Labor Market Adjustments to Trade with China: The Case of Brazil

Peter Brummund* Laura Connolly†

University of Alabama

July 26, 2018

Abstract

Many countries continue to integrate into the world economy, increasing their reliance on international trade. Increased trade often creates large gains dispersed across the economy and losses focused on some sectors and workers. The negative impacts of trade can be mitigated if workers can easily adjust to the changing landscape. In this paper, we analyze the impact of both increased imports from China and exports to China on labor market adjustments in Brazil. We use administrative panel data for the formal labor market in Brazil for 2004 to 2013, and find that workers employed in microregions more exposed to increased exports are: (1) less likely to transition from the traded sector to nonemployment, and (2) more likely to transition from nonemployment to the formal sector, particularly the nontraded and manufacturing sectors. Workers employed in regions more exposed to increased imports are more likely to transition from the manufacturing sector to nonemployment. In contrast to previous findings, our results show that microregions exposed to increased exports see an increase in migration whereas microregions exposed to increased imports see a decrease.

JEL classifications: F16, J61, J63

Keywords: International Trade, Brazilian Labor Market, Mobility.

*Peter Brummund, University of Alabama. email: pbrummund@cba.ua.edu.

†Laura Connolly, University of Alabama. email: leconnolly@crimson.ua.edu.

1 Introduction

Countries around the world have increasingly opened their borders to international trade. Emerging countries in particular have integrated into the world economy in hopes of creating more sustainable economic growth. For example, Brazil liberalized their trade policies in the early 1990's as a means for stimulating economic growth. Critics of trade argue that increased openness harms domestic production and domestic workers. Former President of Brazil Dilma Rousseff, in response to trade openness concerns, introduced a series of defensive trade policies during her first year in office in 2011. Rousseff intended for the restrictive trade policies to boost domestic production and innovation as well as curb fears of deindustrialization in Brazil. While trade critics typically focus on the negative effects of increased imports, they often ignore the potential benefits from increased exports.

In this paper, we explore both aspects of Brazil's trade relationship with China and their effects on migration and labor reallocation in Brazil. More specifically, we analyze the impact of increased imports from China and increased exports to China on labor reallocation across industries and geographic regions in Brazil. We link administrative panel data for the formal labor market in Brazil for the years 2004 to 2013 with UN Comtrade data for Brazil, China, and other countries. Following the instrumental variable approach of Autor, Dorn, and Hanson (2013), we instrument for Brazil's trade with China using other countries' trade with China to eliminate endogeneity concerns common in the trade and labor literature. We focus on the impact of the China trade shock on: (1) migration across microregions in Brazil, (2) labor reallocation from the formal sector to nonemployment within microregions, and (3) labor reallocation from nonemployment to the formal sector within microregions.

This paper makes two primary contributions to the literature. First, we make use of Brazil's unique trade relationship with China to simultaneously analyze the effects of an import shock and an export shock on the labor market. The previous literature has primarily focused on the effects of import shocks on labor markets, whether through trade liberalization episodes (Dix-Carneiro & Kovak, 2017; Menezes-Filho & Muendler, 2011), or through the

impact of increased imports from China on the United States labor market (Autor et al., 2013). Second, we use linked employer-employee data to track workers as they change microregions or sectors. Previous work on Brazil has leveraged both sides of the trade shock, but focused on changes in wages and employment (Costa, Garred, & Pessoa, 2016). We extend this working by analyzing the movements of workers across sectors and microregions using linked employer-employee data.

We find that increased trade with China has impacted the migration patterns of formal sector workers in Brazil. Microregions more exposed to increased exports to China have higher migration rates. We find the opposite result for imports; microregions more exposed to imports from China have lower migration rates. Our results suggest that trade with China has a relatively large effect considering the average microregion has 4% of its workers migrating to a different microregion for employment. A microregion at the 75th percentile of Chinese export exposure experienced migration rates 1.25 percentage points higher in comparison to a microregion at the 25th percentile. A similar comparison for imports shows that a microregion at the 75th percentile for imports had migration rates 0.5 percentage points lower than a microregion at the 25th percentile. These results suggest the pull factors influence internal migration more so than the push factors. These results augment the findings of Dix-Carneiro and Kovak (2017) and Costa, Garred, and Pessoa (2016). Dix-Carneiro and Kovak find that Brazil's trade liberalization episode did not significantly impact migration, whereas Costa, Garred, and Pessoa see only negative impacts of imports on migration.

Our analysis of sectoral reallocations finds that export exposure reduces the movement of workers from the traded sector to nonemployment and increases the movement of workers from nonemployment to the nontraded sector. These movements are primarily driven by the manufacturing sector. We also find that microregions more exposed to imports showed more reallocation from manufacturing to nonemployment, and less movement from the traded sector to the nontraded sector.

These results are important to help policy makers understand the potential negative effects of increased international trade. If the labor market is dynamic, and able to quickly adjust to the changes in demand, the losses from trade exposure can be more distributed across the society, and less born by individual groups of workers (Autor, 2018). One of the important findings from the work analyzing the impact of the China trade shock on the US is that the US labor market was not as dynamic and flexible as previously thought(Autor et al., 2013). Therefore the costs of trade exposure were born more intensely by small groups of workers. Our results suggest that the Brazilian labor market is more flexible than the US labor market, and is also responding more dynamically to the China trade shock than it did to the trade liberalization episode of the 1990's.

This paper will proceed as follows. Section II gives a brief overview of the literature and Section III details the methodology used for the analysis. Section IV describes the data and presents summary statistics. Section V discusses the main results. Last, Section VI offers concluding remarks.

2 Literature Review

2.1 Labor Reallocation in Brazil

Dix-Carneiro and Kovak (2017) analyze labor market reallocation in Brazil in the aftermath of Brazil's trade liberalization in the early 1990's.[1] The authors use both administrative panel data for the formal labor market and Demographic Census data to study worker reallocation from 1991 to 2010 between the formal sector, the informal sector, and nonemployment. Dix-Carneiro and Kovak's findings indicate that workers employed in regions more exposed to reduced tariffs are more likely to transition to employment in the nontraded sector, nonemployment in the medium run, or the informal sector in the long

[1]See Dix-Carneiro and Kovak (2017) or Dix-Carneiro and Kovak (in press) for details of Brazil's trade liberalization.

run. However, they find no significant effects of trade liberalization on regional migration in Brazil. Menezes-Filho and Muendler (2011) also study labor reallocation in Brazil in response to Brazil's trade liberalization. The authors find that large tariff declines associated with Brazil's trade liberalization trigger worker displacements. Similar to Dix-Carneiro and Kovak, Menezes-Filho and Muendler find that trade liberalization causes workers to reallocate to unemployment, service sectors, or out of the labor force entirely. The aim of this paper is to further investigate the role of trade in labor market reallocation in Brazil. However, rather than Brazil's trade liberalization, we use the China trade shock which includes both import and export shocks.

2.2 Labor Market Responses to Trade with China

The unique supply-driven growth of China has been felt by countries around the world.[2] The country has increased their share of worldwide production, particularly in manufacturing products, leading other countries' to increasingly rely on Chinese imports.[3] China's economic rise and subsequent impact on labor market outcomes in other countries has become an increasingly popular branch of the trade and labor literature. This area of research, made popular by Autor et al. (2013), largely focuses on the impact of increased imports from China on manufacturing labor market outcomes in other countries. The literature to date generally agrees that China's rise and dominance in certain trade markets, deemed the "China trade shock," harms workers employed in import competing industries in other countries (see Autor et al. (2013) for the U.S., Costa et al. (2016) for Brazil, Mion and Zhu (2013) for Belgium, and Iacovone, Rauch, and Winters (2013) for Mexico).

The negative impacts of increased imports from China have further fueled trade critics' claims against trade openness policies and trade with China specifically. Brazilian manufacturers pointed to China's extremely cheap labor costs, low labor standards, and high

[2]China's internal economic changes and accession to the World Trade Organization (WTO) in 2001 triggered a massive increase in the country's presence in international markets.

[3]Erten and Leight (2017) calculate that China's share of worldwide manufacturing exports increased from 3% to 17% from 1996 to 2013.

presence of state-owned enterprises (SOEs) in their argument against Brazil's reliance on imports from China (Menendez, 2014). As previously mentioned, former President of Brazil Dilma Rousseff implemented several defensive trade policies in 2011 in response to criticism against free trade policies. Rousseff intended for the restrictive trade policies to boost domestic production and innovation as well as curb fears of deindustrialization in Brazil. Businesses and some policymakers supported the defensive trade policies and believed Brazil should focus on increasing its competitiveness by focusing on "...value-added and the technology component of export[s]" (Doctor, 2012, p. 806), rather than commodity exports. The fear of deindustrialization in Brazil is merely one example of the increasing sentiment among developing countries that are reliant on commodity exports. Further, China has increased its dependence on commodity exports from other countries in response to continued economic growth.[4]

A smaller branch of the literature analyzes the effect of both increased imports from China and increased exports to China. In response to China's economic growth, countries not only rapidly increased their imports from China, but, developing countries in particular, also took advantage of the expanding export market in China. For example, Brazil increased both the value of their imports from China and their exports to China during the 2000's. Costa et al. (2016) analyze the effect of both the supply side of increased imports from China and the demand side of increased exports to China on local labor market outcomes in Brazil from 2000 to 2010. The authors find that microregions more exposed to increased exports to China experienced higher wage growth, but microregions more exposed to increased imports from China experienced lower wage growth.[5] In this paper, we build upon Costa et al.'s work by studying the impact of trade with China on labor market reallocation and migration rather

[4]Commodity exports often inflate a country's currency, decreasing the competitiveness of manufacturing and agriculture products. This eventually leads to increasing imports, decreasing exports, and balance-of-payment problems, all of which are associated with poor economic performance (Gallagher, 2010).

[5]A microregion is commonly used to define a local labor market in Brazil and is similar to a commuting zone in the United States. Other papers in the literature that define a local labor market in Brazil using a microregion include: Dix-Carneiro and Kovak (in press), Dix-Carneiro and Kovak (2017), Kovak (2013), and Gaddis and Pieters (2017).

than labor market outcomes such as employment and wages. We also use administrative panel data, rather than demographic census data, that allows us to follow individual workers over time, which is key for accurately capturing labor market dynamics.

3 Methodology

The method we use in this paper is closely related to Autor et al.'s (2013) instrumental variable approach. Autor et al. analyze the effect of increased imports from China on U.S. local labor market outcomes and instrument for U.S. imports from China using other countries' imports from China. Therefore, the basic idea is to instrument for Brazil's trade with China (imports and exports) using other countries trade with China. The underlying assumption behind the instrumental variable approach is that China's unprecedented economic growth is due to changing internal conditions in China. Therefore, China's dominance in certain trade markets and rising trade values should be common across countries. There are two key trade variables of interest for the analysis. The first, the change in Chinese import exposure per worker in Brazil b for microregion i in year t is defined as follows:

$$\Delta IPW_{bit} = \sum_{j} \frac{L_{ijt}}{L_{bjt}} \frac{\Delta M_{bcjt}}{L_{it}}, \tag{1}$$

where L_{ijt} is employment in microregion i in industry j in year t, L_{bjt} is national employment in industry j in year t in Brazil (b), and L_{it} is total employment in microregion i in year t. ΔM_{bcijt} is the change in imports from China (c) to Brazil (b) in industry j in year t.[6] The change in Chinese import exposure per worker measure is the sum of Brazil's imports from China across all industries, weighted by the initial industry and microregion employment shares. Therefore, the variation in the change in Chinese import exposure variable comes directly from different employment levels across microregions, i, and industries, j, in Brazil.

However, the change in import exposure per worker in Brazil measure is likely endogenous

[6]Equation (1) is analogous to Equation (3) in Autor et al. (2013).

to labor market outcomes in Brazil. For example, labor in Brazil could have reallocated due to supply or demand shocks that we cannot observe in the data. It is therefore necessary to use an instrumental variable, following Autor et al. (2013), as previously described. The instrumental variable, the change in Chinese import exposure in other countries per worker, is calculated as follows:

$$\Delta IPW_{oit} = \sum_{j} \frac{L_{ijt-1}}{L_{bjt-1}} \frac{\Delta M_{ocjt}}{L_{it-1}}, \tag{2}$$

where L_{ijt-1} measures the employment in microregion i in industry j from the start of the previous period *t-1*, L_{bjt-1} is national employment in industry j in Brazil (b) from the start of the previous period *t-1*, and L_{it-1} is total employment in microregion i from the start of the previous period *t-1*.[7] ΔM_{ocjt} measures the change in imports from China (c) to other countries (o) in industry j in year t.[8] The instrumental variable uses lagged employment levels to account for the possibility that employment changes in Brazil occurred in response to anticipated increased imports from China.

So far, the key trade variable of interest and the instrumental variable are directly from Autor et al. (2013). We now extend the methodology to account for Brazil's exports to China. The second trade variable of interest for Brazil, the change in exports to China from Brazil per worker for microregion i in year t is calculated as follows:

$$\Delta EPW_{bit} = \sum_{j} \frac{L_{ijt}}{L_{bjt}} \frac{\Delta E_{bcjt}}{L_{it}}, \tag{3}$$

where L_{ijt}, L_{bjt}, and L_{it} are previously defined in equation (1) and ΔE_{bcijt} is the change in exports to China (c) from Brazil (b) in industry j in year t. Again, the variation in the export exposure measure stems directly from different industry j and microregion i employment structures in Brazil.

[7] Equation (2) matches equation (4) in Autor et al. (2013).

[8] Import IV countries include: Argentina, Chile, Colombia, Indonesia, Peru, South Africa, Thailand, and Uruguay.

However, endogeneity issues are also likely to effect the export exposure variable. Therefore, we extend the instrumental variable in equation (2) to also account for exports to China. The second instrumental variable, the change in Chinese export exposure per worker in other countries, is calculated as follows:

$$\Delta EPW_{oit} = \sum_j \frac{L_{ijt-1}}{L_{bjt-1}} \frac{\Delta E_{ocjt}}{L_{it-1}}, \tag{4}$$

where L_{ijt-1}, L_{bjt-1}, and L_{it-1} are previously defined in equation (2). ΔE_{ocjt} measures the change in exports to China c from other countries o in industry j in year t.[9] The instrumental variable again uses lagged employment levels to account for possible simultaneity bias.

For all analysis, we use a two-stage least squares model to determine the impact of Brazil's trade with China on migration and labor reallocation in Brazil, instrumenting for all of Brazil's trade with China exposure variables using other countries' trade with China. The general 2SLS method is outlined below.

$$log(Y_{it}) = \alpha_0 + \beta_0 \widehat{\Delta IPW}_{bit} + \gamma_0 \widehat{\Delta EPW}_{bit} + \lambda_0 \mathbf{X}_t + \epsilon_t, \tag{5}$$

where the first stage models are estimated as follows:

$$\Delta IPW_{bit} = \alpha_1 + \beta_1 \Delta IPW_{oit} + \gamma_1 \Delta EPW_{oit} + \lambda_1 \mathbf{X}_{it} + \epsilon_{it}, \tag{6}$$

$$\Delta EPW_{bit} = \alpha_2 + \beta_2 \Delta IPW_{oit} + \gamma_2 \Delta EPW_{oit} + \lambda_2 \mathbf{X}_{it} + \epsilon_{it}. \tag{7}$$

Y_{it} represents various reallocation variables that measure micoregion i labor reallocation rates or flows from year t to year *t+1*, $\mathbf{X}_{it}$ is a vector of microregion-specific start of period controls. ΔIPW_{bit}, ΔEPW_{bit}, ΔIPW_{oit}, and ΔEPW_{oit} are previously defined in equations (3.1), (3.2), (3.3), and (3.4), respectively. All regressions are weighted by the microregion share of national employment at the start of the period, t, and standard errors are clustered

[9]Export IV countries include: Chile, Colombia, Mexico, Peru, South Africa, Thailand, Uruguay, and Venezuela.

at the state level. First stage regressions also include all microregion-specific start of period controls included in the second stage.

The main variables of interest in the analysis are migration and various forms of industry reallocation within Brazilian microregions from year t to year *t+1*. The labor market reallocation variables are calculated as the number (or percentage) of workers in a microregion who changed their industry (or microregion) of employment from year t to *t+1*. Therefore, we initially calculate labor market reallocation at the worker level from year t to *t+1* and then aggregate this measure up to the microregion level. For example, one variable of interest in the analysis is the number of workers within a microregion that transitioned from nonemployment in 2008, year t, to employment in the traded sector in 2013, year *t+1*. For this specific worker-level transition, we define $nonemp\_to\_trade_{wit}$ for each worker w in microregion i form year t to year *t+1* as follows:

$$nonemp\_to\_trade_{wit} = \begin{cases} 1 & \text{if nonemployed in } t\text{-}1 \text{ \& employed in traded sector in } t \\ 0, & \text{otherwise} \end{cases}.$$

We then calculate the number of workers within a microregion that reallocated from nonemployment in 2008, year t, to employment in the traded sector in 2013, year *t+1*. We define $micro\_nonemp\_to\_trade_{it}$ for each microregion i in year t as follows:

$$micro\_nonemp\_to\_trade_{it} = \sum_{w \in i} nonemp\_to\_trade_{wit},$$

In the analysis, we focus on labor market reallocation measures from the formal sector to nonemployment or from nonemployment to the formal sector. Due to the nature of our data, nonemployment includes unemployment, employment in the informal sector, and those no longer in the labor market. However, we can only observe nonemployment for workers who are in the data at some point during our sample. For each transition, we follow the

Table 1: List of Labor Reallocation Flows, 2008-2013

Labor Reallocation Flows	Employment (2008)	Employment (2013)
Traded to Nontraded Sector	Traded	Nontraded
Traded Sector to Nonemployment	Traded	Nonemp
Nonemployment to Traded Sector	Nonemp	Traded
Nonemployment to Nontraded Sector	Nonemp	Nontraded
Nonemployment to Manufacturing	Nonemp	Manf
Nonemployment to Agriculture	Nonemp	Agric
Nonemployment to Mining	Nonemp	Mining
Manufacturing to Nonemployment	Manf	Nonemp
Agriculture to Nonemployment	Agric	Nonemp
Mining to Nonemployment	Mining	Nonemp

methodology outlined above. First, we calculate the transition at the worker-level using a dummy variable equal to one if the worker w transitioned from A to B from year t to $t+1$ and equal to zero otherwise. Then, we calculate the number of workers within a microregion i that reallocated from option A in year t to option B in year $t+1$.

4 Data

The data for this project comes from two sources: (1) labor market data for Brazil, and (2) trade data for Brazil, China, and other countries. We use an administrative panel data set for the formal labor market in Brazil, the *Relação Anual de Informações Sociais* (RAIS), for the years 2004 through 2013. The RAIS data set is a matched employer-employee data set collected annually by the Brazilian Ministry of Labor (MTE). An observation in the RAIS data set is defined at the worker level using a worker identification number, which is linked to an establishment identification number and detailed worker and establishment information. The RAIS data has several advantages for this project. First, the linked nature of the data allows us to accurately track individual workers across time. Second, the RAIS also contains detailed worker characteristics and some establishment characteristics, such as

industry, geographic region, occupation, age, hire date, and education, among others.

The unit of analysis is a microregion, our definition of a local labor market in Brazil. We first use the detailed worker-level data to track workers across time, creating a series of dummy variables to track various labor reallocation flows. Then, we aggregate the worker-level data to calculate the percentage of workers within a microregion who migrated or switched their industry of employment. This provides us with microregion-level migration and labor reallocation variables that accurately capture worker movements within and across Brazil over time. Data analysis focuses on the year 2013, tracking movements from 2008 to 2013, and the instrumental variables use lagged employment levels from 2004.

The trade data comes from the UN Comtrade database which keeps trade data for over 150 countries. Since countries often care more about what comes into a country rather than what leaves a country, import data is considered more accurate than export data. Therefore, we use only import data to ensure consistency of the trade data. For example, for Brazil's exports to China, we use data on China's imports from Brazil. We use UN Comtrade data for the years 2008 to 2013, all of which is reported at the 6-digit product level using the Harmonized Tariff System (HS).

However, in order to link the UN Comtrade data to the RAIS data, it is necessary to aggregate the product-level trade data up to industry-level trade data. We follow the standard approach in the literature and map each 6-digit product code to a 4-digit industry code (ISIC; International Standard Industrial Classification System).[10] The RAIS data follows Brazil's National Classification of Economic Activities (CNAE) to classify each workers industry of employment. Therefore, it is also necessary to map each ISIC industry to one CNAE industry to link the two data sets. The Brazilian Institute of Geography and Statistics (IGBE) provides concordances for these two industry classification systems. However, when necessary, we aggregated industries to ensure a one to one match.[11]

[10]We use concordances from the World Bank's Integrated Trade Solutions to map 6-digit HS product codes to 4-digit ISIC industry codes. Concordances are available at http://wits.worldbank.org/product_concordance.html.

[11]The final industry concordances for CNAE to ISIC are available upon request.

Table 2: Summary Statistics: Worker-Level Reallocation, 2008-2013

Type of Reallocation	**mean**	**sd**
Changed Microregion from 2008 to 2013	0.040	0.20
Changed Industry from 2008 to 2013	0.163	0.37
Employed (2008) to Nonemployed (2013)	0.447	0.46
Traded Industry (2008) to Nonemployed (2013)	0.449	0.50
Nontraded Industry (2008) to Nonemployed (2013)	0.446	0.50
Nonemployed (2008) to Employed (2013)	0.345	0.48
Nonemployed (2008) to Traded Industry (2013)	0.409	0.49
Nonemployed (2008) to Manufacturing (2013)	0.186	0.39
Nonemployed (2008) to Mining (2013)	0.005	0.07
Nonemployed (2008) to Agriculture (2013)	0.029	0.17
Nonemployed (2008) to Nontraded Industry (2013)	0.591	0.49
Nontraded (2008) to Traded Industry (2013)	0.113	0.32
Traded (2008) to Nontraded Industry (2013)	0.149	0.36
Traded (2008) to Nonemployment (2013)		
Manufacturing (2008) to Nonemployed (2013)	0.432	0.50
Mining (2008) to Nonemployed (2013)	0.256	0.44
Agriculture (2008) to Nonemployed (2013)	0.501	0.50

The summary statistics for worker-level migration and industry reallocation from 2008 to 2013 are presented in Table 2. The table shows that approximately 4% of all workers employed in the formal sector in 2008 migrated to a different microregion for employment in 2013. In the same five year span, 2008-2013, approximately 16% of all workers employed in the formal sector changed their industry of employment. The remaining summary statistics for different types of worker reallocation from 2008 to 2013 are interpreted as the percentage of all workers in the base category in 2008 that switched to the second category in 2013. For example, "Employed (2008) to Nonemployed (2013)" indicates that 44.7% of all workers employed in the formal sector in 2008 transitioned to nonemployment in 2013; "Manufacturing (2008) to Nonemployed (2013)" indicates that 43.2% of all manufacturing workers in 2008 transitioned to nonemployment in 2013. Due to the structure of the RAIS data, we

Table 3: Summary Statistics: Change in Chinese Import and Export Exposure Measures, 2008-2013

	(1) p25	(2) p50	(3) p75	(4) mean	(5) sd
Δ Imports from China to Brazil per worker (ΔIPW_{bit})	85.04	183.86	357.74	269.50	424.27
Δ Imports from China to other countries per worker (ΔIPW_{oit})	389.09	788.39	1,433.27	1,192.63	1,639.44
Δ Exports to China from Brazil per worker (ΔEPW_{bit})	110.28	381.66	1,366.81	1,349.09	3,465.42
Δ Exports to China from other countries per worker (ΔEPW_{oit})	382.23	973.71	2,073.88	2,999.81	8,154.03

Notes: Calculated using UN Comtrade data for the years 2008 and 2013 and RAIS data for the years 2004-2013. p# indicates the #th percentile. Import IV countries include: Argentina, Chile, Colombia, Indonesia, Peru, South Africa, Thailand, and Uruguay. Export IV countries include: Chile, Colombia, Mexico, Peru, South Africa, Thailand, Uruguay, and Venezuela.

can observe when a worker leaves the formal sector and enters nonemployment. However, we cannot distinguish between different options of nonemployment: unemployed, out of the labor force, or informal employment.

When we focus on the subpopulation of workers who were nonemployed in 2008 and transitioned to employment in the formal sector in 2013, nearly 41% transitioned to employment in the traded sector while 59% transitioned to employment in the nontraded sector. Table 2 also reveals that labor market reallocation at the worker-level is relatively high in Brazil.

Table 3 shows the summary statistics for the two trade exposure variables and the two instrumental variables, the change in Chinese import (export) exposure per worker in Brazil and the change in Chinese import (export) exposure per worker in other countries. Table 3 indicates that the average change in imports from China to Brazil per worker from 2008 to 2013 was approximately \$270. The average change in exports to China from Brazil per worker for the same time period was approximately \$1,350. Further, the table also highlights the variation in exposure to trade with China based on a worker's microregion of employment.

For example, a microregion at the 75th percentile of import exposure experienced nearly a $360 increase in imports from China while a microregion at the 25th percentile only experienced an $85 increase. The pattern is similar, but even larger in magnitude for exports. A microregion at the 75th percentile of export exposure experienced a $1,350 increase in exports while a microregion at the 25th percentile only experienced a $110 increase in exports.

The two instrumental variables, the trade exposure variables using trade data from other countries, also have similar variation. While the instrumental variables are larger in magnitude, this is due to the fact that the instrumental variables include trade values aggregated across eight countries while the trade variables for Brazil only include trade values for Brazil. The variation in trade exposure for imports from China and exports to China across Brazilian microregions further highlights the identification strategy. The analysis will compare microregions more exposed to trade with China to those less exposed to trade with China. Therefore, the results can be interpreted as a local treatment effect.

5 Results

Before presenting the results for the main analysis, it is necessary to first confirm the validity of the instrumental variables. The results for the first stage results are presented in Table 4. The coefficient of 0.18 in column (1) is positive and significant at the one percent level. This indicates that the change in Chinese imports per worker in other countries predicts the change in Chinese imports per worker in Brazil. Similarly, the coefficient of 0.185 in column (2) is also positive and significant, which shows that the change in Chinese exports per worker in other countries predicts the change in Chinese exports in Brazil. The first stage regressions also include control variables for microregion characteristics from the start of the period that are included in the second stage regressions. Control variables are listed in the note in Table 4. The F-statistic is also sufficiently large and significant at the one percent level for both instrumental variables.

Table 4: First Stage Results, 2008-2013

	ΔIPW_{bit}	ΔEPW_{bit}
	(1)	(2)
Δ Imports from China to other countries per worker	0.180***	-0.012
	(0.020)	(0.045)
Δ Exports to China from other countries per worker	0.000	0.185**
	(0.003)	(0.089)
N	557	557
R^2	0.697	0.412

Notes: Change in import and export exposure variables are calculated as the change from 2008 to 2013. All models include a constant, region controls, controls for the initial microregion percent employment high school educated, foreign born, in routine jobs, in traded sectors, and initial average offshorability index. Standard errors in parentheses are clustered at the state level and models are weighted by 2008 microregion employment shares. * p<0.10, ** p<0.05, *** p<0.01

Table 5 presents the results for migration across microregions in Brazil. In addition to the control variables presented in Table 5, the analysis also includes region controls and a constant. The two key variables of interest are the change in Chinese import exposure per worker in Brazil and the change in Chinese export exposure per worker in Brazil (both of which have been instrumented for using the two IVs previously defined). The coefficient of -0.002 associated with imports indicates that an increase in Chinese import exposure decreases the percentage of workers who migrate into a region. This negative relationship is also statistically significant at the ten percent level. For a microregion with average exposure to the change in Chinese imports, this corresponds to a decline in migration of approximately 0.5 percentage points. An alternative way to interpret this result is to compare a microregion at the 75th percentile of import exposure to a microregion at the 25th percentile. A microregion at the 75th percentile of Chinese import exposure experienced a migration rate 0.5 percentage points lower than a microregion at the 25th percentile.

The coefficient of 0.001 in the second row indicates that the change in Chinese export exposure per worker in Brazil is positively related to migration. The effect is also highly significant at the one percent level. For the average microregion, this translates to an increase

Table 5: Migration Across Microregions and Trade with China, 2008-2013

	(1) Migration
Δ Imports from China to Brazil per worker	-0.002* (0.001)
Δ Exports to China from Brazil per worker	0.001*** (0.000)
Percent Employment Traded Sectors$_{-1}$	0.099* (0.060)
Percent Employment Female$_{-1}$	-0.332*** (0.067)
Percent Employment High School Educated$_{-1}$	-0.034 (0.031)
Percent Employment Foreign Born$_{-1}$	4.272 (3.395)
Percent Employment Routine Jobs$_{-1}$	-0.005 (0.100)
Average Offshore Index$_{-1}$	-1.178 (2.023)
Region	Yes
N	558
R^2	0.3335

Notes: Microregion migration is calculated using the RAIS data for 2008 and 2013. An indicator variable is used to determine whether a worker migrated to a different microregion from 2008 to 2013. Then, Microregion migration is calculated as the percent of all workers who migrated to that microregion. All models also include a constant. Standard errors in parentheses are clustered at the state level. First stage estimates are similar to those in Table 1 and therefore are not included. * p<0.10, ** p<0.05, *** p<0.01

in the migration rate of 1.35 percentage points in response to increased exports to China. When we compare a microregion at the 75th percentile of Chinese export exposure to one at the 25th percentile, this translates to a higher migration rate of 1.25 percentage points. Given that only 4 percent of workers migrated to a different microregion for employment

from 2008 to 2013, these increases are relatively large and economically significant. Table 5 also shows that only the initial microregion percent of employment in traded sectors and the initial microregion percent of female employment significantly affect migration rates. Microregions with a higher percentage of workers in the traded sector have higher migration rates while microregions with a higher percentage of female workers have lower migration rates. Overall, Table 5 indicates that microregions more exposed to imports from China attract fewer new employees while microregions more exposed to exports to China attract more new employees. These migration results sharply contrast with those of Dix-Carneiro and Kovak (2017), who found that Brazil's trade liberalization did not affect migration in Brazil.

Next, we transition from migration to industry reallocation within Brazilian microregions in response to increased trade with China. Table 6 presents the results for the analysis of industry reallocation from the traded sector to the nontraded sector, column (1), or nonemployment, column (2). In addition to the control variables listed in the table, the regressions also include a constant and region controls. The results in column (1) show that microregions more exposed to imports from China have a lower percentage of workers who reallocate from the traded sector to the nontraded sector. The coefficient of -0.002 indicates that a microregion at the 75th percentile of Chinese import exposure experienced worker reallocation rates from the traded to the nontraded sector approximately 0.5 percentage points lower than a microregion at the 25th percentile.

The results in column (2) indicate that Chinese export exposure has a negative and significant relationship with reallocation rates from the traded sector to nonemployment. The coefficient of -0.0002 indicates that microregions at the 75th percentile of Chinese export exposure experienced reallocation rates from the traded sector to nonemployment approximately 0.25 percentage points lower than a microregion at the 25th percentile of export exposure. For both columns, the initial percent of microregion employment in traded sectors continues to be positive and significant, while the percent of microregion employment that

Table 6: Industry Reallocation from the Traded Sector and Trade with China, 2008-2013

	(1) Traded to Nontraded Sector	(2) Traded Sector to Nonemployment
Δ Imports from China to Brazil per worker	-0.002*	-0.001
	(0.001)	(0.001)
Δ Exports to China from Brazil per worker	-0.0001	-0.0002*
	(0.0003)	(0.0001)
Percent Employment Traded Sectors$_{-1}$	0.445***	0.939***
	(0.064)	(0.017)
Percent Employment Female$_{-1}$	-0.089	0.067
	(0.096)	(0.064)
Percent Employment High School Educated$_{-1}$	-0.157***	-0.063***
	(0.057)	(0.023)
Percent Employment Foreign Born$_{-1}$	0.964	-0.287
	(6.777)	(1.785)
Percent Employment Routine Jobs$_{-1}$	0.005	-0.015
	(0.120)	(0.051)
Average Offshore Index$_{-1}$	-5.760	-0.717
	(3.675)	(1.415)
Region	Yes	Yes
N	558	558
R^2	0.6983	0.9750

Notes: Microregion level industry reallocation is calculated using the RAIS data for 2008 and 2013. An indicator variable is used to determine whether a worker was initially employed in the traded sector (2008) and transitioned to employment in the nontraded sector or nonemployment in 2013. Microregion reallocation is calculated as the percent of all workers who transitioned from the traded sector to the nontraded sector or nonemployment. All models also include a constant. Standard errors in parentheses are clustered at the state level. First stage estimates are similar to those in Table 1 and therefore are not included. * p<0.10, ** p<0.05, *** p<0.01

is high school educated is negative and significant. This indicates that microregions with a higher percentage of workers with a high school diploma have a smaller percentage of workers reallocate from the traded to the nontraded sector or nonemployment.

Table 7: Labor Reallocation from Nonemployment to the Formal Sector and Trade with China, 2008-2013

	(1) Nonemployment to Traded Sector	(2) Nonemployment to Nontraded Sector
Δ Imports from China to Brazil per Worker	-0.001	-0.000
	(0.002)	(0.002)
Δ Exports to China from Brazil per worker	0.001	0.002*
	(0.001)	(0.001)
Percent Employment Traded Sectors$_{-1}$	-1.033***	-0.559***
	(0.127)	(0.158)
Percent Employment Female$_{-1}$	0.486**	-0.088
	(0.191)	(0.295)
Percent Employment High School Educated$_{-1}$	-0.572***	-0.921***
	(0.159)	(0.206)
Percent Employment Foreign Born$_{-1}$	-21.648	-13.056
	(15.271)	(19.491)
Percent Employment Routine Jobs$_{-1}$	0.123	0.398
	(0.286)	(0.368)
Average Offshore Index$_{-1}$	5.194	4.656
	(6.878)	(8.132)
Region	Yes	Yes
N	558	558
R^2	0.6487	0.6049

Notes: Microregion level industry reallocation is calculated using the RAIS data for 2008 and 2013. An indicator variable is used to determine whether a worker was initially nonemployed (2008) and transitioned to employment in the formal sector (traded or nontraded sector) in 2013. Microregion reallocation is calculated as the percent of all workers who transitioned from the nonemployment to the formal sector. All models also include a constant. Standard errors in parentheses are clustered at the state level. First stage estimates are similar to those in Table 1 and therefore are not included. * p<0.10, ** p<0.05, *** p<0.01

Table 7 presents the results for the relationship between worker reallocation from nonemployment to employment in the formal sector and trade with China. We anticipate that

imports from China will reduce reallocation into the formal sector while exports to China will increase reallocation into the formal sector. The results for reallocation into the traded sector are presented in column (1) and the results for reallocation into the nontraded sector are presented in column (2). Beginning with column (1), we see that there is not a significant relationship between either imports from China or exports to China and reallocation into the traded sector. However, the results in column (2) indicate that imports from China have an insignificant effect, but exports to China have a positive and significant effect on reallocation into the nontraded sector. This indicates that microregions more exposed to exports to China have a higher percentage of workers reallocate from nonemployment to employment in the nontraded sector. The results do not exactly match up with our predictions; however, we do see a positive and significant effect of exports on worker's transition out of nonemployment into the nontraded sector.

Thus far, the analytical results for migration and labor reallocation generally support our hypothesis that imports from China will be associated with negative labor flows for workers while exports to China will be associated with positive labor flows for workers. Microregions more exposed to increased imports from China have lower migration rates than workers less exposed to imports from China. In contrast, microregions more exposed to increased exports to China have higher migration rates than workers less exposed to exports. Therefore, higher export exposure is attracting new workers. Turning to labor reallocation, microregions with higher exposure to exports to China also have lower rates for reallocation out of the formal sector, particularly the traded sector, into nonemployment. We also see that higher exports are increasing the labor reallocation rate out of nonemployment and into the formal sector, specifically the nontraded sector.

We now further break the analysis down by tracking labor reallocation out of nonemployment into three specific traded sectors, manufacturing, agriculture, and mining. We focus on these specific sectors due to the trade relationship between Brazil and China. Approximately 99% of imports from China are in the manufacturing sector, while approximately

Table 8: Labor Reallocation from Nonemployment to the Manufacturing, Agriculture, or Mining Sector and Trade with China, 2008-2013

	(1) Nonemployment to Manufacturing	(2) Nonemployment to Agriculture	(3) Nonemployment to Mining
Δ Imports from China to Brazil per Worker	0.003	-0.015**	0.017
	(0.003)	(0.007)	(0.011)
Δ Exports to China from Brazil per worker	0.003*	-0.001	-0.007
	(0.002)	(0.001)	(0.005)
Percent Employment Traded Sectors$_{-1}$	-0.879***	-0.647***	0.264
	(0.087)	(0.233)	(0.900)
Percent Employment Female$_{-1}$	0.780***	0.878	-1.514
	(0.238)	(0.616)	(0.935)
Percent Employment High School Educated$_{-1}$	-0.890***	-0.472	-1.604*
	(0.147)	(0.307)	(0.862)
Percent Employment Foreign Born$_{-1}$	-16.867	46.602	141.208*
	(15.473)	(36.411)	(83.808)
Percent Employment Routine Jobs$_{-1}$	0.057	-0.378	-1.736**
	(0.280)	(0.389)	(0.874)
Average Offshore Index$_{-1}$	1.430	-12.881	-44.321
	(9.257)	(22.858)	(37.303)
Region	Yes	Yes	Yes
N	555	551	477
R^2	0.5229	0.1554	0.1198

Notes: Microregion level industry reallocation is calculated using the RAIS data for 2008 and 2013. An indicator variable is used to determine whether a worker was initially nonemployed (2008) and transitioned to employment in the formal sector (manufacturing, agricultural, or mining sector) in 2013. Microregion reallocation is calculated as the percent of all workers who transitioned from the nonemployment to each particular sector. All models also include a constant. Standard errors in parentheses are clustered at the state level. First stage estimates are similar to those in Table 1 and therefore are not included. * p<0.10, ** p<0.05, *** p<0.01

40% of exports are in mining, 40% of exports are in agriculture, and about 15% of exports are in manufacturing. We anticipate that imports will increase the rate of reallocation into nonemployment while exports will decrease the rate of reallocation into nonemployment.

Table 8 presents the results for the impact of trade with China on labor reallocation from nonemployment to the manufacturing, agriculture, or mining sector in columns (1), (2), and (3), respectively.[12] The results in column (1) show that imports do not affect labor reallocation from nonemployment into the manufacturing sector, but exports have a positive, significant effect on reallocation from nonemployment to employment in the manufacturing sector. A microregion at the 75th percentile of export exposure experienced a labor reallocation rate from nonemployment to the manufacturing sector approximately 3.75 percentage points higher than a microregion at the 25th percentile. The results in column (2) indicate that imports have the predicted effect on reallocation out of nonemployment into the agriculture sector. A microregion at the 75th percentile of import exposure experienced labor reallocation into the agricultural sector from nonemployment approximately 4 percentage points lower than a microregion at the 25th percentile. There is no significant relationship between trade with China and labor reallocation from nonemployment into the mining sector, seen in column (3). This is likely due to the small size of the mining sector, in terms of employment, in Brazil.

Last, we look at the relationship between trade with China and labor reallocation from the manufacturing, agriculture, or mining sector into nonemployment, seen in Table 9. These three labor flows represent the exact opposite flows presented in the previous table. We predict that import exposure will increase labor reallocation into nonemployment, particularly in the manufacturing sector, while exports will decrease labor reallocation into nonemployment. The results in column (1), those for labor reallocation from the manufacturing sector into nonemployment, match our predictions. Microregions more exposed to imports from China have a higher percentage of workers reallocate from manufacturing to nonemployment. Regions more exposed to exports to China have a lower percentage of workers reallocate to nonemployment from the manufacturing sector. For imports, a microregion at the 75th

[12]The number of observations do fluctuate across the three columns due to the fact that not all microregions experienced labor reallocation from nonemployment into the manufacturing, agriculture, or mining sector.

Table 9: Labor Reallocation from Manufacturing, Agriculture, or Mining to Nonemployment and Trade with China, 2008-2013

	(1) Manufacturing to Nonemployment	(2) Agriculture to Nonemployment	(3) Mining to Nonemployment
Δ Imports from China to Brazil per worker	0.005*	-0.000	0.000
	(0.003)	(0.001)	(0.000)
Δ Exports to China from Brazil per worker	-0.001***	0.000	0.001**
	(0.000)	(0.000)	(0.000)
Percent Employment Traded Sectors$_{-1}$	0.783***	0.082	-0.021**
	(0.064)	(0.056)	(0.009)
Percent Employment Female$_{-1}$	-0.235	-0.048	-0.042**
	(0.226)	(0.180)	(0.021)
Percent Employment High School Educated$_{-1}$	-0.114**	-0.299***	-0.007
	(0.057)	(0.085)	(0.014)
Percent Employment Foreign Born$_{-1}$	-18.500**	3.992	0.370
	(7.418)	(6.000)	(1.206)
Percent Employment Routine Jobs$_{-1}$	-0.424***	-0.128	0.064**
	(0.135)	(0.105)	(0.031)
Average Offshore Index$_{-1}$	23.776***	-14.541***	3.075**
	(5.658)	(3.959)	(1.313)
Region	Yes	Yes	Yes
N	558	558	558
R^2	0.7910	0.4941	-0.5182

Notes: Microregion level industry reallocation is calculated using the RAIS data for 2008 and 2013. An indicator variable is used to determine whether a worker was initially employed in the manufacturing, agriculture, or mining sector (2008) and transitioned to nonemployment in 2013. Microregion reallocation is calculated as the percent of all workers who transitioned from each sector to nonemployment. All models also include a constant. Standard errors in parentheses are clustered at the state level. First stage estimates are similar to those in Table 1 and therefore are not included. * p<0.10, ** p<0.05, *** p<0.01

percentile experienced a labor reallocation rate 1.35 percentage points higher than one at the 25th percentile; for exports, a microregion at the 75th percentile experienced a labor reallocation rate 1.25 percentage points lower than one at the 25th percentile.

The results in column (2) show that labor reallocation from agriculture to nonempoyment does not have a significant relationship with either imports from China or exports to China. Further, in contrast to our predictions, the results in column (3), reveal that microregions more exposed to exports to China actually experienced higher labor reallocation rates from mining to nonemployment. Despite the high export activity in the mining sector, labor reallocation into nonemployment is increasing.

6 Conclusion

Despite recent pushback on trade openness policies, many countries continue to increase their reliance on international trade. As countries increase their trade with others, they often become more specialized in the production of goods. In response to specialization in certain industries, labor reallocates across different sectors of the economy. Additionally, since different sectors are concentrated in different geographic locations, specialization can also lead workers to migrate to regions with more labor market opportunities. In this paper, we explore the link between Brazil's trade with China and labor reallocation within Brazil. We use UN Comtrade data and administrative panel data for the formal labor market in Brazil for the years 2008 to 2013. The RAIS data, a matched employer-employee data set, allows us to track workers across time to accurately measure labor reallocation rates across industries and migration rates across microregions.

The migration results confirm our predictions that exports will attract new workers, leading to higher migration rates, while imports will not attract new workers, leading to lower migration rates. We find that microregions more exposed to increased imports from China experienced migration rates approximately 0.5 percentage points lower on average. Additionally, microregions more exposed to increased exports to China experienced migration rates approximately 1.35 percentage points higher on average. These results suggest that areas with higher exposure to exports to China have more labor market opportunities, which

attract new workers to the region. In contrast, areas with higher exposure to imports from China have fewer labor market opportunities, which does not attract new workers to the region. Our results for trade with China and migration contrast with previous results in the literature on the effect of trade on migration rates in Brazil. For example, Dix-Carneiro and Kovak (2017) analyze migration in Brazil in the aftermath of Brazil's trade liberalization episode, but do not find any significant effect of trade liberalization on microregion migration.

In addition to migration, we also explore the relationship between trade with China and labor reallocation across industries within microregions. We analyze several different labor reallocation flows, but focus on transition into or out of nonemployment. Brazil, like many developing countries, has an extremely large informal sector. However, employment in the formal sector provides workers with mandated benefits such as minimum wages, maximum work hours, and annual bonuses if a worker meets eligibility requirements. In general, our results support our predictions that exports to China are associated with positive labor reallocation flows while imports from China are associated with negative labor flows. For example, microregions more exposed to exports to China experienced higher reallocation rates from nonemployment into the nontraded sector and the manufacturing sector and lower reallocation rates from the formal sector to nonemployment. In contrast, microregions more exposed to increased imports from China experienced higher reallocation rates from the formal sector into nonemployment and lower reallocation rates from nonemployment into the formal sector.

Given the matched employer-employee nature of the RAIS data, we can accurately measure migration and labor market reallocation. This is due to our ability to track workers over time, which is not possible with the majority of other data sets. Our results reveal how labor market dynamics change in response to globalization and increased trade, specifically the China trade shock. We also highlight the importance of determining the effects of both trade channels, imports and exports, rather than focusing on only one trade channel. Our results suggest that workers respond more to the change in pull factors associated with increased

exports than they do to the change in push factors due to increased imports.

Bibliography

Autor, D., Dorn, D., & Hanson, G. (2013). The China Syndrome: Local Labor Market Effects of Import Competition in the United States. *American Economic Review*, *103*(6), 2121-2168.

Costa, F., Garred, J., & Pessoa, J. P. (2016). Winners and Losers from a Commodities-for-Manufactures Trade Boom. *Journal of International Economics*, *102*, 50–69.

Dix-Carneiro, R., & Kovak, B. K. (2017). *Margins of Labor Market Adjustment to Trade.* (NBER Working Paper No. 23595)

Dix-Carneiro, R., & Kovak, B. K. (in press). Regional Effects of Trade Reform: What is the Correct Measure of Liberalization? *American Economic Review*.

Doctor, M. (2012). Brazil's New Government and Trade: An Evaluation of Policy and Performance. *Critical Sociology*, *38*(6), 799–807.

Erten, B., & Leight, J. (2017). *Exporting out of Agriculture: The Impact of WTO Accession on Structural Transformation in China.* (Working Paper)

Gaddis, I., & Pieters, J. (2017). The Gendered Labor Market Impacts of Trade Liberalization Evidence from Brazil. *Journal of Human Resources*, *52*(2), 457-490.

Gallagher, K. P. (2010). *Taking the China Challenge: China and the Future of Latin American Economic Development.* (Latin American Trade Network Brief No. 58)

Iacovone, L., Rauch, F., & Winters, L. A. (2013). Trade as an Engine of Creative Destruction: Mexican Experience with Chinese Competition. *Journal of International Economics*, *89*(2), 379-392.

Kovak, B. K. (2013). Regional Effects of Trade Reform: What is the Correct Measure of Liberalization? *American Economic Review*, *103*(5), 1960-1976.

Menendez, F. (2014). *A Second Look at the China-Brazil Relationship.* (Center for a Secure Free Society)

Menezes-Filho, N. A., & Muendler, M.-A. (2011). *Labor Reallocation in Response to Trade Reform.* (NBER Working Paper No. 17372)

Mion, G., & Zhu, L. (2013). Import Competition from and Offshoring to China: A Curse or Blessing for Firms? *Journal of International Economics*, *89*(1), 202-215.