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Effects of International Trade on Education: Evidence from China Shock in Brazil

Efeito do Comércio Internacional sobre a Educação: Evidência do Choque da China no Brasil

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Effects of International Trade on Education: Evidence from China Shock in Brazil

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Abstract

In this work, we explore the exposure to trade with China to identify the causal effect of international trade on enrollment in Brazilian municipalities. We employ an instrumental variable approach, where the source of trade exposure among regions of the country varies depending on economic specialization. We find evidence that regions more exposed to exports to China are associated with a reduction in the proportion of people enrolled in basic education. Several pieces of evidence indicate that the variation in enrollment may be induced by an increase in the opportunity cost of education due to increased in income for individuals of school age.

Keywords: china shock, trade, education, enrollment.

Resumo

Neste trabalho, exploramos a exposição ao comércio com a China para identificar o efeito causal do comércio internacional na matrícula nos municípios brasileiros. Utilizamos uma abordagem de variáveis instrumentais, onde a fonte de exposição ao comércio entre as regiões do país varia dependendo da especialização econômica. Encontramos evidências de que regiões mais expostas a exportações para a China estão associadas a uma redução na proporção de pessoas matriculadas na educação básica. As evidências indicam que a variação na matrícula pode ser induzida pelo aumento do custo de oportunidade da escolaridade devido ao aumento da renda para indivíduos em idade escolar.

Palavras-chave: choque da china, comércio internacional, educação, matrícula.

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1 Introduction

The incentives generated from trade liberalization can alter educational incentives in the economy? There is a range of theoretical articles that seek to understand the relationship between trade liberalization and individuals' skill acquisition (Findlay; Kierzkowski, 1983; Davidson; Sly, 2014; Ferriere; Navarro; Reyes-Heroles, 2018). The main lessons drawn from the models suggest that a skill-biased shock in the international market can increase the returns to skill-intensive activities and stimulate individuals' educational attainment. However, the increase in exposure to international trade is not always skill-biased (Atkin, 2016), therefore, the educational incentives from the international market shock can be ambiguous. In this dissertation, we seek to identify the effect of trade on education in Brazil by exploring a plausible exogenous shock from international trade.

Due to China's prominence in the international market, there is growing empirical evidence that assesses the effects of the international trade shock through changes in trade with China. The main findings from this literature document that an import shock of manufactured goods from China can reduce employment and income for workers (Autor; Dorn; Hanson, 2013), impact family formation (Autor; Dorn; Hanson, 2019), government revenue and expenditures (Feler; Senses, 2017). In Brazil, China has also increased its relevance as a trading partner. Real growth in Chinese product imports to Brazil between 2000 and 2020 was 537.08%, while exports grew by 455.27% during the same period.

Given its prominence in international trade, China appears to be an interesting source of variation to assess the effect of trade on education in Brazil. It is believed that China's prominence in the international market is due to exogenous factors such as structural changes and market-oriented initiatives (Autor; Dorn; Hanson, 2013; Naughton, 2007). Therefore, we employ a widely used instrumental variable strategy in the literature, where our identification strategy is based on the fact that trade has heterogeneous effects among municipalities due to different labor market structures. Similar to Costa, Garred and Pessoa (2016), we consider the heterogeneity of negotiations with China, also taking exports into account in our estimates, as the country has also been an important demand of Brazilian products.

We found evidence that regions more exposed to exporting products to China are associated with reductions in enrollment for the entire population. The estimates remain robust across a range of different specifications and different standard error estimates. Our results suggest that a USD 1,000 increase in exports reduces the proportion of individuals enrolled by 0.1775 percentage points. This estimate indicates that an increase of one standard deviation in export exposure reduces the enrollment rate by 0.275 percentage points. On the other hand, there is no significant evidence of an effect on the import side.

We then investigated the effect of the trade shock with China on enrollment for different age groups. The estimates suggest that regions more exposed to the import shock to China reduce the enrollment rate for those aged between 06 to 14 years old. On the other hand, regions more exposed to an export shock from China decrease the enrollment rate among children and teenagers aged 11 to 14. We also explored heterogeneity in the effects of the trade shock on enrollment by age, gender, and race. The impacts of trade with China affect all groups similarly.

The effect was also analyzed considering different income heterogeneities. The estimates indicate that regions more exposed to an export shock to China may reduce the proportion of individuals enrolled from the second income quartile. On the other hand, regions more exposed to the import shock from China may increase the proportion of individuals enrolled in basic education, also from those in the second income quartile.

Theoretical literature establishes one of the primary channels through which international trade can affect education is through the opportunity cost (Findlay; Kierzkowski, 1983). However, an international market shock also has the capacity to impact household income and thus influence educational decisions. Therefore, we explore the possible mechanisms of these effects by evaluating the China shock's impact on variables associated with family income and the labor market.

We found evidence that regions more exposed to the export shock to China tend to reduce poverty. In contrast to the results found, these estimates suggest that an export shock can have a positive effect on enrollment due to higher household income. On the other hand, regions more exposed to the import shock from China increase the growth of average wage, include those in school age. Hence, the decrease in school enrollment due to the trade seems be a consequence of the increased opportunity cost of education, as young individuals may achieve higher incomes in the labor market.

This study contributes to the literature by providing evidence of the effect of an exogenous shock in the international trade on education in Brazil. This work is related to the studies of Burga and Turner (2023), Greenland and Lopresti (2016) and Ferriere, Navarro and Reyes-Heroles (2018), who examined the effect of the China shock on education in the United States. They found evidence that a China import shock increases enrollment in the United States as an alternative way to mitigate the negative effects on the labor market.

More broadly, this work is related to the theoretical literature that links international trade and skill acquisition (Findlay; Kierzkowski, 1983). This literature explores how trade liberalization can influence individual decisions regarding education. We contribute to this literature by providing empirical evidence that aligns with the theoretical relationships in the literature.

In this sense, we also contribute to the literature that empirically investigates the relationship between trade and education. An important reference in this topic is Atkin (2016), who provides evidence that the growth of exports of less skill-intensive products in Mexico increases school dropout rates. Another work in this area is Carrillo (2020), which studies the effect of a positive income shock due to variations in the international coffee price on educational decisions in Colombia. The results suggest that this income shock increases the opportunity cost of schooling and consequently raises the school dropout rate. Another significant work in this theme is by Blanchard and Olney (2017), who investigate the effect of export composition on education. They found evidence that the export of skill-intensive products increases education levels, while the opposite occurs with the export of less skill-intensive products.

Finally, our work is related to the literature on the China Shock effect. Many articles focus on the effect of Chinese imports on the labor market (Autor; Dorn; Hanson, 2013), family composition (Autor; Dorn; Hanson, 2019), and government revenue (Feler; Senses, 2017). In our paper, similar to Costa, Garred and Pessoa (2016), we also consider the effects of the export shock. In this literature, we provide evidence of the China Shock's impact on other socioeconomic variables in a developing country.

This dissertation is structured into six chapters in addition to this introduction. The second chapter provides a brief literature review on trade and education and the China Shock. In the third chapter, we present the theoretical model that links trade and education. The fourth chapter discusses the data and descriptive statistics of the study, the fifth chapter outlines the identification strategy to recover the causal effect. In the sixth chapter, we present our main results, and finally, the conclusions are presented.

2 Literature Review

The rapid growth in China's relevance in trade with the rest of the world has been the object of study among economists regarding the effects of the shock in the international market on the labor market. The seminal work by Autor, Dorn and Hanson (2013) finds evidence that an increase in competition from Chinese products in the United States reduces employment in manufacturing, as well wages, with the effects being more pronounced among unskilled workers (Autor et al., 2014). On the other hand, changes in the labor market induced by trade liberalization can influence decisions regarding skill acquisition and alter the educational behavior of individuals (Findlay; Kierzkowski, 1983; Davidson; Sly, 2014; Ferriere; Navarro; Reyes-Heroles, 2018). In this chapter, we investigate how shocks from international trade with China can influence school enrollments in Brazil.

Market-oriented structural changes in China are believed to be driving the country's expanding importance in the international trade. Over the last few decades, Chinese society has undergone a swift transformation from rural to urban, lead to increase in urbanization rates. China's investments in physical capital and technology have solidified the skill-intensive sector and improved the accumulation of human capital and workforce productivity (Naughton, 2007). Evidence suggests that these structural changes have diversified the Chinese industry and integrated the production process (Borghi, 2023).

These changes, associated to China's entry into the World Trade Organization in the early 21st century, have conferred relevance to the country in international trade, with significant growth in trade flows with the rest of the world. Between 2000 and 2020, China's exports experienced a real growth of 455.27% (deflated by the implicit GDP deflator of the United States calculated by BEA[1]), and 537.08% for imports. Figure A.1 illustrates the evolution of Chinese trade. For the rest of the world, excluding China, growth was 46.9% for exports and 47.3% for imports. These high rates make China an important trading partner with various countries.

In Brazil, both the share of exports and imports to China have been gradually increasing over the past decades. In 2000, 2% of Brazilian exports were directed to China, while in 2010 and 2020, this share reached 15% and 31%, respectively. On the import side, around 2% of imports came from China in 2000, and in 2010 and 2020, the import share was 14% and 22% respectively. Figure A.2 illustrates the evolution of China's share in Brazilian exports and imports. The main sectors that benefited from exports to China were extraction and agriculture, together accounting for over 83% of the variation between 2000 and 2010. On the other hand, the manufacturing sector has faced more competition

[1] (BEA) U.S. Bureau of Economic Analysis. Implicit Price Deflators for Gross Domestic Product.

from Chinese products, where over 99% of the variation in imports between 2000 and 2010 consisted of manufactured goods. Figure A.3 highlights the evolution of negotiations between Brazil and China by sector. Therefore, the China shock in Brazil appears to be an interesting source of variation to assess the effects of trade on education.

The import shock from Chinese products has documented significant negative effects on the labor market in the United States (Autor; Dorn; Hanson, 2013; Autor et al., 2014). General equilibrium models in the literature have found that this shock accounts for about 16% of the reduction in US manufacturing jobs between 2000 and 2007, and 28% between 2000 and 2014, being one of the main factors for the decline in employment in the sector (Caliendo; Dvorkin; Parro, 2019; Acemoglu et al., 2016; Dix-Carneiro et al., 2023). On the other hand, Bloom et al. (2019) highlights that the effect is heterogeneous across sectors, suggesting that there is a reallocation of employment and firms to the non-manufacturing sector, and the sectors most exposed to Chinese products are the unskilled labor-intensive, therefore, overall, the China Shock seems to be positive in areas with higher human capital.

In addition to the effect on the labor market in the United States, there is also evidence that the China import shock reduces government revenue and spending (Feler; Senses, 2017), family formation and health, with positive effects on mortality and the proportion of children living in single-parent families (Autor; Dorn; Hanson, 2019), increases the risk of injury, especially in small businesses (McManus; Schaur, 2016), and reduces investment in research and development (Autor et al., 2020).

Costa, Garred and Pessoa (2016) explores the effects of the China shock on the labor market in Brazil. However, since there is also a significant increase in exports to China of Brazilian products, the authors also examine the export shock. The evidence shows that increased competition from Chinese products reduces the wage growth rate in the manufacturing sector. Nevertheless, an export shock is associated with higher overall wage levels and a greater proportion of workers in formal jobs.

There is a range of theoretical articles seeking to understand the relationship between the international market and individuals' acquisition of new skills. The seminal work by Findlay and Kierzkowski (1983) argues that increased exports resulting from the trade liberalization of the skilled (unskilled) sector raise the relative wage, thus encouraging (discouraging) individuals to seek qualification. In this regard, the theoretical discussion sheds light on the notion that the heterogeneity of the sector to which the country is exposed plays a relevant role in education. Empirical evidence appears to support the theoretical relationship, the results of Blanchard and Olney (2017) suggest that exports of goods with unskilled intensity decrease average years of schooling, whereas the opposite occurs with exports of skill-intensive goods.

In the literature, there is evidence that an export shock of unskilled products can increase incomes and the quantity of jobs in the unskilled sector, which raises the opportunity cost for students and thus reduces the proportion of enrolled individuals (Atkin, 2016; Carrillo, 2020; Hou; Karayalcin, 2019; Liu, 2023; Lin; Long, 2020). On the other hand, trade liberalization has a significant income component that plays an important role and may be a positive influence on education. Edmonds and Pavcnik (2005) highlights that the income effect from a positive shock in the international market can reduce child labor, serving as an important channel to increase time allocation to schools in poor countries (Edmonds, 2010). In the United States, however, imports of unskilled manufactured products from China have evidence of increasing high school enrollment and completion (Burga; Turner, 2023; Greenland; Lopresti, 2016; Ferriere; Navarro; Reyes-Heroles, 2018).

3 Theoretical Model

There is a range of theoretical papers that aims to understand how the liberalization of international trade can influence skill acquisition in an economy. The main link between trade and education is driven by opportunities in the job market, with changes in wages that encourage individuals to seek (or not) the acquisition of new skills. One of the relevant points of this literature is the emphasis on the heterogeneous effect of exports on education (Findlay; Kierzkowski, 1983; Davidson; Sly, 2014; Ferriere; Navarro; Reyes-Heroles, 2018). Understanding this inequality of effects is important for directing public policies, given that trade liberalization is not always geared towards skill-intensive products (Atkin, 2016).

The seminal contribution that explores the impact of trade liberalization on skill acquisition is Findlay and Kierzkowski (1983). The authors describe a model with two countries, two goods, and two factors based on the Heckscher-Ohlin model, where the goods differ in the skill intensity. The model suggest that when a country increases the export of skilled intensive products, there is a rise in the relative wage in that sector, and this encourages individuals to acquire education to take advantage of the additional gain generated by trade liberalization. On the other hand, an increase in the export of the unskilled intensive sector can raise the income of unskilled labor compared to skilled labor and incentives people not to pursue education.

Falvey, Greenaway and Silva (2010) incorporate heterogeneity in individuals' academic abilities and allow workers to specialize at any stage of life, providing analysis for people of different ages. The theoretical model suggests that an unanticipated increase in the export of skill intensive products raises earnings for skilled workers and students, on the other hand, leads to a loss of well-being for those in unskilled jobs, especially for the younger individuals. Thus, similar to Findlay and Kierzkowski (1983), the model suggests that in the long run, there is an increase in the number of skilled workers and a reduction in unskilled workers.

In this chapter, we describe a simplified model of Findlay and Kierzkowski (1983) to help us understand how international trade can influence acquisition of skill, and mainly, the potential channels of effect. In this discussion, we notice that the change in the relative wage prices generated by trade liberalization can alter the skill premium of skilled labor, and therefore change the opportunity cost of schooling driven to changes in educational behavior.

3.1 The Model

In this model, are considered an economy with two factors: skilled labor and unskilled labor, producing two products and involving two countries. In each economy, N people are born each year with a constant lifetime of T, resulting in a population of NT. All individuals are initially unskilled workers earning a wage of w_u, but they have the opportunity to study for a fixed time period of θ and become skilled workers earning w_s for the rest of their working lives. Let L represent the number of unskilled workers and H represent the number of skilled workers who are studying or working depending on the time. Thus, the number of individuals in the economy can be expressed as:

$$NT = LT + H\theta + H(T - \theta) \tag{3.1}$$

So, LT represents the total number of unskilled workers in the economy, $H\theta$ represents the total number of workers studying to become skilled workers, and $H(T - \theta)$ represents the total number of skilled workers in the labor market of the economy.

The model suppose that are two countries and two firms in each country. Each firm has constant returns to scale, and the markets are competitive, implying that the wages is the efficiency unit (w_u and w_s) common across firms. The firms differ in composition of labor, there are firm skilled intensive, and other unskilled intensive. There is full employment in these countries.

3.2 Education Market

Education transforms an unskilled worker into a skilled worker, endowing them with qualifications. The resources used in the education process, such as teachers, desks, and other items, are denoted by K. Therefore, the production function for qualification can be expressed as follows:

$$Q = f(K, H|\theta) \tag{3.2}$$

Here, Q denotes the total production of qualification. Assuming constant returns to scale and a fixed value of θ, we can express the production function for qualification as follows:

$$q = f(k) \tag{3.3}$$

Where $q = Q/H$ and $k = K/H$, which represents the amount of efficiency and educational resources per students, respectively. Assume that the return of education is diminishing in k, where $\frac{\partial q}{\partial k} = f'(k) > 0$ and $\frac{\partial^2 q}{\partial k^2} = f''(k) < 0$. Knowing that $Q = f(k)H$, thus:

$$\frac{\partial Q}{\partial H} = f(k) - \frac{\partial q}{\partial k}k > 0 \tag{3.4}$$

$$\frac{\partial^2 Q}{\partial H^2} = \frac{1}{H}k^2\frac{\partial^2 q}{\partial k^2} < 0 \tag{3.5}$$

3.3 Connecting Education and Labor Market

Each economy has two firms with constant returns to scale that produce tradable goods for the international market. We denote the goods produced by the firms as y for the skilled labor-intensive firm and x for the unskilled labor-intensive firms. Suppose that each firm use only one factor (those which is intensive) in your production process, with competitive market and no unemployment. Let q represent the efficiency that education brings to skilled workers, and define the skilled workforce as $L_s = q(T-\theta)H$ and the unskilled workforce as $L_u = LT$. Thus, from profit maximization, the wage level of workers is:

$$\begin{aligned} \pi_y &= f(L_s) - w_s H(T-\theta) \\ \frac{\partial \pi_y}{\partial H} &= q(T-\theta)\frac{\partial f(L_s)}{\partial L_s} - w_s(T-\theta) = 0 \\ w_s &= q\frac{\partial f(L_s)}{\partial L_s} \end{aligned} \tag{3.6}$$

$$\begin{aligned} \pi_x &= f(L_u) - w_u LT \\ \frac{\partial \pi_x}{\partial L} &= T\frac{\partial f(L_u)}{\partial L_u} - w_u T = 0 \\ w_u &= \frac{\partial f(L_u)}{\partial L_u} \end{aligned} \tag{3.7}$$

3.4 Educational Decision

Individuals decide whether to acquire skills by taking into consideration the benefits of education for potential future income increases in relation to the direct costs and opportunity costs of attending school. The gross benefit of education is the skilled wage for an individual's entire life after completing school. To calculate the present value of this benefit, we use the real interest rate from the market, denoted as r. We know that the skilled worker's wage is given by $w_s = f(k)\frac{\partial f(L_s)}{\partial L_s}$, we denote $\frac{\partial f(L_s)}{\partial L_s} = w_y$. Therefore:

$$B = \int_\theta^T f(k)w_y \mathrm{e}^{(-rt)}dt = \frac{1}{r}f(k)w_y[\mathrm{e}^{-r\theta} - \mathrm{e}^{-rT}] \tag{3.8}$$

The cost of education is determined by the direct cost associated with the use of school resources while studying ($C(k)$), Findlay and Kierzkowski (1983) consider this cost as the sum of discounted marginal product over the working life at present value, which is represented by $C(k) = \int_{\theta}^{T} w_y f'(k) k \mathrm{e}^{-rt} dt$. In addition, there is an opportunity cost defined by the unskilled wage that the individual would have earned if they were not in school. Therefore, the total cost of education is:

$$E = \int_{\theta}^{T} w_y f'(k) k \mathrm{e}^{(-rt)} dt + \int_{0}^{T} w_x \mathrm{e}^{(-rt)} dt = \frac{1}{r}[w_y f'(k) k (\mathrm{e}^{-r\theta} - \mathrm{e}^{-rT}) + w_x (1 - \mathrm{e}^{-rT})] \quad (3.9)$$

Where $w_x = \frac{\partial f(L_u)}{\partial L_u}$ is the wage from firm intensive in unskilled work. We denote the net benefit of education as the difference between the gross benefit and the total cost of education. Therefore, we can write the net benefit as:

$$\lambda = \frac{w_y}{r}(\mathrm{e}^{-r\theta} - \mathrm{e}^{-rT})\frac{\partial Q}{\partial H} - \frac{w_x}{r}(1 - \mathrm{e}^{-rT}) \quad (3.10)$$

So, from the equation 3.10, note that, all else being constant, an increase in the wage of skilled labor-intensive firms increases the benefit of education through higher future earnings, but it also increases the direct costs of education. If an increase in the wage of unskilled labor-intensive firms is observed, it raises the opportunity cost of education, as students would forego a higher immediate wage by choosing education. If λ is greater than zero, it means that the benefit of education outweighs the costs, thus providing incentives to pursue education. If it's less than zero, it implies that the present value of returns in the unskilled labor market is greater than the skilled labor market, indicating a lack of incentive for education. In this sense, the equilibrium condition of education is when the net benefit of education equals zero, thus we have:

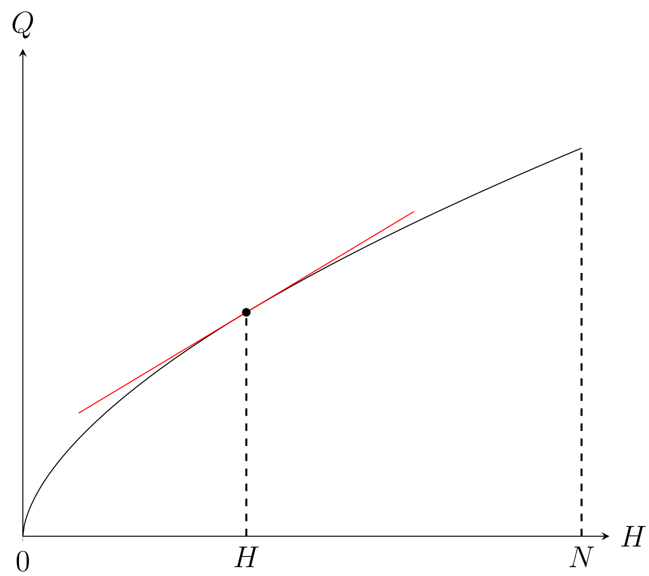
$$\frac{\partial Q}{\partial H} = \frac{w_x}{w_y} D \quad \text{such that} \quad D = \frac{1 - \mathrm{e}^{-rT}}{\mathrm{e}^{-r\theta} - \mathrm{e}^{-rT}} \quad (3.11)$$

Therefore, the equilibrium condition is given when the slope of the education production curve is equal to the ratio of wages in the unskilled and skilled sectors, multiplied by D, which is a constant in this model. We define $w_y/w_x = \mathrm{w}$ as the skill premium, so we can interpret the wage ratio in the equation as the inverse of the skill premium. Figure 1 illustrates the equilibrium condition. The point of tangency represents the quantity of skilled workers in the economy, where the segment from point 0 to H on the x-axis represents the amount of skilled workers, and the difference between N and H indicates the quantity of workers who have chosen to remain unskilled.

3.5 Comparative Statics

From equation 3.11, we obtain the slope at the equilibrium point of production of education. When there is an increase in the skill premium, meaning that the wage of the skilled labor-intensive sector grows more relative to the unskilled labor, it reduces the slope at the equilibrium point given by equation x. Consequently, there is an increase in the proportion of skilled individuals in the economy. This effect stems from the higher earnings in the skilled labor market, which encourage people to seek more qualification. On the other hand, a decrease in the skill premium raises returns in the unskilled sector, thus increasing the opportunity costs of education, and consequently reducing the proportion of skilled workers in the economy.

Figure 1 – Equilibrium Condition



This graph shows the equilibrium condition from equation 3.11.

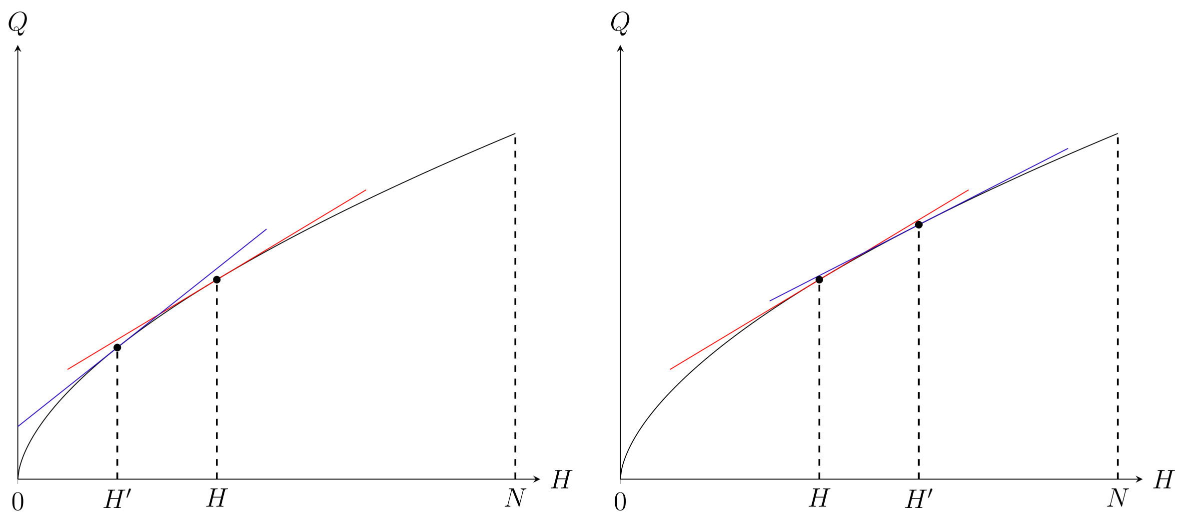
3.6 Trade

Suppose two countries with identical firms, preferences, and educational sector, but differs in educational input, such that $K < K*$. This gives each country a comparative advantage in either unskilled or skilled products. In this model, free trade between these countries leads to a change in relative prices which, under the assumption of competitive markets, directly affects wages. By the Stolper-Samuelson theorem, the unskilled wage increase relatively to the skilled wage in country intensive in unskilled labor, on the other hand, the skilled wage increase in relation to unskilled wage in country intensive in skilled work. Hence, from equation 3.11, the trade driven changes in educational behavioral.

In summary, trade liberalization for the unskilled labor-intensive country stimulates the export of goods from that sector. The relative price changes due to trade encourage a relative increase in wage in the unskilled sector, which reduces the skill premium and thus raises the opportunity cost of education. Consequently, it proportionally reduces the quantity of skilled workers in the economy. On the other hand, for the skilled labor-intensive country, there is an increase in the export of products that require higher intensity of production factors, leading to a rise in the relative wage of that sector. This in turn raises the skill premium, increasing the returns associated with education, and thereby boosting the proportion of qualified individuals. Figure 2 shows the trade effects to each country on educational behavior.

Figure 2 – Theoretical Trade Effects on Educational Behavior

A) Country intensive in unskilled work *B) Country intensive in skilled work*



This graph shows the theoretical effects of trade liberalization on educational behavior. Panel A represent the effect in country intensive in unskilled labor, while the panel B represent the effect in country intensive in unskilled labor.

4 Data Description

To evaluate the effect of trade shocks from China on educational outcomes in Brazil, we calculated the enrollment share by age group in basic education in Brazil using the demographic census. However, a potential identification challenge arises from individuals migrating across municipalities. Costa, Garred and Pessoa (2016) provide evidence that regions more exposed to import shocks from China in Brazil experience a reduction in both in-migrants and out-migrants. In the appendix, we investigate migration as a result of the trade shock from China, the results suggest that an export shock is associated with an increase in in-migration between municipalities. To address this potential issue, we adopt a strategy inspired by Ferriere, Navarro and Reyes-Heroles (2018), where we exclude from the data all households containing at least one individual who resided in another municipality in the last five years.

To access the effect of international trade on enrollment, we construct the index of exposure to international trade with Chinese goods based on information from trade flows stratified by products, using data from *Centre d'Etudes Prospectives et d'Informations Internationales*.

4.1 Enrollment and Social Data

We utilize microdata from Brazilian Demographic Census (*Censo Demográfico*) for 2000 and 2010, which are available through the Brazilian Institute of Geography and Statistics[1] (*IBGE*) to gather information on enrollment in basic education in Brazil. The demographic census contains self-reported social and economic data at individual-level, including information on whether they are currently studying and their current grade of education. We calculate the proportion of people currently enrolled in basic education for those under 25 years old, by age group, and by quantile of income aggregate for municipalities.

Additionally, from the demographic census, we extract economic, social and demographic information at the municipality level. Was calculated the average hourly wage of each individual by dividing the reported monthly income from all jobs by the number of weekly hours worked multiplied by 4.33. To convert all monetary values to their real value in 2010, we deflated them using the consumer price index (*IPCA*) from IBGE. From this data source, we also collect characteristics for municipalities, such as the share of employees, the unemployment rate, the percentage of people whose familiar income per

[1] (IBGE) Instituto Brasileiro de Geografia e Estatística. Censo Demográfico Brasileiro.

capita is less than 25% of the minimum wage (which we refer as poor people), the average familiar income per capita, the share of people living in urban areas, the share of males and share of white individuals. To explore potential mechanism in our results, we collect public finances data at municipality level from FINBRA available by Brazilian Public Sector Accounting and Tax Information System[2] (*Siconfi*), and transform to per capita using population from demographic census.

Table 1 – Brazilian Municipality-Level Summary Statistics 2000

	Mean (1)	Standard Deviation (2)
Workforce		
Workforce (thousands)	439.04	1003.23
Share of workers in agriculture sector	0.1909	0.2311
Share of workers in manufacturing sector	0.1322	0.0853
Share of workers in extractive sector	0.0042	0.0128
Formal jobs	0.3998	0.1729
Social		
Share of female	0.5087	0.0158
Share of white	0.5386	0.2242
Urban residents	0.8072	0.2346
Education and Income		
Share of enrollment	0.5610	0.0471
Per capita income (BRL)	433.26	266.89
Share of poverty	0.2901	0.1892
Average of hourly wage (BRL)	6.66	3.32

This table shows descriptive statistics of demographic, social, income, and labor market characteristics in Brazil in 2000. Column (1) shows the average of 5507 municipalities, and column (2) shows the standard error. The averages were weighted by the amount of population in each municipality in 2000. The labor force is the number of people aged between 14 and 60 who perform some work. Source: 2000 Brazilian Demographic Census.

4.2 Exposure to Trade Shocks

To quantify the China shock experienced by different municipalities in Brazil, we rely on the works of Autor, Dorn and Hanson (2013) and Autor, Dorn and Hanson (2019) to measure how much the workforce in different regions is affected by trade dynamics with China. Building upon the findings of Costa, Garred and Pessoa (2016), we take into account the heterogeneous effects resulting from trade and construct an index to assess import and export exposure. We define the trade shock exposure as follows:

$$Import_m = \sum_j \frac{L_{mj,2000}}{L_{m,2000}} \frac{(V_{CjB,2010} - V_{CjB,2000})}{L_{Bj,2000}} \tag{4.1}$$

[2] (Siconfi) Sistema de Informações Contábeis e Fiscais do Setor Público Brasileiro.

$$Export_m = \sum_j \frac{L_{mj,2000}}{L_{m,2000}} \frac{(V_{BjC,2010} - V_{BjC,2000})}{L_{Bj,2000}} \tag{4.2}$$

Where $L_{mj,2000}$ represent the number of workers from municipality m employed in the sector j in the year 2000. Similarly, $L_{m,2000}$ denotes the total number of workers in municipality m during the same period. The variable $L_{Bj,2000}$ corresponds to the total number of workers from Brazil in the sector j, also recorded in 2000. These data were collected from the demographic census, and we specifically define "workers" as individuals between the ages of 14 and 60 who are engaged in employment.

The term associated to $V_{CjB,2010}$ represent the value in thousands of dollars of products j exported from China to Brazil in the year 2010. In this notation, the letter 'C' signifies China, and 'B' denotes Brazil. To measure the value of international trade in goods, we utilized the BACI database developed by the *Centre d'Etudes Prospectives et d'Informations Internationales* (CEPII) (Gaulier; Zignago, 2010). Furthermore, we deflate the 2000 values to 2010 US dollars using the US GDP deflator from the US Bureau of Economic Analysis (BEA). To connect the 6-digit product category in the CEPII BACI database and the sectors of individuals work from 5-dig CNAE *Domicíliar* classification in 2000 census data, we utilized the concordance provided by Costa, Garred and Pessoa (2016). There are 84 distinct goods, distributed across four main sectors: agricultural, extractive, manufacturing and non-tradable; See table A.2 in appendix for a full list.

Hence, from the equation above, the term $(V_{CjB,2010} - V_{CjB,2000})$ signifies the difference of importation of Brazil from China in real terms for product j between the years 2010 and 2000. We can interpret these term as the total exposition to import from sector j in Brazil during the specified period. Similarly, the term $(V_{BjC,2010} - V_{BjC,2000})$, signifies the variation in Brazil's exports to China for the same product and period. We will refer to these terms as ΔI_j and ΔX_j to import and export, respectively. Dividing ΔI_j and ΔX_j by the number of workers in Brazil in the year 2000, we have a measure of exposition by worker in Brazil in sector j, which we call the term associated with shock. By multiplying this result by the share of workers in a municipality m who belong to sector j (denoted as $\frac{L_{mj,2000}}{L_{m,2000}}$) and sum in j, we obtain the weighted mean of worker's exposure to international trade with China in each municipality. This allows us to assess the magnitude in thousands of dollars of exposure, which varies across municipalities based on their specialization in different sectors during the year 2000.

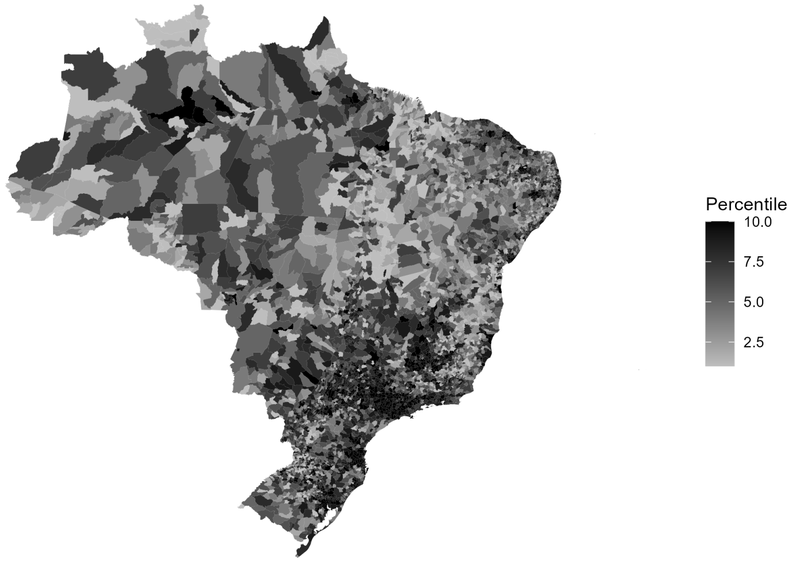
Table 2 presents the main statistics of exposure per worker in Brazil. The mean and quartiles are weighted by the number of workers in each municipality. Therefore, the average exposure per worker in thousands of dollars for imports from China is \$0.472 thousand dollars, while for exports, the average is \$0.533 thousand dollars. A concept we will employ throughout the analyses in this study is the distance between the 10th percentile and the 90th percentile, aiming to capture the effect of variation if the municipality moves between these positions. Figure 3 shows the spatial distribution of exposure in Brazil.

Table 2 – Descriptive Statistics for Exposure to Import and Export by Workers

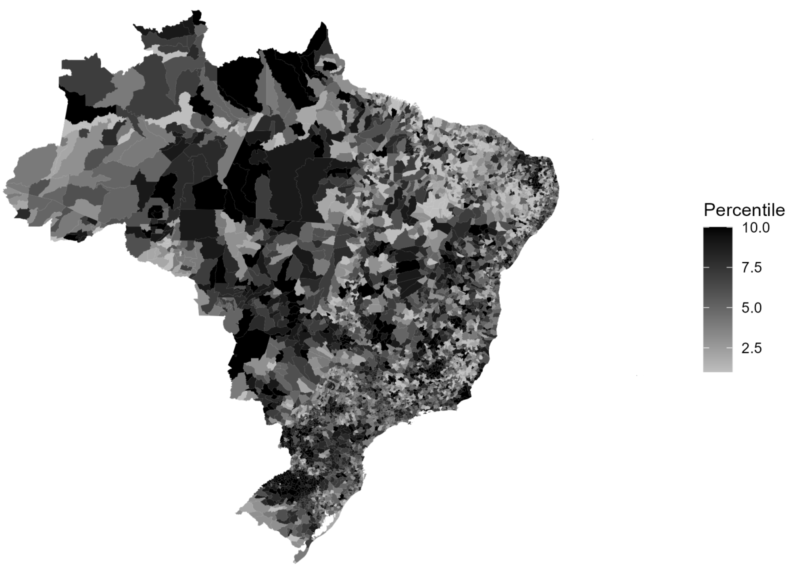
	$Import_m$ (1)	$Export_m$ (2)
Minimum	-0.179	0
1st Quartile	0.122	0.111
Median	0.314	0.201
Mean	0.472	0.533
3rd Quartile	0.628	0.455
Maximum	6.603	192.8
Standard Deviation	0.534	1.673

This table shows descriptive statistics of exposure to trade with China in Brazil. Column (1) show the statistics to import from China, and column (2) show the statistics to export to China. These statistics are weighted based on the number of workers in each municipality in 2000.

Figure 3 – Spatial Distribution of the Trade Shocks in Brazil



(a) $Import_m$



(b) $Export_m$

This graph illustrates the spatial exposure to trade shocks with China by municipality in Brazil, as defined in equation 4.1 for import shocks and equation 4.2 for export shocks. The darker regions on the graph represent municipalities with higher exposure. Sources: 2000 Brazilian Census, and CEPII BACI.

5 Identification Strategy

To identify the causal effect of international trade with China on educational outcomes in Brazil, it is essential that $Import_m$ and $Export_m$ are not correlated with unobserved factors. However, it is challenging to ensure the absence of potential Brazil-specific characteristics that may influence the trade relationship between Brazil and China. Hence, to address this issue, we employ an instrumental variable strategy.

Using an instrumental variable, we can recover the causal effect if the instrument not exhibit correlation with unobserved factors. Autor, Dorn and Hanson (2013) utilize as their instrument the negotiations between other countries, similar to the U.S., and China. They argue that the evolution of international trade with China is influenced by exogenous variations in structural changes that enhance the country's competitiveness and reduce trade barriers. However, even with the lowering of trade barriers, changes in world prices can influence both Brazil's negotiations and those of other countries worldwide with China, which may introduce endogeneity to the model.

To deal with this potential problem, we construct an instrument based on the work of Costa, Garred and Pessoa (2016), which provides an alternative approach to the instrument proposed by Autor, Dorn and Hanson (2013). Therefore, we calculate the instrument through auxiliary regressions that capture changes in trade driven by other characteristics, isolating only the China factor's impact on the growth of export and import. We run the following regression:

$$\frac{\Delta \tilde{I}_{ijk}}{\tilde{I}_{ijk,2000}} = \alpha_j + \psi_{China,j} + v_{i,j,k}$$

$$\frac{\Delta \tilde{X}_{ijk}}{\tilde{X}_{ijk,2000}} = \gamma_j + \delta_{China,j} + e_{i,j,k}$$

Where $\tilde{X}ijk,t$ ($\tilde{I}ijk,t$) denotes the total exports (imports) from county i to (from) country k for product j in year t, excluding Brazil. The term $\frac{\Delta \tilde{X}ijk}{\tilde{X}ijk,2000}$ ($\frac{\Delta \tilde{I}ijk}{\tilde{I}ijk,2000}$) represent the growth rate between 2010 and 2000 of country i's exports (imports) in sector j to (from) country k, net of the trade with Brazil. The coefficients associated with the fixed effects of products (α_j and γ_j) capture the mean growth rate of products across countries, accounting for shocks at the world-level. The coefficients $\psi_{China,j}$ and $\delta_{China,j}$ capture deviations from the mean world growth that are specifically directed to China for sector j to imports and exports, respectively. All regressions are weighted by the imports (exports) from the initial period.

Costa, Garred and Pessoa (2016) uses the China-specific coefficient of trade growth multiplied by the value imported into Brazil in the initial year ($V_{CjB,2000}\hat{\psi}_{China,j}$) as their instrument, which represents the variation in Brazil's imports from China if the growth rate were equal to China's specific growth for the rest of the world, the same to export side. However, the multiplication of the coefficient by Brazil's imports in 2000 may be correlated with endogenous sectoral factors of the economy, leading to inconsistent estimates. To address this issue, we use the volume trade of China to the rest of the world, excluding Brazil, in the initial year to calculate the instrument:

$$ivImport_m = \sum_j \frac{L_{mj,2000}}{L_{m,2000}} \frac{V_{CjB^-,2000} \cdot \hat{\psi}_{China,j}}{L_{Bj,200}} \tag{5.1}$$

$$ivExport_m = \sum_j \frac{L_{mj,2000}}{L_{m,2000}} \frac{V_{B^-jC,2000} \cdot \hat{\delta}_{China,j}}{L_{Bj,2000}} \tag{5.2}$$

The term $V_{CjB^-,2000}$ ($V_{B^-jC,2000}$) indicates the imported (exported) value from all countries, excluding Brazil, from (to) China. When multiplied by the China-specific component that reveals trade growth ($V_{CjB^-,2000} \cdot \hat{\psi}_{China,j}$ to import and $V_{B^-jC,2000} \cdot \hat{\delta}_{China,j}$ to export), this term represents the variation in trade from all countries in the sample, excluding Brazil, considering growth rate net of external shocks. If the total variation in trade with China was not influenced by a world-level shock, this instrument is equal to the instrument proposed by Autor, Dorn and Hanson (2013).

The calculation of the instrument, however, makes use of endogenous weights and may raise issues about the non-correlation between the instrument and unobservable factors. Borusyak, Hull and Jaravel (2022) decompose the estimator using the shift-share instrument and find equivalence with a two-stage sector-level regression using the external shock as instrument. In this regard, these findings suggest that, since the shock is as good as random, the estimates are consistent even in the presence of endogenous weights.

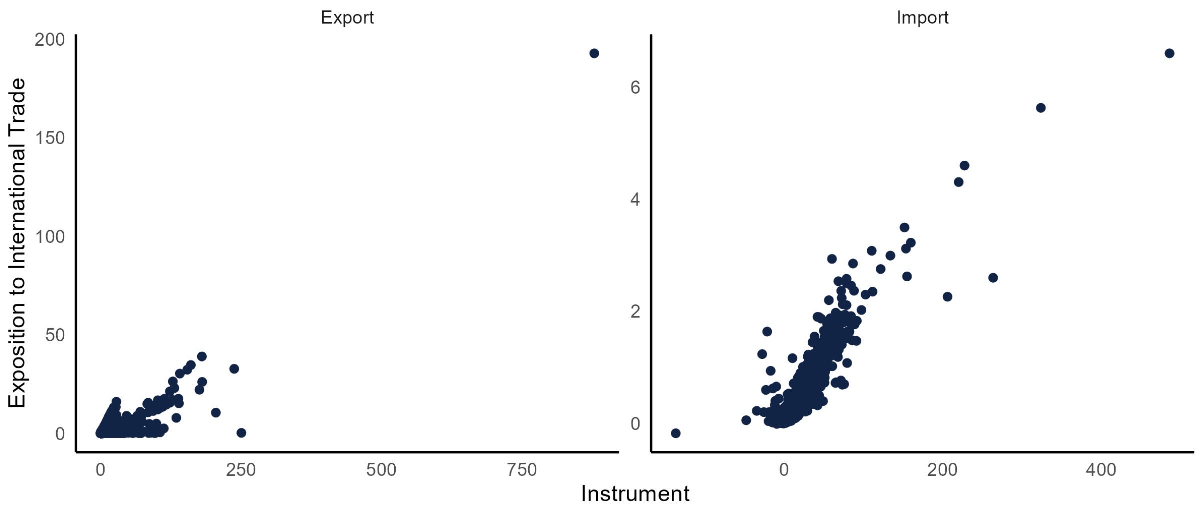
The measures represented by equations 4.1 and 4.2 exhibit a strong correlation with the instruments from equations 5.1 and 5.2, having correlation coefficients of 0.92 (*se = 0.005, t = 170.5*) for imports and 0.96 (*se = 0.003, t = 269.7*) when weighted by the population of municipalities. For exports, these coefficients are 0.94 (*se = 0.007, t = 116.3*) and 0.65 (*se = 0.010, t = 63.4*) when weighted by municipality population. Figure 4 illustrates the relationship between these measures.

To capture the causal effects, we employ a two-stage least squares estimates. Our main specification takes the form:

Second stage:

$$\Delta Y_m = \beta_1 Im\hat{p}ort_m + \beta_2 Ex\hat{p}ort_m + X'\beta + \gamma_s + u_m \tag{5.3}$$

Figure 4 – Relationship Between Exposition to International Trade and the Instrument



This graph shows the scatter plot at the municipality-level of exposure to imports and exports with China against the instrumental variable provided by equations 5.1 for imports and 5.2 for exports. Sources: 2000 Brazilian Census and CEPII BACI.

First stage:

$$Import_m = \alpha_1^i ivImport_m + \alpha_2^i ivExport_m + X'\lambda_i + \gamma_s^i + \epsilon_m^i \tag{5.4}$$

$$Export_m = \alpha_1^e ivImport_m + \alpha_2^e ivExport_m + X'\lambda_e + \gamma_s^e + \epsilon_m^e \tag{5.5}$$

Where, ΔY_m represents the difference in share enrollment at basic education between 2010 and 2000. X is a set of control variables, including the quadratic specification of per capita income in 2000, the 2000 share of male, the 2000 share of white people, the gini's coefficient in 2000, the share of people that receive government transfer in 2000, the share of workers in manufacturing sector in 2000, and the ratio between people with college or higher education and people with high school, the term γ_s is the fixed effects by state. We weight all regressions by municipality population. The results of the estimates for the first stage can be found in Table A.3 in the Appendix.

However, the conventional strategy of the estimates, although producing consistent results, can lead to inadequate estimates of errors. Adao, Kolesár and Morales (2019) argue that the weights used to calculate the instrument can generate sectorial correlation in the errors and produce inappropriate hypothesis tests. We conducted a Monte Carlo simulation considering a sample of 30 thousand randomly with normal distribution shocks with mean 0 and a standard deviation of 4. For the non-tradable sectors, the assigned shock was always 0. The results, presented in Table 5, show an over-rejection of the null hypothesis in several error estimates, except for region-clustered errors, which remained within the range of type 1 error probability.

The approach proposed by Borusyak, Hull and Jaravel (2022), using an aggregated sector-level structure and standard errors robust to heteroscedasticity, leads to appropriate estimates of the confidence interval. Table 5 shows that this approach seems more robust compared to other estimation methods. In this regard, we employ the estimates developed by the authors mentioned in this study for the estimation of the results. In the robustness test, we estimate the conventional model with errors clustered by region and different instruments.

6 Results

6.1 The Impact of the China Shock on Enrollment

Table 3 presents our main results. Column (1) reports the coefficient estimates for the effects of change in Chinese imports and exports on change in the share of enrollment for those under 25 years old. It indicates that an export shock is associated with a reduction in enrollment. Specifically, for each increase of USD 1,000 in exposure by workers, the share of people enrolled in basic education in Brazil decreases by 0.1775 percentage points. This implies that if a municipality moves from the bottom 10th to the top 90th percentile in exposure to export, the share of enrolled individuals decreases by 0.275 percentage points. We find no evidence for import shock.

Table 3 – Effect of China's Trade Shock on Enrollment

	Share of Enrollment (1)
$Import_m$	0.1526 (0.1765)
$Export_m$	-0.1775* (0.0976)
Average at 2000	56.102
N (Municipalities)	5506
N (Sector)	84
First-Stage Tests	
Wald test ($Import_m$)	6.903
Wald test ($Export_m$)	4.207

This table presents the estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in the share of enrollment for those under 25 years old in basic education. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. The regression includes the following controls: a quadratic specification of per capita income, the share of males, the share of white people, the ratio between people with higher education and individuals with high school, the proportion of people that receive transfer from government, the gini's coefficient and fixed effects by state. All controls are available in 2000. The regressions are weighted by municipality population with the same age range of dependent variable. The estimate grouped the data at sector-level. Standard errors, shown in parentheses, are heteroskedastic robust. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4 presents the estimated effects of the China trade shock on enrollment for different age groups. In Column (1), we observe the effect for children aged 6 to 10 years old. For this age group, the estimates suggest that an import shock is associated with a reduction in the share of enrollment. Specifically, for each increase of one thousand dollars in worker exposure, enrollment for this age group decreases by 0.7483 percentage points. This magnitude suggests that a municipality that moves from the 10th to the 90th percentile in import exposure per worker may experience a decrease of 0.73 percentage points in enrollment for this age group. On the other hand, the estimates for an export shock indicate a negative coefficient, suggesting that an export shock also reduces enrollment, but there is no statistical significance.

Table 4 – Effect of China Shock Trade on Enrollment by Age Group

	06 to 10 years old (1)	11 to 14 years old (2)	15 to 17 years old (3)	18 to 25 years old (4)
$Import_m$	-0.7483***	-0.6039***	-0.3087	-0.1294
	(0.1814)	(0.1730)	(0.2785)	(0.2438)
$Export_m$	-0.0753	-0.0434*	-0.0135	-0.1013
	(0.0508)	(0.0225)	(0.0359)	(0.0765)
Average at 2000	92.451	94.466	78.770	24.534
N (Municipalities)	5506	5506	5506	5506
N (Sector)	84	84	84	84
First-Stage Tests				
Wald test ($Import_m$)	6.8475	6.8438	6.8361	7.1013
Wald test ($Export_m$)	3.9211	4.8811	4.8051	3.9966

This table presents the estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in the share of enrollment by age group. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. The regression includes the following controls: a quadratic specification of per capita income, the share of males, the share of white people, the ratio between people with higher education and individuals with high school, the proportion of people that receive transfer from government, the gini's coefficient and fixed effects by state. All controls are available in 2000. The regressions are weighted by municipality population with the same age range of dependent variable. The estimate grouped the data at sector-level. Standard errors, shown in parentheses, are heteroskedastic robust. * significant at 10%; ** significant at 5%; *** significant at 1%.

The second column (2) shows the effect on children aged between 11 and 14 years old. The estimates suggest that both trade shocks may reduce the share of enrollment. For the import shock, an increase of one thousand dollars in exposure may reduce the share of enrollment by 0.6039 percentage points. For the export shock, an increase in exposure by one thousand dollars is associated with a reduction of 0.0434 percentage points. These magnitudes mean that if a municipality moves from the 10th to the 90th percentile in exposure to imports (exports), the share of enrollment decreases by 0.59 (0.041) percentage points.

Column (3) and (4) show the estimates for those aged 15 to 17 years and 18 to 25 years, respectively. For both age groups, the estimates associated with regions more exposed to a China import shock do not show a statistically significant effect, but they are still negative. On the export side, there is also no significant evidence for both age groups. Therefore, the negative effect of the export shock seems to be driven by individuals aged 11 to 14 years.

We perform a set of robustness tests to verify if our results are influenced by specification choices. We estimate using OLS and 2SLS in the conventional approach and use different fixed effects in sector-level 2SLS. Additionally, we conduct estimations with instruments following the approach of Costa, Garred and Pessoa (2016), multiplying China's specific component by the value traded in Brazil in the initial year, and the instrument proposed by Autor, Dorn and Hanson (2013), using the variation in traded volume from all countries, excluding Brazil. The details of these tests can be found in the appendix.

Table A.4 shows the robustness test for the share of enrollment for those under 25 years old, and we note that the estimates are robust across all specifications. From Table A.5 to A.8, we perform robustness tests for estimates within each age group. The estimates remain with the same sign and the significance level remains relatively constant in almost all estimates, suggesting that the results are robust.

We estimated a placebo test in order to check whether our estimates could be driven by random characteristics, and check the consistency of the hypothesis tests. To do this, we ran 30,000 regressions randomizing the term associated with the instrument shock, considering a normal distribution with mean 0 and standard deviation equal to 4. For sectors that do not trade on the international market, zero was always assigned. Table 5 shows the main results. Column (1) shows the average value of the estimated coefficients in all the samples; a value close to zero suggests that there is no bias in the model.

Table 5 – Placebo Tests to Different Standard Errors Estimates

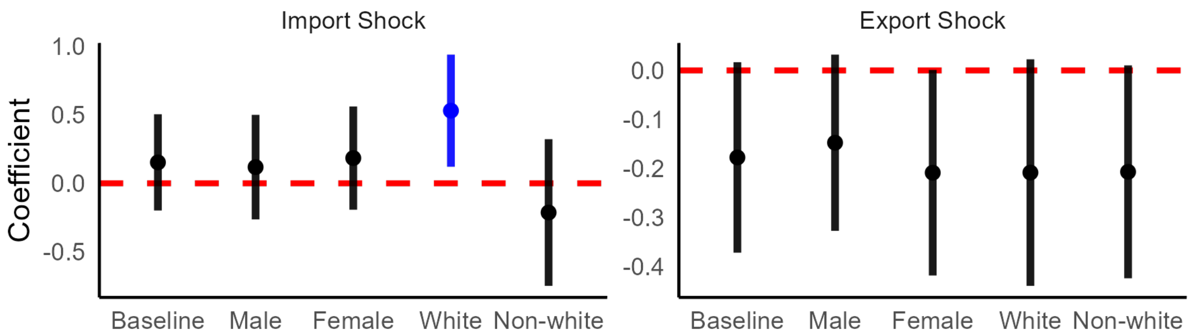
					Clustered by				Sector-level
	Coefficient Average	Significance Level	iid	Heteroskedastic robust	Microregion	Mesoregion	State	Region	Heteroskedastic robust
	(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)
		10%	41.42%	33.47%	23.67%	15.97%	12.41%	9.65%	3.12%
Importshock	-0.0088	5%	33.73%	26.64%	17.17%	10.48%	7.56%	5.30%	1.42%
		1%	22.06%	16.61%	8.75%	3.53%	2.32%	1.28%	0.27%
		10%	36.87%	23.80%	15.08%	9.13%	3.95%	6.31%	1.11%
Exportshock	-0.0193	5%	29.69%	16.50%	9.04%	4.64%	1.36%	3.29%	0.28%
		1%	19.02%	7.16%	2.75%	0.78%	0.13%	0.77%	0.00%

This table shows the main results of the placebo test. Column (1) reports the mean of the estimated coefficient for all random samples. From Column (2), the table shows the proportion of estimates that reject the null hypothesis for different significance levels. Column (2) estimates the standard error considering that the error is independent and identically distributed, Column (3) estimates standard errors robust to heteroscedasticity, and Columns (4) to (7) estimate the standard error clustered by Microregion, Mesoregion, State and Region. Column (8) shows the proportion of rejection considering errors robust to heteroscedasticity in an aggregate approach at sector level.

Columns (2) to (8) show the percentage of estimates that reject the null hypothesis at different significance levels. As argued by Adao, Kolesár and Morales (2019), clustered estimates can provide inadequate hypothesis testing and lead to an over-rejection of the null hypothesis. However, in this context, estimates clustered by region seem to produce adequate hypothesis testing. However, the error robust to heteroscedasticity in an aggregate approach at sector level, which is the estimate used in this dissertation, produces even more robust error estimates.

We explore the heterogeneity of the effects according to individual characteristics, as shown in Figure 5, which presents the estimates for gender and race heterogeneity. We note that an import shock has a positive effect on school enrollment, significant at 5%, among whites, suggesting that regions more exposed to an import shock from China may increase the proportion of white individuals enrolled. There is no evidence for the other characteristics. The 95% confidence interval of the export shock estimates suggests that there is no significant effect for any group; however, the coefficient for all groups is negative, and statistically different from 0 to 10% significance, except for males.

Figure 5 – Effect of the China Shock by Gender and Race



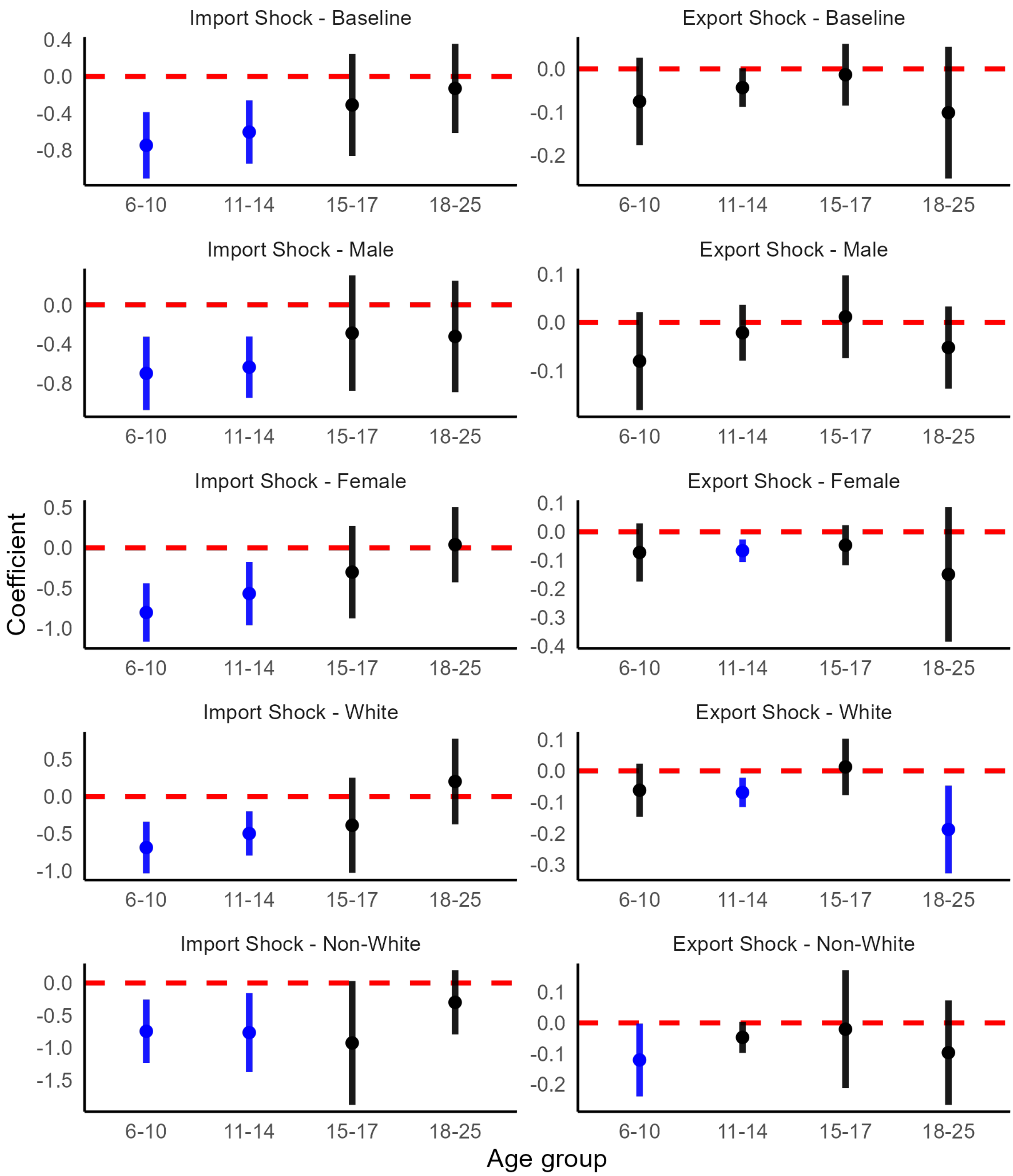
This figure displays the coefficients of the effects of Chinese imports and exports on changes between 2010 and 2000 in the share of enrollment in basic education, categorized by gender and race. The coefficients and standard errors are multiplied by 100, representing percentage point changes. The regression includes the following controls: a quadratic specification of per capita income, the share of males, the share of white people, the ratio between people with higher education and individuals with high school, the proportion of people that receive transfer from government, the gini's coefficient and fixed effects by state. All controls are available in 2000. The regressions are weighted by the population under 25 years old, and standard errors are robust to heteroskedasticity in an aggregate regression at sector level. The intervals are estimated at a 95% confidence level. The color black represents coefficients that are not statistically significant at 5%, while the color blue represents estimates that are significant at 5%.

We also explored this heterogeneity by age group. Figure 6 shows the estimated coefficient and the 95% confidence interval. The estimates indicate that an import shock may reduce enrollment for individuals aged 6 to 10 for all characteristic, and the same can be inferred for individuals aged 11 to 14. On the other hand, there seems to be no significant effect for those aged 15 to 25.

The export shock seems to reduce the enrollment of non-white people between the ages of 6 and 10. Among people aged 11 to 14, an export shock to China reduces the proportion of enrollments among women and whites. There is no significant effect for people aged 15 to 17, but for those aged 18 to 25, the export shock reduces the proportion of enrollments among whites.

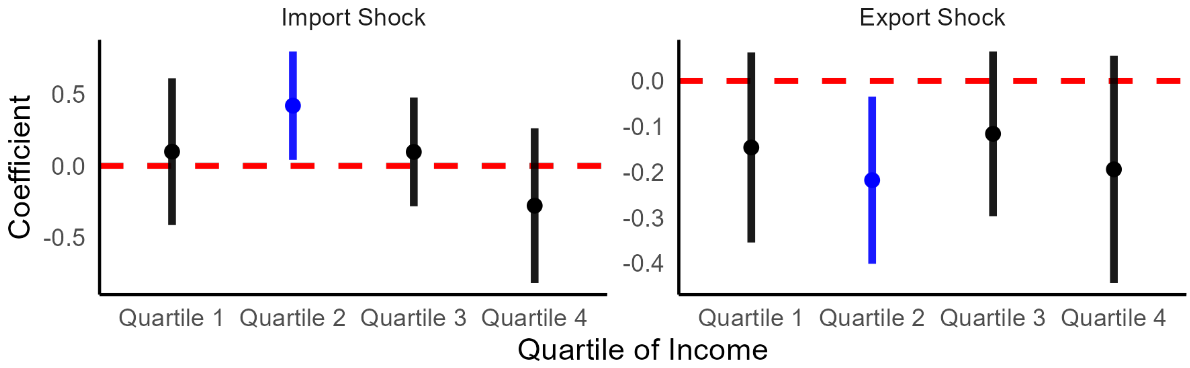
Considering heterogeneity by income from Figure 7, we note that the negative effect of the shock of exporting products to China is among individuals located in the second income quartile. However, on the import side, the results suggest that regions more exposed to the shock may increase the proportion of individuals in the second quartile enrolled in basic education.

Figure 6 – Effect of the China Shock by Age Group, Gender and Race



This figure displays the coefficients of the effects of Chinese imports and exports on changes between 2010 and 2000 in the share of enrollment in basic education by age group, categorized by gender and race. The coefficients and standard errors are multiplied by 100, representing percentage point changes. The regression includes the following controls: a quadratic specification of per capita income, the share of males, the share of white people, the ratio between people with higher education and individuals with high school, the proportion of people that receive transfer from government, the gini's coefficient and fixed effects by state. All controls are available in 2000. The regressions are weighted by the population of each age group, and standard errors are robust to heteroskedasticity in an aggregate regression at sector level. The intervals are estimated at a 95% confidence level. The color black represents coefficients that are not statistically significant at 5%, while the color blue represents estimates that are significant at 5%.

Figure 7 – Effect of the China Shock by Age Group, Gender and Race



This figure displays the coefficients of the effects of Chinese imports and exports on changes between 2010 and 2000 in the share of enrollment in basic education by quartile of income. The coefficients and standard errors are multiplied by 100, representing percentage point changes. The regression includes the following controls: a quadratic specification of per capita income, the share of males, the share of white people, the ratio between people with higher education and individuals with high school, the proportion of people that receive transfer from government, the gini's coefficient and fixed effects by state. All controls are available in 2000. The regressions are weighted by the population under 25 years old, and standard errors are robust to heteroskedasticity in an aggregate regression at sector level. The intervals are estimated at a 95% confidence level. The color black represents coefficients that are not statistically significant at 5%, while the color blue represents estimates that are significant at 5%.

6.2 Mechanism

The conventional model linking trade and education establishes that the effects on skill acquisition resulting from shocks in international trade primarily occur through changes in the opportunity cost of education. On the other hand, we can also observe that a shock in the international market, even though it increases the opportunity cost, can affect schooling through changes in relative wealth. In this sense, another possible impact channel is through the impact on family income.

Therefore, in this section, we assess a variety of mechanisms that could influence individuals' educational decisions. At first, we looked at the effects of the China shock on the income effect, i.e. the change in school choice as a function of changes in the relative wealth of the family. Also on the substitution effect, or opportunity cost, which is the impact generated by changes in labor market incentives.

6.2.1 Income Effect

6.2.1.1 Family Income

A positive shock in household income can have a positive influence on school enrollment in school-age youth (Bulman et al., 2021; Khiem et al., 2020; Mostert; Castello, 2020; Kilburn et al., 2017). In this regard, a shock in income due to trade with China can affect educational outcomes. To evaluate this mechanism, we explore the effect of the China Shock on variables associated with poverty and household income. Table 6 displays our estimates. Column (1) highlights the trade effect on the income of those individuals who are of legal age and live in the same household as school-age youth, column (2) shows the effect on the proportion of people whose per capita household income is less than 25% of the minimum wage, which we define as poverty, column (3) shows the effect on the growth rate of the mean per capita household income.

Table 6 – Effect of the China Shock on Household Income and Poverty

	Family Hourly Wage	Poverty	Household Income Per Capita
	(1)	(2)	(3)
$Import_m$	1.893**	-0.4943	0.0094
	(0.9245)	(0.3500)	(1.239)
$Export_m$	0.2215	-0.2074***	0.6164
	(0.4034)	(0.0689)	(0.4850)
N (Municipalities)	5506	5506	5506
N (Sector)	84	84	84
First-Stage Tests			
Wald Test ($Import_m$)	7.0056	7.0056	7.0056
Wald Test ($Export_m$)	4.0155	4.0155	4.0155

This table presents the estimated effects of Chinese import and export shocks on variables associated with family income. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. The regression includes the following controls: a quadratic specification of per capita income, the share of males, the share of white people, the ratio between people with higher education and individuals with high school, the proportion of people that receive transfer from government, the gini's coefficient and fixed effects by state. All controls are available in 2000. The regressions are weighted by municipality population. The estimate grouped the data at sector-level. Standard errors, shown in parentheses, are heteroskedastic robust. * significant at 10%; ** significant at 5%; *** significant at 1%.

The estimates in column (1) suggest that an import shock to China increases the average wage growth rate of those of legal age living in the same household as individuals under 17 years old. On the other hand, an export shock has a coefficient not statistically significant. These estimates suggest that an import shock to China may increase the incomes of those responsible for school-age individuals.

Column (2) provides evidence that an increase in exposure to one thousand dollars of exports from China can reduce the proportion of individuals below the poverty line by 0.2074 percentage points. There is no significant evidence on the export side. Column (3) displays the estimates of trade on the variation in per capita household income and both coefficients show no significant effect.

In summary, the sets of estimates in Table 6 reveal that regions more exposed to an import shock from China can increase the wage growth rate of those responsible for school-age youth, just as an export shock can reduce the proportion of individuals living below the poverty line. Theoretically, both results argue positively for education. We can see that, for some strata of society, an import shock increases the proportion of those enrolled. For an export shock, on the other hand, although it reduces the proportion of people living below the poverty line, this effect does not help to explain why individuals leave school.

6.2.1.2 Government Expenditures

The change in the dynamics of economic activity due to the trade shock with China can affect revenue and consequently government spending (Feler; Senses, 2017). In this context, given the government's budget constraint, it can impact the provision of public goods, such as education. There is evidence that an increase in resources allocated to school and/or teachers can improve students' academic performance (Mbiti et al., 2019; Romero; Sandefur; Sandholtz, 2020). Therefore, the shock in revenue and government spending resulting from trade with China can influence educational outcomes.

Table 7 – Effect of the China Shock on Government Revenue and Expenditure

	Current Revenue	Tax Revenue	Current Expenditure	Education Expenditure
	(1)	(2)	(3)	(4)
$Import_m$	28.68	12.80	7.359	8.605
	(58.60)	(10.26)	(54.73)	(8.737)
$Export_m$	85.68	19.96	58.91	10.13
	(60.28)	(15.24)	(44.12)	(6.998)
N (Municipalities)	5247	5247	5247	5247
N (Sector)	84	84	84	84
First-Stage Tests				
Wald Test ($Import_m$)	7.0549	7.0549	7.0549	7.0549
Wald Test ($Export_m$)	3.8234	3.8234	3.8234	3.8234

This table presents the estimated effects of Chinese import and export shocks on the variables associated with general government revenue and expenditure. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. The regression includes the following controls: a quadratic specification of per capita income, the share of males, the share of white people, the ratio between people with higher education and individuals with high school, the proportion of people that receive transfer from government, the gini's coefficient and fixed effects by state. All controls are available in 2000. The regressions are weighted by municipality population. The estimate grouped the data at sector-level. Standard errors, shown in parentheses, are heteroskedastic robust. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7 displays the main results. Column (1) presents the estimates of the China trade shock on municipal current revenues per capita. The export shock shows that for every thousand dollars of exposure to the shock per worker, there is an increase of R$ 85.68 in current revenue per capita and an increase of R$ 19.96 in tax revenue; however, these estimates are not statistically significant. Columns (3) and (4) display the result to the variables associated with current expenditure and education expenditure, there is also no evidence of a significant effect of an international trade shock.

Therefore, there is no evidence that the trade shock with China affected public revenue and spending in Brazil. Therefore, public spending does not seem to be a channel of the trade shock on school enrollment.

6.2.2 Opportunity Cost

In addition to the influence of family income and the provision of public goods on educational decisions, another variable that determines the choice of education is income expectations. Traditional models that assess international trade and individuals' skill acquisition establish the opportunity cost of education as one of the main mechanisms of the effect. Therefore, in this section, we will investigate the effects of the China shock on variables associated with the labor market for those at school age.

Table 8 presents the estimates for the main variables associated with income in the labor market. The estimates in Column (1) show the effect of the trade shock on the average wage growth rate for Brazil. The results suggest that an import shock can increase the growth rate of the average wage; on the other hand, there is no significant evidence for an export shock.

Table 8 – Effect of the China Shock on Hourly Wages by Age Group

	Hourly Wage			
	Raw population (1)	11 to 14 years old (2)	15 to 17 years old (3)	18 to 25 years old (4)
$Import_m$	1.737*	19.13***	5.442***	0.8269
	(0.9037)	(3.193)	(1.972)	(0.9747)
$Export_m$	0.2116	0.0341	-0.0304	0.3077
	(0.4060)	(0.8587)	(0.3815)	(0.5258)
N (Municipalities)	5506	5506	5506	5506
N (Sector)	84	84	84	84
First-Stage Tests				
Wald Test ($Import_m$)	7.0056	6.8828	6.8368	7.1013
Wald Test ($Export_m$)	4.0155	4.7139	4.8004	3.9966

This table presents the estimated effects of Chinese import and export shocks on the hourly wages by age group. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. The regression includes the following controls: a quadratic specification of per capita income, the share of males, the share of white people, the ratio between people with higher education and individuals with high school, the proportion of people that receive transfer from government, the gini's coefficient and fixed effects by state. All controls are available in 2000. The regressions are weighted by municipality population of each age group. The estimate grouped the data at sector-level. Standard errors, shown in parentheses, are heteroskedastic robust. * significant at 10%; ** significant at 5%; *** significant at 1%.

Column (2) shows the effect on the average salary for those aged 11 to 14. The results show that the import shock can also increase the average income for this age group, however, the export shock does not seem to have an influence on the average income of these people. Column (3) reports that the import shock also seems to increase the average income of those aged 15 to 17. For those aged between 18 and 25, the shock on the international market does not seem to have an influence on income.

The growth in labor income for school-age individuals increases the opportunity cost of being enrolled in school. Therefore, this is a movement that contributes to the reduction in schooling. The estimates described in Figure 6, suggest a reduction in school enrollment among 11 to 14 year olds. Hence, this effect may be the result of an increase in the opportunity cost of higher wages in the labor market.

Another potential opportunity cost mechanism is the employability of these young people. Income shocks in the international market can encourage companies to expand vacancies in the formal sector of the economy, where young people of school age find little space. In this sense, table 9 investigates the relationship between the shock and formality and employability in different age groups.

Column (1) shows the effect of the shock on the variation in the proportion of individuals in formal jobs. The results find no evidence of an influence of the China Shock on formality. Column (2) of Table 9 shows the effect on the proportion of individuals who are employed, and there is no evidence that a trade shock with China has a significant effect.

Table 9 – Effect of the China Shock on Employment by Age Group

	Formal Job	Share of Employment			
	Formality	Raw population	11 to 14 years old	15 to 17 years old	18 to 25 years old
	(1)	(2)	(3)	(4)	(5)
$Import_m$	0.1003	0.0113	-0.6724**	-0.1968	0.1578
	(0.3262)	(0.3472)	(0.3255)	(0.4014)	(0.5000)
$Export_m$	0.0814	0.0408	0.0229	-0.0239	0.0780*
	(0.0775)	(0.0310)	(0.0342)	(0.1054)	(0.0449)
N (Municipalities)	5506	5506	5506	5506	5506
N (Sector)	84	84	84	84	84
First-Stage Tests					
Wald Test ($Import_m$)	7.3150	7.0056	6.8438	6.8361	7.1013
Wald Test ($Export_m$)	4.4339	4.0155	4.8811	4.8051	3.9966

This table presents the estimated effects of Chinese import and export shocks on employment by age group. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. The regression includes the following controls: a quadratic specification of per capita income, the share of males, the share of white people, the ratio between people with higher education and individuals with high school, the proportion of people that receive transfer from government, the gini's coefficient and fixed effects by state. All controls are available in 2000. The regressions are weighted by municipality population of each age group. The estimate grouped the data at sector-level. Standard errors, shown in parentheses, are heteroskedastic robust. * significant at 10%; ** significant at 5%; *** significant at 1%.

Column (3) describes the effect of the China shock for those aged 11 to 14. The estimates suggest that an import shock can reduce the proportion of individuals in this age group who are employed. The effect on the export side is not statistically significant. Column (4) shows the impact of the shock for those aged 15 to 17, all the estimated coefficients are negative but not significant.

The estimates in Column (5) indicate that an export shock to China seems to increase the proportion of 18 to 25 year old who have an occupation. This result indicates that there is an increase in the opportunity cost of schooling for individuals in this age group. The main results suggest that white individuals between the ages of 18 and 25 leave school as a result of the export shock, part of this effect being driven by an increase in the opportunity cost. There is no evidence that an import shock exerts any influence on the proportion of employees.

7 Conclusion

Over the last few decades, China's growth as a trading partner around the world has generated an important source of variation that has been explored in the literature to identify the effects of international trade on different labor market variables. This dissertation, on the other hand, uses this increase in the dynamics of trade with China to identify the causal effect of trade shocks on enrollment in Brazil. This research innovates in bringing this approach to identify the effect in a developing country.

The results suggest that regions more exposed to an export shock to China may reduce the proportion of people enrolled in basic education in Brazil. No significant effect of the import shock on enrollment was identified. Stratifying by age group, the negative effect of the export shock is observed for those between 11 and 14 years old. On the other hand, even though the import shock has no significant effect on the variation in the aggregate enrollment rate, there is evidence of a reduction in the proportion of enrolled individuals between the ages of 6 and 14.

We also explored the effect for different individual characteristics. On the import side, the results indicate an increase in the proportion of enrollees among white individuals. On the export side, although the coefficients are not significant at 5%, they have similar magnitudes between men, women, whites and non-whites.

The heterogeneities arising from the income quartiles suggest that the import shock is associated with an increase in the proportion of enrollees among individuals in the second income quartile. On the other hand, the export shock seems to reduce the proportion of enrollees in the same income quartile.

We explored several possible mechanisms to understand the reason for the variation in enrollment shown by the estimates. We found evidence that an import shock can increase the income of older people living with school-age people. This result may explain the increase in enrollment coming from the import shock for whites and individuals in the second income quartile, since families with greater disposable resources may encourage greater participation of young people in school.

There is evidence of an increase in the opportunity cost for those of school age. The import shock seems to increase income for individuals aged 11 to 17, and with this increase in income, the cost of spending time at school becomes higher since there are higher premiums in the labor market. Therefore, this mechanism partly explains the reduction in the proportion of those enrolled as a result of the import shock for those aged between 6 and 14.

The evidence in the international literature finds that an import shock increases the proportion of individuals enrolled. The main differences in the effect in this work can be attributed to the nature of the negotiations between these countries. The increase in imports from China into the United States was mainly of low-skill goods, affecting employment mainly among those with few years of schooling. So, to mitigate the effects on the labor market, individuals seek to educate themselves.

In Brazil, on the other hand, the increase in imports from China was almost entirely in manufactured goods, which employ more educated people. Therefore, the jobs that have competed most with Chinese products are those of people with more years of schooling and this can discourage young people from getting more schooling. Similarly, the export shock to China was mainly primary goods, which means that exports to China stimulate sectors with less qualified labor and contribute to an increase in the opportunity cost for students.

Therefore the trade shock with China, which seems to mainly stimulate the less skill-intensive sectors, reduces the proportion of enrollees in various strata of society, except for the responses of whites and people in the second income quartile as a result of the import shock. This effect seems to be driven in part by an increase in the opportunity cost of schooling. It is important to broaden the research on the effect of international trade on different education variables. In addition to this work, another research agenda should understand the trade shock not only on enrollment, but also on the quality of education.

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(Siconfi) Sistema de Informações Contábeis e Fiscais do Setor Público Brasileiro.

Appendix

APPENDIX A – Migration

The adverse effects of the China shock on the labor market may create incentives for workers to migrate between regions. Greenland, Lopresti and McHenry (2019) find evidence that regions more exposed to a China import shock experience lower population growth, suggesting an increase in emigration from those regions. On the other hand, in Brazil, Costa, Garred and Pessoa (2016) highlight that regions more exposed to import shocks experience a reduction in the proportion of immigrants and emigrants. This migratory movement can introduce a potential bias in the estimates of the trade effect on enrollments.

Therefore, in this section, we investigate the population migration behavior as a result of the import and export shock from China, to verify if there was any influence on Brazil. Unlike Costa, Garred and Pessoa (2016), the migration estimates are associated with the trade effect on the population growth rate, instead of the proportion of emigrants and immigrants. Another relevant difference is the territorial delimitation, our results pertain to the influence on municipalities instead of microregions as in the cited work.

For this purpose, the effect is estimated using the instrumental variables approach described in the empirical strategy section of this work. The table below shows the main results. The dependent variable is the logarithmic difference in population between 2010 and 2000. Greenland, Lopresti and McHenry (2019) emphasize the importance of controlling for the pre-trend in population growth, so we also incorporate as a control the logarithmic difference in population between 2000 and 1991.

Table A.1 – Effect of China's Trade Shock on Enrollment

	Population Growth					
	Raw population (1)	Until 25 years old (2)	06 to 10 years old (3)	11 to 14 years old (4)	15 to 17 years old (5)	18 to 25 years old (6)
$Import_m$	0.4638	-0.3704	1.224	1.331	-0.6410	-1.805*
	(0.8653)	(0.8783)	(1.082)	(1.418)	(1.010)	(0.9392)
$Export_m$	1.097***	1.118***	0.6299	0.5787*	0.4512**	1.667***
	(0.4110)	(0.3992)	(0.4121)	(0.3074)	(0.2065)	(0.4874)
N (municipality)	5506	5506	5506	5506	5506	5506
N (Sector)	84	84	84	84	84	84
First-Stage Tests						
Wald Test ($Import_m$)	7.4237	7.4229	7.3685	7.3598	7.3430	7.6098
Wald Test ($Export_m$)	10.915	10.912	10.918	11.512	11.693	10.496

This table displays the estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in the logarithm of population. The coefficients and standard errors are multiplied by 100. The regression includes the following controls: quadratic specification of per capita income, gini's coefficient, the share of males, the share of white people, the share of people that recieve transfers, share of workers in manufactuing sector, the ratio between people with higher education and individuals with high school, and fixed effects by state. All control are available in 2000. The regressions are weighted by municipality population of each age group. Standard errors, shown in parentheses, are clustered by microregion with 557 clusters. * significant at 10%; ** significant at 5%; *** significant at 1%.

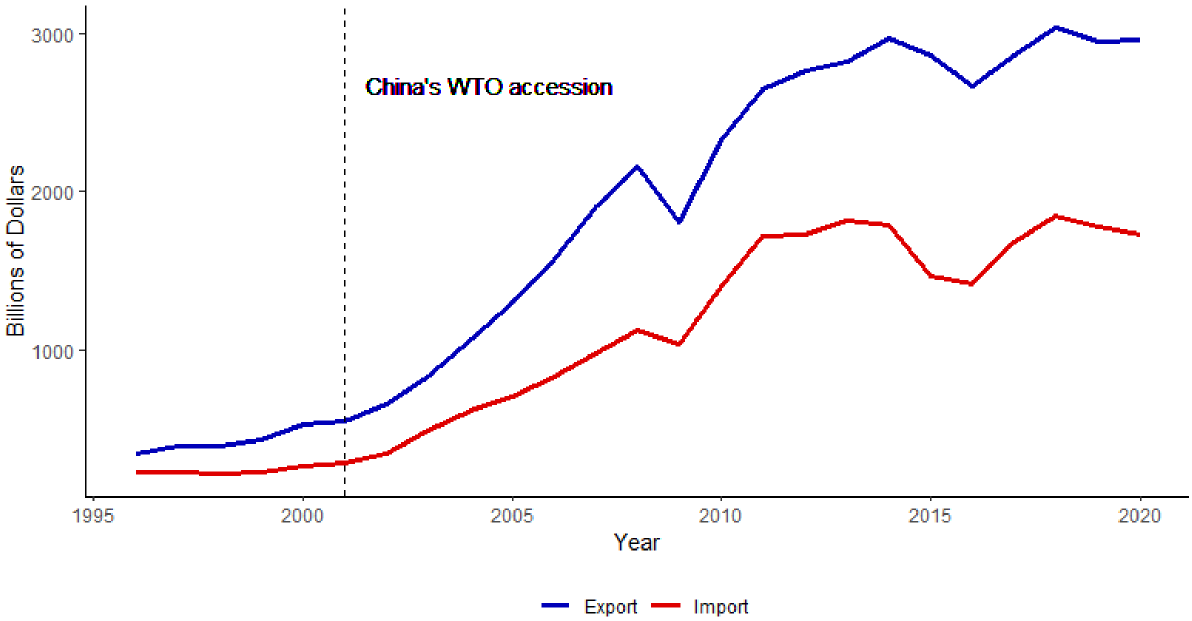
The column (1) of Table A.1 shows the effect of trade shocks with China on the overall population growth rate. The results suggest that an export shock increases the population growth rate, providing evidence of increased immigration in the more exposed regions. On the other hand, there is no significant effect of the import shock. Column (2) assesses the effect on the population until 25 years old, and the estimates also indicate an increase in the population of this age group as a result of the export shock.

Columns (3) and (4) show the effect of the trade shock with China for those between 06 to 10 years old and 11 to 14 years old. The estimates do not show significant results for both the import shock and the export shock. Columns (5) and (6) show the results for individuals aged 15 to 17 and 18 to 25 years, respectively. The estimates indicate that within these age groups, an export shock may increase the population growth rate, suggesting an increase in immigration flow to these age group. No significant effect of the import shock was identified.

Therefore, overall, the estimates suggest a positive and significant effect of the export shock on the population growth rate. Since the estimates are controlled for the pre-trend of population growth, the responses to the trade shock with China may indicate that population adjustment occurs through migration as a response to changes in the labor market.

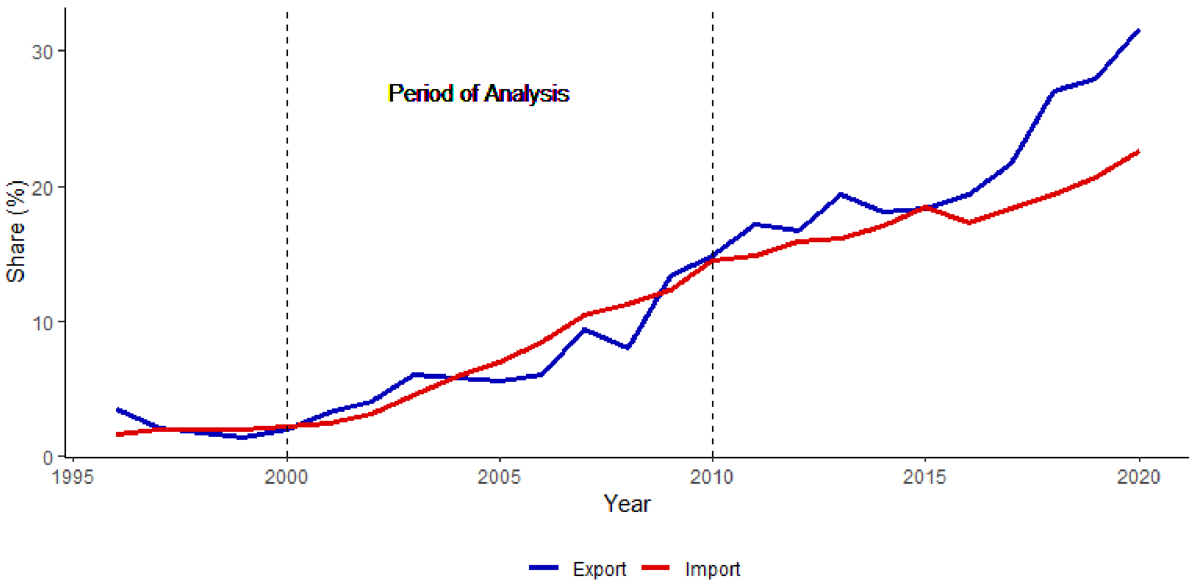
APPENDIX B – Figure and Tables

Figure A.1 – Evolution of China's International Trade Flow



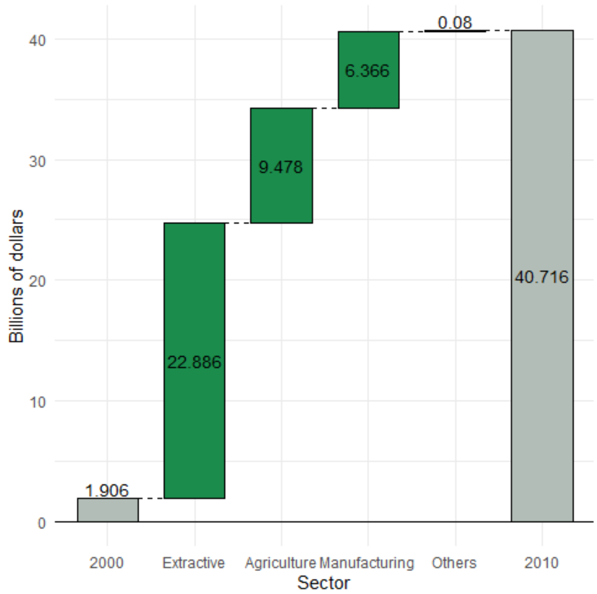
This graph shows the evolution in real values of China's imports and exports, deflated by the implicit GDP deflator of the United States, between 1996 and 2020.

Figure A.2 – Evolution of China's Share in Total Brazilian Exports and Imports

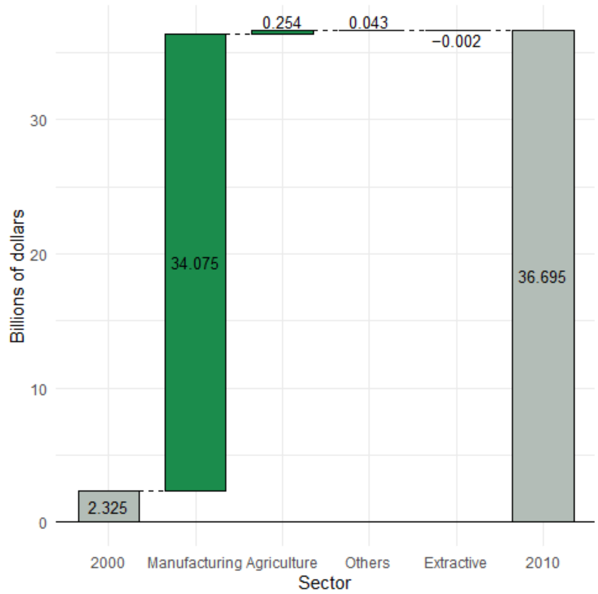


This graph shows the share of Brazilian exports directed to China and the share of imports from China between 1996 and 2020.

Figure A.3 – Evolution of International Trade between Brazil and China by Sector from 2000 to 2010



(a) Export from Brazil to China



(b) Import from China to Brazil

Note: This graph shows the real evolution of exports and imports between Brazil and China, stratified by sector.

Table A.2 – Descriptive Statistics by Sector

Sector	Description	Workforce % (2000)	Share of Imports % (2000)	Share of Imports % (2010)	$\Delta_{2010,2000}$ $ln(Imports+1)$	$\hat{\psi}$	Share of Exports % (2000)	Share of Exports % (2010)	$\Delta_{2010,2000}$ $ln(Exports+1)$	$\hat{\delta}$
Non-tradable	Non-tradable	66.6368	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Agriculture	Other	3.2295	0.5827	0.7153	2.9640	0.6115	0.0357	0.0054	1.1714	2.6213
Agriculture	Maize	2.4086	0.0000	0.0000	0.0000	-1.9651	0.0000	0.0257	8.8850	273.1798
Agriculture	Bovine Animals	2.3158	0.0000	0.0000	0.0000	-0.1226	0.0000	0.0000	0.0000	40.1048
Manufacturing	Apparel	1.9491	6.2716	2.5969	1.8774	1.4982	0.0033	0.0087	4.0037	0.1056
Agriculture	Coffee	1.8701	0.0000	0.0000	0.0000	9.1031	0.0178	0.0094	2.4197	6.6554
Agriculture	Manioc	1.5279	0.0000	0.0000	0.0000	-2.2920	0.0000	0.0000	0.0000	46.6650
Manufacturing	Other Food	1.3063	0.2221	0.2385	2.8294	0.6464	0.1163	0.0482	2.1810	2.8691
Other	Other	1.2735	0.3600	0.1390	1.8076	-0.8815	0.7610	0.2315	1.8713	4.1513
Manufacturing	Metal Products	1.2664	2.3888	3.1544	3.0371	2.9527	0.1281	0.0713	2.4752	1.8030
Agriculture	Rice	1.1144	0.0000	0.0000	0.0000	2.1711	0.0000	0.0000	0.0000	-2.1188
Manufacturing	Furniture	0.9211	0.2040	0.5537	3.7576	4.1578	0.0117	0.0003	-0.6662	4.0271
Agriculture	Forestry	0.6818	0.0346	0.0226	2.3320	1.9686	0.0377	0.0279	2.7593	2.1152
Manufacturing	Wood Products	0.6385	0.2542	0.1209	2.0160	1.7531	3.7758	0.2413	0.3110	1.4156
Agriculture	Tobacco	0.6014	0.0063	0.0000	-4.7005	1.8585	4.3034	1.1154	1.7113	8.5591
Agriculture	Sugar Cane	0.5894	0.0000	0.0000	0.0000	-0.0003	0.0000	0.0000	0.0000	-0.0002
Manufacturing	Printing And Recording	0.5439	0.1947	0.2385	2.9616	2.5009	0.0014	0.0004	1.8020	2.2392
Agriculture	Other Cereals	0.5433	0.0007	0.0034	4.2933	0.3239	0.0000	0.0000	0.0000	-0.3156
Manufacturing	Footwear	0.5317	1.5140	0.4177	1.4713	0.9139	0.0917	0.0139	1.1713	0.3239
Agriculture	Fishing And Aquaculture	0.5308	0.0000	0.0000	0.0000	-0.0406	0.0008	0.0000	0.0999	1.8596
Agriculture	Soya	0.4793	0.0000	0.0000	0.0000	-1.6254	28.8995	23.1915	2.8414	6.1294
Manufacturing	Other Textile Products	0.4711	1.4514	3.0277	3.4944	2.7872	0.0132	0.0156	3.2248	-0.1850
Manufacturing	Ceramic Products	0.4559	0.3445	1.0341	3.8580	3.1000	0.0099	0.0015	1.1846	1.3019
Manufacturing	Machinery	0.4387	7.1089	13.3220	3.3872	8.1645	2.9952	0.6073	1.4658	3.1760
Manufacturing	Spinning And Weaving	0.4023	1.5092	2.8333	3.3889	1.4260	0.0591	0.0350	2.5356	0.0913
Agriculture	Citrus Fruits	0.3706	0.0000	0.0000	0.0000	5.2393	0.0015	0.0000	-1.0868	0.2663
Agriculture	Birds	0.3610	0.0001	0.0000	-0.7316	-1.3528	0.0000	0.0000	0.0000	0.7763
Agriculture	Bananas	0.3322	0.0000	0.0000	0.0000	-0.7924	0.0000	0.0000	0.0000	-0.6347
Agriculture	Cocoa	0.3138	0.0000	0.0000	0.0000	-2.9972	0.0000	0.0000	0.0000	-0.5604
Manufacturing	Other Chemicals	0.3057	11.0891	6.8004	2.2701	3.9300	4.9704	1.0392	1.4965	2.4096
Manufacturing	Plastic Products	0.2985	2.6989	2.8302	2.8066	1.4632	0.5227	0.0243	-0.0090	2.5278
Manufacturing	Meat And Fish	0.2956	0.0264	0.4695	5.6340	0.7881	1.3287	0.7734	2.5202	0.9587
Manufacturing	Motor Vehicle Bodies And Parts	0.2826	0.2742	1.1539	4.1960	5.4762	0.8662	0.2313	1.7410	7.3283
Manufacturing	Other Nonmetallic Mineral Products	0.2728	0.1518	0.2610	3.3005	2.1584	0.6080	0.0279	-0.0209	2.9538
Manufacturing	Other	0.2533	7.2433	3.2474	1.9569	0.9326	0.0467	0.0573	3.2656	0.9968
Agriculture	Cotton	0.2517	0.1564	0.0000	-7.9193	-1.3247	0.0000	0.4559	11.8515	30.1559

Note: This table describes the main information about the sectors. The first and second columns describe the big sector and the sector, respectively. The third column shows the proportion of the workforce in the sector, followed by the proportion of China's imports for 2000 and 2010, and the logarithmic variation between these years. Next is the estimated variation in the import growth rate from other countries to China for each sector. From the 8th column, there is the proportion of exports to China by sector for 2010 and 2000, the logarithmic variation and the estimated variation from other countries.

Table A.2 continued from previous page

		Workforce	Share of Imports		$\Delta_{2010,2000}$		Share of Exports		$\Delta_{2010,2000}$	
Sector	Description	% (2000)	% (2000)	% (2010)	$ln(Imports+1)$	$\hat{\psi}$	% (2000)	% (2010)	$ln(Exports+1)$	$\hat{\delta}$
Manufacturing	Basic Metals	0.2497	1.8812	6.4012	3.9836	3.0824	5.2131	2.6447	2.3828	2.7492
Agriculture	Grapes	0.2404	0.0000	0.0000	0.0000	81.5138	0.0000	0.0000	0.0000	0.3956
Manufacturing	Motor Vehicles	0.2247	0.0022	0.9157	8.7448	21.7635	0.2326	0.0010	-2.4259	14.4503
Agriculture	Flowers And Ornamentals	0.2235	0.0012	0.0001	0.5353	3.8346	0.0001	0.0003	3.7782	2.0535
Manufacturing	Sugar	0.2157	0.0003	0.0002	2.4449	-1.0769	0.0000	1.6719	13.1511	0.9669
Manufacturing	Dairy Products	0.2056	0.0000	0.0025	6.5248	-0.8513	0.0024	0.0000	-2.1518	6.7456
Manufacturing	Electrical Equipment	0.1694	9.2059	7.9060	2.6069	2.3323	0.3684	0.0841	1.5841	2.2655
Manufacturing	Pharmaceuticals	0.1619	3.5796	1.8569	2.1028	2.3151	0.4446	0.1005	1.5743	2.8997
Agriculture	Pigs	0.1449	0.0000	0.0000	0.0000	-0.9612	0.0000	0.0000	0.0000	-0.4871
Agriculture	Other Animals	0.1435	0.0265	0.0000	-3.5097	-0.7814	0.0000	0.0042	7.1554	7.0385
Manufacturing	Beverages	0.1430	0.0019	0.0042	3.5169	-0.2017	0.0036	0.0009	1.6685	11.7012
Manufacturing	Pulp And Paper	0.1308	0.0133	0.3397	5.9961	4.7745	5.9070	3.9900	2.6691	0.7692
Mining	Nonmetals For Construction	0.1293	0.0458	0.0105	1.2843	0.3905	0.8891	0.0930	0.8040	4.6771
Manufacturing	Cleaning And Hygiene Products	0.1205	0.0090	0.0979	5.1403	3.9978	0.0052	0.0794	5.7723	4.4356
Manufacturing	Paper Products	0.0993	0.0346	0.0990	3.8080	2.9669	0.0681	0.0005	-1.9424	-0.0690
Manufacturing	Rubber Products	0.0977	1.4802	1.3888	2.6954	5.1558	0.0623	0.0423	2.6734	9.9856
Manufacturing	Electronics	0.0933	15.2754	17.1168	2.8729	5.2301	0.9021	0.1606	1.3358	2.8034
Manufacturing	Leather Products	0.0877	0.0990	0.0769	2.5057	1.0756	0.0032	0.0001	-0.3414	3.8109
Manufacturing	Medical Instruments	0.0759	0.3582	0.5893	3.2569	4.6856	0.0309	0.0067	1.5364	2.7658
Manufacturing	Domestic Appliances	0.0733	1.8858	2.1591	2.8945	2.3908	0.0222	0.0036	1.2489	0.9554
Agriculture	Sheep	0.0645	0.0000	0.0000	0.0000	-1.2830	0.0000	0.0000	0.0000	1.5105
Agriculture	Beekeeping	0.0644	0.0000	0.0000	2.5228	-0.7995	0.0026	0.0017	2.6135	10.4486
Agriculture	Silk	0.0632	0.0000	0.0027	6.6317	0.4789	0.0000	0.0000	0.0000	-0.3487
Manufacturing	Glass Products	0.0561	0.9035	0.7513	2.5745	4.4369	0.1361	0.0197	1.1263	0.5047
Mining	Oil And Gas	0.0528	0.0000	0.0000	0.0000	-1.6904	3.0926	13.1666	4.5101	4.7120
Manufacturing	Refined Petroleum	0.0507	0.0113	0.2178	5.7114	2.9509	0.0019	0.0014	2.7086	0.1139
Manufacturing	Leather Processing	0.0411	0.1149	0.0101	0.3277	-0.2506	2.1012	1.1487	2.4576	0.2540
Manufacturing	Paints And Varnishes	0.0393	0.0325	0.0308	2.7029	2.3210	0.0149	0.0122	2.8557	1.1566
Manufacturing	Tobacco	0.0384	0.0000	0.0000	0.0000	1.0999	0.0000	0.0000	-0.2486	2.7947
Mining	Precious Metals	0.0372	0.0000	0.0000	0.0000	19.2385	0.0000	0.0000	0.0000	4.5273
Mining	Precious Stones	0.0371	0.0014	0.0000	-0.6766	-0.1160	0.1313	0.0280	1.5141	0.7494
Manufacturing	Fruits And Vegetables	0.0358	0.2195	0.2539	2.9044	1.1336	0.4635	0.3393	2.7494	0.7149
Manufacturing	Shipbuilding	0.0346	0.0144	1.5713	7.4494	13.1258	0.0000	0.0000	0.0000	-0.7677
Mining	Other Nonmetals	0.0314	0.0701	0.0439	2.2895	-0.0184	0.1065	0.0052	0.0502	1.6576
Mining	Other Metals	0.0308	0.3014	0.0170	-0.1147	-2.1761	23.6027	44.2188	3.6893	21.3752
Manufacturing	Computing	0.0307	9.9902	6.7233	2.3631	5.8398	0.0500	0.0156	1.8941	1.8806
Manufacturing	Coffee	0.0297	0.0000	0.0000	2.6503	0.2560	0.0290	0.0047	1.2367	16.7298

Note: This table describes the main information about the sectors. The first and second columns describe the big sector and the sector, respectively. The third column shows the proportion of the workforce in the sector, followed by the proportion of China's imports for 2000 and 2010, and the logarithmic variation between these years. Next is the estimated variation in the import growth rate from other countries to China for each sector. From the 8th column, there is the proportion of exports to China by sector for 2010 and 2000, the logarithmic variation and the estimated variation from other countries.

Table A.2 continued from previous page

		Workforce	Share of Imports		$\Delta_{2010,2000}$		Share of Exports		$\Delta_{2010,2000}$	
Sector	Description	% (2000)	% (2000)	% (2010)	$ln(Imports+1)$	$\hat{\psi}$	% (2000)	% (2010)	$ln(Exports+1)$	$\hat{\delta}$
Manufacturing	Aircraft	0.0275	0.0000	0.0021	6.3864	0.9557	3.1796	1.2350	2.1159	2.4086
Manufacturing	Optical Equipment	0.0271	2.4633	5.7562	3.6079	4.5149	0.2566	0.0386	1.1660	20.9344
Manufacturing	Other Transport	0.0241	0.9848	1.0474	2.8207	1.8325	0.0000	0.0012	5.7985	0.6630
Mining	Coal	0.0234	1.2962	0.0330	-0.9107	-3.7322	0.0000	0.0000	1.0061	115.8062
Manufacturing	Measuring Instruments	0.0216	0.5490	0.6890	2.9860	5.5134	0.0742	0.0272	2.0588	3.9860
Mining	Radioactive Metals	0.0159	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-2.6784
Manufacturing	Oils And Fats	0.0149	0.0014	0.0012	2.6235	-0.5435	2.9956	2.5920	2.9168	4.5484
Manufacturing	Railway Products	0.0063	0.0029	0.0151	4.3815	4.4318	0.0000	0.0007	5.3822	3.6433
Manufacturing	Watches And Clocks	0.0052	0.6697	0.2090	1.5946	0.1442	0.0010	0.0000	-1.6797	0.3590
Manufacturing	Coke	0.0004	4.3855	0.4797	0.5462	-1.7394	0.0000	0.0000	0.0000	1.7214
Manufacturing	Nuclear Fuel	0.0003	0.0000	0.0000	0.0000	5.6088	0.0000	0.0000	0.0000	21.0658

Note: This table describes the main information about the sectors. The first and second columns describe the big sector and the sector, respectively. The third column shows the proportion of the workforce in the sector, followed by the proportion of China's imports for 2000 and 2010, and the logarithmic variation between these years. Next is the estimated variation in the import growth rate from other countries to China for each sector. From the 8th column, there is the proportion of exports to China by sector for 2010 and 2000, the logarithmic variation and the estimated variation from other countries.

Table A.3 – First Stage Estimates Aggregated at Sector-Level and Conventional Approach

	Sector-Level		Raw data	
	$Import_m$	$Export_m$	$Import_m$	$Export_m$
	(1)	(2)	(3)	(4)
Shock Import ($\frac{V_{CjB-,2000} \cdot \hat{\psi}_{China,j}}{L_{Bj,200}}$)	0.00008**	-0.0003**	-	-
	(0.000034)	(0.0001)		
Shock Export ($\frac{V_{B-jC,2000} \cdot \hat{\delta}_{China,j}}{L_{Bj,2000}}$)	0.00009*	0.0015***	-	-
	(0.00005)	(0.0005)		
$ivImport_m$	-	-	0.0174***	-0.0353***
			(0.0012)	(0.0017)
$ivExport_m$	-	-	0.0034***	0.1161***
			(0.0005)	(0.0092)
N	84	84	5476	5476
R^2	0.1602	0.3638	0.9516	0.6929
Standard Errors	Robust	Robust	Region	Region
Wald test ($ivImport_m = ivExport_m = 0$)	6.9026	4.2067	130.44	222.10

This table presents the first stage from estimates. The regression includes the following controls: a quadratic specification of per capita income, the share of males, the share of white people, the ratio between people with higher education and individuals with high school, the proportion of people that receive transfer from government, the gini's coefficient and fixed effects by state. All controls are available in 2000. The regressions are weighted by municipality population under 25 years old. Standard errors are shown in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

APPENDIX C – Robustness Test

Table A.4 – Robustness Tests for Effect of China Trade on Enrollment

	Share of Enrollment						
	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Import_m$	-0.0632	0.1526	0.2532	0.0995	0.1526	0.2217	0.0890
	(0.2111)	(0.2213)	(0.2539)	(0.2032)	(0.1765)	(0.1747)	(0.2010)
$Export_m$	-0.1163*	-0.1775**	-0.1384*	-0.1608	-0.1775*	-0.0893**	-0.1881*
	(0.0514)	(0.0432)	(0.0793)	(0.0974)	(0.0976)	(0.0416)	(0.1017)
Average at 2000	56.102	56.102	56.102	56.102	56.102	56.102	56.102
Sector-level	N	N	Y	Y	Y	Y	Y
Fixed Effects	State	State	Microregion	Mesoregion	State	State	State
Instrument	-	Souza Junior (2024)	Souza Junior (2024)	Souza Junior (2024)	Souza Junior (2024)	Costa et al. (2016)	Autor et al. (2013)
S.E.	Region	Region	Robusts	Robusts	Robusts	Robusts	Robusts
N (Municipalities)	5476	5476	5476	5476	5476	5476	5476
N (Sector)	84	84	84	84	84	84	84
First-Stage Tests							
Wald Test ($Import_m$)	-	130.43	7.5884	7.0523	6.9026	2.8961	8.0866
Wald Test ($Export_m$)	-	222.09	2.1082	3.3110	4.2067	114.67	3.5524

This table presents the estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in the share of enrollment with different specifications. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. In Column (1), the coefficients are estimated by OLS. Column (2) performs a conventional 2SLS. From Column (3) the regressions are at sector-level. Columns (3) to (5) estimate with fixed effects by microregion, mesoregion, and state, respectively. In Column (6), we use the instrument proposed by Costa, Garred and Pessoa (2016). The last column (7) shows the estimates with the instrument proposed by Autor, Dorn and Hanson (2013). All regressions include the controls specified in the Identification Strategy section. The regressions are weighted by municipality population with the same age range of dependent variable. Standard errors are showed in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.5 – Robustness Tests for Effect of China Trade on Enrollment to 06 to 10 years old

	Share of Enrollment to 06 to 10 years old						
	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Import_m$	-0.7690	-0.7483	-0.4871*	-0.5065**	-0.7483***	-0.6726***	-0.7980***
	(0.9564)	(1.015)	(0.2470)	(0.2074)	(0.1814)	(0.1566)	(0.2031)
$Export_m$	-0.1068*	-0.0753	-0.0701**	-0.0942**	-0.0753	-0.0919***	-0.0785
	(0.0473)	(0.0581)	(0.0281)	(0.0395)	(0.0508)	(0.0208)	(0.0550)
Average at 2000	92.451	92.451	92.451	92.451	92.451	92.451	92.451
Sector-level	N	N	Y	Y	Y	Y	Y
Fixed Effects	State	State	Microregion	Mesoregion	State	State	State
Instrument	-	Souza Junior (2024)	Souza Junior (2024)	Souza Junior (2024)	Souza Junior (2024)	Costa et al. (2016)	Autor et al. (2013)
S.E.	Region	Region	Robusts	Robusts	Robusts	Robusts	Robusts
N (Municipalities)	5476	5476	5476	5476	5476	5476	5476
N (Sector)	84	84	84	84	84	84	84
First-Stage Tests							
Wald Test ($Import_m$)	-	129.43	7.4289	6.9404	6.8475	2.9115	8.0837
Wald Test ($Export_m$)	-	162.75	2.0748	3.1491	3.9211	131.40	3.2510

This table presents the estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in the share of enrollment to children between 06 to 10 years old with different specifications. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. In Column (1), the coefficients are estimated by OLS. Column (2) performs a conventional 2SLS. From Column (3) the regressions are at sector-level. Columns (3) to (5) estimate with fixed effects by microregion, mesoregion, and state, respectively. In Column (6), we use the instrument proposed by Costa, Garred and Pessoa (2016). The last column (7) shows the estimates with the instrument proposed by Autor, Dorn and Hanson (2013). All regressions include the controls specified in the Identification Strategy section. The regressions are weighted by municipality population with the same age range of dependent variable. Standard errors are showed in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.6 – Robustness Tests for Effect of China Trade on Enrollment to 11 to 14 years old

	Share of Enrollment						
	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Import_m$	-0.6539	-0.6039	-0.3427	-0.4972**	-0.6039***	-0.6017***	-0.6355***
	(0.4474)	(0.4352)	(0.2203)	(0.2016)	(0.1730)	(0.1567)	(0.1896)
$Export_m$	-0.0696*	-0.0434*	-0.0488*	-0.0645*	-0.0434*	-0.0588**	-0.0470**
	(0.0275)	(0.0202)	(0.0289)	(0.0374)	(0.0225)	(0.0258)	(0.0226)
Average at 2000	94.466	94.466	94.466	94.466	94.466	94.466	94.466
Sector-level	N	N	Y	Y	Y	Y	Y
Fixed Effects	State	State	Microregion	Mesoregion	State	State	State
Instrument	-	Souza Junior (2024)	Souza Junior (2024)	Souza Junior (2024)	Souza Junior (2024)	Costa et al. (2016)	Autor et al. (2013)
S.E.	Region	Region	Robusts	Robusts	Robusts	Robusts	Robusts
N (Municipalities)	5476	5476	5476	5476	5476	5476	5476
N (Sector)	84	84	84	84	84	84	84
First-Stage Tests							
Wald Test ($Import_m$)	-	136.59	7.5305	6.9795	6.8438	2.9216	8.0482
Wald Test ($Export_m$)	-	194.00	2.3938	3.8130	4.8811	89.620	4.0788

This table presents the estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in the share of enrollment to 11 to 14 years old with different specifications. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. In Column (1), the coefficients are estimated by OLS. Column (2) performs a conventional 2SLS. From Column (3) the regressions are at sector-level. Columns (3) to (5) estimate with fixed effects by microregion, mesoregion, and state, respectively. In Column (6), we use the instrument proposed by Costa, Garred and Pessoa (2016). The last column (7) shows the estimates with the instrument proposed by Autor, Dorn and Hanson (2013). All regressions include the controls specified in the Identification Strategy section. The regressions are weighted by municipality population with the same age range of dependent variable. Standard errors are showed in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.7 – Robustness Tests for Effect of China Trade on Enrollment to 15 to 17 years old

	Share of Enrollment						
	OLS (1)	2SLS (2)	2SLS (3)	2SLS (4)	2SLS (5)	2SLS (6)	2SLS (7)
$Import_m$	-0.5265	-0.3087	0.4891	-0.2590	-0.3087	-0.2375	-0.3598
	(0.4721)	(0.4081)	(0.3661)	(0.3300)	(0.2785)	(0.2466)	(0.3029)
$Export_m$	-0.0320	-0.0135	0.0152	-0.0231	-0.0135	-0.0137	-0.0158
	(0.0609)	(0.0260)	(0.0241)	(0.0639)	(0.0359)	(0.0459)	(0.0371)
Average at 2000	78.770	78.770	78.770	78.770	78.770	78.770	78.770
Sector-level	N	N	Y	Y	Y	Y	Y
Fixed Effects	State	State	Microregion	Mesoregion	State	State	State
Instrument	-	Souza Junior (2024)	Souza Junior (2024)	Souza Junior (2024)	Souza Junior (2024)	Costa et al. (2016)	Autor et al. (2013)
S.E.	Region	Region	Robusts	Robusts	Robusts	Robusts	Robusts
N (Municipalities)	5476	5476	5476	5476	5476	5476	5476
N (Sector)	84	84	84	84	84	84	84
First-Stage Tests							
Wald Test ($Import_m$)	-	136.59	7.5305	6.9795	6.8438	2.9216	8.0482
Wald Test ($Export_m$)	-	194.00	2.3938	3.8130	4.8811	89.620	4.0788

This table presents the estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in the share of enrollment to 15 to 17 years old with different specifications. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. In Column (1), the coefficients are estimated by OLS. Column (2) performs a conventional 2SLS. From Column (3) the regressions are at sector-level. Columns (3) to (5) estimate with fixed effects by microregion, mesoregion, and state, respectively. In Column (6), we use the instrument proposed by Costa, Garred and Pessoa (2016). The last column (7) shows the estimates with the instrument proposed by Autor, Dorn and Hanson (2013). All regressions include the controls specified in the Identification Strategy section. The regressions are weighted by municipality population with the same age range of dependent variable. Standard errors are showed in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.8 – Robustness Tests for Effect of China Trade on Enrollment to 18 to 25 years old

	Share of Enrollment						
	OLS (1)	2SLS (2)	2SLS (3)	2SLS (4)	2SLS (5)	2SLS (6)	2SLS (7)
$Import_m$	-0.2891	-0.1294	0.4479*	0.1413	-0.1294	-0.0554	-0.1995
	(0.4089)	(0.4168)	(0.2672)	(0.1845)	(0.2438)	(0.2255)	(0.2722)
$Export_m$	-0.0710	-0.1013*	-0.0767	-0.0785	-0.1013	-0.0419	-0.1162
	(0.0356)	(0.0425)	(0.0765)	(0.0936)	(0.0765)	(0.0339)	(0.0833)
Average at 2000	24.534	24.534	24.534	24.534	24.534	24.534	24.534
Sector-level	N	N	Y	Y	Y	Y	Y
Fixed Effects	State	State	Microregion	Mesoregion	State	State	State
Instrument	-	Souza Junior (2024)	Souza Junior (2024)	Souza Junior (2024)	Souza Junior (2024)	Costa et al. (2016)	Autor et al. (2013)
S.E.	Region	Region	Robusts	Robusts	Robusts	Robusts	Robusts
N (Municipalities)	5476	5476	5476	5476	5476	5476	5476
N (Sector)	84	84	84	84	84	84	84
First-Stage Tests							
Wald Test ($Import_m$)	-	127.90	7.8246	7.3020	7.1013	2.9484	8.2163
Wald Test ($Export_m$)	-	218.58	1.9681	3.1342	3.9966	121.96	3.4508

This table presents the estimated effects of Chinese import and export shocks on changes between 2000 and 2010 in the share of enrollment to 18 to 25 years old with different specifications. The coefficients and standard errors are multiplied by 100, making the coefficients represent percentage point changes. In Column (1), the coefficients are estimated by OLS. Column (2) performs a conventional 2SLS. From Column (3) the regressions are at sector-level. Columns (3) to (5) estimate with fixed effects by microregion, mesoregion, and state, respectively. In Column (6), we use the instrument proposed by Costa, Garred and Pessoa (2016). The last column (7) shows the estimates with the instrument proposed by Autor, Dorn and Hanson (2013). All regressions include the controls specified in the Identification Strategy section. The regressions are weighted by municipality population with the same age range of dependent variable. Standard errors are showed in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.