WEB APPENDIX
The Global Welfare Impact of China: Trade Integration and Technological Change

Julian di Giovanni
International Monetary Fund

Andrei A. Levchenko
University of Michigan
and NBER

Jing Zhang
Federal Reserve Bank of Chicago

June 4, 2013

Appendix A Analytical Results: Proofs and Endogenous Wages

Proof of Lemma 1: Combining equations (5) and (6), welfare can be expressed as:

$$\begin{aligned} w_n/P_n &= w_n \left(p_n^A p_n^B\right)^{-\frac{1}{2}\alpha} \left(p_n^H\right)^{\alpha-1} \\ &\propto \left\{ \left[\sum_{i=1}^{N} T_i^A \left(w_i d_{ni}^A\right)^{-\theta}\right] \left[\sum_{i=1}^{N} T_i^B \left(w_i d_{ni}^B\right)^{-\theta}\right] \right\}^{\frac{\alpha}{2\theta}}, \end{aligned} \tag{A.1}$$

From (A.1) and the constraint that $\left(T_1^A T_1^B\right)^{\frac{1}{2}} = c$, welfare in country n as a function of T_1^A becomes

$$\left\{ \left[T_1^A + \sum_{i=2}^{N} T_i^A \left(\frac{w_i d_{ni}^A}{w_1 d_{n1}^A}\right)^{-\theta}\right] \left[\frac{1}{T_1^A} + \frac{1}{c^2} \sum_{i=2}^{N} T_i^B \left(\frac{w_i d_{ni}^B}{w_1 d_{n1}^B}\right)^{-\theta}\right] \right\}^{\frac{\alpha}{2\theta}}.$$

Taking the first-order condition with respect to T_1^A yields the following welfare-minimizing value:

$$T_1^A = c \sqrt{\frac{\sum_{i=2}^{N} T_i^A \left(\frac{w_i d_{ni}^A}{w_1 d_{n1}^A}\right)^{-\theta}}{\sum_{i=2}^{N} T_i^B \left(\frac{w_i d_{ni}^B}{w_1 d_{n1}^B}\right)^{-\theta}}}.$$

The second-order condition easily verifies that this is indeed a (global) minimum. Using the welfare-minimizing T_1^A together with $\left(T_1^A T_1^B\right)^{\frac{1}{2}} = c$ leads to the expression for relative technologies (8). Q.E.D.

A.1 Endogenous Wages

The results in the main text were derived under the assumption that there is a homogeneous costlessly traded good and thus the relative wages do not change in response to relative technology changes in country 1. The advantage of this approach is that we could obtain the main results analytically even with multiple countries and arbitrary iceberg trade costs, and demonstrate most clearly the roles of the various simplifying assumptions. The disadvantage is that general equilibrium movements in relative wages could potentially have independent effects on welfare. Note that as the number of countries increases, the general equilibrium changes in relative wages in response to technical change in an individual country are likely to become smaller and smaller. Nonetheless, it is important to examine whether allowing wages to adjust in the global trade equilibrium weakens any of the analytical results in the main text.

This Appendix implements a 2-sector model in which wages adjust in the global trade equilibrium, and thus changes in relative sectoral productivity can also affect countries' relative factor prices. Because even the simplest multi-sector model with more than two countries does not admit an analytical solution, we demonstrate the results using numerical examples. The essential message of the model is equally strong under endogenous factor prices. While with 2 countries, welfare is minimized when relative sectoral productivity is the same in the two countries, with 3 countries that is no longer generically the case.

Specifically, we remove the homogeneous good from the model: $\alpha = 1$. To simplify the model further, we assume there are no trade costs ($d_{ni}^j = 1\ \forall j, n, i$). Unfortunately, even in the simplest cases, there is no closed-form solution for wages with more than two countries. We first prove analytically that with 2 countries, the welfare-minimizing relative productivity has the same form as in Lemma 1 under these parameter values but now with endogenous wages.

Lemma A1. *Let there be 2 countries and 2 tradeable sectors, with utility given by (7) with* $\alpha = 1$*. Let there be no international trade costs:* $d_{ni}^{j} = 1 \; \forall j, n, i$*. Assume* $T_2^A = T_2^B = 1$ *and* $L_1 = L_2 = 1$*. The country 1 relative technology* T_1^A/T_1^B *that minimizes welfare in both countries subject to the constraint that* $\left(T_1^A T_1^B\right)^{\frac{1}{2}} = c$ *is given by*

$$\frac{T_1^A}{T_1^B} = \frac{T_2^A}{T_2^B}.$$

Proof. Since trade is costless, the price levels are equalized across countries, at both sectoral and aggregate levels. Thus for $j \in \{A, B\}$

$$P_1^j = P_2^j = P^j = \left[T_1^j w_1^{-\theta} + T_2^j w_2^{-\theta}\right]^{-\frac{1}{\theta}},$$

and the consumption price level in both countries is given by

$$P = \sqrt{P^A P^B}.$$

The welfare of country 1, w_1/P, then becomes

$$W_1^{2\theta} = w_1^{2\theta}\left[w_1^{-\theta} T_1^A + w_2^{-\theta} T_2^A\right]\left[w_1^{-\theta} T_1^B + w_2^{-\theta} T_2^B\right].$$

When we normalize $w_1 = 1$, set $T_2^A = T_2^B = 1$, and constrain $T_1^A T_1^B = 1$ as T_1^A varies,

$$W_1^{2\theta} = \left[T_1^A + w_2^{-\theta}\right]\left[\left(T_1^A\right)^{-1} + w_2^{-\theta}\right] = 1 + w_2^{-\theta}\left[T_1^A + \left(T_1^A\right)^{-1}\right] + w_2^{-2\theta}.$$

Similarly, welfare in country 2 is

$$W_2^{2\theta} = w_2^{2\theta} + w_2^{\theta}\left[T_1^A + \left(T_1^A\right)^{-1}\right] + 1.$$

Clearly, since the prices are equalized across countries, the ratio of welfares equals the ratio of wages:

$$\frac{W_2}{W_1} = w_2.$$

If the wages are pinned down by another homogeneous sector, it is clear that the welfare-minimizing T_1^A satisfies $T_1^A/T_1^B = 1$ – the same ratio of productivities as in country 2. Now consider the general equilibrium effect on wages. The derivatives of welfare with respect to T_1^A are equal to

$$\frac{dW_1^{2\theta}}{dT_1^A} = -\theta w_2^{-\theta-1}\left[T_1^A + \left(T_1^A\right)^{-1} + 2w_2^{-\theta}\right]\frac{dw_2}{dT_1^A} + w_2^{-\theta}\left[1 - \left(T_1^A\right)^{-2}\right]$$

and

$$\frac{dW_2^{2\theta}}{dT_1^A} = \theta w_2^{\theta-1}\left[T_1^A + \left(T_1^A\right)^{-1} + 2w_2^{\theta}\right]\frac{dw_2}{dT_1^A} + w_2^{\theta}\left[1 - \left(T_1^A\right)^{-2}\right].$$

Setting the first order conditions to zero, we have

$$\frac{dw_2}{dT_1^A} = \frac{w_2}{\theta} \frac{1 - \left(T_1^A\right)^{-2}}{T_1^A + \left(T_1^A\right)^{-1} + 2w_2^{-\theta}},$$

and

$$\frac{dw_2}{dT_1^A} = -\frac{w_2}{\theta} \frac{1 - \left(T_1^A\right)^{-2}}{T_1^A + \left(T_1^A\right)^{-1} + 2w_2^{\theta}}.$$

At first glance, the welfare-minimizing points do not appear to be the same for countries 1 and 2. However, we will show next that in equilibrium, $dw_2/dT_1^A = 0$ and $w_2 = 1$ for any T_1^A. Thus the welfare-minimizing relative productivity is the same for both countries and is such that $T_1^A/T_1^B = 1$.

Under frictionless trade, trade shares are given by

$$\pi_{12}^A = \frac{w_2^{-\theta}}{T_1^A + w_2^{-\theta}} = 1 - \pi_{21}^A$$

and

$$\pi_{12}^B = \frac{w_2^{-\theta}}{\left(T_1^A\right)^{-1} + w_2^{-\theta}} = 1 - \pi_{21}^B.$$

Therefore, the net exports in each tradable sector $j \in \{A, B\}$ are given by

$$NX_1^j = \pi_{21}^j X_2^j w_2 L_2 - \pi_{12}^j X_1^j w_1 L_1 = \frac{1}{2}\left(\pi_{21}^j w_2 - \pi_{12}^j\right) = \frac{1}{2}\left(\pi_{21}^j \left(w_2 + 1\right) - 1\right),$$

where the symmetric Cobb-Douglas preferences across the two sectors lead to expenditure shares $X_2^s = X_1^s = \frac{1}{2}$ and we used the assumption that $L_1 = L_2 = 1$. The balanced-trade condition then implies

$$w_2 = \frac{\pi_{12}^A + \pi_{12}^B}{\pi_{21}^A + \pi_{21}^B}.$$

Plugging in the expressions for the trade shares in the above equation yields

$$2w_2^{\theta+1} + w_2\left[T_1^A + \left(T_1^A\right)^{-1}\right] - 2w_2^{-\theta} - \left[T_1^A + \left(T_1^A\right)^{-1}\right] = 0.$$

Clearly $w_2 = 1$ is the solution to the above trade balance condition for any T_1^A, which also implies $\frac{dw_2}{dT_1^A} = 0$. Q.E.D. □

In other words, in this special case the result that perfect similarity minimizes welfare generalizes to a setting with endogenously determined wages. The key to this outcome is in the assumptions that the average productivity in both countries is constant as we vary T_1^A/T_1^B, the two countries have the same size, and trade is costless. As a result, the relative wages remain constant as the relative sectoral productivity in country 1 changes.

However, we cannot provide a corresponding analytical result with three countries. Thus, we compare the outcomes under two and three countries using the following numerical example.

Country 2's productivity is the same in the two sectors: $T_2^A = T_2^B = 0.5$. Exactly as above, we vary country 1's relative productivity subject to the constraint that its geometric average equals 0.5 (the same as in country 2). We solve for wages and welfare in all countries numerically for each set of country 1's relative productivities.

In the two-country case the welfare of both countries as a function of T_1^A/T_1^B is plotted in Figure WebA1(a). As proven analytically, both countries' welfare is at its lowest point when $T_1^A/T_1^B = T_2^A/T_2^B = 1$. Indeed, only one line is distinguishable in the picture: the welfare of the two countries is always the same. Next, we introduce a third country of the same size but with a comparative advantage in sector B: $T_3^A = 0.25$ and $T_3^B = 1$ (so that the geometric average productivity in country 3 is the same as in 1 and 2). Figure WebA1(b) reports the results. Now, no country's welfare is minimized when T_1^A/T_1^B is the same as its relative technology. Notice that if we start from the right and approach 1 – the point at which $T_1^A/T_1^B = T_2^A/T_2^B$ – welfare of country 2 actually increases slightly. On the other hand, as we approach 1 from the left, the welfare of country 1 rises. All in all, it is clear that country 1 becoming more similar to country 2 no longer implies that either country's welfare falls.

Because the analytical solutions are not available under endogenous wages, we further dissect the mechanisms behind these welfare results by considering two particular values of country 1's technology parameters, and discussing the behavior of price levels and relative wages. The top panel of Table WebA1 presents the changes in welfare, price levels, and relative wages when moving from $T_1^A/T_1^B = 2$ to $T_1^A/T_1^B = 1$.[1] Since $T_2^A/T_2^B = 1$, with this technological change country 1 becomes more similar (indeed identical) to country 2. The left column presents the welfare change in the 2-country world. As already shown, greater similarity between the two countries lowers welfare in both. This effect operates entirely through a rise in the consumption price level: the relative wage between the countries does not move. The right column instead presents the results in the 3-country world. The exact same change in technology in country 1 now raises welfare in country 2. Part of what is happening is that due to this change in productivity, w_3/w_2 falls. Thus it appears that in this numerical example, changes in comparative advantage of country 1 lead to a "multilateral relative wage effect:" country 2 gains in welfare over this range partly because technology changes in country 1 lead to cheaper imports from country 3.

Table WebA1 also reports the changes in sector A net exports as a share of GDP in all the countries (by balanced trade, net exports of sector A and B sum to zero in each country). A greater absolute deviation from zero implies a greater degree of inter-industry trade. With 2 countries, as country 1 becomes more similar to country 2 in relative technology, inter-industry trade disappears entirely: country 2 goes from being a net importer in sector A to balanced trade within the sector. With 3 countries, the same exact change in country 1's technology leads to an *increase* in inter-industry trade in country 2 (a rise in sector A net exports to GDP from 0.05 to 0.11). Thus, just as greater similarity between countries 1 and 2 need not lower country 2's welfare when there are more than 2 countries, greater similarity also need not reduce inter-industry trade.

These comparative statics are not strictly speaking identical to Samuelson (2004). The classic treatment of unbalanced productivity growth assumes that productivity in one sector rises, while in the other sector it remains unchanged. Thus, there is net productivity growth on average in the partner country. By contrast, our comparative statics exercises consider changes in relative sectoral productivity while keeping the average productivity across sectors constant. This approach allows for the cleanest statement of the main results, especially under fixed factor prices, and corresponds precisely to the comparison between our two quantitative counterfactuals, in which

[1]Welfare in country n is given by w_n/P, where P is the consumption price level. Only one change in P is reported because in this example trade is costless so the consumption price level is the same everywhere.

we also constrain average productivity to be the same.

We now circle all the way back to the original Samuelson (2004) comparative static in which productivity grows in country 1's comparative disadvantage sector, but stays constant in its comparative advantage sector, implying net average productivity growth in country 1 as it becomes more similar to country 2. In this experiment, $T_1^A = 0.5$ throughout, while T_1^B rises from 0.1 to 0.5. Thus, by design, the end point of this technological change is exactly the same as in the experiment above: countries 1 and 2 end up identical. The bottom panel of Table WebA1 reports the results. With two countries, it is still the case that as country 1 becomes more similar, country 2 sees absolute welfare losses. Here, the mechanics for the effect are somewhat distinct. While the consumption price level expressed relative to the numeraire – the wage of country 1 – falls, country 2's relative wage falls by more, precipitating welfare losses. By contrast, with three countries, the same change in country 1's technology leads to welfare gains for country 2. Again, part of what is happening is that w_3/w_2 falls, leading to cheaper imports from country 3. Inter-industry trade in country 2 also rises in this experiment. The essential result that adding a third country can reverse the sign of the welfare changes from the same productivity growth is equally true in this experiment.

We conclude from the numerical examples with endogenous wages that third country effects are of first-order importance for evaluating the impact of changes in relative technology in one country on itself and its trading partners, echoing the analytical results with fixed wages.

Finally, it is worth mentioning the relationship between our results and a common interpretation that the mechanism in the Samuelson (2004)-type result operates through the terms of trade. In the 2×2 first-generation Ricardian model, terms of trade are isomorphic to welfare. The easiest way to see this is to suppose that utility is Cobb-Douglas in two symmetric sectors A and B, country 1 produces A with productivity z_{1A}, while country 2 produces B with productivity z_{2B}. Then, welfare – indirect utility – in country 2 is given by $w_2/P_2 = w_2/(w_2 z_{2B} w_1 z_{1A})^{1/2} = (w_2/w_1)^{1/2}(z_{2B}z_{1A})^{-1/2}$. The terms of trade, on the other hand, are equal to $(w_2/w_1)(z_{2B}/z_{1A})$. Thus, as long as z_{2B} and z_{1A} are unchanged – as was the case in the comparative static considered by Samuelson (2004) – the terms of trade are the same as welfare up to a constant. This equivalence may be helpful to build intuition but it breaks down in more sophisticated models such as EK, where it is no longer the case that the terms of trade are isomorphic to welfare. The conceptually correct object of analysis is indirect utility rather than the terms of trade.

Appendix B 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.

B.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 (2004). 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:

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

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 (B.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:

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

B.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 $\theta\widehat{ex}_{i}^{j}$.

B.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

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

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 (2009a). We thus use the model to back out the true level of T_{us}^{j} of each tradeable sector in the United States. Here we follow Finicelli et al. (2009a) and use the following relationship:

$$(\Lambda_{us}^{j})^{\theta} = T_{us}^{j} + \sum_{i \neq us} T_{i}^{j} \left(\frac{c_i^j d_{us,i}^{j}}{c_{us}^{j}} \right)^{-\theta}.$$

Thus, we have

$$(\Lambda_{us}^{j})^{\theta} = T_{us}^{j} \left[1 + \sum_{i \neq us} \frac{T_i^j}{T_{us}^j} \left(\frac{c_i^j d_{us,i}^{j}}{c_{us}^{j}} \right)^{-\theta} \right] = T_{us}^{j} \left[1 + \sum_{i \neq us} S_i^j \left(d_{us,i}^{j} \right)^{-\theta} \right]. \qquad \text{(B.3)}$$

This equation can be solved for underlying technology parameters T_{us}^{j} in the U.S., given estimated observed TFP Λ_{us}^{j}, and all the S_i^j's and $d_{us,i}^{j}$'s estimated in the previous subsection.

To estimate the taste parameters $\{\omega_j\}_{j=1}^{J}$, we use information on final consumption shares in the tradeable sectors in the U.S.. We start with a guess of $\{\omega_j\}_{j=1}^{J}$ and find sectoral prices p_n^k 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_n^j's, and update prices according to equation (5), iterating until the prices converge. We then update the taste parameters according to equation (13), 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

$$p_n^{J+1} = \Gamma(T_n^{J+1})^{-\frac{1}{\theta}} c_n^{J+1}.$$

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

Appendix C Robustness

This section presents a number of robustness checks on the main results. We describe the results of (i) incorporating trade imbalances; (ii) adding non-manufacturing production and trade; (iii) using directly measured productivities in countries where they are available; (iv) carrying out all of the analysis under alternative assumptions on the dispersion parameter θ; (v) using country-specific I-O matrices; and (vi) considering alternative specifications of the unbalanced counterfactual.

C.1 Trade Imbalances

One aspect of Chinese trade that has receives a lot of attention is its large surpluses in goods trade. Trade surpluses result from dynamic decisions, whereas our model is static in nature. In the absence of a working model that explains trade imbalances, we incorporate the impact of trade imbalances following the approach of Dekle, Eaton and Kortum (2007, 2008) and assuming that at a point in time, a trade imbalance represents a transfer from the surplus to the deficit country. Specifically, the budget constraint (or the resource constraint) of the consumer is now

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

where D_n is the trade surplus of country n. When D_n is negative, countries are running a deficit and consume more than their factor income. The deficits add up to zero globally, $\sum_n D_n = 0$, and are thus transfers of resources between countries. The rest of the model remains the same. In implementing the model, the deficits are taken directly from the data. To evaluate how trade imbalances affect our quantitative results, we want to ignore the transfer itself. In other words, when the U.S. opens to trade with China, in this model there will be gains from goods trade, but also direct income gains from the transfer of resources from China to the U.S.. In calculating the welfare impact, we abstract from the latter, since in the intertemporal sense, it is not really a transfer. Thus, in the model with deficits, the metric for welfare continues to be equation (14).

In evaluating the welfare gains from trade with China, we assume that when China is in autarky, its bilateral imports and exports (and thus bilateral deficits) with each country are set to zero. Thus, the rest of the world's bilateral trade imbalances remain unchanged, and trade is still generically not balanced for the other 74 countries. In the balanced and unbalanced growth counterfactuals, we assume that the vector of D_n's in the world remains the same. Both assumptions are not perfect, but without a working model of endogenous determination of D_n's, there is no clearly superior alternative.

Table WebA2 reports the results in a model with trade imbalances. Not surprisingly, China gains about half a percentage point less compared to the model without trade imbalances, since in the trade equilibrium it is transferring resources abroad, while the rest of the world gains more with trade imbalances. Note that we are not counting the direct impact of income transfers in the welfare calculations. Thus, larger gains from trade with China to the rest of the world compared to the baseline model come from the general equilibrium effects on goods and factor prices. Intuitively, a country receiving a transfer will experience an increase in demand, which will push up factor prices, while in the country sending out the transfer (China), factor prices will be lower relative to the model in which trade is balanced. Consequently, countries receiving the transfers gain more from trade with China in the model with trade imbalances (Dornbusch, Fischer and Samuelson 1977).

The global impact of balanced and unbalanced growth in China is very similar to the baseline results. The mean welfare impact of balanced growth in China, 0.003%, is slightly smaller than without trade deficits, but of the same order of magnitude. The mean gains from unbalanced growth, 0.39%, are very similar to the baseline case. In each growth scenario, the gains across countries with and without trade deficits have a correlation coefficient of above 0.93.

C.2 Agriculture and Mining Sectors

Another concern is that the baseline model includes only manufacturing sectors in the tradeable sector. Exclusion of agricultural and mining production and trade is unlikely to have a large impact on the results, as agriculture and mining account for only about 14% of global trade in the 2000s. To check robustness of the results, we collected data on total output in Agriculture, Hunting, Forestry and Fishing ("Agriculture" for short) and Mining and Quarrying ("Mining") from the United Nations Statistics Division. The output data are not available at a finer level of disaggregation. Several countries in our sample did not have information on agricultural and mining output in this database. In those cases, we imputed total output in these sectors by using agricultural and mining value added data from the World Bank's World Development indicators, and "grossing up" value added data by $1/(1-\beta_j)$ to obtain a guess for total gross output. Though we performed extensive quality and consistency checks on the resulting data points, one must treat them with caution, as they come from different sources than the manufacturing data, are in several important cases imputed, and are clearly observed at a coarser level of aggregation than manufacturing.

Combining agricultural and mining output data with information on bilateral trade, we estimate T_n^j's and d_{ni}^j's in those two sectors in each country using the same procedure as for manufacturing, described in Appendix B. We use the U.S. Input-Output table, which includes information on non-manufacturing, to compute α_j, β_j, and all the $\gamma_{k,j}$'s associated with agriculture and mining as either output or input sectors. We also use the U.S. Input-Output table for the final consumption shares of those sectors, in order to estimate non-manufacturing ω_j's. We apply the same value of θ to non-manufacturing sectors as we do to the rest of the model. Note that because of input-output linkages between all the sectors, adding non-manufacturing affects all of the productivity estimates, including those of the manufacturing sector. Thus, adding non-manufacturing involves re-running the entire estimation procedure for all sectors from scratch.

Having estimated all the technology and trade cost parameters for non-manufacturing, we then solve the full model augmented with the non-manufacturing sectors, and perform all of the counterfactuals. The results are reported in Table WebA3. By and large, the conclusions are unchanged. The magnitudes of the gains/losses from trade with China are remarkably similar. Exactly as in the baseline model, the gains from unbalanced growth are an order of magnitude larger than the gains from balanced growth.

C.3 Directly Measured Productivity

One may also be concerned that the results may be unduly influenced by the way sectoral productivity is measured. The productivity estimates used in this analysis rely on extracting information from international trade flows. An alternative approach would be to use sectoral data on output and inputs and measure TFP using the standard Solow residual approach. As detailed in Levchenko and Zhang (2011), the basic difficulty in directly measuring sectoral TFP in a large sample of countries and over time is the lack of comparable data on real sectoral output and inputs. To our knowledge, the most comprehensive database that can be used to measure sectoral

TFP on a consistent basis across countries and time is the OECD Structural Analysis (STAN) database. It contains the required information on only 11 developed countries: Austria, Belgium, Czech Republic, Denmark, Finland, France, Greece, Italy, Norway, Slovenia, and Sweden (though upon closer inspection it turns out that the time and sectoral coverage is poor even in that small set of countries). Nonetheless, to check robustness of our results, we built direct TFP estimates for those 11 countries, and used them instead of the international trade-implied baseline estimates.

The resulting welfare changes are quite similar to the baseline results: for all three counterfactuals, the correlation between the welfare changes in the main analysis and the welfare changes using STAN-based estimates is above 0.99. The magnitudes of the welfare changes are very similar to the main results as well. Table WebA4 replicates all of the welfare results using the STAN-based productivity estimates for the available countries. The average welfare impacts in all three panels are very similar, and the contrast between the balanced and the unbalanced growth counterfactuals is equally stark. We conclude from this exercise that using direct estimates of productivity wherever those are available does not change the main message of the analysis.

C.4 Alternative Assumptions on the Dispersion Parameter θ

As mentioned in the calibration section, one may be concerned about the sensitivity of the results with respect to the choice of the parameter θ. We check the robustness of the results under (i) a lower value of θ and (ii) sector-specific values of θ.

In the EK model, θ measures dispersion of productivity draws. Our baseline analysis uses the EK preferred value of 8.28, which is relatively high compared to others used in the literature, implying a relatively low dispersion in productivity draws within sectors. We thus repeat the analysis under an alternative, lower value of $\theta = 4$. This value is at or near the bottom of the range suggested in the literature, and has been advocated by Simonovska and Waugh (2010). Note that adopting an alternative value of θ requires re-estimating the model, most importantly all of the T_n^j's and d_{ni}^j's. While all of the parameters in principle change, in practice the correlation between estimated T_i^j's under $\theta = 4$ and the baseline is above 0.95, and there is actually somewhat greater variability in T_i^j's under $\theta = 4$.

The results of the analysis under $\theta = 4$ are presented in Table WebA5. None of the substantive results are affected by the choice of θ. Most importantly, the world gains far more in the unbalanced counterfactual (0.52%) compared to the balanced one (0.03%). As the table makes clear, this pattern is evident in every region, and is equally pronounced as in the baseline. As expected, the absolute numbers are different, generally implying larger gains from trade with China. For China itself, the gains relative to autarky are 6.22% instead of 3.72% in the baseline, while for the rest of the world the gain from trade with China are 0.28% compared to the baseline 0.13%.

Recent contributions have argued that θ actually varies across sectors (Imbs and Méjean 2009, Caliendo and Parro 2010, Chen and Novy 2011). To check whether our results are affected by the assumption that θ is the same across sectors, we re-implement the model with sector-specific θ_j's. Since Caliendo and Parro (2010)'s framework is closest to ours, we adopt the θ_j estimates in that paper. Once again, this robustness check requires re-estimating the entire set of T_n^j's and d_{ni}^j's under sector-specific θ_j's. The results are presented in Table WebA6. Our main results are robust to incorporating sector-specific θ_j's into the exercise. The world gains far more from the unbalanced growth in China compared to balanced growth.

C.5 Country-Specific Input-Output Matrices

The baseline analysis uses a single Input-Output matrix (based on the U.S. values) for all countries. In this section, we establish the robustness of the results to this approach. We collect country-specific Input-Output matrices from the GTAP database, and implement the model with those. The reason we do not use country-specific I-O matrices in the baseline analysis is that the GTAP database does not contain all of the sectors and countries present in our database, requiring some imputation.

Table WebA7 shows that the results are fully robust to using country-specific I-O matrices. The mean gains from the unbalanced counterfactual are virtually identical to the baseline case, 0.42%. The mean gains from the balanced counterfactual are 0.04%, an order of magnitude lower. As in the baseline, every major region and country group benefits more from the unbalanced growth in China compared to balanced one.

C.6 Alternative Unbalanced Counterfactuals

Finally, we assess to what extent the quantitative results are driven by the particular form of the unbalanced counterfactual we impose. One concern is that to make the Chinese sectoral productivity a constant fraction of the world frontier in every sector while at the same time keeping the average productivity the same as in the balanced counterfactual, some sectors must actually experience an absolute reduction in productivity relative to the baseline. Thus, it is important to check that our main results are not driven by absolute productivity reductions. To that end, we implement two alternative unbalanced counterfactuals. The first, which we call "linear," keeps the productivity of the top sector constant, and "rotates up" the relative productivities of the other sectors around the top sector. That is, the productivity of the second-most productive sector is set equal to the productivity of the top sector times a constant $\delta < 1$. The productivity of the third-most productive sector is then the productivity of the top sector times δ^2 and so on. This is done subject to the constraint that the resulting average counterfactual productivity is the same as in the main balanced and unbalanced counterfactuals.

The second alternative unbalanced counterfactual, called "no regress," imposes productivity that is a constant fraction of the world frontier in every sector, unless doing so would imply an absolute productivity reduction in a sector, in which case productivity in the sector is kept constant. Once again, counterfactual productivities in this scenario are set such that the resulting average productivity is the same as in all the other balanced and unbalanced counterfactuals. Importantly, in both of these alternative counterfactuals no sector experiences an absolute productivity reduction.

The next counterfactual we implement is one in which Chinese productivity relative to the world frontier in each sector is the same as the U.S. productivity relative to the world frontier, up to a multiplicative constant, once again subject to the constraint that average Chinese productivity is the same as in all the other counterfactuals. This counterfactual does imply technological regress in some sectors relative to the baseline. However, it allows us to check whether there is something special about productivity in China becoming the same as the world frontier, as opposed to another individual country. The sectoral productivities under these three alternative counterfactuals are depicted graphically in Appendix Figure WebA2.

Finally, all of the previous counterfactual scenarios have been set up so that the unweighted (geometric) average growth rate of T_n^j is the same between the balanced and the unbalanced counterfactuals – or, equivalently, the geometric average levels of counterfactual productivities are the same. However, if sectors in China are of different initial size, it could be that the weighted-average growth rate – i.e., measured aggregate productivity growth – is different between unbalanced and balanced growth scenarios. Thus, we implement an alternative unbalanced counterfactual, that instead matches the sector size-weighted growth rate of productivity to the balanced counterfactual growth rate, where sector size is proxied by its share in total tradeable value added.[2] The difference in the unbalanced productivity level between the unweighted and the weighted case is small: while in the unweighted case, each sector's productivity is about 0.39 of the world frontier, in the weighted case it is slightly higher at 0.41.

The counterfactual welfare results are summarized in Appendix Table WebA8. The top panel presents the summary statistics for the welfare impact under each counterfactual on all the countries other than China. For ease of comparison, the top two rows present the two main counterfactuals in the paper, the balanced and the unbalanced. The last four rows describe the alternative unbalanced counterfactuals. All four alternative unbalanced counterfactuals produce average welfare impacts that are an order of magnitude greater than the balanced case. The smallest impact, produced by the "linear" counterfactual, is still 10 times larger on average compared to the balanced counterfactual. The fact that the "linear" counterfactual implies smaller welfare changes is not surprising, since it is by far the closest to the balanced case. Matching size-weighted rather than unweighted productivity growth produces a slightly larger welfare impact on the rest of the world.

The bottom panel of Appendix Table WebA8 presents the correlations between the welfare impacts of all six counterfactuals we consider. While the welfare impact of the balanced counterfactual is virtually uncorrelated with any of the unbalanced counterfactuals, all of the unbalanced counterfactuals are extremely highly correlated amongst themselves, with correlation coefficients ranging from 0.94 to virtually 1. The size-weighted counterfactual in particular produces virtually indistinguishable outcomes compared to the unweighted one. We conclude from this exercise that the essential contrast between the balanced and the unbalanced cases is robust to alternative ways of defining the unbalanced counterfactual. In all cases, the world benefits much more from unbalanced growth in China.

The counterfactual in which we set Chinese relative productivity to the U.S. values can be used to check how welfare in the U.S. changes when China becomes *exactly* like the U.S. in relative productivity. It turns out that the gains to the U.S. from China becoming exactly like it, 0.174%, are nearly the same as the 0.178% U.S. gains in the main unbalanced counterfactual. The U.S. turns out to gain about the same from China becoming exactly like itself as from China becoming the same as the world frontier, and much more than it gains in the balanced counterfactual.

References

Bartelsman, Eric J. and Wayne Gray, "The NBER Manufacturing Productivity Database," October 1996. NBER Technical Working Paper 205.

Berthelon, Matias and Caroline Freund, "On the Conservation of Distance in International Trade," *Journal of International Economics*, July 2008, *75* (2), 310–320.

Caliendo, Lorenzo and Fernando Parro, "Estimates of the Trade and Welfare Effects of NAFTA," January 2010. mimeo, University of Chicago.

[2]The results are identical if we use employment-weighted averages instead. Of course, since in the balanced counterfactual every sector has the same growth rate, it doesn't matter how they are weighted. Thus, this alternative counterfactual only affects the numbers for the unbalanced counterfactual.

Chen, Natalie and Dennis Novy, "Gravity, Trade Integration, and Heterogeneity across Industries," *Journal of International Economics*, November 2011, *85* (2), 206–221.

Dekle, Robert, Jonathan Eaton, and Samuel Kortum, "Unbalanced Trade," *American Economic Review: Papers and Proceedings*, May 2007, *97* (2), 351–355.

___ , ___ , and ___ , "Global Rebalancing with Gravity: Measuring the Burden of Adjustment," *IMF Staff Papers*, 2008 2008, *55* (3), 511–540.

Do, Quy-Toan and Andrei A. Levchenko, "Comparative Advantage, Demand for External Finance, and Financial Development," *Journal of Financial Economics*, December 2007, *86* (3), 796–834.

Dornbusch, Rudiger, Stanley Fischer, and Paul Samuelson, "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods," *American Economic Review*, 1977, *67*, 823–39.

Finicelli, Andrea, Patrizio Pagano, and Massimo Sbracia, "Ricardian Selection," October 2009a. Bank of Italy *Temi di Discussione* (Working Paper) No. 728.

Imbs, Jean and Isabelle Méjean, "Elasticity Optimism," February 2009. CEPR Discussion Paper 7177.

Levchenko, Andrei A. and Jing Zhang, "The Evolution of Comparative Advantage: Measurement and Welfare Implications," February 2011. NBER Working Paper No. 16806.

Samuelson, Paul A., "Where Ricardo and Mill Rebut and Confirm Arguments of Mainstream Economists Supporting Globalization," *Journal of Economic Perspectives*, 2004, *18* (3), 135–146.

Shikher, Serge, "Putting industries into the Eaton-Kortum model," July 2004. Forthcoming, *Journal of International Trade and Economic Development*.

Simonovska, Ina and Michael E. Waugh, "The Elasticity of Trade: Estimates and Evidence," December 2010. Mimeo, UC Davis and NYU.

Waugh, Michael, "International Trade and Income Differences," *American Economic Review*, December 2010, *100* (5), 2093–2124.

Table WebA1. Numerical Examples: the Impact of Technological Change in Country 1

	2 countries	**3 countries**
	Constant Average Productivity in Country 1	
$\Delta(w_1/P)$	-0.181	-0.849
$\Delta(w_2/P)$	-0.181	0.158
$\Delta(w_3/P)$		-0.655
$\Delta(P)$	0.181	0.856
$\Delta(w_1/w_2)$	0.000	-1.006
$\Delta(w_3/w_2)$		-0.812
NX_1^A (before, after)	$(0.09, 0.00)$	$(0.21, 0.11)$
NX_2^A (before, after)	$(-0.09, 0.00)$	$(0.05, 0.11)$
NX_3^A (before, after)		$(-0.26, -0.22)$
	Net Productivity Growth in Country 1	
$\Delta(w_1/P)$	8.490	6.195
$\Delta(w_2/P)$	-0.362	0.455
$\Delta(w_3/P)$		-1.114
$\Delta(P)$	-7.825	-5.834
$\Delta(w_1/w_2)$	8.883	5.714
$\Delta(w_3/w_2)$		-1.562
NX_1^A (before, after)	$(0.20, 0.00)$	$(0.33, 0.11)$
NX_2^A (before, after)	$(-0.18, 0.00)$	$(0.00, 0.11)$
NX_2^A (before, after)		$(-0.30, -0.22)$

Notes: This table presents the proportional changes (in percent) in welfare, the consumption price level expressed relative to the numeraire (wage in country 1), and the changes in relative wages, that come from a change in relative technology in country 1. The rows labeled "NX_n^A (before, after)" for $n = 1, 2, 3$ report the net exports from country n in sector A relative to country n's GDP, before and after the technological change considered in the experiment. The top panel reports the changes due to moving from $T_1^A/T_1^B = 2$ to $T_1^A/T_1^B = 1$ while keeping $\left(T_1^A T_1^B\right)^{\frac{1}{2}} = 0.5$. The bottom panel reports the changes due to moving from $\left\{T_1^A = 0.5, T_1^B = 0.1\right\}$ to $\left\{T_1^A = 0.5, T_1^B = 0.5\right\}$. The other model parameters are described in the main text.

Table WebA2. Welfare Changes, Unbalanced Trade

Panel A: Welfare Gains from Trade with China

	Mean	Median	Min	Max	Countries
China	3.09				
OECD	0.30	0.27	0.04	0.89	22
East and South Asia	0.32	0.22	-0.29	1.92	12
East. Europe and Cent. Asia	0.44	0.32	0.03	0.99	11
Latin America and Caribbean	0.25	0.26	-0.36	1.13	15
Middle East and North Africa	0.80	0.49	0.18	2.37	6
Sub-Saharan Africa	0.63	0.55	0.10	1.95	8

Panel B: Welfare Gains from Balanced Growth in China

	Mean	Median	Min	Max	Countries
China	11.56				
OECD	0.01	0.01	-0.01	0.04	22
East and South Asia	0.01	0.02	-0.09	0.07	12
East. Europe and Cent. Asia	0.00	0.00	-0.02	0.05	11
Latin America and Caribbean	-0.01	0.00	-0.09	0.03	15
Middle East and North Africa	-0.01	0.00	-0.08	0.02	6
Sub-Saharan Africa	0.00	0.00	-0.02	0.01	8

Panel C: Welfare Gains from Unbalanced Growth in China

	Mean	Median	Min	Max	Countries
China	10.64				
OECD	0.14	0.12	-0.10	0.69	22
East and South Asia	0.83	0.76	0.23	1.69	12
East. Europe and Cent. Asia	0.36	0.36	0.09	0.83	11
Latin America and Caribbean	0.49	0.42	-0.20	1.49	15
Middle East and North Africa	0.43	0.44	0.18	0.69	6
Sub-Saharan Africa	0.22	0.25	-0.12	0.58	8

Notes: Units are in percentage points. This table reports the changes in welfare from three counterfactual scenarios under the assumption of unbalanced trade. Panel A presents the welfare gains in the benchmark for 2000s, relative to the scenario in which China is in autarky. Panel B presents the changes in welfare under the counterfactual scenario that growth is balanced in China across sectors, relative to the benchmark. Panel C presents the changes in welfare under the counterfactual scenario of unbalanced growth in China, relative to the benchmark. The technological changes assumed under the counterfactual scenarios are described in detail in the text.

Table WebA3. Welfare Changes, with Agriculture and Mining Sectors

Panel A: Welfare Gains from Trade with China

	Mean	Median	Min	Max	Countries
China	3.53				
OECD	0.12	0.11	-0.04	0.31	22
East and South Asia	0.18	0.12	-0.26	0.69	12
East. Europe and Cent. Asia	0.06	0.07	-0.12	0.27	11
Latin America and Caribbean	0.04	0.04	-0.27	0.25	15
Middle East and North Africa	0.01	0.05	-0.16	0.13	6
Sub-Saharan Africa	0.08	0.09	-0.04	0.23	8

Panel B: Welfare Gains from Balanced Growth in China

	Mean	Median	Min	Max	Countries
China	10.60				
OECD	0.01	0.02	-0.01	0.04	22
East and South Asia	0.02	0.03	-0.04	0.09	12
East. Europe and Cent. Asia	0.00	0.01	-0.03	0.04	11
Latin America and Caribbean	0.00	0.00	-0.05	0.02	15
Middle East and North Africa	0.01	0.01	-0.02	0.02	6
Sub-Saharan Africa	0.01	0.01	-0.02	0.02	8

Panel C: Welfare Gains from Unbalanced Growth in China

	Mean	Median	Min	Max	Countries
China	8.59				
OECD	0.13	0.08	-0.09	0.59	22
East and South Asia	0.70	0.67	0.20	1.33	12
East. Europe and Cent. Asia	0.31	0.30	0.06	0.62	11
Latin America and Caribbean	0.39	0.41	0.05	0.99	15
Middle East and North Africa	0.51	0.59	0.11	0.68	6
Sub-Saharan Africa	0.28	0.26	-0.09	0.58	8

Notes: Units are in percentage points. This table reports the changes in welfare from three counterfactual scenarios in the model that includes Agriculture and Mining sectors in addition to manufacturing and nontradeables. Panel A presents the welfare gains in the benchmark for 2000s, relative to the scenario in which China is in autarky. Panel B presents the changes in welfare under the counterfactual scenario that growth is balanced in China across sectors, relative to the benchmark. Panel C presents the changes in welfare under the counterfactual scenario of unbalanced growth in China, relative to the benchmark. The technological changes assumed under the counterfactual scenarios are described in detail in the text.

Table WebA4. Welfare Changes, Direct Measures of Productivity

Panel A: Welfare Gains from Trade with China

	Mean	Median	Min	Max	Countries
China	3.81				
OECD	0.15	0.14	-0.04	0.30	22
East and South Asia	0.22	0.18	-0.24	0.79	12
East. Europe and Cent. Asia	0.14	0.09	-0.13	0.71	11
Latin America and Caribbean	0.09	0.08	-0.28	0.38	15
Middle East and North Africa	0.11	0.13	0.02	0.22	6
Sub-Saharan Africa	0.07	0.05	-0.06	0.19	8

Panel B: Welfare Gains from Balanced Growth in China

	Mean	Median	Min	Max	Countries
China	11.41				
OECD	0.01	0.02	-0.01	0.04	22
East and South Asia	0.02	0.03	-0.05	0.09	12
East. Europe and Cent. Asia	0.00	0.01	-0.02	0.05	11
Latin America and Caribbean	-0.01	0.00	-0.07	0.04	15
Middle East and North Africa	-0.01	-0.01	-0.06	0.02	6
Sub-Saharan Africa	0.00	0.00	-0.02	0.02	8

Panel C: Welfare Gains from Unbalanced Growth in China

	Mean	Median	Min	Max	Countries
China	10.71				
OECD	0.17	0.14	-0.42	0.77	22
East and South Asia	0.86	0.73	0.21	1.68	12
East. Europe and Cent. Asia	0.43	0.41	-0.03	1.45	11
Latin America and Caribbean	0.50	0.44	0.08	1.68	15
Middle East and North Africa	0.45	0.50	0.19	0.77	6
Sub-Saharan Africa	0.23	0.21	-0.03	0.62	8

Notes: Units are in percentage points. This table reports the changes in welfare from three counterfactual scenarios. The productivity estimates used in this exercise are directly estimated using production data for 11 OECD countries. Panel A presents the welfare gains in the benchmark for 2000s, relative to the scenario in which China is in autarky. Panel B presents the changes in welfare under the counterfactual scenario that growth is balanced in China across sectors, relative to the benchmark. Panel C presents the changes in welfare under the counterfactual scenario of unbalanced growth in China, relative to the benchmark. The technological changes assumed under the counterfactual scenarios are described in detail in the text.

Table WebA5. Welfare Changes, $\theta = 4$

Panel A: Welfare Gains from Trade with China

	Mean	Median	Min	Max	Countries
China	6.22				
OECD	0.26	0.25	-0.04	0.64	22
East and South Asia	0.49	0.43	-0.42	1.56	12
East. Europe and Cent. Asia	0.30	0.21	-0.13	1.50	11
Latin America and Caribbean	0.20	0.22	-0.40	0.72	15
Middle East and North Africa	0.34	0.30	0.13	0.57	6
Sub-Saharan Africa	0.19	0.14	0.01	0.41	8

Panel B: Welfare Gains from Balanced Growth in China

	Mean	Median	Min	Max	Countries
China	13.51				
OECD	0.03	0.04	-0.01	0.08	22
East and South Asia	0.07	0.10	-0.05	0.19	12
East. Europe and Cent. Asia	0.03	0.02	-0.02	0.16	11
Latin America and Caribbean	0.01	0.01	-0.07	0.08	15
Middle East and North Africa	0.01	0.02	-0.06	0.06	6
Sub-Saharan Africa	0.03	0.02	0.00	0.06	8

Panel C: Welfare Gains from Unbalanced Growth in China

	Mean	Median	Min	Max	Countries
China	6.60				
OECD	0.22	0.18	-0.13	0.74	22
East and South Asia	1.11	1.00	0.32	2.41	12
East. Europe and Cent. Asia	0.57	0.49	0.10	1.64	11
Latin America and Caribbean	0.52	0.48	0.04	1.46	15
Middle East and North Africa	0.63	0.70	0.28	0.89	6
Sub-Saharan Africa	0.29	0.24	-0.05	0.82	8

Notes: Units are in percentage points. This table reports the changes in welfare from three counterfactual scenarios. The model is estimated, solved, and simulated under the assumption that $\theta = 4$. Panel A presents the welfare gains in the benchmark for 2000s, relative to the scenario in which China is in autarky. Panel B presents the changes in welfare under the counterfactual scenario that growth is balanced in China across sectors, relative to the benchmark. Panel C presents the changes in welfare under the counterfactual scenario of unbalanced growth in China, relative to the benchmark. The technological changes assumed under the counterfactual scenarios are described in detail in the text.

Table WebA6. Welfare Changes, Sector-Specific θ_j's

Panel A: Welfare Gains from Trade with China

	Mean	Median	Min	Max	Countries
China	3.30				
OECD	0.22	0.20	-0.02	0.44	22
East and South Asia	0.46	0.49	-0.13	1.02	12
East. Europe and Cent. Asia	0.28	0.15	0.05	0.75	11
Latin America and Caribbean	0.25	0.27	-0.20	0.65	15
Middle East and North Africa	0.44	0.49	0.19	0.71	6
Sub-Saharan Africa	0.63	0.63	0.07	1.32	8

Panel B: Welfare Gains from Balanced Growth in China

	Mean	Median	Min	Max	Countries
China	15.36				
OECD	0.01	0.02	-0.06	0.05	22
East and South Asia	0.00	0.01	-0.19	0.16	12
East. Europe and Cent. Asia	-0.04	0.00	-0.21	0.02	11
Latin America and Caribbean	-0.04	-0.05	-0.16	0.05	15
Middle East and North Africa	-0.08	-0.10	-0.12	-0.01	6
Sub-Saharan Africa	-0.10	-0.10	-0.24	0.01	8

Panel C: Welfare Gains from Unbalanced Growth in China

	Mean	Median	Min	Max	Countries
China	9.68				
OECD	0.05	0.06	-0.37	0.43	22
East and South Asia	0.56	0.68	-0.46	1.50	12
East. Europe and Cent. Asia	0.19	0.19	-0.23	0.51	11
Latin America and Caribbean	0.27	0.26	-0.31	0.99	15
Middle East and North Africa	0.18	0.21	-0.19	0.39	6
Sub-Saharan Africa	0.06	0.12	-0.41	0.50	8

Notes: Units are in percentage points. This table reports the changes in welfare from three counterfactual scenarios. The model is estimated, solved, and simulated under the assumption that θ_j's are sector-specific. The values of θ_j are sourced from Caliendo and Parro (2010). Panel A presents the welfare gains in the benchmark for 2000s, relative to the scenario in which China is in autarky. Panel B presents the changes in welfare under the counterfactual scenario that growth is balanced in China across sectors, relative to the benchmark. Panel C presents the changes in welfare under the counterfactual scenario of unbalanced growth in China, relative to the benchmark. The technological changes assumed under the counterfactual scenarios are described in detail in the text.

Table WebA7. Welfare Changes, Country-Specific $\gamma_{k,j}$'s

Panel A: Welfare Gains from Trade with China

	Mean	Median	Min	Max	Countries
China	6.10				
OECD	0.21	0.20	-0.06	0.46	22
East and South Asia	0.46	0.47	0.00	0.94	12
East. Europe and Cent. Asia	0.29	0.17	-0.01	1.31	11
Latin America and Caribbean	0.19	0.14	-0.20	0.93	15
Middle East and North Africa	0.14	0.15	0.08	0.23	6
Sub-Saharan Africa	0.13	0.10	0.00	0.44	8

Panel B: Welfare Gains from Balanced Growth in China

	Mean	Median	Min	Max	Countries
China	19.08				
OECD	0.05	0.05	0.00	0.10	22
East and South Asia	0.13	0.11	-0.10	0.43	12
East. Europe and Cent. Asia	0.04	0.03	-0.05	0.21	11
Latin America and Caribbean	0.00	0.01	-0.12	0.06	15
Middle East and North Africa	0.02	0.02	-0.10	0.12	6
Sub-Saharan Africa	-0.01	-0.01	-0.11	0.10	8

Panel C: Welfare Gains from Unbalanced Growth in China

	Mean	Median	Min	Max	Countries
China	12.63				
OECD	0.13	0.09	-0.47	0.82	22
East and South Asia	0.70	0.69	0.23	1.56	12
East. Europe and Cent. Asia	0.45	0.37	0.08	1.59	11
Latin America and Caribbean	0.63	0.47	0.13	2.56	15
Middle East and North Africa	0.43	0.49	0.04	0.77	6
Sub-Saharan Africa	0.33	0.36	-0.05	0.59	8

Notes: Units are in percentage points. This table reports the changes in welfare from three counterfactual scenarios. The model is estimated, solved, and simulated under the assumption that the Input-Output matrices ($\gamma_{k,j}$'s) are country-specific. The country-specific Input-Output matrices are sourced from the GTAP database. Panel A presents the welfare gains in the benchmark for 2000s, relative to the scenario in which China is in autarky. Panel B presents the changes in welfare under the counterfactual scenario that growth is balanced in China across sectors, relative to the benchmark. Panel C presents the changes in welfare under the counterfactual scenario of unbalanced growth in China, relative to the benchmark. The technological changes assumed under the counterfactual scenarios are described in detail in the text.

Table WebA8. Alternative Counterfactuals

Panel A: Summary Statistics

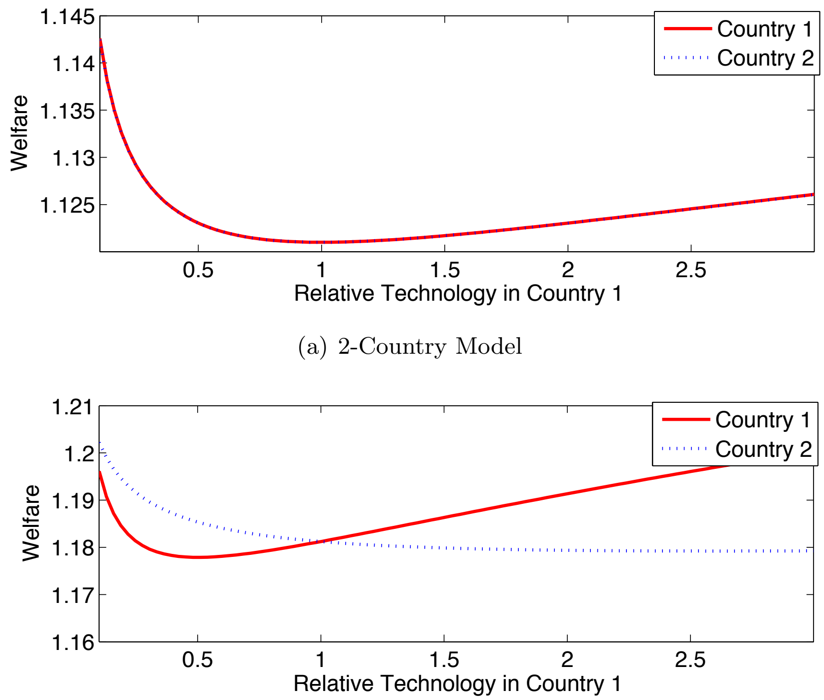
	Mean	St. Dev.	Min	Max
Balanced	0.01	0.03	-0.07	0.09
Unbalanced	0.42	0.39	-0.07	1.70
Unbalanced – Linear	0.11	0.12	-0.02	0.56
Unbalanced – No Regress	0.28	0.28	-0.06	1.28
Unbalanced – U.S. Values	0.43	0.42	-0.10	1.89
Unbalanced – VA-Weighted	0.44	0.41	-0.06	1.82

Panel B: Correlations

	Balanced	Unbalanced	Unbalanced – Linear	Unbalanced – No Regress	Unbalanced – U.S. Values
Balanced	1.000				
Unbalanced	0.065	1.000			
Unbalanced – Linear	-0.157	0.946	1		
Unbalanced – No Regress	0.131	0.984	0.9394	1.000	
Unbalanced – U.S. Values	0.054	0.997	0.9368	0.973	1.000
Unbalanced – VA-Weighted	0.082	1.000	0.9423	0.984	0.995

Notes: The top panel of this table reports the summary statistics for the different counterfactual scenarios for Chinese productivity growth. "Balanced" and "Unbalanced" are the two main counterfactuals in the paper, depicted graphically in Figure 3. "Unbalanced – Linear" is a counterfactual in which the most productive Chinese sector relative to the world frontier keeps the same productivity, while each successive sectors's productivity relative to the world frontier is lower by a fixed multiplicative constant. "Unbalanced – No Regress" is a counterfactual in which productivity in each Chinese sector becomes a constant ratio to the world frontier, unless that would imply an absolute reduction in sectoral productivity, in which case the productivity remains unchanged. "Unbalanced – U.S. Values" is a counterfactual in which Chinese productivity relative to the world frontier is the same as in the U.S. Across all counterfactuals, the geometric average sectoral productivity in Chinese sectors is kept the same. These three counterfactuals are depicted graphically in Figure WebA2. The "Unbalanced – VA-Weighted" counterfactual is designed so that the value-added-weighted (rather than unweighted) geometric average productivity growth is the same in the unbalanced counterfactual as in the balanced one.

Figure WebA1. Welfare and Technological Similarity: A Numerical Example

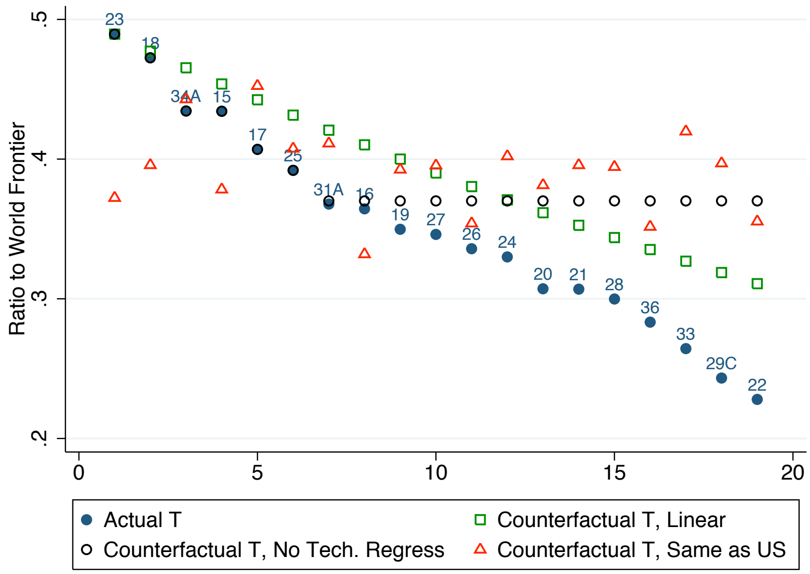


(a) 2-Country Model

(b) 3-Country Model

Notes: This figure plots welfare in country 1 and country 2 as a function of T_1^A/T_1^B. The top panel considers a 2-country model, whereas the bottom panel a 3-country model. For country 2, $T_2^A/T_2^B = 1$, so countries 1 and 2 have the same technology when the value on the x-axis equals 1. Exact parameter values are decribed in Section A.1.

Figure WebA2. China: Alternative Counterfactual Productivities



Notes: This figure displays the sectoral productivities unter three alternative unbalanced counterfactual scenarios in China. The construction of the three scenarios is described in detail in the text. The key for sector labels is reported in Table A3 of the main text.