaller dispersion in draws.

The production cost of one unit of good q in sector j and country n is thus equal to $c_n^j/z_n^j(q)$. Each country can produce each good in each sector, and international trade is subject to iceberg costs: $d_{ni}^j > 1$ units of good q produced in sector j in country i must be shipped to country n in order for one unit to be available for consumption there. The trade costs need not be symmetric – d_{ni}^j need not equal d_{in}^j – and will vary by sector. We normalize $d_{nn}^j = 1$ for any n and j.

All the product and factor markets are perfectly competitive, and thus the price at which country i supplies tradeable good q in sector j to country n is:

$$p_{ni}^j(q) = \left(\frac{c_i^j}{z_i^j(q)}\right) d_{ni}^j.$$

Buyers of each good q in tradeable sector j in country n will only buy from the cheapest source country, and thus the price actually paid for this good in country n will be:

$$p_n^j(q) = \min_{i=1,\ldots,N} \left\{p_{ni}^j(q)\right\}.$$

2.2 Characterization of Equilibrium

The **competitive equilibrium** of this model world economy consists of a set of prices, allocation rules, and trade shares such that (i) given the prices, all firms' inputs satisfy the first-order conditions, and their output is given by the production function; (ii) given the prices, the consumers' demand satisfies the first-order conditions; (iii) the prices ensure the market clearing conditions for labor, capital, tradeable goods and nontradeable goods; (iv) trade shares ensure balanced trade for each country.

The set of prices includes the wage rates $\{w_n^j\}_{j=1}^{J+1}$, the rental rates $\{r_n^j\}_{j=1}^{J+1}$, the sectoral prices $\{p_n^j\}_{j=1}^{J+1}$, and the aggregate price P_n in each country n. The allocation rules include final consumption demand $\{Y_n^j\}_{j=1}^{J+1}$, total demand $\{Q_n^j\}_{j=1}^{J+1}$ (both final and intermediate goods) for each sector, and potentially the capital and labor allocation across sectors $\{K_n^j, L_n^j\}_{j=1}^{J+1}$. The trade shares include the expenditure share π_{ni}^j in country n on goods coming from country i in sector j.

We distinguish between 4 types of equilibria, that differ in the assumptions on factor market frictions: (i) flexible-factors equilibrium, in which both capital and labor are free to move across sectors; (ii) fixed-factors equilibrium, in which both capital and labor belong to a particular sector and cannot move across sectors; (iii) flexible-labor, fixed-capital equilibrium, in which capital cannot move across sectors but labor can do so frictionlessly, and (iv) flexible-capital, fixed-labor equilibrium, in which labor cannot move across sectors but capital can do so frictionlessly. All throughout, both capital are labor are immobile across countries.

2.2.1 Demand and Prices

The four equilibria have identical goods market clearing conditions. It can be easily shown that the price of sector j's output will be given by:

$$p_n^j = \left[\int_0^1 p_n^j(q)^{1-\varepsilon} dq\right]^{\frac{1}{1-\varepsilon}}.$$

Following the standard EK approach, it is helpful to define

$$\Phi_n^j = \sum_{i=1}^{N} T_i^j \left(c_i^j d_{ni}^j\right)^{-\theta}.$$

This value summarizes, for country n, the access to production technologies in sector j. Its value will be higher if in sector j, country n's trading partners have high productivity (T_i^j) or low cost (c_i^j). It will also be higher if the trade costs that country n faces in this sector are low. Standard steps lead to the familiar result that the price of good j in country n is simply

$$p_n^j = \Gamma\left(\Phi_n^j\right)^{-\frac{1}{\theta}}, \tag{2}$$

where $\Gamma = \left[\mathbf{\Gamma}\left(\frac{\theta+1-\varepsilon}{\theta}\right)\right]^{\frac{1}{1-\varepsilon}}$, with $\mathbf{\Gamma}$ the Gamma function. The consumption price index in country n is then:

$$P_n = B_n \left(\sum_{j=1}^{J} \omega_j (p_n^j)^{1-\eta}\right)^{\frac{1}{1-\eta}\xi_n} (p_n^{J+1})^{1-\xi_n}, \tag{3}$$

where $B_n = \xi_n^{-\xi_n}(1-\xi_n)^{-(1-\xi_n)}$.

The budget constraint (or the resource constraint) of the consumer is thus given by

$$\sum_{j=1}^{J+1} p_n^j Y_n^j = \sum_{j=1}^{J+1} w_n^j L_n^j + \sum_{j=1}^{J+1} r_n^j K_n^j, \tag{4}$$

where K_n^j and L_n^j are the amounts of capital and labor, respectively, in country n, sector j.

Given the set of prices $\{\{w_n^j\}_{j=1}^{J+1}, \{r_n^j\}_{j=1}^{J+1}, P_n, \{p_n^j\}_{j=1}^{J+1}\}_{n=1}^{N}$, we first characterize the optimal allocations from final demand. Consumers maximize utility (1) subject to the budget constraint (4). The first order conditions associated with this optimization problem imply the following final demand:

$$p_n^j Y_n^j = \xi_n \left(\sum_{j=1}^{J+1} w_n^j L_n^j + \sum_{j=1}^{J+1} r_n^j K_n^j\right) \frac{\omega_j (p_n^j)^{1-\eta}}{\sum_{k=1}^{J} \omega_k (p_n^k)^{1-\eta}}, \text{ for all } j = \{1, .., J\} \tag{5}$$

and

$$p_n^{J+1}Y_n^{J+1} = (1-\xi_n)\left(\sum_{j=1}^{J+1} w_n^j L_n^j + \sum_{j=1}^{J+1} r_n^j K_n^j\right).$$

2.2.2 Production Allocation and Goods Market Clearing

Let Q_n^j denote the total sectoral demand in country n and sector j. Q_n^j is used for both final consumption and as intermediate inputs in domestic production of all sectors. Denote by $X_n^j = p_n^j Q_n^j$ the total *spending* on the sector j goods in country n, and by X_{ni}^j country n's total spending on sector j goods coming from country i, i.e. n's imports of j from country i. The EK structure in each sector j delivers the standard result that the probability of importing good q from country i, π_{ni}^j is equal to the share of total spending on goods coming from country i, X_{ni}^j/X_n^j, and is given by:

$$\frac{X_{ni}^j}{X_n^j} = \pi_{ni}^j = \frac{T_i^j\left(c_i^j d_{ni}^j\right)^{-\theta}}{\Phi_n^j}. \tag{6}$$

The market clearing condition for expenditure on sector j in country n is:

$$p_n^j Q_n^j = p_n^j Y_n^j + \sum_{k=1}^{J}(1-\beta_k)\gamma_{j,k}\left(\sum_{i=1}^{N}\pi_{in}^k p_i^k Q_i^k\right) + (1-\beta_{J+1})\gamma_{j,J+1}p_n^{J+1}Q_n^{J+1}.$$

Total expenditure in sector j of country n, $p_n^j Q_n^j$, is the sum of (i) domestic final consumption expenditure $p_n^j Y_n^j$; (ii) expenditure on sector j goods as intermediate inputs in all the traded sectors $\sum_{k=1}^{J}(1-\beta_k)\gamma_{j,k}(\sum_{i=1}^{N}\pi_{in}^k p_i^k Q_i^k)$, and (iii) expenditure on the j's sector intermediate inputs in the domestic non-traded sector $(1-\beta_{J+1})\gamma_{j,J+1}p_n^{J+1}Q_n^{J+1}$. These market clearing conditions summarize two important features of the world economy captured by our model: complex international production linkages, as much of world trade is in intermediate inputs, and a good crosses borders multiple times before being consumed (Hummels, Ishii and Yi 2001); and two-way input linkages between the tradeable and the nontradeable sectors.

In each tradeable sector j, some goods q are imported from abroad and some goods q are exported to the rest of the world. Country n's exports in sector j are given by $EX_n^j = \sum_{i=1}^{N}\mathbb{1}_{i\neq n}\pi_{in}^j p_i^j Q_i^j$, and its imports in sector j are given by $IM_n^j = \sum_{i=1}^{N}\mathbb{1}_{i\neq n}\pi_{ni}^j p_n^j Q_n^j$, where $\mathbb{1}_{i\neq n}$ is the indicator function. The total exports of country n are then $EX_n = \sum_{j=1}^{J} EX_n^j$, and total imports are $IM_n = \sum_{j=1}^{J} IM_n^j$. Trade balance requires that for any country n, $EX_n - IM_n = 0$.

2.2.3 Factor Market Clearing in the Four Equilibria

Given the total production revenue in tradeable sector j in country n, $\sum_{i=1}^{N} \pi_{in}^{j} p_i^j Q_i^j$, the sectoral factor allocations and factor prices must satisfy

$$\sum_{i=1}^{N} \pi_{in}^{j} p_i^j Q_i^j = \frac{w_n^j L_n^j}{\alpha_j \beta_j} = \frac{r_n^j K_n^j}{(1-\alpha_j)\beta_j}. \tag{7}$$

For the nontradeable sector $J+1$, the optimal factor allocations in country n are simply given by

$$p_n^{J+1} Q_n^{J+1} = \frac{w_n^{J+1} L_n^{J+1}}{\alpha_{J+1}\beta_{J+1}} = \frac{r_n^{J+1} K_n^{J+1}}{(1-\alpha_{J+1})\beta_{J+1}}. \tag{8}$$

Finally, the feasibility conditions for factors are given by, for every n,

$$\sum_{j=1}^{J+1} L_n^j = L_n \text{ and } \sum_{j=1}^{J+1} K_n^j = K_n, \tag{9}$$

where L_n and K_n are aggregate country endowments of labor and capital.

In the **flexible-factors equilibrium**, both factors can move, so that wages and returns to capital must be equalized across sectors in each country: $w_n^j = w_n$ and $r_n^j = r_n$ for all j. Correspondingly, sectoral factor allocations L_n^j and K_n^j are equilibrium outcomes that will adjust to satisfy equality of factor returns in all sectors. Equilibrium w_n, r_n, and $\{K_n^j, L_n^j\}_{j=1}^{J+1}$ are the solutions to the systems of equations (7)-(8)-(9).

In the **fixed-factors equilibrium**, $\{K_n^j, L_n^j\}_{j=1}^{J+1}$ are instead fixed endowments in each country and sector. Once we take a stand on what those endowments are, the set of conditions (9) becomes vacuous, and the systems of equations (7)-(8) are instead solved for sectoral factor prices $\{w_n^j, r_n^j\}_{j=1}^{J+1}$ given sectoral factor endowments.

The **flexible-labor, fixed-capital** and **flexible-capital, fixed-labor** equilibria are intermediate cases. In the former, $\{L_n^j\}_{j=1}^{J+1}$ are endogenous equilibrium outcomes that ensure equality of wages across sectors within a country, $w_n^j = w_n$ for all j, but $\{K_n^j\}_{j=1}^{J+1}$ are exogenous endowments used to compute sector-specific rates of return $\{r_n^j\}_{j=1}^{J+1}$. In the latter, assumptions on which factors are fixed and flexible are reversed.

The fixed-factor equilibria are in effect modern versions of the Specific-Factors Model (Jones 1971, Mussa 1974). Though all of the models in our analysis are formally static, the implicit assumption is that the fixed-factor models are in some sense short-run, whereas the long-run outcome is captured by the flexible-factor equilibrium. An extreme opposite approach to factor market frictions is adopted by Święcki (2013) (following Haberler 1950, Hagen 1958, Bhagwati and Ramaswami 1963). In that framework, wage disparities across sectors are due to institutional frictions and persist even under perfect cross-sectoral factor mobility. By assumption, the size of those wage disparities is fixed, and thus trade shocks have no effect on cross-sectoral wage distributions.

One limitation of our analysis is that we do not model the transition between the fixed-factors ("short-run") and the flexible-factors ("long-run") equilibria, and thus cannot provide a unified intertemporal welfare assessment that cumulates welfare changes for workers along the transition path. To do so would require a model of frictional unemployment, since a typical finding in the literature is that workers in import-competing industries suffer unemployment spells and only find new jobs with some delay (Menezes-Filho and Muendler 2011, Autor et al. 2012a). Combining a multi-sector frictional unemployment model with a global general equilibrium production and trade framework is a substantial modeling and computational challenge that is left to future work.

The model has two principal uses. The first is to estimate the sector-level technology parameters T_n^j for a large set of countries. The technology parameters in the tradeable sectors relative to a reference country (the U.S.) are estimated using data on sectoral output and bilateral trade. The procedure relies on fitting a structural gravity equation implied by the model. Intuitively, if controlling for the typical gravity determinants of trade, a country spends relatively more on domestically produced goods in a particular sector, it is revealed to have either a high relative productivity or a low relative unit cost in that sector. The procedure then uses data on factor and intermediate input prices to net out the role of factor costs, yielding an estimate of relative productivity. This step also produces estimates of bilateral, sector-level trade costs d_{ni}^j. The next step is to estimate the technology parameters in the tradeable sectors for the U.S.. This procedure requires directly measuring TFP at the sectoral level using data on real output and inputs, and then correcting measured TFP for selection due to trade. Third, we calibrate the nontradeable technology for all countries using the first-order condition of the model and the relative prices of nontradeables observed in the data. The detailed procedures for all three steps are described in Levchenko and Zhang (2011) and reproduced in Appendix A.

The second use of the quantitative model is to perform welfare analysis. Given the estimated sectoral productivities, factor endowments, trade costs, and model parameters, we solve the system of equations defining the equilibrium under the baseline values, as well as under counterfactual scenarios, and compare welfare. The algorithm for solving the model is described in Levchenko and Zhang (2011).

2.3 Welfare

Welfare in this framework corresponds to the indirect utility function. The functional form of the utility function and homothetic preferences imply that welfare of any agent in the economy equals his/her total income divided by the price level. Since both goods and factor markets are competitive, total income equals the total returns to factors of production. Total welfare in the economy is given by

$$\frac{\sum_{j=1}^{J+1} w_n^j L_n^j + \sum_{j=1}^{J+1} r_n^j K_n^j}{P_n}, \tag{10}$$

where the consumption price level P_n comes from equation (3). This expression is the metric of aggregate welfare in all counterfactual exercises below. Of course, in the flexible market equilibrium, when all factor returns are the same, the expression above simplifies to, in per capita terms, the more familiar expression $(w_n + r_n k_n)/P_n$, where $k_n = K_n/L_n$ is capital per worker.

When (some) factor markets are not flexible, workers and units of capital employed in the different sectors will earn different wages and returns. Without making assumptions about individuals' capital asset holdings, we cannot make statements about individuals' welfare. Thus, when discussing distributional impacts in our counterfactual exercises, we will present results with respect to the real wage and the real returns to capital across sectors, w_n^j/P_n and r_n^j/P_n.

2.4 Calibration

In order to implement the model numerically, we must calibrate the following sets of parameters: (i) moments of the productivity distributions T_n^j and θ; (ii) trade costs d_{ni}^j; (iii) production function parameters α_j, β_j, $\gamma_{k,j}$, and ε; (iv) country factor endowments L_n and K_n; and (v) preference parameters ξ_n, ω_j, and η. We discuss the calibration of each in turn.

Estimation of sectoral productivity parameters T_n^j and trade costs d_{ni}^j requires data on total output by sector, as well as sectoral data on bilateral trade. For 52 countries in the sample, information on output comes from the 2009 UNIDO Industrial Statistics Database. For the European Union countries, the EUROSTAT database contains data of superior quality, and thus for those countries we use EUROSTAT production data. The two output data sources are merged at the roughly 2-digit ISIC Revision 3 level of disaggregation, yielding 19 manufacturing sectors. Bilateral trade data were collected from the UN COMTRADE database, and concorded to the same sectoral classification. The baseline analysis assumes that the dispersion parameter θ does not vary across sectors. We pick the value of $\theta = 8.28$, which is the preferred estimate of EK. To check whether our conclusions are sensitive to this restriction, Section 3.4 reports the results of implementing the model with sector-specific values of θ_j sourced from Caliendo and Parro (2010).[2]

[2]It may also be important to assess how the results below are affected by the level of θ. One may be especially concerned about how the results change under lower values of θ. Lower θ implies greater within-sector heterogeneity in the random productivity draws. Thus, trade flows become less sensitive to the costs of the input bundles (c_i^j), and the gains from intra-sectoral trade become larger relative to the gains from inter-sectoral trade. Elsewhere (Levchenko and Zhang 2011) we re-estimated all the technology parameters using instead a value of $\theta = 4$, which has been advocated by Simonovska and Waugh (2011) and is at or near the bottom of the range that has been used in the literature. Overall, the outcome was remarkably similar. The correlation between estimated T_i^j's under

The production function parameters α_j and β_j are estimated using the UNIDO and EUROSTAT production data, which contain information on output, value added, employment, and wage bills. To compute α_j for each sector, we calculate the share of the total wage bill in value added, and take a simple median across countries (taking the mean yields essentially the same results). To compute β_j, we take the median of value added divided by total output.

The intermediate input coefficients $\gamma_{k,j}$ are obtained from the Direct Requirements Table for the United States. We use the 1997 Benchmark Detailed Make and Use Tables (covering approximately 500 distinct sectors), as well as a concordance to the ISIC Revision 3 classification to build a Direct Requirements Table at the 2-digit ISIC level. The Direct Requirements Table gives the value of the intermediate input in row k required to produce one dollar of final output in column j. Thus, it is the direct counterpart to the input coefficients $\gamma_{k,j}$. Note that we assume these to be the same in all countries.[3] In addition, we use the U.S. I-O matrix to obtain α_{J+1} and β_{J+1} in the nontradeable sector, which cannot be obtained from UNIDO.[4] The elasticity of substitution between varieties within each tradeable sector, ε, is set to 4 (as is well known, in the EK model this elasticity plays no role, entering only the constant Γ).

The total labor force in each country, L_n, and the total capital stock, K_n, are obtained from the Penn World Tables 6.3. Following the standard approach in the literature (see, e.g. Hall and Jones 1999, Bernanke and Gürkaynak 2001, Caselli 2005), the total labor force is calculated from the data on the total GDP per capita and per worker.[5] The total capital is calculated using the perpetual inventory method that assumes a depreciation rate of 6%: $K_{n,t} = (1-0.06)K_{n,t-1}+I_{n,t}$, where $I_{n,t}$ is total investment in country n in period t. For most countries, investment data start in 1950, and the initial value of K_n is set equal to $I_{n,0}/(\gamma + 0.06)$, where γ is the average growth rate of investment in the first 10 years for which data are available.

The share of expenditure on traded goods, ξ_n in each country is sourced from Yi and Zhang (2010), who compile this information for 36 developed and developing countries. For countries unavailable in the Yi and Zhang data, values of ξ_n are imputed based their level of development. We fit a simple linear relationship between ξ_n and log PPP-adjusted per capita GDP from the Penn World Tables on the countries in the Yi and Zhang (2010) dataset. The fit of this simple

$\theta = 4$ and the baseline is above 0.95, and there is actually somewhat greater variability in T_i^j's under $\theta = 4$.

[3]di Giovanni and Levchenko (2010) provide suggestive evidence that at such a coarse level of aggregation, Input-Output matrices are indeed similar across countries. To check robustness of the results, we collected country-specific I-O matrices from the GTAP database. Productivities computed based on country-specific I-O matrices were very similar to the baseline values. In our sample of countries, the median correlation was 0.98, with all but 3 out of 75 countries having a correlation of 0.93 or above, and the minimum correlation of 0.65.

[4]The U.S. I-O matrix provides an alternative way of computing α_j and β_j. These parameters calculated based on the U.S. I-O table are very similar to those obtained from UNIDO, with the correlation coefficients between them above 0.85 in each case. The U.S. I-O table implies greater variability in α_j's and β_j's across sectors than does UNIDO.

[5]Using the variable name conventions in the Penn World Tables, $L_n = 1000 * pop * rgdpch/rgdpwok$.

bivariate linear relationship is quite good, with an R^2 of 0.55. For the remaining countries, we then set ξ_n to the value predicted by this bivariate regression at their level of income. The taste parameters for tradeable sectors ω_j were estimated by combining the model structure above with data on final consumption expenditure shares in the U.S. sourced from the U.S. Input-Output matrix, as described in Appendix A. The elasticity of substitution between broad sectors within the tradeable bundle, η, is set to 2. Since these are very large product categories, it is sensible that this elasticity would be relatively low. It is higher, however, than the elasticity of substitution between tradeable and nontradeable goods, which is set to 1 by the Cobb-Douglas assumption.

2.5 Summary of the Estimates and Basic Patterns

All of the variables that vary over time are averaged over the period 2005-2007 (the latest available year), which is the time period on which we carry out the analysis. Appendix Table A1 lists the 75 countries used in the analysis, separating them into the major country groups and regions. Appendix Table A2 lists the 20 sectors along with the key parameter values for each sector: α_j, β_j, the share of nontradeable inputs in total inputs $\gamma_{J+1,j}$, and the taste parameter ω_j.

What do the data tell us about the emerging giants' comparative advantage? Figure 2 reports the population-weighted average sectoral productivities of emerging giant countries, expressed as a ratio to the world frontier. To be precise, we compute the world frontier productivity in each sector as the geometric average of the top two productivities in the sample of all countries. Since average sectoral productivity scales with $(T_n^j)^{1/\theta}$ rather than T_n^j, we report the (population-weighted) ratio of $(T_n^j)^{1/\theta}$ to the world frontier $(T_F^j)^{1/\theta}$.

Even taken as a group, emerging giants do indeed have pronounced comparative advantage. The top four sectors are Wearing Apparel (ISIC 18), Food and Beverages (15), Fuels (23), and Textiles (15). In these sectors, emerging giants' productivity is about $0.50-0.55$ of the world frontier. By contrast, the least productive sectors are Printing and Publishing (22) and Medical, Precision, and Optical Instruments (33), with productivity in the range of $0.3-0.35$ of the world frontier.

3 Welfare Analysis

This section analyzes the global welfare impact of emerging giants' trade integration under the different assumptions on factor market reallocation. We proceed by first solving the model under the baseline values of all the estimated parameters, and present a number of checks on the model fit with respect to observed data. The baseline estimation and solution is carried out under the assumption of flexible factor markets. This approach in effect assumes that by the mid-2000s, factor market adjustment to the trade opening of these countries had already (largely) occurred.

Then, we compute counterfactual welfare and sectoral factor allocations under the assumption that the emerging giants are in autarky, and factor markets are flexible. This is the "long-run" state of the world economy in the hypothetical absence of trade with emerging giants. The welfare change due to the opening of emerging giants under flexible factor markets is then given by the comparison of baseline welfare to welfare when emerging giants are in autarky.

Then, we solve the model under three additional scenarios with inflexible factor markets. In the fixed-factors equilibrium, emerging giants are open to trade, but all factors must remain in sectors where they were *when the emerging giants were in autarky.* The comparison between this counterfactual and the equilibrium with emerging giants in autarky thus captures the welfare change that occurs when emerging giants open to trade, but factors cannot move to optimally adjust to this trade integration. In the fixed-labor equilibrium, only labor cannot move from its allocation when emerging giants were in autarky, while in the fixed-capital equilibrium, only capital cannot.

3.1 Model Fit

Table 1 compares the wages, returns to capital, and trade shares in the baseline model and in the data. The top panel shows that mean and median wages implied by the model are very close to the data. The correlation coefficient between model-implied wages and those in the data is above 0.99. The second panel performs the same comparison for the return to capital. Since it is difficult to observe the return to capital in the data, we follow the approach adopted in the estimation of T_n^j's and impute r_n from an aggregate factor market clearing condition: $r_n/w_n = (1-\alpha)L_n/(\alpha K_n)$, where α is the aggregate share of labor in GDP, assumed to be 2/3. Once again, the average levels of r_n are very similar in the model and the data, and the correlation between the two is about 0.94.

Since much of the paper is concerned with the cross-sectoral distributional effects, it is important to check how well the baseline model solution reproduces observed sectoral labor shares. For most (but not all) countries in the sample, sectoral employment data for manufacturing are available in the EUROSTAT and UNIDO databases. We correlate those observed sectoral employment shares with those implied by the model. The correlation, reported in Table 1, is quite high at 0.711.[6] It is important to emphasize that there are many reasons why the model would not reproduce sectoral labor shares perfectly, beyond the fact that our match of relative factor prices and trade shares is not exact. For instance, taste parameters (ω_j's), I-O matrices, and factor intensities (α_j's) may differ across countries, whereas our model assumes those to be the same. Nonetheless, it is quite reassuring that the model employment shares are actually close to

[6] We do not report model and data averages for sectoral trade shares, since the mean sectoral employment share is by construction equal to $1/J$.

the data. To flesh out country detail, Appendix Table A3 summarizes country-specific employment share correlations by region.[7] We can see that by and large the fit of the model to observed employment shares in individual countries is quite good. In many regions, mean/median country-level correlations of sectoral employment shares between the model and the data are around 0.8. Even looking at the minimum values of those correlations, we can see that these are still quite high in most regions. The exception is Saudi Arabia, for which sectoral labor shares in the model and data are virtually uncorrelated. Saudi Arabia is very special in its extreme reliance on oil exports. Since our model does not include the raw mining sectors, it is not surprising that the model fit to Saudi Arabia is poor. As will become clear below, none of the results are driven by what happens in this particular country.[8]

Next, we compare the trade shares implied by the model to those in the data. The fourth panel of Table 1 reports the spending on domestically produced goods as a share of overall spending, π^j_{nn}. These values reflect the overall trade openness, with lower values implying higher international trade as a share of absorption. Though we under-predict overall trade slightly (model π^j_{nn}'s tend to be higher), the averages are quite similar, and the correlation between the model and data values is 0.91. Finally, the bottom panel compares the international trade flows in the model and the data. The averages are very close, and the correlation between model and data is nearly 0.9.

Figure 3 presents the comparison of trade flows graphically, by depicting the model-implied trade values against the data, along with a 45-degree line. Red/solid dots indicate π^j_{ni}'s that involve one of the emerging giants, that is, trade flows in which an emerging giant is either an exporter or an importer. All in all the fit of the model to trade flows is quite good. Emerging giants are unexceptional, with their trade flows clustered together with the rest of the observations.

We conclude from this exercise that our model matches quite closely the relative incomes of countries, sectoral employment shares, as well as bilateral and overall trade flows observed in the data. We now use the model to carry out a number of counterfactual scenarios to assess the emerging giants' global welfare impact.

3.2 Gains under Flexible Factor Markets

Panel A of Table 2 reports the gains from trade with the emerging giants around the world under the assumption of flexible factor markets. To compute these, we compare the welfare of each country in the baseline (current levels of trade costs and productivities as we estimate them

[7]Note that not all countries have data on sectoral labor shares. In addition, we impose a cutoff that to compute a country-specific correlation of employment shares, the country must have data for at least 17 out of 19 possible tradeable sectors. Varying this data availability cutoff between 2 and 19 produces quite similar results.

[8]We cannot compare model and data sectoral allocations of capital, because we do not have comprehensive data on sectoral capital stocks. To construct sectoral capital stocks in our data would require cumulating sectoral investment series. However, these investment series are not as reliable we as would like, have patchy coverage, and for many countries start too late to make the perpetual inventory method applicable.

in the world today) against a counterfactual scenario in which emerging giants are in autarky. The table reports the change in welfare for emerging giants themselves, as well as the summary statistics for each region and country group. China's gains from trade relative to complete autarky are 3.48%, India's 1.63%, and CEECs' gains range from 2.75% for Russia to 13.26% for Bulgaria, with an average of 7.26%. Elsewhere in the world, the gains range from −0.37% to 2.28%, with the mean of 0.37%.[9] The gains for the rest of the world from emerging giants' trade integration are smaller than for emerging giants themselves because these gains are relative to the counterfactual that preserves all the global trade relationships other than with the emerging giants.

The countries gaining the most tend to be close to the emerging giants geographically. The top three are Sri Lanka (2.28%), Senegal (1.21%), and Malaysia (1.16%). Of the top 10, 6 are in Asia, the other four being Senegal, Ethiopia, Kuwait, and Austria. As a region, East and South Asia gains the most (0.7% average), while Latin America and the Caribbean gain the least (0.16%). Table 2 also reveals that in several major country groups, the welfare changes range from negative to positive. A total of four countries lose in absolute terms from entry of emerging giants into world trade: Honduras (−0.37%), El Salvador (−0.13%), Pakistan (−0.05%), and Portugal (−0.01%).

3.3 Sectoral Reallocation and Reaping the Aggregate Gains

The preceding counterfactual assumed that factor markets are fully flexible within countries, and thus the welfare changes computed in that scenario corresponded to the long-run, complete gains from trade integration with the emerging giants. Next, we assess the importance of cross-sectoral reallocation in reaping the full magnitude of those gains.

Panel B of Table 2 reports the welfare gains from trade with emerging giants under the assumption of all factors fixed. It is immediate that gains are smaller. For China, for instance, the gains from trade are now 3.13%, compared to 3.48% under flexible factors. It is also clear that the broad patterns in the data as to which regions gain the most and least are the same.

Table 3 reports the differences between the percentage changes in welfare from the opening up of emerging giants under the assumption of fixed factor(s) and the welfare changes under flexible markets. Negative numbers imply that gains under the fixed factors are (unsurprisingly) smaller than under flexible factors. The first column presents the difference under both factors fixed. China gains 0.35 percentage points less when both factors are fixed compared to the flexible case (3.13% vs. 3.48%). India gains 0.23% less, while in the CEECs the effect is somewhat larger in absolute terms, 0.78%. Elsewhere in the world, the mean difference amounts to 0.03−0.16%. By and large, perfect factor reallocation between sectors contributes 10−15% of the total gains from

[9] This is the unweighted mean across the 63 rest-of-the-world countries. The population-weighted mean is similar at 0.33%.

trade with these countries.

Is there a factor of production that is especially crucial for reaping the benefits of factor reallocation? To answer this question, we evaluated the gains from trade with the emerging giants under two additional sets of assumptions: fixed-labor and fixed-capital, with the corresponding other factor being mobile. The results are reported in the second and third columns of Table 3. Several conclusions stand out. As expected, the differences with respect to the flexible-factor case tend to be smaller under these two scenarios: gains tend to be larger when one of the factors can reallocate optimally than when none of the factors can. However, the difference is quite minor quantitatively. For all intents and purposes, the scenarios with one factor fixed produce very similar results to the case in which both factors are fixed. This result points to a strong complementarity between reallocation of labor and capital. Both are required to reap the full gains from reallocation, and just one immobile factor prevents the large majority of total gains from factor reallocation.

We explore further the relationship between the welfare gains under the different factor (im)mobilities in Table 4 and Figure 4. The table presents the correlations between the welfare changes implied by the four scenarios. It is clear that all four are extremely highly correlated, with correlation coefficients in excess of 0.98 in nearly all cases, and above 0.99 between the three fixed-factors equilibria. The figure presents the scatterplot of the welfare changes in the three inflexible equilibria on the y-axis against the welfare change in the flexible case on the x-axis, along with the 45-degree line. By and large, the observations are slightly below the 45-degree line. The different inflexible equilibria are different from each other, but only very slightly.

Why does the cross-sectoral factor reallocation contribute relatively little to reaping the aggregate gains from trade with emerging giants? A proximate explanation for this outcome is that even with fully flexible factor markets, the cross-sectoral reallocation that occurs in response to emerging giants' opening is minor. In the rest of the world, when emerging giants open to trade absolute changes in sectoral employment shares range from -1.5% to 1.9% (that is, in the entire sample of the rest of the world country-sectors, an individual sector's share of total employment rises by a maximum of 1.9 percentage points). In most countries this range is much smaller. For instance, in the U.S. the most hard-hit sector contracts its share of aggregate employment by 0.03 percentage points, while the sector with the largest expansion lifts its share of total employment by 0.06 percentage points. Thus, the absolute factor reallocation required to adjust to the emerging giants' trade opening is not that large in most countries. As a result, cross-sectoral reallocation contributes relatively little to aggregate gains. However, as we will see below the lack of factor reallocation does produce more substantial distributional effects.

3.4 Additional Exercises

Before moving on to the distributional effects, we discuss two sets of additional experiments. A number of recent papers have called attention to the differences in trade elasticities across sectors (Caliendo and Parro 2010, Chen and Novy 2011, Imbs and Méjean 2011). To check how our results change if we instead assume that the trade elasticities differ across sectors, we re-implement the model using Caliendo and Parro (2010)'s estimates of sector-specific θ_j. Note that this alternative approach requires us to re-estimate the entire model, starting with the sectoral productivity parameters T_n^j and trade costs d_{ni}^j.

Table 5 reports the results. The gains from the emerging giants' integration do appear somewhat larger than under the baseline assumption of identical θ across sectors. Under flexible factor markets (Panel A), the mean gains to the rest of the world are 0.87%, with a median of 0.53%. The range is similar to the baseline, from -0.25% to 3.94%. The relative importance of cross-sectoral reallocation for aggregate gains is also close to the baseline. The mean gains to the rest of the world under immobile factors (Panel B) are 0.78%, or about 0.09% lower than under flexible factor markets.

Next, rather than evaluating the impact of emerging giants by placing them in autarky, we consider two intermediate experiments. First, we simulate a less drastic change in trade costs. Ideally, one would look at how emerging giants' estimated trade costs changed between some pre-trade liberalization period and the present, and evaluate the welfare impact of that change. Unfortunately, for most of the emerging giants we only have data starting in the mid-1990s, and our estimates for that period indicate that by then the reduction in d_{ni}^j had already largely occurred (that is, the subsequent change in d_{ni}^j between mid-1990s and the 2005-07 period has been minor). To simulate a substantial change in trade costs, we evaluate the welfare impact of a uniform 45% reduction in trade costs of all emerging giants down to their present level. That is, we compare the baseline level of welfare to the welfare that would obtain if all emerging giants' trade costs were 45% higher. The value of 45% is motivated by the size of the drop in d_{ni}^j between the 1970s and 2005-07 for India, the one emerging giant for which we have pre-1980 data. Panel A of Table 6 presents the results. On average, the gains to the rest of the world from a 45% reduction in trade costs are 0.16%, or nearly half of the total gains from trade with emerging giants.

A closely related question is whether the gains to the rest of the world come from the reductions in trade costs *per se* or from the rapid productivity growth in emerging giants over this period. Note that in a multi-sector environment, it is well known that productivity growth in one trading partner need not improve the welfare of another (Hicks 1953, Dornbusch, Fischer and Samuelson 1977, Samuelson 2004, Ju and Yang 2009), and the outcomes become even more nuanced when there are more than 2 countries (di Giovanni et al. 2013). To assess the global welfare impact of emerging giants' growth, we simulate the effect of the productivity growth in those countries between the 1995-99 and 2005-07 periods. To be precise, we compare welfare in the baseline to the counterfactual in which trade costs are unchanged, but the emerging giants' productivity in each sector is reduced to the 1995-99 estimated value.

Panel B of Table 6 presents the results. Not surprisingly, the welfare changes from productivity growth are smaller than the full wefare impact of trade integration. The mean gains to the rest of the world from emerging giants' productivity growth are 0.12%, or about one-third of the full gains from their integration relative to autarky. There is some interesting variation across regions as well. The OECD countries experience on average a 0.05% welfare loss from observed productivity growth in emerging giants, equivalent in absolute value to about one-sixth of their average gains from trade with those countries. Other regions show gains that are higher than the global average. In the Middle East-North Africa region, the average gains from the emerging giants' productivity growth, 0.34%, are more than three-quarters of the total gains from trade with emerging giants, which are 0.44% in this group.

All in all, though there is no reason to expect the impacts of reductions in trade costs and productivity growth to be additive, the combined average gains to the rest of the world from these two experiments are 0.28%, equivalent to three-quarters of the total average gains from trade with emerging giants, which are 0.37%.

3.5 Distributional Effects

The key feature of the fixed-factors equilibrium is that the changes in real wages and returns to capital brought about by the opening of emerging giants will differ across sectors. This allows us to examine the distributional effects of this episode. Appendix Tables A4 and A5 report the summary statistics for the distribution of sectoral real wage changes (w_n^j/P_n's) for the emerging giant and the rest of the world samples, respectively.[10]

The first important conclusion is that the distributional effects are an order of magnitude larger than the average/aggregate effects. We saw above that for emerging giants, aggregate welfare gains were on the order of a few percentage points, ranging from about 1.7% to about 14% in this set of countries. The cross-sectoral standard deviation of real wage changes, by contrast, ranges from 7.24% in Poland to 31.96% for Kazakhstan, with an average of 15.76%. The range of outcomes is very wide, from large losses (more than halving of the real wage) to large gains (such as a doubling of the real wage). For the rest of the world, both the aggregate gains (as we saw

[10]Due to the Cobb-Douglas assumption in production, the changes in real returns to capital are very close to the changes in real wages, both in terms of the overall magnitudes, and in terms of correlations between changes in real wages and real returns to capital across country-sectors. Thus, the focus on real wages is in some sense without loss of generality.

above), and the dispersion are smaller, but it is still the case that the distributional consequences are far larger than the aggregate changes.

We now document the patterns found in these sectoral real wage changes. The first question we ask is, are there particular sectors that bore the brunt of the adjustment, and others that on average benefited the most? Table 7 reports the cross-country medians of the real wage changes in each sector, separately for the emerging giants and the rest of the world. The beneficiary sectors for emerging giants are Wood Products, Leather and Footwear, Basic Metals, and Wearing Apparel. By contrast, Medical, Precision, and Optical Instruments and Paper and Paper Products experience net losses, on average. For the Rest of the World, the sectors with the largest losses are Wearing Apparel, Textiles, Furniture, and Leather and Footwear, all experiencing absolute losses between 1.5% and 3.5%.

There is a striking (though not surprising) regularity that the sectoral gains and losses are negatively correlated across the two groups. Figure 5 presents a scatterplot of sectoral wage changes in the rest of the world on the y-axis against sectoral wage changes in emerging giants, along with the least squares fit line. The negative relationship is quite pronounced, with the correlation of -0.63. Sectors that tend to gain in emerging giant countries tend to lose in the rest of the world, and vice versa. By and large, the opening of emerging giants benefited light manufacturing in the emerging giants (Textiles, Apparel, Footwear), and hurt workers in those sectors elsewhere. By contrast, in the rest of the world workers in high-tech manufacturing sectors (Medical and Precision Machinery, Office and Computing Equipment) tend to gain.

This pronounced global pattern at sector level hides a fair amount of heterogeneity across countries and regions. Figure 6 plots, for each sector, the median real wage change in each region. For emerging giants, we separate China, India, and the median for the CEECs. For the rest of the world, we report medians for each major region/country group. (The numbers used to build this figure are reported in Table A6.) The cross-regional heterogeneity is apparent. For instance, the rest of the world loses on average in Wearing Apparel. We see from the figure that the highest losses in that sector were in the OECD and East and South Asia. For Leather and Footwear, the gains across regions actually range from large negative for the OECD to large positive for the Middle East/North Africa and East and South Asia. On average we found that the high-tech manufacturing sectors in the rest of the world tend to benefit. It is clear from the figure that the main beneficiaries are the OECD and East and South Asian countries.

For the emerging giants, we see a great deal of dispersion within each sector as well. In the light manufacturing sectors, the gains to China and India are much larger than to the CEECs, while the losses in Paper and Products and high-tech manufacturing are also larger for China and India. There are sectors, notably Basic Metals, for which the regions diverge dramatically, some exhibiting largest losses, some largest gains.

Finally, we disaggregate further to the country level and exploit the role of sectoral productivity (T_n^j) in driving the real wage changes. While import competition should lower real wages on average, it should still be the case that the losses are smaller (or gains are larger) in countries in which a sector is more productive. To assess the importance of this effect, we regress the percent change in the real wage on the full set of country and sector effects, as well as sectoral productivity expressed as a ratio to world frontier, $(T_n^j/T_F^j)^{1/\theta}$. The partial correlation plots are presented in Figure 7, broken down into two country groups. In both the rest of the world and the emerging giants, relatively more productive sectors gain more/lose less. The effect is highly statistically significant (we use robust standard errors), and economically large.[11] In the rest of the world one standard deviation change in T relative to the frontier (a change 0.24, for example, a move from 0.2 to 0.44 of the world frontier productivity) leads to a 1 percentage point higher real wage due to the opening of emerging giants. Given that average real wage changes are for the most part less than 1%, this is a large effect. In other words, while import-competing sectors such as Wearing Apparel, Textiles, and Footwear do lose from the opening of emerging giants on average, for individual sectors in individual countries higher productivity can still play a major role in mitigating the losses.

4 Conclusion

The rapid trade integration of the major emerging markets has been the major development in world trade over the past 20 years. This paper carries out a quantitative assessment of both aggregate and distributional consequences of the emerging giants' trade opening. Our findings can be summarized as follows. First, the aggregate welfare gains from the integration of emerging giants to the rest of the world are 0.37% on average, with a range from modest absolute losses in a small number of countries to gains of 1−2 percentage points. Second, cross-sectoral reallocation of labor and capital contributes only modestly (0.065 percentage points) to the overall aggregate gains. This is because there is a great deal of room for within-sector reallocation of production to reap the gains from trade with these countries. Third, there are strong complementarities between cross-sectoral mobility of factors. Fixing one of the factors to its initial sectors results in very similar welfare losses to the case in which both factors cannot move. This suggests that policies promoting smooth functioning of labor and capital markets will have the largest effect when implemented together. Fourth, the distributional consequences of this episode of trade opening are an order of magnitude larger than aggregate consequences. While aggregate gains to a typical country are a fraction of a percent, the real wage changes across sectors typically range

[11] These figures are presented dropping the top 2.5% and bottom 2.5% of the sample in terms of percentage changes in the real wage. Keeping outliers does not change the size or significance of the coefficients.

from -5% to 5%. There are pronounced patterns in the distributional impact of emerging giants. Light manufacturing industries tend to gain the most in emerging giants, and lose the most in the rest of the world, and the opposite is true for high-tech manufacturing. Controlling for sectoral and country average changes, more productive sectors gain more.

Appendix A Procedure for Estimating T_n^j, d_{ni}^j, and ω_j

This appendix reproduces from Levchenko and Zhang (2011) the details of the procedure for estimating technology, trade costs, and taste parameters required to implement the model. Interested readers should consult that paper for further details on estimation steps and data sources.

A.1 Tradeable Sector Relative Technology

We now focus on the tradeable sectors. Following the standard EK approach, first divide trade shares by their domestic counterpart:

$$\frac{\pi_{ni}^j}{\pi_{nn}^j} = \frac{X_{ni}^j}{X_{nn}^j} = \frac{T_i^j \left(c_i^j d_{ni}^j\right)^{-\theta}}{T_n^j \left(c_n^j\right)^{-\theta}},$$

which in logs becomes:

$$\ln\left(\frac{X_{ni}^j}{X_{nn}^j}\right) = \ln\left(T_i^j (c_i^j)^{-\theta}\right) - \ln\left(T_n^j (c_n^j)^{-\theta}\right) - \theta \ln d_{ni}^j.$$

Let the (log) iceberg costs be given by the following expression:

$$\ln d_{ni}^j = d_k^j + b_{ni}^j + CU_{ni}^j + RTA_{ni}^j + ex_i^j + \nu_{ni}^j,$$

where d_k^j is an indicator variable for a distance interval. Following EK, we set the distance intervals, in miles, to [0, 350], [350, 750], [750, 1500], [1500, 3000], [3000, 6000], [6000, maximum). Additional variables are whether the two countries share a common border (b_{ni}^j), belong to a currency union (CU_{ni}^j), or to a regional trade agreement (RTA_{ni}^j). Following the arguments in Waugh (2010), we include an exporter fixed effect ex_i^j. Finally, there is an error term ν_{ni}^j. Note that all the variables have a sector superscript j: we allow all the trade cost proxy variables to affect true iceberg trade costs d_{ni}^j differentially across sectors. There is a range of evidence that trade volumes at sector level vary in their sensitivity to distance or common border (see, among many others, Do and Levchenko 2007, Berthelon and Freund 2008).

This leads to the following final estimating equation:

$$\ln\left(\frac{X_{ni}^j}{X_{nn}^j}\right) = \underbrace{\ln\left(T_i^j (c_i^j)^{-\theta}\right) - \theta ex_i^j}_{\text{Exporter Fixed Effect}} \underbrace{- \ln\left(T_n^j \left(c_n^j\right)^{-\theta}\right)}_{\text{Importer Fixed Effect}}$$
$$\underbrace{-\theta d_k^j - \theta b_{ni}^j - \theta CU_{ni}^j - \theta RTA_{ni}^j}_{\text{Bilateral Observables}} \underbrace{-\theta \nu_{ni}^j}_{\text{Error Term}}.$$

This equation is estimated for each tradeable sector $j = 1, ...J$. Estimating this relationship will thus yield, for each country, an estimate of its technology-cum-unit-cost term in each sector j, $T_n^j (c_n^j)^{-\theta}$, which is obtained by exponentiating the importer fixed effect. The available degrees of freedom imply that these estimates are of each country's $T_n^j (c_n^j)^{-\theta}$ relative to a reference country, which in our estimation is the United States. We denote this estimated value by S_n^j:

$$S_n^j = \frac{T_n^j}{T_{us}^j} \left(\frac{c_n^j}{c_{us}^j} \right)^{-\theta},$$

where the subscript us denotes the United States. It is immediate from this expression that estimation delivers a convolution of technology parameters T_n^j and cost parameters c_n^j. Both will of course affect trade volumes, but we would like to extract technology T_n^j from these estimates. In order to do that, we follow the approach of Shikher (2012). In particular, for each country n, the share of total spending going to home-produced goods is given by

$$\frac{X_{nn}^j}{X_n^j} = T_n^j \left(\frac{\Gamma c_n^j}{p_n^j} \right)^{-\theta}.$$

Dividing by its U.S. counterpart yields:

$$\frac{X_{nn}^j / X_n^j}{X_{us,us}^j / X_{us}^j} = \frac{T_n^j}{T_{us}^j} \left(\frac{c_n^j}{c_{us}^j} \frac{p_{us}^j}{p_n^j} \right)^{-\theta} = S_n^j \left(\frac{p_{us}^j}{p_n^j} \right)^{-\theta},$$

and thus the ratio of price levels in sector j relative to the U.S. becomes:

$$\frac{p_n^j}{p_{us}^j} = \left(\frac{X_{nn}^j / X_n^j}{X_{us,us}^j / X_{us}^j} \frac{1}{S_n^j} \right)^{\frac{1}{\theta}}. \tag{A.1}$$

The entire right-hand side of this expression is either observable or estimated. Thus, we can impute the price levels relative to the U.S. in each country and each tradeable sector.

The cost of the input bundles relative to the U.S. can be written as:

$$\frac{c_n^j}{c_{us}^j} = \left(\frac{w_n}{w_{us}} \right)^{\alpha_j \beta_j} \left(\frac{r_n}{r_{us}} \right)^{(1-\alpha_j)\beta_j} \left(\prod_{k=1}^{J} \left(\frac{p_n^k}{p_{us}^k} \right)^{\gamma_{k,j}} \right)^{1-\beta_j} \left(\frac{p_n^{J+1}}{p_{us}^{J+1}} \right)^{\gamma_{J+1,j}(1-\beta_j)}.$$

Using information on relative wages, returns to capital, price in each tradeable sector from (A.1), and the nontradeable sector price relative to the U.S., we can thus impute the costs of the input bundles relative to the U.S. in each country and each sector. Armed with those values, it is straightforward to back out the relative technology parameters:

$$\frac{T_n^j}{T_{us}^j} = S_n^j \left(\frac{c_n^j}{c_{us}^j} \right)^{\theta}.$$

A.2 Trade Costs

The bilateral, directional, sector-level trade costs of shipping from country i to country n in sector j are then computed based on the estimated coefficients as:

$$\ln \hat{d}_{ni}^j = \theta \hat{d}_k^j + \theta \hat{b}_{ni}^j + \theta \widehat{CU}_{ni}^j + \theta \widehat{RTA}_{ni}^j + \theta \widehat{ex}_i^j + \theta \widehat{\nu}_{ni}^j,$$

for an assumed value of θ. Note that the estimate of the trade costs includes the residual from the gravity regression $\theta \widehat{\nu}_{ni}^j$. Thus, the trade costs computed as above will fit bilateral sectoral trade flows exactly, given the estimated fixed effects. Note also that the exporter component of the trade costs $\widehat{ex}_i^j$ is part of the exporter fixed effect. Since each country in the sample appears as both an exporter and an importer, the exporter and importer estimated fixed effects are combined to extract an estimate of $\theta \widehat{ex}_i^j$.

A.3 Complete Estimation

So far we have estimated the levels of technology of the tradeable sectors relative to the United States. To complete our estimation, we still need to find (i) the levels of T for the tradeable sectors in the United States; (ii) the taste parameters ω_j, and (iii) the nontradeable technology levels for all countries.

To obtain (i), we use the NBER-CES Manufacturing Industry Database for the U.S. (Bartelsman and Gray 1996). We start by measuring the observed TFP levels for the tradeable sectors in the U.S.. The form of the production function gives

$$\ln Z_{us}^j = \ln \Lambda_{us}^j + \beta_j \alpha_j \ln L_{us}^j + \beta_j (1 - \alpha_j) \ln K_{us}^j + (1 - \beta_j) \sum_{k=1}^{J+1} \gamma_{k,j} \ln M_{us}^{k,j}, \tag{A.2}$$

where Λ^j denotes the measured TFP in sector j, Z^j denotes the output, L^j denotes the labor input, K^j denotes the capital input, and $M^{k,j}$ denotes the intermediate input from sector k. The NBER-CES Manufacturing Industry Database offers information on output, and inputs of labor, capital, and intermediates, along with deflators for each. Thus, we can estimate the observed TFP level for each manufacturing tradeable sector using the above equation.

If the United States were a closed economy, the observed TFP level for sector j would be given by $\Lambda_{us}^j = (T_{us}^j)^{\frac{1}{\theta}}$. In the open economies, the goods with inefficient domestic productivity draws will not be produced and will be imported instead. Thus, international trade and competition introduce selection in the observed TFP level, as demonstrated by Finicelli, Pagano and Sbracia (2013). We thus use the model to back out the true level of T^j_{us} of each tradeable sector in the United States. Here we follow Finicelli et al. (2013) and use the following relationship:

$$(\Lambda^j_{us})^\theta = T^j_{us} + \sum_{i \neq us} T^j_i \left(\frac{c^j_i d^j_{us,i}}{c^j_{us}} \right)^{-\theta}.$$

Thus, we have

$$(\Lambda^j_{us})^\theta = T^j_{us} \left[1 + \sum_{i \neq us} \frac{T^j_i}{T^j_{us}} \left(\frac{c^j_i d^j_{us,i}}{c^j_{us}} \right)^{-\theta} \right] = T^j_{us} \left[1 + \sum_{i \neq us} S^j_i \left(d^j_{us,i} \right)^{-\theta} \right]. \tag{A.3}$$

This equation can be solved for underlying technology parameters T^j_{us} in the U.S., given estimated observed TFP Λ^j_{us}, and all the S^j_i's and $d^j_{us,i}$'s estimated in the previous subsection.

To estimate the taste parameters $\{\omega_j\}^J_{j=1}$, we use information on final consumption shares in the tradeable sectors in the U.S.. We start with a guess of $\{\omega_j\}^J_{j=1}$ and find sectoral prices p^k_n as follows. For an initial guess of sectoral prices, we compute the tradeable sector aggregate price and the nontradeable sector price using the data on the relative prices of nontradeables to tradeables. Using these prices, we calculate sectoral unit costs and Φ^j_n's, and update prices according to equation (2), iterating until the prices converge. We then update the taste parameters according to equation (5), using the data on final sectoral expenditure shares in the U.S.. We normalize the vector of ω_j's to have a sum of one, and repeat the above procedure until the values for the taste parameters converge.

Finally, we estimate the nontradeable sector TFP using the relative prices. In the model, the nontradeable sector price is given by

$$p^{J+1}_n = \Gamma (T^{J+1}_n)^{-\frac{1}{\theta}} c^{J+1}_n.$$

Since we know the aggregate price level in the tradeable sector p^T_n, c^{J+1}_n, and the relative price of nontradeables (which we take from the data), we can back out T^{J+1}_n from the equation above for all countries.

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Table 1. The Fit of the Baseline Model with the Data

		model	data
Wages:			
	mean	0.463	0.413
	median	0.149	0.154
	corr(model, data)	*0.994*	
Return to capital:			
	mean	1.035	1.074
	median	0.767	0.758
	corr(model, data)	*0.938*	
Sectoral labor shares:			
	corr(model, data)	*0.711*	
π_{nn}^j			
	mean	0.620	0.565
	median	0.678	0.607
	corr(model, data)	*0.914*	
π_{ni}^j, $i \neq n$			
	mean	0.0055	0.0059
	median	0.0002	0.0002
	corr(model, data)	*0.886*	

Notes: This table reports the means and medians of wages relative to the U.S. (top panel); return to capital relative to the U.S. (second panel); correlations between model and data sectoral employment shares (third panel); share of domestically produced goods in overall spending (fourth panel); and share of goods from country i in overall spending (bottom panel) in the model and in the data. Wages and return to capital in the data are calculated as described in Appendix A.

Table 2. Welfare Gains from Trade with Emerging Giants

Panel A: Flexible Factors

	Mean	Median	Min	Max	Countries
China	3.48				
India	1.63				
CEECs	7.26	7.18	2.75	13.36	10
OECD	0.28	0.30	-0.01	0.57	22
East and South Asia	0.70	0.58	-0.05	2.28	11
Latin America and Caribbean	0.16	0.15	-0.38	0.54	15
Middle East and North Africa	0.44	0.49	0.25	0.60	7
Sub-Saharan Africa	0.48	0.29	0.12	1.21	8

Panel B: Fixed Factors

	Mean	Median	Min	Max	Countries
China	3.13				
India	1.40				
CEECs	6.48	6.17	2.09	11.76	10
OECD	0.23	0.25	-0.09	0.52	22
East and South Asia	0.67	0.53	-0.08	2.33	11
Latin America and Caribbean	0.11	0.13	-0.53	0.50	15
Middle East and North Africa	0.29	0.28	0.04	0.48	7
Sub-Saharan Africa	0.40	0.22	0.07	1.17	8

Notes: Units are in percentage points. This table reports the changes in welfare from two counterfactual scenarios. Panel A presents the welfare gains in the benchmark for 2005-2007, relative to the scenario in which emerging giants are in autarky, under the assumption that factor markets are flexible. Panel B presents the changes in welfare relative to the scenario in which emerging giants are in autarky, under the assumption that factors are fixed in their respective sectors, at the equilibrium values pre-opening of emerging giants to trade.

Table 3. Differences in Welfare Changes, Alternative Factor Market Equilibria

	Difference with Respect to Flexible Factors			
	Fixed Factors	Fixed Labor	Fixed Capital	Countries
China	-0.35	-0.25	-0.28	
India	-0.23	-0.15	-0.19	
CEECs	-0.78	-0.50	-0.65	10
OECD	-0.05	-0.04	-0.05	22
East and South Asia	-0.03	-0.02	-0.04	11
Latin America and Caribbean	-0.06	-0.04	-0.05	15
Middle East and North Africa	-0.15	-0.10	-0.13	7
Sub-Saharan Africa	-0.08	-0.05	-0.07	8

Notes: Units are in percentage points. This table reports the correlations between the welfare gains from trade integration of emerging giants under the different assumptions on the factor market equilibrium.

Table 4. Correlations in Welfare Gains across Factor Market Equilibria

Panel A: Emerging Giants (n = 12)			
	Flexible	Fixed Factors	Fixed Labor
Fixed Factors	0.981		
Fixed Labor	0.991	0.998	
Fixed Capital	0.987	0.999	0.999

Panel B: Rest of the World (n = 63)			
	Flexible	Fixed Factors	Fixed Labor
Fixed Factors	0.977		
Fixed Labor	0.989	0.997	
Fixed Capital	0.984	0.999	0.999

Notes: Units are in percentage points. This table reports the differences in the welfare gains from trade integration of emerging giants under the different assumptions on the factor market equilibrium.

Table 5. Welfare Gains from Trade with Emerging Giants: Sector-Specific θ_j

Panel A: Flexible Factors

	Mean	Median	Min	Max	Countries
China	3.10				
India	1.81				
CEECs	10.76	11.04	3.54	18.26	10
OECD	0.45	0.44	0.04	0.87	22
East and South Asia	1.69	1.01	0.50	3.94	11
Latin America and Caribbean	0.52	0.40	-0.25	2.27	15
Middle East and North Africa	0.77	0.87	0.37	1.35	7
Sub-Saharan Africa	1.69	1.73	0.41	3.33	8

Panel B: Fixed Factors

	Mean	Median	Min	Max	Countries
China	2.95				
India	1.72				
CEECs	9.72	9.37	2.92	16.90	10
OECD	0.41	0.39	-0.01	0.88	22
East and South Asia	1.61	0.93	0.48	3.80	11
Latin America and Caribbean	0.46	0.28	-0.34	2.34	15
Middle East and North Africa	0.51	0.52	0.09	0.83	7
Sub-Saharan Africa	1.52	1.49	0.35	3.37	8

Notes: Units are in percentage points. This table reports the changes in welfare from two counterfactual scenarios, under sector-specific θ_j's sourced from Caliendo and Parro (2010). Panel A presents the welfare gains in the benchmark for 2005-2007, relative to the scenario in which emerging giants are in autarky, under the assumption that factor markets are flexible. Panel B presents the changes in welfare relative to the scenario in which emerging giants are in autarky, under the assumption that factors are fixed in their respective sectors, at the equilibrium values pre-opening of emerging giants to trade.

Table 6. Welfare Gains: Intermediate Experiments

Panel A: 45% Drop in d_{ni}^j of Emerging Giants

	Mean	Median	Min	Max	Countries
China	1.06				
India	0.78				
CEECs	2.31	2.36	1.18	3.76	10
OECD	0.11	0.10	0.04	0.19	22
East and South Asia	0.29	0.20	0.10	0.90	11
Latin America and Caribbean	0.10	0.09	-0.12	0.34	15
Middle East and North Africa	0.18	0.17	0.13	0.25	7
Sub-Saharan Africa	0.21	0.15	0.05	0.46	8

Panel B: Productivity Growth of Emerging Giants

	Mean	Median	Min	Max	Countries
China	102.94				
India	13.44				
CEECs	92.65	77.75	2.81	218.61	10
OECD	-0.05	-0.04	-0.16	0.09	22
East and South Asia	0.25	0.10	-0.34	1.58	11
Latin America and Caribbean	0.15	0.01	-0.29	1.43	15
Middle East and North Africa	0.34	0.14	-0.16	1.28	7
Sub-Saharan Africa	0.14	0.01	-0.05	1.04	8

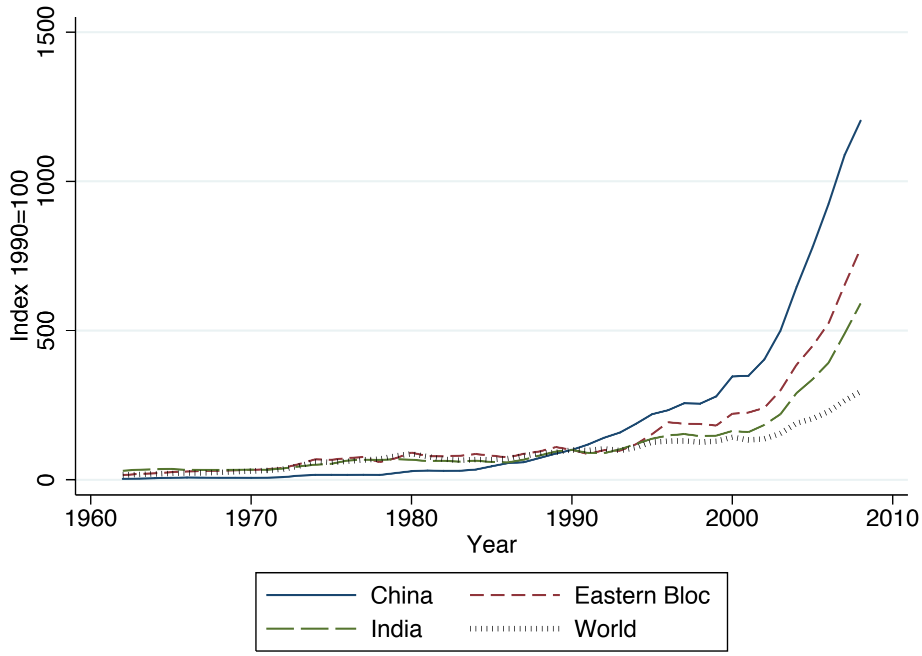
Notes: Units are in percentage points. This table reports the changes in welfare from two counterfactual scenarios. Panel A presents the welfare gains in the benchmark for 2005-2007, relative to the scenario in which emerging giants' trade costs d_{ni}^j are uniformly 45% higher. Panel B presents the changes in welfare relative to the scenario in which emerging giants' productivities in all sectors are set to the 1995-1999 values.

Table 7. Sectoral Real Wage Changes, Medians

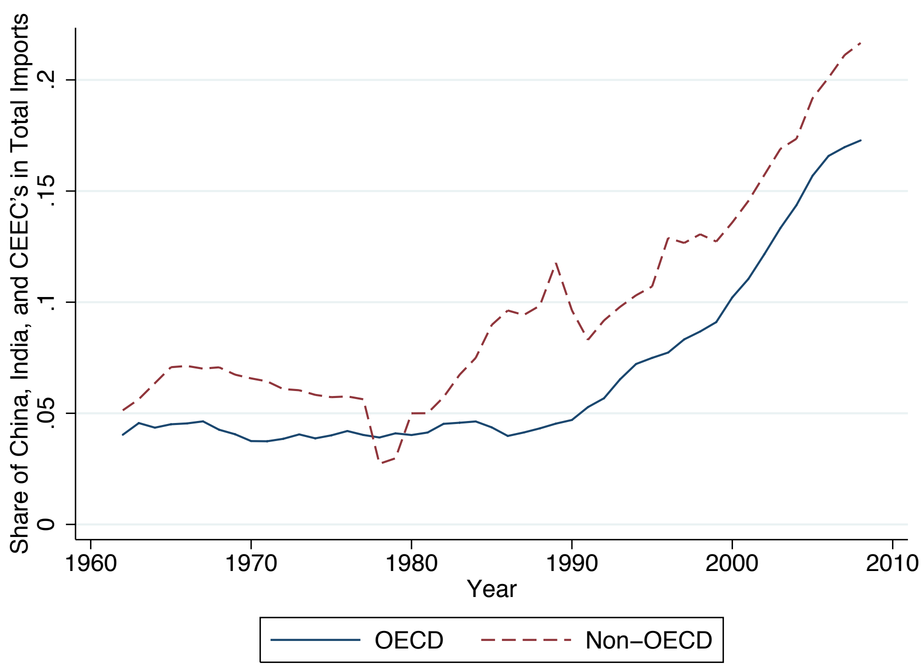
ISIC code	Sector Name	Emerging Giants	Rest of World
15	Food and Beverages	0.57	0.67
16	Tobacco Products	0.92	-0.40
17	Textiles	9.97	-2.27
18	Wearing Apparel, Fur	10.81	-3.64
19	Leather, Leather Products, Footwear	16.67	-1.29
20	Wood Products (Excl. Furniture)	18.35	-0.65
21	Paper and Paper Products	-0.99	1.30
22	Printing and Publishing	2.12	0.15
23	Coke, Refined Petroleum Products, Nuclear Fuel	10.61	-0.53
24	Chemical and Chemical Products	0.86	0.56
25	Rubber and Plastics Products	9.91	-0.91
26	Non-Metallic Mineral Products	6.83	-0.82
27	Basic Metals	13.91	0.37
28	Fabricated Metal Products	3.79	-0.30
29C	Office, Accounting, Computing, and Other Machinery	0.53	1.52
31A	Electrical Machinery, Communication Equipment	5.89	-0.19
33	Medical, Precision, and Optical Instruments	-2.56	1.55
34A	Transport Equipment	2.22	0.85
36	Furniture and Other Manufacturing	7.45	-1.43
4A	Nontradeables	6.03	0.28

Notes: This table reports the median percentage changes in real wages (w_n^j/P_n) in each sector, separating emerging giants and the rest of the world.

Figure 1. Emerging Giants' Trade, 1962-2007



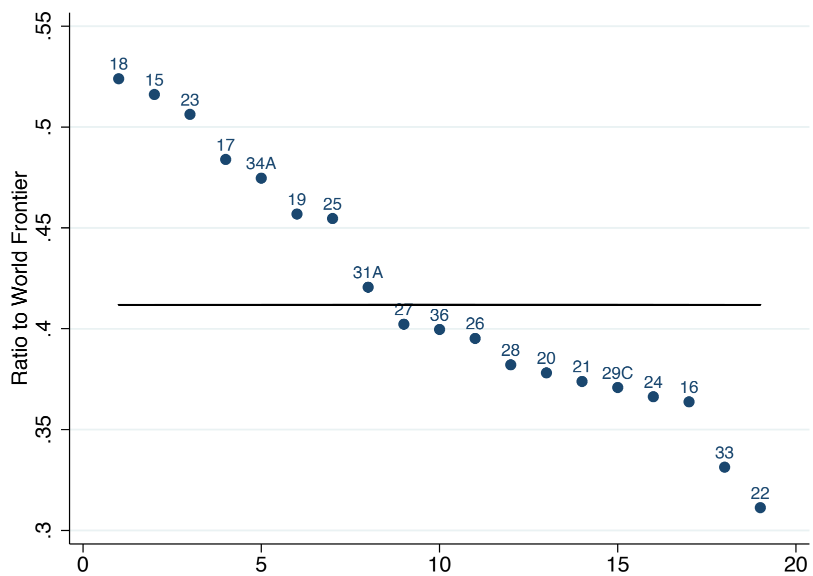
(a) Exports, Index Number 1990=100



(b) Share of Emerging Giants in Global Imports

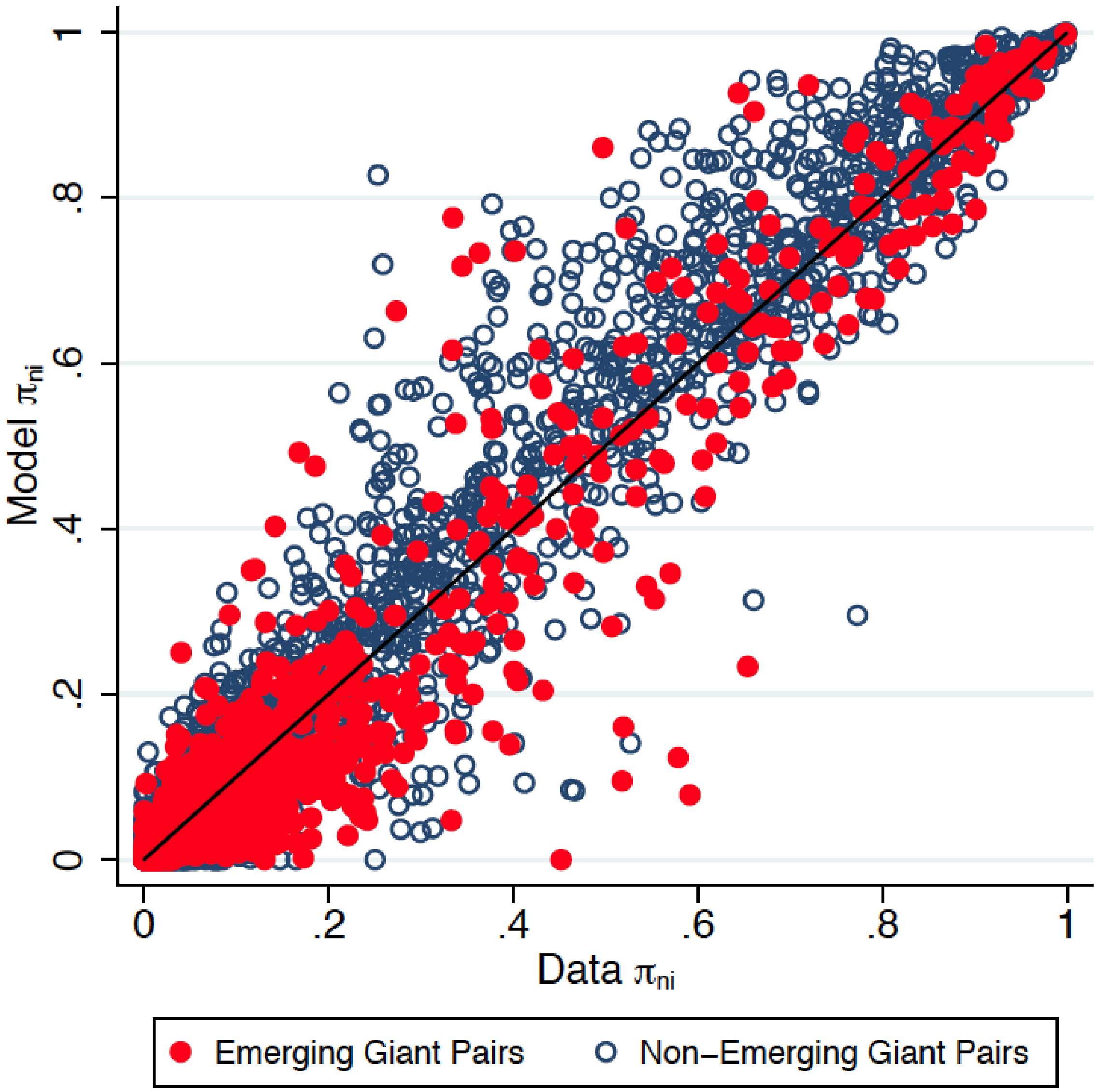
Notes: Figure 1(a) plots the total real (inflation-adjusted) exports from China, India, the CEECs, and the world for the period 1962-2007. All series are normalized such that the 1990 value equals 100. Figure 1(b) plots the share of imports coming from these countries in the total imports of the OECD and the non-OECD countries, 1962-2007.

Figure 2. Productivity in Emerging Giants, Population-Weighted



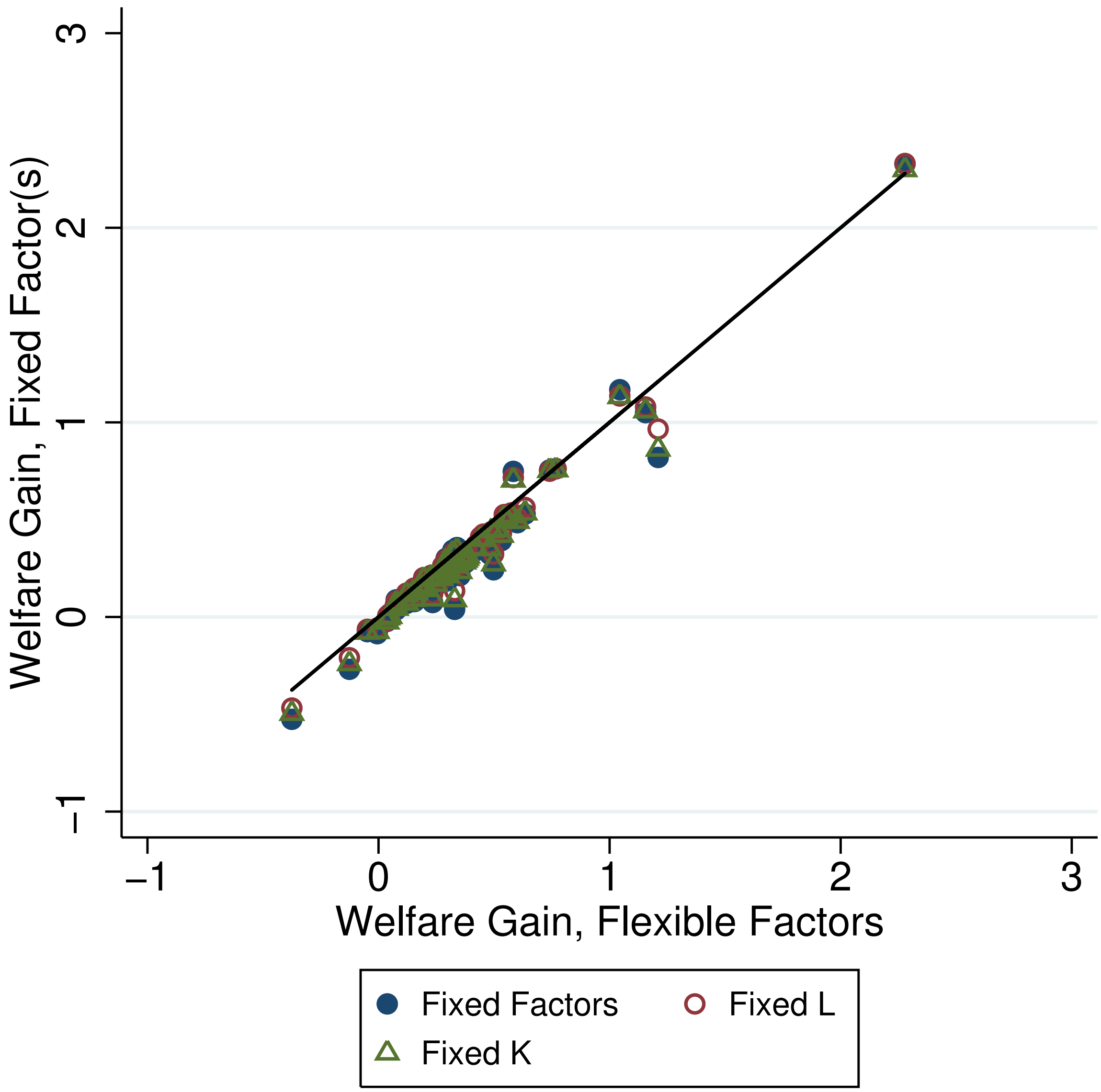
Notes: This figure displays the emerging giants' population-weighted productivity ($(T_n^j)^{1/\theta}$), as a ratio to the world frontier in each sector. The horizontal line is the geometric average emerging giants' productivity across sectors. The key for sector labels is reported in Table A2.

Figure 3. Benchmark Model vs. Data: π^j_{ni} for Emerging Giants and the Rest of the Sample



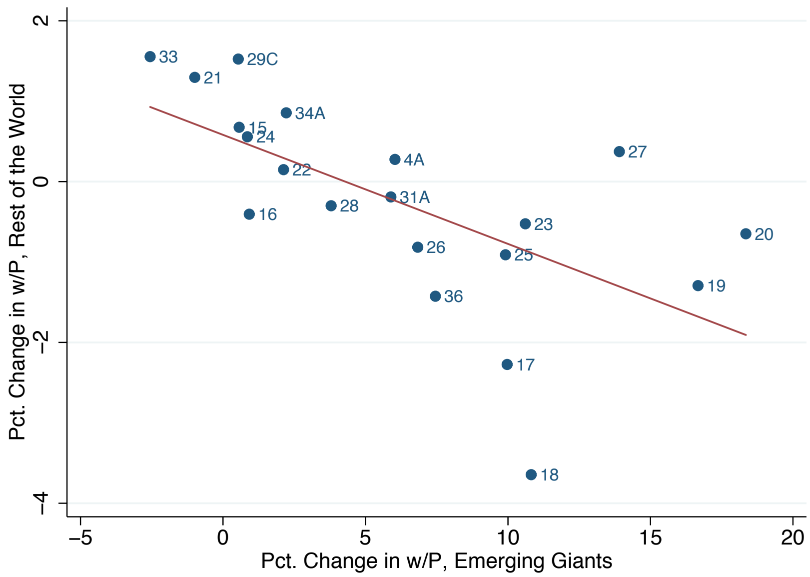
Notes: This figure displays the model-implied values of π^j_{ni} on the y-axis against the values of π^j_{ni} in the data on the x-axis. Solid red dots depict π^j_{ni} in which either n or i is one of the emerging giants. Hollow dots represent the non-emerging giant π^j_{ni}'s. The line through the points is the 45-degree line.

Figure 4. Welfare Gains Under Flexible and Fixed Factors



Notes: This figure displays the welfare gains to the rest of the world under flexible factor markets (on the x-axis) against the gains to the rest of the world under the three alternative assumptions on the factor markets (all factors fixed, L only fixed, and K only fixed), along with the 45-degree line.

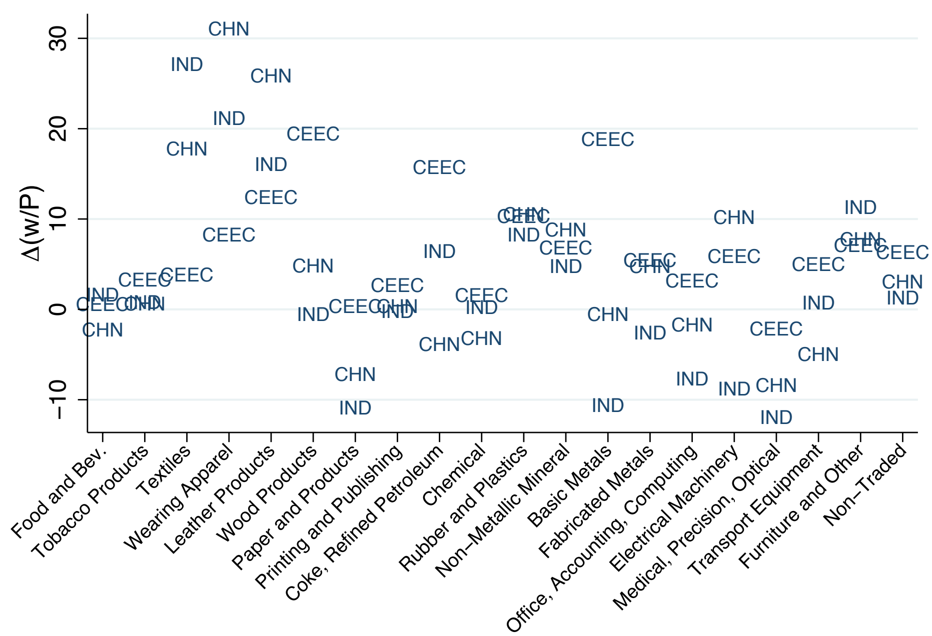
Figure 5. Changes in Real Factor Returns by Sector: Emerging Giants vs. Rest of World



Notes: This figure displays the median percentage change in the real wage in the rest of the world (y-axis) against the median percentage change in the real wage in the emerging giants in each sector. The key for sector labels is reported in Table A2.

Figure 6. Changes in Real Wages, Fixed Factors, by Sector and Region

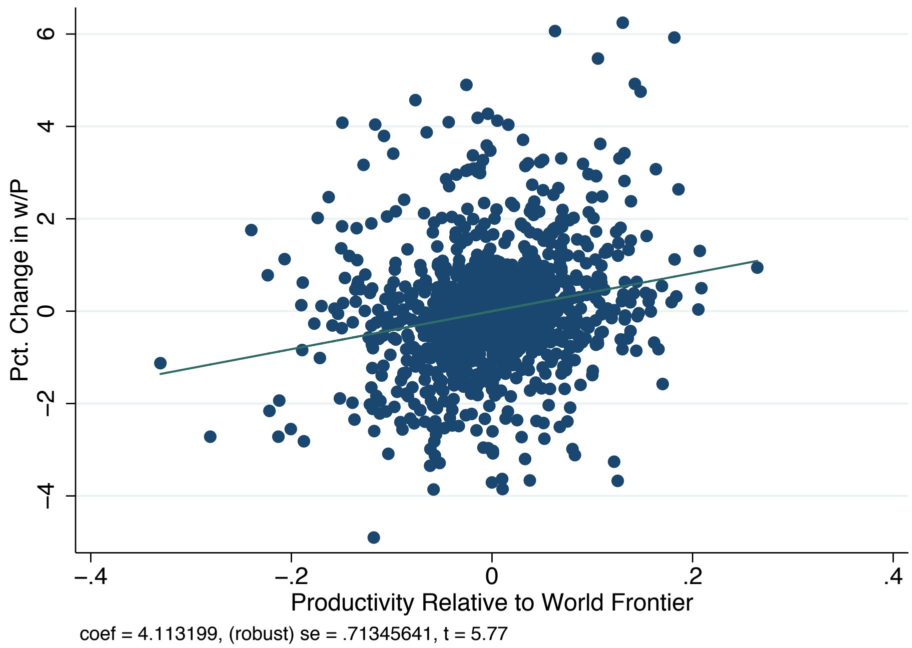
(a) Rest of World



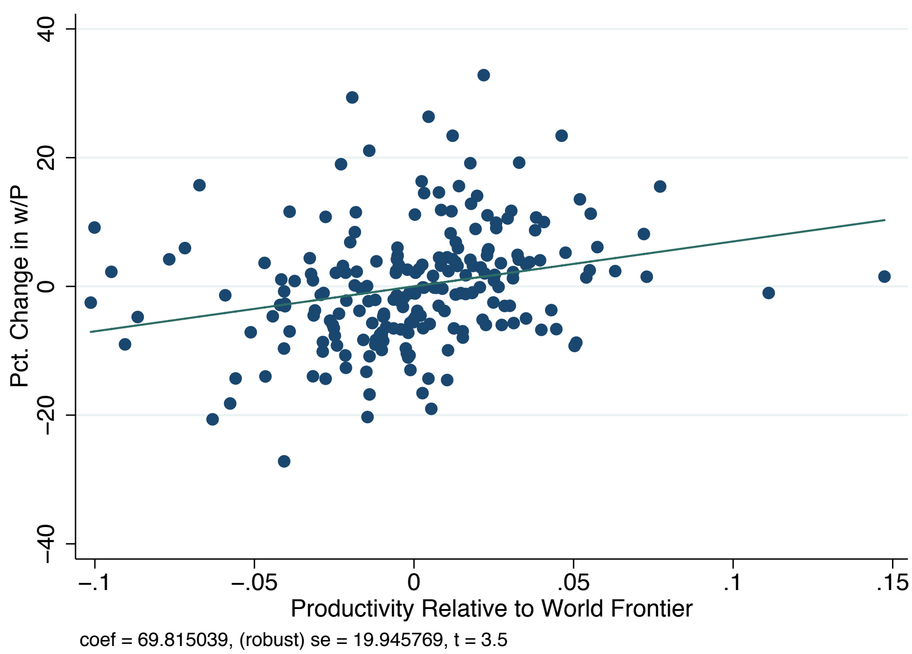
(b) Emerging Giants

Notes: This figure displays the scatterplots of the median percentage changes in real wages in the rest of the world (top panel) and in emerging giants (bottom panel) in each sector and each region when emerging giants open to trade but factors cannot reallocate across sectors. Region label key: CHN=China, IND=India, CEEC=CEECs, OECD=OECD, ESA=East and South Asia, LAC=Latin America and Caribbean, MENA=Middle East and North Africa, SSA=Sub-Saharan Africa.

Figure 7. Changes in Real Wages and Sectoral Productivity: Partial Correlations



(a) Rest of World



(b) Emerging Giants

Notes: This figure displays the partial correlations between changes in sectoral real wages and the productivity relative to the world frontier in a sector, after partialling out the full set of country and sector effects. The top panel represents the rest of the world, the bottom panel emerging giants.

Table A1. Country Coverage

Emerging Giants	
Bulgaria	Poland
China	Romania
Czech Republic	Russian Federation
Hungary	Slovak Republic
India	Slovenia
Kazakhstan	Ukraine
OECD	**Latin America and Caribbean**
Australia	Argentina
Austria	Bolivia
Belgium-Luxembourg	Brazil
Canada	Chile
Denmark	Colombia
Finland	Costa Rica
France	Ecuador
Germany	El Salvador
Greece	Guatemala
Iceland	Honduras
Ireland	Mexico
Italy	Peru
Japan	Trinidad and Tobago
Netherlands	Uruguay
New Zealand	Venezuela, RB
Norway	
Portugal	**Middle East and North Africa**
Spain	Egypt, Arab Rep.
Sweden	Iran, Islamic Rep.
Switzerland	Israel
United Kingdom	Jordan
United States	Kuwait
	Saudi Arabia
East and South Asia	Turkey
Bangladesh	
Fiji	**Sub-Saharan Africa**
Indonesia	Ethiopia
Korea, Rep.	Ghana
Malaysia	Kenya
Pakistan	Mauritius
Philippines	Nigeria
Sri Lanka	Senegal
Taiwan Province of China	South Africa
Thailand	Tanzania
Vietnam	

Notes: This table reports the countries in the sample.

Table A2. Sectors

ISIC code	Sector Name	α_j	β_j	$\gamma_{J+1,j}$	ω_j
15	Food and Beverages	0.290	0.290	0.303	0.169
16	Tobacco Products	0.272	0.490	0.527	0.014
17	Textiles	0.444	0.368	0.295	0.019
18	Wearing Apparel, Fur	0.468	0.369	0.320	0.109
19	Leather, Leather Products, Footwear	0.469	0.350	0.330	0.015
20	Wood Products (Excl. Furniture)	0.455	0.368	0.288	0.008
21	Paper and Paper Products	0.351	0.341	0.407	0.012
22	Printing and Publishing	0.484	0.453	0.407	0.005
23	Coke, Refined Petroleum Products, Nuclear Fuel	0.248	0.246	0.246	0.141
24	Chemical and Chemical Products	0.297	0.368	0.479	0.009
25	Rubber and Plastics Products	0.366	0.375	0.350	0.014
26	Non-Metallic Mineral Products	0.350	0.448	0.499	0.073
27	Basic Metals	0.345	0.298	0.451	0.002
28	Fabricated Metal Products	0.424	0.387	0.364	0.013
29C	Office, Accounting, Computing, and Other Machinery	0.481	0.381	0.388	0.051
31A	Electrical Machinery, Communication Equipment	0.369	0.368	0.416	0.022
33	Medical, Precision, and Optical Instruments	0.451	0.428	0.441	0.038
34A	Transport Equipment	0.437	0.329	0.286	0.220
36	Furniture and Other Manufacturing	0.447	0.396	0.397	0.065
4A	Nontradeables	0.561	0.651	0.788	
	Mean	0.400	0.385	0.399	0.053
	Min	0.248	0.246	0.246	0.002
	Max	0.561	0.651	0.788	0.220

Notes: This table reports the sectors used in the analysis. The classification corresponds to the ISIC Revision 3 2-digit, aggregated further due to data availability. α_j is the value-added based labor intensity; β_j is the share of value added in total output; $\gamma_{J+1,j}$ is the share of nontradeable inputs in total intermediate inputs; ω_j is the taste parameter for tradeable sector j, estimated using the procedure described in Section A.3. Variable definitions and sources are described in detail in the text.

Table A3. Sectoral Labor Shares: Correlations of Model and Data, by Region

	Mean	Median	Min	Max	Countries
Emerging Giants	0.627	0.704	0.202	0.861	8
OECD	0.764	0.790	0.479	0.927	18
East and South Asia	0.792	0.800	0.675	0.878	8
Latin America and Caribbean	0.717	0.743	0.351	0.957	9
Middle East and North Africa	0.514	0.581	-0.001	0.766	6
Sub-Saharan Africa	0.833	0.864	0.638	0.997	3

Notes: This table report the summarizes the country-specific correlations between sectoral labor shares between the model and the data, by region and country group.

Table A4. Emerging Giants: Sectoral Real Wage Changes, Summary Statistics by Country

	Mean	Median	St. Dev.	Min	Max
Bulgaria	14.275	11.207	20.058	-23.994	75.773
China	4.668	1.846	10.511	-8.390	31.037
Czech Republic	4.332	5.107	8.689	-8.219	19.624
Hungary	5.360	3.527	10.618	-10.231	39.865
India	2.327	0.753	10.555	-11.946	27.139
Kazakhstan	7.426	3.662	31.958	-34.266	123.651
Poland	4.436	4.259	7.235	-7.215	20.095
Romania	7.179	7.746	22.622	-74.360	42.703
Russian Federation	4.663	-1.635	18.307	-17.603	50.224
Slovak Republic	7.661	8.968	11.834	-16.095	28.412
Slovenia	6.539	13.353	21.790	-67.104	24.555
Ukraine	7.637	4.163	14.923	-11.734	52.387

Notes: This table reports the median percentage changes in real wages (w_n^j/P_n) in each sector, by region.

Table A5. Rest of the World: Sectoral Real Wage Changes, Summary Statistics by Country

	Mean	Median	St. Dev.	Min	Max
Argentina	-0.334	-0.783	2.224	-2.594	7.252
Australia	0.303	0.151	3.512	-6.771	11.827
Austria	0.250	0.150	1.878	-4.146	4.242
Bangladesh	0.256	0.322	2.948	-6.767	9.380
Belgium-Luxembourg	-0.065	0.231	2.374	-4.476	5.089
Bolivia	0.008	-0.116	1.496	-2.747	3.127
Brazil	-0.201	-0.223	1.029	-2.033	1.931
Canada	-0.310	-0.116	1.956	-4.632	2.872
Chile	-0.663	-0.479	1.917	-4.623	3.937
Colombia	-0.059	0.003	0.975	-1.788	1.551
Costa Rica	-0.966	-1.122	2.025	-4.237	5.585
Denmark	0.076	-0.062	1.720	-3.280	3.619
Ecuador	-0.116	-0.159	0.875	-1.889	1.581
Egypt, Arab Rep.	0.347	0.270	1.867	-2.199	5.533
El Salvador	0.241	0.385	1.324	-2.423	2.170
Ethiopia	0.064	-0.193	2.367	-3.505	7.021
Fiji	0.447	0.602	2.992	-8.515	4.412
Finland	-0.309	0.130	1.935	-5.253	3.358
France	-0.385	-0.174	1.847	-4.419	2.463
Germany	-0.328	-0.328	2.028	-4.236	3.595
Ghana	-0.189	-0.202	1.704	-2.642	5.536
Greece	0.237	0.592	1.338	-2.633	1.779
Guatemala	-0.360	-0.357	1.693	-2.774	3.818
Honduras	0.404	0.493	1.093	-1.808	2.066
Iceland	-0.290	0.189	1.682	-4.470	2.523
Indonesia	0.782	0.478	3.241	-4.043	11.343
Iran, Islamic Rep.	0.191	0.066	2.473	-4.148	6.275
Ireland	-1.089	-0.751	2.249	-5.708	1.758
Israel	-0.557	-0.056	2.256	-4.720	3.820
Italy	-0.051	0.014	1.508	-3.343	3.261
Japan	-0.718	-0.095	3.412	-11.567	4.694
Jordan	0.791	0.097	3.850	-4.144	15.753
Kenya	0.123	-0.198	1.988	-1.912	7.247
Korea, Rep.	0.720	0.440	3.030	-3.644	8.232
Kuwait	-0.056	-2.073	6.553	-5.760	23.051
Malaysia	0.374	0.025	2.338	-4.391	4.135
Mauritius	0.188	0.320	2.022	-4.833	3.681
Mexico	-0.109	0.094	1.588	-3.712	2.350
Netherlands	0.114	0.105	2.107	-4.062	4.787
New Zealand	-0.222	-0.100	2.345	-5.841	4.689
Nigeria	-0.069	-0.042	0.900	-2.962	1.322
Norway	-0.394	-0.036	2.189	-6.104	2.980
Pakistan	0.314	-0.005	2.391	-5.770	5.428
Peru	-0.784	-0.934	2.173	-3.761	6.576
Philippines	-0.321	-1.196	4.462	-5.153	14.520
Portugal	0.090	0.154	1.818	-3.881	3.513
Saudi Arabia	0.271	-0.751	5.187	-4.966	20.942
Senegal	0.637	-0.707	9.954	-8.199	41.274
South Africa	0.190	0.202	1.938	-2.506	5.390
Spain	-0.212	-0.083	1.479	-3.239	2.062
Sri Lanka	6.247	3.430	10.383	-8.741	43.442
Sweden	-0.435	0.063	1.917	-4.825	2.805
Switzerland	-0.703	-0.610	1.973	-4.807	2.839
Taiwan Province of China	0.523	-0.554	4.875	-6.972	17.459
Tanzania	0.231	0.320	2.257	-3.455	5.690
Thailand	0.185	0.063	2.735	-5.015	7.553
Trinidad and Tobago	-0.262	0.051	1.429	-3.008	1.633
Turkey	0.799	0.415	1.958	-2.479	4.586
United Kingdom	-0.233	-0.108	1.774	-4.315	3.094
United States	-0.400	-0.127	1.924	-4.944	3.207
Uruguay	-0.184	-0.221	1.031	-1.905	1.977
Venezuela, RB	-0.270	-0.167	0.795	-1.532	1.353
Vietnam	0.971	0.578	2.015	-2.917	4.580

Notes: This table reports the median percentage changes in real wages (w_n^j/P_n) in each sector, by region.

Table A6. Sectoral Real Wage Changes, Medians by Region

ISIC code	Sector Name	China	India	East. Europe and Cent. Asia	OECD	East and South Asia	Latin America and Carib.	Middle East and N. Africa	Sub-Saharan Africa
15	Food and Beverages	-2.256	1.629	0.565	0.410	1.623	1.255	0.146	1.057
16	Tobacco Products	0.638	0.786	3.254	-0.507	-0.219	-0.326	-0.405	-0.479
17	Textiles	17.772	27.139	3.851	-2.557	-1.716	-1.927	-2.275	-1.632
18	Wearing Apparel, Fur	31.037	21.166	8.269	-4.367	-4.043	-1.597	-2.339	-0.445
19	Leather, Leather Products, Footwear	25.836	16.074	12.427	-3.411	3.375	-1.294	3.868	1.954
20	Wood Products (Excl. Furniture)	4.805	-0.558	19.416	-0.928	0.413	0.079	-2.810	-0.103
21	Paper and Paper Products	-7.188	-10.870	0.344	1.545	1.613	1.551	0.162	0.304
22	Printing and Publishing	0.319	-0.197	2.652	0.236	-0.189	0.110	0.099	0.068
23	Coke, Refined Petroleum, Fuel	-3.882	6.416	15.740	-0.664	-0.258	-0.290	-1.863	-1.280
24	Chemical and Chemical Products	-3.225	0.241	1.565	0.845	0.558	0.013	0.861	0.195
25	Rubber and Plastics Products	10.546	8.264	10.332	-1.014	0.170	-1.045	-0.844	-1.443
26	Non-Metallic Mineral Products	8.794	4.764	6.834	-1.034	-0.951	-0.505	-0.327	-0.754
27	Basic Metals	-0.545	-10.630	18.824	0.492	0.511	0.035	1.771	-0.372
28	Fabricated Metal Products	4.787	-2.590	5.417	0.449	0.058	-0.660	-0.865	-0.545
29C	Office, Accounting, Computing Mach.	-1.694	-7.685	3.136	2.641	4.254	0.154	0.699	0.946
31A	Electrical Machinery, Comm. Equip.	10.178	-8.782	5.894	-0.143	2.644	-1.118	-0.363	-1.465
33	Medical, Precision, and Optical Instr.	-8.390	-11.946	-2.124	2.397	3.486	0.375	0.858	0.791
34A	Transport Equipment	-4.972	0.719	4.988	1.398	-0.039	0.208	1.092	0.254
36	Furniture and Other Manufacturing	7.745	11.293	7.120	-1.446	-1.488	-1.426	-1.726	-0.554
4A	Nontradeables	3.053	1.303	6.322	0.275	0.580	0.160	0.300	0.247

Notes: This table reports the median percentage changes in real wages (w_n^j/P_n) in each sector, by region.

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