Labor Market Dynamics and Trade with China: The Case of Brazil*

Peter Brummund† Laura Connolly‡

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, and the ability to adjust may be different by gender. In this paper, we analyze the impact of both increased imports from China and exports to China on labor market adjustments in Brazil, separately by gender. We use administrative panel data for the formal labor market in Brazil for the years 2004 to 2013. In contrast to previous findings, our results show that microregions exposed to increased exports see an increase in both in-migration and out-migration, whereas microregions exposed to increased imports see a decrease in out-migration. We also find that exposure to either imports or exports increases the transitions to the traded sector and reduces the transitions to nonemployment, for both males and females. Males consistently exhibit slightly stronger responses.

JEL classifications: F16, J61, J63

Keywords: International Trade, Brazilian Labor Market, Mobility.

*The authors are grateful to Paul Pecorino, Amanda Ross, and participants at the Southern Economic Association Annual Meeting (2018), Northeast Universities Development Consortium Conference (2018), LACEA/LAMES (2018), and Michigan Technological University's internal seminar series (2019) for comments and suggestions. All remaining errors are our own.

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

‡Laura Connolly, Michigan Technological University. email: leconn@mtu.edu.

1 Introduction

As the world becomes more globalized, 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 (Dix-Carneiro & Kovak, 2019). Critics of trade argue that increased trade 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. Trade critics typically focus on the negative effects of increased imports, often ignoring the potential benefits from increased exports. In particular, it is possible that exports can mitigate the negative impacts from imports if exports lead to labor market gains or increase worker mobility.

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 separately by gender. 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, and (2) labor reallocation across industries 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 worker mobility and labor reallocation. After China's

accession to the World Trade Organization (WTO) in 2001, most developed countries experienced a drastic surge in imports from China. In contrast, emerging and developing countries, like Brazil, experienced a drastic increase in both imports from China and exports to China.[1] The previous literature on the impacts of trade on the labor market in Brazil has primarily focused on Brazil's trade liberalization episode in the early 1990's (Dix-Carneiro & Kovak, 2017, 2019; Menezes-Filho & Muendler, 2011; Gaddis & Pieters, 2017; Benguria & Ederington, 2017). Researchers generally find that worker mobility is limited in response to trade shocks, particularly those that are import driven. However, a dual sided trade shock, one that is import and export driven, has the potential to increase worker mobility if increased exports mitigate the documented, negative impacts of imports. Thus, we explore the impacts of both sides of the China trade shock on worker mobility in Brazil. Second, we use linked employer-employee data, which allows us to track workers over time as they migrate across geographic regions or sectors. Previous work on Brazil has leveraged both sides of the trade shock, but focused on overall average impacts within microregions (Costa, Garred, & Pessoa, 2016). We extend this work by analyzing the movements of individual workers by gender across sectors and microregions using linked employer-employee data. Previous work finds that the impacts of trade differ by gender (Gaddis & Pieters, 2017; Connolly, 2020), thus it is important to determine if trade also has differential effects by gender on worker mobility and labor reallocation.

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 in migration and out migration rates for both males and females. We find the opposite result for imports; microregions more exposed to imports from China have lower out-migration rates. Men experience slightly larger effects in comparison to females, highlighting the importance of allowing the impacts of trade to vary by gender. Our results suggest that trade with China has a relatively large effect considering the average microre-

[1]From 1992 to 2013, Brazil simultaneously increased their share of total imports from China by 14 percentage points and increased their share of total exports to China by 21 percentage points.

gion has 4% of its workers migrating to a different microregion for employment. These results suggest that pull factors influence internal migration more so than the push factors. These results augment the findings of Dix-Carneiro and Kovak (2019) 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 reallocation finds that import and export exposure reduces the movement of workers from the traded and nontraded sectors to nonemployment and increases the movement of workers from nontraded to traded sector employment. We again observe larger effects for men than women, which could at least be partially due to the relatively high share of male employment in the formal sector. We also find that both channels of trade are reducing labor reallocation across specific industries (3 digit industry codes) and broad industries (2 digit industry codes) for both men and women. This is primarily through exports, which suggests that workers employed in microregions more exposed to exports are more likely to remain employed in their original industry of employment.

These results are important to help policy makers better understand the effects of increased international trade and the potential for worker mobility to mitigate those effects. If the labor market is dynamic, and workers are 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 (David, 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 (2019) analyze labor market reallocation in Brazil in the aftermath of Brazil's trade liberalization in the early 1990's.[2] 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 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 has both import and export components, and allow the impacts of trade to vary by gender. If men and women are viewed as imperfect substitutes in the labor market, then it is expected that trade will have differential effects by gender Gaddis and Pieters (2017); Do, Levchenko,

[2]See Dix-Carneiro and Kovak (2019) or Dix-Carneiro and Kovak (2017) for details of Brazil's trade liberalization.

and Raddatz (2016).

2.2 Labor Market Responses to Trade with China

The unique supply-driven growth of China has been felt by countries around the world.[3] The country has increased their share of worldwide production, particularly in manufacturing products, leading other countries' to increasingly rely on Chinese imports.[4] 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 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

[3]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.

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

fear of deindustrialization in Brazil is merely one example of the increasing sentiment among developing countries that are reliant on commodity exports. However, China has continued to increase their dependence on commodity exports from other countries in response to continued economic growth.[5]

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.[6] In this paper, we build upon the previous literature by studying the impact of trade with China on labor market reallocation and migration rather than labor market outcomes such as employment and wages, and allowing the effects to differ across genders. 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 worker mobility across geographic regions and across sectors of the economy.

[5]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).

[6]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 & Kovak, 2017), Dix-Carneiro and Kovak (2019), Kovak (2013), and Gaddis and Pieters (2017).

3 Methodology

We use a local labor markets approach and define a local labor market as a microregion in Brazil, which is consistent with the literature. We also closely follow Autor et al.'s (2013) instrumental variable approach to measure increased trade with China. 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.[7] 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 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

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

use an instrumental variable to mitigate endogeneity concerns. The instrumental variable, the change in Chinese import exposure in other countries per worker (in Brazil), 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*.[8] ΔM_{ocjt} measures the change in imports from China (c) to other countries (o) in industry j in year t.[9] 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.

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

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

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

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

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

The main variables of interest in the analysis are migration across Brazilian microregions and various forms of industry reallocation within Brazilian microregions from year t to year *t+1*. The labor market reallocation variables for each gender 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 2004, year t, to employment in the traded sector in 2013, year *t+1*, for each gender. 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 male (m) and female ($female$) workers within a microregion that reallocated from nonemployment in 2004, year t, to employment in the traded sector in 2013, year *t+1*. We define $micro\_male\_nonemp\_to\_trade_{itm}$ and $micro\_female\_nonemp\_to\_trade_{it}$ each microregion i in year t as follows:

$$micro\_male\_nonemp\_to\_trade_{itm} = \sum_{m \in i} nonemp\_to\_trade_{wit},$$

$$micro\_female\_nonemp\_to\_trade_{itf} = \sum_{f \in i} nonemp\_to\_trade_{wit},$$

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 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 male and female 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 or number of male and female workers within a microregion who migrated to a different geographic region 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 2004 to 2013, and the instrumental variables use

lagged employment levels from 1995.

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 2004 to 2013, all of which is reported at the 6-digit product level using the Harmonized Tariff System (HS).

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).[11] 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.[12]

The summary statistics for worker-level migration and industry reallocation from 2004 to 2013 are presented in Table 1. The table shows that approximately 11% of all female workers and 18% of all male workers employed in the formal sector in 2004 migrated to a different microregion for employment by 2013. In the same time frame, 2004-2013, approximately 90% of all workers employed in the formal sector changed their 3-digit industry of employment, and 67% of workers changed their broad sector of employment. Thus, during the time frame of study, labor reallocation was extremely high, particularly reallocation across industries or sectors. Due to the structure of the RAIS data, we can observe when a worker leaves the

[11] 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.

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

Table 1: Summary Statistics: Worker-Level Dynamics by Gender, 2004-2013

	Female		*Male*	
	(1)	(2)	(3)	(4)
Type of Reallocation	mean	sd	mean	sd
Changed Microregion	0.112	0.32	0.179	0.38
Changed 3-Digit Industry	0.893	0.31	0.848	0.36
Changed 2-Digit Industry	0.859	0.35	0.811	0.39
Changed Sector	0.674	0.47	0.611	0.49
Traded to Nontraded Industry	0.275	0.45	0.196	0.40
Traded to Nonemployment	0.132	0.34	0.161	0.37
Nontraded to Traded Industry	0.270	0.44	0.210	0.41
Nontraded to Nonemployment	0.095	0.29	0.125	0.33

Notes: RAIS Data, 2004 - 2013. Columns (1) and (2) show the summary statistics for females and columns (3) and (4) show the summary statistics for males.

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

Table 2 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 2 indicates that the average change per worker in imports from China to Brazil from 2004 to 2013 was approximately $1,122. The average change in exports to China from Brazil per worker for the same time period was approximately $1,656. 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 $1,446 increase in imports from China while a microregion at the 25th percentile only experienced an $521 increase. The pattern is similar for exports. A microregion at the 75th

Table 2: Summary Statistics: Change in Chinese Import and Export Exposure Measures, 2004-2013

	(1) p25	(2) p50	(3) p75	(4) mean	(5) sd
Δ Imports from China to Brazil per worker (IPW_{bit})	521	818	1,446	1,122	1,153
Δ Imports from China to Other Countries per worker (IPW_{oit})	1,816	3,374	6,585	4,352	4,393
Δ Exports to China from Brazil per worker (EPW_{bit})	120	214	1,033	1,656	6,452
Δ Exports to China from Other Countries per worker (EPW_{oit})	1,281	2,516	3,653	4,559	12,113

Notes: Change in trade exposure variables are interpreted as the change in the value of trade (US Dollars) per worker. The variables are calculated using the RAIS data for 2004 and 2013, de-identified RAIS data for 1995, and UN Comtrade data for 2004 and 2013. Trade exposure variables are calculated at the microregion level for 2004 - 2013.

percentile of export exposure experienced a $1,033 increase in exports while a microregion at the 25th percentile only experienced a $120 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. One drawback of the local labor markets approach is the inability to identify any country-wide effects.

Table 3: First Stage Results, 2004-2013

	ΔIPW_{bit} (1)	ΔEPW_{bit} (2)
Δ Imports from China to other countries per worker	0.2518*** (0.0155)	-0.2349 (0.0654)
Δ Exports to China from other countries per worker	0.0134 (0.0191)	1.3115** (0.5352)
N	558	558
R^2	0.8331	0.2385
F-Stat	142.10***	6.89***

Notes: Change in import and export exposure variables are calculated as the change from 2004 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 2004 microregion employment shares. * p<0.10, ** p<0.05, *** p<0.01

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 3. The coefficient of 0.25 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 1.3115 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 3. The F-statistic is also sufficiently large and significant at the one percent level for both instrumental variables.

First, we look at the results for migration across microregions for men and women in Brazil (Table 4). The results for males are presented in the first two columns, and the

Table 4: Microregion Migration and Trade with China by Gender, 2004-2013

	Male		*Female*	
	Out Migration (1)	In Migration (2)	Out Migration (3)	In Migration (4)
Δ Imports from China to Brazil per worker	-0.0007*** (0.0003)	-0.0001 (0.0004)	-0.0005*** (0.0002)	-0.0001 (0.0001)
Δ Exports to China from Brazil per worker	0.0002** (0.0001)	0.0006*** (0.0002)	0.0001* (0.0000)	0.0001* (0.0000)
N	558	558	558	558
R^2	0.4339	0.1495	0.2051	0.3322

Notes: Microregion out migration and in migration are calculated using the RAIS data for 2004 - 2013. An indicator variable is used to determine whether a worker migrated out of their initial microregion in 2004 (out migration) and into a different microregion by 2013 (in migration). All models also controls for microregion characteristics at the start of the period, region controls, and a constant. Standard errors in parentheses are clustered at the state level and models are weighted by 2004 microregion employment shares. Columns (1) and (2) show results for males and columns (3) and (4) show results for females. * p<0.10, ** p<0.05, *** p<0.01

results for females are presented in the last two columns. Only the two key variables of interest, the trade exposure variables (both of which have been instrumented for using the two IVs previously defined), are presented for the sake of space.[13] The coefficient of -0.0007 associated with imports for males (column 1) 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. For a microregion with average exposure to the change in Chinese imports, this corresponds to a decline in migration of approximately 0.80 percentage points. An alternative way to interpret this result is that 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.

Overall, Table 4 shows that increased import exposure reduces out migration for both men and women, but men experience a slightly larger decline. Both avenues of migration are

[13]The analysis also includes microregion specific start of period controls, region controls, and a constant.

Table 5: Microregion Dynamics in the Traded Sector and Trade with China, 2004-2013

	Male		*Female*	
	Traded to Nontraded (1)	Traded to Nonemployment (2)	Traded to Nontraded (3)	Traded to Nonemployment (4)
Δ Imports from China to Brazil per worker	-0.0007	-0.0009***	-0.0004*	-0.0006***
	(0.0004)	(0.0003)	(0.0002)	(0.0002)
Δ Exports to China from Brazil per worker	0.0001	-0.0002**	0.0000	-0.0001*
	(0.0001)	(0.0001)	(0.0000)	(0.0000)
N	557	557	557	557
R^2	0.5475	0.4982	0.5978	0.7044

Notes: Microregion level industry reallocation is calculated using the RAIS data for 2004 - 2013. An indicator variable is used to determine whether a worker was initially employed in the traded sector (2004) and transitioned to employment in the nontraded sector or nonemployment by 2013. Microregion reallocation is calculated as the percent of all male or female workers in a microregion who transitioned from the traded sector to the nontraded sector (columns 1 and 3) or nonemployment (columns 2 and 4). All models also include a constant, region controls, and controls for microregion characteristics at the start of the period. Standard errors in parentheses are clustered at the state level and all models are weighted by 2004 microregion employment shares. Columns (1) and (2) show results for males and columns (3) and (4) show results for females. * p<0.10, ** p<0.05, *** p<0.01

associated with increased export exposure. Microregions more exposed to exports to China experience higher rates of out migration and in migration for both men and women, and men continue to see a slightly larger impact than females. The migration results highlight the importance of allowing trade to differentially impact men and women in the labor market, as males consistently see larger impacts on migration than females. Additionally, the results show both the negative impact of imports on migration, but also the positive impact of exports on migration. Previous literature often finds limited worker mobility in response to trade, particularly via imports (Dix-Carneiro & Kovak, 2017, 2019). Our results suggest that exports can play an important role in mitigating the negative impacts of trade via increasing worker mobility.

Thus far, it is clear that both channels of trade with China impact worker mobility in Brazil. Next, we turn to industry reallocation by gender within Brazilian microregions to see

Table 6: Microregion Dynamics in the Nontraded Sector and Trade with China, 2004-2013

	Male		*Female*	
	Nontraded to Traded (1)	Nontraded to Nonemployment (2)	Nontraded to Traded (3)	Nontraded to Nonemployment (4)
Δ Imports from China to Brazil per worker	0.0006***	-0.0003**	0.0005***	0.0002
	(0.0002)	(0.0002)	(0.0001)	(0.0002)
Δ Exports to China from Brazil per worker	0.0003***	-0.0001**	0.0001***	-0.0001*
	(0.0001)	(0.0000)	(0.0000)	(0.0000)
N	557	557	557	557
R^2	0.5475	0.4982	0.5978	0.7044

Notes: Microregion level industry reallocation is calculated using the RAIS data for 2004 - 2013. An indicator variable is used to determine whether a worker was initially employed in the nontraded sector (2004) and transitioned to employment in the traded sector or nonemployment by 2013. Microregion reallocation is calculated as the percent of all male or female workers in a microregion who transitioned from the nontraded sector to the traded sector (columns 1 and 3) or nonemployment (columns 2 and 4). All models also include a constant, region controls, and controls for microregion characteristics at the start of the period. Standard errors in parentheses are clustered at the state level and all models are weighted by 2004 microregion employment shares. Columns (1) and (2) show results for males and columns (3) and (4) show results for females. * p<0.10, ** p<0.05, *** p<0.01

if increased trade with China also affects worker mobility across sectors. We begin by looking at reallocation from employment in the traded sector to either employment in the nontraded sector or nonemployment (Table 5). Both channels of trade with China have a negative and significant impact on male and female reallocation from employment in the traded sector to nonemployment. This means that increased trade with China is reducing transitions to nonemployment, which is a positive outcome for workers. Males continue to see slightly larger effects, which is not surprising given the high representation of male workers in the traded sector. There are no significant effects of trade with China on worker reallocation from employment in the traded sector to the nontraded sector.

The reallocation results for workers originally employed in the nontraded sector (Table 6) are similar to those for workers employed in the traded sector. For both men and women, both channels of the China trade shock increase transitions from employment in the non-

traded sector to employment in the traded sector. This suggests that trade with China is increasing worker mobility by drawing more workers to the traded sector, but men continue to experience slightly larger effects than women. We also continue to see the negative association between trade with China and reallocation to nonemployment. Exports reduce worker reallocation from employment in the nontraded sector to nonemployment; imports from China also reduce reallocation to nonemployment for men.

Together, Tables 5 and 6 suggest that trade with China is reducing worker transitions to nonemployment and keeping workers formally employed. This is a positive result for workers and contrasts with previous results in the literature that document the negative impact of imports on workers and worker mobility (Dix-Carneiro & Kovak, 2017, 2019; Costa et al., 2016). Our results indicate the importance of also accounting for the mitigating role exports can play via reducing transitions to nonemployment for workers in the formal sector. One potential explanation behind imports reducing worker reallocation to nonemployment, is that increased imports can lead firms to increase their productivity and/or technology (Harrison & Hanson, 1999; Muendler, 2004). Assuming this also leads to increased opportunities for workers, this can potentially explain the negative association between imports and worker reallocation to nonemployment.

Last, we look at the relationship between worker reallocation across specific industries (3-digit industry codes), broad industries (2-digit industry codes), and sectors (1-digit industry codes) and trade with China by gender (Table 7). The results indicate that trade with China is reducing industry reallocation. For example, microregions more exposed to increased exports to China observe lower reallocation across specific industries and broad industries for both males and females. This is an interesting result, particularly given the high levels of industry reallocation in Brazil during the time period. While a majority of workers reallocated to a different specific industry of employment, trade with China was not a contributing factor to this trend. In fact, trade with China either had no effect or had the opposite effect by inducing workers to remain employed in their original industry

Table 7: Microregion Industry Dynamics and Trade with China, 2004-2013

	Male			*Female*		
	Changed 3-Digit Industry (1)	Changed 2-Digit Industry (2)	Changed Broad Sector (3)	Changed 3-Digit Industry (4)	Changed 2-Digit Industry (5)	Changed Broad Sector (6)
Δ Imports from China to Brazil per worker	-0.0002	-0.0001	-0.0010**	-0.0005*	-0.0004	-0.0002
	(0.0003)	(0.0004)	(0.0005)	(0.0003)	(0.0003)	(0.0003)
Δ Exports to China from Brazil per worker	-0.0003**	-0.0003**	0.0000	-0.0002*	-0.0002*	-0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)
N	558	558	558	558	558	558
R^2	0.3958	0.4278	0.4513	0.8517	0.8223	0.7896

Notes: Worker level industry reallocation is calculated using the RAIS data for 2004 - 2013. An indicator variable is used to determine whether a worker is employed in a different 3-digit industry, 2-digit industry, or sector by 2013 (columns 4-6). Then, the percentage of male or female workers within each microregion that changed 3-digit industry, 2-digit industry, or sector is calculated. All models also include a constant, region controls, and controls for microregion characteristics at the start of the period. Standard errors in parentheses are clustered at the state level and all models are weighted by 2004 microregion employment shares. Columns (1) - (3) show results for males and columns (4) - (6) show results for females. * p<0.10, ** p<0.05, *** p<0.01

of employment. The literature documents the high costs of turnover to both workers and firms. This is particularly the case for workers employed in industries that require knowledge specific to that industry that doesn't easily transfer to other industries. Thus, it is possible that workers prefer to remain employed in their original industry of employment, and trade with China aides this. However, we are unable to measure worker preferences to confirm this.

6 Conclusion

Despite recent pushback on trade openness policies, many countries continue to increase their reliance on international trade to further integrate into the world economy. 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, focusing on both geographic migration and reallocation across industries and sectors of the economy. We also allow the impacts of trade to differ by gender to account for the fact that men and women often respond differently to trade shocks. We use UN Comtrade data and administrative panel data for the formal labor market in Brazil for the years 2004 to 2013. The RAIS data, a matched employer-employee data set, allows us to track individual workers across time to more accurately measure labor reallocation rates across industries and migration rates across microregions.

The migration results confirm our predictions that imports are negatively associated with migration and exports are positively associated with migration. We find that microregions more exposed to imports from China experienced out migration rates approximately 0.78 percentage points lower for men and 0.56 pp lower for females on average. Additionally, microregions more exposed to increased exports to China experienced in migration rates approximately 0.33 percentage points higher for men and 0.16 higher for women on average. Exports also have a positive association with out migration. These results suggest that areas with higher exposure to exports to China translate to increased worker mobility, which both attracts new workers to the region and enhances workers' ability to move elsewhere. In contrast, areas with higher exposure to imports from China have fewer labor market opportunities, which does not attract new workers to the region and even pushes existing workers to move elsewhere. The effects for men are consistently larger in magnitude than those for women, indicating the importance of allowing the impacts of trade to differ by gender. Our results for trade with China and migration contrast with previous results in the literature. For example, Dix-Carneiro and Kovak (2019) 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. However, trade liberalization was an import-driven trade shock, while the China trade shock has both import and export components.

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 transitions into nonemployment and reallocations across industries. 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 indicate that trade with China is associated with lower rates of reallocation to nonemployment. Both imports and exports are associated with declines in worker reallocation from employment in the nontraded or traded sectors to nonemployment. Men continue to experience slightly larger effects than women. This highlights an unexpected avenue for imports from China to positively impact labor reallocation. It is possible that increased trade with China gives firms easier access to new technologies or cheaper inputs, which then translates to increased opportunities within the formal sector. We also observe higher transitions from employment in the nontraded sector to the traded sector for both men and women, suggesting increased trade is also pulling workers towards employment in the traded sector. Last, our results suggest that trade with China is reducing worker reallocation across specific of broad industries of employment, meaning that many workers are remaining in their original industry of employment.

Overall, our results highlight the importance of determining the effects of both trade channels, imports and exports, rather than focusing on only one trade channel, when analyzing the impact of trade on worker mobility and labor reallocation. We also consistently observe slightly larger effects for men than women, which confirms the need to allow the impacts of trade to differ by gender. Workers in Brazil respond to both the pull factors associated with exports to China and the push factors associated with imports to China. In the future, we plan to further utilize the panel data and the ability to track workers across

time to determine what types of workers are migrating across geographic regions and reallocating to new industries in response to trade with China. We also plan to explore alternative instrumental variables to more explicitly control for world wide trends in international trade that are not necessarily due to China.

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.

Benguria, F., & Ederington, J. (2017). *Decomposing the Effect of Trade on the Gender Wage Gap.* (Working Paper)

Connolly, L. (2020). *The Effects of a Trade Shock on Gender-Specific Labor Market Outcomes in Brazil.* (Working Paper)

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.

David, H. (2018). Trade and labor markets: Lessons from china's rise. *IZA World of Labor*.

Dix-Carneiro, R., & Kovak, B. K. (2017). Trade liberalization and regional dynamics. *American Economic Review*, *107*(10), 2908–46.

Dix-Carneiro, R., & Kovak, B. K. (2019). Margins of labor market adjustment to trade. *Journal of International Economics*, *117*, 125–142.

Do, Q.-T., Levchenko, A. A., & Raddatz, C. (2016). Comparative advantage, international trade, and fertility. *Journal of Development Economics*, *100*(119), 48–66.

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)

Harrison, A., & Hanson, G. (1999). Who gains from trade reform? some remaining puzzles. *Journal of development Economics*, *59*(1), 125–154.

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.

Muendler, M.-A. (2004). Trade, technology and productivity: a study of brazilian manufacturers 1986-1998.