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Winners and losers from a commodities-for-manufactures trade boom☆

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ABSTRACT

A recent boom in commodities-for-manufactures trade between China and other developing countries has led to much concern about the losers from rising import competition in manufacturing, but little attention on the winners from growing Chinese demand for commodities. Using census data for Brazil, we find that local labour markets more affected by Chinese import competition experienced slower growth in manufacturing wages between 2000 and 2010. However, we observe faster wage growth in locations benefiting from rising Chinese commodity demand during the same period.

1. Introduction

China's recent emergence as a major force in the world economy is one of the largest economic events of recent times. The combination of China's exceptionally high rates of economic growth, its increasingly deep engagement with the rest of the world via international trade, and the sheer size of its stock of labour, land and capital has generated a set of economic shocks whose influence stretches worldwide. These shocks have stirred great interest among economists in studying the global effects of China, both because they provide an opportunity to learn more about the impact of trade shocks in general, but also because of the apparent scale of the global impact of China in particular.

So far, most of the attention on the effects of China on the economies of other countries has focused on the import competition shock associated with the massive growth of the Chinese manufacturing sector. However, China is also an increasingly large consumer of goods produced abroad: if China has been the source of a large supply shock, it must also have been the source of a large demand shock. We will consider the heterogeneous effects of these supply-side and demand-side 'China shocks' on developing-country labour markets, by examining the case of Brazil.

For developing countries, the 'China demand shock' has taken a distinctive form: increasingly, outside of the manufacturing supply chains of East and Southeast Asia, the goods being sent to China

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Fig. 1. Evolution of the share of agricultural and extractive sectors in the exports and imports of non-high-income countries. These graphs present the evolution of the share of products of the agricultural and extractive sectors (agriculture, forestry, fisheries/aquaculture and mining) in the exports and imports of non-high-income countries (excluding those in East and Southeast Asia) from 1995 to 2010.
Sources: CEPII BACI for trade data; definition of high-income countries from the World Bank.

by non-high-income countries are products of the agricultural and extractive sectors. Panel A of Fig. 1 shows that while there has been a gradual rise in the share of agricultural and extractive sectors in the exports of non-high-income countries (excluding those in East and Southeast Asia) to destinations other than China, the importance of these industries in their exports to China has changed much more dramatically, rising from less than 20% in 1995 to nearly 70% in 2010. Meanwhile, developing countries' imports from China have become increasingly concentrated in manufactures: Panel B of Fig. 1 shows that the share of products of the agricultural and extractive sectors in the imports of non-high-income countries from China, already small (6%) in 1995, had dwindled to 1% by 2010. This shift towards a commodities-for-manufactures trade relationship with China has coincided with a sharp increase in China's overall importance in developing countries' foreign trade, as shown in Panel A of Fig. 2.[1]

Just as the import side of this boom in trade with China has often been met with suspicion by policymakers and commentators concerned about effects on local industry (see e.g. Economist, 2012), China's rising demand for unglamorous agricultural and mining products has similarly not always been treated with enthusiasm. Before a visit to China in 2011, Brazil's president pledged that she would be "working to promote Brazilian products other than basic commodities," amid concern that "overreliance on exports of basic items such as iron ore and soy" might result in 'de-industrialization' (LA Times, 2011). Similarly, a former trade minister of Brazil has spoken of the "need to iron out distortions in the trade relationship, in which Brazil sells commodities and China manufactures" (Bloomberg, 2011).

In our study of Brazil, we examine the changing labour market outcomes of regions producing manufactures affected by rising Chinese import supply and localities specializing in raw materials demanded by China. We find that labour markets in 'loser' regions indeed appear to have suffered from Chinese import competition via slower growth in manufacturing wages. However, it is also the case that 'winner' regions have gained from Chinese export demand, through faster wage growth and shifts in the local economy towards formal jobs.

Brazil provides an excellent context for a study of China's impact on developing countries' labour markets for several reasons. First, the importance of China in both the imports and exports of Brazil has risen steeply in recent years, as seen in Panel B of Fig. 2. In 2000, Brazil received approximately 2.3% of its imports by value from China and sent 2.0% of its exports to China; by 2010, these shares were 14.5% and 15.1% respectively.[2] Second, the pattern of Brazil–China trade has followed the broad trends outlined above for the wider set of non-high-income countries: Brazilian exports to China are increasingly products of the agricultural and extractive sectors, while Brazilian imports from China have remained concentrated in manufacturing (see Fig. 3). Third, Brazil is particularly large and has a diverse geography, generating a set of local labour markets that are highly varied in their comparative advantages, and thus allowing for identification of the heterogeneous effects of trade with China without relying on cross-country regressions. Fourth, the Brazilian population census captures a variable of particular relevance in developing countries: informality. This is important both because the informal sector is large – in Brazil, approximately half of the employed population in 2000 were either informal salaried workers or self-employed – and because the (de-)formalization of labour markets is a potentially important but understudied effect of trade shocks affecting developing countries.

In order to identify the effects of demand and supply shocks originating from China on local labour markets in Brazil, we use the theoretical framework of Autor et al. (2013) to generate predictions about the effects of these shocks on wages across regions. This yields an empirical strategy analogous to the shift-share methodology of Bartik (1991). In particular, we compare locations with different

[1] Panel A of Table B1 shows the evolution in trade flows between non-high-income countries and China during this period in levels rather than shares.

[2] See Panel B of Table B1 for the evolution in trade flows between Brazil and China, and Brazil and the rest of the world, in levels.

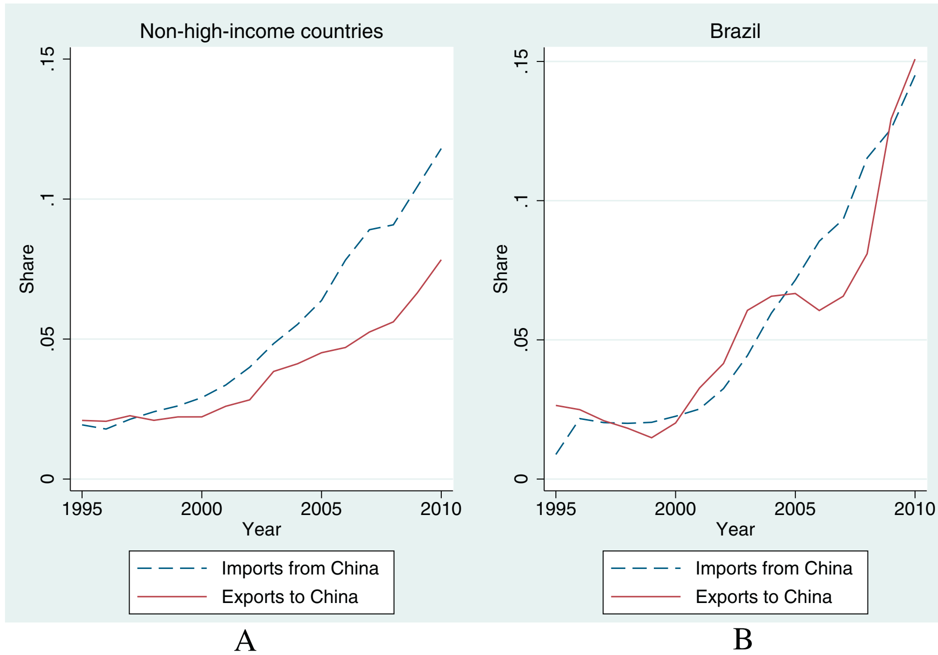

Fig. 2. Evolution of the share of China in the imports and exports of non-high-income countries and Brazil. Panel A presents the evolution of the share of China in the imports and exports of non-high-income countries (excluding those in East and Southeast Asia) from 1995 to 2010. Panel B presents the time series of the share of China in the imports and exports of Brazil from 1995 to 2010.
Sources: CEPII BACI for trade data; definition of high-income countries from the World Bank.

initial comparative advantages, tracing the fortunes of regions whose basket of industries has been faced with steeper increases in Chinese supply or demand, as compared to locations whose industries have been relatively unaffected by China's emergence.[3]

Because some agricultural, extractive and manufacturing industries have been affected more than others by China, we are able to compare regions with identical initial employment shares in each of these three broad categories. For example, our identification strategy relies on comparisons of regions with the same share of employment in agriculture in 2000 but different patterns of specialization across crops. Our measures of Chinese supply and demand shocks are based on changes in actual trade flows between China and Brazil, but we instrument for these variables to ensure that our results capture neither Brazil-specific shocks nor changes in world prices that are not directly due to China. We also include state fixed effects and lagged dependent variables in our preferred specification, in order to account for the possibility that our results are driven by state-specific or pre-existing trends.

Our theoretical framework predicts that although labour markets subject to steeper rises in import competition from China should have experienced slower wage growth, wages in regions benefiting more from increasing Chinese demand should have risen more quickly. Indeed, we find that a local labour market at the 80th percentile of the shock to Chinese demand experienced growth in average wages that was approximately 0.93 percentage points higher between 2000 and 2010 as compared to a region at the 20th percentile. At the same time, while the estimated effects of Chinese import competition on average wages are statistically insignificant in most specifications, we observe a significant negative impact of imports from China on the wages of manufacturing workers. For a local labour market at the 80th percentile of the 'China supply shock' relative to one at the 20th percentile, wage growth in manufacturing sectors was lower by 0.82 percentage points over the course of the decade.

Along with wages, we consider changes between 2000 and 2010 in several other key characteristics of local labour markets, including employment rates, sectoral composition, informality and migration. We do not find robust evidence of an effect of either 'China shock' on local employment rates. Our most robust finding is that increased demand from China is associated with a rise in the share of employed workers in formal jobs. As with wage growth, an increase in formality is likely to have improved worker well-being in 'winner' regions: because workers in the informal sector do not have access to benefits such as unemployment insurance, paid medical leave and pensions, formalization may be interpreted as a rise in nonwage compensation.

This paper contributes to a growing literature on the worldwide effects of the rise of China. This includes papers that have studied the impact of Chinese import competition on economic variables such as manufacturing employment (Pierce and Schott, 2012; Autor et al., 2013), worker earnings (Pessoa, 2014), skill upgrading (Hsieh and Woo, 2005, Mion and Zhu, 2013), firm and product selection (Iacovone et al., 2013) and innovation (Bloom et al., 2016). There are a much smaller number of papers which, like this one, also take account of demand-side effects. Dauth et al. (2014) take a reduced-form approach, examining the impact of rising imports from and exports to China and Eastern Europe on local labour market variables in Germany. Dauth et al. study a developed-country context in which agricultural and extractive sectors are relatively unimportant, and so focus on the effects of these trade shocks on the manufacturing and services sectors. General equilibrium analyses of China's effect on the world economy (such as Hsieh and Ossa, 2011 and di Giovanni et al., 2014) also take account of both the supply and demand effects of China on other countries, but these studies summarize the impact of China on aggregate welfare rather than distinguishing between the potentially heterogeneous impacts of rising Chinese import competition and export demand.

[3] An alternative strategy would have been to identify these effects at the industry level. These two approaches should be viewed as complements, given that it is possible to write models linking trade shocks to outcomes via either unit of aggregation. Our decision to focus on local labour markets is a practical one, since we have data on 412 local labour markets within Brazil, but only 82 industries producing tradables.

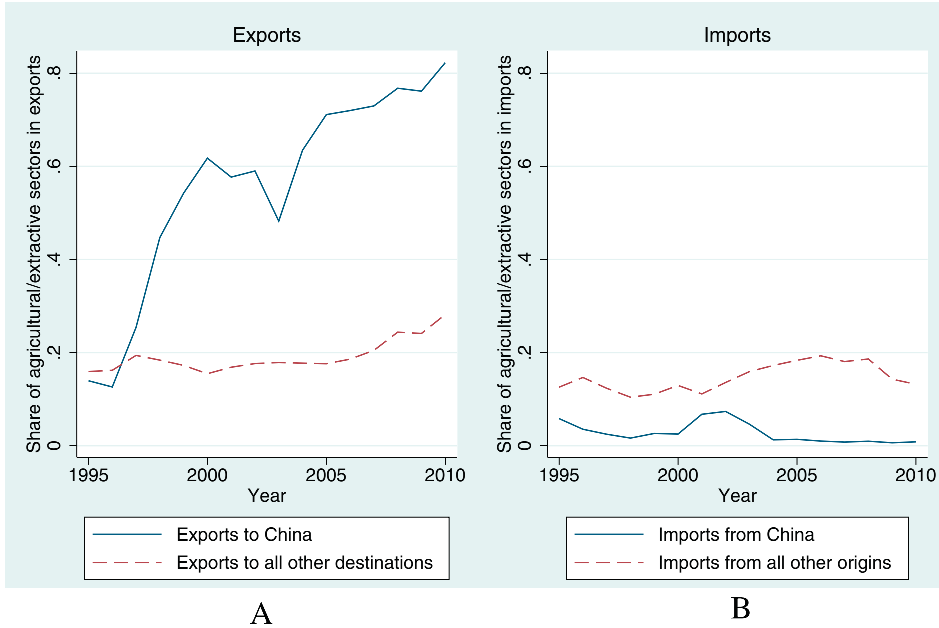

Fig. 3. Evolution of the share of agricultural and extractive sectors in the exports and imports of Brazil. These graphs present the evolution of the share of products of the agricultural and extractive sectors (agriculture, forestry, fisheries/aquaculture and mining) in the exports and imports of Brazil from 1995 to 2010.
Sources: CEPII BACI for trade data; definition of high-income countries from the World Bank.

Our work also relates to the wider literature studying the impact of trade shocks on labour markets. Several other papers investigate the effect of trade on workers in Brazil (e.g. Dix-Carneiro, 2014, Dix-Carneiro and Kovak, 2015a,b, Gonzaga et al., 2006, Helpman et al., 2012, Kovak, 2013, Menezes-Filho and Muendler, 2011), with particular attention given to Brazil's early 1990s trade liberalization. Most research on trade and labour markets, including much of the literature on Brazil, is limited to studying workers in formal employment. Our work also fits into the smaller literature on trade and informality, including Goldberg and Pavcnik (2003), McCaig and Pavcnik (2014), Nataraj (2011) and Paz (2014). Finally, the paper contributes to the literature on the local labour market effects of shocks involving nonmanufacturing sectors; one particularly relevant study is Aragón and Rud (2013), who examine the local economic impact of a Peruvian gold mine.

The paper is organized as follows: in Section 2, we outline our theoretical framework and how this is brought to the data. We then describe our data sources and present summary statistics in Section 3. We next discuss our empirical strategy, including our instrumental variables, in Section 4. Finally, we present the results of our empirical analysis in Section 5, and draw conclusions in Section 6. Additional figures and tables, as well as further details about the theoretical framework, are included in appendices.

2. Theoretical framework

This section presents a simple theoretical framework to guide our empirical analysis. Our goal is to derive predictions about the effect of the 'China shock' on outcomes in Brazilian local labour markets, and our framework will focus on nominal wages as the outcome variable of interest.[4] Here, the shock is characterized as a set of exogenous sector-specific changes in Chinese labour productivity and trade costs between China and Brazil.

We use the small open economy model of Autor et al. (2013) to assess the effects of China on Brazil; this will result in expressions relating changes in trade flows between Brazil and China to wages in Brazil. Some of the literature on trade and labour markets (Dix-Carneiro and Kovak, 2015a,b, Kovak, 2013) provides theoretical models describing how prices (rather than trade flows) affect wages in local labour markets. These papers investigate changes to tariff schedules that can readily be related to shocks to import prices. However, the combination of productivity growth and expansion of trade-facilitating infrastructure in China is not easily mapped to sector-specific changes in the prices of Brazilian imports and exports, and so we do not pursue this approach in our paper.

Suppose a large number of economies i which produce in J traded goods sectors, indexed by j, and one nontraded good sector N. We will henceforth refer to these economies as 'regions' (or local labour markets), as we will later restrict the analysis to Brazil and consider each local labour market within Brazil to be one small open economy. The traded sectors supply differentiated goods and are characterized by monopolistic competition, while the nontraded good is homogeneous. Any two regions i and k may trade goods in sector j with one another at the expense of an iceberg trade cost. Production in all sectors requires only one homogeneous factor (labour), and the total stock of labour is fixed in each region; i.e. we rule out migration.[5]

Below, the notation $\hat{x}$ represents proportional changes of the variable x relative to initial conditions. The variables $\hat{Z}_{ijC}$ and $\hat{A}_{Cjk}$

[4] We will focus on changes in nominal wages as the best available empirical proxy for local welfare. Unfortunately, the lack of data on consumer price indices at the local labour market level means that we cannot examine effects of China on real wages (i.e. purchasing power).

[5] This assumption is consistent with our empirical focus on the short- to medium-run effects of the 'China shock'. However, we will account for the possibility of changes in workforce composition in our empirical analysis by running auxiliary regressions to filter out compositional effects. We will also examine whether in practice, China appears to have had a significant effect on Brazilian migration patterns during the ten-year period we study.

summarize shocks to Chinese demand and supply (respectively) in each sector j, and can be expressed as:

$$\hat{Z}_{ijC} = \hat{E}_{Cj} - (\sigma_j - 1)\,(1 - \phi_{ijC})\,\hat{\tau}_{ijC},$$
$$\hat{A}_{Cjk} = \hat{M}_{Cj} - (\sigma_j - 1)\left(\hat{W}_C + \hat{\beta}_{Cj} + \hat{\tau}_{Cjk}\right).$$

As summarized in this way, the demand-side shock in sector j is increasing in the change in Chinese expenditure on goods from this sector, $\hat{E}_{Cj}$, and decreasing in the change in the cost of exporting goods to China from Brazilian region i, $\hat{\tau}_{ijC}$. Here, $\sigma_j > 1$ is the elasticity of substitution between any pair of varieties in sector j, while $\phi_{ijC} \in (0,1)$ corresponds to the share of imports (in value) from region i in China's consumption of sector j goods. Meanwhile, the supply-side shock in sector j is decreasing in changes in Chinese input costs, including the change in Chinese wages $\hat{W}_C$ and the change in the number of workers required to produce an additional unit of output, $\hat{\beta}_{Cj}$. The supply shock is also increasing in the change in the number of Chinese firms in the sector, $\hat{M}_{Cj}$, and decreasing in the change in the cost of exporting goods from China to Brazilian region k, $\hat{\tau}_{Cjk}$.

Having defined these two shocks, we can now write the key equation of the model:

$$\hat{W}_i = h_i \sum_j b_{ij} \frac{L_{ij}}{L_{Ni}} \left[\theta_{ijC}\hat{Z}_{ijC} - \sum_k \theta_{ijk}\phi_{Cjk}\hat{A}_{Cjk} \right] \quad (1)$$

where θ_{ijk} represents the share of exports to region k in the total output of region i in sector j. In Eq. (1), the effect of $\hat{Z}_{ijC}$ is positive and that of $\hat{A}_{Cjk}$ is negative under weak conditions because h_i and b_{ij} are positive constants (see the theory appendix for details). The equation thus shows that regions' wages decline because of import competition from China as captured by $\hat{A}_{Cjk}$. However, workers in a region also win from the 'China shock' in a given sector j because the components of $\hat{Z}_{ijC}$ – lower costs of sending Brazilian goods to China $(\hat{\tau}_{ijC})$ and higher expenditure by China on imported goods $\left(\hat{E}_{Cj}\right)$ – boost Brazilian exports.

The equation also suggests that workers in different regions will win or lose from the boom in trade with China to different extents. The shocks $\hat{Z}_{ijC}$ and $\hat{A}_{Cjk}$ vary by sector, and different regions have different comparative advantages, and thus different distributions of workers across sectors. The magnitudes of the effects of both shocks in a given region i increase in the term L_{ij}/L_{Ni}, which captures the number of region i workers in sector j relative to the stock of workers in the local nontraded sector.

Initial patterns of trade also play an important role in determining the mapping between changes in China and changes in wages in each region i. The importance to a region of a shock to Chinese demand in sector j is governed in part by the initial relevance of Chinese demand for i: recall that in Eq. (1), θ_{ijC} represents the quantity of sector j goods exported to China by region i relative to the total production of region i in sector j. Similarly, the relevance of a shock to Chinese supply in sector j for region i depends on initial Chinese import penetration in each of the regions k to which i exports, weighted by the importance of each market k to region i (θ_{ijk}). To see this, note that the term ϕ_{Cjk} in Eq. (1) is equal to the share of expenditure on Chinese imports in sector j as a share of total spending on j in region k.

2.1. Connecting theory with data

For our empirical analysis, we consider the effects of China on Brazilian microregions, using data that we will describe in the next section. To derive our empirical specifications, we use Eq. (1) as a starting point, but make some simplifying assumptions, which closely follow those of Autor et al. (2013).[6] This results in the following equation in terms of trade flows V_{ijk} from i to k in sector j:

$$\hat{W}_i = \zeta_i \left[\sum_j \frac{L_{ij}}{L_{Bj}L_i} V_{BjC}\hat{Z}_{ijC} - \sum_j \frac{L_{ij}}{L_{Bj}L_i} V_{CjB}\hat{A}_{Cji} \right] \quad (2)$$

where Brazil-wide variables carry the subscript B.

To construct estimating equations from these expressions, we proxy for the shocks $\hat{Z}_{ijC}$ and $\hat{A}_{Cji}$ with the growth rates of exports from Brazil to China and imports of Brazil from China respectively. When multiplied by their initial levels V_{BjC} and V_{CjB}, this gives long differences in each of these two trade flows. Also, while the model suggests that ζ_i is heterogeneous across regions i, we restrict this coefficient to be a constant, which means that our estimates will capture a weighted average of these heterogeneous effects. Finally, in our main specification, we separately estimate coefficients on our export-side and import-side variables, but test the model's prediction that the two coefficients are of equal and opposite sign. The resulting estimating equation is as follows:

$$\ln W_{it} - \ln W_{i,t-1} = \zeta_X \sum_j \frac{L_{ij,t-1}}{L_{Bj,t-1}L_{i,t-1}} \left(V_{BjC,t} - V_{BjC,t-1}\right) + \zeta_I \sum_j \frac{L_{ij,t-1}}{L_{Bj,t-1}L_{i,t-1}} \left(V_{CjB,t} - V_{CjB,t-1}\right). \quad (3)$$

3. Data and summary statistics

3.1. Data sources

For our baseline specification, we use individual-level labour market and socioeconomic data from the long form Brazilian Demographic Census (*Censo Demográfico*) for 2000 and 2010, sourced from the Brazilian Institute of Geography and Statistics (IBGE). Some specifications also use individual-level data from the 1980 and 1991 censes. We restrict our sample to the subpopulation most likely to participate in the labour market, defining the workforce as every individual between 18 and 60 years old. We calculate employed individuals' average hourly wages by deflating the reported monthly wage by the number of hours worked per week multiplied by 4.33 weeks. We use a consumer price index (IPCA) from IBGE to deflate wages so that they are measured in 2010 Brazilian reals.

Our empirical analysis is conducted at the level of the 'microregion', a level of aggregation that has been constructed by IBGE by grouping Brazilian municipalities according to information on integration of local economies, which we interpret as local labour markets. So that our work is based on microregions whose boundaries

[6] We first assume that $V_{ijC} \approx \frac{L_{ij}}{L_{Bj}} V_{BjC}$, i.e. the value of shipments from region i to China in sector j equals the total value of Brazilian shipments in sector j to China multiplied by region i's share in the Brazilian labour force in this industry. Next, we ignore the effects of greater import competition in the foreign markets served by Brazilian regions, rewriting the second term of Eq. (1) as a sum over Brazilian regions b. We then assume that $\sum_{b \in B} \frac{X_{ijb}}{X_{ij}} \frac{V_{Cjb}}{E_{bj}} \hat{A}_{Cjb} \approx \frac{X_{ijB}}{X_{ij}} \frac{V_{CjB}}{E_{Bj}} \hat{A}_{Cji}$, where B represents Brazil as a whole. Note that this holds as an equality if all Brazilian regions have the same utility function and trade costs between Brazilian regions are zero; in this case, $\frac{V_{Cjb}}{E_{bj}} \hat{A}_{Cjb}$ will be identical across regions and the result follows. Finally, we renormalize the denominator of Eq. (1) using the total labour force in a region i rather than L_{Ni}, and assume that the general equilibrium scaling factor $b_{ij} = 1/\sum_k \theta_{ijk}\phi_{ijk}$ is constant across sectors.

are consistent over time, we use a definition of microregions from Reis et al. (2007) and provided by Dix-Carneiro and Kovak (2015b), which merges some microregions whose borders changed between 1980 and 2010. Our sample includes 412 Brazilian microregions.[7]

While our main specifications focus on wages, we also examine the effect of China on several other outcomes, including private sector employment, informality and migration. We draw information on informality from questions in the census asking employed individuals about their job type: government worker; employee registered at the Brazilian Ministry of Labour and Employment (*com carteira assinada*); employee not registered at the Ministry of Labour and Employment (*sem carteira assinada*); self-employed; or in unpaid work. We include the final three categories in our definition of the informal sector.[8]

To construct data on in-migration and out-migration from microregions, we use information in the census on whether an individual moved to their current location within the previous five years, and from which location they moved. We use this information to calculate the proportion of newly arrived working-age individuals in a microregion and the share of individuals leaving a microregion, both of which are defined relative to the microregion's workforce five years earlier.[9]

Our data on international trade in goods is from the BACI database developed by Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), which reconciles the data separately reported by importers and exporters in the United Nations Statistical Division's COMTRADE database. CEPII BACI contains the total annual value of bilateral trade at the 6-digit level of the Harmonized System classification for more than 200 countries from 1995 to 2010; we use data for 2000 and 2010 in the analysis below. The CEPII data is denominated in thousands of current US dollars; we convert 2000 values to 2010 US dollars using the US GDP deflator from the US Bureau of Economic Analysis.

Our empirical strategy requires us to classify employed individuals in the 2000 census data and products in the 2000 and 2010 trade data into sectors. In the 2000 Brazilian census, individuals are asked to state their sector of activity according to the 5-digit *CNAE Domicílio* classification.[10] We thus construct a concordance assigning products in the trade data to *CNAE Domicílio* sectors, which requires us to combine some of the traded goods sectors in *CNAE Domicílio* when these cannot be separately identified in the trade data. We are left with a total of 82 traded goods sectors, including 24 agricultural sectors, 8 extractive sectors and 50 manufacturing sectors; see Table B2 for a full list.[11]

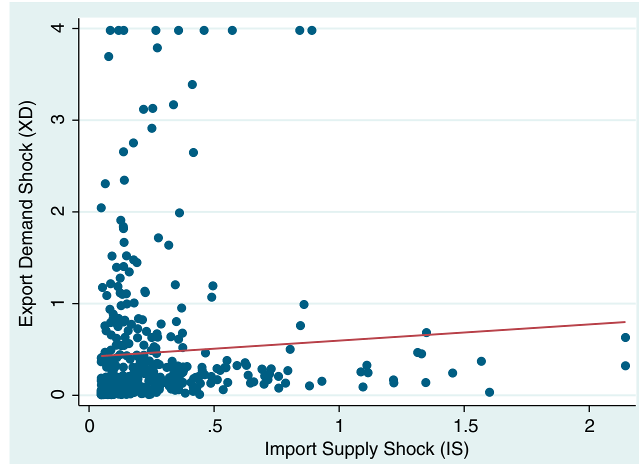

Fig. 4. Import supply vs export demand measures. This graph presents scatter plots of microregion-level import supply against export demand shocks (IS_m and XD_m), in thousands of US dollars per worker. The line depicts the results of a simple regression of XD_m on IS_m (coefficient .18, robust s.e. .12 and t-statistic 1.48).
Sources: 2000 Brazilian Census, and CEPII BACI.

3.2. Summary statistics

Eq. (3.2) at the end of Section 2 defines the two key right-hand-side variables in our empirical specifications, which vary by Brazilian microregion m:

$$XD_m \equiv \sum_j \frac{L_{mj,2000}}{L_{Bj,2000}L_{m,2000}} \Delta X_j$$

$$IS_m \equiv \sum_j \frac{L_{mj,2000}}{L_{Bj,2000}L_{m,2000}} \Delta I_j$$

where we now use simpler notation for exports from Brazil to China, $\Delta X_j \equiv V_{BjC,2010} - V_{BjC,2000}$, and imports of Brazil from China, $\Delta I_j \equiv V_{CjB,2010} - V_{CjB,2000}$. The variable $L_{mj,2000}$ is defined as the size of the workforce in sector j within microregion m, while $L_{Bj,2000}$ and $L_{m,2000}$ are the Brazil-wide workforce in sector j and the total workforce in microregion m respectively. We denominate both IS_m and XD_m in thousands of 2010 US dollars per worker.[12]

As measured by IS_m and XD_m, the average Brazilian microregion received an import competition shock from China of US\$260 per worker and an export demand shock of US\$466 per worker.[13] As shown in Fig. B1, the dispersion of the export demand shock is also larger, though both distributions are highly skewed to the right. The microregion at the 20th percentile of IS_m received an import supply shock of US\$82 per worker, while the supply shock to the microregion at the 80th percentile of IS_m was US\$361 per worker. The corresponding figures for XD_m are US\$41 and US\$630, respectively.

Fig. 4 shows that the two shocks affected different sets of microregions, as the unconditional distributions of the two measures are

[7] We drop Fernando de Noronha, a tiny microregion that did not separately report data in the 1980 census. Including it in regressions that do not require the 1980 census data does not change any of our results.

[8] Although a self-employed worker could be registered with the federal government, these cases constitute a small fraction of all self-employed individuals. Publicly available administrative data from the *Relaçao Anual de Informaçoes Sociais* (RAIS) database – the official records of the Ministry of Labour and Employment – show that only 0.9% and 0.8% of the workforce were registered as self-employed in 2000 and 2010, respectively. We observe total rates of self-employment of 18.3% and 15.7% of the workforce in these two years' censes.

[9] Calculation of this denominator requires us to impute the distribution of working-age individuals across microregions five years before the census. To do this, we begin with the current workforce of each microregion, subtract individuals of working age who in-migrated within the previous five years, and add individuals of working age who out-migrated within the previous five years.

[10] This is defined as the main sector of activity of the firm or other institution of an employed person or the nature of the activity of a self-employed person.

[11] Forestry and fisheries/aquaculture are defined here as agricultural sectors. Several products from the Harmonized System classification, mostly waste or scrap (e.g. scrap metal, used clothing) could not be concorded to the *CNAE Domicílio* classification; these products make up less than 1% of Brazilian trade by value.

[12] In order to prevent our empirical results from being driven by outliers, we assign values of IS_m and XD_m below the 1st and above the 99th percentiles, weighted by microregion-level workforce size, to the values of the 1st and 99th percentiles. We do the same for the instrumental variables defined in Section 4.2. The means across microregions of the distributions of the sector-microregion-level variables $(L_{mj,2000}/L_{Bj,2000}L_{m,2000})\Delta I_j$ and $(L_{mj,2000}/L_{Bj,2000}L_{m,2000})\Delta X_j$ are shown in columns (3) and (5) of Table B2.

[13] These two figures differ in magnitude even though trade between China and Brazil was approximately in balance in both 2000 and 2010; this is because both measures include a microregion-level per-worker normalization.

Table 1
Brazilian microregion-level summary statistics 2000.

	All microregions	Top quintile of IS_m	Top quintile of XD_m
	(1)	(2)	(3)
Workforce (thousands)	231.529	563.017	261.286
Private sector workers	.573	.605	.580
Agriculture	.321	.129	.273
Extractive	.007	.006	.014
Manufacturing	.116	.198	.117
Nontraded	.545	.655	.584
Formal jobs	.310	.492	.362
Informal jobs	.690	.508	.638
Rural residents	.299	.121	.237
Inmigrated in the last 5 years	.075	.086	.076
Outmigrated in the last 5 years	.088	.065	.096
Average hourly wage (reals)	1.292	1.766	1.459

This table displays descriptive statistics of the Brazilian labour market in 2000, averaged at the microregion level. Column (1) includes all microregions, column (2) includes only microregions among the top 20% of IS_m, and column (3) includes only microregions in the top 20% of XD_m. Unless otherwise indicated, figures are shares of the total workforce, except for the categories listed under 'Private sector workers', which are shares of total private sector employees. The workforce is defined here as the total number of citizens between 18 and 60 years old. Average hourly wage is in current reals. *Sources:* 2000 Brazilian Census, and CEPII BACI.

nearly orthogonal, with a correlation of 0.07. Table 1 charts the characteristics of microregions in the top 20% of IS_m and XD_m in 2000, while the geographical distribution of microregions in the top 20% of each of the two measures is plotted in Fig. 5. Table 1 shows that the microregions most exposed to Chinese imports tended to have a lower proportion of workers engaged in agriculture and a higher proportion working in manufacturing in 2000 as compared to the average region, as well as a much smaller share of rural residents. On average, these regions also had a larger working-age population, a greater share of the workforce in formal jobs and a higher average wage than the mean microregion.[14]

Table 1 also suggests that microregions with large values of XD_m had an average hourly wage higher than that of the mean microregion, though smaller than the top quintile of IS_m. In terms of most other labour market variables, regions in the top 20% of XD_m were similar on average to the mean Brazilian microregion in 2000, and in general they were more similar to the average microregion than were the locations in the top quintile of IS_m.[15]

4. Empirical strategy

4.1. Baseline specification and controls

The theoretical model in Section 2 yielded a specification relating wages to the shocks IS_m and XD_m, resulting in an empirical strategy in line with the shift-share approach of Bartik (1991), as applied to the effect of China on US labour markets by Autor et al. (2013). Since we have seen that IS_m and XD_m are correlated with various initial characteristics of microregions, all of our regressions also include a set of microregion-level controls T_m. Our baseline specification is thus as follows:

$$\Delta \ln W_m = \zeta_I IS_m + \zeta_X XD_m + T_m' \gamma + \epsilon_m. \tag{4}$$

In all regressions, we control for the size of the local workforce, the share employed in informal jobs, the proportion of rural residents, and a cubic polynomial of income per capita, all measured at the microregion level for the year 2000. Importantly, we also control for the share of each microregion's workforce employed in agricultural sectors, extractive sectors and manufacturing sectors in 2000. This means that our results depend on comparisons between microregions with the same initial economic structure (in terms of the distribution of local employment across these three broadly defined categories) but specialized in different particular agricultural, extractive and manufacturing sectors.

This strategy is feasible because the distribution of Brazil–China trade growth is skewed across sectors on both the import and export sides. Approximately 40% of the total growth in Brazil's imports from China between 2000 and 2010 (i.e. $\sum_j \Delta I_j$) is accounted for by electronics (19%), machinery (13%) and electrical equipment (8%). Meanwhile, just three sectors, all of which are agricultural or extractive sectors, were responsible for 82% of the growth in Brazil's exports to China between these two years: mining of nonprecious metals (45%), soybeans (23%) and oil and gas (14%).[16] This breakdown actually understates the level of concentration of Brazil's exports to China, since its exports in the 'mining of nonprecious metals' sector are almost exclusively made up of exports of iron ore. This high degree of concentration in a few commodities is a typical pattern of exports to China among developing countries for whom trade with China is important.[17]

The maps in Fig. 5 suggest that the incidence of Chinese trade shocks is relatively widely distributed across Brazil. Nonetheless,

[14] Unsurprisingly, the three microregions with the highest IS_m are all major industrial centres: São José dos Campos, Manaus and Santa Rita do Sapucaí. The last of these regions is sometimes referred to as the 'Electronic Valley' due to the size of its electronics industry.

[15] The three observations with the largest values of XD_m include a major centre of the offshore oil industry (Macaé) and two microregions in Minas Gerais (Itabira and Itaguara), an important outpost of the iron ore mining complex.

[16] To calculate these measures, we take the difference between the 2010 and 2000 values of Brazil's imports from China (or exports to China) in each sector and divide by the aggregate difference between 2010 and 2000 Brazilian imports from China (or exports to China). The resulting figures for each of the 82 traded goods sectors may be found in columns (1) and (2) of Table B2. The value of imports from China actually decreased in several sectors, but their total decline constitutes a tiny proportion of the total difference in imports, so that the total of all positive values only slightly exceeds 1; the same is true of exports to China. As noted in footnote 11, some Harmonized System codes (mostly waste and scrap) are not concorded to any sector; trade in these products is included in the denominator but not listed in Table B2.

[17] According to the CEPII BACI data, in all 27 non-high-income countries outside East and Southeast Asia for whom exports to China constituted a minimum of 10% of total exports by value in 2010, at least 80% of exports to China were concentrated in three or fewer of the sectors defined in this paper (82 sectors plus a residual 'waste and scrap' category). In 16 of these 27 countries (including Brazil), at least 80% of exports to China were in agricultural and/or extractive sectors; in a further five, at least 80% of exports were concentrated in up to two agricultural or extractive sectors and either the 'basic metals' manufacturing sector or scrap metal.

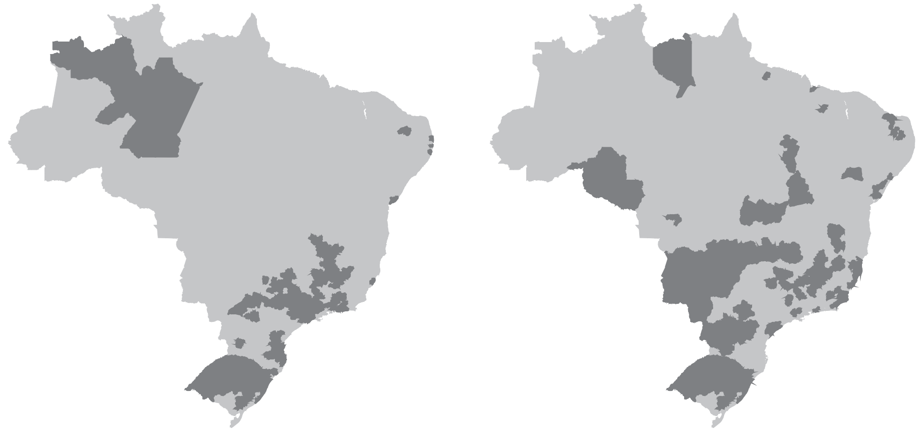

Fig. 5. Geographical distributions of top quintile of import supply and export demand measures. These maps display the spatial distributions of microregions in the top quintile of the import supply shock measure IS_m and microregions in the top quintile of the export demand shock measure XD_m.
Sources: 2000 Brazilian Census, and CEPII BACI.

it is possible that the outcomes we observe might be driven by other circumstances specific to individual Brazilian states. In our preferred specification, we thus add fixed effects for Brazil's 26 states and one federal district, so as to check whether the results are robust to accounting for contemporaneous state-specific trends in the dependent variable. That is, in this specification we investigate the within-state effects of the two 'China shocks'.

In our preferred specification, we also address the potential concern that any results we observe simply represent the continuation of local labour market trends that began in years before our period of study. For example, Brazil underwent a major trade liberalization episode in the late 1980s and early 1990s that is known to have had a significant impact on affected local labour markets (see e.g. Dix-Carneiro and Kovak, 2015a,b, Kovak, 2013, Menezes-Filho and Muendler, 2011); adjustments resulting from this shock also varied by local sector of specialization and might still have been occurring between 2000 and 2010. Thus, in order to account for pre-sample-period trends, we use data from the 1980 and 1991 Brazilian censes to add two lags of the dependent variable to our set of controls; that is, we control for microregion-level changes between 1991 and 2000, and between 1980 and 1991, in the outcome of interest. Because of likely correlation between the first lagged dependent variable and the residual ϵ_m, we instrument for this variable using 1991 levels, as suggested by Anderson and Hsiao (1981).[18]

In all regressions, in order to allow for spatial correlation of errors across microregions, we cluster standard errors at the level of the mesoregion. Like the microregion, this geographical unit has been defined by IBGE according to measures of local market integration; adjusting for changes in mesoregion boundaries over time, there are 91 mesoregions in our sample. Also, we weight all regressions by the share of the national workforce in each microregion.[19]

4.2. Instrumental variables

Our goal is to identify the causal effect of the two 'China shocks' on local labour market dynamics in Brazil. However, even with the controls described above, regression Eq. (4) may not capture causality in the presence of additional shocks that are both relevant for our dependent variables and correlated with our exposure measures *IS* and *XD*. In particular, given the sector-level variation that underlies our identification strategy, one potential issue would be the existence of Brazil-specific supply or demand shocks in sectors in which Brazil also experienced a relatively large change in trade with China. For example, changes in Brazil–China trade patterns might be capturing sector-specific productivity growth or changes in patterns of consumption associated with rising incomes in Brazil rather than phenomena originating in China.

Alternatively, changes in the sectoral pattern of trade between Brazil and China may be driven in part by changes in *world* prices or quantities traded that are not due to China. If the world price of a given product rises due to other factors, or all countries trade more intensively in the products of some sector due to a worldwide technology or demand shock, this will be reflected in the trade flows of all countries. This is a particular issue for our study given its focus on commodities, whose world prices were on an upward trajectory over the course of the decade we study. If, for instance, the share of oil by value increased in the import baskets of all countries between 2000 and 2010 due to rises in its world price, our baseline regression specification would assign this effect to China. However, while China likely played a pivotal role in changes in world prices in many sectors during this period, we do not want to ascribe world price or quantity changes to China when these actually resulted from other factors.

To deal with these potential confounding factors, we construct instrumental variables for *IS* and *XD*. We address the possibility of

[18] Note that the consistency of our estimates then depends on the assumption that the 1991 level of the dependent variable is uncorrelated with ϵ_m. While it seems credible that the direct influence of $\ln W_{m,1991}$ on $(\ln W_{m,2010} - \ln W_{m,2000})$ occurs through its effect on $(\ln W_{m,2000} - \ln W_{m,1991})$, it might be that $\ln W_{m,1991}$ is correlated with the initial levels of other variables that affect $(\ln W_{m,2010} - \ln W_{m,2000})$. It is thus important that we control, via T_m, for the 2000 levels of a number of key microregion-level variables, such as income, workforce size and workforce composition. In order for our identification assumption to be violated, the relevant correlate of $\ln W_{m,1991}$ would need to have an effect on the dependent variable that is independent of these year-2000 controls. We do not use $(\ln W_{m,1991} - \ln W_{m,1980})$ as an instrument for $(\ln W_{m,2000} - \ln W_{m,1991})$ because this serves as an additional control in our preferred specification.

[19] Since Eq. (2) in Section 2 implies that the effects of the China shocks are heterogeneous across microregions, this weighting strategy means that the estimated average treatment effect is weighted by worker rather than by microregion. We display the results of unweighted regressions in column (4) of Table B3 (for our main specifications) and in the online appendix (for all other specifications). Note that the same weighting strategy is employed by Autor et al. (2013).

Fig. 6. Raw measures vs instrumental variables measures. This graph presents scatter plots of microregion-level import supply and export demand shocks (IS_m and XD_m) against the instrumental variables $ivIS_m$ and $ivXD_m$, all in thousands of US dollars per worker. The lines depict the results of simple regressions of IS_m on $ivIS_m$ (coefficient 4.01, robust s.e. .14 and t-statistic 28.33) and XD_m on $ivXD_m$ (coefficient 1.90, robust s.e. .04 and t-statistic 46.50).
Sources: 2000 Brazilian Census, and CEPII BACI.

Brazil-specific sectoral trends by using information on growth in trade between China and countries other than Brazil. This is a standard approach in the 'China shock' literature (see, for example, Autor et al., 2013 and Iacovone et al., 2013). However, differently from the strategy employed in these papers, our instrumental variables strategy also deals with the possibility of correlated world-level shocks by using auxiliary regressions to 'clean out' changes in prices and quantities at the global level.

In particular, instead of multiplying trade between Brazil and China in 2000 by the growth rate of trade between these two countries from 2000 and 2010, we take the product of initial trade levels and the fixed effects from a set of auxiliary regressions. We first define $\tilde{I}_{ijt}$ and $\tilde{X}_{ijt}$ to be the total imports (exports) of country i in sector j in year t from (to) all countries other than Brazil. We then run the following auxiliary regressions, using data on $\tilde{I}_{ijt}$ and $\tilde{X}_{ijt}$ in 2000 and 2010 for all countries available in the CEPII trade data except Brazil:

$$\frac{\Delta\tilde{I}_{ij}}{\tilde{I}_{ij,2000}} = \alpha_j + \psi_{China,j} + \nu_{ij}$$
$$\frac{\Delta\tilde{X}_{ij}}{\tilde{X}_{ij,2000}} = \gamma_j + \delta_{China,j} + \mu_{ij}.$$

The left-hand side of the two regressions above is the growth rate of the imports (exports) of a country in a given sector, net of its imports from (exports to) Brazil. The sector fixed effect α_j (or γ_j) then captures the mean growth rate, across countries, of net-of-Brazil imports (or exports) in that sector; that is, it captures world-level shocks such as worldwide price changes. The regressions are weighted by 2000 import (export) volumes, so that the values of these fixed effects are not driven by large positive or negative growth rates in countries with small shares of world trade. This means that the China-specific dummies $\psi_{China,j}$ and $\delta_{China,j}$ represent the deviation in the growth rates of China's imports and exports in sector j excluding trade with Brazil, as compared to this weighted cross-country average.

We next relate the resulting estimates $\hat{\psi}_{China,j}$ and $\hat{\delta}_{China,j}$ to microregion-level measures in the same way as we did for IS_m and XD_m. We first multiply these estimates by the values of Brazil–China imports and exports in 2000, defining $\Delta\hat{I}_j \equiv I_{j,2000}\hat{\delta}_{China,j}$ and $\Delta\hat{X}_j \equiv X_{j,2000}\hat{\psi}_{China,j}$.[20] Our instrumental variables are then constructed as follows:

$$ivXD_m \equiv \sum_j \frac{L_{mj,2000}}{L_{Bj,2000}L_{m,2000}}\Delta\hat{X}_j$$
$$ivIS_m \equiv \sum_j \frac{L_{mj,2000}}{L_{Bj,2000}L_{m,2000}}\Delta\hat{I}_j.$$

If Chinese trade with the rest of the world (excluding Brazil) had evolved in the same way as that of the (weighted) average country in each sector, $\Delta\hat{I}_j$ and $\Delta\hat{X}_j$ would be equal to zero for all sectors j. In practice, however, this is not the case: the two vectors $\Delta\hat{I}_j$ and $\Delta\hat{X}_j$, like the 'raw' measures ΔI_j and ΔX_j, vary widely across sectors. That is, the pattern of trade of China with the rest of the world evolved in a different way from worldwide trends over this period. It is exactly this distinctive pattern that underlies our identification strategy. In fact, our 'raw' and 'IV' measures of trends in Chinese trade are highly correlated, with correlation coefficients of 0.93 for the sector-level import supply shocks ΔI_j and $\Delta\hat{I}_j$ and 0.86 for the export demand

[20] Note that $\hat{\psi}_{China,j}$ relates to Chinese imports and thus to the export-side shock for Brazil, while $\hat{\delta}_{China,j}$ relates to Chinese exports and thus the import-side shock for Brazil. The averages across microregions of the sector-microregion-level variables analogous to those in footnote 12, but constructed using $\Delta\hat{I}_j$ and $\Delta\hat{X}_j$, may be found in columns (4) and (6) of Table B2.

shocks ΔX_j and $\Delta \hat{X}_j$. Scatter plots of IS_m against $ivIS_m$ and XD_m against $ivXD_m$ are shown in Fig. 6.

A closer look at the evolution of exports from China to Brazil may help to illustrate the effect of our IV strategy. Recall from the previous section that the bulk of growth in Brazil's exports to China is accounted for by mining of nonprecious metals, soybeans and oil and gas. The main effect of the instrument $ivXD_m$ is to diminish the importance of oil in the 'China demand shock' as compared to XD_m – since $\Delta \hat{X}_{oil}$ accounts for only 2% of $\sum_j \Delta \hat{X}_j$ – while boosting the relative importance of the other two sectors.[21] This is because the growth in exports of oil from Brazil to China was due in part to supply shocks in Brazil and changes in world prices. By value, Brazilian exports accounted for just 0.04% of world trade in oil in 2000, but this rose to 1.04% by 2010. Moreover, from 2000 to 2010, trade with China accounted for just one quarter of the growth in the quantity of Brazil's worldwide exports of oil.

In contrast, there is evidence that the rise in Brazil–China exports in the other two sectors was mainly due to a Chinese demand shock. First, the share of Brazil in world trade by value in the two sectors changed relatively little between 2000 and 2010: Brazil accounted for 23% of world exports of soybeans in 2000 and 27% in 2010, and for 13% of world exports of nonprecious metal ores in 2000 and 17% in 2010. Meanwhile, China's share of world imports in these two sectors rose much more steeply during this period: from 21% to 56% for soybeans, and from 10% to 45% for nonprecious metal ores. Exports to China accounted for 98% of the growth in the total quantity of soybeans exported from Brazil, and 87% of the growth in the quantity of Brazil's exports of nonprecious metal ores, between the two years.[22]

As noted above, our IV approach is analogous to that of Autor et al. (2013), which also exploits information on trade between China and countries other than the destination country of interest (here, Brazil). Autor et al. (2013) instrument for import and export shocks using long differences in trade flows between China and a set of other countries. A key distinction between our methodology and that of Autor et al. (2013) is that, in line with Eq. (2) of the theoretical model, our instruments are constructed by multiplying Brazilian trade flows in 2000 by shocks in the form of growth rates, rather than using differences in the levels of trade between China and the rest of the world. In practice, this increases the relevance of the instruments by diminishing the relative importance of high-growth sectors in which Brazil was not initially an exporter. A second important difference is that we remove a potential source of endogeneity by 'cleaning out' changes in world-level prices and quantities, as described in detail above.[23]

[21] To see this visually, note that the two points in the upper left of the scatter plot of XD_m against $ivXD_m$ (see Fig. 6) are both major producers of oil (Macaé and Catu).

[22] Notably, Bustos et al. (2015) present evidence of non-Brazil-specific technological change in the soybean sector via the development in the US of a genetically modified soybean variety in 1996, and suggest that the adoption in Brazil of this technology in the early 2000s led to increases in agricultural productivity per worker, decreases in the labour intensity of agricultural production, rising manufacturing employment shares and declining manufacturing wages in affected locations. Bustos et al. also discuss a Brazil-specific technological change in the maize sector (*milho safrinha*) which they find is associated with rises in labour intensity, declines in manufacturing employment shares and increases in wages.

[23] An instrument for *XD* constructed in the same way as Autor et al. (2013) using trade between China and all countries other than Brazil is weak in many of our specifications. Moreover, this instrument weights oil more than twice as heavily as soya and nonprecious metal ore combined. See Figure C.1 of our online appendix for a scatter plot of *XD* against this instrument. We display the results of regressions using this instrument (along with a similar instrument for *IS*) in column (5) of Table B3 (for our main specifications) and in the online appendix (for all other specifications). The results suggest that using the instrument of Autor et al. (2013) leads to estimates that are generally larger in magnitude as compared to estimates using our instrument. This may be because our instrument purges world price changes that are due to China as well as correlated positive shocks to the prices of Brazilian export commodities such as oil. Thus, our results are probably conservative estimates of the effects of China on local labour markets in Brazil.

5. Results

5.1. Main results

We now provide evidence on the effects of shocks to Chinese supply and demand, as captured by *IS* and *XD*, on wages at the level of the local labour market in Brazil. Panel A of Table 2 displays the results of microregion-level regressions of differences in log average hourly wages between 2000 and 2010 on *IS*, *XD* and controls. Coefficients and standard errors are multiplied by 100, so that they may be (approximately) interpreted as the effect of a US\$1000 increase in imports or exports per worker on changes in the dependent variable in percentage points.

The OLS estimates in column (1) of Panel A suggest that larger export demand shocks are associated with higher growth in wages over these ten years. Columns (2) through (5) show that the result is qualitatively unchanged by our instrumental variables strategy and specifications including state fixed effects (column (3)), two lags of the dependent variable (column (4)) and both of these additional controls (column (5)). In our preferred specification, column (5), a US\$1000 per worker increase in exports to China is associated with higher growth in wages of 1.58 percentage points over the course of the decade. This implies that Chinese demand led to additional wage growth of 0.93 percentage points in a microregion at the 80th percentile of the distribution of *XD* as compared to a microregion at the 20th percentile. Meanwhile, the estimated effect of Chinese import competition on wages is statistically insignificant in all five specifications.

These results suggest that the boom in Brazil–China trade had positive effects on Brazilian microregions with an initial comparative advantage in sectors stimulated by Chinese demand, as predicted by the simple model presented in Section 2. However, the model assumes that workers are homogeneous and cannot migrate between microregions, while the estimates in Panel A subsume both 'pure' wage effects and effects due to changes in the composition of workers during this period. Previous studies of trade shocks and labour markets have dealt with this issue by running auxiliary regressions to filter out compositional effects (Goldberg and Pavcnik, 2003, Kovak, 2013). We thus follow such a procedure here and present the results in Table 2 Panel B.

In particular, we use individual-level census data to regress individual log average hourly wage on age, age squared, and dummies for gender, race (nonwhite), education (literate, basic education, high school, college and above) and microregion. The coefficients of the microregion dummies capture the microregion-level averages of the component of each worker's wage that cannot be explained by these characteristics. These estimated coefficients are then normalized by redefining them as deviations from the employment-weighted average across microregions. We estimate one such auxiliary regression for each year of census data, and use the long difference in the normalized microregion fixed effects from the 2000 and 2010 regressions as our new dependent variable in Panel B of Table 2.[24]

The results of estimating our preferred specification using this new left-hand-side variable may be found in column (5) of Panel B. The estimated coefficient on *XD* is now approximately 20% smaller than in column (5) of Panel A, but it remains positive and on the border of statistical significance, with a p-value slightly above 0.1. The estimated coefficients on *XD* in the specifications of columns (1)

[24] Since these are estimated variables, in the regressions of Table 2 Panel B we weight by the inverse of the variance of the normalized estimates, using the procedure of Haisken-DeNew and Schmidt (1997). Also, workers with a zero wage are dropped in the individual-level auxiliary regressions, which have log hourly wage on the left-hand side. However, these workers are taken into account in the construction of the dependent variable in Panel A of Table 2.

Table 2
Main results — log average hourly wages.

	OLS	IV	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)
Panel A. Log average hourly wages (raw)					
IS (ζ_I)	−2.97	−2.64	.36	−1.99	.28
	(2.8)	(2.69)	(1.2)	(2.89)	(1.15)
XD (ζ_X)	2.69***	2.02**	1.55**	2.07**	1.58**
	(.7)	(.83)	(.65)	(.83)	(.66)
1st stage (KP F-stat.)		226.3	89.7	126.2	83.2
$H_0: \zeta_I + \zeta_X = 0$ (p-value)	.921	.822	.163	.978	.164
Panel B. Log average hourly wages (net of composition)					
IS (ζ_I)	−4.76*	−4.42*	−2.33	−.58	−1.07
	(2.48)	(2.36)	(1.71)	(3.07)	(1.7)
XD (ζ_X)	2.52***	2.04**	1.02	1.92*	1.28
	(.85)	(.93)	(.65)	(1.04)	(.78)
1st stage (KP F-stat.)		189.5	88.2	62.7	38.3
$H_0: \zeta_I + \zeta_X = 0$ (p-value)	.363	.321	.449	.692	.913
State fixed effects			Y		Y
Lag dep. variable				Y	Y

This table displays estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in raw log average hourly wages (Panel A) and composition-adjusted log average hourly wages (Panel B), as captured by ζ_I and ζ_X from Eq. (4). In order to filter out compositional effects in Panel B, we first estimate auxiliary regressions as described in Section 5.1. Each column corresponds to a different regression with specification indicated. In the columns marked with IV, we *instrument* imports from (exports to) China using a measure based on growth in Chinese exports to (imports from) all countries, excluding Brazil, relative to a weighted cross-country average. The unit of observation is a microregion according to Reis et al. (2007); N = 412. Coefficients and standard errors are multiplied by 100, so that coefficients roughly represent percentage point changes. All regressions include a constant and the following *controls*: 2000 workforce, 2000 share of workforce in agricultural sectors, 2000 share of workforce in extractive sectors, 2000 share of workforce in manufacturing, 2000 share of workforce in informal jobs, 2000 share of workforce in rural areas, and a cubic polynomial of income per capita in 2000. Regressions in columns (3) and (5) include state fixed effects, and in columns (4) and (5) include the lag of the dependent variable for the periods 1980–1991 and 1991–2000, the latter instrumented with the 1991 level (Anderson and Hsiao, 1981). Regressions in Panel A are weighted by share of national workforce in 2000 and regressions in Panel B are weighted according to Haisken-DeNew and Schmidt (1997). *Standard errors* are clustered by mesoregion, 91 clusters. *Sources:* 1980, 1991, 2000 and 2010 Brazilian Census, and CEPII BACI.
*** $p< .01$.
** $p< .05$.
* $p< .1$.

to (4) are also positive and of similar magnitudes to their counterparts in Panel A. This result suggests that changes in composition likely play a role in the microregion-level effect of Chinese demand on wages (as estimated in Panel A), but that the 'pure' wage effect of Chinese demand is positive and of a magnitude only slightly smaller than the estimates of Panel A.

The theoretical framework of Section 2 also predicted that the effect of *IS* on wage growth should be of equal magnitude and opposite sign to that of *XD*, and indeed, a test of the hypothesis that $\zeta_I + \zeta_X = 0$ is not rejected for any of the five specifications in either panel. In the specifications most closely related to the model – those of Table 2 Panel B – the predicted signs of the coefficients (negative for *IS* and positive for *XD*) are in line with the point estimates in all five cases. However, the estimated effect of the Chinese supply shock on growth in wages is again statistically insignificant in most specifications in Panel B.

To better understand these results, we step outside our model to examine the sector-level movements underlying the estimates in Table 2. While the model assumes that there are no wage differences across sectors, in practice there may be frictions to the intersectoral movement of labour that put wedges between sector-specific average wages. Table 3 thus separately considers changes in the average wages of workers in the agricultural and extractive, manufacturing and nontraded sectors respectively, using long differences in the log average wages of workers in these sectors on the left-hand side. Table B4 displays the results of similar exercises in which the effects

Table 3
Results — log average hourly wages by sector.

	OLS	IV	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)
Panel A. Agricultural/extractive sectors					
IS (ζ_I)	−5.93	−6.25	−1.16	−6.69	−1.43
	(3.97)	(4.64)	(7.58)	(5.14)	(7.08)
XD (ζ_X)	4.41**	3.65*	5.62***	3.68*	5.42***
	(1.98)	(2.1)	(1.46)	(2.15)	(1.42)
1st stage (KP F-stat.)		226.3	89.7	12.8	27
Panel B. Manufacturing sectors					
IS (ζ_I)	−7.81***	−7.48***	−3.76***	−7.31***	−2.93***
	(1.17)	(1.16)	(1.07)	(1.26)	(1.08)
XD (ζ_X)	3.93***	3.58***	2.05***	3.46***	2.04***
	(.85)	(.84)	(.64)	(.91)	(.66)
1st stage (KP F-stat.)		226.3	89.7	60	29.2
Panel C. Nontraded sectors					
IS (ζ_I)	−2.07	−1.84	.59	−1.04	.6
	(3.01)	(2.96)	(1.35)	(3.1)	(1.44)
XD (ζ_X)	2.33***	1.6**	1.14*	1.39*	1.11*
	(.63)	(.74)	(.63)	(.73)	(.64)
1st stage (KP F-stat.)		226.3	89.7	84.3	66.9
State fixed effects			Y		Y
Lag dep. variable				Y	Y

This table displays estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in log average hourly wages, as captured by ζ_I and ζ_X from Eq. (4). Panel A presents results for agricultural and extractive sectors, Panel B for manufacturing sectors, and Panel C for nontraded sectors. Each column corresponds to a different regression with specification indicated. In the columns marked with IV, we *instrument* imports from (exports to) China using a measure based on growth in Chinese exports to (imports from) all countries, excluding Brazil, relative to a weighted cross-country average. The unit of observation is a microregion according to Reis et al. (2007); N = 412. Coefficients and standard errors are multiplied by 100, so that coefficients roughly represent percentage point changes. All regressions include a constant and the following *controls*: 2000 workforce, 2000 share of workforce in agricultural sectors, 2000 share of workforce in extractive sectors, 2000 share of workforce in manufacturing, 2000 share of workforce in informal jobs, 2000 share of workforce in rural areas, and a cubic polynomial of income per capita in 2000. Regressions in columns (3) and (5) include state fixed effects, and in columns (4) and (5) include the lag of the dependent variable for the periods 1980–1991 and 1991–2000, the latter instrumented with the 1991 level (Anderson and Hsiao, 1981). All regressions are weighted by share of national workforce. *Standard errors* are clustered by mesoregion, 91 clusters. *Sources:* 1980, 1991, 2000 and 2010 Brazilian Census, and CEPII BACI.
*** $p< .01$.
** $p< .05$.
* $p< .1$.

of composition are filtered out in the same way as in Panel B of Table 2.[25]

Table 3 suggests that the Chinese supply shock had a statistically significant effect on the sector most directly affected: manufacturing. Column (5) of Panel B implies that in microregions experiencing a US$1000 higher rise in imports per worker, manufacturing workers' average wages rose 2.93 percentage points more slowly. This result remains very similar after filtering out compositional effects; the corresponding estimate in column (5) of Table B4 is −3.44. The smaller, statistically insignificant aggregate estimates in Table 2 result from the facts that manufacturing workers are a relatively small share of total workers even in regions experiencing large import shocks (see Table 1) and that other sectors do not experience statistically significant movements in wages (Panels A and C of Tables 3 and B4).

Table 3 also shows that the wage effect of the Chinese demand shock is largest for workers in agricultural and extractive sectors, but is also positive and significant for workers in other industries, perhaps because of linkages between the sectors stimulated by Chinese demand and other local firms (see Bustos et al. (2015) for evidence

[25] In order to create the dependent variables in Table B4, the auxiliary regression discussed earlier is estimated separately for each sector and year.

of such linkages in the case of soybeans). However, the difference between these sector-level effects is eliminated once compositional effects are filtered out, as shown in Table B4. Both sets of results indicate broadly distributed wage gains from Chinese export demand in affected microregions, but they suggest that much of the wage growth in the agricultural and extractive industries in these areas may have been fuelled by changes in workforce composition.

We consider the robustness of the results of Table 2 in Table B3.[26] Column (1) of this table reproduces the results of our preferred specification for reference. Columns (2) and (3) display the estimated coefficients from regressions in which *IS* and *XD* are included one at a time rather than in a single specification. Column (4) shows the results of unweighted regressions, while column (5) employs instruments constructed in the same way as in Autor et al. (2013) instead of the instruments introduced in Section 4.2. Finally, in columns (6) and (7), we directly assess pre-sample period trends by using differences from 1991 to 2000 (column (6)) or 1980 to 2000 (column (7)), instead of differences from 2000 to 2010, as the dependent variable in our IV specification with state fixed effects.

Because the Chinese supply and demand shocks are uncorrelated across Brazilian microregions, as shown earlier (in Fig. 4), the regressions of columns (2) and (3) of Table B3 produce estimates of the coefficients on *IS* and *XD* that are little different from those of our preferred specification. While the unweighted regression in column (4) yields an estimate of the effect of *XD* on log average wages that remains positive but is somewhat smaller than that of our preferred specification, using the IV strategy of Autor et al. (2013) produces an estimate of somewhat larger magnitude (column (5)). As noted in our footnote at the end of Section 4.2, this may be because our instrument purges world price changes that are due to China as well as correlated world-level shocks, and in this sense our main estimates should be interpreted as conservative. Finally, columns (6) and (7) show no evidence of statistically significant pre-trends in wage growth; this is consistent with the fact that the introduction of two lags of the dependent variable in columns (4) and (5) of Table 2 has little effect on our results.

5.2. Additional results

Having examined the impact of *XD* and *IS* on wages as suggested by our theoretical model, we now attempt to further understand Brazil's response to these trade shocks by considering their effects on other outcomes. We first examine the possibility that the response of Brazilian local labour markets to Chinese supply and demand shocks may have occurred through changes in employment rates as well as wages. We thus step outside our model, which assumes full employment of factors, in order to consider the effect of trade with China on local employment rates. This effect is theoretically ambiguous: while intuition suggests that we might expect demand shocks to stimulate employment and supply shocks to raise unemployment, some labour market models without full employment (e.g. Pissarides, 2000) predict that shocks that ultimately affect productivity in the labour market should have only a temporary effect on (un)employment rates. When wages and unemployment benefits move together – as is the situation in Brazil, where these two variables are generally indexed to inflation – the effects of such shocks should be fully absorbed by wages.[27]

Table 4
Results — employment patterns.

	OLS	IV	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)
Panel A. Employment share					
IS (ζ_I)	.08	.19	.93**	−.09	.8*
	(.34)	(.36)	(.35)	(.38)	(.41)
XD (ζ_X)	.26	.27	.27*	.29	.37**
	(.19)	(.21)	(.16)	(.18)	(.17)
1st stage (KP F-stat.)		226.3	89.7	69.6	139.7
Panel B. Share of workers in nontraded sectors					
IS (ζ_I)	1.25**	1.34**	.74	.87	.6
	(.51)	(.54)	(1.26)	(.58)	(1.38)
XD (ζ_X)	−.19	.01	−.49**	.14	−.47**
	(.15)	(.14)	(.2)	(.15)	(.19)
1st stage (KP F-stat.)		226.3	89.7	232.8	297.6
Panel C. Share of workers in formal jobs					
IS (ζ_I)	.62	.66	.34	1.17*	.81
	(.56)	(.58)	(.93)	(.63)	(1.05)
XD (ζ_X)	.62***	.48*	.69***	.53**	.67***
	(.22)	(.24)	(.22)	(.22)	(.19)
1st stage (KP F-stat.)		226.3	89.7	94.8	162.3
State fixed effects			Y		Y
Lag dep. variable				Y	Y

This table displays estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in the share of the workforce employed in the private sector (Panel A), the share of private sector workers employed in nontraded sectors (Panel B) and the share of private sector workers employed in formal jobs (Panel C), as captured by ζ_I and ζ_X from Eq. (4). Each column corresponds to a different regression with specification indicated. In the columns marked with IV, we *instrument* imports from (exports to) China using a measure based on growth in Chinese exports to (imports from) all countries, excluding Brazil, relative to a weighted cross-country average. The unit of observation is a microregion according to Reis et al. (2007); N = 412. Coefficients and standard errors are multiplied by 100, so that coefficients represent percentage point changes. All regressions include a constant and the following *controls*: 2000 workforce, 2000 share of workforce in agricultural sectors, 2000 share of workforce in extractive sectors, 2000 share of workforce in manufacturing, 2000 share of workforce in informal jobs, 2000 share of workforce in rural areas, and a cubic polynomial of income per capita in 2000. Regressions in columns (3) and (5) include state fixed effects, and in columns (4) and (5) include the lag of the dependent variable for the periods 1980–1991 and 1991–2000, the latter instrumented with the 1991 level (Anderson and Hsiao, 1981). All regressions are weighted by share of national workforce. *Standard errors* are clustered by mesoregion, 91 clusters. *Sources:* 1980, 1991, 2000 and 2010 Brazilian Census, and CEPII BACI.
*** $p < .01$.
** $p < .05$.
* $p < .1$.

In Panel A of Table 4, we display the results of regressions whose dependent variable is the change in the microregion-level private sector employment rate between 2000 and 2010. These do not provide robust evidence of an effect of trade with China on employment rates. The estimated effect of the Chinese demand shock is positive and similar in magnitude in all five specifications, but it is statistically significant only in specifications with state fixed effects. When the effects of composition are filtered out using the same methodology as in Panel B of Table 2, the significance of the results in columns (3) and (5) disappears (see Panel A of Table B5). Meanwhile, neither the magnitude nor the sign of the estimated coefficient on *IS* is consistent across specifications, although the estimates with state fixed effects are statistically significant and (unexpectedly) positive.[28] According to the point estimates in column (5) of Table 4, a microregion at the 80th percentile of *XD* saw its employment rate rise by 0.22 percentage points relative to one at the 20th percentile, and similarly, the

[26] In our online appendix, we also display the results of running the robustness checks in Table B3 for all other specifications in Section 5.

[27] More precisely, in Pissarides (2000), unemployment rates will only be affected by (labour-augmenting) productivity shocks when unemployment benefits are fixed, a condition that can only hold in the very short run (particularly in Brazil, where benefits and wages are indexed to inflation). When unemployment benefits are proportional to wages, the impact of the productivity shock on the unemployment rate vanishes, and all of the adjustments occur through wages.

[28] One possible reason for these positive estimates is a backward-bending household labour supply curve: negative shocks to wages for manufacturing workers might bring family members of those workers into the labour force in order to supplement household income.

employment rate of a region at the 80th percentile of *IS* is estimated to have increased by 0.22 percentage points as compared to a region at the 20th percentile.

Another potential effect of the boom in Brazil–China trade is that there were changes in the composition of local employment across sectors. In particular, our model suggests that in response to trade shocks, local labour might be reallocated between the traded and nontraded sectors. In the regressions of Panel B of Table 4, the left-hand-side variable is the long difference between 2000 and 2010 in the share of employed individuals working in the nontraded sector. The point estimates in column (5) suggest that *XD* is associated with a shift in employment towards traded sectors, while *IS* is associated with a shift to the nontraded sector among employed individuals. However, neither result is robust – the estimated effect of *IS* is statistically insignificant in columns (3) to (5), while the coefficient on *XD* changes sign across columns.[29] The sign of the result for *IS* is in line with the findings of Menezes-Filho and Muendler (2011) and Dix-Carneiro and Kovak (2015b), both of which observe movement of workers from manufacturing into services after Brazil's early 1990s trade liberalization.

A further possible channel of adjustment to the 'China shocks' is a change in the prevalence of informality, which is widespread in the Brazilian economy: in 2000, more than half of private sector workers were working in the informal sector as defined in Section 3.1. Being part of the informal sector brings disadvantages for workers, since they are not granted unemployment insurance, paid medical leave, a retirement plan and other benefits. In this sense, formality may be seen as a nonwage benefit, and so trade shocks may affect the well-being of workers not only through their effects on wages, but also through their impact on job formalization.

Our theoretical framework does not allow for heterogeneity across firms within the same sector and microregion, but predictions for the effects of trade shocks on formalization are suggested by the substantial literature on heterogeneous firms and trade (e.g. Melitz, 2003). This predicts that rises in foreign demand will disproportionately benefit the most productive firms, who tend to be the exporters. If formal firms are systematically more productive than informal firms, we would expect the Chinese demand shock to lead to formalization in affected microregions. The likely effect of a rise in Chinese import competition is less clear, as such a shock might not only drive informal firms at the bottom of the productivity distribution out of the market, but may also cause some relatively unproductive formal firms to become informal.

In Panel C of Table 4, we examine the impacts of *IS* and *XD* on changes between 2000 and 2010 in the share of employed workers in formal jobs, while estimated effects net of changes in composition are displayed in Panel C of Table B5. All of the specifications in both tables show a positive and statistically significant association between the Chinese demand shock and job formalization during this period. The estimate in column (5) of Table 4 suggests that as compared to a microregion at the 20th percentile of *XD*, a microregion at the 80th percentile saw growth in the share of formal jobs that was 0.39 percentage points faster between 2000 and 2010. Meanwhile, although the estimated effect of *IS* is also positive in all specifications, it is generally statistically insignificant.

We next check whether there was a migration response within Brazil to the Chinese trade shocks. Our model rules out migration between regions, but a theory incorporating migration might predict that net migration to microregions affected by import competition would fall, while net migration to microregions stimulated by increased demand would rise. Such a pattern of movement would dampen the effects of *IS* and *XD* on local wages, and could also account for differences between our raw and net-of-composition results. In a study of the effects of Brazilian trade liberalization, Dix-Carneiro and Kovak (2015b) find that in-migration responds to this shock while out-migration does not. Kovak (2011) observes a migration response to the same shock using census data from 1991 and 2000.

In Table 5, we assess the effects of China on microregion-level net migration (Panel A), and break this down into effects on in-migration (Panel B) and out-migration (Panel C). The dependent variable in Panel B is the change between 2000 and 2010 in the share of newly arrived working-age individuals relative to the workforce five years earlier, while in Panel C, it is the difference from 2000 to 2010 in the share of individuals leaving the microregion relative to its workforce five years earlier. The change in net migration during this period is measured as the difference between these two variables.[30]

The results in Panel A do not show a robust impact of either *IS* or *XD* on net migration. The estimated effect of *IS* is negative, in line with the intuition described above, but this finding is significant at the 10% level only in column (5). Meanwhile, the estimated coefficient on *XD* switches sign across specifications and is never statistically significant. However, Panels B and C show that *IS* is associated with significant declines in both in-migration and out-migration rates. While the in-migration result is in line with intuition, the (smaller) negative estimated effect of *IS* on out-migration may be due to the relevance of outcomes in nearby microregions to the migration decision. In particular, the fact that high-*IS* microregions tend to occur within larger clusters of other high-*IS* microregions (see Fig. 5) suggests that a high *IS* may be associated not only with a rise in the potential gain from out-migration, but also an increase in the cost of the easiest out-migration option: moving to a neighbouring area.

Finally, in an online appendix, we analyse the impact of China on wage inequality within Brazilian local labour markets. The estimation of these effects is a more complex problem than for average wages, because it requires us to consider heterogeneous effects of trade with China across individuals within each microregion. We first present the results of an extension of the theoretical framework of Section 2 that allows for two types of workers (or jobs), skilled and unskilled. This model predicts that changes in the skill premium are linearly related to *IS* and *XD* under the assumption that skill intensity does not vary across industries. We then present regressions relating changes in the microregion-level skill premium to *IS* and *XD*, but acknowledge that these are now the appropriate measures of exposure to trade only under this strong simplifying assumption.[31] We find that *IS* is associated with an increase in local wage inequality in most of our specifications, but this result is not robust. Meanwhile, we do not find a strong effect of *XD* on wage inequality; this is consistent with the broad-based wage gains we document in Section 5.1.

[29] The results accounting for changes in composition are very similar (Panel B of Table B5).

[30] Table B6 presents alternative estimates of the effects of the 'China shocks' on in-migration and out-migration, using the methodology of Table 2 Panel B. For out-migration, each individual is assigned to the microregion in which they lived five years before the census, and the dependent variable of our auxiliary regressions is an indicator for whether the individual left that microregion in the subsequent five years. For in-migration, each individual is assigned to the microregion in which they lived at the time of the census, and the left-hand side of the auxiliary regressions is an indicator for having in-migrated in the previous five years. Because the denominator of the in-migration measure in Table 5 is the microregion's workforce five years before the census, the two sets of in-migration estimates are not strictly comparable. The results are nonetheless qualitatively similar to those in Table 5.

[31] If this assumption is relaxed, the expression relating the skill premium to changes in trade flows becomes much more complex, and it is difficult to derive an estimable empirical specification. An alternative model without this assumption is presented by Dix-Carneiro and Kovak (2015a), who extend the model of Kovak (2013) to include skilled and unskilled workers. They find that changes in the skill premium depend on different measures of exposure to trade than those that drive changes in average wages with homogeneous workers. However, their model requires trade shocks to be expressed in terms of shocks to prices; as noted in Section 2, this is not feasible in the context we study.

Table 5
Results — migration.

	OLS	IV	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)
Panel A. Net migration					
IS (ζ_I)	−.33	−.48	−.66	−.64	−.86*
	(.67)	(.74)	(.45)	(.83)	(.49)
XD (ζ_X)	.27	−.06	.16	−.04	.21
	(.22)	(.25)	(.27)	(.23)	(.26)
1st stage (KP F-stat.)		226.3	89.7	63.3	67.3
Panel B. In-migrated					
IS (ζ_I)	−1.34***	−1.51***	−1.24***	−1.51***	−1.35***
	(.48)	(.54)	(.39)	(.56)	(.41)
XD (ζ_X)	.23	−.07	.14	−.07	.18
	(.19)	(.21)	(.22)	(.2)	(.22)
1st stage (KP F-stat.)		226.3	89.7	151.3	63.1
Panel C. Out-migrated					
IS (ζ_I)	−1.02***	−1.03***	−.59***	−.66**	−.48**
	(.29)	(.3)	(.22)	(.28)	(.24)
XD (ζ_X)	−.04	−.01	−.02	−.01	−.02
	(.1)	(.1)	(.09)	(.1)	(.1)
1st stage (KP F-stat.)		226.3	89.7	291.8	60.9
State fixed effects			Y		Y
Lag dep. variable				Y	Y

This table displays estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in migration, as captured by ζ_I and ζ_X from Eq. (4). The dependent variable in Panel B is the change between 2000 and 2010 in the share of newly arrived working-age individuals relative to the workforce five years earlier. The dependent variable in Panel C is the difference from 2000 to 2010 in the share of individuals leaving the microregion relative to its workforce five years earlier. The dependent variable in Panel A is the difference between these two variables. Each column corresponds to a different regression with specification indicated. In the columns marked with IV, we *instrument* imports from (exports to) China using a measure based on growth in Chinese exports to (imports from) all countries, excluding Brazil, relative to a weighted cross-country average. The unit of observation is a microregion according to Reis et al. (2007); N = 412. Coefficients and standard errors are multiplied by 100, so that coefficients represent percentage point changes. All regressions include a constant and the following *controls*: 2000 workforce, 2000 share of workforce in agricultural sectors, 2000 share of workforce in extractive sectors, 2000 share of workforce in manufacturing, 2000 share of workforce in informal jobs, 2000 share of workforce in rural areas, and a cubic polynomial of income per capita in 2000. Regressions in columns (3) and (5) include state fixed effects, and in columns (4) and (5) include one lag of the dependent variable, instrumented with the 1991 level (Anderson and Hsiao, 1981). The lagged dependent variable is the change between 1991 and 2000 in the share of newly arrived individuals (Panel B), individuals leaving (Panel C) or the difference (Panel A) relative to the workforce five years earlier. Data on a second lag is unavailable due to the less detailed information on migration in the 1980 Brazilian Census. All regressions are weighted by share of national workforce. *Standard errors* are clustered by mesoregion, 91 clusters. *Sources:* 1991, 2000 and 2010 Brazilian Census, and CEPII BACI.

*** $p < .01$.
** $p < .05$.
* $p < .1$.

6. Conclusion

In this paper, we investigate the impact of China's ascent into one of the world's largest economies on local labour markets in Brazil. As in other developing countries, Brazil's imports from China are dominated by manufactures while most of the growth in its exports to China has been concentrated in agricultural and extractive sectors. This provides us with an opportunity to study the heterogeneous effects of a commodities-for-manufactures trade boom. In particular, we use data from the Brazilian demographic censes of 2000 and 2010 to provide empirical evidence of the effects on Brazilian microregions of shocks to both Chinese import supply and export demand. Using a shift-share methodology motivated by a theoretical framework, we compare trends in local labour markets with a similar initial employment structure (proportion of workers in agricultural, extractive and manufacturing sectors) but differently exposed to these two 'China shocks' due to specialization in different specific industries.

Our findings suggest that growth in commodities-for-manufactures trade spurred by the rise of China has created winners as well as losers across regions. In local labour markets experiencing larger growth in Chinese export demand, average hourly wages increased more quickly and the share of employed workers in formal jobs rose between 2000 and 2010. At the same time, local labour markets more affected by Chinese import competition experienced slower growth in manufacturing wages. We do not find robust evidence of an effect of either 'China shock' on local employment rates, suggesting that Brazilian local labour markets adjusted to these shocks via changes in wages rather than (un)employment.

This brings us back to one of the key motivating facts in our introduction: policymakers' apparent concern that export demand from China has been of insignificant benefit to Brazil compared to the harm from Chinese import competition. Our results appear to suggest a scenario in which industries producing commodities and manufactures are symmetric rather than systematically different. Indeed, we do not reject the prediction of our model – which assumes such a scenario – that a \$1000 per worker rise in Chinese imports and a \$1000 per worker increase in exports to China have effects on wage growth of opposite sign but equal magnitude. Of course, winner regions might be systematically smaller than loser regions or have lower initial wages. However, when we take weighted averages of our shock measures *IS* and *XD* across microregions using either total microregion workforce or total microregion income in 2000 as weights, we find that the implied 'aggregate average shocks' are of similar magnitude to one another: \$421 for *IS* and \$481 for *XD* if the shocks are weighted by workforce size, and \$515 for *IS* and \$461 for *XD* if they are weighted by income. This is in line with the fact that trade between China and Brazil was approximately in balance during this period.

Our results thus fail to bolster the argument that the losses in some Brazilian labour markets from Chinese manufacturing trade outweighed the gains to others from the concurrent boom in commodity exports. However, we cannot necessarily infer that the argument is false: given our identification strategy, our estimates do not inform us about the Brazil-wide effects of trade with China.[32] Moreover, there are many other possible reasons why policymakers might be concerned about increased specialization in commodity production; for example, these sectors are often perceived to have less stable demand conditions and smaller across-firm technology spillovers. It will therefore be important for researchers to revisit the boom in commodities-for-manufactures trade between China and other developing countries as its consequences continue to be felt over the coming years.

Appendix A. Theory appendix

In this appendix, we present our theoretical framework, which closely follows the model of Autor et al. (2013). Its goal is to derive predictions about the effect of the 'China shock' on outcomes in Brazilian local labour markets, focusing on nominal wages as the outcome variable of interest. The main features of the framework are:

1. There are many regions, indexed by i.
2. There is one type of labour that can be employed in the production of traded or nontraded goods but that cannot migrate between regions. Its supply in region i is L_i.

[32] Instead, they can be used only to make comparisons between microregions experiencing different shocks to Chinese imports or exports per worker.

3. The nontraded good is produced with diminishing marginal returns to the labour L_{Ni} employed in its production in region i:

$$X_{Ni} = L_{Ni}^{\eta}, \tag{5}$$

where X_{Ni} is the quantity of the nontraded good produced in region i and $\eta < 1$.
4. There are J monopolistically competitive sectors, indexed by j, in which firms produce traded goods. The labour required for production of a quantity x_{ij} of a given variety in sector j is:

$$l_{ij} = \alpha_{ij} + \beta_{ij}x_{ij}, \tag{6}$$

where the fixed cost α_{ij} and marginal cost β_{ij} are both denominated in terms of labour.
5. Producers incur an iceberg transport cost τ_{ijk} of delivering one unit of a good in sector j from region i to region k.
6. Consumers have a Cobb–Douglas utility function, with expenditure shares γ/J for each traded goods sector and $1-\gamma$ for the nontraded good. Consumers have a CES subutility function for each traded sector with elasticity of substitution $\sigma_j > 1$.
7. The 'China shock' is characterized as a set of sector-specific changes in Chinese labour productivity in traded sectors (β_{Cj}) and trade costs (τ_{Cjk}, τ_{ijC}), which are treated as exogenous to all other regions.

From the profit maximization condition for firms in the nontraded goods sector, we may derive an expression for the wage W_i in region i:

$$W_i = \eta P_{N_i} L_{N_i}^{\eta-1}, \tag{7}$$

where P_{Ni} is the price of the nontraded good in region i. Also, goods market clearing in the nontraded sector implies that:

$$P_{Ni}X_{Ni} = (1-\gamma)(W_iL_i + B_i), \tag{8}$$

where the term inside parentheses is total expenditure $E_i = W_iL_i + B_i$, so that B_i represents the difference between expenditure and income in region i.

Total shipments of a variety, x_{ij}, are given by the sum over the quantity x_{ijk} sent to each destination k:

$$x_{ij} = \sum_k x_{ijk} = \sum_k \tau_{ijk} \frac{P_{ijk}^{-\sigma_j}}{\Phi_{jk}^{(1-\sigma_j)}} \frac{\gamma}{J} E_k, \tag{9}$$

where $\Phi_{jk} = \left(\sum_h M_{hj} P_{hjk}^{(1-\sigma_j)}\right)^{1/(1-\sigma_j)}$ is the price index for traded goods of sector j in market k, and $P_{ijk} = \frac{\sigma_j}{\sigma_j - 1}\beta_{ij}W_i\tau_{ijk}$ is the price in region k of a variety produced in region i in sector j. A free-entry assumption implies that $x_{ij} = \alpha_{ij}(\sigma_j - 1)/\beta_{ij}$ for each of the M_{ij} firms producing in region i and sector j.

Labour market clearing implies that:

$$L_i = L_{Ni} + L_{Ti}. \tag{10}$$

To solve the model, we insert Eq. (5) into Eq. (8). We also substitute for x_{ij}, P_{ijk} and Φ_{jk} in Eq. (9). We can then use Eqs. (7), (8), (9) (for $j = 1,\ldots,J$) and (10) to solve for P_{Ni}, L_{Ni}, W_i and M_{ij} (for $j = 1,\ldots,J$).

After assembling the system of equations required to solve this version of the model with these assumptions and log differentiating it, we get:

$$\hat{W}_i = \hat{P}_{Ni} - (1-\eta)\hat{L}_{Ni}, \tag{11}$$

$$\hat{P}_{Ni} + \eta\hat{L}_{Ni} = \bar{\chi}_i\left(\hat{W}_i + \hat{L}_i\right) + (1-\bar{\chi}_i)\hat{B}_i, \tag{12}$$

$$\hat{L}_i = \frac{L_{Ni}}{L_i}\hat{L}_{Ni} + \sum_j \frac{L_{ij}}{L_i}\hat{M}_{ij}, \tag{13}$$

$$\begin{aligned}\sigma_j\hat{W}_i &= \sum_k \frac{x_{ijk}}{x_{ij}}\left[\hat{\mathrm{E}}_{kj} + (1-\sigma_j)\,\hat{\tau}_{ijk} + (\sigma_j - 1)\,\hat{\Phi}_{jk}\right] \\ &= \sum_k \theta_{ijk}\left[\hat{\mathrm{E}}_{kj} + (1-\sigma_j)\,\hat{\tau}_{ijk}\right] - \sum_k \theta_{ijk}\sum_h \phi_{hjk}\hat{\mathrm{A}}_{hjk}, \quad j = 1,\ldots,J,\end{aligned} \tag{14}$$

where $\bar{\chi}_i = W_iL_i/(W_iL_i + B_i)$, $\theta_{ijk} = x_{ijk}/x_{ij}$, $\hat{\mathrm{A}}_{hjk} = \hat{M}_{hj} - (\sigma_j - 1)\left[\hat{W}_h + \hat{\beta}_{hj} + \hat{\tau}_{hjk}\right]$ and $\hat{\mathrm{E}}_{kj} = \hat{\mathrm{E}}_k$. Here, $\phi_{hjk} = (M_{hj}P_{hjk}x_{hjk}/\tau_{hjk})/\sum_l(M_{lj}P_{ljk}x_{ljk}/\tau_{ljk})$ corresponds to the share of imports from region h in region k consumption of sector j goods.

Note that $\hat{\mathrm{E}}_k = \bar{\chi}_k\left(\hat{W}_k + \hat{L}_k\right) + (1-\bar{\chi}_k)\,\hat{B}_k$. From this point on, we assume that trade imbalances of regions do not change $\left(\hat{B}_k = 0\right)$, so that because workers do not move across regions $\left(\hat{L}_k = 0\right)$, we have that $\hat{\mathrm{E}}_k = \bar{\chi}_k\hat{W}_k$.

Rearranging Eq. (14), we can get:

$$\hat{M}_{ij} = \frac{1}{\bar{c}_{ij}}\left(\bar{a}_{ij}\hat{\Gamma}_{ij} - \hat{W}_i\right), \quad j = 1,\ldots,J, \tag{15}$$

where $\bar{a}_{ij} = \left[\sigma_j - (\sigma_j - 1)\sum_k\theta_{ijk}\phi_{ijk} - \theta_{iji}\bar{\chi}_i\right]^{-1}$, $\bar{c}_{ij} = \bar{a}_{ij}\sum_k\theta_{ijk}\phi_{ijk}$ and $\hat{\Gamma}_{ij} = \theta_{ijC}\left[\hat{\mathrm{E}}_{Cj} + (1-\sigma_j)(1-\phi_{ijC})\hat{\tau}_{ijC}\right] - \sum_k\theta_{ijk}\phi_{Cjk}\hat{\mathrm{A}}_{Cjk}$. To derive this equation, we assume that the only relevant terms $\hat{\mathrm{E}}_{kj}$ and $\hat{\mathrm{A}}_{hjk}$ for region i are those for which the source region is China $\left(\hat{\mathrm{E}}_{Cj} \text{ and } \hat{\mathrm{A}}_{Cjk}\right)$ and those for which the source region is i itself $\left(\hat{\mathrm{E}}_{ij} \text{ and } \hat{\mathrm{A}}_{ijk}\right)$.

Now, substituting for $\hat{M}_{ij}$ in Eq. (13) from Eq. (15), and using Eqs. (11), (12) and (13) to solve for the wage in region i we get:

$$\hat{W}_i = \frac{1}{1 - \bar{\chi}_i + \sum_j \frac{L_{ij}}{\bar{c}_{ij}L_{Ni}}}\sum_j \frac{L_{ij}}{L_{Ni}}\frac{\bar{a}_{ij}}{\bar{c}_{ij}}\hat{\Gamma}_{ij}. \tag{16}$$

A sufficient condition for the coefficient of $\hat{\Gamma}_{ij}$ to be positive in the equation above is that the region is not generating a current account surplus ($B_i \geq 0$) and that $\sum_k\theta_{ijk}\phi_{ijk} > \theta_{iji}\bar{\chi}_i$. The last condition implies that $\bar{a}_{ij} > 0$.

A.1. Relating wages to IS and XD

Autor et al. (2013) derive the *IS* measure in their paper. Here we will derive both the *IS* and *XD* measures considering changes in wages as our left-hand-side variable. To do so, we first define $\hat{Z}_{ijC} = \hat{\mathrm{E}}_{Cj} + (1-\sigma_j)(1-\phi_{ijC})\hat{\tau}_{ijC}$. Note that $\hat{Z}_{ijC}$ increases when expenditure on sector j in China increases ($\hat{\mathrm{E}}_{Cj} > 0$) or when the cost of exporting goods to China decreases ($\hat{\tau}_{ijC} < 0$). As Autor et al. do, we abstract from changes in import competition in the foreign markets served by Brazilian regions. Hence, Eq. (16) becomes:

$$\begin{aligned}\hat{W}_i &= \frac{1}{1-\bar{\chi}_i+\sum_j \frac{L_{ij}}{\bar{c}_{ij}L_{Ni}}}\sum_j \frac{L_{ij}}{L_{Ni}}\frac{\bar{a}_{ij}}{\bar{c}_{ij}}\left[\theta_{ijC}\hat{Z}_{ijC}-\sum_{b\in B}\theta_{ijb}\phi_{Cjb}\hat{A}_{Cjb}\right],\\ &= \frac{1}{1-\bar{\chi}_i+\sum_j \frac{L_{ij}}{\bar{c}_{ij}L_{Ni}}}\sum_j \frac{1}{\sum_k\theta_{ijk}\phi_{ijk}}\\ &\quad\times\left[\frac{L_{ij}}{L_{Ni}}\theta_{ijC}\hat{Z}_{ijC}-\frac{L_{ij}}{L_{Ni}}\sum_{b\in B}\theta_{ijb}\phi_{Cjb}\hat{A}_{Cjb}\right],\\ &= \frac{1}{1-\bar{\chi}_i+\sum_j \frac{L_{ij}}{\bar{c}_{ij}L_{Ni}}}\sum_j \frac{1}{\sum_k\theta_{ijk}\phi_{ijk}}\\ &\quad\times\left[\frac{L_{ij}}{L_{Ni}}\frac{X_{ijC}}{X_{ij}}\hat{Z}_{ijC}-\frac{L_{ij}}{L_{Ni}}\sum_{b\in B}\frac{X_{ijb}}{X_{ij}}\frac{V_{Cjb}}{E_{bj}}\hat{A}_{Cjb}\right],\\ &= \frac{1}{W_i\left(1-\bar{\chi}_i+\sum_j \frac{L_{ij}}{\bar{c}_{ij}L_{Ni}}\right)}\sum_j \frac{1}{\sum_k\theta_{ijk}\phi_{ijk}}\\ &\quad\times\left[\frac{P_{ijC}X_{ijC}}{\tau_{ijC}L_{Ni}}\hat{Z}_{ijC}-\frac{P_{ijB}X_{ijB}}{E_{Bj}}\frac{V_{CjB}}{L_{Ni}}\hat{A}_{Cji}\right].\end{aligned} \tag{17}$$

In the above derivation, we use the notation $\sum_{b\in B}$ to mean that we are summing across Brazilian regions, where B represents Brazil as a whole. Second, we define $X_{ij} = M_{ij}x_{ij}$ and $X_{ijk} = M_{ij}x_{ijk}$. Third, note that $\phi_{hjk} = (M_{hj}P_{hjk}x_{hjk}/\tau_{hjk})/\sum_l(M_{lj}P_{ljk}x_{ljk}/\tau_{ljk}) = V_{hjk}/E_{jk}$, where V_{hjk} represents the value of trade in sector j goods from region h to region k. Fourth, we assume that $\sum_{b\in B}\frac{X_{ijb}}{X_{ij}}\frac{V_{Cjb}}{E_{bj}}\hat{A}_{Cjb} \approx \frac{X_{ijB}}{X_{ij}}\frac{V_{CjB}}{E_{Bj}}\hat{A}_{Cji}$. This follows if all of these regions have the same utility function and trade costs between Brazilian regions are zero. In this case, $\frac{V_{Cjb}}{E_{bj}}\hat{A}_{Cjb}$ will be the same across regions and the result follows. Fifth, we use the assumption of no trade costs between Brazilian regions to posit a single Brazil-wide price P_{ijB} of goods produced in region i and sector j. Sixth, we use the fact that $P_{ijk}X_{ij} = \tau_{ijk}W_iL_{ij}$.

We next impose that $\frac{P_{ijB}X_{ijB}}{E_{Bj}} \approx \frac{L_{ij}}{L_{Bj}}$, i.e. the share of region i's consumption in total Brazilian consumption in sector j can be approximated by its share in the Brazilian labour force in this sector. Additionally to Autor et al., we will further assume that $\frac{P_{ijC}X_{ijC}}{\tau_{ijC}} \approx \frac{L_{ij}}{L_{Bj}}\frac{P_{BjC}X_{BjC}}{\tau_{BjC}}$, i.e. the value of shipments from region i to China in sector j equals the total value of Brazilian shipments in sector j to China multiplied by region i's share of the Brazilian workers employed in this sector. Noting that $V_{BjC} = \frac{P_{BjC}X_{BjC}}{\tau_{BjC}}$, we get:

$$\hat{W}_i = \zeta_i\left[\sum_j \frac{L_{ij}}{L_{Bj}}\frac{V_{BjC}}{L_{Ni}}\hat{Z}_{ijC}-\sum_j \frac{L_{ij}}{L_{Bj}}\frac{V_{CjB}}{L_{Ni}}\hat{A}_{Cji}\right], \tag{18}$$

where $\zeta_i = (1/W_i)\left[1/\left(1-\bar{\chi}_i+\sum_j\frac{L_{ij}}{\bar{c}_{ij}L_{Ni}}\right)\sum_k\theta_{ijk}\phi_{ijk}\right]$, i.e. we impose that the general equilibrium scaling factor $\sum_k\theta_{ijk}\phi_{ijk}$ is constant across sectors. Renormalizing the denominator (using total labour force in region i instead of the labour force in the nontraded sector), the first term inside the brackets of Eq. (18) corresponds to our *XD* measure, while the second corresponds to *IS*.

Appendix B. Appendix figures and tables

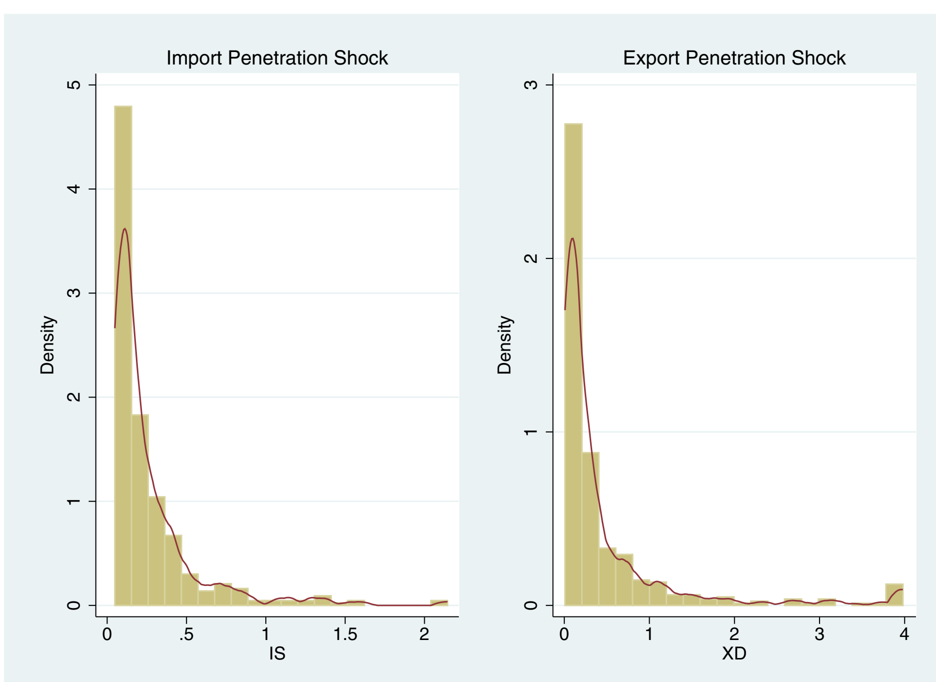

Fig. B1. Distributions of import supply and export demand measures. This graph presents the histogram of microregion-level import supply and export demand shocks (IS_m and XD_m), in thousands of US dollars per worker. N = 412.
Sources: 2000 Brazilian Census, and CEPII BACI.

Table B1
Value of trade with China for Brazil and non-high-income countries — 2000–2010.

	Trade with China		Trade with rest of world	
	Imports from China	Exports to China	Imports from rest of world	Exports to rest of world
	(1)	(2)	(3)	(4)
Panel A. Non-high-income countries				
Value in 2000	31.18	24.99	955.33	1480.45
Value in 2010	337.15	219.54	2602.33	3960.74
Growth 2000–2010	981.30 %	778.51 %	172.4 %	167.54 %
Panel B. Brazil				
Value in 2000	1.61	1.44	69.87	69.78
Value in 2010	26.45	30.87	155.92	173.77
Growth 2000–2010	1542.86 %	2043.75 %	123.16 %	149.03 %

Panel A displays the imports from and exports to China and the rest of the world of non-high-income countries (excluding those in East and Southeast Asia) in 2000 and 2010. Panel B presents the imports from and exports to China and the rest of the world of Brazil in 2000 and 2010. All values in millions of 2010 US dollars, deflated using the US GDP deflator from the Bureau of Economic Analysis. *Sources:* CEPII BACI for trade data; definition of high-income countries from the World Bank.

Table B2
List of sectors and additional summary statistics (Part 1).

	Import share	Export share	Import supply from China		Export demand to China	
			Mean	IV	Mean	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Agriculture: rice	–	–	–	–	–	–
Agriculture: maize	–	.000	–	–	.000	–
Agriculture: other cereals	.000	–	.000	.000	–	–
Agriculture: cotton	.000	.005	.000	.000	.013	–
Agriculture: sugar cane	–	–	–	–	–	–
Agriculture: tobacco	.000	.010	.000	.000	.022	.015
Agriculture: soya	–	.229	–	–	.555	.259
Agriculture: manioc	–	–	–	–	–	–
Agriculture: flowers and ornamentals	.000	.000	.000	.000	.000	–
Agriculture: citrus fruits	–	.000	–	–	.000	.000
Agriculture: coffee	–	.000	–	–	.000	.000
Agriculture: cocoa	–	–	–	–	–	–
Agriculture: grapes	–	–	–	–	–	–
Agriculture: bananas	–	–	–	–	–	–
Agriculture: other	.007	.000	.006	.000	.000	.000
Agriculture: bovine animals	–	–	–	–	–	–
Agriculture: sheep	–	–	–	–	–	–
Agriculture: pigs	–	–	–	–	–	–
Agriculture: birds	–	–	–	–	–	–
Agriculture: beekeeping	.000	.000	.000	–	.000	.000
Agriculture: silk	.000	–	.000	–	–	–
Agriculture: other animals	.000	.000	.000	.000	.000	–
Forestry	.000	.000	.000	.000	.000	.000
Fishing and aquaculture	–	.000	–	–	.000	.000
Mining: coal	−.001	.000	−.002	−.018	.000	–
Mining: oil and gas	–	.137	–	–	.219	.015
Mining: radioactive metals	–	–	–	–	–	–
Mining: precious metals	–	–	–	–	–	–
Mining: other metals	.000	.453	.000	−.001	.917	.649
Mining: nonmetals for construction	.000	.001	.000	.000	.001	.002
Mining: precious stones	.000	.000	.000	.000	.001	.001
Mining: other nonmetals	.000	.000	.001	.000	.000	.001
Manuf: meat and fish	.004	.008	.002	.000	.005	.001
Manuf: fruits and vegetables	.002	.003	.002	.000	.003	.000
Manuf: oils and fats	.000	.026	.000	.000	.045	.015
Manuf: dairy products	.000	.000	.000	–	.000	.000
Manuf: sugar	.000	.018	.000	.000	.019	–
Manuf: coffee	.000	.000	.000	–	.000	.000
Manuf: other food	.003	.000	.001	.000	.000	.000
Manuf: beverages	.000	.000	.000	.000	.000	.000
Manuf: tobacco	.000	–	.000	.000	–	–

This table displays the share of each sector in the total growth of Brazil's imports and exports to China between 2000 and 2010 in columns (1) and (2), the means across microregions of the sector-microregion-level variables used to calculate IS_m and XD_m in columns (3) and (5), and the means across microregions of the sector-microregion-level variables used to calculate $ivIS_m$ and $ivXD_m$ in columns (4) and (6). Continued on next page.

Table B2
List of sectors and additional summary statistics (Part 2).

	Import share	Export share	Import supply from China		Export demand to China	
			Mean	IV	Mean	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Manuf: spinning and weaving	.026	.000	.009	.000	.000	.000
Manuf: other textile products	.029	.000	.014	.001	.000	.000
Manuf: apparel	.025	.000	.008	.001	.000	.000
Manuf: leather processing	.000	.011	.000	.000	.014	.000
Manuf: leather products	.001	.000	.000	.000	.000	.000
Manuf: footwear	.003	.000	.001	.001	.000	.000
Manuf: wood products	.001	.001	.001	.000	.001	.002
Manuf: pulp and paper	.003	.039	.003	.000	.041	.002
Manuf: paper products	.001	.000	.000	.000	.000	.000
Manuf: printing and recording	.003	.000	.001	.000	.000	.000
Manuf: coke	.003	–	.040	−.119	–	–
Manuf: refined petroleum	.002	.000	.001	.000	.000	.000
Manuf: nuclear fuel	–	–	–	–	–	–
Manuf: paints and varnishes	.000	.000	.000	.000	.000	.000
Manuf: pharmaceuticals	.018	.001	.004	.002	.000	.000
Manuf: cleaning and hygiene products	.001	.001	.000	.000	.000	.000
Manuf: other chemicals	.065	.008	.026	.014	.004	.003
Manuf: rubber products	.014	.000	.004	.001	.000	.000
Manuf: plastic products	.025	.000	.007	.001	.000	.000
Manuf: glass products	.006	.000	.002	.001	.000	.000
Manuf: ceramic products	.009	.000	.006	.000	.000	.000
Manuf: other nonmetallic mineral products	.003	.000	.001	.000	.000	.000
Manuf: basic metals	.064	.026	.027	.002	.013	.003
Manuf: metal products	.029	.002	.007	.001	.000	.000
Manuf: machinery	.133	.005	.038	.010	.002	.002
Manuf: domestic appliances	.019	.000	.009	.001	.000	.000
Manuf: computing	.073	.000	.033	.017	.000	.000
Manuf: electrical equipment	.080	.001	.023	.005	.000	.000
Manuf: electronics	.192	.001	.065	.024	.000	.001
Manuf: medical instruments	.006	.000	.002	.000	.000	.000
Manuf: measuring instruments	.008	.000	.004	.001	.000	.000
Manuf: optical equipment	.061	.000	.030	.006	.000	.002
Manuf: watches and clocks	.002	.000	.002	.000	.000	.000
Manuf: motor vehicles	.009	.000	.002	.000	.000	.001
Manuf: motor vehicle bodies and parts	.011	.002	.003	.000	.001	.001
Manuf: shipbuilding	.018	–	.016	.000	–	–
Manuf: railway products	.000	.000	.000	.000	.000	–
Manuf: aircraft	.000	.011	.000	–	.012	.005
Manuf: other transport	.009	.000	.007	.001	.000	–
Manuf: furniture	.005	.000	.002	.000	.000	.000
Manuf: other	.026	.001	.008	.001	.000	.000

This table displays the share of each sector in the total growth of Brazil's imports and exports to China between 2000 and 2010 in columns (1) and (2), the means across microregions of the sector-microregion-level variables used to calculate IS_m and XD_m in columns (3) and (5), and the means across microregions of the sector-microregion-level variables used to calculate $ivIS_m$ and $ivXD_m$ in columns (4) and (6). Continued from previous page.

Table B3
Main results — robustness tests.

	Preferred specification	IS only	XD only	Unweighted regressions	ADH (2013) instrument	Pre-trends	
						1991–2000	1980–2000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Log average hourly wages							
IS (ζ_I)	.28	−.03		.93	−.16	−.37	2.43
	(1.15)	(1.1)		(1.18)	(1.12)	(9.17)	(2.42)
XD (ζ_X)	1.58**		1.58**	1.06	3.23***	−.35	−.53
	(.66)		(.67)	(.72)	(.9)	(2.38)	(1.2)
1st stage (KP F-stat.)	83.2	119.6	436.8	78	7.1	89.7	90.1
$H_0 : \zeta_I + \zeta_X = 0$ (p-value)	.164			.162	.028	.936	.498
Panel B. Log average hourly wages (net of composition)							
IS (ζ_I)	−1.07	−1.34		1.06	−1.5	−3.14	−2.29
	(1.7)	(1.7)		(2.37)	(1.63)	(4.21)	(2.11)
XD (ζ_X)	1.28		1.28	.7	2.68**	−.2	−1.14
	(.78)		(.77)	(.55)	(1.27)	(.7)	(1.07)
1st stage (KP F-stat.)	38.3	57.5	63.6	56.4	4.3	100.8	82.8
$H_0 : \zeta_I + \zeta_X = 0$ (p-value)	.913			.476	.535	.417	.175

(continued on next page)

Table B3 (*continued*)

	Preferred specification	IS only	XD only	Unweighted regressions	ADH (2013) instrument	Pre-trends	
						1991–2000	1980–2000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
IV	Y	Y	Y	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y	Y	Y	Y
Lag controls	Y	Y	Y	Y	Y		

This table displays estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in raw log average hourly wages (Panel A) and composition-adjusted log average hourly wages (Panel B), as captured by ζ_I and ζ_X from Eq. (4). In order to filter out compositional effects in Panel B, we first estimate auxiliary regressions as described in Section 5.1. Each column corresponds to a different regression with specification indicated. All regressions are estimated using instrumental variables. In column (5), we *instrument* imports from (exports to) China using the growth in total Chinese exports to (imports from) all countries, excluding Brazil, as in Autor et al. (2013). In all other columns we *instrument* imports from (exports to) China using a measure based on growth in Chinese exports to (imports from) all countries, excluding Brazil, relative to a weighted cross-country average. Regressions in column (4) are not weighted, while other regressions are weighted by share of national workforce in 2000 (Panel A) or according to Haisken-DeNew and Schmidt (1997) (Panel B). Column (1) presents our preferred specification, column (2) excludes *XD* from this specification and column (3) excludes *IS* from this specification. Columns (6) and (7) investigate pre-trends by using 1991 to 2000 and 1980 to 2000 long differences as dependent variables, respectively. The unit of observation is a microregion according to Reis et al. (2007); N = 412. Coefficients and standard errors are multiplied by 100, so that coefficients roughly represent percentage point changes. All regressions include a constant and the following *controls*: 2000 workforce, 2000 share of workforce in agricultural sectors, 2000 share of workforce in extractive sectors, 2000 share of workforce in manufacturing, 2000 share of workforce in informal jobs, 2000 share of workforce in rural areas, a cubic polynomial of income per capita in 2000, and state fixed effects. Specifications in columns (1) to (5) include the lag of the dependent variable for the periods 1980–1991 and 1991–2000, the latter instrumented with the 1991 level (Anderson and Hsiao, 1981). *Standard errors* are clustered by mesoregion, 91 clusters. *Sources:* 1980, 1991, 2000 and 2010 Brazilian Census, and CEPII BACI.

*** $p < .01$.
** $p < .05$.
* $p < .1$.

Table B4
Results — log average hourly wages by sector (net of composition).

	OLS	IV	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)
Panel A. Agricultural/extractive sectors					
IS (ζ_I)	−7.09***	−6.73***	−.3	−4.2*	−.68
	(1.72)	(1.78)	(2.52)	(2.29)	(2.31)
XD (ζ_X)	2.5**	1.68	1.16	1.44	1.12
	(1.05)	(1.13)	(.7)	(1.21)	(.73)
1st stage (KP F-stat.)		234.8	230.5	29.8	59.7
Panel B. Manufacturing sectors					
IS (ζ_I)	−6.09***	−6.28***	−4.52***	−2.94	−3.44**
	(2.14)	(2.34)	(1.62)	(2.77)	(1.55)
XD (ζ_X)	1.89*	1.49	.78	1.24	1.2
	(1.01)	(1.11)	(.83)	(1.09)	(.92)
1st stage (KP F-stat.)		209	110.4	36.2	21.3
Panel C. Nontraded sectors					
IS (ζ_I)	−3.65	−3.41	−.92	.21	−.2
	(2.46)	(2.33)	(1.55)	(3.26)	(1.84)
XD (ζ_X)	2.53***	2.19**	.7	2**	1.04
	(.84)	(.91)	(.66)	(1)	(.72)
1st stage (KP F-stat.)		144.6	61.2	38.9	29.8
State fixed effects			Y		Y
Lag dep. variable				Y	Y

This table displays estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in composition-adjusted log average hourly wages, as captured by ζ_I and ζ_X from Eq. (4). Panel A presents results for agricultural and extractive sectors, Panel B for manufacturing sectors, and Panel C for nontraded sectors. In order to filter out compositional effects, we first estimate auxiliary regressions as described in Section 5.1. Each column corresponds to a different regression with specification indicated. In the columns marked with IV, we *instrument* imports from (exports to) China using a measure based on growth in Chinese exports to (imports from) all countries, excluding Brazil, relative to a weighted cross-country average. The unit of observation is a microregion according to Reis et al. (2007); N = 412. Coefficients and standard errors are multiplied by 100, so that coefficients roughly represent percentage point changes. All regressions include a constant and the following *controls*: 2000 workforce, 2000 share of workforce in agricultural sectors, 2000 share of workforce in extractive sectors, 2000 share of workforce in manufacturing, 2000 share of workforce in informal jobs, 2000 share of workforce in rural areas, and a cubic polynomial of income per capita in 2000. Regressions in columns (3) and (5) include state fixed effects, and in columns (4) and (5) include the lag of the dependent variable for the periods 1980–1991 and 1991–2000, the latter instrumented with the 1991 level (Anderson and Hsiao, 1981). All regressions are weighted according to Haisken-DeNew and Schmidt (1997). *Standard errors* are clustered by mesoregion, 91 clusters. *Sources:* 1980, 1991, 2000 and 2010 Brazilian Census, and CEPII BACI.

*** $p < .01$.
** $p < .05$.
* $p < .1$.

Table B5
Results — employment patterns (net of composition).

	OLS	IV	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)
Panel A. Employment share					
IS (ζ_I)	.16	.26	.86**	−.11	.75*
	(.41)	(.42)	(.4)	(.38)	(.44)
XD (ζ_X)	.22	.24	.16	.27	.22
	(.18)	(.2)	(.14)	(.18)	(.15)
1st stage (KP F-stat.)		218.8	103.8	51.8	115.3
Panel B. Share of workers in nontraded sectors					
IS (ζ_I)	1.02*	1.01*	.85	.88	1.06
	(.56)	(.6)	(1.1)	(.68)	(1.2)
XD (ζ_X)	−.07	.11	−.39**	.2	−.35*
	(.17)	(.15)	(.18)	(.16)	(.19)
1st stage (KP F-stat.)		152.8	62.3	162.9	170.9
Panel C. Share of workers in formal jobs					
IS (ζ_I)	.26	.33	.71	.84	1.42
	(.55)	(.55)	(.94)	(.56)	(1.04)
XD (ζ_X)	.69***	.55**	.72***	.56**	.71***
	(.21)	(.23)	(.19)	(.22)	(.17)
1st stage (KP F-stat.)		217	113.6	131	159
State fixed effects			Y		Y
Lag dep. variable				Y	Y

This table displays estimated effects, net of composition, of Chinese import and export shocks on changes between 2000 and 2010 in the share of the workforce employed in the private sector (Panel A), the share of private sector workers employed in non-traded sectors (Panel B) and the share of private sector workers employed in formal jobs (Panel C), as captured by ζ_I and ζ_X from Eq. (4). In order to filter out compositional effects, we first estimate auxiliary regressions as described in Section 5.1. Each column corresponds to a different regression with specification indicated. In the columns marked with IV, we *instrument* imports from (exports to) China using a measure based on growth in Chinese exports to (imports from) all countries, excluding Brazil, relative to a weighted cross-country average. The unit of observation is a microregion according to Reis et al. (2007); N = 412. Coefficients and standard errors are multiplied by 100, so that coefficients represent percentage point changes. All regressions include a constant and the following *controls*: 2000 workforce, 2000 share of workforce in agricultural sectors, 2000 share of workforce in extractive sectors, 2000 share of workforce in manufacturing, 2000 share of workforce in informal jobs, 2000 share of workforce in rural areas, and a cubic polynomial of income per capita in 2000. Regressions in columns (3) and (5) include state fixed effects, and in columns (4) and (5) include the lag of the dependent variable for the periods 1980–1991 and 1991–2000, the latter instrumented with the 1991 level (Anderson and Hsiao, 1981). All regressions are weighted according to Haisken-DeNew and Schmidt (1997). *Standard errors* are clustered by mesoregion, 91 clusters. *Sources:* 1980, 1991, 2000 and 2010 Brazilian Census, and CEPII BACI.

*** $p < .01$.
** $p < .05$.
* $p < .1$.

Table B6
Results — migration (net of composition).

	OLS	IV	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)
Panel A. In-migrated					
IS (ζ_I)	−1.09***	−1.2***	−.76**	−1.16***	−.83**
	(.29)	(.32)	(.32)	(.37)	(.36)
XD (ζ_X)	.1	-.05	.12	−.05	.14
	(.13)	(.13)	(.16)	(.13)	(.14)
1st stage (KP F-stat.)		254.4	119.4	66.4	80.3
Panel B. Out-migrated					
IS (ζ_I)	−1.01***	−.99***	−.8**	−.54**	−.44
	(.25)	(.25)	(.32)	(.22)	(.35)
XD (ζ_X)	.25**	.36***	−.03	.2***	−.04
	(.12)	(.12)	(.11)	(.07)	(.1)
1st stage (KP F-stat.)		244.3	153.1	16.6	10.3
State fixed effects			Y		Y
Lag dep. variable				Y	Y

This table displays estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in migration, as captured by ζ_I and ζ_X from Eq. (4). The dependent variable in Panel A is the change between 2000 and 2010 in the share of newly arrived working-age individuals relative to the workforce in that year. The dependent variable in Panel B is the difference from 2000 to 2010 in the share of individuals leaving the microregion relative to its workforce five years earlier. In order to filter out compositional effects, we first estimate auxiliary regressions as described in Section 5.1. Each column corresponds to a different regression with specification indicated. In the columns marked with IV, we *instrument* imports from (exports to) China using a measure based on growth in Chinese exports to (imports from) all countries, excluding Brazil, relative to a weighted cross-country average. The unit of observation is a microregion according to Reis et al. (2007); N = 412. Coefficients and standard errors are multiplied by 100, so that coefficients represent percentage point changes. All regressions include a constant and the following *controls*: 2000 workforce, 2000 share of workforce in agricultural sectors, 2000 share of workforce in extractive sectors, 2000 share of workforce in manufacturing, 2000 share of workforce in informal jobs, 2000 share of workforce in rural areas, and a cubic polynomial of income per capita in 2000. Regressions in columns (3) and (5) include state fixed effects, and in columns (4) and (5) include one lag of the dependent variable, instrumented with the 1991 level (Anderson and Hsiao, 1981). Data on a second lag is unavailable due to the less detailed information on migration in the 1980 Brazilian Census. All regressions are weighted according to Haisken-DeNew and Schmidt (1997). *Standard errors* are clustered by mesoregion, 91 clusters. *Sources:* 1991, 2000 and 2010 Brazilian Census, and CEPII BACI.
*** p< .01.
** p< .05.
* p< .1.

Appendix C. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jinteco.2016.04.005.

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