

INCOME SHOCKS AND GENDER INEQUALITY: THE CHINESE SHOCK AND ITS EFFECTS ON SCHOOL INDICATORS OF BRAZILIAN TEENAGERS

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Income shocks, such as those originating in the international market, provide an opportunity to assess the effects of exogenous variations on important economic indicators. In this context, China's entry into the World Trade Organization in 2001 triggered the so-called Chinese Shock. Such shocks may not be gender neutral, impacting men and women differently due to the heterogeneous distribution of workers in different sectors of economic activity. This paper seeks to investigate whether such a shock, evaluated in general and disaggregated by sectors specialized in female and male labor, also has an unequal impact on quantitative and qualitative educational indicators according to the student's gender. In elementary school, the Chinese Shock negatively affects the enrollment of girls and, for those who remain enrolled, there is an improvement in performance, both in Portuguese and Mathematics. For boys, this improvement is also observed, but to a lesser extent, with a parallel increase in their enrollments. In Higher Education, this shock increases enrollment in higher education courses and the magnitude is the same for both genders. The exception occurs in "Agriculture and Veterinary" courses, where women have a greater participation compared to men. As for the disaggregated shock between sectors that employ men and women differently, it is noted that the effects between the sexes are uneven only for the indicators of quality education, since they are always more intense for girls than for boys.

KEYWORDS: International trade shock, Labor market, Gender education differential.

1. INTRODUCTION

Unexpected events, considered exogenous shocks, can lead to changes in societal well-being that are not gender neutral, so as to increase or reduce inequalities between men and women (and even between men and women) in different aspects of life. In recent years, one of the shocks that has gained prominence in the economic debate is China's entry into the World Trade Organization (WTO) in 2001, which increased the supply of Chinese products in international trade, significantly impacting the dynamics of exchanges in the world and, consequently, generating diverse effects on nations, especially on their productive orientations and the labor market.

In the workplace, these impacts do not occur homogeneously for all workers because the shock affects sectors in different ways, which, in turn, operate with different levels of occupational segregation by gender. As a result, changes occur in terms of opportunity creation and

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wage gains or, in the opposite direction, through job destruction and relative loss of income. According to [Benguria and Ederington \(2017\)](#), this unexpected change promoted, in Brazil, a fall in wage inequality between men and women, which occurred from the reduction of the male average income, the increase of female participation in occupations with better pay and the increase of returns in occupations where they are the majority. Similar results are estimated by [Connolly \(2022\)](#), when he observes that the increase in employment in the Brazilian regions most exposed to Chinese imports is higher for women, and the increase in wages is lower for men than for women. Moreover, he identifies a reallocation of workers to the formal sector, which reduces occupational segregation.

Such changes in the labor market and their impacts on family income may also translate into effects on education, since they modify the current economic scenario in such a way as to promote adjustments in individuals' expectations regarding the existing possibilities. This can occur both through intra-family decisions about children's education, sensitive to changes in the socioeconomic environment ([Duflo, 2012](#)), and through the propensity to enter college (and the choice of major), which may be associated with economic cycles ([Johnson, 2013](#)). In this process, there is also the possibility that educational impacts occur differently by gender, which could promote a reduction or widening of gender educational inequalities. This is seen, for example, in the work of [Beyene and Decaluwe \(2008\)](#), who analyze the impact of trade opening in South Africa. While a decrease in income based on qualifications, skill premium, for women leads to a substitution of education for housework for girls, an increase in skill premium for men has the opposite effect for boys. By focusing on Mexico, [Atkin \(2016\)](#) notes that an increase in employment given an export shock in the country has a negative effect on educational indicators for both genders, but the effect is greater for boys. The studies by [Bandara et al. \(2015\)](#) and [Björkman-Nyqvist \(2013\)](#), meanwhile, which look at crop shocks that negatively impact income, find negative and significant effects on girls' enrollment and no significant effect for boys.

In light of this, this paper seeks to evaluate the effects of the Chinese shock on students' education by gender. It is assumed that the impacts of the shock already observed on wages in the labor market could be transmitted to the schooling results of teenagers, generating effects on quantitative (enrollment in elementary school and in higher education)¹ and qualitative (grades in Portuguese and Mathematics) educational indicators, as well as being distinct between boys and girls. In addition to highlighting the impacts on enrollment and grade indicators, it is important to shed light on the deeper consequences of the economic shock on the configuration of enrollments in the knowledge areas of higher education, which are often related to opportunities in the labor market.

The article that most closely resembles the goals proposed here is that of [Atkin \(2016\)](#). While [Atkin \(2016\)](#) analyzes the effect of an export shock on school dropout in Mexico, the present study verifies the result of an import shock in Brazil on its educational indicators, both quantitative and qualitative. According to the results found by [Atkin \(2016\)](#), school dropout increases with the export shock, which according to the author is due to the opportunity cost for the student at the margin. Furthermore, he finds that teenagers respond more to employment shocks that impact their corresponding sex: women respond more to employment shocks in female-dominated labor and men to employment shocks in male-dominated sectors, and they are more sensitive than women.

¹ Although the focus of the paper is on the early (elementary school) and more advanced (higher education) levels, it is not assumed that the effects in between are non-existent. They are explored because the goal is the possible effects of the Chinese shock in borderline educational cases (on the one hand, without so much direct articulation with the labor market; on the other, with the focus on professionalization through technical careers), without entering into the discussion for high school.

The papers by [Viaro \(2017\)](#) and [Greenland and Lopresti \(2016\)](#) also intersect with the present proposal by analyzing Chinese shock from the demand side (increased imports of Chinese goods) on investments in education. However, they do not distinguish the effects of the shock between female- and male-dominated sectors and do not analyze the effects on higher education. While the first author finds a reduction in Brazilian children's school attendance, [Greenland and Lopresti \(2016\)](#) estimate an increase in the public high school completion rate for the United States.

On the empirical side, the contribution of the paper, by using an exogenous income shock on the educational indicators of adolescents, lies in the fact that simply estimating the effect of income on these indicators would only lead to the identification of a correlation between the variables, since there are other unobservable factors that affect both family income and aggregate educational outcomes. Thus, by making use of an exogenous household income shock, that is, explained by factors outside the model (China's entry into the WTO), it is possible to approach a causal relationship between a change in household income and the intended educational impacts by sex. Moreover, this strategy allows for greater external validity of the results, enabling policies to be implemented and applied to everyone, not just specific families, and for these results to serve as evidence for other negative exogenous labor market disturbances.

To this end, the identification strategy adopted relies on the fact that different regions within a country specialize in the production of disparate goods, and that sectors are affected to different degrees by trade shocks. To measure the intensity of exposure to the shock, an index of imports of Chinese goods is used, as performed in the works of [Autor et al. \(2013\)](#), [Ben-guria and Ederington \(2017\)](#), and [Braga \(2018\)](#). The present paper advances by adding to the index the variations of imports between the years of analysis—from 1999 to 2017—and by disaggregating it between sectors with predominantly male and female labor.

From this effort, we observe that the Chinese shock negatively affects the enrollment of girls in the last grade of elementary school and, for those who remain enrolled, there is an improvement in performance, both in Portuguese and Mathematics. For boys, this improvement is also observed, but to a lesser extent, with a parallel increase in their enrollment. Thus, the Chinese shock, which has disparate effects on the labor market, also generates differentiated impacts on education by sex. Moreover, when the shock is analyzed disaggregated into sectors that employ female and male labor at different intensities, no effects are observed on the quantitative educational indicator, but the qualitative effect depends on the source of income reduction: if it occurs due to a drop in employment, keeping wages constant (as it happens through the more feminized sectors) the effect on the grades of both sexes is negative; if, on the other hand, there is an increase in employment, but at lower wages (as it occurs in the more masculinized sectors), the effect is positive.

Finally, in the analysis for higher education, it is observed that Chinese shock increases enrollment in higher education majors and the magnitude is the same for people of different sexes. The exception occurs for "Agriculture and Veterinary" majors where women have a higher participation compared to men. In the case of the desegregated shock in sectors that employ more men or women, in general there are no significant effects on enrollments at this educational level.

Besides this introduction, the rest of the article is organized as follows: Section 2 provides the theoretical framework, Section 3 presents the empirical and identification strategy, as well as the bases used and the treatment performed on the data, Section 4 exposes and discusses the results found and, finally, Section 5 indicates the conclusions that can be reached with this work.

2. THE CHINESE SHOCK AND EDUCATIONAL EFFECTS

The identification of mechanisms through which the shock caused by the increase in Brazilian imports of Chinese products can affect the education of teenagers is initially envisioned based on the theoretical model of [Autor et al. \(2013\)](#). For the authors, given China's entry into the WTO and its effects on the local market of trading partners, there are two main channels of impact: (i) through the increased supply of Chinese products in the country, and (ii) through increased import demand by China.

The first channel is through the increase in China's export capacity, increasing rivalry in the markets of countries that sell similar products. For a country that trades with China, a shock that positively impacts the supply of Chinese exports decreases wages and employment in the tradable goods producing region (mainly sectors that contain a large number of monopolistic firms and a wide variety of differentiated products), and increases employment in regions that specialize in non-tradable goods (such as transportation and cultural goods). The second channel, which consists of a shock that positively impacts China's demand, captures the increase in Chinese spending on imported goods. This type of shock affects its trading partners by decreasing employment in the non-tradable goods sector and increasing wages and employment in the tradable goods regions, which will have to expand their production in order to supply the demanded products. In an economy with balanced trade (in which increases in imports in some sectors are offset by increases in exports in others) there would be no effect on the demand for employment. However, the opposite happens in economies with an unbalanced trade balance.

In addition, shocks can differentially affect the working conditions of sectors and microregions that unequally employ men and women, and this can occur due to observable and unobservable factors. Regarding observable factors, as highlighted by [Juhn et al. \(2014\)](#), one can mention the fact that sectors are differently impacted in the face of changes in international trade and such productive segments employ men and women in different proportions. The industrial sector, for example, is mostly made up of male labor and competes directly with imported Chinese products, so that intensive microregions in this type of employment are, on average, left with a labor market in worse conditions than those intensive in female labor, as in the case of the largely non-tradable services sector. Another observable factor that explains this heterogeneous effect of trade shocks is technology. Companies, with trade openness, tend to invest and import more machinery and equipment making work more technological and less physical, which favors women, since they are seen as less skilled in jobs that require strength ([Csillag and Koren, 2011](#); [Juhn et al., 2014](#)).

As for the unobservable factors, the theory proposed by [Becker \(1957\)](#) defends that those companies that discriminate between men and women when hiring labor cannot survive in the face of increased competition. Thus, Brazilian companies that differentiate certain groups would end up leaving the market when faced with the entry of imported products.

Given these different possible outcomes from the Chinese shock, [Benguria and Ederington \(2017\)](#) note that, for Brazil, the effect of the shock was a reduction in average wages, explained in its entirety by the fall in average wages of men, which is due to the characteristic of a supply shock for exports of tradable goods. The fall in income may, in turn, generate effects on education, manifested both in enrollment and student performance. This behavior seen in aggregate may reflect individual decisions to invest in human capital in the face of changes in the economic environment.

According to [Soares et al. \(2012\)](#), the choice between work and study ponder the income effect and the substitution effect. In the first case, education is positively related to income (luxury good), so that if there is a reduction in income there is less investment in education, and thus a shock that reduces average wages would be perceived by reducing the country's enrollment levels. The substitution effect, on the other hand, takes into account the opportunity

cost of working and studying, so that if low wages are offered in the labor market, there may be a preference for education given the prospect of future earnings—and so a shock that reduces average wages would be realized by raising the country's enrollment levels. The aggregate outcome will depend on which of the two effects has greater weight in the decision-making process, and there is no guarantee that the relationship is equal for men and women. According to [Atkin \(2016\)](#), different effects on the educational indicators of boys and girls given a labor market shock can occur both because people of different genders respond in different ways to job opportunities and because some opportunities are gender-specific, such as jobs affected by international trade. If there is a positive effect on labor market opportunities associated with jobs held especially by women (men), one would expect a more intense effect on female (male) schooling.

For [Björkman-Nyqvist \(2013\)](#), children's educational outcomes in elementary school are the result of weighing the benefits and costs of educational investment, with the marginal benefit being the increase in income from children's future work, while the marginal cost of education is represented by the reduction in children's time spent on domestic activities. Since in Brazil domestic chores are still performed more intensively by girls² and the return to education is more unfavorable for women than for men,³ it is the gender roles that count, so that the fall in income negatively impacts the possibilities of access to study for girls in comparison to boys.

For qualitative indicators of primary education, [Björkman-Nyqvist \(2013\)](#) highlights two channels through which shocks that negatively impact income can generate effects on student grades: (i) the selection effect and (ii) the resource effect. In the first, the shock causes the marginal student to drop out of school, so that the average scores of remaining students rise. In the second, fewer resources are invested and/or less time is allocated to education, which negatively impacts average ability. It is not known which of the two effects exerts greater dominance, but according to simulations, the resource effect dominates in low-income families and the selection effect dominates in high-income families. Simulations also show that the effects on the educational quality of adolescents, when more than 20% and less than 80% of girls are enrolled in schools,⁴ will be more intense for girls than for boys. In short, from the author's observations, one could conclude that the income shock from Chinese imports in Brazil must have promoted a worsening of educational indices, both quantitative and qualitative, and that these effects were more intense for girls.

With regard to general enrollment and by major areas in higher education courses, the decision to continue studying and which course to choose is more related to labor market conditions, reflected in greater employment and income opportunities. Furthermore, many undergraduates already work, absorbing more intensely labor fluctuations. According to [Johnson \(2013\)](#), the effects on graduation are counter-cyclical since, at times when unemployment is higher or wages are relatively low, the opportunity cost of schooling becomes lower, thus increasing the demand for higher education.

Finally, it is necessary to emphasize that the labor market channel can impact the educational results through the role model channel, both for primary and higher education, since children see in their parents' example the return on education. According to [Baum \(2004\)](#), in the face

²According to data from the National Household Sample Survey (PNAD) for the years 1999 and 2017, a higher percentage of girls perform domestic activities compared to boys. In 1999, approximately 50% of boys and 90% of girls were engaged in household chores. In 2017, the difference narrowed, but girls remained more responsible (85.2% versus 63.5%). Thus, it can be assumed that in Brazil, work at home is geared more towards girls than boys.

³According to [Teixeira and Menezes-Filho \(2012\)](#), in Brazil it is possible to identify gender discrimination in relation to remuneration in the labor market, since the authors prove that the wage return from education is higher for white men compared to women.

⁴In Brazil, according to [Rosemberg \(2001\)](#), the proportion of women in primary education in 1999 was 66.8%.

of a positive return, children will seek to study and dedicate themselves more. Given that international trade shocks put less qualified people in worse conditions in the labor market,⁵ the model to be followed suggests that children, when they see in their parents' example that those who have more education are in a better situation, tend to improve their educational indicators. In the same sense, employed parents in more qualified jobs tend to encourage their children to study more, because they perceive its importance to develop their skills at work (Kohn, 1977). Moreover, according to this theory, girls tend to follow the mother's example and boys, the father's, due to the identification with the person of the same sex (Wolfer and Moen, 1996). Since, according to Benguria and Ederington (2017) and Connolly (2022), women were in a better position in the labor market than men, given Chinese shock, it is expected that the effect will be more intense for girls than for boys.

The same channel also helps to explain the decisions as to which major area of Higher Education to attend, because teenagers tend to reproduce the professional example of their relatives or people who inspire them, while parents tend to encourage their children when they believe in the work they are developing.⁶ When children see that their parents have had professional success in a certain area, they tend to opt to study related areas in Higher Education. In the same way, they may stop taking a certain course when they see their parents' failure.

Given differing interpretations for how the Chinese shock may affect the country's educational outcomes, it is necessary to assess what the observed impacts actually are. Next section explores the empirical mechanisms used in this task.

3. EMPIRICAL STRATEGY

3.1. *Income shock and the gender education gap*

The empirical strategy used in this essay follows Autor et al. (2013) and Benguria and Ederington (2017). To identify the effect of exogenous changes in household income on education outcomes for men and women the increase in Brazil's imports originating from China is used as a shock. Thus, a panel dataset was constructed by microregion,⁷ aggregating the education data at the individual level, for the years 1999, 2003, 2005, 2011, 2013, 2015 and 2017,⁸ with 1999 referring to the period before China entered the WTO and the interval from 2003 to 2017 comprising the years after that. The analysis for microregions becomes important, according to Autor et al. (2013), because as trade shocks act on the general equilibrium, it is necessary to empirically map the various shocks onto a small number of aggregate outcomes. If we analyze only national labor markets over a year, we will have few observations and many confounding factors, but by using the analyses at the micro-region and annual level we can circumvent the degrees of freedom problem.

⁵See Castilho (2010), Bustos (2011), Juhn et al. (2014), and Greenland and Lopresti (2016).

⁶See Porter and Serra (2020), Kohn (1977), and Wolfer and Moen (1996).

⁷A microregion is a grouping of adjacent municipalities, within the same state, with similar geographical and economic characteristics, which has often been used in the economic literature as a unit of analysis because it resembles a local labor market (Dix-Carneiro et al., 2018; Braga, 2018).

⁸These years were chosen due to the limited SAEB database, collected every two years. The years 2007 and 2009 were excluded because private institutions were not part of the sample, being important for analyzing parental investment in the education of their children. In order to control this problem and obtain greater homogeneity between the analyses, the same years are used for all the estimations, since the results from the different databases are complementary.

Thus, the interest effect is identified by means of Equation 1, which uses the variation within the micro-region:

$$y_{rs,t} = \rho + \zeta \text{Chinese_Shock}_{rs,t} + \alpha (\text{Chinese_Shock}_{rs,t} \times \text{sex_student}_{rs,t}) + \varphi \text{sex_student}_{rs,t} + X'_{rs,t} \beta + \rho_r + \varphi_s + \eta_t + \mu_{s,t} + \varepsilon_{rs,t}, \quad (1)$$

where $y_{rs,t}$ are the educational indicators divided into two levels: (i) Primary Education—enrollment and grades in Portuguese and Mathematics and (ii) Higher Education—total enrollment and by major areas,⁹ all varying by microregion r , by state s and between the years 1999 to 2017.¹⁰ $\text{Chinese_Shock}_{rs,t}$ is the measure of Brazilian import shock originating from China in which each micro-region r is exposed-discussed in detail in the next subsection; and $\text{Chinese_Shock}_{rs,t} \times \text{sex_student}_{rs,t}$ is the variable of interest in this paper, which captures the heterogeneous effect of the Chinese shock on educational indicators by sex, consisting of the interaction between the variable $\text{Chinese_Shock}_{rs,t}$ and the student sex variable, $\text{sex_student}_{rs,t}$.¹¹ The variable identifying the student's sex is given a value of 1 for observations that were collected for male students and zero for information from female students.¹²

According to Morduch (1994), households with different incomes experience income shocks heterogeneously (being more harmful to the most vulnerable), so it is likely that poorer regions are also more impacted. Given this, we use a vector of controls $X'_{rs,t} \beta$ that contains the average proportion, by microregion, of the following variables: educational level of mothers and fathers (divided into four groups: uneducated (baseline variable), with elementary school, with high school, and with college education), proportion of black and white adolescents, and proportion of adolescents in the labor market. Such controls explain the possibility that the more and less exposed regions are on different trajectories of educational indices during the period.

Microregion and state fixed effects (ρ_r and φ_s , respectively) were also included, which make it possible to control for unobserved heterogeneity at the microregion and state level (such as regional aptitudes to investments in education and cultural and religious norms). In addition, time fixed effects η_t were added to control for any condition that has changed in each time period, and $\mu_{s,t}$ which refers to the state-specific linear trend, which controls for possible micro and macro factors that vary over time and across observation units. Data was weighted by population in the microregions in the year of 1999 and, following the work of Dix-Carneiro et al. (2018), the standard errors were clustered at the mesoregion level, taking into account potential spatial correlations in the results between contiguous mesoregions.¹³

3.2. Identification strategy: The use of Brazilian imports of Chinese products as an exogenous shock to variations in family income

The difficulty of estimating the causal relationship between household economic conditions and the educational attainment of children of different sexes lies in the fact that both are explained by schooling, family structure, and unobservable factors such as innate ability, productivity difference at home and in the labor market, and parental care/attention to children. In

⁹The major areas are those defined by the Census of Higher Education: “Education”, “Humanities and Arts”, “Social Sciences, Business, and Law”, “Health and Welfare”, “Services”, “Sciences, Mathematics, and Computing”, “Engineering, Production, and Construction”, and “Agriculture and Veterinary”.

¹⁰The contemporary effect between imports of Chinese goods and the education of students of different genders was estimated.

¹¹Thus, ζ captures the marginal effect of the Chinese shock on the educational indicators of female students and $\zeta + \alpha$ the marginal effect on male students.

¹²In order to obtain this strategy, the bases for the male students' data and the female students' data were stacked.

¹³The mesoregions comprise 91 groups of micro-regions defined by IBGE, see Lima et al. (2022).

the impossibility of conducting randomized experiments that generate income shocks across Brazilian households, this paper explores the exogenous variation in income across microregions, over time, caused by the increase in Brazilian imports of Chinese goods.

The interest in the Chinese shock is mainly due to the rapid growth of Brazilian imports of products from China since 2001 (the year the country joined the WTO). In addition, according to [Costa et al. \(2016\)](#), studying this event is an opportunity to learn more about trade shocks in general and to understand the global impact of China, pointing out that the main characteristic of its products are the low prices associated with low production costs. Those companies that compete directly with such imported products probably cannot compete via price and suffer the negative impacts of this competition. Consequently, we have the possibility of evaluating a shock that negatively impacts income on Brazilian households, which, in fact, is estimated by [Benguria and Ederington \(2017\)](#).

To estimate the effect of the Chinese shock on the education of students of different genders, an index ($\text{Chinese_Shock}_{r,t}$) was constructed that aims to signal how microregions are exposed to the effect of this shock. Those that are more specialized in import-intensive industry are likely to be more exposed (having a higher index), while regions that are more intensive in the production of goods, such as beverages and food, will be less vulnerable to the impacts (lower the index). The intended impact is under the assumption that in the absence of the growth in Brazilian imports of Chinese goods, i.e., if China had not joined the WTO in 2001, the reduction in income and change in education would not have been systematically different between the regions most and least affected by the shock.

The measure of regional exposure to increased competition from imports from China followed [Autor et al. \(2013\)](#) and [Benguria and Ederington \(2017\)](#). The index was estimated by the change in Brazilian imports¹⁴ of Chinese products between the year 1999—prior to China's WTO entry—and the subsequent years of the sample in each industry (ΔI_i), weighted by the ratio of employment in industry i for each microregion r to employment in industry i in the initial year ($E_{ir,1999} \div E_{i,1999}$), and normalized by employment in microregion r (E_r),¹⁵ expressed as follows:

$$\text{Chinese_import}_{r,t} = \sum_i \frac{E_{ir,1999}}{E_{i,1999}} \cdot \frac{\Delta I_i}{E_r,1999} \quad (2)$$

Equation (1) takes advantage of controlling for unobserved (time-fixed) heterogeneity at the micro-region level for the identification of the effect of interest. To this end, unobserved time-varying factors cannot simultaneously correlate with the intensity of the Chinese shock experienced and educational outcomes. In order to deal with the possibility that this is a limitation of the identification strategy, another source of exogenous variation was used, following [Benguria and Ederington \(2017\)](#), who propose an instrument for Chinese shock.

By using this instrument, one deals with the possibility of the existence of any correlation between the intensity of receiving Chinese products in the micro-region and other variables. These include domestic industrial demand and supply, productivity shocks, and the quality of Brazilian products or any other factor that is present in the Brazilian economy, such as the

¹⁴For the construction of the index, we used import data at the country level, weighted by employment per sector and per micro-region. The response of each sector and each micro-region to imports from China will be explained by the competitiveness, via price, between the imported product and the product produced in the same sector and in the same micro-region, which may impact production and the local labor market. Thus, the main interest is not to investigate the import that came to a particular micro-region, but to analyze the effect of the product that entered the Brazilian economy and that will compete directly with that produced in each micro-region.

¹⁵These weightings allowed us to capture the relative importance of each sector in a given micro-region in the period before the shock.

commodities boom, income transfers, or some educational policy, which may also have affected the micro-region's level of investment in schooling, in turn impacting the educational indices. These and other potential confounding effects ("confounding factors") are controlled for by the instrument used here, as discussed by [Costa et al. \(2016\)](#) and [Autor et al. \(2013\)](#).

Thus, the use of the Chinese shock index illustrates the effect of the growth in Brazilian imports from China that is explained by China's own growth or the fall in trading costs and not by the fall in productivity in Brazil. This instrument corresponds to an index of imports of Chinese products by Latin American countries with characteristics and economies "similar" to Brazil (Argentina, Bolivia, Chile, Colombia, Paraguay, and Uruguay),¹⁶ constructed as follows:

$$\Delta \text{Chinese_Imports}_{r,t}^{\text{neighbors}} = \sum_i \frac{E_{ir,1999}}{E_{i,1999}} \cdot \frac{\Delta I_i^{\text{neighbors}}}{E_{r,1999}}, \quad (3)$$

being $\Delta I_i^{\text{neighbors}}$ the imports from China destined to these countries "similar" to Brazil, with the weights being the same used for the Brazilian index.

Under the assumption that the Chinese shock experienced by Latin American countries explains the Brazilian shock¹⁷ and the latter, in turn, has great relevance in justifying the income variation of Brazilian microregions, the effect of interest is estimated via Two-Stage Minimum Squares (MQ2E), also considering the additional hypothesis that the shock experienced by neighbors does not directly affect the educational outcomes of Brazilian adolescents. This is because there is no direct relationship established between imports of Chinese products by the other countries considered and Brazilian education and labor market, if not for the effect they have on Brazilian imports from China.¹⁸

3.3. Chinese shock via female- and male-intensive sectors

Due to the fact that men and women are employed differently across industries and microregions in Brazil (a phenomenon associated with horizontal segregation of the labor market), the present study seeks to investigate whether the supply shock of Chinese products, by impacting differently sectors and microregions in which female labor is predominant (F) and sectors and microregions in which male labor is predominant (M), would also affect unequally the education of people of opposite sexes. Thus, the following equation was estimated:

$$\begin{aligned} y_{rs,t} = & \alpha_1 + \alpha_2 \text{Chinese_Shock}_{r,t}^F \\ & + \alpha_3 (\text{Chinese_Shock}_{r,t}^F \times \text{sex_student}_{rs,t}) + \alpha_4 \text{Chinese_Shock}_{r,t}^M \\ & + \alpha_5 (\text{Chinese_Shock}_{r,t}^M \times \text{sex_student}_{rs,t}) + \pi_s \text{sex_student}_{rs,t} \\ & + X'_{rs,t} \lambda^t + \rho_r + \varphi_s + \eta_t + \mu_s t + \varepsilon_{rs,t}, \end{aligned} \quad (4)$$

¹⁶The choice of these countries lies in the fact that they are important trade partners of Brazil. However, according to [Dell et al. \(2019\)](#), even if other countries are used, one would still have similar interpretation and effect.

¹⁷This test is presented in Table A.I.

¹⁸One could consider, however, that one possible way that trade from neighboring countries impacts Brazilian productivity would be through labor migration. However, the literature shows that the migration of people between the most and least affected microregions within Brazil is limited ([Connolly, 2022](#); [Dix-Carneiro and Kovak, 2015](#); [Costa et al., 2016](#)), so even more limited would be the migration of people between Brazil and neighboring countries. Thus, this is not a possible channel of interference of China's trade with other countries in the labor market and educational indicators.

in which all variables correspond to the same ones mentioned in Equation (1), with the exception of the Chinese import indices discussed below.

The adaptation of general index occurs in the weighting by the ratio between employment in industry i for each micro-region r and employment in industry i in the initial year, which is now for workers of the same sex, that is, it is used ($E_{ir,1999}^g \div E_{i,1999}^g$), where g is the sex of each worker (F, M). Thus, one has:

$$\text{Chinese_Shock}_{r,t}^F = \sum_i \frac{E_{ir,1999}^F}{E_{i,1999}^F} \cdot \frac{\Delta I_i}{E_{r,1999}} \quad (5)$$

$$\text{Chinese_Shock}_{r,t}^M = \sum_i \frac{E_{ir,1999}^M}{E_{i,1999}^M} \cdot \frac{\Delta I_i}{E_{r,1999}}, \quad (6)$$

in which Equation (5) refers to the shock to female labor-intensive sectors and Equation (6), to male labor-intensive sectors.¹⁹ The objective of this index follows the idea of the general index, but reflecting the notion that a supply shock of Chinese products in Brazil will have heterogeneous effects depending on the set of sectors in which men and women are employed more intensively, capturing the existing heterogeneity among Brazilian micro-regions and industries. The interest of disaggregating the index is to isolate this impact among workers of different genders. When analyzing via sectors where female employment predominates, the effect of the constant shock on male workers is maintained, and the opposite is also true. As already discussed in the previous sections, it is to be expected that the Chinese shock has different effects in these segments.

3.4. Source and data treatment

Firstly, the work aims to analyze the educational indicators of students in the eighth grade (ninth year) of elementary school. To this end, the qualitative indicators of education—grades in Portuguese and Mathematics—as well as the variables referring to the socioeconomic characteristics of the Brazilian micro-regions were taken from the SAEB (Basic Education Evaluation System) database for the years 1999 (period before China's entry into the WTO) and 2003, 2005, 2011, 2013, 2015 and 2017 (period after China's entry). Data regarding the quantitative indicator—enrollment—were taken from the School Census for the same years.

In addition, this study sought to capture, through the educational indicators of Higher Education, whether the opportunities in the labor market generated from the Chinese shock are paramount to define investments in education at this stage of life.²⁰ To do this, it is necessary to use the Census of Higher Education, in order to analyze the enrollments and the choices by major areas of knowledge. We have opted to keep the same years as those cited above in order to make the results comparable with each other.

The option of analyzing the results of the Chinese shock only for Elementary and Higher Education (not including High School) is associated with the intention of capturing, through different threshold stages of the educational life cycle, the different channels that impact investments in education by gender. As previously presented, decisions in Primary Education are made taking into consideration the comparison between the benefits and costs of educational

¹⁹The same is done for the instruments.

²⁰This possibility is suggested in the theoretical model proposed by Soares et al. (2012) through the idea of a substitution effect.

investment, the marginal benefit being given by the increase in the children's future labor income, while the marginal cost of education is represented by the reduction of the children's time spent on domestic activities, with no direct articulation with the present labor market. Investments in higher education reflect more the conditions of the labor market, which is focused on professionalization through technical careers. High School, for being in an intermediate condition, would demand its own analysis, articulating the present and future effects observed by its link with the labor market.

In order to create the index of Brazilian imports from China, two databases were used: WITS (World Integrated Trade Solution) and RAIS (Annual Report of Social Information), for the same years as the SAEB data. The first base brings the information about the imports, following the harmonized system (NCM) of 6 figures. Import values, both for Brazil and for other countries, were transformed from Dollar to Real and deflated by the IGP-DI (base year 2017). With regard to RAIS, it should be noted that this is information related to formal employment, so this study does not include informality in its results, therefore comprising partial effects.²¹ Finally, the economical sectors were classified according to the three-digit CNAE (National Classification of Economic Activity), as suggested by IBGE (Brazilian Institute of Geography and Statistics), and the employment data were made compatible with the import data using the IBGE conversion table (NCM × CNAE).

4. RESULTS AND DISCUSSION

4.1. *Descriptive statistics*

The existing educational differential between boys and girls in the period analyzed in this work (1999 to 2017) is presented in Table I. Since the data of the present study is at the micro-region level, for the descriptive analysis the annual average per micro-region of the educational variables is considered, both for the year 1999 and for the period from 2003 to 2017. From it, it is observed that, in the last year of elementary school, there is no significant difference between the average enrollment of boys and girls in the average microregion, neither for the year before China entered the WTO, nor for the later period. In other words, boys and girls are present with the same intensity in the last year of elementary school in both periods. As for Higher Education, it is noted that in the initial year there is no significant difference in the average enrollments between genders in the average micro-region, but in later years it is the girls who are more present, evidencing the creation of an educational gap in their favor.

With regard to performance, boys in the eighth grade (ninth year) of elementary school, on average and at the micro-regional level, have higher grades in Mathematics and girls in Portuguese, in the two periods analyzed. Whereas the difference in Mathematics scores decreased from one period to the next (due to the expansion of female scores and the reduction of male scores), the difference in Portuguese scores increased, even with the expansion of scores for both genders.

For the undergraduate courses, regarding major areas, it can be observed that women, in the average micro-region, are in the majority in "Education", "Health and Welfare", "Services", "Humanities and Arts" and "Social Sciences, Business and Law", while men are in the majority in the exact and land-related courses. The largest gender gap, to their benefit, is in engineering courses and, to their benefit, in health and wellness courses. This is in line with the conclusions of the [World Economic Forum \(2018\)](#) Global Gender Gap Index, showing that the expansion

²¹We chose to consider only formal employment, even though it is a partial analysis, because there is no consensus in the literature on the effects of the Chinese shock on the informal labor market. See [Carneiro \(2021\)](#), [Paz \(2022\)](#), and [Connolly \(2022\)](#).

TABLE I
DESCRIPTIVE STATISTICS OF HUMAN CAPITAL DATABASES

	Girls		Boys	
	1999	2003-2017	1999	2003-2017
Panel 1. School Census				
Enrollment	3085.77* (295.69)	2607.86* (6700.06)	2780.29* (598.84)	2640.24* (6796.20)
Panel 2. SAEB				
Mathematics Grades	239.22 (30.72)	243.26 (21.73)	253.21 (31.37)	251.92 (21.58)
Portuguese Grades	234.85 (27.50)	248.13 (19.94)	225.17 (26.06)	233.10 (19.52)
Panel 3. Census and Higher Education				
General Enrollment	1057.57* (3821.08)	1735.91 (7225.31)	884.80* (3556.85)	1402.26 (6025.30)
Education	1011.60 (2048.10)	1873.56 (4905.45)	352.74 (681.43)	803.94 (2035.65)
Humanities and Arts	642.71* (1396.99)	880.32 (2965.89)	381.98* (771.74)	632.72 (2115.89)
Social Sciences, Administration and Law	2117.74* (7497.43)	4031.27 (14658.22)	2059.20* (7064.00)	3317.48 (12093.00)
Science, Math and Computing	537.37* (1274.99)	596.17 (1998.6)	865.75* (2116.63)	1192.42 (4237.79)
Engineer, Production and Construction	586.04 (1326.05)	1106.94 (2900.52)	1577.10 (3607.06)	2483.77 (6918.56)
Agriculture and Veterinary	199.50 (268.69)	332.18 (510.29)	318.76 (336.94)	406.31 (463.38)
Health and Welfare	1491.45 (3296.23)	2698.63 (7280.35)	635.59 (1414.57)	1001.79 (2810.84)
Services	292.71 (765.12)	465.96 (1368.07)	119.60 (330.19)	235.99 (710.41)

Note: (1) Standard deviation in parentheses. (2) All tests of means between boys and girls were performed. (3) Those data with an asterisk (*) represent the differences in means that were not significant. Source: Research results.

of women in higher education is not transversal, and that they are still a minority in areas more related to technology.

As for the Chinese shock, the index of imports of Chinese products (constructed according to Equation (2) to capture the variation in imports between the year before China joined the WTO (1999) and the years after that, weighted by the number of workers by sectors of the economy and among microregions), has as a general average the value of R\$1,014, while for the shock in female labor-intensive sectors it is R\$1,028 and, for the shock in male labor-intensive sectors, R\$1,174. That is, in the period between 2003 and 2017, compared to 1999, the population in the middle microregion was exposed to an import increase of R\$1,014 per worker, with women in the middle microregion being exposed to an increase of R\$1,028/worker and men, R\$1,174/worker.

Weighting this index by workers across sectors and microregion, according to [Benguria and Ederington \(2017\)](#), enables one to capture the fact that different regions within a country specialize in the production of disparate goods and that sectors are affected to different degrees by trade shocks. This can be proven by the variation of the index estimated here, which ranges from -8.4588 to 82.3913; that is, there are micro-regions that, on average, showed a reduction

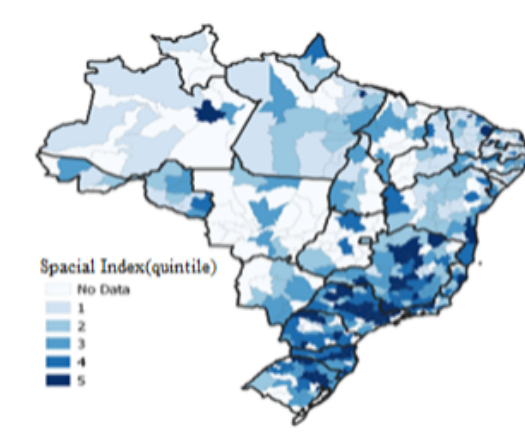


FIGURE 1.—Geographical distribution of import index by quintile (2003-2017). Source: Own elaboration with research data.

of R\$8,458.80 in their imports per worker, comparing the period before and after China's entry into the WTO, while others show an increase of R\$82,391.30. When viewing the geographical distribution of this information, available in Figure 1, one notices that the Southeast and South regions have a large part of the micro-regions classified starting in the third quintile, indicating that they were more affected by the increase in Chinese imports. Specifically, the microregions with higher indexes (and consequently greater exposure to the shock) contain municipalities considered important industrial centers, such as São José dos Campos (SP), Santa Rita do Sapucaí (MG) and Manaus (AM). The microregions with lower average indices, on the other hand, are Tobias Barreto (SE), Serra do Teixeira and Guarabira (PB) and Alto Araguaia (MT), whose main economic sectors are agriculture and cattle raising and services.

With regard to the index related to the intensity of the sectors according to the participation of female and male labor, Figure 2 presents the geographic distributions, which are similar to each other and refer back to what was shown in Figure 1. Three microregions where women receive more imports from China per worker are Manaus (AM), Santa Rita do Sapucaí (MG) and Grão Mogol (MG), the latter being more specialized in the service sector. For men, they are Grão Mogol (MG), Manaus (AM) and Bocaiúva (MG), the latter having, as its main economic activities, agriculture and cattle ranching and the extractive industry.²² Meanwhile, the micro-regions in which men received the least amount of imports from China per worker are Santa Cruz do Sul (RS), Itajaí (SC) and Estância (SE), and the micro-regions in which women received the least imports per worker are Imperatriz (MA), Passo Fundo (RS) and Vacaria (RS).

From this comparison, it is possible that the microregions where women were more exposed to the Chinese shock are those more focused on the technology industry, while for men the greatest exposure occurs in the microregions specialized in agricultural activities. Even though Manaus and Grão Mogol are among the microregions with the highest index for both sexes, it is noted that the index for Manaus is higher when female employment is considered, while for Grão Mongol the opposite occurs.

²²The information about the main sectors of the economy in each micro-region was taken from the Atlas of Human Development in Brazil (UNDP and IPEA, 2020), considering which sector employed the most labor.

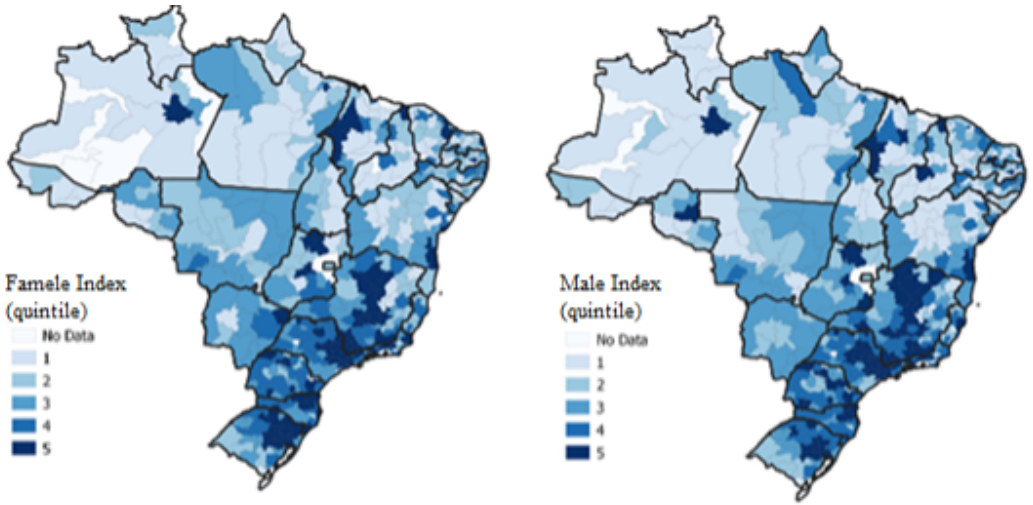


FIGURE 2.—Geographical distribution of import index by quintile in sectors employing more female and male labor (2003-2017). Source: Own preparation with research data.

4.2. Chinese shock: The labor market channel

This study starts from the assumption that it is the labor market conditions that transmit the effect of the Chinese shock to the educational indicators of children and adolescents. Thus, in Table II, we present the results concerning the investigation of this hypothesis, that is, the effects of the index indicative of the Chinese shock on the average income of formal workers—columns (1) and (2)—and on the number of formal employees—columns (3) and (4). Furthermore, this table exposes these effects when estimated by Ordinary Least Squares (OLS)—columns (1) and (3)—and Two-Step Least Squares (TWLS) - columns (2) and (4)—, using, in this case, the instrument of the China Supply Shock in “similar” countries.²³ The coefficients are interpreted as the effect of a R\$1,000 increase in imports per worker on the results of interest, in percentage points.

When comparing the results by MQO and MQ2E, it can be seen that the estimations by MQO underestimate the true impact. This is because the estimation via MQ2E considers only the effect of the supply shock in China that occurred due to the increase in its export capacity, and not due to internal factors of the Brazilian economy. That is, the effect is on the supply side, not on the demand side. We do not consider, for example, the policies of income transfer and appreciation of the minimum wage, which culminated in the change in the consumption pattern of Brazilian families during, mainly, the years from 1999 to 2010. This demand shock caused the demand for imported and domestic products to increase, softening the effect of the Chinese shock on workers’ income, which may be related to the underestimation of the results when the endogeneity of the shock is not taken into account (with MQO). In this sense, the results by MQ2E are shown to be more robust, and these are the ones used in all next analyses.

One notices that the Chinese shock has a negative effect on the average income of Brazilians: an increase of R\$1,000 in imports of Chinese products leads to an average reduction of 0.42

²³When the same models are estimated by MQO and by MQ2E without the control variables, the signs and magnitudes are conserved, showing that the China Shock is exogenous with respect to the observed variables of the micro regions analyzed.

TABLE II
CHINESE SHOCK'S EFFECT ON THE LABOR MARKET—BRAZIL, 1999 TO 2017

	Average Income		Employment	
	MQO (1)	MQ2E (2)	MQO (3)	MQ2E (4)
Panel 1. Chinese shock: total Effect				
Chinese shock	-0.0015*	-0.0042*	-0.0002	-0.0020
	(0.0008)	(0.0022)	(0.001)	(0.0023)
Panel 2. Chinese shock: Disaggregated Effect				
Chinese shock ^F	-0.0015	0.0054	-0.0192***	-0.0336***
	(0.0037)	(0.005)	(0.0051)	(0.0099)
Chinese shock ^M	-0.0039	-0.0116*	0.0159***	0.0312***
	(0.0043)	(0.006)	(0.0042)	(0.0091)

Note: (1) Income, in reais and in logarithmic form, is deflated by the IGP-DI for the year 2017. (2) Employment is also in logarithmic form and accounts for formal jobs only. (3) Controls, year, state, and microregion fixed effects, and state-specific linear trend are included in all regressions. (4) In parentheses are robust standard errors. (5) (***), (**), and (*) indicate significance levels of 1%, 5%, and 10%, respectively. Source: Survey results.

percentage points in income, considering all sectors analyzed. This effect is also found by [Benguria and Ederington \(2017\)](#) and, when analyzing only the manufacturing sector, by [Costa et al. \(2016\)](#). In addition to the above, the data in Panel 2 show that when the shock occurs in female labor-intensive sectors, there are no significant effects on the average income of workers. In turn, when it occurs via masculinized sectors, the effect is negative and in the amount of 1.16 percentage points. This occurs mainly because Brazil's import mix from China is composed of products from sectors in which male workers are more representative, with domestic goods being replaced by imported goods, so that they become more sensitive to changes in international trade. Moreover, according to [Juhn et al. \(2014\)](#), women are less affected by external shocks because they tend to promote technological improvement that is more complementary to the skills developed by female workers. On the other hand, for [Benguria and Ederington \(2017\)](#), the discriminatory effect of Chinese shock on the gender wage gap is potentially justified by the changes in bargaining power provided by the shock.

Regarding the effect of Chinese shock on the number of people employed in the formal sector, we observe that results were significant only when segregating the shock between local labor markets with different intensities of workers by gender (results presented in Panel 2 of Table II). It should also be noted that this impact is inverse for men and women: when they are exposed to the China supply shock there is a reduction in overall employment and when men are exposed there is an increase in it, with the magnitudes of effects on disaggregated shocks being practically equal, signaling a compensation of formal jobs by the shock between these sectors. Additional evidence of this is that when the shock effect is considered without such disaggregation, there is no significant effect on employment, since the positive effect of one compensates the negative effect on the other.

In contrast to the effect on income, the results indicate that regardless of whether the shock is general or occurs in specific female or male labor sectors, there is a worsening in the labor market, accompanied by a reduction in household income. When the shock occurs in sectors mostly occupied by women, there is a loss of jobs without, however, generating effects on income; when, on the other hand, it impacts sectors mainly occupied by men, even if there is an increase in the average number of people employed, these jobs are at lower wages because there is a negative effect on income. Thus, there is a reduction in the wage differential between labor-intensive sectors mostly made up of women and men, with both being closer in terms of income, but this greater equality being associated with lower income levels.

4.3. Chinese shock: What about the education of boys and girls?

In the light of Chinese shock's effects on local labor market, we evaluate the results of Equation (1), estimated using MQ2E, which analyzes impacts on the education of boys and girls in the last year of elementary school, presented in Table III. For the quantitative educational indicator (enrollments), the overall effect of Chinese shock leads to a reduction in the average amount of girls enrolled and an increase in the average amount of boys, all constant. The data show that a \$1,000 increase in imports per worker decreases, on average, girls' enrollments by 1.05 percentage points and increases, on average, boys' enrollments by 0.76 percentage points, with the difference in effect between these groups being significant and amounting to 1.81 percentage points.

Negative and significant effect on girls' enrollment is in line with the results of Bandara et al. (2015) and Björkman-Nyqvist (2013) who, as in the present paper, analyze shocks that negatively impact household income, but do so by means of crop shocks. According to the authors, part of this negative effect can be explained by the substitution between time devoted to education and time devoted to household activities, which are more directed to girls.²⁴ On the other hand, the positive and significant effect of boys' enrollment may be reflecting families' decisions to invest in education, which, among other factors, can be explained by the future wage returns of boys compared to girls. Even if the Chinese shock has led to a reduction in gender wage inequalities, as evidenced by Benguria and Ederington (2017) and Connolly (2022), women are still penalized more in the labor market than men, showing that returns to education do not guarantee full income equality between the sexes (Gomes, 2019; Teixeira and Menezes-Filho, 2012).

TABLE III

EFFECT OF THE CHINESE POSITIVE SUPPLY SHOCK ON THE EDUCATION OF BOYS AND GIRLS IN THE EIGHTH GRADE (NINTH GRADE) OF ELEMENTARY SCHOOL—1999 TO 2017

	Enrollments (1)	Mathematics Grades (2)	Portuguese Grades (3)
Panel 1 - Chinese Shock: Total Effect			
Chinese Shock	-0.0105** (0.0056)	1.1800** (0.498)	0.8510* (0.449)
Chinese Shock × boys	0.0181*** (0.0029)	-0.4120*** (0.145)	-0.3790*** (0.121)
Panel 2 - Chinese Shock: Disaggregated Effect			
Chinese Shock ^F	-0.0061 (0.0082)	-2.0714*** (0.7545)	-2.2821*** (0.5688)
Chinese Shock ^F × boys	-0.0030 (0.0079)	0.0305 (0.2569)	0.2385 (0.2431)
Chinese Shock ^M	-0.0021 (0.0092)	3.4773*** (0.9357)	3.2431*** (0.7585)
Chinese Shock ^M × boys	0.0147** (0.0067)	-0.4140* (0.2313)	-0.5448** (0.2316)

Note: (1) The variable 'enrollments' is in its logarithmic form. (2) Controls, year, state and microregion fixed effects, and state-specific linear trend are included in all regressions. (3) In parentheses are the robust standard errors. (4) (***), (**), and (*) indicate significance levels of 1%, 5%, and 10%, respectively. Source: Survey results.

²⁴The data available for the same unit of analysis used here (micro-region) and for the years prior to China's entry into the World Trade Organization in 2001 prevent this effect from being verified empirically, since there is no information on household chores on these bases.

Regarding the indicators of educational quality, presented in columns (2) and (3) of Table III, we observe that the Chinese shock's total effect increases the Portuguese and Mathematics scores of both girls and boys, with greater intensity for girls. Moreover, we observe that the effects on mathematics grades are greater than on Portuguese grades. This performance corroborates that observed by [Viaro \(2017\)](#).

One hypothesis that can be raised in light of these results is that the positive effect on the quality of girls' education may result from the dropout of marginal students, since this shock negatively impacted female enrollment, which would cause the average grades of the remaining students to increase. In other words, the shock would not be promoting improvements in these educational indicators, but would only reflect the departure of students with worse performance. In order to verify this issue, Equation (1) was estimated by replacing the dependent variables by the average socioeconomic characteristics of the students in the last year of elementary school (the results are presented in Table B.I). If the Chinese shock has no significant effect on them, it is shown that this exogenous event does not promote a change in the composition of the students presented to take the SAEB exam. According to the results, this is what happens, so that Brazilian imports of Chinese products do not significantly impact the participation rate²⁵ of students in the test. Moreover, there is also no evidence of significant effects of this shock on the proportion of boys and on the other characteristics analyzed (whites, mothers and fathers with low education—illiterate or who have not completed elementary school—, and students aged 14 years old).

Once this argument is discarded, another one that can be raised is the weighting between present income and future income given an international trade shock. According to [Duflo \(2012\)](#), parents and children are sensitive to the perceived returns on education, so that if both believe that the learning and schooling process will leave adolescents in better conditions, there will be greater educational investment. Thus, it is relevant to see whether people with different educational levels are unequally affected in the labor market given the Chinese shock. These results are presented in Table B.II. Through them, we observe that the negative impact of the general Chinese shock on monthly income decreases the more qualified the worker is and, when reaching the highest level of education in the analysis (higher education), no significant effects are found, showing that people with higher education are the least affected in terms of income.

Thus, we see that the increase in imports of Brazilian products by China reduces the earnings expectations for less educated Brazilians. This effect, added to the other changes analyzed here occur due to long term movements in the international market, which may be interpreted as persistent, so that the concern between present and future income becomes something relevant in the decision process of investing in the education of their children.²⁶ That is, for those adolescents who remain studying, this concern may make them dedicate themselves more to their studies, and parents may also encourage their children more, spending more care/attention with them, which may result in higher educational quality indicators.

Furthermore, teenagers may feel the adverse effects of the shock on less educated people through their mother's and father's example, and this channel is known as the role model channel. In order to investigate this hypothesis, we estimated the effect of the Chinese shock on the Portuguese and Mathematics proficiency of adolescents in relation to their parents' education,

²⁵The participation rate corresponds to the number of students in the eighth grade (ninth year) of elementary school who took the SAEB test divided by the total number of people enrolled in that grade.

²⁶Although extrapolations to the other educational stages are not possible, the work of [Greenland and Lopresti \(2016\)](#) provides support for this argument, but does so by analyzing high school, a level that is not addressed in the current study.

through the interaction of the index with the proportion of mothers and fathers with high school (Panel 1 and 2 in Table B.III) and college education (Panel 3 and 4 in Table B.III). The results corroborate this hypothesis for math scores, both for boys and girls, since the higher the proportion of mothers and fathers with high school and college degrees, the more intense and positive is the effect of the shock on this indicator of educational quality of the children. In the case of grades in Portuguese, girls follow the example of their mothers (they have positive effects) for both educational levels considered, while for boys only the proportion of fathers with higher education generates positive impacts on their grades in the subject.

Finally, still regarding the indicators of educational quality, when the shock is disaggregated into sectors that employ differently male and female labor (Panel 2 of Table III), we observe that there is no effect on enrollment and that the effects on grades are uneven, which seems to be explained by the impact on employment. A reduction in employment due to a shock to sectors that employ mostly women decreases the number of jobs and educational quality, while a shock to male labor-intensive sectors has the opposite effect. In order to see if, as previously discussed, this is related to educational attainment, the disaggregated Chinese Shock across sectors on employment by educational attainment was estimated (see Table B.IV). The results show that for the most educated people (High School and College), the shock in sectors employing mostly female labor reduces employment, while the shock in sectors employing mostly male labor shows a positive effect on jobs, which is consistent with what has already been discussed. In this case, educational quality indicators can reflect the effects on more educated people: if the shock tends to impact more favorably, there is an increase in educational quality indicators; if it tends to impact unfavorably, there is a reduction in educational indicators, which is observed from gender differential.

4.4. *The Chinese shock: Men and women's choice among undergraduate majors*

In the previous sections, it was possible to identify heterogeneity in the way the Chinese shock impacts educational variables of boys and girls in the last year of elementary school, showing that conditions in labor market are associated with enrollment (by decisions on investment in education) and quality indicators, which reflect the most qualified positions. In order to provide additional evidence, we seek to verify whether the Chinese supply shock in Brazil also promotes divergent effects on men's and women's higher education and on the choice of undergraduate courses. The results of these questions are shown in Tables IV, V and VI.²⁷

In all three models, the dependent variable is the number of enrollments in higher education in its logarithmic form and the variable of interest is the index that captures the effect of the Chinese shock in Brazil. Furthermore, the three models were estimated by MQ2E with the instrument being the Chinese product shock for countries similar to Brazil. In the first model (1) neither the control variables nor the dummies of major areas of undergraduate courses were included; in the second (2) the dummies were included, and in the third (3), the vector of control variables $X'_{rs,t}$. In all three estimations the year, state, and microregion fixed effects and the state-specific linear trend are included. The last model is the most complete and, therefore, the one used in the analyses presented here.

²⁷Although the objective of the paper is anchored in the borderline cases (primary and tertiary education), additional estimated results for secondary education are included in Table B.V in order to verify whether, in the transitional phase, the Chinese shock could generate effects that reinforce the analysis in the current section. Based on the estimations, it is observed that there are no significant effects of the Chinese shock on boys' and girls' enrollment in high school, neither for the general nor for the gender-specific shock. In this regard, it is suggested that this phase of the education cycle be further explored in future research.

TABLE IV
THE EFFECT OF THE CHINESE SHOCK ON MEN'S AND WOMEN'S HIGHER EDUCATION

	Enrollments (1)	Enrollments (2)	Enrollments (3)
Panel 1 - Chinese Shock: Total Effect			
Chinese Shock	0.019*** (0.006)	0.016** (0.006)	0.018** (0.007)
Chinese Shock × boys	0.004 (0.004)	0.005 (0.004)	0.005 (0.004)
Panel 2 - Chinese Shock: Disaggregated Effect			
Chinese Shock ^F	0.037 (0.019)	0.013 (0.024)	0.032 (0.029)
Chinese Shock ^F × boys	0.014 (0.017)	0.014 (0.017)	0.008 (0.008)
Chinese Shock ^M	-0.003 (0.026)	0.018 (0.025)	-0.022 (0.032)
Chinese Shock ^M × boys	-0.049*** (0.001)	-0.049*** (0.019)	-0.008 (0.009)
Control Variables	No	No	Yes
Large Area Dummies	No	Yes	Yes

Note: (1) The variable 'enrollments' is in its logarithmic form. (2) In parentheses are the robust standard errors. (3) (***), (**) and (*) indicate significance levels of 1%, 5% and 10%, respectively. Source: Survey results.

From the results in column 3 of Table IV, it can be seen that only the general Chinese product supply shock (panel 1) is significant and has a positive effect on the enrollment of men and women, although there is no gender difference. An increase of R\$1,000 in imports per worker increases male and female enrollment in higher education by an average of 1.84 percentage points, all else constant. This result is in line with the fact that, according to [Dellas and Koubi \(2003\)](#), education decisions are related to the labor market, so that if current wages are relatively lower than expected earnings, people tend to trade work for education, investing more in education in the present period. Moreover, as noted in Table B.II, the total effect of the Chinese shock leads to a reduction in the wages of workers with high school education and has no effect on the wages of workers with college education, so it is more beneficial to turn, in the present, to a higher level of education. Therefore, investment in higher education tends to be counter-cyclical: as estimated in subsection 4.2, the total effect of the Chinese shock negatively affects the average wage of Brazilians while positively affecting enrollment in higher education.

Even though these results are symmetric between genders, it is important to verify the decisions regarding the major areas of higher education courses because, as discussed earlier, different sectors are impacted differently by international trade shocks. Table V shows the results of the impact of the China supply shock on men's and women's enrollment in the major areas in which they are a majority.²⁸ The results show that the only significant effect was that of the general shock on "Health and Welfare" courses. The R\$1,000 increase in Chinese imports per worker increases enrollment of both genders by 1.99 percentage points on average, keeping women in the majority in this area.

Concerning general areas of higher education majors in which men are the majority (see Table VI), it can be observed that the only one that had significant effects when analyzing

²⁸The results display was divided between the major areas where women are the majority (Table V) and those where men predominate (Table VI) so that the effects on educational gaps can be observed. However, all the major areas considered by the Higher Education Census were taken into account in the estimations.

TABLE V

EFFECT OF THE CHINESE SHOCK ON MAJOR AREAS OF HIGHER EDUCATION COURSES WHERE WOMEN ARE THE MAJORITY

	Education	Humanities and Arts	Social Sciences. Admin. and Law	Health and Welfare	Services
	(1)	(2)	(3)	(4)	(5)
Panel 1 - Chinese Shock: Total Effect					
Chinese Shock	-0.013 (0.013)	0.008 (0.029)	0.013 (0.008)	0.020* (0.012)	0.028 (0.027)
Chinese Shock × boys	0.025*** (0.008)	0.043** (0.018)	-0.031*** (0.005)	-0.006 (0.007)	0.004 (0.017)
Panel 2 - Chinese Shock: Disaggregated Effect					
Chinese Shock ^F	0.032 (0.049)	-0.087 (0.079)	0.021 (0.030)	0.051 (0.056)	0.071 (0.124)
Chinese Shock ^F × boys	-0.008 (0.022)	0.037 (0.034)	-0.0004 (0.0017)	0.0009 (0.015)	0.002 (0.052)
Chinese Shock ^M	-0.050 (0.052)	0.068 (0.073)	-0.009 (0.032)	-0.021 (0.049)	-0.054 (0.119)
Chinese Shock ^M × boys	0.029 (0.049)	-0.008 (0.036)	-0.030* (0.017)	-0.004 (0.015)	-0.007 (0.061)

Note: (1) Enrollment variables are in their logarithmic form. (2) Included in all regressions are controls, year, state, and microregion fixed effects, and state-specific linear trend. (3) In parentheses are robust standard errors, (4) (***), (**), and (*) indicate significance levels of 1%, 5%, and 10%, respectively. Source: Survey results.

the general shock was “Agriculture and Veterinary”. The increase of R\$1,000 in imports per worker increases the enrollment of women in land-related courses by 8.56 percentage points and of men by 2.1 percentage points on average, all else constant. Since the effect is more intense for females, it can be seen that the Chinese shock can contribute to reducing gender inequalities in courses related to the major field of farming.

When the shock is disaggregated in terms of worker intensity by gender, the increase in imports from China in male labor-intensive sectors also raises enrollments in “Agriculture and Veterinary” college courses. However, the effect is not different across genders. In contrast, the shock in female labor-intensive sectors reduces the number of people studying in courses related to “Engineering, Production and Construction” (Table VI). This may be associated with migration between sectors, since, as [Viaro \(2017\)](#), [Menezes-Filho and Muendler \(2011\)](#), and [Dix-Carneiro and Kovak \(2015\)](#) show, international trade shocks cause workers in the manufacturing sector to migrate to the agricultural sector and to non-tradable sectors, and thus, a parallel movement of flow of students linked to “Engineering, Production and Construction” to courses in the “Agriculture and Veterinary” area may occur. What does not occur, however, is an effect on enrollments in “Science, Mathematics and Computing” major.

5. CONCLUSIONS

Income shocks, such as those originated in the international market, provide an opportunity to assess the effects of exogenous changes in income on important economic indicators. More recently, many authors have been studying the shock caused by China’s entry into the World Trade Organization (WTO) in 2001, especially due to the global and unusual impact generated by the country, since its main characteristic is the large and low-cost labor force, which makes it

TABLE VI

CHINESE SHOCK EFFECT ON THE OVERALL AREAS OF HIGHER EDUCATION MAJORS IN WHICH MEN ARE THE MAJORITY

	Science, Math. & Computer Science (1)	Engineering, Production and Construction (2)	Agriculture and Veterinary (3)
Panel 1 - Chinese Shock: Total Effect			
Chinese Shock	0.0033 (0.0130)	-0.0099 (0.0148)	0.0856*** (0.0265)
Chinese Shock × boys	0.0160 (0.0103)	0.0158** (0.0068)	-0.0646*** (0.0111)
Panel 2 - Chinese Shock: Disaggregated Effect			
Chinese Shock ^F	0.0358 (0.0476)	-0.0846* (0.0473)	-0.0814 (0.1017)
Chinese Shock ^F × boys	-0.0025 (0.0334)	0.0268 (0.0193)	-0.0360 (0.0470)
Chinese Shock ^M	-0.0353 (0.0524)	0.0656 (0.0488)	0.1829* (0.1069)
Chinese Shock ^M × boys	0.0152 (0.0318)	0.0083*** (0.0030)	-0.0294 (0.0075)

Note: (1) Enrollment variables are in their logarithmic form. (2) Included in all regressions are controls, year, state, and microregion fixed effects, and state-specific linear trend. (3) In parentheses are robust standard errors. (4) (***), (**), and (*) indicate significance levels of 1%, 5%, and 10%, respectively. Source: Survey results.

possible to offer a large quantity of products at lower prices. Much has been discussed about the effects of this shock on the labor market, and the results indicate that Brazilian micro-regions most affected by the increase in imports of Chinese products have presented, on average, worse labor conditions and, when the effect of this on the income of men and women is analyzed, it is observed that they are in a better situation than they are.

This paper starts from the idea that this negative effect on workers' income and this asymmetric effect between genders can be used as a source of exogenous variation to estimate the causal effect of variations in income on the educational investments of boys and girls. To pursue this goal, we use the identification strategy of comparing the educational indicators of Brazilian micro-regions most and least affected by imports of Chinese products, before and after China's entry into the WTO (1999 to 2017). To ensure that the shock is, in fact, exogenous to Brazilian internal factors, we use as an instrument the imports of Chinese products from other countries neighboring Brazil. This strategy also allows for greater external validity of the results, allowing them to serve as evidence for other exogenous disturbances that negatively impact the labor market. We also evaluate the fact that the shock may be felt differently among sectors that employ men and women to different degrees.

In order to explore the channel through which the shock is believed to impact the education of young people, its effects on the formal labor market are investigated. Among the results found, it is established that the Chinese shock occurring in sectors with a predominance of female labor does not affect the average income of formal workers, but reduces the average employment of the Brazilian population. On the other hand, when more male labor-intensive sectors are more exposed, there is a reduction in average income and an increase in employment, evidencing an average increase in jobs for the Brazilian population, but at lower wages.

Regarding the effects of the Chinese shock on educational indicators, one can conclude that, for enrollments in the last year of elementary school, the results are distinct by gender: girls

drop out of school while boys increase their participation. It is also observed that for those enrolled, there is a better educational performance for both genders, given the total effect of the Chinese shock, but this effect is more intense for girls. This means that those who drop out are being doubly disadvantaged educationally (by dropping out of school and widening the gap with those who stay in school, as the latter perform better), which will further harm their future opportunities in the labor market.

In the educational indicators for higher education, it is not possible to observe very different effects for men and women. However, it should be noted that both the results on educational quality indicators (general shock and disaggregated shock) and the results for the general shock on quantitative indicators of higher education are positively related to the effect of these shocks on the employment and income of more educated people. In the case of the disaggregated shock, it is observed that in sectors that employ mostly women there is a negative and more intense effect on the employment of those with higher education and on the indicators of educational quality. The opposite happens with the shock on sectors where the majority of the workforce is male: in this case, there is a positive and more intense effect on the employment of those with a higher level of education and on educational quality indicators. For the general shock, we also notice a positive effect on labor market conditions among workers of different educational levels, since the negative effect of the aggregate Chinese shock on average income loses significance for those with higher educational levels, positively affecting the indicators of educational quality of students in the last year of elementary school and the quantitative indicators of higher education (undergraduate enrollments).

In conclusion, it can be seen that the Chinese shock affects heterogeneously workers with different educational level, and the effects on the labor market and on educational indicators are uneven when the shock occurs in sectors that employ in different intensity female and male labor.

APPENDIX A: FIRST STAGE: INSTRUMENTAL VARIABLE

In the table below are the first-stage results estimated by MQ2E for the variable math proficiency using the instrument Chinese imports from neighboring countries. The first-stage estimates for all additional specifications are similar and are not, therefore, presented separately. The table shows that the coefficient of the instrumental variable shows the expected sign and is statistically significant at the 1% level. The coefficient of 0.70472 means that a R\$1,000 increase in Chinese imports by neighboring countries increases Brazil's imports from China by R\$704.72. The F-test is 98.86, indicating that the instrument is significant and strong.

TABLE A.I
FIRST STAGE OF THE INSTRUMENTAL VARIABLE

	Chinese Shock
IV Chinese Shock	0.705*** (0.072)
R ²	0.912
F Test	98.86

Note: (1) All controls, year, state, microregion fixed effects and state-specific linear trend are included. (2) IV indicates the Chinese Shock (imports from China), and is calculated as described in subsection 3.2. (3) In parentheses are the robust standard errors. (4) (***), (**) and (*) indicate significance levels of 1%, 5% and 10%, respectively. Source: Survey results.

APPENDIX B: ADDITIONAL TABLES

TABLE B.I
MARGINAL STUDENT CHANNEL

	Participation Rate	Boy	White	Low Schooling Mother	Low Schooling Father	Age
	(1)	(2)	(3)	(4)	(5)	(6)
Chinese Shock	-0.003 (0.003)	0.00036 (0.00101)	0.00132 (0.00248)	-0.00016 (0.000835)	-0.00021 (0.00138)	0.00374 (0.00286)

Note: (1) Controls, year, state and microregion fixed effects and state-specific linear trend are included in all regressions. (2) In parentheses are the robust standard errors. (3) (***) (** and *) indicate significance levels of 1%, 5% and 10%, respectively. (4) All data are for students in the eighth grade. (5) Column (1) refers to the effect of the Chinese shock on the participation rate of students on the SAEB test, columns (2) and (3) refer to the effects of this shock on the proportion of male and white students, respectively, columns (4) and (5) show this effect on the proportion of mothers and fathers with low education, respectively, and finally, column (6) expresses the relationship between the Chinese shock and the proportion of 14-year-old students. Source: Survey results.

TABLE B.II

GENERAL EFFECT OF THE CHINESE SHOCK ON AVERAGE WORKER INCOME BY EDUCATIONAL LEVEL

	Semi-illiterate (1)	Elementary (2)	High (3)	Higher (4)
Chinese Shock	-0.0162*** (0.0043)	-0.0117*** (0.0020)	-0.0090*** (0.0020)	-0.0007 (0.0041)

Note: (1) Included in all regressions are: controls, year, state, and microregion fixed effects, and state-specific linear trend. (2) In parentheses are robust standard errors. (3) (***) (** and *) indicate significance levels of 1%, 5%, and 10%, respectively. Source: Survey results.

TABLE B.III

CHINESE SHOCK EFFECT ON TEENAGERS' PROFICIENCY GIVEN THE PARENTAL EDUCATION CHANNEL

	Math Grades		Portuguese	
	Girls (1)	Boys (2)	Girls (1)	Boys (2)
Panel 1 - Mother with High School Education				
Chinese Shock	-3.707*** (1.417)	-4.853* (2.911)	-1.917** (0.959)	-0.289 (1.547)
Chinese Shock × Mother high school	25.330*** (7.378)	16.510* (9.187)	6.617** (3.108)	2.692 (3.726)
Panel 2 - Father with High School Education				
Chinese Shock	-3.849*** (1.237)	-2.646 (2.204)	-0.197 (0.957)	-0.755 (1.466)
Chinese Shock × Father high school	26.160*** (6.391)	11.470 (7.982)	2.208 (2.951)	4.196 (4.058)
Panel 3 - Mother with Higher Education				
Chinese Shock	-2.981 (2.255)	-8.523*** (1.707)	-6.459 (4.310)	-1.182 (3.010)
Chinese Shock × Mother higher education	12.181** (5.906)	82.212*** (15.992)	68.264 (44.413)	18.498 (22.044)
Panel 4 - Father with Higher Education				
Chinese Shock	-2.377* (1.421)	-5.725*** (62.125)	-2.061** (0.818)	-3.819*** (0.985)
Chinese Shock × Father higher education	11.006*** (3.738)	62.135*** (19.80)	27.164*** (5.624)	37.526*** (6.482)

Note: (1) All controls are included: years of schooling of mothers and fathers, proportion of black, white, and labor market adolescents, for the year 1999. (2) In parentheses are the robust standard errors. (3) (***), (**), and (*) indicate significance levels of 1%, 5%, and 10%, respectively. (4) Included in all regressions were: year, state, and microregion fixed effects, and state-specific linear trend. Source: Research results.

TABLE B.IV

DISAGGREGATED EFFECT OF THE CHINESE SHOCK ON EMPLOYMENT BY EDUCATIONAL LEVEL

	Semi-illiterate (1)	Elementary (2)	High (3)	Higher (4)
Chinese Shock ^F	-0.0298 (0.0185)	-0.0298*** (0.0115)	-0.0355*** (0.0132)	-0.0641** (0.0255)
Chinese Shock ^M	0.0415** (0.0186)	0.0137 (0.0116)	0.0305** (0.0137)	0.0434** (0.0215)

Note: (1) Employment is in logarithmic form and accounts for formal jobs only. (2) Included in all regressions are: controls, year, state, and microregion fixed effects, and state-specific linear trend. (3) In parentheses are robust standard errors. (4) (***), (**), and (*) indicate significance levels of 1%, 5%, and 10%, respectively. Source: Survey results.

TABLE B.V

EFFECT OF CHINESE POSITIVE SUPPLY SHOCK ON BOYS' AND GIRLS' ENROLLMENT IN HIGH SCHOOL—1999 TO 2017

	Enrollments (1)	Enrollments (2)
Panel 1 - Chinese Shock: Total Effect		
Chinese Shock	-0.012 (0.014)	-0.014 (0.143)
Chinese Shock \times boys	-0.003 (0.007)	-0.004 (0.007)
Panel 2 - Chinese Shock: Disaggregated Effect		
Chinese Shock ^F	-0.011 (0.017)	-0.006 (0.017)
Chinese Shock ^F \times boys	-0.004 (0.009)	-0.013 (0.014)
Chinese Shock ^M	0.004 (0.022)	-0.002 (0.023)
Chinese Shock ^M \times boys	0.000 (0.011)	0.008 (0.016)
Control Variables	No	Yes

Note: (1) The variable 'enrollments' is in its logarithmic form and is formed by the cumulative enrollments in the three years of Regular and Integrated High School. (2) The estimation of column (1) includes year, state and microregion fixed effects and the state-specific linear trend, but does not include control variables. The estimation in column (2) is complete, including control variables, fixed effects and state-specific linear trend. (3) In parentheses are the robust standard errors. (4) (***) (** and *) indicate significance levels of 1%, 5% and 10%, respectively. Source: Survey results.

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