China Shock and Female Labor Market Participation in Brazil

Juliana Cristofani[1]
Ana Claudia Polato e Fava[2]
Mônica Yukie Kuwahara[3]

ABSTRACT

Brazil was a successful case of economic growth based on import substitution. Recently, with the China shock, the country's economy has been exposed to greater competition. In a similar period, an increase of 12 percent in the proportion of formalized female workers took place in the Brazilian labor market. This paper explores the variation of China Shock between Brazilian local labor markets (or microregions) to identify whether the expansion of Chinese participation in international trade was able to improve the women's conditions in the Brazilian labor market between 2000 and 2013 measured by the proportion of women formalized, and the wage ratio of female to male workers. It is the first study to assess how the two channels of China shock affected the outcomes of formal Brazilian women, with data from the Brazilian labor market (RAIS and Census) and information on trade flows between Brazil and China (BACI database).

Keywords: China shock. Female formal workers. Gender wage ratio.

Jel Codes: F16, J21, J31, J71.

[1] Federal University of ABC, juh.cristofani@gmail.com
[2] Federal University of ABC, ana.fava@ufabc.edu.br
[3] Federal University of ABC, monica.kuwahara@ufabc.edu.br

1. INTRODUCTION

Brazil remained closed to international trade to promote its economic growth (WORLD BANK, 2008). Even though it carried out a trade liberalization in the 1990s, focusing on an inflation control policy based on the pegged exchange rate, the country retreated, reestablishing the protectionist import tariff policy (KUME, 1998). At the beginning of this century, Brazil intensified its trade relations with China, with the latter becoming one of Brazil's main economic partners (PAUTASSO, 2010). The commodity boom and the increase in Chinese demand boosted the Brazilian economy (HIRATUKA and SARTI, 2016), with China positively affecting the Brazilian labor market via commodity exports (COSTA et al., 2016).

Trade liberalization's effects on women's economic status are not a consensus. There is evidence that trade shocks are related to workforce defeminization in manufacturing sectors (DOMÍNGUEZ-VILLALOBOS; BROWN-GROSSMAN, 2010; SAURÉ; ZOABI, 2014). Especially in low-skilled industries (SARAÇOĞLU et al., 2018), it worsens the conditions of poorer women (SIDDIQUI, 2009), and in some cases, there is no impact at all (TEJANI and MILBERG, 2016). However, trade shocks can benefit women if it raises competition for local industries reducing discrimination in the labor market (BLACK; BRAINERD, 2004; ALAZZAWI, 2014). Or if the new productive structure derived from trade liberalizations demands skills related to female workers (AGUAYO-TELLEZ et al., 2010; JUHN et al., 2014).

The trade shock effect on working women depends on the level of women's participation in the affected sector (TRAN-NGUYEN and ZAMPETTI, 2004). Highly female-dominated sectors under positive trade shocks exhibit benefits to women in low-wage employment (STANDING, 1989). Alternatively, adverse trade shocks in low women participation sectors show relative improvements for working women in employment and wages compared to their male counterparts (BRUSSEVICH, 2018; WAMBOYE; SEGUINO, 2015). Brussevich (2018) finds evidence of women's wages and welfare relative improvements from the China Shock in

the U.S. Indeed, China shock was a negative shock on U.S. industry which is a male-dominated sector.

The Brazilian trade liberalization in the 1990s resulted in worsening workforce outcomes (ARBACHE; CORSEUIL, 2004; DIX-CARNEIRO, 2019; KOVAK, 2013; ULYSSEA; PONCZEK, 2018). However, it improved the relative position of women in the labor market since they tend to be less negatively affected than men (GADDIS and PIETERS, 2017). Cavalcanti et al. (2020) observe a drop in wage premiums for men and women, driven by a more significant drop in male workers' wage due to the 1990s tariff reduction.

Unlike the 1990s, the intensification of trade with China in the 2000s coincides with formal employment growth (MACIEL and OLIVEIRA, 2018). Indeed, female labor force participation in the formal sector improved by 12% during the period, as shown by the data used in this work. However, Benguria and Ederington (2017) observed a wage reduction in the Brazilian workforce, with the adverse effects pulled by men, reducing wage differences in favor of women. The lower impact would be associated with the more significant presence of female workers in less affected sectors (BENGURIA and EDERINGTON, 2017).

Moreover, Brazilian women are treated as second earners, carrying out the most extensive domestic services and care load within their houses (MADALOZZO; MARTINS; SHIRATORI, 2010; GUIGINSKI, WAJNMAN, 2019). They tend to enter the market in positions inferior to those of men, gathering in more precarious segments, which allow flexible hours with low wages (GUIGINSKI and WAJNMAN, 2019). Formal female workers are concentrated in service activities, while plenty of female workers are concentrated in informal activities (MADALOZZO, 2010).

In this context, this paper explores the variation of China Shock across Brazilian local labor markets to identify whether Chinese international trade expansion has affected female formal labor market conditions in Brazil between 2000 and 2013. The identification strategy

follows Autor et al. (2013) and Costa et al. (2016), creating metrics that relate the changes in trade flows between Brazil and China to the Brazilian employment outcomes. The present study is the first to analyze how the two channels of China Shock affected the relative position of Brazilian female workers.

We use administrative data from the Ministry of Labor (RAIS), and information about the trade flows between Brazil and China from the BACI database developed by the Centre d'Etudes Prospectives et d'Informations Internationale (CEPII). The analysis measurement unit is the microregion, a grouping of economically integrated municipalities. This paper explores female formal employment and female to male wage ratio variation in microregion to check China shock on female labor market conditions. We also control by microregional factors such as age, schooling, average wages of the formal labor force, a cubic polynomial of income per capita the log of formal women's employment4 during the initial period.

Our findings suggest that despite the increase in female participation in the formal market between 2000 and 2013, the China Shock has worsened the entry of women into the formal market in Brazilian microregions most exposed, mainly due to the imports channel. The Chinese import influx has improved the relative position of women measure by average monthly wages for those who remained in the formal market. We also consistently find rises in female and male hourly wages from the effect of the export channel.

2. TRADE SHOCKS IN BRAZIL AND GENDER DIFFERENCES IN LABOR MARKET

This paper is related to the literature on labor market adjustment to trade shocks. The Brazilian labor market adjustment to trade shocks provides an exciting contrast to the case of

[4] When we estimate the effects on formal men's employment and wages separately, we replace this control by the log of men's employment in 2000.

developed countries due to the differences in labor market structures (DIX-CARNEIRO, 2019; COSTA et al., 2016). Indeed, Brazil has a large informal sector, comprising about half of the workers in 2000 (COSTA et al., 2016). However, it faced a positive labor market adjustment – in terms of wage gains and formalization – due to the commodities demand boom (COSTA et al., 2016).

Due to trade liberalization in early 1990, Brazil experienced a gradual and uneven reduction in import tariffs (DIX-CARNEIRO, 2019; KOVAK, 2013), but it remains a relatively protected economy (DIX-CARNEIRO, 2019; KUME, 1998). Depending on the period analyzed, the average import tariff dropped from 55 in 1987 to 10 percent in 1994 (AVERBUG, 1999; KUME et al., 2000), and from 31 in 1990 to 13 percent in 1995 (DIX-CARNEIRO, 2019).

Assessing the main results for Brazil, the literature finds that the effects of the 1990's trade opening are adverse for the workforce. Arbache and Corseuil (2004), using a household survey (PNAD), find that the penetration of imports from this period reduced the industrial workforce's employment and wages. With a different approach, using the Brazilian demographic censuses of 1991 and 2000, Kovak (2013) shows that workers from regions more exposed to the tariff reductions of 1990 experienced a more significant relative drop in wages when compared to those less exposed to trade.

This shock also influences informality and non-employment. In the medium run, the tariff reduction causes an increase in the proportion of informal workers and non-employment in more exposed regions (ULYSSEA; PONCZEK, 2018). The adverse effects tend to persist in the medium and long run (DIX-CARNEIRO et al., 2017). Displaced workers from the formal sector face a long spell of unemployment and tend to find employment in the informal sector (DIX-CARNEIRO et al., 2017). Dix-Carneiro et al. (2017) uses data on formal market (RAIS) and on formal and informal market (censuses).

The rise of China was an important event in the global economy (DIX-CARNEIRO, 2019; COSTA et al., 2016; AUTOR et al., 2013). After the seminal paper of Autor et al. (2013), the series of adverse trade shocks in the U.S. economy was known as China Shock. Most articles have consistently identified that the rising competition in manufactured goods from China has damaged the U.S. manufacturing labor market, with the regions and industries most exposed to this trade shock experiencing relatively more significant declines in employment and wages (AUTOR et al., 2013; AUTOR et al., 2014; ACEMOGLU et al., 2016). These adverse effects also extend to other dimensions, such as increased children living in poverty and single-headed households (AUTOR et al., 2018).

Women have relative improvements in wages and welfare caused by the China Shock in the U.S. (BRUSSEVICH, 2018). However, this relative improvement was mainly due to worsening in male workers' economic conditions, primarily because the share of male workers allocated in manufacturing sector is high (BRUSSEVICH, 2018). Moreover, men face higher exit costs from manufacturing than women, who are generally relocated to service activities (BRUSSEVICH, 2018).

The Brazilian trade liberalization and the China Shock are events that are unlikely to be experienced again soon (DIX-CARNEIRO, 2019). Even though Brazil remains a relatively protected economy (DIX-CARNEIRO, 2019; KUME, 1998), it has undergone another trade shock after its liberalization with the rise of China (COSTA et al., 2016). China became Brazil´s major trade partner (PAUTASSO, 2010; COSTA et al., 2016). Using a Brazilian household survey data, Paz (2019) finds that the Chinese import penetration reduces the level of employment and the hourly wages of the workforce. At the same time, with demographic census data, Costa et al. (2016) show that manufacturing workers from Brazilian microregions that were more exposed to the Chinese import penetration face slower growth in their wages when compared to those less exposed regions.

However, China has also been a source of a significant demand shock (COSTA et al., 2016; OLIVEIRA, 2014). Indeed, the Brazil-China trade partnership has adversely affected the labor market regions where imports from China have risen in competition and has positively impacted the labor market of commodities exporter regions with faster wage growth and job formalization (COSTA et al., 2016). These authors find that between the years 2000 and 2010, a US$ 1,000 per worker increase in exports to China led to a 1.58 percentage points growth in the workforce wages (COSTA et al., 2016).

Although there is a lot of interest in the adjustment of labor markets to trade liberalization and China's shock to Brazil, little attention has been given to the impact of these labor market adjustments on the relative position of women in the labor market. Regarding the 1990s trade liberalization, two papers look at the changes in the relative position of women in the labor market: Gaddis and Pieters (2017) and Cavalcanti et al. (2020). The first one finds that a decline in trade protection by one percentage point tends to reduce the female labor force participation by two percentage points, while for the male workforce, this value is more than four percentage points (GADDIS and PIETERS, 2017). Meanwhile, Cavalcanti et al. (2020) observe that men face a wage reduction of 0.531 percentage points higher than the wage reduction for women, reducing the gender wage gap over time.

Benguria and Ederington (2017) find that the labor market adjustment to the China Shock due to increasing import competition in Brazil impacted the gender wage gap positively, with a relative decline of around one percentage point in the regions more exposed to trade. Our paper is the first to measure the impact on women's labor market relative position due to labor market adjustments to the rise of imports and exports from China.

3. EMPIRICAL STRATEGY

3.1. Identification Strategy

We use the identification strategy of Autor et al. (2013) e Costa et al. (2016). This strategy is based on a theoretical trade model[5] which considers each local labor market as a small open economy, allowing the creation of metrics that relate the variations in trade flows between Brazil and China with the structure of the local labor market in the period before the shock (2000, in this case). Here, we define local markets as microregions, a grouping of economically integrated municipalities (COSTA et al., 2016; DIX-CARNEIRO et al., 2018).

Two exogenous channels spread China Shock in Brazil. On the first channel, an increase in the local market competition is expected due to the influx of Chinese manufacturers. On the second channel, there is an increase in Chinese demand for Brazilian commodities, which positively impacts the local economy, especially in agricultural sectors (AUTOR et al., 2013; COSTA et al., 2016).

By adopting the model and assumptions developed by Autor et al. (2013) and Costa et al. (2016), we obtain the following variables, which measure how the formal employment of each Brazilian microregion is exposed to trade between Brazil and China: IS_{mt} represents the influx of Chinese imports in Brazil, and XD_{mt}, the increase in Chinese demand for Brazilian exports:

$$\mathrm{IS_{mt}} = \sum_j \frac{\mathrm{L_{jm,2000}}}{\mathrm{L_{j,2000}}} \frac{\Delta I_j}{\mathrm{L_{m,2000}}} \tag{1a}$$

$$\mathrm{XD_{mt}} = \sum_j \frac{\mathrm{L_{jm,2000}}}{\mathrm{L_{j,2000}}} \frac{\Delta X_j}{\mathrm{L_{m,2000}}} \tag{1b}$$

[5] In this model, each microregion has j industries producing differentiated tradable goods, operating under the regime of monopolistic competition, and only one sector producing homogeneous non-tradable goods. It also rules out the possibility of worker's migration between local markets. See Autor et al. (2013).

ΔI_j represents the variation in the volume of Chinese imports to Brazil between 2000 and 2013 in thousands of US$ ($\Delta I_j = V_{CjB,2013} - V_{CjB,2000}$) while ΔX_j shows the variation in the volume of Brazilian exports to China ($\Delta X_j = V_{BjC,2013} - V_{BjC,2000}$). Then, we weighted the trade flows by the workforce structure in Brazil during 2000, where $L_{jm,2000}$ is the total workforce in sector *j* and microregion *m*, $L_{j,2000}$ the total workforce in sector *j* and $L_{m,2000}$ the total workforce in microregion *m*.

Thus, using the microregion (*m*) and year (*t*) as the unit of measurement, we apply a first difference model for the estimates, represented by the following equation:

$$\Delta Y_{mt} = \beta_1 IS_{mt} + \beta_2 XD_{mt} + Z'_{m2000}\beta_3 + \varepsilon_{mt} \quad (2)$$

On the left side of the equation, the dependent variable (ΔY_{mt}) takes on different formats. To estimate how the China Shock has influenced women's entry into the formal labor market, $\Delta Relative_{participation}$ represents the variation between 2000 and 2013 in the proportion of female workers in the formal market by microregion (*m*). The dependent variable is transformed into $\Delta lnWage_{female/male}$, which indicates the changes in the log ratio of female to male hourly wages in each microregion (*m*), to assess whether there has been a wage advance for these women relative to men. We also analyze the evolution of the employment and hourly wages of formal women and men separately, by using their changes in log.

On the right side, we have IS_{mt} and XD_{mt}, which are the metrics of competitive exposure created by Autor et al. (2013). We also control for the formal workforce characteristics by microregion in 2000 - represented by the vector Z'_{m2000} – such as the average age, the proportion of workers with a high school degree and a college degree, their average monthly

wages, and the log of formal women's employment[6]. To represent the productive structure of microregions prior to the shock, we use a cubic polynomial of income per capita (COSTA et al., 2016).

Following the empirical literature on Brazilian trade shocks, to control for possible unobserved state trends that may be linked to the dependent variables, we add fixed effects for the twenty-seven Brazilian states in some specifications (COSTA et al., 2016; DIX-CARNEIRO; KOVAK, 2017; ULYSSEA; PONCZEK, 2018). Standard errors are also clustered by mesoregions, correcting for possible spatial correlation across microregions. We expect the parameters of interest (β_1 and β_2) to be positive and statistically significant, as it would be an indication that more women are occupying the formal labor market and getting better wages compared to their male counterparts due to the China Shock.

We also consider the possibility that variations in the pattern of trade between Brazil and China (represented by ΔI_j and ΔX_j) are capturing changes in the Brazilian economy – such as productivity growth in a specific sector *j*, or changes in consumption patterns associated with increased income in Brazil (COSTA et al., 2016). To deal with this possible endogeneity, we employ the instrumental variables strategy suggested by the literature (AUTOR et al., 2013; ACEMOGLU et al. 2016; COSTA et al., 2016).

Thus, we instrumentalize the IS_{mt} and XD_{mt} metrics, replacing the variations in trade flows between Brazil and China by ΔI_j^* and ΔX_j^*Calculated by the variation between 2000 and 2013 on China exports (imports) to all countries in the BACI database, except Brazil. This strategy is valid since the China Shock in Brazil maintains a correlation with trade flows

[6] When we estimate the effects on formal men's employment and wages separately, we replace this control by the log of men's employment in 2000.

between China and the rest of the world. Still, these flows are exogenous to the Brazilian labor market in 2000. We have the following instruments:

$$\text{ivIS}_{mt} = \sum_j \frac{L_{jm,2000}}{L_{j,2000}} \frac{\Delta I_j^*}{L_{m,2000}} \quad (3a)$$

$$\text{ivXD}_{mt} = \sum_j \frac{L_{jm,2000}}{L_{j,2000}} \frac{\Delta X_j^*}{L_{m,2000}} \quad (3b)$$

3.2. Data

We use administrative data from the Ministry of Labor (RAIS), a census of the Brazilian formal labor market at an individual level, collected annually. For the dependent variables, we use the number of workers, their average monthly wages, and weekly hours worked[7], disaggregated by gender in 2000 and 2013. We also use a consumer price index (IPCA) from the Brazilian Institute of Geography and Statistics (IBGE) to deflate the wages in 2000, to represent in 2013 Reais. We decided to use 2013 as the final period to avoid some confounding aspects due to the Brazilian economic crisis on subsequent years.

Brazilian formal labor force characteristics in 2000 available at RAIS are used as control variables. Also, the income per capita cubic polynomial, calculated from the 2000 Brazilian demographic census from IBGE, is used as a control variable.

The unit of analysis for this study is the microregion, a regional classification developed by IBGE by grouping economically integrated municipalities, defined by the literature as Brazilian local labor markets (COSTA et al., 2016; DIX-CARNEIRO et al., 2018). We use the minimally comparable areas (AMC), provided by Dix-Carneiro et al. (2018), to ensure no significant variations in the microregion's boundaries between 2000 and 2013. The minimally

[7] To calculate the hourly wages of the formal workforce, we multiply the weekly hours worked by 4.33, transforming this variable in monthly hours worked, and then divide the average monthly wages by the latter.

comparable areas group some microregions that changed between 1980 and 2010, making regions comparable across years. By matching the municipalities of RAIS with the AMCs, we obtain a sample of 411 Brazilian microregions[8].

We use trade data between countries from the BACI database, which reconciles the information declared by importing and exporting countries to the UN statistical division (Comtrade). They have information on the total annual value of bilateral trade flows between more than 200 countries in current US$ 1,000 for products classified under the six-digit Harmonized System (HS6) since 1995.

To calculate the metrics of China Shock and its instruments, we use the variation between 2000 and 2013 of Brazilian imports from (exports to) China in thousands of dollars (US$), as well as the variation of all other BACI's countries exports to (imports from) China. We deflate this data using the US GDP deflator, provided by the US Bureau of Economic Analysis, considering 2013 as the base year. To finish the calculation of the IS_{mt} and XD_{mt} metrics, we had to transform the BACI data of tradable products into *j* sectors of activity. For this reason, we construct a concordance between the BACI product codes (HS6) and the RAIS economic activity codes (CNAE 95), obtaining 227 tradable sectors[9].

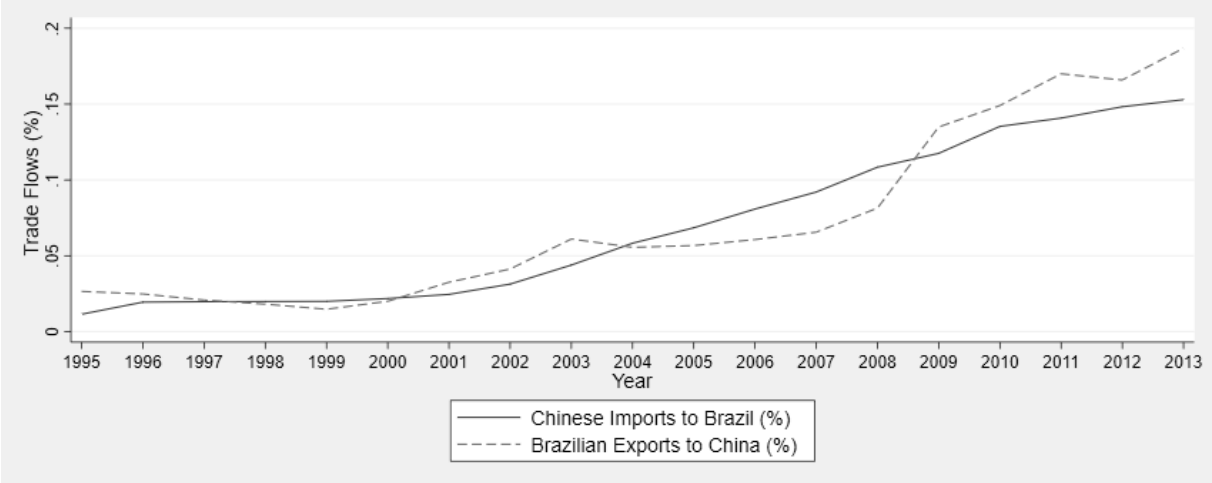
3.3. Descriptive Analysis

Analyzing the trends in Brazil and China's trade flows, described in figure 1, we observe that, in the years 1995 to 2000, imports and exports between these countries were relatively low and stable. From 2001 onwards - when China joined the World Trade Organization (AUTOR et al., 2013) - the trajectories were upward until 2013. Indeed, imports from China went from

[8] We dropped *Lencois Maranhenses* and *Japura*, tiny microregions registering only services on RAIS. Because of that, their China Shock metrics were missing.
[9] Waste and scrap (HS6) could not be concorded with the CNAE, as they are not inputs for the recycling industry. As Costa et al. (2016), we remove these HS6 from IS_{mt} and XD_{mt}, and consider recycling as non-tradable (services).

2.17% in 2000 to 15.29% in 2013. At the same time, these values for the share of Brazilian exports to China were 1.99% in 2000 and 18.68% in 2013.

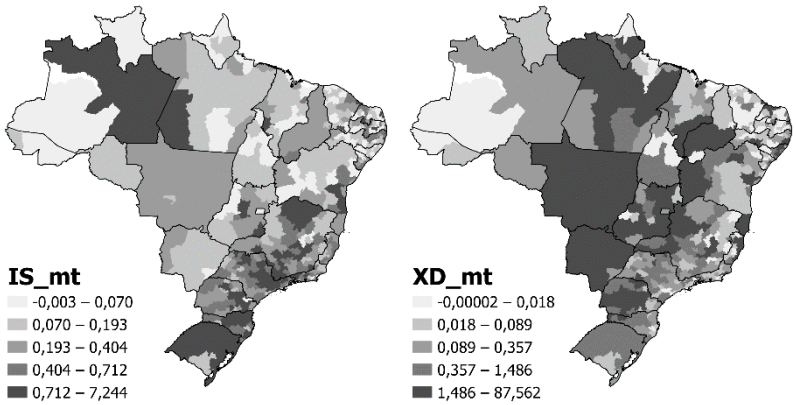
Figure 1 - Trade Flows Between Brazil and China: 1995 to 2013



Sources: BACI database, 2021.

When calculating the China Shock metrics for each of the Brazilian microregions, as described in equations (1a) and (1b), we construct figure 2, which shows how these regions trade with China, both in terms of imports (left side) and exports (right side). We observe that the Brazilian microregions trade with China differently, depending on their productive structure before the shock, corroborating the empirical strategy adopted.

Figure 2 - Geographic Distribution of China Shock's Metrics (IS_{mt} e XD_{mt}) by quintile



Sources: RAIS microdata and BACI database, 2021.

As expected, regions more intensive in manufacturing production during the year 2000 were relatively more affected by the China Shock imports channel, emphasizing the states located further south and southeast of Brazil, marked in dark blue on the left-side map of Figure 2. For the exports channel, we observe on the right-side map that the region most affected was the Brazilian middle west, known for its agricultural production.

It is possible to notice a positive evolution in favor of female workers by analyzing the descriptive statistics of women's participation in the formal labor market and the wage ratio between male and female formal workers. Table 1 contains information on the variables representing the formal labor market in each of the Brazilian microregions, during the years 2000 and 2013, used to estimate the main models of this study.

Table 1 – Description and Summary of Variables by Microregion

Variable	Mean	Std. Dev.	Min	Max
$\Delta Relative_{participation}$	0.0381	(0.0802)	-0.2492	0.3138
$\Delta lnWomen_{employment}$	0.9852	(0.3470)	-0.8178	2.5792
$\Delta lnMen_{employment}$	0.8111	(0.4191)	-0.9789	2.7046
$\Delta \ln \text{Wage}_{\text{female/male}}$	0.0877	(0.2178)	-0.9199	1.0499
$\Delta \ln \text{Women}_{\text{hourly wage}}$	1.2906	(0.2556)	0.5827	2.0728
$\Delta \ln \text{Men}_{\text{hourly wage}}$	1.2029	(0.1931)	0.3540	1.8334
IS_{mt}	0.4986	(0.7096)	-0.0029	7.2440
XD_{mt}	2.1594	(7.7427)	0.0000	87.5621
$ivIS_{mt}$	24.3211	(32.3083)	0.0087	316.8055
$ivXD_{mt}$	34.4260	(100.9242)	-0.5021	1,579.3810
ln Women's employment 2000	8.9209	(1.5144)	4.9272	14.5262
ln Men's employment 2000	9.4223	(1.6946)	5.0304	14.9186
Average Monthly Wages 2000	0.4168	(0.1574)	0.1023	1.1770
Average Age 2000	34.2680	(2.0377)	29.4057	43.4854
% Workers with High School	0.2445	(0.0831)	0.0727	0.5754
% Workers with College Education	0.0513	(0.0327)	0.0040	0.3129
Income per Capita	158.01	(91.07)	27.55	571.51
Income per Capita^2	3.32E+04	(3.64E+04)	759.14	3.27E+05
Income per Capita^3	8.38E+06	(1.49E+07)	2.09E+04	1.87E+08

Sources: RAIS microdata, Brazilian Census, and BACI database, 2021.

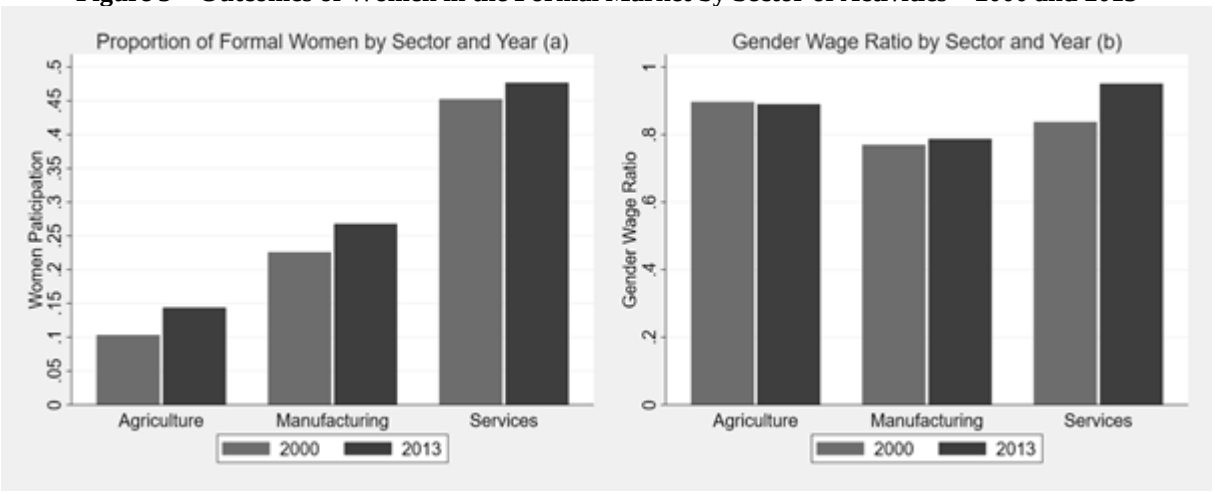
An increase in formal female participation was observed from the evolution of the dependent variables used for the estimates. In the initial period, about 38.23% of the formal workforce was made up of women, with this proportion increasing around four percentage points from 2000 to 2013. There was also an evolution of approximately 8.77 percentage points

in the log female to male wage ratio. These earned about 86.09% of what their male colleagues received during the initial year.

Based on these data, it is also possible to understand some characteristics of the formal labor workforce in each Brazilian microregion in 2000. These workers were, on average, 34 years old and had low levels of education, with only 24.45% of the workforce achieving a high school degree and 5.13% of them getting a college degree. The average monthly wages of these workers were also low, with an average nominal salary of 416 Reais. In turn, the average income per capita, considering the entire population, reached the average nominal value of R$ 158,01.

Women and men are usually concentrated in different activities, with more women occupying the services sector (MADALOZZO, 2010). Figure 3 shows the mean proportion of women in the formal market employed in each sector during the years 2000 and 2013 (a) and the mean of the gender wage ratio by sector and year (b).

Figure 3 – Outcomes of Women in the Formal Market by Sector of Activities – 2000 and 2013



Sources: RAIS microdata, 2021.

Women were much more concentrated in services activities during both years, where about 48% of this sector workers are women in 2013. In agriculture and extractive activities, the proportion of female workers was only 14% in this same year. In manufacturing activities, 27% of workers were women in 2013.

However, when we compare how women's participation is evolving through time, we notice that in tradable sectors, which are directly affected by China Shock, the proportion of female workers has grown by approximately four percentage points in agriculture, extractive and manufacturing activities. In contrast, in the sector with the highest concentration of women (services), the growth was two percentage points.

Observing the gender wage ratio, the wage gap between men and women is more extensive in the manufacturing sector, with women receiving a little less than 80% of what men received in both years. In the agriculture and extractive sector, the wage inequality among genders is small, with women receiving 90% of their male colleagues' wages, without significant variations during the period. Lastly, in services activities, we can see the most considerable variation, with women receiving 84% of a man's wage in 2000 and the next period, this value was about 95%.

4. RESULTS

4.1. Main Results

This section presents the estimates of the China Shock effects on the employment (Table 2) and hourly wages (Table 3) of formal women and men by microregion, between 2000 and 2013. The coefficients and standard errors of all tables are multiplied by 100 so that they can be interpreted as the approximate effect of an increase of US$ 1,000 in imports (exports) per formal worker on variations of the dependent variables in percentage points. Underidentification and weak identification tests corroborate the validity of the instruments.

Panel A in Table 2 summarizes the estimates of the first difference model, reporting the impact of IS_{mt} and XD_{mt} and their respective instruments – $ivIS_{\mathrm{mt}}$ and $ivXD_{mt}$ – on the proportion of female formal workers in each microregion *m*. The results indicate that only a

few specifications have statistical significance, and according to these, the China Shock negatively affects female workers' entry into the formal labor market in Brazilian microregions most affected.

When estimating the model by ordinary least squares (OLS, Column 1), we observe that the microregions most affected by the IS_{mt} channel incurred a drop of 0.563 pp in the participation of women in the formal market, while in the places most affected by XD_{mt}, the effect on women was -0.063 pp, with greater significance. After adding state fixed effects (Column 2), the results are maintained but with higher significance for the IS_{mt}. This trend is compatible with Gaddis and Pieters (2017) findings, which find adverse effects on both men's and women's participation due to the 1990 trade liberalization.

Using the two-stage least squares (2SLS) strategy, the results for microregions most affected by the export and import channel lose statistical significance in the last two columns. To better understand these trends, we decided to see what happened to women's and men's employment separately. In panels B and C of Table 2, we do not find significant effects of the import channel on either women's or men's wages. However, when we look to the export channel, we can see that the effects are positive for men's wages in most specifications, while for women, we find similar results only in column 2, which was estimated by OLS with fixed effects.

Table 2 – Effects of China Shock on Employment of Formal Women and Men by Microregion

	OLS (1)	OLS (2)	2SLS (3)	2SLS (4)
Panel A: $\Delta Relative_{participation}$				
IS_{mt}	-0.563*	-0.639***	-0.554*	-0.429
	(0.332)	(0.243)	(0.315)	(0.318)
XD_{mt}	-0.063***	-0.091***	-0.049	-0.100
	(0.022)	(0.028)	(0.083)	(0.071)
Panel B: $\Delta lnWomen_{employment}$				
IS_{mt}	-3.18	-2.03	-3.00	-1.40
	(2.05)	(2.44)	(2.36)	(2.91)
XD_{mt}	0.371	0.212**	0.200	0.335
	(0.230)	(0.106)	(0.300)	(0.326)
Panel C: $\Delta lnMen_{employment}$				
IS_{mt}	-0.393	1.28	-0.259	1.17
	(2.04)	(2.61)	(2.39)	(2.86)
XD_{mt}	0.634***	0.563***	0.416	0.685*
	(0.232)	(0.184)	(0.300)	(0.411)
Observations	411	411	411	411
State Fixed effects	No	Yes	No	Yes

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in women's relative employment (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) employment separately in the Brazilian formal labor market by microregion. Column (1): Estimation by OLS; Column (2): Estimation by OLS, with state fixed effects; Column (3): Estimation by 2SLS; Column (4): Estimation by 2SLS, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions (91 clusters). Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

On the first panel of Table 3, we notice that the impact of the imports channel was positive and significant on the gender wage ratio in most specifications. In contrast, the exports channel was not significant in any model. In Column 4, with estimations using 2SLS and state fixed effects, we find that an increase of US$ 1,000 in imports of Chinese products per worker led to a rise of 2.11 percentage points in the gender wage ratio, in favor of women, with 5% of significance.

The other panels (B and C) show how the China Shock affected the variation of formal women's and men's hourly wages, separately. It seems that the improvement in the gender wage ratio observed in panel A is pulled by an increase in women's wages. According to our preferred specification (Column 4 of Table 3), the IS_{mt} channel is associated with a rise of 3.38 pp on

formal women's hourly wage (with 1% of significance), while we do not find an effect of IS_{mt} on men's wages. This insight is contrary to Benguria and Ederington (2017) findings since they observe that the improvements on the gender wage gap in favor of women are due to the worsening of men's wages.

Considering the XD_{mt} channel, we can see that in microregions most affected by an increase in exports to China, there was a positive and similar evolution of hourly wages for both men and women, which is probably why we could not find significant effects for the gender wage ratio.

Table 3 – Effects of China Shock on Hourly Wages of Formal Women and Men by Microregion

	OLS (1)	OLS (2)	2SLS (3)	2SLS (4)
Panel A: $\Delta lnWage_{female/male}$				
IS_{mt}	1.57	2.37*	2.08*	2.11**
	(0.968)	(1.20)	(1.12)	(1.03)
XD_{mt}	-0.120	-0.061	-0.052	-0.207
	(0.080)	(0.073)	(0.176)	(0.233)
Panel B: $\Delta lnWomen_{hourly\ wage}$				
IS_{mt}	1.62	3.64**	2.26	3.38***
	(1.13)	(1.42)	(1.56)	(1.29)
XD_{mt}	0.334**	0.325***	1.38**	1.24**
	(0.137)	(0.105)	(0.687)	(0.614)
Panel C: $\Delta lnMen_{hourly\ wage}$				
IS_{mt}	-0.153	0.959	0.0130	1.02
	(1.02)	(0.948)	(1.38)	(1.12)
XD_{mt}	0.467***	0.416***	1.46**	1.51**
	(0.119)	(0.113)	(0.673)	(0.762)
Observations	411	411	411	411
State Fixed effects	No	Yes	No	Yes

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in the *ln* gender wage ratio (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) wages separately in the Brazilian formal labor market by microregion. Column (1): Estimation by OLS; Column (2): Estimation by OLS, with state fixed effects; Column (3): Estimation by 2SLS; Column (4): Estimation by 2SLS, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. N = 411 microregions. Standard errors in parentheses, clustered by mesoregions (91 clusters). Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

By these results, it seems that the China Shock effects of both channels on relative's women formal employment in Brazilian microregions are negative, but this trend must be

interpreted with caution since we find significance only in models estimated by OLS, which may be contaminated by some Brazilian economic factors that happened in the same period (COSTA et al., 2016).

However, the Chinese import influx in Brazilian microregions has improved the relative wages position of women compared to their male colleagues, since they have experienced an improvement in their hourly wages, while we do not find any effect on men's wages separately. Regarding the exports channel, the effects on women's and men's wages separately are positive and similar.

Considering the possibility that China Shock has affected Brazilian economic sectors in different ways, the literature has carried out empirical tests to check whether trade shocks have led to a reallocation of workers among sectors (COSTA et al., 2016). In this way, we subdivided the sample into three major sectors (*s*): agriculture and extractive activities, manufacturing, and services, repeating the estimates from the previous table, using the same microregional controls in the initial period and the China Shock metrics.

Table 4 summarizes the results estimated by 2SLS with state-fixed effects for women's relative formal participation (Panel A) and for women's and men's employment separately (Panels B and C) for each sector of activities and microregion. When compared to microregional models (Table 2, Column 4), we can see that the results on major sectors' employment are relatively more robust.

Regarding the effects on relative formal women's employment, we find significance only for services, showing that a US$ 1,000 increase in Chinese imports per worker is related to a drop of 0.748 pp on the proportion of women in this sector, with 5% of significance (Column 3, Panel A). When we look to the women's and men's employment in services separately, we could not find significant results (Column 3, Panels B and C).

For the other sectors, we find a positive association between both men's and women's employment and the exports channel in agriculture (Column 1, Panels B and C), while for manufacturing, an increase of US$ 1,000 on Chinese imports per worker led to a rise of 16.5 pp on women's employment, with 1% of significance (Column 2, Panel B).

Table 4 – Effects of China Shock on Employment of Formal Women and Men by Sector and Microregion

	Agricult. + Extract.	Manufacturing	Services
	(1)	(2)	(3)
Panel A: $\Delta Relative_{participation}$			
IS_{mt}	-0.819	1.83	-0.748**
	(0.600)	(1.13)	(0.356)
XD_{mt}	-0.009	-0.038	-0.132
	(0.059)	(0.086)	(0.100)
Panel B: $\Delta lnWomen_{employment}$			
IS_{mt}	-4.76	16.5***	-2.37
	(6.50)	(4.54)	(3.07)
XD_{mt}	2.09**	-0.881	0.327
	(1.04)	(0.765)	(0.343)
Panel C: $\Delta lnMen_{employment}$			
IS_{mt}	-7.52	2.18	1.24
	(5.90)	(4.90)	(2.91)
XD_{mt}	1.92**	-0.668	0.723
	(0.815)	(0.936)	(0.504)
Observations	401	408	411

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in women's relative employment (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) employment separately in the Brazilian formal labor market by major sector and microregion. All models were estimated by 2SLS, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). Column (1): Effects on agricultural and extractive sectors; Column (2): Effects on manufacturing sector; Column (3): Effects on services sector. As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions (91 clusters). Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

We also analyze the effects on wages. In table 5, we have the China Shock effects on the gender wage ratio (Panel A) and in the hourly wages of women and men (Panels B and C) for each sector of activities and microregion. Although we could not find significant effects on the gender wage ratio, there are some interesting trends when we look to their wages separately.

For the agriculture sector, we do not see any effect (Column 1). However, in manufacturing, while we find a positive association between the imports channel and women's hourly wages (Panel B, Column 2), we can see this same trend between the exports channel and men's wages (Panel C, Column 2). Finally, for the services sector (Column 3), we observe that both China Shock channels benefits women's hourly wages, and for men, we find a positive association between their wages and the exports channel.

Table 5 – Effects of China Shock on Hourly Wages of Formal Women and Men by Sector and Microregion

	Specialized in Agricult. + Extract. (1)	Specialized in Manufacturing (2)	Specialized in Services (3)
Panel A: $\Delta lnWage_{female/male}$			
IS_{mt}	-2.65	0.087	1.66
	(2.20)	(1.58)	(1.75)
XD_{mt}	-0.285	-0.376	-0.543
	(0.354)	(0.308)	(0.358)
Panel B: $\Delta lnWomen_{hourly\ wage}$			
IS_{mt}	-5.16	5.00**	3.14**
	(4.80)	(2.33)	(1.47)
XD_{mt}	-0.867	1.41	1.03*
	(0.560)	(0.860)	(0.527)
Panel C: $\Delta lnMen_{hourly\ wage}$			
IS_{mt}	-4.46	2.28	1.55
	(3.49)	(2.24)	(1.46)
XD_{mt}	-0.789	1.97*	1.58**
	(0.516)	(1.01)	(0.739)
Observations	378	404	411

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in the *ln* gender wage ratio (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) wages separately in the Brazilian formal labor market by major sector and microregion. All models were estimated by 2SLS, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). Column (1): Effects on agricultural and extractive sectors; Column (2): Effects on manufacturing sector; Column (3): Effects on services sector. As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions (91 clusters). Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

By looking for the results in major sectors, we can see that the China Shock produce winners and losers. When considering the effects of the imports channel for those allocated in manufacturing, we notice that it favors the women's employment and their salaries, while we

did not see robust effects for men. At the same time, considering those allocated in agriculture and extractive activities, we can see that the exports channel benefits men's employment, with not significant effects for women.

4.2. Heterogeneities

In the previous section, we observed the average effects of China Shock on female participation in the formal labor market in each Brazilian microregion (Tables 2 and 3) and through sectors (Tables 4 and 5). However, as these regions have different structural and productive characteristics, it is essential to verify whether the effects on women also vary, depending on these characteristics.

We have selected some microregional structural characteristics in 2000 and separated the data into terciles to know the effects on women of regions more or less affected by the chosen characteristics. In all specifications, models are estimated by 2SLS. Table 7 shows the results in different microregions: with more educated and less educated workers[10] (Columns 1 and 2), in the richest and the poorest[11] (Columns 3 and 4), and more or less populated[12] (Columns 5 and 6).

For the gender wage ratio (Panel A), we find interesting results, primarily through the imports channel (IS_{mt}), since most of the coefficients were higher than those of the main specifications – 2.11 pp with 5% of significance (Table 3, Panel A, Column 4).

Regarding different levels of education, we find no evidence that the gender wage ratio is affected by the China Shock in microregions with a higher concentration of college degree

[10] Microregions more educated are those with a higher proportion of workers that concluded college education, while less educated are those with a higher proportion of workers that concluded elementary school, both in 2000.
[11] Richest and Poorest microregions are defined by their level of income per capita in 2000.
[12] More or less populated microregions are defined by their total population in 2000.

workers. On the other hand, we find that the trade shock has been quite positive for female workers wages in low education regions since the IS_{mt} channel has an effect of 3.22 pp on the gender wage ratio and a slightly negative impact due to the XD_{mt}, of -0.468 pp.

The IS_{mt} impact on average women's relative wage was positive both in richer and poorer microregions. However, it was higher in the poorest regions, with a 7.26 pp increase in gender wage ratio at 5% significance (Panel A, Column 4). For microregions with different population sizes, we find significance only in those less populated, with the IS_{mt} increasing the gender wage ratio by 7.39 pp at 5% significance (Panel A, Column 6).

Panels B and C of Table 7 shows the heterogeneity results for the evolution of women's and men's hourly wages separately. In the poorest, the richest and in less populated locations, we can see that the positive effect of the IS_{mt} on their gender wage ratios was driven by an increase in wages for women, while this channel did not affect men's wages. Regarding the effect of XD_{mt}, we can see that they are positive for men and women, with few exceptions that did not have significance.

Table 7 – Heterogeneity Results by Structural Characteristics: Effects of China Shock on Hourly Wages of Formal Women and Men by Microregion

	More Educated (1)	Less Educated (2)	Richest Microregions (3)	Poorest Microregions (4)	More Populated (5)	Less Populated (6)
Panel A: $\Delta lnWage_{female/male}$						
IS_{mt}	0.585	3.22**	3.78***	7.26**	1.73	7.39**
	(1.14)	(1.53)	(1.36)	(3.46)	(1.24)	(3.43)
XD_{mt}	-0.028	-0.468***	0.015	-1.48	0.043	-0.526
	(0.128)	(0.145)	(0.178)	(1.75)	(0.370)	(0.321)
Panel B: $\Delta lnWomen_{hourly\ wage}$						
IS_{mt}	0.318	2.29	3.63*	11.6**	-0.042	8.56**
	(1.03)	(1.41)	(2.13)	(4.93)	(0.803)	(4.37)
XD_{mt}	1.27**	0.356	1.96***	2.80**	0.521	1.02**
	(0.593)	(0.219)	(0.321)	(1.19)	(0.470)	(0.513)
Panel C: $\Delta lnMen_{hourly\ wage}$						
IS_{mt}	-0.326	-1.37	-0.025	4.27	-1.82*	0.677
	(1.09)	(1.75)	(1.77)	(4.04)	(0.933)	(4.26)
XD_{mt}	1.33*	0.868***	1.92***	4.34	0.496**	1.52***
	(0.681)	(0.232)	(0.262)	(2.68)	(0.219)	(0.575)
Observations	137	137	137	137	137	137

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in the *ln* gender wage ratio (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) wages separately in the Brazilian formal labor market by microregion. All models were estimated by 2SLS, in microregions more (1) and less (2) educated, richest (3) and poorest (4) and in more (5) and less (6) populated. As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions. Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

In table A1 of Appendix A, we have the heterogeneity results for employment. We could not find many significant results, but there is an interesting trend regarding microregions with less educated workers (Column 2). By looking at the import channel effects, we can see that there is a drop in the relative participation of women by 1.07 pp. However, we find evidence that this result is pulled by men, since they have experienced a 6.54 pp drop in their employment, while for women, this drop was of 1.10 pp.

In Table 8, we create terciles for each of the major economic sectors defined in the previous section, separating the microregions[13] more intensive in the production of agricultural and extractive goods (1), in manufacturing (2), and services (3).

In microregions specialized in agriculture and services (Columns 1 and 3), although we did not find changes on the gender wage ratio from either channel, the effects are positive and similar for men's and women's wages due to the export channel.

In microregions specialized in manufacturing (Column 2), the import channel affects the gender wage ratio positively (Panel A). We already expected this result on the gender wage ratio since the Chinese import influx tends to be harmful to the total manufacturing workforce (COSTA et al., 2016). However, as women participate less in manufacturing, they tend to be less affected than men by the shock, with relative wage improvements (BRUSSEVICH, 2018).

[13] Microregions intensive in the production of a major sector *s* are defined by the total number of formal workers allocated in each one of them during 2000. For example, microregions specialized in manufacturing are those with a higher proportion of formal workers allocated in this sector.

Indeed, in Panels B and C, we can see that the imports channel is related to an increase in the women's hourly wages by 3.15 pp at 1% of significance, while did not present statistical relation with changes in the men's wages.

Table 8 – Heterogeneity Results by Productive Characteristics: Effects of China Shock on Hourly Wages of Formal Women and Men by Microregion

	Specialized in Agricult. + Extract. (1)	Specialized in Manufacturing (2)	Specialized in Services (3)
Panel A: $\Delta lnWage_{female/male}$			
IS_{mt}	2.80	2.86**	0.203
	(2.42)	(1.21)	(1.28)
XD_{mt}	0.459	-0.759**	-0.392
	(0.357)	(0.380)	(0.383)
Panel B: $\Delta lnWomen_{hourly\ wage}$			
IS_{mt}	3.45	3.15***	0.412
	(4.17)	(1.17)	(1.22)
XD_{mt}	1.60**	0.499	2.70***
	(0.707)	(0.475)	(0.410)
Panel C: $\Delta lnMen_{hourly\ wage}$			
IS_{mt}	0.579	-0.236	0.242
	(2.37)	(1.21)	(1.53)
XD_{mt}	1.14**	1.35***	3.09***
	(0.525)	(0.490)	(0.414)
Observations	137	137	137

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in the *ln* gender wage ratio (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) wages separately in the Brazilian formal labor market by microregion. All models were estimated by 2SLS, in microregions specialized in agriculture and extractive activities (1), in manufacturing (2) and in services (3). As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions. Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

Table A2 in Appendix A shows the China Shock heterogenous effects on employment, depending on microregional productive characteristics. Regarding the IS_{mt} channel, we observe a negative effect on women's employment in microregions specialized on agriculture and manufacturing (Panel B), with no significant changes in their relative participation (Panel A). On the other hand, the XD_{mt} channel have negative effects for the women's employment in microregions specialized in services, in absolute and relative terms (Panels A and B).

4.3. Results in Short, Medium and Long Terms

In order to check if the microregional results can vary throughout different periods, we decided to repeat the main specification (2SLS model with state fixed effects) considering three other time intervals: 2000-2005, 2000-2010 and 2000-2015, which represents short, medium and long terms, respectively. We also consider our main results on 2000-2013 interval in these tables, to compare the results' trends.

Table 9 shows the China Shock's effects on the relative employment (Panel A), and on women's (Panel B) and men's (Panel C) employment separately in four different periods: 2000-2005, 2000-2010, 2000-2013 and 2000-2015.

Regarding the women's relative formal employment in Panel A, we notice that the imports channel tends to remain negative in each period with no significance only in 2000-2013 interval. However, the coefficient's magnitude diminishes throughout years. Between 2000 and 2005, the IS_{mt} effect on the relative employment of women was of -4.91 pp, while between 2000 and 2015, this effect was of -0.795 pp, indicating that the effect of the trade shock is diluted in the long run. The exports channel results' present this same trend, but we find some significance only in the 2000-2005 and 2000-2010 intervals (10% of significance).

When we look to the effects for women's and men's employment separately, we do not find trends that could be helpful to explain the panel A results. For women's employment (Panel B), only the first interval has some significance, showing that the IS_{mt} channel worsens their situation in the short term (2000-2005). On the other hand, we observe that the XD_{mt} channel was positive for men's employment (Panel C), but the magnitude decreases over time, losing significance in 2000-2015 interval.

Table 9 – Effects of China Shock on Employment of Formal Women and Men by Microregion: Short, Medium and Long Terms

	Short Term (2000-2005) (1)	Medium Term (2000-2010) (2)	Main Specification (2000-2013) (3)	Long Term (2000-2015) (4)
Panel A: $\Delta Relative_{participation}$				
IS_{mt}	-4.91***	-1.24***	-0.429	-0.795**
	(1.10)	(0.393)	(0.318)	(0.384)
XD_{mt}	-1.19*	-0.139*	-0.100	-0.119
	(0.627)	(0.0824)	(0.071)	(0.114)
Panel B: $\Delta lnWomen_{employment}$				
IS_{mt}	-15.4*	-1.42	-1.40	-4.08
	(9.01)	(3.59)	(2.91)	(3.93)
XD_{mt}	0.747	0.464	0.335	0.323
	(2.21)	(0.382)	(0.326)	(0.443)
Panel C: $\Delta lnMen_{employment}$				
IS_{mt}	7.05	4.69	1.17	0.222
	(10.7)	(4.25)	(2.86)	(3.71)
XD_{mt}	6.43*	1.11*	0.685*	0.761
	(3.60)	(0.589)	(0.411)	(0.587)
Observations	411	411	411	411

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in women's relative employment (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) employment separately in the Brazilian formal labor market by microregion, estimated by 2SLS with state fixed effects, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). Column (1): changes in 2000 - 2005; Column (2): changes in 2000 - 2010; Column (3): changes in 2000-2013; Column (4): changes in 2000 – 2015. As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions (91 clusters). Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

Table 10 shows the China Shock's effects on the gender wage ratio (Panel A), and on women's (Panel B) and men's (Panel C) wages separately in four different periods: 2000-2005, 2000-2010, 2000-2013 and 2000-2015. To compare the results, all wages were deflated according 2013.

Considering the gender wage ratio (Panel A), we can see that the coefficients were significant in only two periods. In the short term (2000-2005), the imports channel was quite adverse for women, since a U$S 1000 increase on Chinese imports per worker produces a 15.4 pp drop on the gender wage ratio. However, in the long term, there is a turn out: the IS_{mt} causes an increase in the gender wage ratio of 2.11 pp with 5% of significance in the 2000-2013 interval. The XD_{mt} channel does not produce effects on the gender wage ratio in any period.

Taking the wages separately, we can see other interesting trends. Observing the imports channel effects, the results were positive and significant for women's wages only in the long term – 3.38 pp in 2000-2013 interval and 3.20 pp in 2000-2015 interval – while for men's wages, the results were positive and significant only in the short term – 12.3 pp in 2000-2005 interval. However, regarding the exports channel, the effects were similar for both genders: the coefficients were all positive, with some variations in magnitude and significance throughout the years.

Table 10 – Effects of China Shock on Hourly Wages of Formal Women and Men by Microregion: Short, Medium and Long Terms

	Short Term (2000-2005) (1)	Medium Term (2000-2010) (2)	Main Specification (2000-2013) (3)	Long Term (2000-2015) (4)
Panel A: $\Delta lnWage_{female/male}$				
IS_{mt}	-15.1***	-1.18	2.11**	1.62
	(4.39)	(1.76)	(1.03)	(1.29)
XD_{mt}	-3.20	-0.479	-0.207	-0.292
	(2.50)	(0.355)	(0.233)	(0.344)
Panel B: $\Delta lnWomen_{hourly\ wage}$				
IS_{mt}	-1.74	1.52	3.38***	3.20**
	(4.39)	(1.63)	(1.29)	(1.45)
XD_{mt}	5.63**	0.847*	1.24**	1.64***
	(2.35)	(0.440)	(0.614)	(0.446)
Panel C: $\Delta lnMen_{hourly\ wage}$				
IS_{mt}	12.3***	2.27	1.02	1.44
	(4.00)	(1.84)	(1.12)	(1.44)
XD_{mt}	9.16**	1.42*	1.51**	2.01***
	(4.02)	(0.751)	(0.762)	(0.616)
Observations	411	411	411	411

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in the *ln* gender wage ratio (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) wages separately in the Brazilian formal labor market by microregion, estimated by 2SLS with state fixed effects, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). Column (1): changes in 2000 - 2005; Column (2): changes in 2000 - 2010; Column (3): changes in 2000-2013; Column (4): changes in 2000 – 2015. As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. N = 411 microregions. Standard errors in parentheses, clustered by mesoregions (91 clusters). Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

4.4. Robustness Checks

In order to check if our main specification's results are robust, we make two different robustness tests. In the first one, we made modifications to the instruments (3a and 3b) to see how sensitive the results are to changes in the countries that trade with China. We chose three different groups of countries. The first is the variation in trade flows between China and South American countries (Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, and Venezuela), chosen by Benguria and Ederington (2017) as their principal instrument. Then, we added another 10 countries[14] to verify the trade between China and Latin America. Finally, we analyze the trade variations between China and the other BRICS countries: Russia, India, and South Africa. In the second test, we opted for a placebo test, by regressing the China Shock measures (2000 – 2013) on changes in past dependent's variables (1995-2000).

Table 11 summarizes the test results on wages. All models were estimated by 2SLS, with fixed state effects, and after underidentification and weak identification tests, we confirmed the validity of the instruments. In Column 1, we have the results of our preferred specification for comparative purposes. In the other columns, we have the results using the South American (2), Latin American (3), BRICS (4) instruments, and for the placebo test (5).

[14] Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Cuba, Haiti, Dominican Republic.

Table 11 – Robustness Results: Effects of China Shock on Hourly Wages of Formal Women and Men by Microregion

	Main Specification (1)	South America Instrument (2)	Latin America Instrument (3)	BRICS Instrument (4)	Placebo Test (1995-2000) (5)
Panel A: $\Delta lnWage_{female/male}$					
IS_{mt}	2.11**	2.87***	2.41**	3.00**	0.195
	(1.03)	(1.07)	(1.03)	(1.29)	(1.75)
XD_{mt}	-0.207	0.329	0.362	-0.222	0.238
	(0.233)	(0.447)	(0.455)	(0.291)	(0.334)
Panel B: $\Delta lnWomen_{hourly\ wage}$					
IS_{mt}	3.38***	4.03***	3.96***	4.40**	0.007
	(1.29)	(1.40)	(1.31)	(1.82)	(1.83)
XD_{mt}	1.24**	1.69***	1.69***	1.59**	-0.415
	(0.614)	(0.531)	(0.552)	(0.646)	(0.331)
Panel C: $\Delta lnMen_{hourly\ wage}$					
IS_{mt}	1.02	0.885	1.28	1.20	-1.14E-05
	(1.12)	(0.966)	(1.11)	(1.21)	(1.23)
XD_{mt}	1.51**	1.44**	1.39**	1.89**	-0.704
	(0.762)	(0.651)	(0.645)	(0.799)	(0.483)
Observations	411	411	411	411	411

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between 2000 and 2013 in women's hourly wages (Panel A) and in men's hourly wages (Panel B) in the Brazilian formal labor market by microregion. All models were estimated by 2SLS, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). In Column (1) we have our main specification, using the IV with all countries (except Brazil). In the others, we use IV with South American countries (2), with Latin American countries (3) and BRICS countries (4). As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions. Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

In columns (2) to (4), the signs of the results are the same in most specifications, with some changes in magnitude and significance compared with the main estimates. As in the latter, the results suggest that China Shock improved the female workers' salaries relative to men (Panel A), with women benefited by the import channel, while both men and women have improvements in their wages due to the export channel. In column (5), as expected, we did not find effects of the "future" China Shock measures on wages' changes between 1995 and 2000. In table A3 of Appendix A, the robustness checks also have the expected effects on employment.

5. FINAL REMARKS

This work explores the China Shock variation across Brazilian local labor markets to identify whether China shock affects Brazil female labor market conditions between 2000 and 2013. Female formal sector participation and female to male wage ratio are the two measures of female labor market conditions used. Brazil experienced two channels from China Shock: the commodities exports risen to China, and imports risen from China, making Brazil an interesting case to study winners and losers from trade (COSTA et al., 2016). This work is the first study to assess how these two channels affected the labor outcomes of Brazilian women.

Like Gaddis and Pieters (2017), our findings suggest that both China Shock channels has worsened women's entry into the formal market in Brazilian microregions most exposed to the shock. However, the result is not robust across specifications.

Regarding the imports channel, for women who remained in the formal market, this shock has improved their wages relative position. Contrary to Benguria and Ederington (2017) and Cavalcanti et al. (2020) findings, this women's wage relative improvement was not due to the wage worsening of men. Looking at women's and men's hourly wages separately results we verify an increase in women's wages promoting gender wage ratio improvement. At the same time, we do not find statistical effects on men's wages.

Although we could not find robust changes in the gender wage ratio due to the exports channel, we consistently find that men and women benefit from the China exports increases, with an increase in their hourly wages.

Regarding the results in major sectors, we can see that the China Shock produce winners and losers. Observing the China Shock’s imports channel effects on manufacturing, we notice that it favors the women’s formal employment and their salaries, while there are not robust effects for men. At the same time, considering agriculture and extractive activities, we can see

that the exports channel benefits men's formal employment, with not significant effects for women.

The China Shock effects on women tend to be heterogeneous conditional on initial microregional characteristics. Formal female workers experience rises in relative wages in disadvantaged regions - less educated, poorest, and less populated -, and manufacturing-intensive regions.

Considering the China Shock effects in different periods, we notice that the imports channel's impact on women's relative formal employment tends to remain negative in the short, medium, and long run. However, the coefficient's magnitude diminishes throughout years. Taking the wages separately for men and women, we can see that the imports channel effects were positive and significant for men in the short term, while for women, this same trend occurs only at the long run. Finally, towards the exports channel, the effects were similar for both genders - the coefficients were all positive, with some variations in magnitude and significance throughout the years.

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APPENDIX A – Additional Results Tables

Table A1 – Heterogeneity Results by Structural Characteristics: Effects of China Shock on Employment of Formal Women and Men by Microregion

	More Educated (1)	Less Educated (2)	Richest Microregions (3)	Poorest Microregions (4)	More Populated (5)	Less Populated (6)
Panel A: $\Delta Relative_{participation}$						
IS_{mt}	-0.103	-1.07**	-0.719	0.409	-0.009	-0.202
	(0.281)	(0.539)	(0.491)	(0.949)	(0.243)	(1.07)
XD_{mt}	-0.008	0.007	0.015	0.002	0.208	-0.007
	(0.052)	(0.047)	(0.039)	(0.372)	(0.151)	(0.120)
Panel B: $\Delta lnWomen_{employment}$						
IS_{mt}	-3.86	-1.10***	-1.60	3.73	-4.58*	0.237
	(2.51)	(3.51)	(4.53)	(5.37)	(2.64)	(6.97)
XD_{mt}	0.573	0.725*	0.981**	-1.44	0.396	0.727
	(0.480)	(0.375)	(0.440)	(2.38)	(0.455)	(0.616)
Panel C: $\Delta lnMen_{employment}$						
IS_{mt}	-3.24	-6.54**	1.44	2.61	-4.41*	1.57
	(2.64)	(2.97)	(4.83)	(5.84)	(2.37)	(5.64)
XD_{mt}	0.509	0.770**	0.768*	-0.609	-0.388	1.25
	(0.319)	(0.304)	(0.420)	(1.61)	(0.450)	(0.777)
Observations	137	137	137	137	137	137

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in women's relative employment (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) employment separately in the Brazilian formal labor market by microregion. All models were estimated by 2SLS, in microregions more (1) and less (2) educated, richest (3) and poorest (4) and in more (5) and less (6) populated. As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions. Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

Table A2 – Heterogeneity Results by Productive Characteristics: Effects of China Shock on Employment of Formal Women and Men by Microregion

	Specialized in Agricult. + Extract. (1)	Specialized in Manufacturing (2)	Specialized in Services (3)
Panel A: $\Delta Relative_{participation}$			
IS_{mt}	-0.263	-1.04	-0.302
	(0.565)	(0.664)	(0.570)
XD_{mt}	-0.049	0.149	-0.268***
	(0.071)	(0.180)	(0.090)
Panel B: $\Delta lnWomen_{employment}$			
IS_{mt}	-5.72**	-9.47***	0.196
	(2.86)	(3.35)	(2.83)
XD_{mt}	0.123	0.393	-1.42*
	(0.344)	(0.452)	(0.746)
Panel C: $\Delta lnMen_{employment}$			
IS_{mt}	-4.19	-4.45	1.03
	(3.05)	(4.52)	(1.97)
XD_{mt}	0.334	-0.165	-0.365
	(0.473)	(0.859)	(0.635)
Observations	137	137	137

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in women's relative employment (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) employment separately in the Brazilian formal labor market by microregion. All models were estimated by 2SLS, in microregions specialized in agriculture and extractive activities (1), in manufacturing (2) and in services (3). As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions. Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.

Table A3 – Robustness Results: Effects of China Shock on Employment of Formal Women and Men by Microregion

	Main Specification (1)	South America Instrument (2)	Latin America Instrument (3)	BRICS Instrument (4)	Placebo Test (1995-2000) (5)
Panel A: $\Delta Relative_{participation}$					
IS_{mt}	-0.429	-0.701***	-0.313	-0.577**	0.247
	(0.318)	(0.258)	(0.436)	(0.258)	(0.425)
XD_{mt}	-0.100	-0.135	-0.131	-0.059	0.0656
	(0.0708)	(0.131)	(0.134)	(0.104)	(0.0740)
Panel B: $\Delta lnWomen_{employment}$					
IS_{mt}	-1.40	-2.78	-1.26	-0.857	-0.190
	(2.91)	(2.69)	(3.22)	(2.78)	(2.23)
XD_{mt}	0.335	-0.018	-0.038	0.460	-0.354
	(0.326)	(0.465)	(0.470)	(0.444)	(0.263)
Panel C: $\Delta lnMen_{employment}$					
IS_{mt}	1.17	0.875	0.929	2.32	-1.13
	(2.86)	(2.89)	(2.93)	(2.83)	(1.75)
XD_{mt}	0.685*	0.656	0.636	0.623	-0.724*
	(0.411)	(0.652)	(0.652)	(0.525)	(0.380)
Observations	411	411	411	411	411

Notes: This table displays estimated effects of China Shock (IS_{mt} and XD_{mt}) on changes between periods in women's relative employment (Panel A) and *ln* women's (Panel B) and *ln* men's (Panel C) employment separately in the Brazilian formal labor market by microregion. All models were estimated by 2SLS, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). In Column (1) we have our main specification, using the IV with all countries (except Brazil). In the others, we use IV with South American countries (2), with Latin American countries (3) and BRICS countries (4). As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers, the log of formal women's (men's) employment and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions. Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. *** p <0.01, ** p <0.05, * p <0.1. Sources: RAIS microdata and BACI database.