Winners and Losers from China's Ascension in International Trade: a Structural Approach[*]

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Abstract

This paper employs a unified theoretical framework to estimate the effect of changes within China on the Brazilian and World's economy. Based on the Ricardian model of trade of Costinot, Donaldson, and Komunjer (2012), we perform counterfactuals exercises to analyze how industries in Brazil would have performed in the absence of the Chinese ascension. We discuss two main counterfactual exercises. First, we model productivity growth in China as the main lever by which Chinese supply and demand conditions evolve and affect economies worldwide. Second, we study how changes in composition of Chinese demand (taste) affects trade flows around the world. The two counterfactual exercises together suggest that changes in China's comparative advantage hampered manufacturing sectors abroad, in particular labor-intensive Brazilian manufacture producers. We find no support for the idea of a China taste shock driving demand towards raw materials. Our model suggests that if China triggered a commodity boom in the world, or at least in Brazil, this was driven mostly by increased income in China. And any changes in China's tastes over products contributed to moderate such boom. Specifically, our model indicates that the boom of soybeans cultivation in Brazil is due to changes in Brazilian comparative advantage paired with a level increase in demand for this product within China.

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1   Introduction

Between 1990 and 2008, the Chinese economy grew at two-digit rates for years and became well integrated in the world's production chain. In this period, Chinese trade with the world grew at a stunning average of 19 percent per year. Triggered by internal market-oriented structural reforms, this growth was supported in part by the development of a strong export-oriented, labor-intensive manufacturing sector at the same time that the country became a major importer of raw materials and components for final assembly in Chinese factories. Naturally, a phenomenon of this magnitude should affect production and labor markets in the rest of the world.

On the way to estimating an effect of the ascension of China in labor markets worldwide, we want to learn what China has meant for the world's cross-sectoral production composition. In particular, in the light of Costa, Garred, and Pessoa (2016), we want to learn about the interacting effects of changing Chinese supply and demand conditions on Brazil's sectoral structure. Our main motivation is that the Autor, Dorn, and Hanson (2013)-inspired regressions in Costa et al. (2016), using Brazil's imports from China and Brazil's exports to China as independent variables, have two main issues. First, growth in Chinese productivity may lead to Chinese imports replacing other countries' imports to Brazil as well as affecting Brazilian production itself (Gallagher, Moreno-Brid, & Porzecanski, 2008), and this could affect Costa et al. (2016)'s cross-sectoral interpretation of the effects of Chinese growth on Brazilian production. Second, growth in Brazilian productivity should not be assigned to demand from China, e.g. growth in Brazil's exports to China may be due to productivity growth within Brazil rather than Chinese demand (Bustos, Caprettini, & Ponticelli, 2016), and the papers that study the impact of the Chinese boom on other economies want to consider only the latter.

In this paper we employ a unified theoretical framework to directly estimate the effect of changes within China on production in Brazil and in the rest of the world. In order to do so, we use the Ricardian model of trade of Costinot et al. (2012) which, building on Eaton and Kortum (2002), provides theoretically consistent foundations for estimating the relative production cost at a country-industry level. We use these estimates to develop counterfactuals in which China stays at its 'original' state, and then compare Brazil's production composition in this counterfactual world and the observed one. We perform two main counterfactual exercises. First, we model productivity growth in China as the main lever by which Chinese supply and demand conditions evolve and affect

Brazil. In other words, we investigate to what extent changes in global trade flows are affected just by scaling China up, without considering productivity changes across industries within China. Second, we study how changes in composition of Chinese demand (taste) affects trade flows around the world, and how it affects Brazilian production.

We present a general equilibrium Ricardian model where factor prices and demand adjust endogenously. This creates feedback between the supply and demand components of the model, making counterfactual exercises much less tractable. In order to perform a full general equilibrium exercise, our counter-factuals would require considerably more structure and additional assumptions. Therefore, in favor of simplicity, and to illustrate the different mechanisms more clearly, we adopt a partial-equilibrium approach. We separately investigate the supply-side and demand-side aspects of China growth within the model, highlighting which general equilibrium mechanisms we switch off in each case. We understand that this partial equilibrium approach comes at the expense of having an unified theoretically consistent counterfactual, but we gain in clarity and in the plausibility of assumptions in the Brazilian case.

Our counterfactual results show that, within this Ricardian model of trade, China supply shock hampered Brazilian manufacturing and, to a much smaller extent, contributed to the expansion of iron ore production. We find no support for the idea of a demand (taste) shock in China that led to the increased production of soybeans and iron ore in Brazil. The two exercises—the supply and demand partial-equilibrium counterfactuals—together suggest that the boom of soybeans cultivation in Brazil is due to changes in Brazilian comparative advantage paired with a level increase in demand for this product within China. Our finding on iron and manganese ore are similar to the soybeans one, but on a smaller magnitude.

The main contribution of this paper is to provide evidence based on a theoretical general equilibrium trade framework on the assumptions underlying the instruments used in Costa et al. (2016), and in many papers in the literature which followed Autor et al. (2013). The counterfactual worlds generated in this paper suggest that our concerns regarding the plausibility of these instruments seem to be mild. It does seem that, within China, supply shocks led to competition to manufacturing abroad, reducing the average trade share of developed countries. In particular, Chinese trade evolution seems more directed to labor-intensive products. At the same time, evidence suggest that changes in China's consumption pattern—i.e., spending a smaller share of their income in

raw materials—actually weakened the international commodities boom.

Our paper also relates to the literature that uses general equilibrium structural models to investigate the effects of the recent growth in China. Most of this literature, as Hsieh and Ossa (2016) and Caliendo, Dvorkin, and Parro (2019), intends to estimate the global welfare effects of China, while we want to understand to which extent changing Chinese supply and demand conditions affected Brazilian sectoral composition. Notably, di Giovanni, Levchenko, and Zhang (2014) models China's effect on the rest of the world taking into account multiple factors, intermediate goods and trade imbalances. To do so, the paper incorporates further structure to Eaton and Kortum (2002) to develop a complex computable general equilibrium model. Different from that paper, our exercise uses more disaggregate industry-level data, and explicitly takes into account agriculture and mining sectors in all our calculations.

The paper is organized as follows. We describe the theoretical framework in section 2. Section 3 introduces the data and describes the estimation of the relative production costs. Section 4 presents the preliminary counterfactual exercises. Section 5 concludes.

2 Theoretical Framework

In this section we present the Ricardian model of trade of Costinot et al. (2012), which is based on Eaton and Kortum (2002). Suppose a world economy with $i = 1, \dots, I$ countries and one factor of production, labor (we will consider a multi-factor environment in the next section). Let L_i and w_i be the number of workers and wages in country i. There are $k = 1, \dots, K$ products (or industries). labor is immobile across countries but free to move across industries. Each product exhibits constant returns to scale production function, but we allow for intra-industry heterogeneity.

Technology. Each product k has an infinite number of varieties $\omega \in \Omega \equiv \{1, \dots, +\infty\}$. Let $z_i^k(\omega)$ be the productivity of variety ω of product k in country i, i.e., it is the amount of good produced with one unit of labor. As Eaton and Kortum (2002), assume $z_i^k(\omega)$ is a random variable independently distributed for each (i, k, ω) from a Fréchet distribution $F_i^k(\cdot)$ such that

$$F_i^k(z) = \exp\left[-\left(z/z_i^k\right)^{-\theta}\right], \qquad \forall z \geq 0, \tag{1}$$

where $z_i^k > 0$ and $\theta > 1$.

That is, the production technology of each country-industry is defined by two parameters θ, which captures the intra-industry heterogeneity, and z_i^k, which captures the *fundamental productivity* of country i in industry k. As Costinot et al. (2012), we assume θ to be constant across countries and industries, so any comparative advantage will emerge from differences in the fundamental productivities (or in the cost of production, as we will see) as a standard Ricardian model.

Trade costs. We assume standard "iceberg" costs. Formally, for each unit of product k going from country i to country j, only $1/d_{ij}^k$ units arrive, where $d_{ij}^k \geq 1$. Also, assume that there is no cost of internal trade, $d_{ii}^k = 1$, and no profitable triangulation, $d_{ij}^k \leq d_{ij}^k d_{jl}^k$ for any other country l.

Market structure. We assume perfect competition, such that consumers in country j always pay the lowest price when buying variety ω of product k, that is

$$p_j^k(\omega) = \min_{1 \leq i \leq I} \left[c_{ij}^k(\omega) \right], \tag{2}$$

where $c_{ij}^k(\omega) = d_{ij}^k w_i / z_i^k(\omega)$ is the cost of producing variety ω of product k in country i delivered in country j.

Preferences. In order to allow for intra-industry trade, assume a two tier utility function with Cobb–Douglas upper tier and a constant elasticity of substitution in the lower tier. Therefore, the total expenditure in country j on variety ω of good k is

$$x_j^k(\omega) = \left[\frac{p_j^k(\omega)}{p_j^k} \right]^{1-\sigma_j^k} \alpha_j^k w_j L_j, \tag{3}$$

where σ_j^k is the elasticity of substitution between varieties of a product, $\sigma_j^k < 1 + \theta$, and

$$p_j^k \equiv \left[\sum_{\omega' \in \Omega} p_j^k(\omega')^{1-\sigma_j^k} \right]^{1/\left(1-\sigma_j^k\right)}$$

is the consumer price index. The parameter α_j^k, $0 \leq \alpha_j^k \leq 1$, will be at the core of our demand counterfactual, it measures the share of expenditure on product k in country j.

Trade balance. Assume that trade is balanced

$$\sum_{j=1}^{I}\sum_{k-1}^{K}\pi_{ij}^{k}\alpha_{j}^{k}\phi_{j} = \phi_{i}, \tag{4}$$

$$\phi_{i} \equiv \frac{w_{i}L_{i}}{\sum_{i'}^{I}w_{i'}L_{i'}},$$

where ϕ_i is the share of country i in world income, and π_{ij}^{k} is the share of exports from country i in country j industry k. Formally, let $x_{ij}^{k} \equiv \sum_{\omega \in \Omega_{ij}^{k}} x_{ij}^{k}(\omega)$, where $\Omega_{ij}^{k} \equiv \left\{\omega \in \Omega | c_{ij}^{k}(\omega) = \min_{1 \leq i' \leq I}\left[c_{i'j}^{k}(\omega)\right]\right\}$ is the set of all varieties of product k exported from country i to country j.

Trade flows and equation (4) solve countries relative wages $w_i/w_{i'}$.

3 Data and Estimation

In this section we introduce the data and present the estimation of the relevant parameters of the model.

3.1 Data

The trade data is from the world trade database developed by the CEPII (CEPII BACI). In contains the annual total value (in thousands of US dollars) of trade at industry-importing country-exporting country level from 1998 to 2010, containing more than 200 countries. This is a reconciled dataset originally from COMTRADE by the United Nations Statistical Division. Product disaggregation is at HS96 6-digit level.

For the counterfactual analysis, apart from the trade data we need gross output data for agriculture/forest, mining/energy and manufacturing industries. Data for agriculture and forestry is from FAOSTAT. Data is in current US dollars by country-industry-year. First, we use concordance HS96 to ISIC3 to figure out which goods where classified as agriculture rather than manufacturing by COMTRADE. Then, we drop all products associated with manufacturing from FAOSTAT. Concordance was made in two stages, first FAOCODE to HS (from FAO) and then concorded by hand to CNAE. We use only one one category for forest: roundwood.[1] The unit of production data is in quantities, but FAO trade data is in quantities and values. We use unit values to convert quantity produced to values. Outliers unit values (below the 5th and above the 95th

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[1] This is the best proxy for unprocessed logs according to FAO classification guide.

percentiles) were assigned the values of the 5th and 95th percentiles. Missing unit values assigned the median for the country across years.

Mining/energy data is from the BGS World Mineral Statistics, BP Statistical Review of World Energy, and World Input-Output Database. We concorded CNAE2.0 and HS96 by hand (CNAE was the limiting factor). Again, this data is in quantities, so we use unit values and prices (US Energy Information Administration and others) to convert to values.[2]

Last, data for manufacturing is from UNIDO INDSTAT4. This is all gross output data with ISIC3 classification, all in values of current US dollars. Data was cleaned to impute missing values. Data from China between 1999 and 2002, missing in the main dataset, comes from the summary statistics from the Annual Survey of Manufacturing from China, concorded to ISIC 3.[3] We hand concorded CNAE2.0 to 3-digit ISIC3 and used HS96 to ISC3 concordance. We restrict attention to 1999–2007, the years for which Brazilian 3-digit production data is available in UNIDO INDSTAT4.[4]

Overall, we end up with 35 countries between 1999 and 2007 (we use only 1999 and 2007 in this version of the project), and 73 sectors (17 agricultural/forestry, 7 mining/energy, 49 manufacturing). We also use bilateral trade information from the CEPII gravity database. It provides data on several trade cost dimensions for all pair of countries from 1948 to 2006.[5]

3.2   Estimation

Much of the motivation for Costa et al. (2016) is based on the fact that Brazil has access to endowments (e.g., land) that are highly in demand in China, so we consider the Costinot et al. (2012) model presented in section 2 but allowing for the possibility of multiple factors of production. This does not affect the mechanisms of the model, but it helps understanding the underlying assumptions in our counterfactuals. In particular, let the cost of production of variety ω of

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[2] "Other mining" category was derived from trade data.

[3] We applied the official exchange rate from China Statistical Yearbook 2003 to convert to current USD.

[4] We drop the following sectors: publishing (not in Chinese dataset, because it is considered service), recycling (not separate trade data for that), and refined petroleum and nuclear fuel (large number of missing data).

[5] Since data for 2007 is unavailable, in our estimation for the year 2007 we use 2006 trade costs instead.

industry k in country i be:

$$c_i^k(\omega) = \frac{\prod_f (w_{fi})^{s_f^k}}{z_i^k(\omega)}. \tag{5}$$

where w_f^i is the cost of input f and $w_i^k \equiv \prod_f (w_{fi})^{s_f^k}$.

From (3) we have that:

$$x_{ij}^k = \frac{\left(w_i^k d_{ij}^k / z_i^k\right)^{-\theta}}{\sum_{i'=1}^{I} \left(w_{i'}^k d_{i'j}^k / z_{i'}^k\right)^{-\theta}} D_j^k \tag{6}$$

$$= \frac{\left(c_i^k d_{ij}^k\right)^{-\theta}}{\Phi_j^k} D_j^k, \tag{7}$$

where D_j^k represents demand for the output of industry k in country j, which we will not model explicitly here in order to keep the focus on the estimation of the supply side. The last equality follows from equation (5). This gives us the following relationship in logs:

$$\ln x_{ij}^k = -\theta \ln c_i^k - \theta \ln d_{ij}^k - \ln \Phi_j^k + \ln D_j^k. \tag{8}$$

Following Costinot et al. (2012), we estimate the cost parameters via exporter-industry fixed effects. By rewriting the expression above, and adding a time index t, we obtain:

$$\ln x_{ijt}^k = \delta_{it}^k - \theta \ln d_{ijt}^k + \delta_{jt}^k + \ln D_{jt}^k + \epsilon_{ijt}^k. \tag{9}$$

Here, we intend for δ_{it}^k to identify $-\theta \ln c_{it}^k$, the cost of producing k in country i. This identification is industry-specific, so it does not give us across-industry information about costs, only within industry comparative costs in terms of a numeraire. That is, fixed effects identify the relative production costs in first differences relative to a base country. Note that this is a difference from Costinot et al. (2012). In their case, with a single-factor economy, the fixed effects regressions identify the fundamental productivity parameters in double-differences—i.e., relative to a base country *and* a base product. In our case, the fixed effects regressions do not identify productivity anymore, but production costs which are a combination of factor costs *and* productivity as in equation (5).

Therefore, in each industry we define a base (omitted) country with industry-level unit cost 1, and the cost parameters for all other countries will be expressed

as multiples of this country's unit cost.[6] In our main specification we use the United States as our baseline country. We estimate this equation separately for two years: 1999 and 2007.

We also control for trade costs in our estimates, allowing it to vary over time.[7] Controlling for trade costs is important for obtaining consistent estimates of the fixed effects of interest. Hence, we use several measures of bilateral trade costs to obtain a proxy for $-\theta \ln d_{ijt}^k$. More precisely, we have that:

$$\theta \ln d_{ij}^k = \beta' X_{ij}^k, \tag{10}$$

where X_{ij}^k contains dummy variables for when countries i and j share a border, have the same official language, had a common colonizer post 1945, if they had a colonial relationship post 1945, if they have a regional trade agreement, and a variable containing the weighted distance between the two countries. We also include a variable that is equal to 1 for within country trade and zero otherwise, this controls for border effects in the same way as in Head and Mayer (2002).

Table 1 and 2 report cost differences (adjusted for θ) around the world for 1999 and 2007 taking the US as our baseline country. That is, we consider $c_{\text{USA}t}^k = 1$ for all industries k and show the value of $(c_{it}^k)^\theta$ for the rest of the world. We have a total of 72 industries, but for the sake of simplicity we report the 10 among the 12 industries for which China observed the greatest reduction in costs[8] (or increase in productivity) between 1999 and 2007.

Looking at the Motor Vehicles column in Table 1, we can see that China cost parameter relative to the US is equal to 23.02. Since this number is greater than 1, in 1999 it was more costly to produce motor vehicles in China than in the US. Using $\theta = 6.53$, as estimated in Costinot et al. (2012), we can have some idea on how does these numbers translate in cost/productivity terms. In this case, our estimates suggests that Motor Vehicles was $(23.02)^{1/6.53} = 1.6$ times mores costly to produce in China relative to the US in 1999. In 2007, the same Motor Vehicles column in Table 2 shows that China surpassed the US and became more productive in producing motors. By 2007, it was $(0.5)^{1/6.53} = 0.9$ times less costly to produce this type of product in China relative to the US,

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[6] The component $-\ln \Phi_{jt}^k$ is captured through the fixed effect δ_{jt}^k and summarizes how states of technology, input costs and barriers affect prices in the importer country—see Eaton and Kortum (2002) for a more detailed description.

[7] In our counterfactual analysis we will use end of period trade costs, such that estimates of the term $-\theta \ln d_{ijt}^k$ will not affect *directly* our counterfactual exercises in the next section.

[8] Even though manufacturing of beverages and batteries were among the top ten, we do not report them due to many missing values among the other countries.

Table 1. Cost/Productivity Differences in 1999

	Wiring	Watches	Aluminum	Wood	CPU/Machinery	Precious Metals	Plastics	Mineral Goods	Motor Vehicles	Soya
AUS	32.35	66.50	26.38	60.61	30.33	28.35	46.35	23.20	64.05	9.94
AUT	48.43	104.55	53.30	34.71	73.06	31.06	178.59	22.19	42.47	9.27
BGR	1698.49	2378.80	5100.80	11210.46	1149.56	165.63	30362.26	894.24	403.30	–
BRA	38.80	103.18	7.20	18.05	8.16	10.16	353.68	179.12	90.09	0.03
CAN	19.10	33.92	15.25	16.25	3.87	12.85	16.52	6.12	27.76	0.74
CHN	14.11	5.55	20.23	82.72	41.37	1.83	8.49	14.75	23.02	1.12
CYP	17459.09	13525.18	13708.22	2633.20	6783.87	1362.84	22606.10	1893.22	3818.53	0.78
CZE	138.52	472.90	74.73	61.91	185.09	55.38	3762.93	61.61	363.50	15.59
DEU	3.48	7.78	1.92	0.78	17.49	2.30	10.42	2.24	2.69	0.90
DNK	64.02	98.28	88.66	284.99	135.26	15.20	160.88	26.16	146.64	2.22
ESP	32.97	53.27	7.58	5.15	145.79	4.50	133.43	14.18	16.60	0.18
EST	6128.98	15835.96	2097.27	5246.16	144.75	236.81	4678.66	326.07	11984.48	4.16
FIN	37.97	81.70	111.35	74.31	19.12	48.41	12.23	18.26	125.43	4.21
FRA	13.68	18.34	5.05	2.70	53.34	5.31	11.17	5.57	15.49	2.92
GBR	11.71	13.20	7.08	3.61	228.69	6.31	10.91	7.48	9.03	2.08
HUN	836.33	260.46	193.77	83.15	341.18	155.72	7306.24	92.46	858.60	8.27
IDN	277.22	55.07	88.84	387.73	2.87	1.19	214.56	72.62	4.91	0.04
IND	163.05	257.20	71.70	85.90	419.45	40.89	1130.16	59.77	19.70	–
IRL	337.44	40.97	817.32	2009.03	2184.50	206.48	47.74	140.98	71.27	2.96
ITA	5.66	13.05	5.14	5.26	29.18	1.03	42.66	3.58	8.04	4.40
JPN	1.58	1.98	0.76	0.22	470.90	9.86	3.24	14.23	1.93	0.15
KOR	15.07	8.64	6.69	0.86	252.34	30.92	6.76	18.27	2.40	2.49
LTU	8779.22	28431.97	8478.47	5953.15	232.71	340.18	28403.47	1329.84	1001.69	1.92
LVA	12790.84	37055.71	12472.99	17436.35	101.87	435.30	37385.32	1951.76	347.91	49.06
MEX	139.06	45.39	44.89	23.96	507.87	16.94	62.40	133.41	28.11	0.18
MLT	24942.79	26021.65	31273.59	26113.75	12624.37	1165.53	20136.54	3377.77	2734.84	–
NLD	32.72	27.50	28.61	13.82	129.08	20.21	97.55	9.42	13.88	0.58
POL	256.71	517.42	148.31	96.43	160.80	15.63	1605.88	42.77	279.89	1.09
PRT	233.99	817.97	144.75	61.79	348.02	62.48	994.16	53.42	110.43	4.82
ROM	1300.01	2018.84	1452.12	1457.25	150.44	57.18	12881.01	201.49	195.83	0.08
SVK	847.61	2084.98	582.50	527.76	253.01	217.41	9270.06	338.44	175.83	1.22
SVN	1151.92	2414.81	1884.72	748.44	788.54	131.48	9908.23	237.07	274.90	2.65
SWE	21.96	54.55	20.46	7.63	15.86	12.48	6.33	15.32	303.83	6.00
TUR	328.98	916.67	73.61	170.95	678.42	62.49	1676.03	61.49	38.67	–
USA	1	1	1	1	1	1	1	1	1	1

Table 2. Cost/Productivity Differences in 2007

	Wiring	Watches	Aluminum	Wood	CPU/Machinery	Precious Metals	Plastics	Mineral Goods	Motor Vehicles	Soya
AUS	19.56	39.54	18.84	75.09	32.77	20.60	37.69	15.82	138.77	0.24
AUT	28.74	56.08	41.56	19.06	16.74	12.36	267.65	10.35	25.15	20.58
BGR	758.23	761.36	1904.44	7024.47	829.30	69.74	6917.14	264.44	471.42	0.33
BRA	13.55	20.76	3.86	23.30	1.15	7.42	52.48	47.10	23.88	0.01
CAN	12.43	15.81	16.56	32.55	2.05	11.04	6.00	7.47	27.61	0.54
CHN	1.11	0.43	1.34	5.29	1.93	0.08	0.23	0.32	0.50	0.00
CYP	5722.47	5231.10	16688.77	2818.82	792.03	1300.11	4943.89	3977.97	20494.22	6.12
CZE	72.99	50.15	23.41	35.62	70.74	22.62	119.34	14.81	215.31	7.20
DEU	3.11	3.95	1.21	0.80	5.21	1.34	6.73	1.40	2.14	1.19
DNK	66.75	53.80	62.09	373.86	115.24	7.82	131.99	15.00	67.20	0.96
ESP	30.59	22.71	5.26	4.42	89.13	4.16	103.56	6.16	11.53	0.26
EST	2293.35	2816.10	1953.46	1309.55	48.80	134.67	528.24	119.27	3796.46	3.57
FIN	28.48	56.48	72.14	96.04	9.08	60.92	6.86	12.21	204.50	4.90
FRA	12.78	12.17	3.49	3.14	36.30	4.03	17.73	5.46	13.39	1.24
GBR	11.96	13.26	6.83	3.83	266.75	6.70	15.95	8.83	8.22	3.20
HUN	331.11	67.79	43.07	24.31	262.27	60.10	17.20	67.60	528.65	2.89
IDN	40.34	28.84	21.20	352.49	2.45	0.64	95.61	20.81	1.88	0.01
IND	50.36	31.73	9.42	28.13	92.71	7.41	91.45	14.41	5.59	–
IRL	128.64	24.85	758.16	1610.75	1509.70	352.46	54.38	128.40	109.27	1.99
ITA	5.55	7.00	3.52	5.93	21.22	0.86	20.60	2.46	4.47	2.41
JPN	0.91	1.60	0.44	0.25	937.39	7.22	3.24	8.17	1.35	2.89
KOR	4.05	3.67	2.12	0.76	868.42	11.59	0.70	3.54	1.08	0.74
LTU	3357.67	2483.71	2070.50	1501.75	132.72	34.23	4431.35	255.84	767.61	2.50
LVA	6012.05	3971.97	7579.58	1935.68	45.17	171.02	6874.09	566.16	461.26	1.94
MEX	54.01	19.27	11.48	8.70	486.65	22.54	10.25	121.41	26.43	0.24
MLT	8019.25	7095.13	11951.47	9037.41	9413.43	7894.05	12990.95	9290.72	35667.63	–
NLD	14.78	14.06	18.36	16.01	72.75	15.32	14.20	6.67	8.93	0.28
POL	111.25	94.71	19.49	38.83	75.00	3.33	165.14	9.85	132.90	1.46
PRT	240.82	299.38	68.08	43.81	198.63	27.73	449.12	43.08	37.55	0.62
ROM	606.96	292.67	102.17	597.40	66.29	16.92	793.45	152.22	263.22	7.77
SVK	309.59	213.10	136.34	22.27	205.97	42.95	970.12	68.89	112.21	3.76
SVN	610.29	488.91	535.27	233.18	390.29	52.22	2442.70	84.02	193.12	18.35
SWE	20.93	27.06	14.32	7.40	11.79	9.40	9.09	10.14	847.46	2.65
TUR	90.32	154.65	16.01	17.02	682.79	10.82	1193.00	12.68	10.46	–
USA	1	1	1	1	1	1	1	1	1	1

our baseline country.

In sum, the two tables can give us some idea of what is happening in terms of productivity (production costs) across industries around the world relative to our baseline country, the US. These and the other sector estimates will be the core of the first counterfactuals analyzed in the following section.

4 Counterfactual Exercises

Based on the estimates from the previous section, we turn to perform counterfactuals exercises to analyze how industries in Brazil would have performed in the absence of the recent Chinese ascension. The framework presented in section 2 is a full general equilibrium model, where factor prices and demand adjust endogenously. This creates feedback between the supply and demand components of the model in any counterfactual exercise—as we describe next. Performing counterfactuals incorporating these feedback elements would require considerable additional structure, as in di Giovanni et al. (2014). In favour of simplicity, and to derive clearer intuition from the counterfactuals, we adopt a partial-equilibrium approach in this section.

According to an Eaton-Kortum formula based on exporter-level cost of production c_i^k and iceberg trade costs d_{ij}^k, the model allocates the market share for each importer-industry jk across exporters i:

$$\frac{x_{ij}^k}{\sum_{i'} x_{i'j}^k} = \frac{\left(c_i^k d_{ij}^k\right)^{-\theta}}{\sum_{i'} \left(c_{i'}^k d_{i'j}^k\right)^{-\theta}}. \tag{11}$$

The denominator of the left-hand side above defines the expenditure of importer j on industry k. In the model, this is determined by the country's income from its own production across all industries and the Cobb–Douglas preference parameter α_j^k, which is idiosyncratic to that country:

$$\sum_{i'} x_{i'j}^k = \alpha_j^k \sum_{k'} \sum_{j'} x_{jj'}^{k'}. \tag{12}$$

The feedback between these supply and demand components of the model occurs on a few levels. To clarify these, keep the model fixed at only these two equations and imagine that there is a shock to the cost of production of industry 1 in country 1. If c_i^k decreases, then the share of exports from country 1 will rise for all importers j in industry 1 only, and remain the same in all other industries. So, for industry 1, the left-hand side of the equation (11) rises for

country 1 and falls for everyone else. For all other industries, equation (11) remains unchanged.

However, whether a particular country gains or loses in levels (rather than shares) in any industry—i.e. whether x_{ij}^k rises or falls in each industry—depends on the behaviour of the denominator in equation (11). This is the first feedback effect between demand and supply, which we call the "*expenditure feedback*". The change in country 1's income resulting from its cost decrease in industry 1 will result in a change in expenditure, but this will be spread over several industries according to equation (12). At the same time, all other countries' incomes will change both because of their changing shares in industry 1, and because of additional expenditure from country 1 in other industries, and this will result in changes in expenditure for them too, and so on.

The second feedback mechanism is what we might call the "*cost feedback*", and requires production costs to be driven in part by an endogenous variable—factor prices—and for income from production to be paid to factors. In Costinot et al. (2012), there is a single factor, labor, that serves this role. Consider again the above shock to production costs in industry 1 in country 1, and assume that they are driven by a rise in productivity. Then, for given wages, productivity rises mean that each unit of labor in country 1 can produce more units of industry 1 goods. The income from this additional production is paid in wages to labor, which raises the equilibrium wage, and thus the cost of production, in every industry in country 1. The net effect of productivity growth in industry 1 is thus that production costs in country 1 fall in industry 1 (although by less than the rise in productivity), and rise in all other industries in the country via this feedback mechanism.

Still on this point, note that we do not need data on wages—or factor prices—in order to calculate the counterfactuals. Restating the equations of the model to take this into account simply involves rewriting c_i^k in equation (11) as w_i/z_i^k, and adding a new factor market-clearing equation:

$$w_i L_i = \sum_k \sum_j x_{ij}^k. \tag{13}$$

This equation makes clear that wages can be written as a function of the x_{ij}^k terms and the labor endowment, so that one could simply write $c_i^k = \left(\sum_k \sum_j x_{ij}^k\right)/z_i^k L_i$ and keep wages out of the model altogether. That is what we do.

One last note on the model. Starting from an existing equilibrium, the changes in income and expenditure caused by the cost shock, say in country 1,

presumably lead to a new equilibrium trade pattern. However, the equations above do not determine the level of income and expenditure in the initial equilibrium (unsurprisingly, given that this is a model of comparative advantage). We can see this by rewriting equation (11) and moving expenditure to the right-hand side:

$$x_{ij}^k = \frac{\left(c_i^k d_{ij}^k\right)^{-\theta}}{\sum_{i'} \left(c_{i'}^k d_{i'j}^k\right)^{-\theta}} \sum_{i'} x_{i'j}^k. \tag{14}$$

Now, note that equations (12) and (14) are ambiguous with respect to the overall size of the world economy. Everybody could be very rich, so that the left-hand side and right-hand side of both equations are very large; or everybody could be very poor, so that the left-hand side and right-hand side of both equations are very small. Presumably this accounts for multiple-equilibria problem if we try to determine counterfactual levels of world income.

4.1   Supply Side Counterfactuals

Assume that Chinese cost of production evolved (in relative terms to the US) from 1999 up to 2007 in the same fashion as the world average. That is, from the cost of production estimates, δ_{it}^k, we calculate the average world growth in each sector, and substitute for $\delta_{\text{China},07}^k$ by using $\delta_{\text{China},99}^k$ multiplied by this average industry growth. The intuition for this counterfactual is that China's comparative advantage evolved from 1999 to 2007 as the world average in each industry.[9]

We run two separate exercises for this type of shock. The first, named "*unrestricted*", considers supply and demand interactions given the counterfactual evolution of Chinese production costs. The second exercise, named "*restricted*", restricts total world consumption to its 2007 level—i.e., we switch off the "*expenditure feedback*" discussed previously.

In both cases we switch off the "*cost feedback*". We do not incorporate factors as a full-fledged part of the model, assuming that the determination of the country-industry cost parameters (i.e. the parameters encompassing both productivities and factor prices) occurs outside the model. We simply posit that China's position in the world with respect to cost (productivities *and* factor prices) evolved exogenously, without allowing factor prices to adjust further in response to the resulting shifts in trade flows. Essentially, we are assuming that

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[9] For example, if producing electronics became less costly (relative to the US) everywhere in the world, electronics became less costly to produce (relative to the US) in China as well.

factor prices are determined in a large outside sector in each country and we are not allowing these prices to adjust endogenously with trade flows.

4.1.1   Unrestricted

We know from Costinot et al. (2012) that we can write a counterfactual in terms of shares of the importer's industry-level demand as follows:

$$\frac{\tilde{x}_{ijt}^{k}/\tilde{D}_{jt}^{k}}{x_{ijt}^{k}/D_{jt}^{k}} = \frac{\tilde{\pi}_{ijt}^{k}}{\pi_{ijt}^{k}} = \frac{\left(\tilde{c}_{it}^{k}/c_{it}^{k}\right)^{-\theta^{k}}}{\sum_{i'=1}^{I}\pi_{i'jt}^{k}\left(\tilde{c}_{i't}^{k}/c_{i't}^{k}\right)^{-\theta^{k}}} \tag{15}$$

$$= \frac{e^{\left(\tilde{\delta}_{it}^{k}-\delta_{it}^{k}\right)}}{\sum_{i'=1}^{I}\pi_{i'jt}^{k}e^{\left(\tilde{\delta}_{i't}^{k}-\delta_{i't}^{k}\right)}}, \tag{16}$$

where the tilde identifies the counterfactual variables. We then assign the updated 1999 values of comparative advantage to China in 2007, and recalculate trade shares. So, in 2007 the counterfactual 2007 trade shares of China, c, and all other countries, i, are, respectively:

$$\tilde{\pi}_{cj07}^{k} = \frac{e^{\left(\tilde{\delta}_{c07}^{k}-\delta_{c07}^{k}\right)}}{\pi_{cj07}^{k}e^{\left(\tilde{\delta}_{c07}^{k}-\delta_{c07}^{k}\right)}+\sum_{i'\neq c}\pi_{i'j07}^{k}}\pi_{cj07}^{k} \tag{17}$$

$$\tilde{\pi}_{ij07}^{k} = \frac{1}{\pi_{cj07}^{k}e^{\left(\tilde{\delta}_{c07}^{k}-\delta_{c07}^{k}\right)}+\sum_{i'\neq c}\pi_{i'j07}^{k}}\pi_{ij07}^{k}. \tag{18}$$

Remember that we are interested in calculating new trade flows, $\tilde{x}_{ij07}^{k}$. With $\tilde{\pi}_{ij07}^{k}$ in hands, from equation (7) above, we obtain each country's expenditure given that a constant fraction of their income is spent in a given sector, α_{jt}^{k} (the Cobb–Douglas preferences parameters). Therefore, in each country the following equation must hold:

$$D_{it} = \sum_{j'}\sum_{k}x_{ij't}^{k}+\gamma_{jt} \tag{19}$$

$$= \sum_{j'}\sum_{k}\left(\pi_{ij't}^{k}\alpha_{j't}^{k}D_{j't}\right)+\gamma_{jt}, \tag{20}$$

where γ_{jt} is a measure of trade imbalance for country j. We impose a world trade balance condition in every period of time t: $\sum_{j}\gamma_{jt} = 0$. This assumption is less strict than the country-by-country trade balance condition in Costinot et al. (2012). Rewriting the above equation in terms of the counterfactuals, we

obtain the following:

$$\tilde{D}_{i07} = \sum_{j'}\sum_k \left(\tilde{\pi}^k_{ij'07}\alpha^k_{j'07}\tilde{D}_{j'07}\right) + \tilde{\gamma}_{j07}. \tag{21}$$

This is a linear system that can be easily solved numerically, but two observations should be made. First, the system possesses 35 unknowns and 35 equations, but not independent ones.[10] Remember that we have multiple equilibria with respect to the overall size of the world economy, so we must impose a condition on the demand (or the supply) to find a solution. We assume that world total demand is given by:

$$\sum_{j'}\tilde{D}_{j'07} = \sum_{j'\neq c}D_{j'07} + \frac{D_{c99}}{D_{us99}}D_{us07}. \tag{22}$$

That is, we are assuming that the size of world demand equals the sum of all countries apart from China plus a component saying that China would have grown at the same rate as the US in the period. Note that we are *not* fixing China's demand, we are simply fixing the total world demand.

The second condition we need to add is related to trade imbalances. We will assume that China's new trade imbalance will be fixed at:

$$\tilde{\gamma}_{c07} = \frac{\gamma_{c99}}{\gamma_{us99}}\gamma_{us07}. \tag{23}$$

This implies that China's surplus relative to the US is constant over time. Since the imbalances must sum up to zero, we proportionally cut $\tilde{\gamma}_{i07}$ for all countries with deficits such that $\sum_j \tilde{\gamma}_{j07} = 0$ is satisfied.

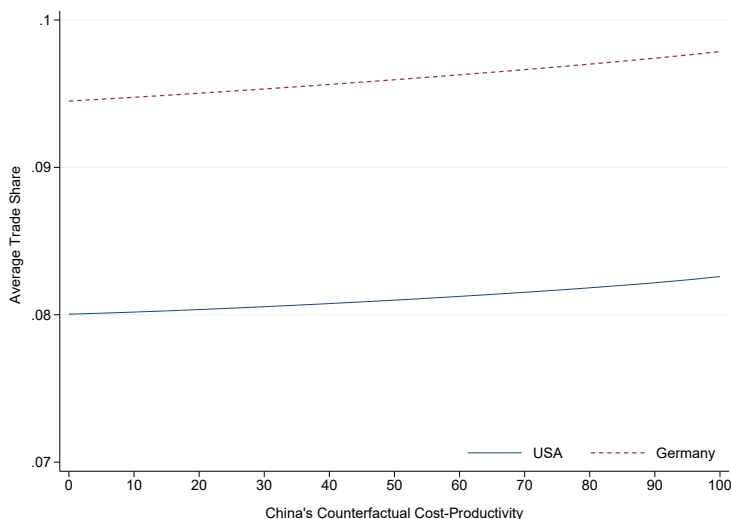In all the following figures, we move the counterfactual in a smooth way towards our target $\tilde{\delta}^k_{c07}$. So, the horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the actual 2007 values, δ^k_{c07}. A value of 50 means that we are half way to our objective, $(\tilde{\delta}^k_{c07} - \delta^k_{c07})(50/100) + \delta^k_{c07}$, and 100 implies that we reached our final counterfactual $\tilde{\delta}^k_{c07}$.

Figures 1 to 3 show trade shares for China, developing countries (Brazil, India, and Mexico) and developed ones (USA and Germany).[11] As we can see in Figure 1, Chinese average trade share would be almost 30 percent smaller if its comparative advantage relative to the US in 2007 was similar to its 1999 levels.

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[10] It is easy to verify this by summing up all the equations in the system.

[11] Figures A1 to A3 presents the trade levels for these countries.

While developing countries trade share would be virtually equal to their actual level, developed countries would have a larger share of the world trade. That is, according to this Ricardian model, Chinese structural productivity change shifted China's comparative advantage towards product otherwise produced by developed countries, without crowding out developing countries trade with the rest of the world.

Figures 4 to 6 show the counterfactual Brazilian supply for some industries in agriculture, mining and manufacturing sectors. As we can see in Figure 4, Chinese technological growth had almost no impact on soybean production in Brazil. However, we see that Brazilian production of cereals and sugar cane would be larger if China's comparative advantage relative to the US had followed the world trend. In Figure 5, we see a modest reduction on the share of iron and manganese ore in this counterfactual world, compensated by a larger production of other mining. This suggest that, within this Ricardian model of trade, Chinese development across-industries held back the expansion of Brazilian primary sector overall, and it was not crucial to the development of soya and iron ore production in Brazil.

In Figure 6, we can see that recent Chinese technological transformation indeed represented competition to the Brazilian manufacturing sector. We can observe that mostly all industries within the manufacturing sector would have been producing more if China's production cost had evolved as the world average. In particular, we see that labor-intensive products, such as plastics and textiles, would have experienced the larger changes. This is in line with the "import competition shock" studied in Costa et al. (2016).

4.1.2 Supply Restricted

We now perform a simpler exercise where demand for each country is restricted, switching off the "*expenditure feedback*". In this way we can have an idea to which extent across-industries technological changes within China affected international trade and production net general equilibrium effects on countries' expenditures. In this scenario, we simply impose the realized demand, $D_{jt}^k = \tilde{D}_{jt}^k$, and apply equations (17) to back out trade flows $\tilde{x}_{ijt}^k$. Note that we do not need to solve any system of equations or make assumptions about countries' surplus or world demand, such that conditions (22) and (23) are put aside. As discussed in the beginning of this section, trade shares are not affected by the level of world demand, so these results are identical to the "unrestricted" counterfactual.[12]

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[12] Figures A4 to A6 show trade shares for China, developing countries (Brazil, India, and Mexico) and developed ones (USA and Germany). Figures A7 to A9 presents the trade levels for these
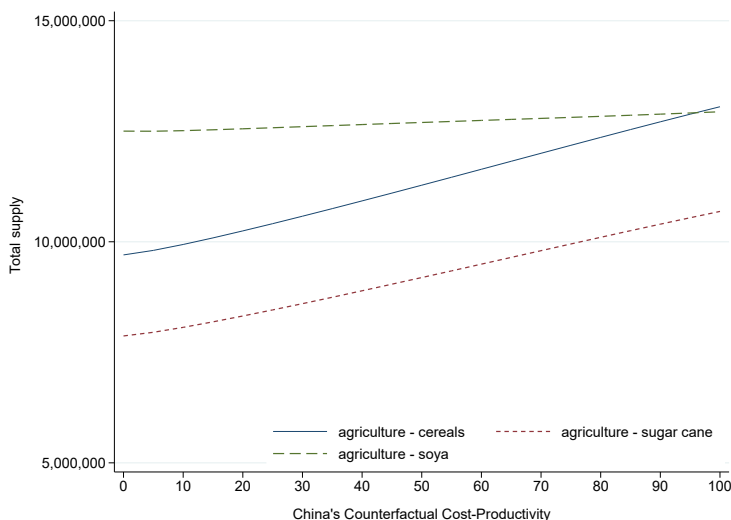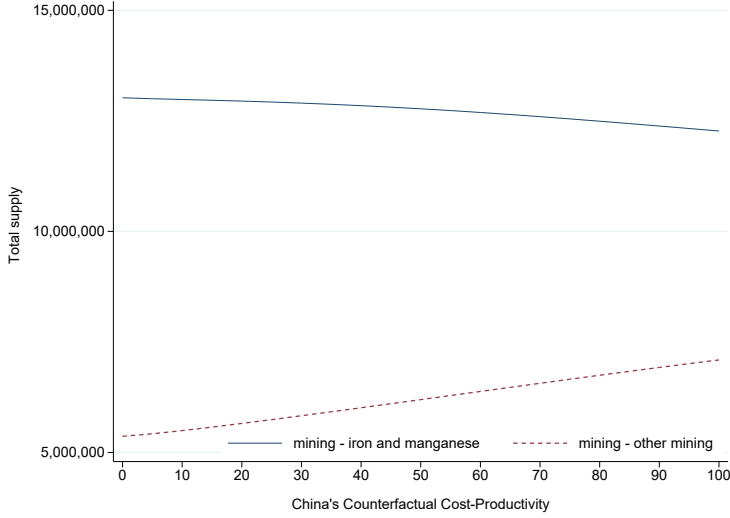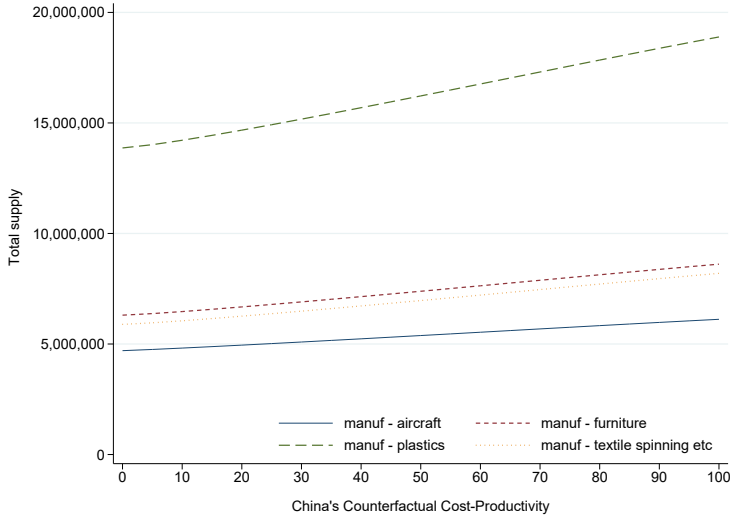
Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure 1. Unrestricted Supply Counterfactuals: Chinese Average Trade Share.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure 2. Unrestricted Supply Counterfactuals: Developing Countries' Average Trade Share.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ^k_{c07}. A value of 50 means that we are half way to our objective, $(\tilde{\delta}^k_{c07} - \delta^k_{c07})(50/100) + \delta^k_{c07}$, and 100 implies that we reached our target $\tilde{\delta}^k_{c07}$.

Figure 3. Unrestricted Supply Counterfactuals: Developed Countries' Average Trade Share.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ^k_{c07}. A value of 50 means that we are half way to our objective, $(\tilde{\delta}^k_{c07} - \delta^k_{c07})(50/100) + \delta^k_{c07}$, and 100 implies that we reached our target $\tilde{\delta}^k_{c07}$.

Figure 4. Unrestricted Supply Counterfactuals: Brazilian Supply, Agriculture.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure 5. Unrestricted Supply Counterfactuals: Brazilian Supply: Mining.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure 6. Unrestricted Supply Counterfactuals: Brazilian Supply (Manufacturing).

Figures 7 to 9 show the "restricted" counterfactual Brazilian supply for some industries in agriculture, mining and manufacturing sectors. We see in Figures 7 and 8 that soybeans and mining production in Brazil evolve similarly to the "unrestricted" counterfactual. However, without considering the effects of production costs on international expenditure, we observe that the counterfactual production of other agricultural products and other mining are equal to the realized ones. We also find no effects on production of manufacturing products, as in Figure 9. Again, within this model, it is not the case that across-industries Chinese productivity growth directly stimulated Brazilian soybean and iron ore production, but it did depreciate Brazilian manufacture by affecting world's expenditure across industries.

4.2   Demand Restriction

In our last counterfactual we study how a demand (taste) shock in China affects trade flows, generating a world in which China's tastes over products did not change over time. In this exercise we focus on a change in the Cobb–Douglas parameters, α_{c07}^k, maintaining the supply parameters δ_{c07}^k equal to the real ones. We assume that China's consumption shares over industries in 2007 were the same as in 1999, $\tilde{\alpha}_{c07}^k = \alpha_{c99}^k$. We proceed in the same fashion as in our unrestricted counterfactual to find the new demand values $\tilde{D}_{j'07}$ applying a slightly modified version of equation (21):

$$\tilde{D}_{i07} = \sum_{j'} \sum_{k} \left(\pi_{ij'07}^k \tilde{\alpha}_{j'07}^k \tilde{D}_{j'07} \right) + \tilde{\gamma}_{j07}. \tag{24}$$

Note that conditions on total world demand (22) and trade imbalances (23) need to be imposed once more.

Since trade shares are unchanged by hypothesis, it is trivial to find the counterfactual trade flows after the new demand is calculated. Figures 10 to 12 show the aggregate supply for China, developing countries (Brazil, India, and Mexico) and developed ones (USA and Germany). We observe Chinese supply higher in a world where Chinese tastes did not change in the last decade. Potentially, this is due to smaller consumption of technology intensive products.

In Figures 13 to 15 we can see the counterfactual Brazilian supply in products in agriculture, mining and manufacturing sectors. We observe virtually no effects in all products in these three sectors, except soybeans and iron and manganese
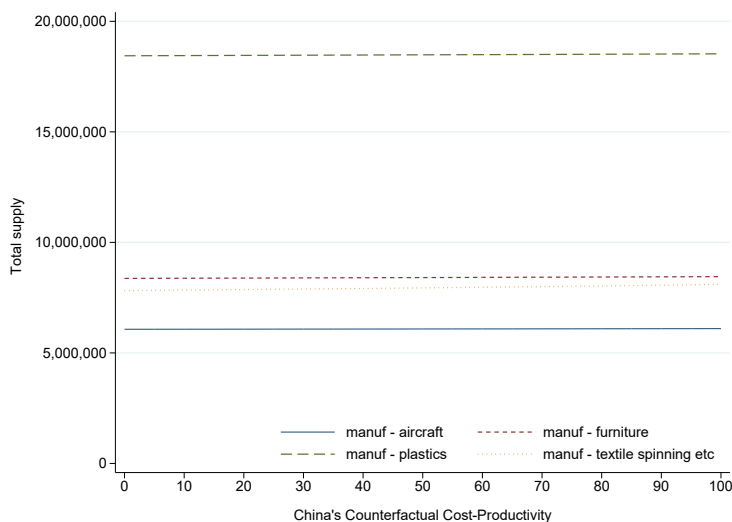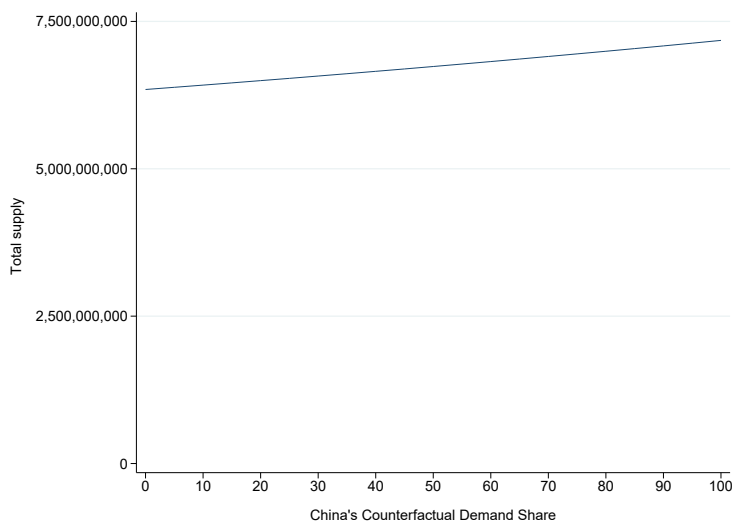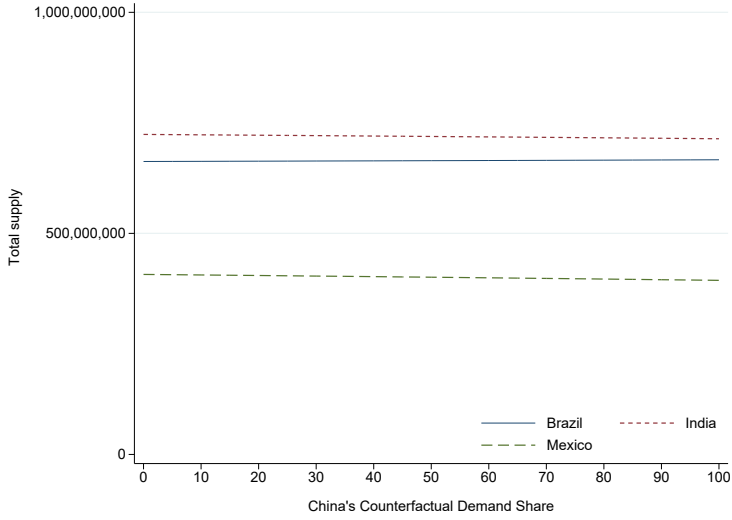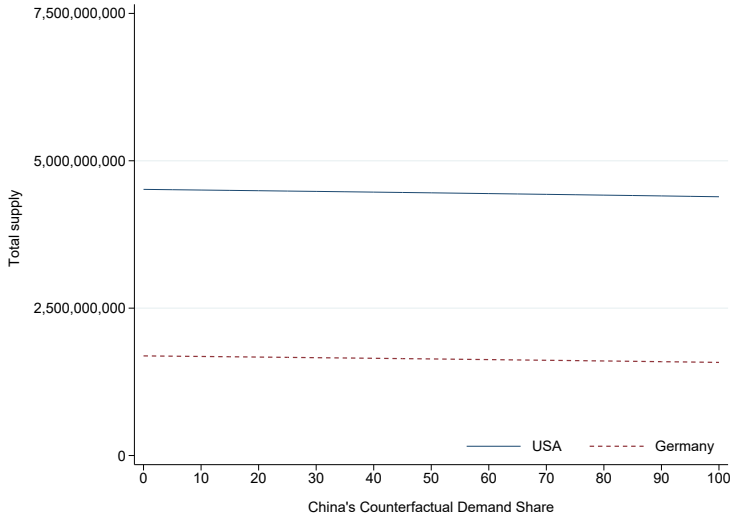
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countries.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^{k}. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^{k} - \delta_{c07}^{k})(50/100) + \delta_{c07}^{k}$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^{k}$.

Figure 7. Restricted Supply Counterfactuals: Brazilian Supply (Agriculture).

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^{k}. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^{k} - \delta_{c07}^{k})(50/100) + \delta_{c07}^{k}$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^{k}$.
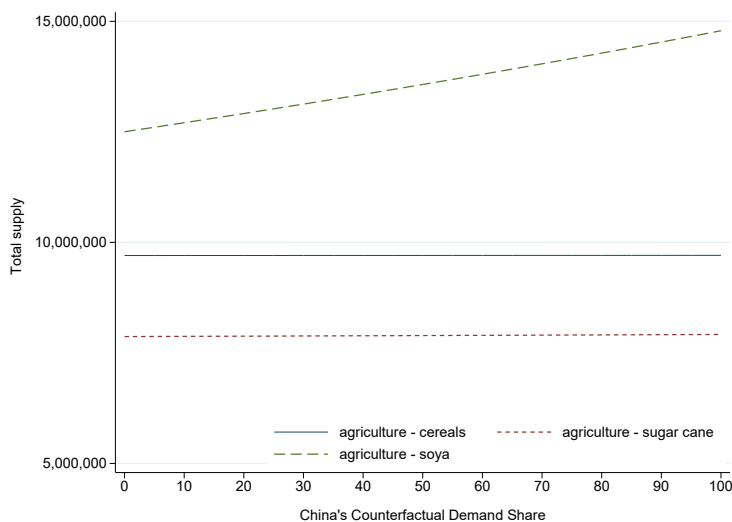
Figure 8. Restricted Supply Counterfactuals: Brazilian Supply (Mining).

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.
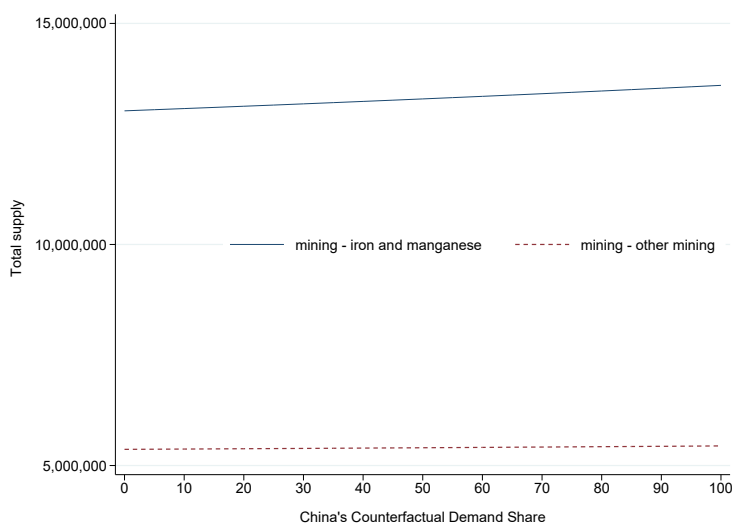
Figure 9. Restricted Supply Counterfactuals: Brazilian Supply (Manufacturing).
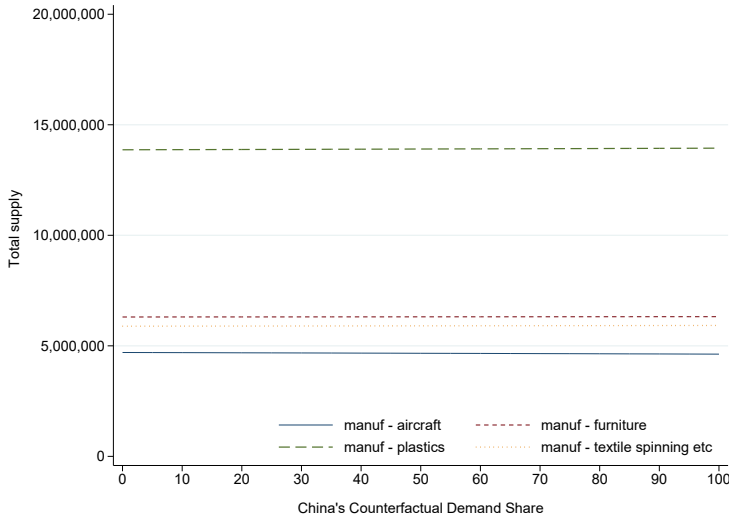

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure 10. Demand Counterfactuals: Chinese Supply.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure 11. Demand Counterfactuals: Developing Countries' Supply.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure 12. Demand Counterfactuals: Developed Countries' Supply.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure 13. Demand Counterfactuals: Brazilian Supply (Agriculture).

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure 14. Demand Counterfactuals: Brazilian Supply (Mining).

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure 15. Demand Counterfactuals: Brazilian Supply (Manufacturing).

ore—the two main exports from Brazil to China. If China's preferences in 2007 was the same as its preferences in 1999, Brazilian production of these products would have been even larger than the observed ones. China spends a smaller share of its income in raw material today than in 1999, particularly soybeans and iron and manganese ore, and a larger share in technology-intensive goods. In other words, if China triggered a commodity boom in the world, or at least in Brazil, this was driven mostly by a level effect of increased income in China, and any changes in China's tastes over products contributed to moderate such boom. This goes against the idea of a positive China demand (taste) shock towards soybeans and iron and manganese ore.

5 Conclusion

In this paper we performed counterfactuals exercises to analyze how Brazilian sectoral production would have performed in the absence of the massive Chinese growth. With this objective, we employ the Ricardian model of trade of Costinot et al. (2012) which, building on Eaton and Kortum (2002), provides theoretically consistent foundations for estimating the relative production cost at a country-industry level. We use these estimates to develop counterfactuals in which China stays at its "original" state, and then compare Brazil's production composition

in this world and the real world. We perform two main counterfactual exercises. First, we model productivity growth in China as the main lever by which Chinese supply and demand conditions evolve and affect Brazil. Second, we study how changes in composition of Chinese demand (taste) affects trade flows around the world and Brazilian production.
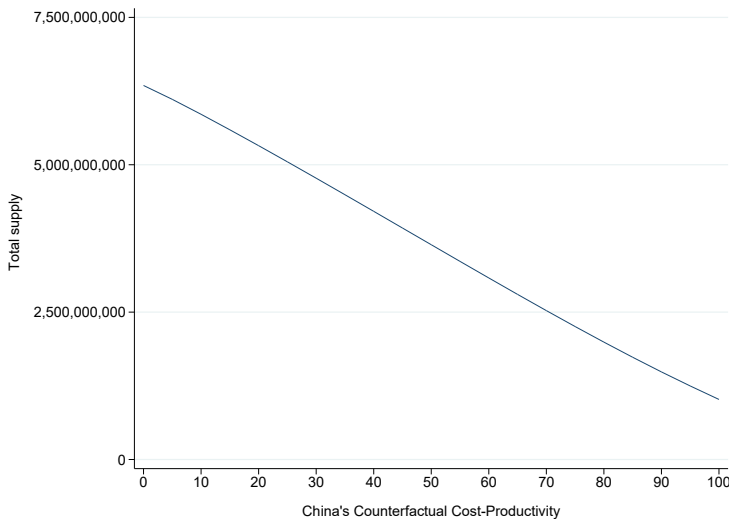
These exercises help us to understand the plausibility of the assumptions underlying the instruments used in Costa et al. (2016), and in many papers in the literature that followed Autor et al. (2013). For example, Brazil increasingly imports manufactured products from China, at the same time that Brazil is a great producer of soybeans and one of its main suppliers to China. Within the counterfactuals we can address questions, such as: how would the manufacturing production in Brazil have performed in the absence of the Chinese technological changes between 1999 and 2007? Or, how would the soybean production in Brazil have performed in the absence of the Chinese demand changes between 1999 and 2007? We find that Brazilian manufacture would have grown more due to a softer competition if Chinese production costs had evolved as the world average. We also see that changes in China's preferences over consumption actually reduced the growth of soybean production in Brazil, due to an increasing preferences for technology-intensive manufactured goods.

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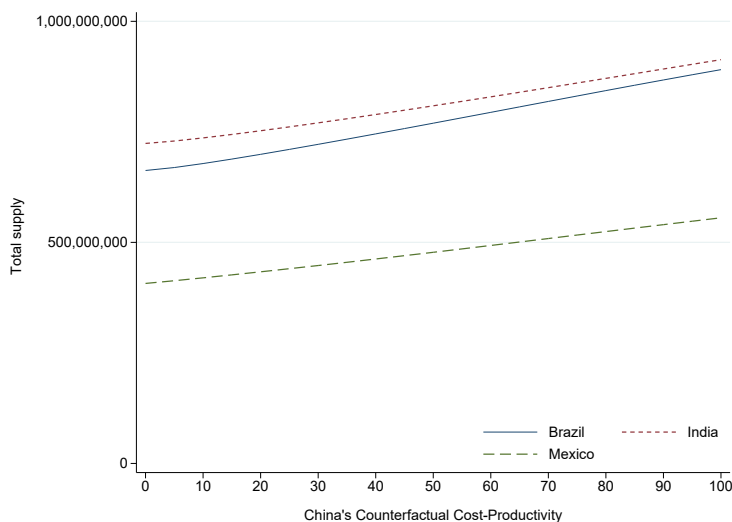
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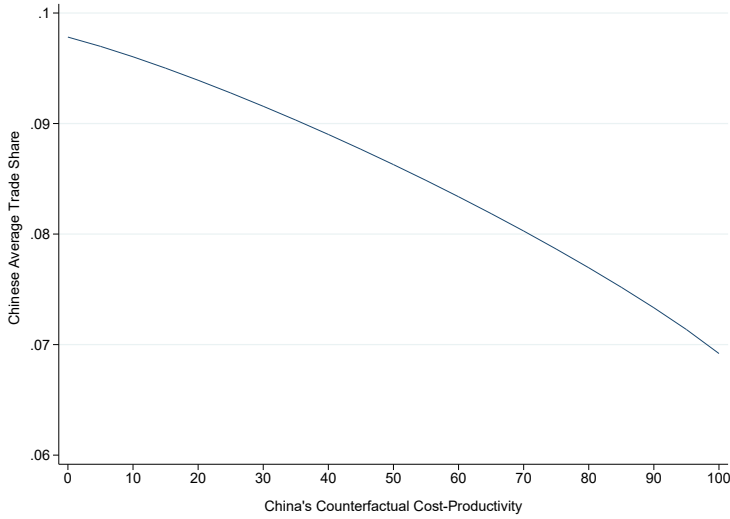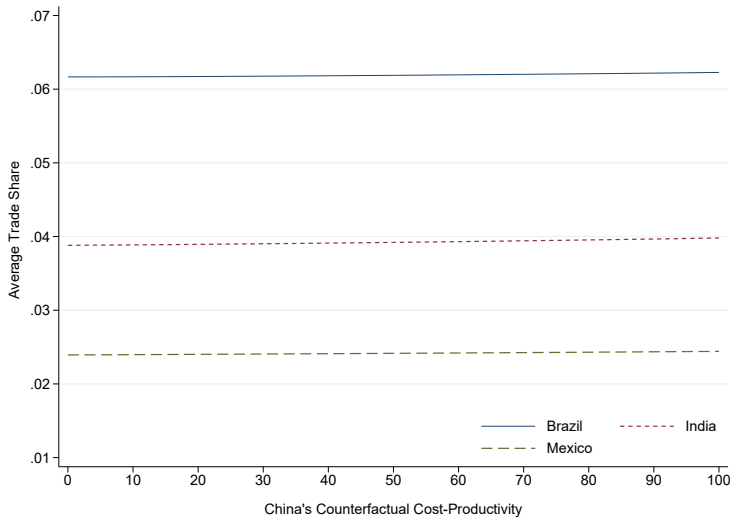
Appendix A

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^{k}. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^{k} - \delta_{c07}^{k})(50/100) + \delta_{c07}^{k}$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^{k}$.

Figure A1. Unrestricted Supply Counterfactuals: Chinese Total Supply.

Figure A2. Unrestricted Supply Counterfactuals: Developing Countries' Total Supply.
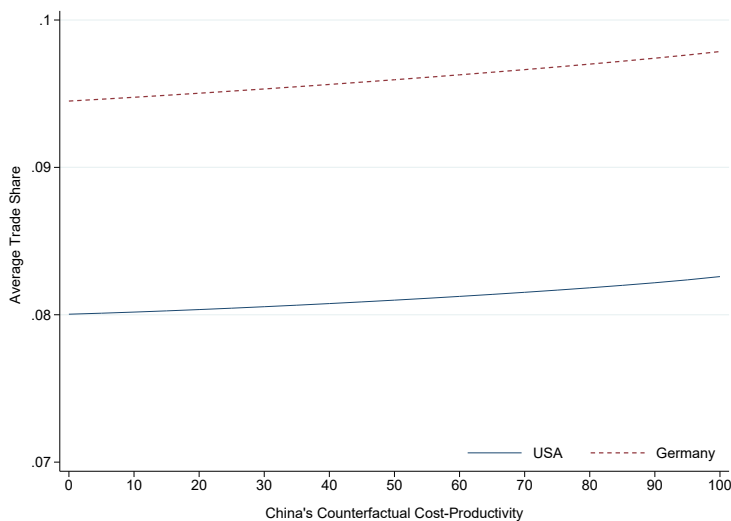

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ^k_{c07}. A value of 50 means that we are half way to our objective, $(\tilde{\delta}^k_{c07} - \delta^k_{c07})(50/100) + \delta^k_{c07}$, and 100 implies that we reached our target $\tilde{\delta}^k_{c07}$.

Figure A3. Unrestricted Supply Counterfactuals: Developed Countries' Total Supply.
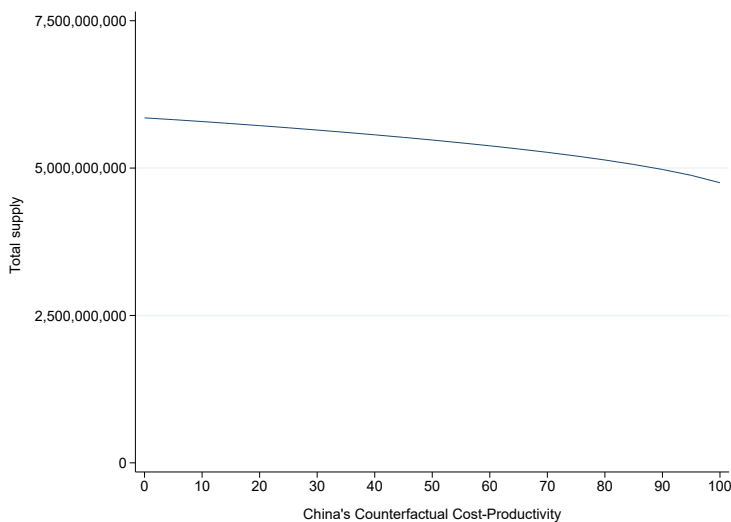
Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure A4. Restricted Supply Counterfactuals: Chinese Average Trade Share.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure A5. Restricted Supply Counterfactuals: Developing Countries' Average Trade Share.
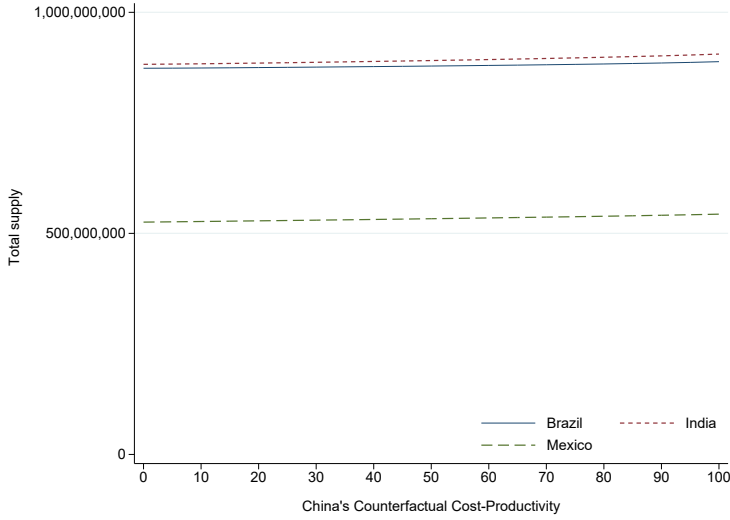
Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure A6. Restricted Supply Counterfactuals: Developed Countries' Average Trade Share.
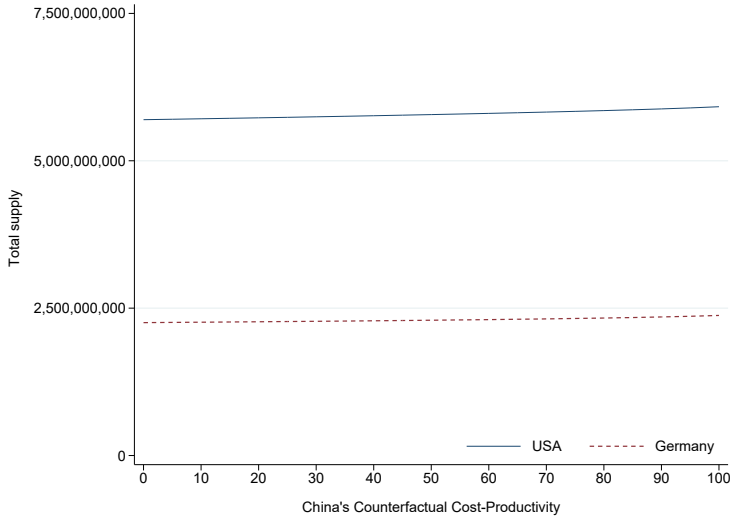

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^k. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^k - \delta_{c07}^k)(50/100) + \delta_{c07}^k$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^k$.

Figure A7. Restricted Supply Counterfactuals: Chinese Total Supply.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^{k}. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^{k} - \delta_{c07}^{k})(50/100) + \delta_{c07}^{k}$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^{k}$.

Figure A8. Restricted Supply Counterfactuals: Developing Countries' Total Supply.

Notes: The horizontal axis represents the proximity to our counterfactual target. For example, 0 means that we are using the 2007 China values, δ_{c07}^{k}. A value of 50 means that we are half way to our objective, $(\tilde{\delta}_{c07}^{k} - \delta_{c07}^{k})(50/100) + \delta_{c07}^{k}$, and 100 implies that we reached our target $\tilde{\delta}_{c07}^{k}$.

Figure A9. Restricted Supply Counterfactuals: Developed Countries' Total Supply.