rbe
REVISTA BRASILEIRA DE ECONOMIA

DOI 10.5935/0034-7140.202100??
ISSN 1806-9134 (online)

FGV
FUNDAÇÃO GETULIO VARGAS

Skill prices and compositional effects on the declining wage inequality in Latin America: Evidence from Brazil*

Paul Garcia Hinojosa†

Contents

1. Introduction 1
2. Overview of the Labour Market 5
3. Occupational and Sectoral Structure 19
4. The Sources of Declining Wage Inequality 26
5. Conclusions 40
Appendix. 46

Keywords
wage inequality, skill premium, minimum wage

JEL Codes
J31, J24, J38

Abstract · Resumo

This paper studies potential explanations of the declining wage inequality in Brazil such as changes in demographic/skill composition, wage structure, occupations/sectors and minimum wage. I perform a wage inequality decomposition to quantify composition and price effects and use a CES production function to estimate the effects of the skill supply on relative wages. I find that the fall in upper-tail inequality is driven by changes in the returns to education and experience, while that in lower-tail inequality is also given by those to minimum wage and female workers. These patterns are consistent with the decline in relative wages between skill groups which are given by the increase in both the supply of skills and the real minimum wage.

1. Introduction

The decline in income inequality in Latin America over the 2000s has motivated an extensive literature investigating the driving factors behind this trend. Social transfers in favour of the poorest, redistribution through progressive taxation and changes in the skill and demographic composition of the labour market are commonly mentioned in the literature (López-Calva & Lustig, 2010; Cornia, 2014; Fritz & Lavinas, 2016; Bértola & Williamson, 2017). The empirical consensus suggests that most of the decline in income inequality has been driven by the fall in wage inequality (Barros, Carvalho, Franco, & Mendonça, 2010; Gasparini, Galiani, Cruces, & Acosta, 2011; Cruces, García Domench, & Gasparini, 2014). Although labour earnings

*I have received many useful comments and suggestions from participants at RSS (University of Essex, Department of Economics). I remain solely responsible for any errors and interpretations.

†Postgraduate researcher at University of Essex, Colchester, UK. 0000-0000-0000-0000

pagarc@essex.ac.uk

Received on ??
Final Acceptance on ??

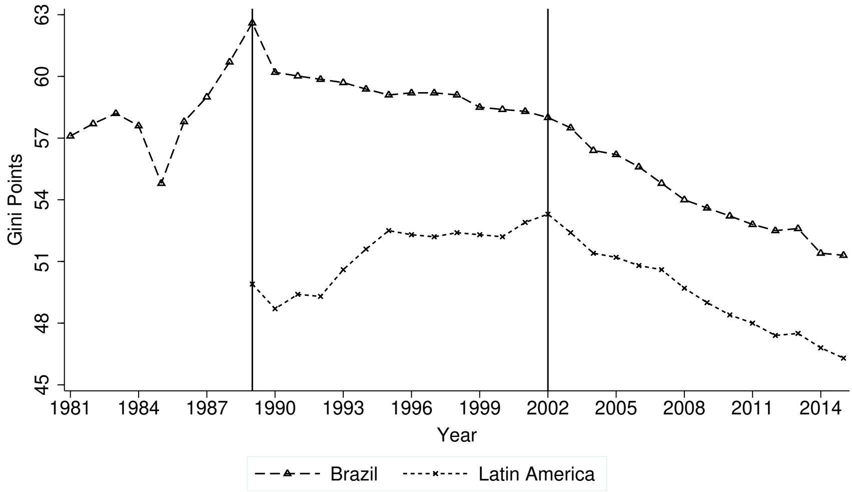
depend on several workers' individual characteristics, changes in the price of skills seem to play a significant role in shaping wage inequality. Traditional literature has linked changes in the price of skills to the interaction between the labour supply of and demand for skills. In fact, there is empirical evidence of the effects of skill demand shifts on the increase in income inequality that the region experienced in the 1990s (Robertson, 2004; Behrman, Birdsall, & Székely, 2007; Goldberg & Pavcnik, 2007; Kahhat, 2010). The favourable trade conditions in the 1990s such as a reduction in tariffs on imports of capital goods shifted the labour demand in favour of high-skilled workers because capital is assumed to be skill-biased, thus trade liberalization increased the skill premium and income inequality in this period (Green, Dickerson, & Arbache, 2001; Sánchez-Páramo & Schady, 2003; Parro, 2013).[1]

As the region experienced a turning point in income inequality over the early 2000s, traditional factors that shaped wage inequality in the 1990s are unlikely to explain the long-lasting decline in income inequality over the last decade. In Brazil, income inequality reversed its trend in the late 1980s and has been falling since then in spite of the trade liberalization process that the country experienced over the 1990s. As Brazil accounts for approximately 34 percent of total GDP in Latin America and 33 percent of its entire population, it is not surprising that most of the literature has focused on this country to understand the declining income inequality in the region. However, income inequality has also fallen among 15 other Latin American economies, particularly in the 2000s. Figure 1 depicts the evolution of income inequality in Brazil and Latin America measured by the Gini coefficient.

Income inequality in Brazil increased sharply from 1985 to 1989, this was a period characterized by economic instability and four-digits inflation rates. Currency depreciation led to the abolition of several local currencies which lasted less than two years on average. Finally, the adoption of the "Brazilian Real" in 1994 stopped the rampant inflation that the country experienced in previous years. Income inequality decreased at a slow pace but steadily over the 1990s in Brazil unlike average income inequality in Latin America.[2] In the early 2000s, income inequality decreased faster not only for Brazil but also for most Latin American economies, following the boom in the commodity prices in this period. The Gini coefficient fell on average 0.5 points per year during the period 2001–2014, reaching its lowest point recorded in more

[1] Literature on the subject for Latin American economies follows the pioneering work of Tinbergen (1974). The increase in the skill premium is explained by the relative increase in the demand for skills which is linked to the development of skill-biased technology (Acemoglu, 1998; Autor, Katz, & Krueger, 1998; Berman, Bound, & Machin, 1998; Caselli, 1999; Acemoglu, 2007). This technology is embodied in capital goods which are more complementary with high-skilled workers. Moreover, globalization has enabled the transmission of the capital-skill complementary effect from industrialized countries to developing ones (Goldberg & Pavcnik, 2007).

[2] Although most of the literature attributes the increase in income inequality in the 1990s to trade liberalization, Dix-Carneiro and Kovak (2015) find that this had a small but significant equalizing effect in Brazil.



Source: Socio-Economic Database for Latin America and the Caribbean (CEDLAS and The World Bank). Version: May 2018. Gini coefficient for the distribution of household per capita income excluding zero income. The average Gini coefficient for Latin America is an arithmetic average of 18 Latin American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela) from 1989 to 2015. Data became available only after 1989 for most countries and there are missing observations in specific countries and years, thus around 25 percent of the observations were obtained by interpolation.

Figure 1. GINI Coefficient in Brazil and Latin America

than three decades in the last year of the sample.[3] The reduction in income inequality mirrors the decrease in the income gap between the richest and the poorest in Brazil.[4]

The long-lasting decline in income inequality in Brazil as well as in other Latin American economies is an opportunity to understand how labour market forces and other factors interact with income inequality in the region. As an extensive literature predicted that wage inequality in Latin America would follow the same pattern as in more developed regions because Latin American countries are still highly dependent on capital goods import which are essentially skill-biased, some questions arise on this matter. Is capital less skill-biased than it was in previous decades? Has the supply of skills outweighed the effects of skill demand shifts on the skill premium? or Are labour market institutions responsible for this pattern?

[3]Despite the remarkable decline in income inequality over the 2000s, Latin America is still the region with the highest Gini coefficient in the world. According to data from the World Bank and United Nations Development Programme (UNDP) for 2013, the Gini coefficient for the region is 3 points higher than in Sub-Saharan Africa—the second region with the highest income inequality—and 16 points higher than in North America and the European Union—the region with the lowest income inequality.

[4]According to data from the World Bank, the income share held by the poorest 10 percent grew at an annual average of 2.6 percent from 2001 to 2013, while that held by the richest 10 percent decreased by approximately 1 percent over the same period. Moreover, the decline in income inequality has been accompanied by a reduction in the proportion of people living in extreme and moderate poverty, both indicators fell by an annual average rate of 8.2 and 8.4 percent, respectively.

Some of these questions and others are addressed by studying changes in the skill and demographic composition of the labour market and their respective prices, changes in occupational and sectoral structure and minimum wage policies in Brazil from 1981 to 2015. I perform a counterfactual exercise following Firpo, Fortin, and Lemieux (2018) to estimate composition and price effects on wage inequality. As the validity of this counterfactual exercise relies on the assumption that changes in quantities do not affect prices, I complement the study by estimating the effects of changes in the labour supply of skills on relative wages among educational groups following the supply-demand framework proposed by Katz and Murphy (1992). This framework has been used in previous studies for a panel of Latin American countries such as Manacorda, Sánchez-Páramo, and Schady (2010) and Gasparini et al. (2011). Given the heterogeneity among Latin American economies in terms of labour market composition and minimum wage policies, it is worthwhile to perform an analysis at a country level. This study also uses the traditional Katz and Murphy framework to estimate elasticities of substitution for more than the two traditional educational groups (college and high-school graduates). The reasons are merely obvious; the skill composition in the Brazilian labour market is substantially different from that in developed countries. High-school graduates and high-school dropouts constitute the bulk of the labour force in Brazil, thus these might not necessarily be perfect substitutes in the eyes of the employers.[5] I further use this specification to examine whether workers with different years of experience are perfect substitutes within the same educational group and whether changes in the real minimum wage, net of the effects of labour market forces, has contributed to the evolution of the skill premium in Brazil, something that has been overlooked in previous specifications.

I use cross-sectional data from the Brazilian National Household Survey (PNAD, Pesquisa Nacional por Amostra de Domicílios) which is the most disaggregate source of microdata in the country after the Census. I find that changes in the wage structure explain the entire decline in both upper and lower-tail inequality. The former is explained by changes in the returns to education and age/experience, while the latter is also explained by those to minimum wage and female workers. The empirical evidence also suggests that wage structure is driven by changes in the skill composition of the labour market which is reflected in the decline of the skill premium. In agreement with previous literature, the increase in the relative supply of skills has played a significant role in the decline of the tertiary/non-tertiary wage gap. On the other hand, the fall in the skill premium between secondary and primary educated workers is driven by the increase in the real minimum wage rather than by changes in their relative labour supply. This last finding seems to be opposed to what

[5] The skill composition of these educational groups has changed significantly in the last decades. For instance, the share of individuals with high-school diplomas has quadrupled from 1981 to 2015, whereas the share of individuals with less than a high-school diploma has decreased around 40 percent over this period.

has been found previously in the literature on the subject. The disagreement may arise for both the inclusion of additional years of data in which the minimum wage increases rapidly and the heterogeneity among Latin American labour markets in panel data studies. Furthermore, the increase in the labour earnings among workers who perform low-skill occupations such as personal services and agriculture, in spite of the decline in their employment participation, along with the sharp decrease in the skill premium, particularly among young workers, reinforces the idea that the minimum wage plays a significant role in the compression of wage inequality. There is also evidence of a significant effect of labour demand shifts on the skill premium, however, this effect is relatively small compared to other potential explanations.

The remainder of the paper is organized as follows. Section 2 describes data sources and provides non-causal information on changes in wages and labour supplies by educational and demographic groups. Section 3 sheds light on changes in occupational/sectoral structure and their interaction with labour earnings. Section 4 estimates the causal relationship between the minimum wage and wage inequality, presents a counterfactual exercise to decompose wage inequality into composition and price effects and outlines the supply-demand framework to estimate the effects of changes in the skill supply and minimum wage on relative wages. Section 5 concludes.

2. Overview of the Labour Market

2.1 Data Sources

Studies in income inequality for Latin American economies are relatively new compared to those from more developed countries because household surveys were not available until the late 1970s. Moreover, it was not until the early 1980s that Latin American countries reconciled data collection strategies and provided more reliable data. Undoubtedly, Brazil takes the lead with respect to its counterparts when it comes to the availability of microdata sources. I draw on the National Brazilian household survey (PNAD, in its Portuguese acronym) which is carried out by the Brazilian Institute of Geography and Statistics (IBGE, in its Portuguese acronym). This annual household survey provides socio-economic information from 26 regions in Brazil with national coverage. I use 31 household surveys that cover the period 1981–2015.[6]

I construct two different samples, one for labour earnings and one for labour supply, by following Katz and Murphy (1992) to account for composition-adjusted labour earnings and efficiency units of labour supply. The "wage sample" provides a reasonable constant composition of workers' characteristics through time. This

[6]There are no data available for 1991, 1994, 2000 and 2010 because the National Census was carried out instead of PNAD in those years.

comprises labour earnings in the main occupation of full-time workers—those who worked at least 35 hours or more per week—, aged 18 to 65 years old. Workers who do not report labour earnings in the month prior to the PNAD survey reference week are excluded from the sample as well as those who declare to be self-employed, volunteer or produce for self-consumption. Labour earnings from 1981 to 1993 are converted to Brazilian Reals—the official currency in Brazil since 1994—, and deflated using the Consumer Price Index deflator for PNAD (INPC base year 2012, in its Portuguese acronym) which is obtained from the Institute for Applied Economic Research (IPEA, in its Portuguese acronym).[7] The measure of labour earnings is the logarithm of the hourly real wage—real monthly wages divided by 4.3 and the number of working hours per week for each worker.

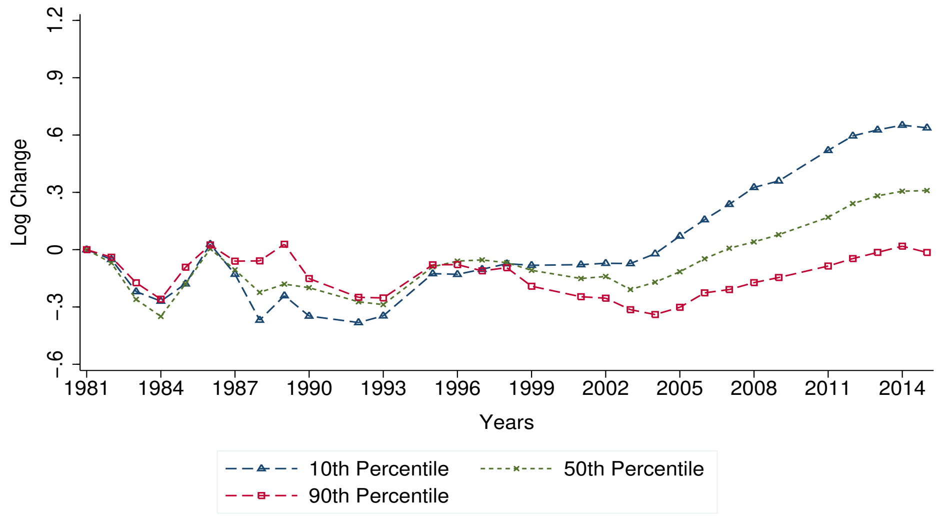
The "supply sample" comprises all individuals that worked in the reference week or were employed in the year prior to the reference week regardless of whether they are salary or wage workers, self-employed or otherwise. The measure of labour supply is simply the number of individuals adjusted to the sample weights provided by PNAD. Additional information on sampling can be found in the notes of each figure and table.

2.2 Overall Wage Inequality

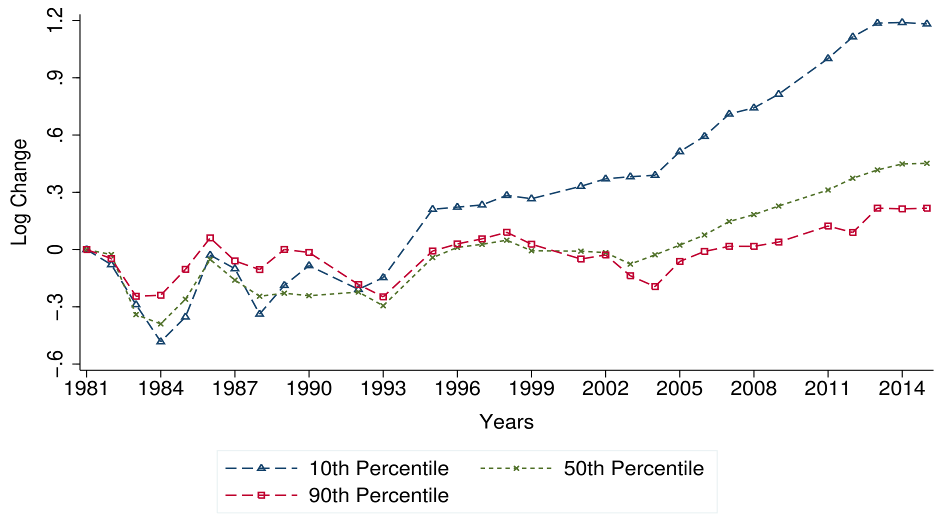
I begin this discussion by studying the changes in the wage distribution over the sample period 1981–2015. Figure 2 illustrates the evolution of the log real hourly wage at the 10th, 50th and 90th percentiles by gender.

The spikes in the evolution of real wages over the 1980s and the early 1990s reflect the economic and political turbulence that the country experienced over this period. Monetary financing of budget deficits and frequent devaluations led Brazil to experience three-to-four-digit annual inflation rates. The attempts to control hyperinflation failed, and the country changed currencies several times. As expected, the 90th percentile had a better evolution over the inflationary period, as price volatility was more detrimental to the poor. The launch of the "Plano Real" in 1994 which involved the adoption of a new currency the "Brazilian Real" with a crawling peg against the dollar, austerity policies and de-indexation of the economy were successful in controlling inflation rates. Currency stabilization did not imply the end of the macroeconomic instability, thus the recovery of real wages in 1994 was followed by a stagnation of the 10th percentile and a fall of the 50th and 90th percentiles over the late 1990 and early 2000s. It was not until the mid-2000s that real wages rose rapidly throughout the wage distribution as the economy benefited

[7]The following exchange rates are used according to the period: 1 Brazilian Real = 2,750 billion Cruzeiros from 1981 to 1985; 1 Brazilian Real = 2,750 million Cruzados from 1986 to 1988; 1 Brazilian Real = 2.75 million Cruzeiros/Cruzado Novos from 1989 to 1992; and 1 Brazilian Real = 2,750 Cruzeiro Real for 1993.



(a) Males



(b) Females

Source: PNAD data from 1981 to 2015. Log changes in hourly wages at the 10th, 50th and 90th percentiles from the "wage sample" are normalized to zero in 1981.

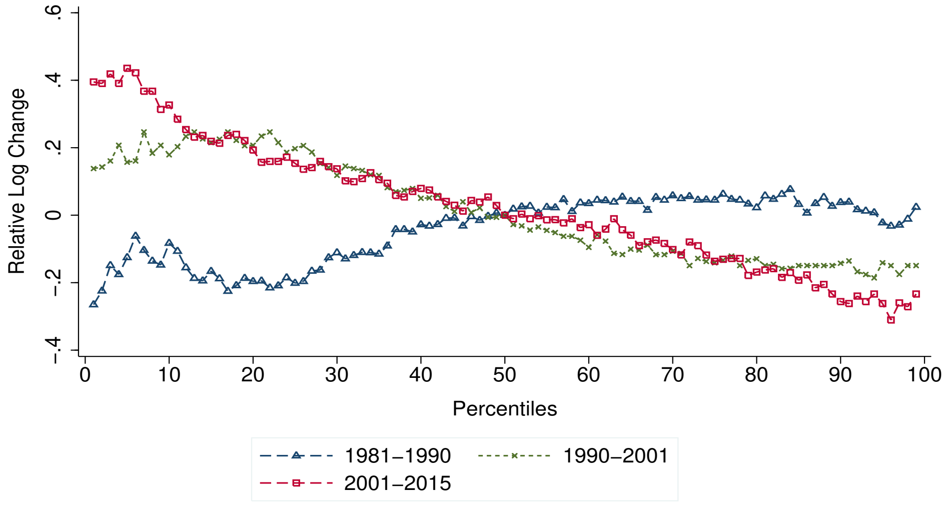
Figure 2. Log Change in Wage Percentiles by Gender

from increases in commodity prices. Notice that there is a deceleration in real wages growth in the last years of the sample as inflation has increased above the targets.

In terms of wage inequality, the 90th/10th wage gap increased in the 1980s as the 90th percentile was less affected than the 10th percentile over the inflationary period. Wage inequality decreased in the 1990s as the 10th percentile grows faster, particularly among women. Further decreases in wage inequality can be observed in the 2000s as the 10th percentile pulls away from the other percentiles. Notice that both lower and upper-tail inequality measured by the 50th/10th and 90th/50th, respectively, fall over the 2000s. Both inequality measures shrink continuously and symmetrically among males, while the 50th/10th shrinks more rapidly than the 90th/50th among females. The evolution of wage inequality seems to track remarkably well the evolution of the GINI coefficient in Figure 1 over the 1980s, 1990s and 2000s. The contrast among these periods is shown in Figure 3 which plots the change in log hourly wage percentiles relative to the median wage for 1981–1990, 1990–2001 and 2001–2015.

The 1980s were characterized by a non-monotone change throughout the wage distribution. The negative change in percentiles below the median implies an increase in lower-tail inequality throughout all percentiles in the bottom half of the wage distribution among males and those between the 22nd and 50th percentiles among females. Upper-tail inequality remains relatively constant among males, whereas there is a sizeable increase among females. These patterns change dramatically in the 1990s and both lower and upper-tail inequality fall for both genders. Further decreases in wage inequality can be observed in the 2000s mostly driven by the rise in the lowest percentiles of the wage distribution. Notice that wage inequality shrinks further for percentiles below the 15th and above the 80th among males and below the 25th percentile among females. These results suggest that the further compression in wage inequality in the 2000s is driven by the faster growth of the lowest percentiles of the wage distribution with respect to the median.

To put this information in context, I use the 10th and the 90th percentiles relative to the median wage as measures of lower and upper-tail inequality. Lower-tail inequality among males fell by 18 log points in the 1990s and 33 log points in the 2000s, while upper-tail inequality decreased by 14 and 26 log points in each period, respectively. Among females, the fall in lower-tail inequality is even more significant around 22 log points in the 1990s and 40 log points in the 2000s, while upper-tail inequality fell more modestly around 16 log points in each period. The empirical evidence on the subject for more developed countries suggests that changes in wage inequality are mainly driven by changes in the upper half of the wage distribution. This is clearly not the case in the Brazilian labour market as most of the recent decline in wage inequality is given by the compression of the bottom half of the wage distribution. The remarkable increase in the lowest wage percentiles might echo the unprecedented rise in the real value of the minimum wage over the 2000s.



(a) Males

(b) Females

Source: PNAD data for 1981, 1990, 2001 and 2015. Relative changes in log hourly wages from the "sample" between two years. The change in the log hourly wage at the median is normalized to zero for each period.

Figure 3. Relative Log Change in Wage Percentiles by Gender and Periods

According to data from the Brazilian Ministry of Labour (MTE, in its Portuguese acronym), the real minimum wage increased by approximately 80 percent from 2001 to 2015. There is not a straightforward explanation for the slower growth in the highest wage percentiles with respect to the median, but we can intuit that the same factors that shape wage inequality in developed countries might have played a role in this phenomenon such as wage growth polarization and changes in the return to skills.

2.3 Skill Premium and Relative Labour Supply

The effects of labour market forces such as supply of and demand for skills on the return to education and inequality have been well documented in the literature, particularly for more developed countries. These empirical studies reach two conclusions that explain the widening of wage inequality, particularly in the U.S. First, wage inequality echoes the rise in the labour earnings of more educated workers which is linked to the development of computer-based technologies and the corresponding labour demand shifts in favour of this skill type (Autor et al., 1998; Berman et al., 1998; Caselli, 1999; Krusell, Ohanian, Ríos-Rull, & Violante, 2000; Acemoglu, 2007). The idea that capital is more complementary with high-skilled workers was initially introduced by Griliches (1969) and this is still widely popular in the literature to explain increases in wage inequality. In fact, the literature for Latin America suggests that the increase in inequality over the 1990s was driven by a capital-skill complementarity effect which was spread from the developed world towards the region through capital acquisition (Green et al., 2001; Sánchez-Páramo & Schady, 2003; Parro, 2013). Second, a rising wage inequality requires that the secular increase in the labour supply of more educated workers does not outweigh the skill-biased technological effect on the returns to skills.

As most of the Latin American countries experienced a decrease in wage inequality over the 2000s, a question arises: How do labour market forces affect the return to skills in the region over that period? A decrease in the return to skills requires that the labour supply of skills outweigh the labour demand for them. The remarkable educational upgrading of the labour force in the region is the most straightforward explanation of the decrease in the price of skills and the corresponding decrease in wage inequality (Barros et al., 2010; Gasparini et al., 2011; Cruces et al., 2014). Thus, a natural starting point is to study the evolution of the labour supply of skills and its effects on the skill premium.

Motivated by the labour supply-demand framework of Katz and Murphy (1992), and Acemoglu and Autor (2011), I estimate measures of relative wages and labour supplies between educational groups. The samples described in the Data section are split into different cells that comprise homogeneous workers in order to estimate changes in labour earnings driven by factors others than changes in the demographic composition of the workforce. Workers are sorted into two genders (males and females), five groups of education (illiterate, less than 11 years of schooling, 11 years of schooling, 12 to 14 years of schooling, and 15+ years of schooling)[8] and 49 groups of experience (corresponding to single-year categories from 0 to 48 years of potential experience).[9] Consequently, workers are sorted into 490 gender-education-experience categories by year.

The "wage sample" is used to estimate the composition-adjusted log hourly wages which are the weighted average of the predicted log wage from a regression of log hourly wages on education and race dummies, a quartic in experience, and interactions between education and experience in each one of the 490 gender-education-experience groups. I use a set of fixed weights equal to the participation in employment of each cell to aggregate through demographic groups.

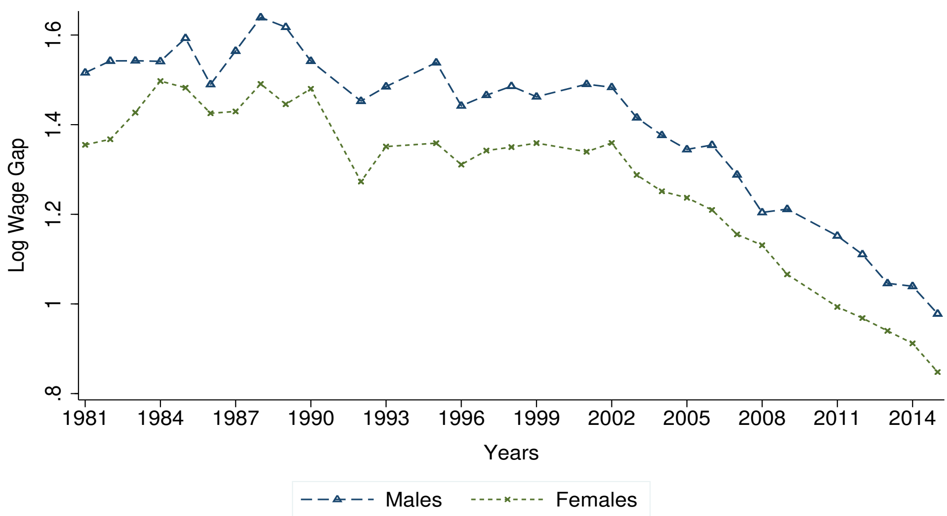
Figure 4 plots the wage gap between tertiary/non-tertiary and secondary/primary educated workers. Although the former is the standard measure of the skill premium, the latter provides a clearer picture of the effects of the educational upgrading on the price of skills because the increase in the average years of education has been mostly attributed to the expansion of secondary education in Brazil.

The irregular pattern of the skill premium between tertiary/non-tertiary educated workers over the 1980s and the early 1990s mirrors the struggle for a stable currency and macroeconomic stability. After the adoption of the Brazilian Real in 1994, the skill premium seems to plateau for several years until 2002. On average, the skill premium was approximately 142 log points in this year which implies that the labour earnings of tertiary-educated workers were three times higher than those of non-tertiary-educated ones (i.e. $\exp(1.42) - 1$). The skill premium falls sharply thereafter, which is consistent with the decline in the GINI coefficient that we observed in Figure 1. Following a decade of decrease, the tertiary/non-tertiary skill premium reaches its lowest point on average in 2015 at 92 log points which implies that the wage gap shrank by 163 percent (i.e. $\exp(1.42) - \exp(0.92)$) over this period.

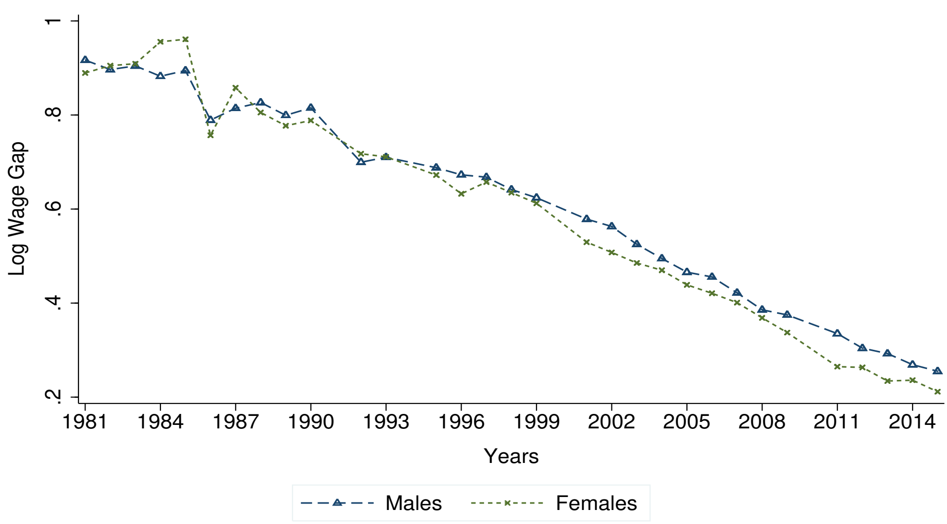
The decrease in the skill premium between secondary and primary-educated workers has been falling instead for more than three decades. Notice that this is only 25 log points in 2015, which implies a remarkable decrease of 118 percent

[8] The required years of schooling to complete an educational category have changed over time, particularly for primary education. For example, primary education was completed after 4 years of schooling in the 1960s, 6 years in the 1970s, 8 years in the 1980s and 9 years from the 1990s to the present. To obtain consistent sample cells in terms of education over time, I consider primary-educated workers as those who are literate and have less than 11 years of schooling, secondary-educated workers as those with 11 years of schooling, and complete-tertiary-educated/postgraduate workers as those with 15 or more years of schooling, thus incomplete-tertiary-educated workers report years of schooling between the two previous categories.

[9] Years of potential experience are estimated as $\max\left(\min\left(\text{age-years of schooling} - 6, \text{age} - 17\right), 0\right)$. This ensures either zero or a positive number of years of experience and that no individual has started working before 18 years of age.



(a) Tertiary/Non-Tertiary



(b) Secondary/Primary

Source: PNAD data from 1981 to 2015. Log hourly wages for full-time salary workers are regressed by gender in each year on four education dummy variables (less than 11, 11, 12 to 14, and 15 or more years of schooling), a quartic in experience, two race dummies (black/indigenous and others non-white/non-mix-race) and the corresponding interactions between education and experience. I calculate a set of fixed weights equal to the participation in employment of each one of the 490 gender-education-experience groups. The composition-adjusted log wage for each educational group is the weighted average of the predicted log wage of white/mix-race workers evaluated at each demographic group. The skill premiums are the weighted average of the composition-adjusted log wages between the corresponding educational categories. Tertiary and non-tertiary educated workers are aggregate categories. The former comprises workers with at least some tertiary education and the latter comprises illiterate, primary and secondary educated workers.

Figure 4. Skill Premium by Gender

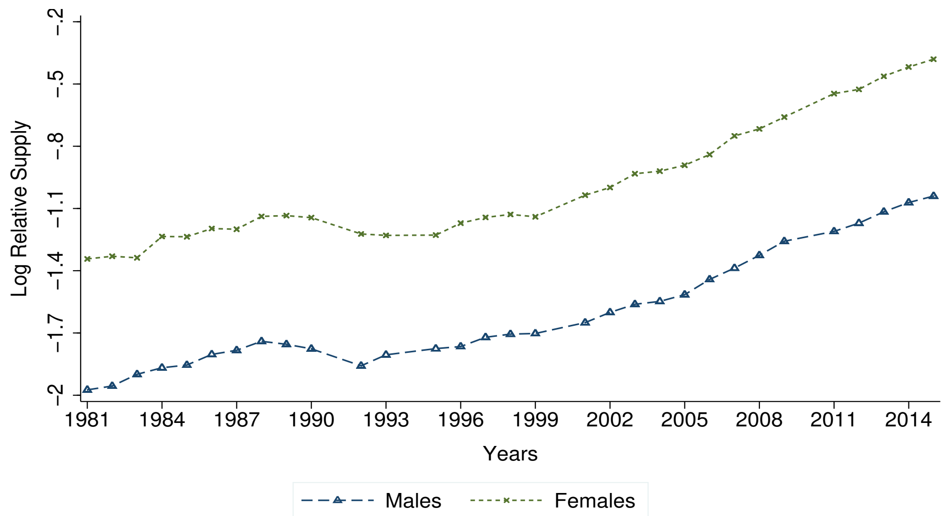
(i.e. exp(0.90) – exp(0.25)) from 1981 to 2015. Interesting, there are no significant differences in the secondary/primary skill premium between genders, unlike the tertiary/non-tertiary skill premium which is larger for males than for females over the entire sample period. Figure A-1 in the Appendix provides additional information on the respective skill premiums by two groups of experience (0–9 and 20–29 years of potential experience). The tertiary/non-tertiary skill premium falls sharper among workers with 0–9 years of experience between 2002 and 2015, particularly among females. On the other hand, the decline in the secondary/primary skill premium over the sample period seems to be mostly driven by the decline in the wage gap of workers with 20–29 years of experience. In fact, Figure A-1 shows that the secondary/primary wage gap of the most experienced workers converges almost to the same level as that of the least experienced ones in 2015.

The remarkable decrease in the skill premium in Brazil as well as in most of the Latin American economies has been linked to the secular growth in the supply of skills in the region over the 2000s. In fact, Gasparini et al. (2011) argue that the increase in the supply of skills, particularly among high-school graduates, might explain the entire decrease in the skill premium for this educational group leaving a modest role for labour demand factors and labour market institutions.

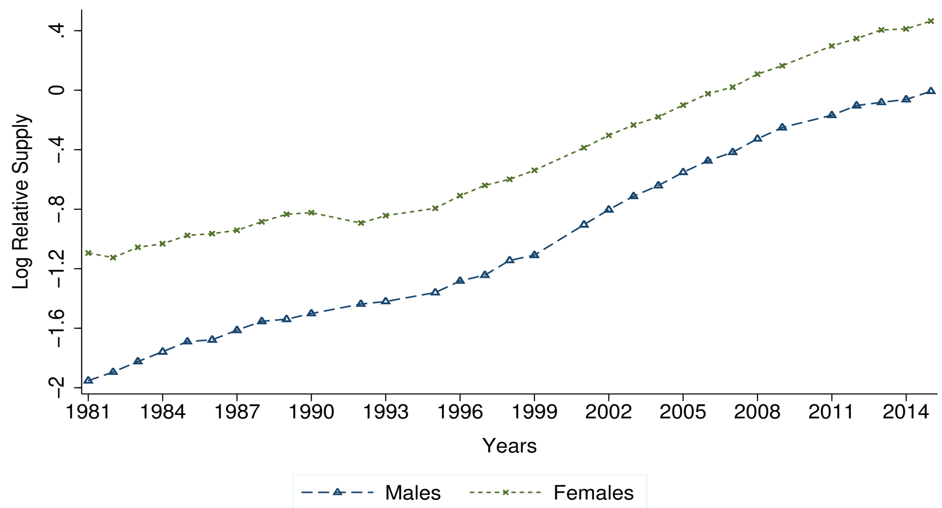
I use the "supply sample" to estimate efficiency units of labour supply among skill groups by following Katz and Murphy (1992), and Acemoglu and Autor (2011) as follows. Individual labour supplies are given by the employment share of the 490 gender-education-experience groups. Labour supplies are weighted by using a set of fixed weights equal to the mean wage in each cell normalized to the wage of a base group over the sample period. Efficiency units of labour supply are then given by the weighted average of the individual labour supplies. Figure 5 plots the log efficiency units of labour supply between workers with tertiary/non-tertiary and secondary/primary education.

There is a clear educational upgrading of the labour force over the last decades which reflects the efforts of the Brazilian government to invest in education, particularly in primary and secondary education.[10] Barros et al. (2010) state that the access to education grew twice faster in the 1990s and 2000s than this did in previous decades which explains the rapid increase particularly in the secondary/primary relative supply since the mid-1990s. College enrolment has also grown in the last decades, though at a much slower pace. In fact, Figure 5 shows a deceleration in the tertiary/non-tertiary relative supply over the early and mid-1990s which is given by the stagnation in the relative supply of young workers (those with 0–9 years of potential experience) as can be seen in Figure A-2 in the Appendix. Figure A-2 shows that the tertiary/non-tertiary supply among the least experienced workers

[10]Data from ECLAC (Economic Commission for Latin America and the Caribbean) show that public spending on education in Brazil has grown 5 percent per year over the past two decades.



(a) Tertiary/Non-Tertiary



(b) Secondary/Primary

Source: PNAD data from 1981 to 2015. Employment participation of the 490 gender-education-experience groups from the "supply sample" is weighted by using a set of fixed weights equal to the mean wage in each cell normalized to the wage of male workers with secondary education and 10 years of potential experience (base group) over the sample period. Efficiency units of labour supply are given by the weighted average of labour supplies in each demographic group. Relative supply of tertiary/non-tertiary and secondary/primary educated workers is the logarithm of the ratio between efficiency units of labour supply of the corresponding skill group.

Figure 5. Relative Labour Supply by Gender

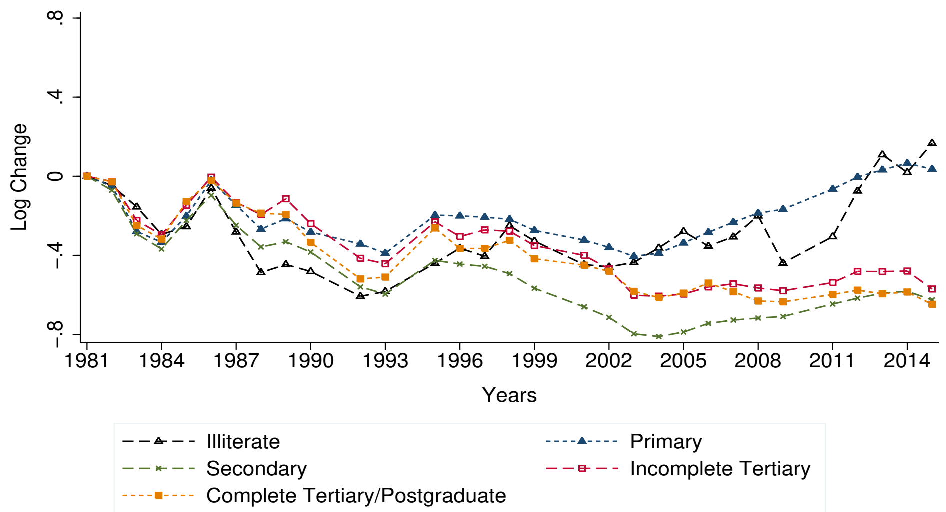
grows faster since the early 2000s which agrees with the sharper decline in their corresponding skill premium as was mentioned previously.

There are some additional features we can draw from Figure 5. First, the relative supply among females is larger than among males, implying that female workforce has a higher proportion of more educated workers than the male workforce. Second, despite the remarkable increase in the relative supply of skills, the Brazilian labour market is still intensive in low-skilled workers. The negative log tertiary/non-tertiary relative supply suggests that the proportion of tertiary-educated workers is still lower than that of non-tertiary-educated ones for both genders. In fact, the proportion of secondary-educated workers is also smaller than that of primary-educated ones among males, while the former overcomes the latter among females, but only after 2006.

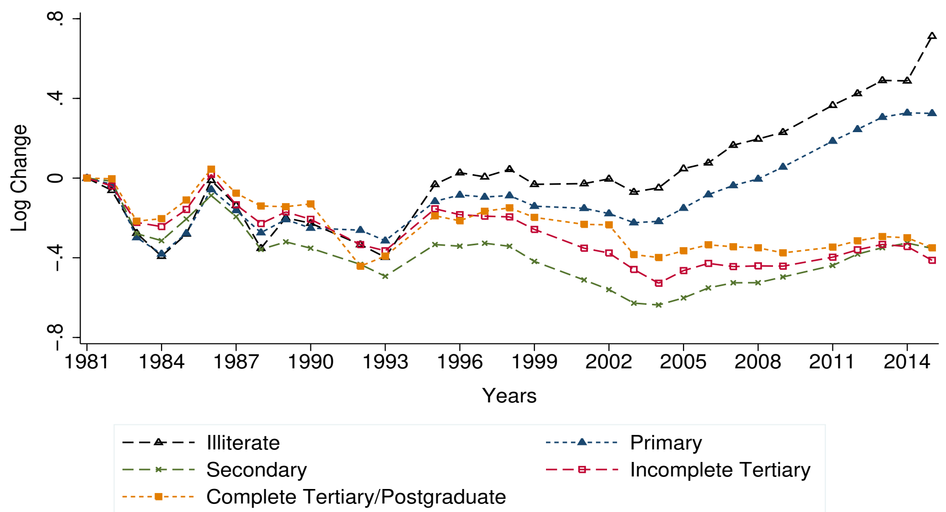
At first glance, there is a strong correlation between relative supplies in Figure 5 and the corresponding skill premiums in Figure 4 which suggests that changes in the skill composition of the labour market might explain most of the variation in the price of skills. An obvious limitation of figures 4 and 5 is that both omit information on individual skill groups. For example, the tertiary/non-tertiary skill premium might have decreased because of a fall in the market value of tertiary-educated workers, an increase in that of the non-tertiary-educated ones or both. Labour demand and supply models predict that a decrease in the skill premium must be driven by an increase in the relative supply of skills which is consistent with the findings so far. This does not necessarily imply that the labour earnings of the most educated workers must fall to be consistent with the decline in the skill premium. In fact, there is no reason to believe that labour demand is no longer skill-biased, or that capital is less skill complementary in Brazil. Figures 6 and 7 show the changes in the composition-adjusted log hourly wages and the participation of labour supplies by educational groups, respectively.

The effects of the macroeconomic instability in Brazil over the 1980s and the early 1990s are reflected in the erosion of the real labour earnings of all educational groups. Notice that the rising prices appear to have a more negative effect on the wages of illiterate and secondary educated males and secondary educated females in the late 1980s and early 1990s which explains why the tertiary/non-tertiary skill premium did not decrease over these periods. The patterns of the labour earnings are more dispersed after the adoption of the Brazilian Real in 1994. Although this proved to be a more stable currency than its predecessors, real wages remained falling until the early 2000s. The recovery of labour earnings over the 2000s is evident among primary and illiterate workers, these also recovered among secondary educated ones though at a much slower pace. In contrast, labour earnings for more educated workers seem to stagnate in this period.

Figure 7 suggests that labour earnings trends across educational groups might be linked to the evolution of their corresponding participation in the labour supply,



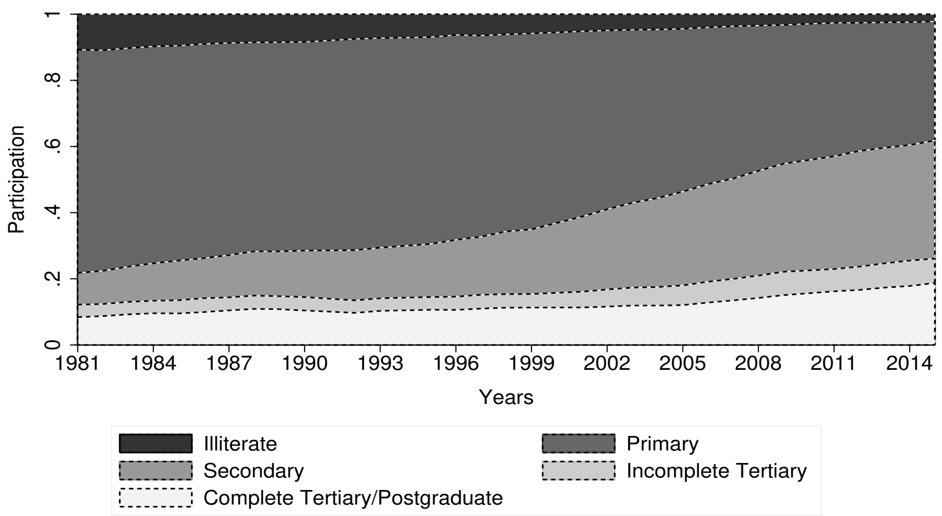
(a) Males



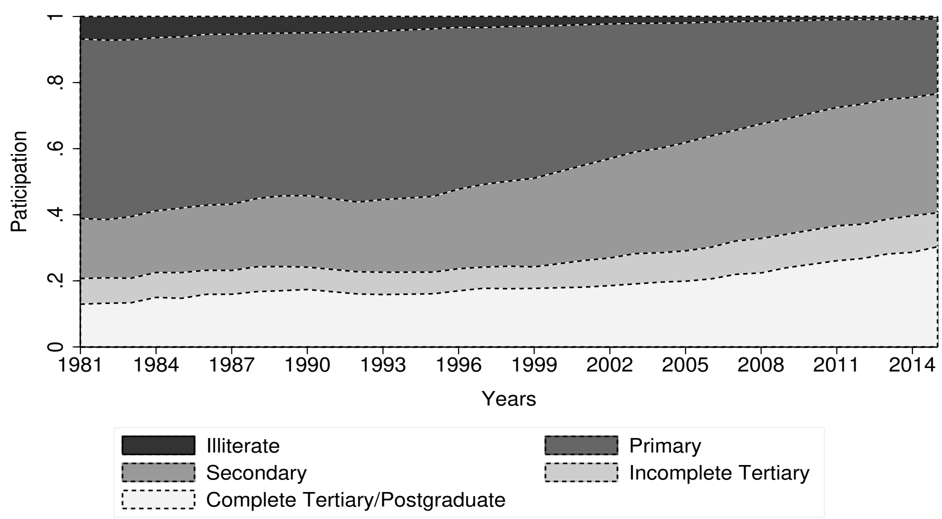
(b) Females

Source: PNAD data from 1981 to 2015. Composition-adjusted log hourly wages for full-time workers are the weighted average of the predicted log wage in each of the 490 gender-education-experience groups. Each series is normalized at zero in 1981. See Figure 4 notes for more details.

Figure 6. Composition-Adjusted Log Hourly Wages by Educational Groups



(a) Males



(b) Females

Source: PNAD data from 1981 to 2015. Efficiency units of labour supply are the weighted average of the employment participation of 490 gender-education-experience groups. See Figure 5 notes for more details.

Figure 7. Efficiency Units of Labour Supply by Educational Groups

particularly among the least-educated workers. To put this information in context, log wages among primary-educated workers grew by 36 log points among males and by 48 log points among females, while their participation in the labour supply falls by 20 percent for both genders from 2001 to 2015. The increase in the labour earnings of illiterate workers is even larger, however, their participation in the labour supply has been falling over the sample period and these only represent less than 2 percent of the total labour supply in 2015. On the other hand, the labour earnings of high-school graduates grew over the 2000s in spite of the increase in their labour supply participation. The increase in the labour supply of more educated workers seems not to have adverse effects on their labour earnings either, which is consistent with a skill-biased labour demand.

Figures A-3 and A-4 in the Appendix provide additional information on changes in the composition-adjusted log wages and labour supply participation of each educational group by years of potential experience, respectively. Four important conclusions can be drawn from this analysis. First, the labour earnings of the least educated workers (illiterate and primary educated) increase over the 2000s within each experience group. Second, their labour market participations decrease irrespectively of the experience group, however, these patterns are more significant among the least experienced workers (those with 0–9 and 10–19 years of experience). In fact, the labour market participation of young-illiterate workers almost vanishes over this period. Third, the recovery in the labour earnings of secondary-educated workers that we observed in Figure 6 is given by the rise in real wages of young high-school graduates despite the growth in their labour supply. Finally, the increase in the labour supply of college-educated workers is mostly given by a higher participation of young college graduates.

In summary, the decline in the tertiary/non-tertiary skill premium over the 2000s is given by the increase in the labour earnings of primary and illiterate workers, whereas the fall in the secondary/primary skill premium is given by the sharp decrease in the labour earnings of high-school graduates in the 1990s and their relatively slow recovery in the 2000s. Apparently, years of potential experience play a modest role in the evolution of real wages except among the youngest workers in the sample. These trends might reflect the desire of the labour market for younger and cheaper labour force. Although we cannot claim causality between wages and labour supplies at this stage, it seems that changes in the skill composition of the labour force might have determined the changes in the price of skills. However, another question arises regarding the increase in the labour earnings of the least educated and youngest workers over the 2000s. Given the characteristics of these workers, it is straightforward to believe that factors such as labour market institutions might have contributed to this phenomenon, I will come back to this latter. We cannot rule out the possibility that this polarization of wage growth has been induced by a change in the share of low-skill occupations either. Gasparini, Cruces, and Tornarolli (2008) state that the improvement in the terms of trade given by the boom in the price of commodities and devaluations benefit low-skill intensive sectors in the 1990s and 2000s, thus changes in occupational and sectoral structure might explain the evolution of the skill premium in the last decades.

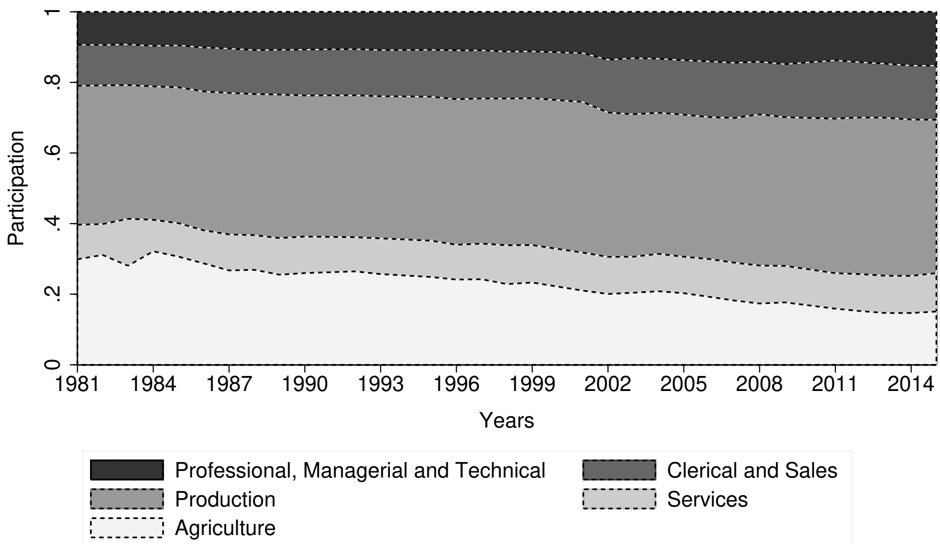
3. Occupational and Sectoral Structure

It is well known that wage inequality may arise by labour demand shifts in favour of workers with specific skills. Changes in technological progress and capital acquisition have been studied in the literature for developed countries as potential sources of wage and job polarization (Levy & Murnane, 2005; Autor, Katz, & Kearney, 2008; Autor & Dorn, 2013). Acemoglu and Autor (2011) show that the simultaneous growth in low and high-wage occupations in detriment of middle-wage ones in the U.S is driven by job polarization in favour of non-routine-task jobs. This is because low-wage occupations such as personal services involve non-routine-manual tasks which are difficult to substitute with capital, unlike middle-wage occupations such as clerical jobs which involve routine-manual tasks. Figure 3 showed that the lowest percentiles in the wage distribution had a better evolution than the median wage in the 1990s and 2000s, while the opposite is true for the highest percentiles. If the hypothesis of job polarization also applies to the Brazilian labour market, we certainly might rule out that this has benefited high-wage occupations, but this might explain the gains in low-wage ones.

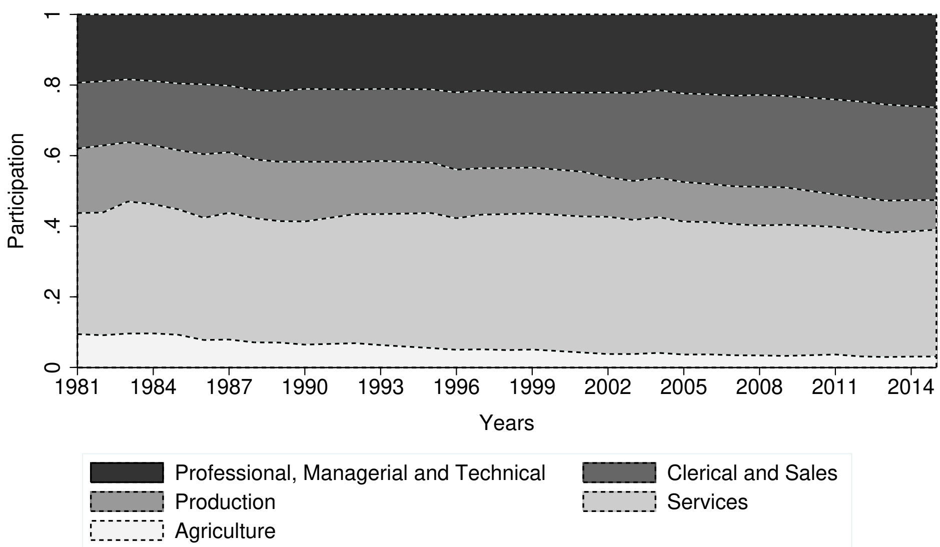
Even in the absence of wage and job polarization in the Brazilian labour market, it is important to understand how changes in the occupational and sectoral structure have affected the evolution of the labour earnings in the country. There is limited empirical work on this matter, perhaps for the lack of a data source that provides consistent occupational categories over the sample period. PNAD provides information on individual and aggregate occupational categories that are only consistent within two periods (1981–2001 and 2002–2015). I use the definition of each individual occupation to reconcile categories throughout the sample period and construct five broad occupational categories: (i) managers, professionals and technicians; (ii) office/administration and sales; (iii) production and repair; (iv) personal services; and (v) agricultural occupations.[11] Figure 8 shows the participation of employment among occupational categories by gender.

The employment share in professional, managerial and technical occupations grew from 9 to 15 percent among males and from 19 to 26 percent among females

[11] Acemoglu and Autor (2011) following the U.S. Department of Labour's Dictionary of Occupational Titles (DOT) classify these categories as non-routine cognitive, routine-cognitive, routine-manual and non-routine manual tasks, respectively. There is no agreement in the literature about the type of tasks performed in agricultural occupations. However, we can assume that these are more likely to comprise routine and non-routine manual tasks.



(a) Males



(b) Females

Source: PNAD data from 1981 to 2015. Sample comprises salary/wage workers and self-employed, aged 18-65 years old. Workers employed in the military are excluded from the sample. PNAD provides information on individual occupations and eight aggregate categories (Managers, Professionals, Technicians, Office and administration, Sales, Production and repair, Personal services and Agricultural occupations) from 2002 to 2015. This categorisation is not consistent with that in prior years. I sort around 380 occupations from 1981 to 2001 into the previous eight occupational categories by matching the definitions of individual occupations between the two periods. Occupations that are not assigned to any category are excluded from the sample (around 7 percent). Figure 8 plots five aggregate occupations: Professional, managerial and technical, Clerical (office and administration) and sales, Production (Production and repair), Services (personal services) and Agriculture (agricultural occupations).

Figure 8. Employment Shares by Occupations

from 1981 to 2015. We can also observe a growth in the participation of clerical and sales occupations, particularly among women. This is consistent with the educational upgrading of the workforce as most of the employees in these occupational categories have at least a secondary education. Figure A-5 in the Appendix shows that the participation of workers with at least some tertiary education in professional, managerial and technical occupations grew from 40 percent for both genders in 1981 to 55 percent among males and 68 percent among females in 2015. The educational upgrading in clerical and sales occupations, in turn, was mostly driven by the increase in the participation of high-school graduates in detriment of less-educated ones. The participation of workers with at least a high school diploma in clerical and sales occupations grew approximately 40 percentage points among males and 33 percentage points among females from 1981 to 2015.

Production occupations have been traditionally held by males, we can see that a large proportion of male workers are employed in these occupations and their participation in male employment has remained relatively constant over the sample period. This is not the case among females, their participation in production occupations fell in 10 percentage points from 1981 to 2015. The decrease in the participation of female workers in production occupations might be related to changes in automation in labour-intensive industries. However, the participation of women in production remained relatively steady during the trade liberalization reforms in the 1980s and 1990s as the market demanded more labour force, thus the posterior fall over the 2000s might be the result of changes in trade policies. The educational upgrading of the labour force is also evident in production occupations as can be seen in Figure A-5 in the Appendix. Workers with at least a high-school diploma represented less than 5 percent of the workforce in 1981 for both genders, whereas these represent half of the female workforce and one-third of the male one in 2015.

Personal services, unlike production occupations, have been traditionally held by females, these represent one-third of the total employment among females and only 10 percent among males. The employment share of personal services has remained relatively constant through time for both genders. As the previous occupational categories, there has been a remarkable educational upgrading of the labour force given by the higher participation of high-school graduates, however personal services are still mostly performed by primary educated workers.

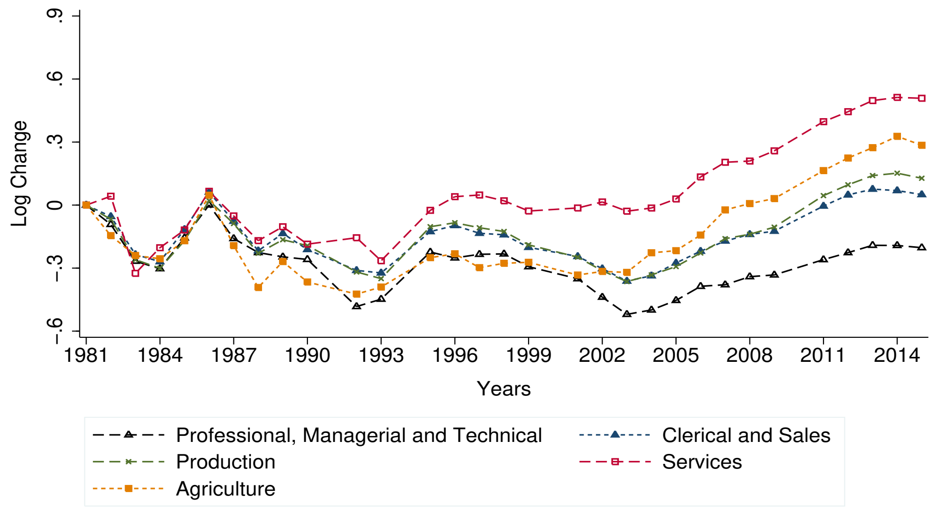
The most important feature in Figure 8 is the sharp decrease in the employment share of agricultural occupations for both genders. The fall in 15 percentage points among males and 6 percentage points among females over the sample period responds to the development of labour-saving agricultural technologies and genetically modified crops (Bustos, Caprettini, & Ponticelli, 2016).[12] The bulk of the labour force in agricultural occupations is comprised of illiterate and primary educated workers, however, the latter ones have been gaining ground over the sample period as can be seen in Figure A-5.

There are two conclusions that we can draw from the previous analysis. First, the educational upgrading of the workforce is present in each occupational category and this is more significant among females than among males. This difference responds to the remarkable increase in the labour market participation of more educated women relative to that of more educated men in the last decade. Second, whether technical changes have been labour saving, these have only affected agricultural occupations for both genders and production occupations among females. In that sense, it is expected that changes in employment shares of these occupations have significant effects on the labour earnings of the workers who perform them. Figure 9 provides information on this matter.

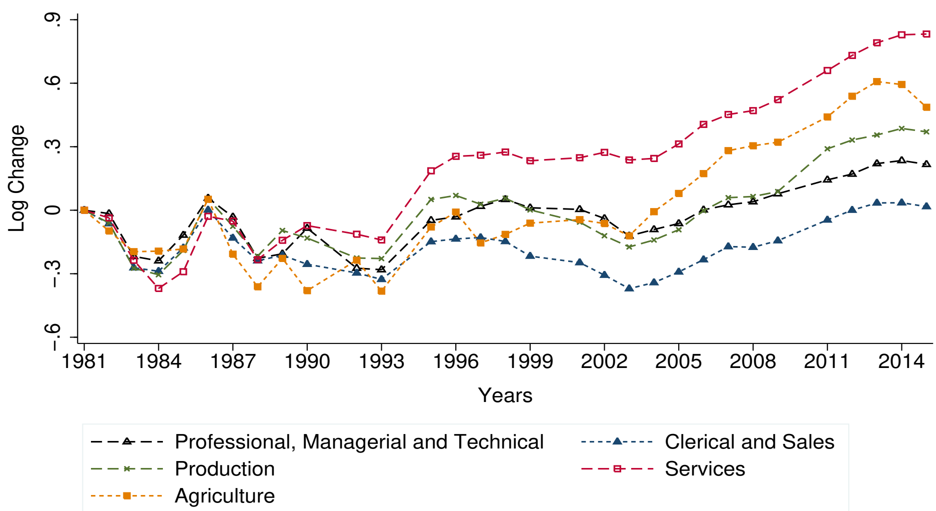
Figure 9 keeps certain similarities with the changes in wage percentiles in Figure 2 and changes in real wages by educational groups in Figure 6. High inflation rates over the 1980s and the early 1990s harmed the labour earnings in all occupational categories and these seem to recover only after the early 2000s. Although professional, managerial and technical occupations have been gaining ground in employment, the labour earnings of the workers performing these occupations seem to have a slower recovery than those of their counterparts. Moreover, the mild growth of the labour earnings among these occupations in the 2000s is mostly driven by the growth of wages among the least educated workers as can be seen in Figure A-6 in the Appendix. In fact, real wages in other occupations with a high percentage of workers with at least secondary education such as clerical and sales, and production occupations have a slower recovery than those intensive in primary educated workers such as personal services and agriculture. Notice the remarkable recovery of the labour earnings in personal services that unlike other occupations, reached the same level of 1981 immediately after the adoption of the Brazilian Real in 1994. After a period of stagnation, real wages in personal services increase rapidly over the 2000s. This positive trend can also be observed across all educational groups performing these occupations in Figure A-6. Although the sharp decrease in the participation of agricultural occupations in employment, there is a substantial increase in the labour earnings of workers employed in agriculture over the 2000s, irrespectively of their educational attainment.

The decrease in the employment of agricultural occupations for both genders and production occupations among females might signal a change in the demand for routine-manual tasks. However, it is expected that a labour-saving technical

[12] It is important to mention that the low participation of agricultural occupations in total employment is given by the exclusion of individuals that work for self-consumption who are basically the bulk of the agricultural sector.



(a) Males



(b) Females

Source: PNAD data from 1981 to 2015. Log hourly wages of salary/wage workers and self-employed excluding those in the military, aged 18–65 years old. Each series is normalized at zero in 1981. See Figure 8 notes for more details on occupational categories.

Figure 9. Log Hourly Wages by Occupations

change harms the labour earnings of workers performing these tasks which is not the case in Brazil. Moreover, the employment in clerical and sales occupations that are also assumed to involve routine-manual tasks has grown over the sample period along with the labour earnings of their workers. Nevertheless, this is not proof of a non-existent job polarization as there are different factors that might have affected the evolution of the labour earnings among these workers. For instance, the unprecedented increase in the real minimum wage could have masked the adverse effects of the technical change on wages, particularly among workers employed in agriculture and production. In order to understand the nature of the changes in the employment across occupations, I perform a between and within decomposition of changes in national employment of occupation i during time interval t, following Acemoglu and Autor (2011). Formally:

$$\Delta\,\mathbb{E}_{it} = \sum_j \Delta\,\mathbb{E}_{jt}\,\mathbb{E}_{ijt} + \sum_i \Delta\,\mathbb{E}_{ijt}\,\mathbb{E}_{jt},$$

where $\Delta\,\mathbb{E}_{jt}$ is the change in employment share of industry j in period t; $\mathbb{E}_{ijt}$ is the average employment share of occupation i in industry j during t; $\Delta\,\mathbb{E}_{ijt}$ is the change in employment share of occupation i in industry j during t; and $\mathbb{E}_{jt}$ is the average employment share of industry j in period t. Table 1 shows the results of this exercise.[13]

There is a relatively small growth in managerial, professional and technical occupations among males compared to that among females over the 1980s and the 1990s. Over the 2000s, the employment share of these occupations increased significantly for both genders and seems to be mostly driven by within-industry shifts among males, while among females both between and within-industry shifts play a role in this change. Similarly, the increase in employment of clerical and sales occupations is more significant for females than for males, and this is driven by both between and within-industry changes, particularly over the 1990s and 2000s. The decrease in the employment of production occupations among females over the last two periods is driven by within-industry shifts and this behaviour can also be observed among males over the 2000s. The within-industry shifts against production occupations which involve routine-manual tasks and favouring high-skill occupations which involve non-routine cognitive tasks might signal some polarization of employment across occupations. However, the employment in other occupations that involve non-routine tasks such as personal services follows a decreasing pattern among males. Moreover, the increase in employment of personal services among women, in decades previous to the 2000s, is dominated by between-industry shifts, that is, these were primarily driven by employment shifts towards

[13]Table 1 provides information on changes in total employment (males and females) across occupations, these estimates are not directly comparable to those in Figure 8 which provides information on changes in employment within each gender.

Table 1. Decomposition of Changes in Employment of Occupational Categories

	Males			Females		
	1981–1990	1990–2001	2001–2015	1981–1990	1990–2001	2001–2015
Professional, Manag.and Technical						
Between-Industry	0.01	0.11	−0.17	1.47	0.58	1.28
Within-Industry	0.37	0.06	1.87	0.24	0.67	1.14
Total	0.38	0.17	1.69	1.70	1.26	2.41
Clerical and Sales						
Between-Industry	0.54	0.31	0.13	1.68	0.67	1.16
Within-Industry	−0.35	−0.31	0.33	0.08	0.85	1.15
Total	0.19	0.00	0.46	1.76	1.52	2.31
Production						
Between-Industry	−2.64	−0.62	1.10	1.11	0.10	0.61
Within-Industry	0.86	0.68	−1.86	−0.59	−1.15	−2.11
Total	−1.79	0.05	−0.76	0.52	−1.05	−1.50
Services						
Between-Industry	0.28	0.56	0.10	1.78	3.24	0.10
Within-Industry	−0.46	−0.71	−0.34	0.33	−0.40	−0.14
Total	−0.18	−0.15	−0.25	2.11	2.84	−0.04
Agriculture						
Between-Industry	−3.74	−4.27	−3.97	−0.50	−0.68	−0.33
Within-Industry	−0.42	0.28	0.00	−0.06	0.03	−0.03
Total	−4.15	−3.99	−3.96	−0.56	−0.65	−0.36

Note: Sample comprises salary/wage workers and self-employed, aged 18-65 years old. Workers employed in the military are excluded from the sample. PNAD provides information on individual industries and 11 aggregate categories (Agriculture, Industry, Manufacturing, Construction, Wholesale and retail trade, Business service, Transportation and communication, Public administration, Professional services, Domestic services, Personal services and entertainment) over the period 2002–2015. This categorisation is not consistent with that in prior years. I sort around 170 industries from 1981 to 2001 into the previous 11 industrial categories by matching the definitions of individual industries between these two periods. Industries that are not assigned to any of these categories or those which are wrong defined are excluded from the sample (around 6 percent). See Figure 8 notes for more details on occupational categories.

Source: PNAD data for 1981, 1990, 2001 and 2015.

industries intensive in personal services rather than shifts in favour of non-routine tasks. Finally, the decline in the employment of agricultural occupations is entirely driven by changes in industrial composition.[14]

To sum up, there are three important findings that can be drawn from this analysis: i) within-industry shifts are responsible for the decline in employment of production occupations over the 2000s; ii) within and between-industry shifts have favoured high-skill occupations, particularly among females; iii) changes in employment of personal services are mostly driven by changes in industry structure

[14] As the agricultural occupations are mostly employed in agriculture, the change in their employment is given by changes in the participation of the agriculture sector in the economy.

and are only significant among females over the 1980s and 1990s. The first two might suggest some degree of job polarization in the Brazilian labour market against routine-manual task and favouring non-routine cognitive tasks. However, it is only logical to think that as workers become more educated, these move from low-paid occupations to high-paid ones. This seems to be a more reasonable explanation given that the labour earnings in production occupations grew at a faster pace than those in higher-wage occupations. Finally, there is no evidence that the increase in the labour earnings of low-wage occupations such as personal services and agricultural occupations is the result of a shift in the demand for the task performed in these occupations. Once again, the increase in the real value of the minimum wage seems to provide a more reasonable explanation for these patterns.

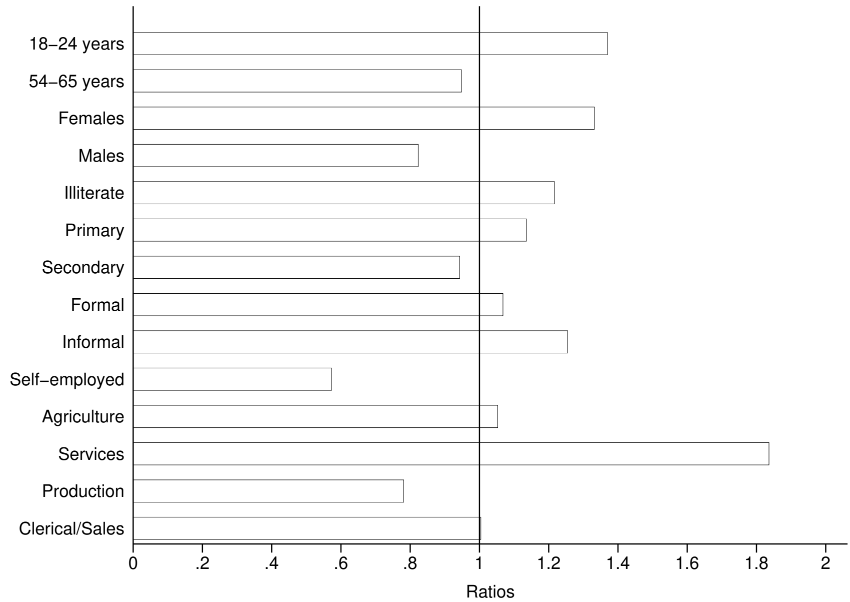
4. The Sources of Declining Wage Inequality

4.1 The Role of the Minimum Wage

Labour market institutions and their effects on wage inequality have been extensively studied, particularly in developed countries. The literature on the subject suggests that changes in minimum wage policies might shape wage inequality as much as labour market forces, particularly in the lower half of the wage distribution (DiNardo, Fortin, & Lemieux, 1996; Lee, 1999; Card & DiNardo, 2002). Minimum wage effects on wage inequality go beyond the direct impact on the labour earnings of minimum wage workers and might affect wages way above the minimum level through changes in the returns to human capital (Teulings, 2003). These effects are known in the literature as spillover effects of the minimum wage which are beyond the scope of this paper, but these might offer a reasonable explanation on the compression of the upper half of the wage distribution that is not accounted for by changes in labour market forces.

Minimum wages might play a more significant role in shaping wage inequality in Latin American countries than in more developed ones given the larger proportion of workers earning at the minimum wage level in the region. Cunningham (2007) states that up to 20 percent of the labour force earns the minimum wage in Latin American economies. Of course, this proportion varies across countries, demographic and occupational groups. Figure 10 shows the ratio of the proportion of minimum wage workers in each demographic and occupational group to the proportion of minimum wage workers in the economy. Thus, a ratio above 1 suggests that the demographic/occupational group is overrepresented among minimum wage workers.

Young, females, illiterate or primary educated workers are overrepresented among the minimum wage population. Regarding occupational groups, personal services and agriculture have a large proportion of minimum wage workers than

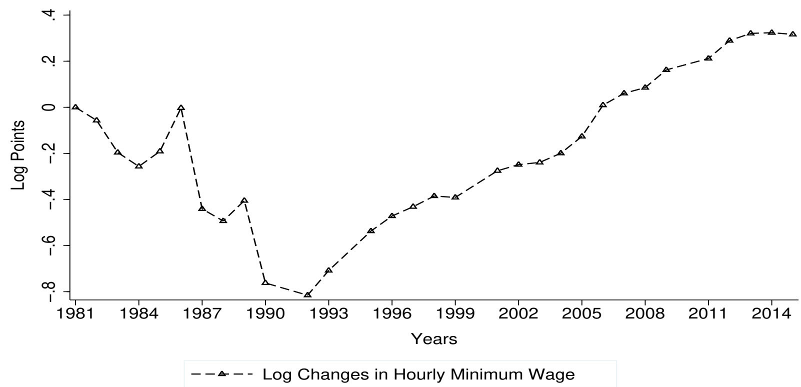


Source: PNAD and MTE data from 1981 to 2015. Sample comprises salary/wage workers and self-employed, aged 18–65 years old. The ratio is the proportion of minimum wage workers in each demographic/occupational group to the proportion of minimum wage workers in the workforce. Minimum wage workers are defined as those who earn +/− 5 percent the nominal minimum wage in each year.

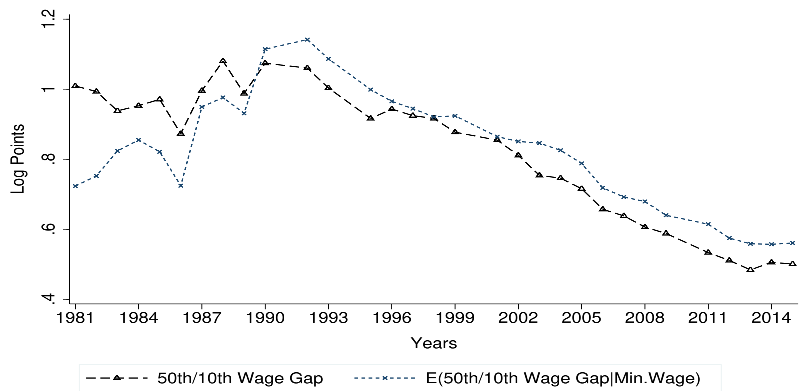
Figure 10. Ratio of the Proportion of Minimum Wage Workers in each Group relative to that in the Workforce

the other occupational groups. Minimum wage workers are also overrepresented in the formal and informal sectors. It is not surprising the over-representation in the formal sector given the large proportion of workers earning at the minimum wage level in Brazil. What it is striking is the over-representation of minimum wage workers in the informal sector who are not typically covered by minimum wage policies. This suggests that the minimum wage might act as a benchmark for wage setting in the informal sector. Given the demographic and occupational characteristics of the groups with a large proportion of minimum wage workers is straightforward to think that minimum wage policies play a significant role in the declining wage inequality.

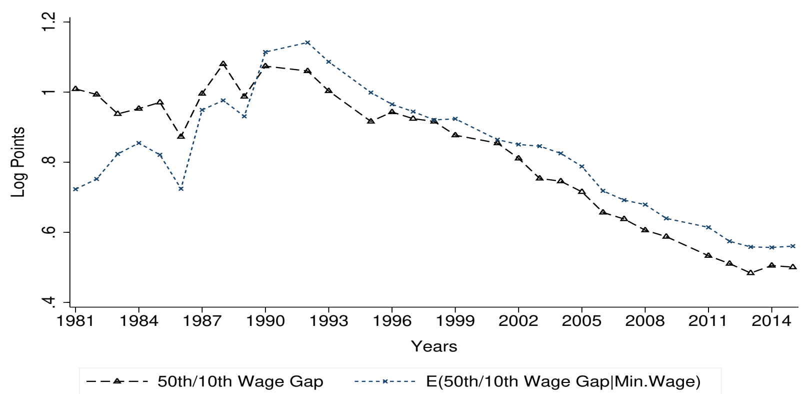
The real value of the minimum wage increased in 14 out of 18 Latin American countries in the 2000s (Keifman & Maurizio, 2014). Brazil is not the exception, the real value of the minimum wage decreased more than 50 percent over the inflationary period in the 1980s, recovered around 45 percent in the 1990s and increased approximately 80 percent from 2001 to 2015. Figure 11 shows that there is a strong time-series relationship between the real minimum wage and wage inequality.



(a)



(b)



(c)

Source: PNAD and MTE data from 1981 to 2015. Figure on the top shows changes in log real hourly minimum wage normalized at zero in 1981. The remaining figures show the observed and predicted wage gap between 50th/10th and 90th/50th percentiles for full-time salary/wage workers aged 18–65 years old. Predicted values are obtained from separate OLS regressions of wage gaps on a constant term and the log real minimum wage. Coefficients, robust standard deviations in parentheses, and R-squared are reported.

Figure 11. Log Hourly Wage Gaps and Real Minimum Wage

A simple regression between lower-tail inequality measured by the 50th/10th wage gap on the real value of the minimum wage yields a coefficient of −0.51 and R-squared of 0.73. The tight correspondence between the observed 50th/10th, and the predicted 50th/10th suggests that the decline in lower-tail inequality might be attributed to the secular increase in the real minimum wage. As most of the decline in overall wage inequality in the 2000s is given by the compression in the lower half of the wage distribution, the minimum wage could have played a much more significant role that it is believed in the most recent decline in wage inequality. However, somewhat the real minimum wage is also correlated with upper-tail inequality. In fact, the coefficient of this relationship suggests that an increase in 1 log point in the real value of the minimum wage is associated with a decrease of 0.32 log points in upper-tail inequality.

This strong relationship is highly robust even when other explanatory variables such as a time trend and the relative supply between tertiary/non-tertiary educated workers are included in the regressions. The coefficients suggest that an increase in 1 percentage point in the real minimum wage compresses the 50th/10th wage gap in 0.30 log points and the 90th/50th wage gap in 0.21 log points both significant at 1 percent level. Of course, one could argue that the robustness of the results regarding the significant association between the real minimum wage and upper-tail inequality might indicate a potential spurious relationship between them. However, several explanations come to mind that could suggest that this is a legitimate relationship. The minimum wage is significantly binding in Brazil even above the 50th percentile in some demographic and occupational groups, which could explain the compression in upper-tail inequality. Moreover, the compression in the upper half of the wage distribution might also be the result of spillover effects of the minimum wage on the median wage.

4.2 Compositional and Wage Structure Effects on Wage Inequality

To explicitly quantify the effects of changes in the skill and demographic composition of the labour market and the prices of these characteristics (wage structure) on wage inequality, I use a decomposition approach based on recentered influence function (RIF) regressions by Firpo et al. (2018). Let $IF(w, q_p)$ denotes the influence function corresponding to an observed wage, w, for the quantile, q_p.[15] To obtain the recentered influence function (RIF), we simply add the quantile, q_p, to the influence function such as:

$$IF(w, q_p) = q_p + IF\big(w, q_p\big). \tag{1}$$

[15]The influence function basically quantifies changes in the quantile, q_p, in response to small changes in the data and takes the form: $IF(w, q_p) = \big(p - \mathbf{1}[w \leq q_p]\big)/\big(f_w(q_p)\big)$, where $\mathbf{1}[w \leq q_p]$ is an indicator function and $f_w(q_p)$ is the pdf which is estimated by using non-parametric kernel densities.

RIF regressions are performed in the same way as standard regressions in Oaxaca-Blinder decompositions, except that RIF is used as the dependent variable. RIF regressions allow us to perform a detailed decomposition for any statistic that admits an influence function.[16] The decomposition exercise consists of two steps. First, I use a reweighting procedure as in DiNardo et al. (1996). I use a probit model to estimate the probability of observing a worker with certain demographic characteristics, X, in period 1. I reweight period 0 to have the same distribution of X as in period 1 in order to recover the counterfactual wage distribution. Second, I run Oaxaca-Blinder decompositions using RIF regressions on the reweighted data to decompose compositional and wage structure effects into the contribution of individual explanatory variables to changes in wage inequality. Formally:

$$\hat{\Delta}^{q_p} = \underbrace{\left(\overline{X}_0^c - \overline{X}_0\right)'\hat{\beta}_0 + \overline{X}_0^{c\prime}\left(\hat{\beta}_c - \hat{\beta}_0\right)}_{\hat{\Delta}_x^{q_p}} + \underbrace{\overline{X}_1'\left(\hat{\beta}_1 - \hat{\beta}_c\right) + \left(\overline{X}_1 - \overline{X}_0^c\right)'\hat{\beta}_c}_{\hat{\Delta}_s^{q_p}}, \qquad (2)$$

where $\overline{X}_t$ and $\hat{\beta}_t$ denote the average of demographic characteristics and the estimated vector of parameters from RIF regressions on the corresponding X_t in period t, with $t = 0, 1$; and $\overline{X}_0^c$ and $\hat{\beta}_c$ those from the reweighted period 0 that mimics period 1. The composition effect, $\hat{\Delta}_x^{q_p}$, reflects the part of the change in q_p that is explained by changes in the distribution of demographic characteristics, X, and is given by the first two terms in equation (2) which correspond to the pure composition effect and specification error, respectively. The wage structure effect, $\hat{\Delta}_s^{q_p}$, reflects the part of the change in q_p that is explained by changes in the return to demographic characteristics and is given by the last two terms in equation (2) which correspond to the pure wage structure effect and the reweighting error which goes to zero in large samples.

In the present analysis, the vector of $X's$ comprises education, age and their corresponding squared terms, and dummy variables for female workers, low-skill occupations, and minimum wage workers. Table 2 shows the compositional and wage structure effects on changes in wage inequality between 1995 and 2015 (post-inflationary period) for the 90th/10th, 50th/10th and 90th/50th wage gaps.

The results in Table 2 are in line with the observed decline in wage inequality over the post-inflationary period, 1995–2015. Overall wage inequality measured by the wage gap 90th/10th decreases by 72 log points from 1995 to 2015, approximately 60 percent of this decline was driven by the fall in the 50th/10th. The estimates in Table 2 suggest that the decline in both upper and lower-tail inequality was entirely driven by wage structure effects, that is, the residual part that cannot be explained by group differences. In fact, wage structure effects counteracted the composition

[16] As the expectation of RIF is the quantile, q_p, Firpo et al. (2018) demonstrate that $\mathbb{E}[IF(w, q_p)|X_t] = X_t'\beta_t$. The expression relates the effects of changes in the expected value of X_t on q_p.

Table 2. Compositional and Wage Structure Effects on Wage Inequality, 1995–2015

	90th/10th	50th/10th	90th/50th
Overall Change	−0.723***	−0.425***	−0.298***
	(0.012)	(0.002)	(0.013)
Composition Effects	0.084***	−0.012	0.095***
	(0.023)	(0.028)	(0.012)
Education	0.076***	0.002*	0.073***
	(0.005)	(0.001)	(0.004)
Age	0.014	−0.001	0.015***
	(0.014)	(0.014)	(0.001)
Female	−0.007**	−0.006***	−0.002**
	(0.003)	(0.001)	(0.001)
Low-Skill Occupations	−0.011	−0.012***	0.001
	(0.008)	(0.004)	(0.002)
Minimum Wage Workers	0.012***	0.004	0.008
	(0.003)	(0.007)	(0.006)
Wage Structure Effects	−0.808***	−0.413***	−0.393***
	(0.028)	(0.029)	(0.023)
Education	−0.579***	−0.075***	−0.503***
	(0.073)	(0.008)	(0.072)
Age	−1.767***	−0.001	−1.765***
	(0.315)	(0.040)	(0.283)
Female	0.161***	−0.023***	0.184***
	(0.036)	(0.004)	(0.034)
Low-Skill Occupations	0.080**	0.025*	0.055*
	(0.039)	(0.014)	(0.030)
Minimum Wage Workers	−0.014***	−0.018**	0.003
	(0.004)	(0.007)	(0.004)
Constant	1.310***	−0.321***	1.631***
	(0.303)	(0.031)	(0.273)

Note: Sample comprises full-time salary workers. I perform two Oaxaca-Blinder decompositions using RIF regressions. In the first decomposition, I use the sample in period 0 and the counterfactual sample in period 0 that mimics period 1 to obtain composition effects. In the second decomposition, I use the sample in period 1 and the counterfactual sample to obtain wage structure effects. Standard errors in parentheses are obtained by bootstrapping with 100 replications. Significant at 1 percent ***, at 5 percent ,** and at 10 percent *.

Source: PNAD and MTE data from 1995 to 2015.

effects that were increasing wage inequality, particularly in the upper half of the wage distribution. In that sense, upper-tail inequality measured by the 90th/50th wage gap would have decreased by 39 log points, instead of the observed 30 log points, between 1995 and 2015 under a constant demographic composition of the labour market.

Table 2 decomposes further the compositional and wage structure effects on wage inequality measures accounting for the contribution of education, age as a measure for experience, female participation, low-skill occupations including production, personal services and agricultural occupations and whether a worker is a minimum wage earner, that is, earns a wage +/−5 percent the nominal minimum wage. Among the compositional effects, changes in the participation of females and the employment of low-skill occupations have an equalizing effect on lower-tail inequality, while changes in the years of schooling and age/experience have an unequalizing effect in upper-tail inequality. The counterfactual estimates suggest that compositional effects driven by changes in education would have increased the 90th/10th in 7.6 log points between 1995 and 2015 under constant price of demographic characteristics.

Among wage structure effects, education and age/experience have a large equalizing effect, particularly in upper-tail inequality, which offsets the unequalizing composition effect and others that counteracted the decline in wage inequality. The counterfactual estimates suggest that changes in the return to education would have contributed to a decline of 58 log points in the 90th/10th wage gap which represents 80 percent of the actual decline. Notice that changes in the return to education are more significant to explain the decline in the 90th/50th than in the 50th/10th. In fact, the estimates for the 50th/10th suggests that changes in the schooling premium would have decreased this gap in 7.5 log points which represents only 18 percent of the actual decline in lower-tail inequality.

Other factors besides education and age/experience seem to have less significant effects on the declining wage inequality. We can see that a higher participation of females in the labour market has an equalizing compositional and wage structure effect on the 50th/10th, whereas the equalizing compositional effect is offset by the unequalizing wage structure effect on the 90th/50th. Changes in low-skill occupations seem to have an equalizing compositional effect only in the 50th/10th and this is relatively small. Finally, changes in the proportion of minimum wage workers appear to affect neither lower nor upper-tail inequality, however, the return to minimum wage workers has a significant equalizing effect on the 50th/10th. These results should be seen in the light of changes in the proportion of minimum wage workers and the minimum wage. In that sense, this variable does not account for spillover effects of the minimum wage neither above nor below the minimum wage level which have been proved to drive most of the compression of lower-tail inequality in developed countries.[17]

In conclusion, changes in the skill and demographic composition of the labour market cannot explain the changes in wage inequality over the last two decades in Brazil by themselves. In fact, the changes in the price of skills and the price of other demographic characteristics seem to explain the entire declining pattern in wage inequality over this period. Of course, the validity of this counterfactual exercise relies on the partial equilibrium assumption that changes in quantities and prices are independent of each other. As Autor et al. (2008) mention that although this assumption is analytical convenient to perform decompositions of wage inequality, this is opposite to what is observed in labour market studies. In section 2, we observed a significant correlation between labour earnings and employment participation among educational groups which suggests that changes in the wage structure might be driven by changes in the composition of the labour market and not necessarily in spite of them. For instance, if workers are not perfect substitutes in production, then a change in the skill composition would affect relative wages. In the next section, I provide an analysis of this mechanism to rationalize the observed patterns so far.

4.3 The Effects of the Skill Supply on Relative Wages

The following analysis employs a supply-demand framework based on the ideas of Tinbergen (1974), Katz and Murphy (1992), Katz and Autor (1999), Goldin and Katz (2007), Autor et al. (2008), Acemoglu and Autor (2011) among many others to analyse the effects of shifts in labour supply of and demand for skills on the skill premium.[18] The model traditionally involves two types of workers who are imperfect substitutes in production under a competitive labour market. The substitution between these two types of workers is captured by a constant elasticity production function CES of the form:

$$Q_t = \left[\alpha_t (a_t H_t)^{\frac{\eta-1}{\eta}} + (1-\alpha_t)(b_t L_t)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{3}$$

where H_t and L_t are the quantities employed of high and low-skilled workers in period t; a_t and b_t are their respective factor-augmenting technology terms; α_t is a time-varying technological parameter, for example, the share of activities allocated

---

[17] The small effect of the minimum wage on wage inequality might also be the result of the sample choice. As the sample comprises salary workers both formal and informal, the 50th/10th might be not necessarily affected by changes in the minimum wage as the 10th percentile mostly comprises the labour earnings of informal workers who are not covered by minimum wage policies.

[18] Building on the ideas in these papers, Manacorda et al. (2010) and Gasparini et al. (2011) study the evolution of the skill premium by pooling data from Latin American economies. The present analysis extends this earlier work allowing for different educational groups and drawing on additional years of data for Brazil.

to each skill group; and $\eta \in [0, \infty)$ is the elasticity of substitution between high and low-skill labour. Both skill groups are gross substitutes if $\eta > 1$ and are gross complements if $\eta < 1$. A skill-neutral technological change raises a_t and b_t by the same proportion, whereas a skill-biased technological change increases either a_t/b_t, or α_t. Under the assumption that both skill groups are paid their marginal products, the wage of high-skilled workers w_t^H and low-skilled ones w_t^L can be obtained by differentiating (3):

$$w_t^H = \frac{dQ_t}{dH_t} = \alpha_t a_t^{\frac{\eta-1}{\eta}} \left[\alpha_t a_t^{\frac{\eta-1}{\eta}} + (1-\alpha_t) b_t^{\frac{\eta-1}{\eta}} \left(\frac{H_t}{L_t} \right)^{-\frac{\eta-1}{\eta}} \right]^{\frac{1}{\eta-1}} \tag{4}$$

$$w_t^L = \frac{dQ_t}{dL_t} = (1-\alpha_t) b_t^{\frac{\eta-1}{\eta}} \left[(1-\alpha_t) b_t^{\frac{\eta-1}{\eta}} + \alpha_t a_t^{\frac{\eta-1}{\eta}} \left(\frac{H_t}{L_t} \right)^{\frac{\eta-1}{\eta}} \right]^{\frac{1}{\eta-1}}. \tag{5}$$

There are two important implications of equation (4) and (5). First,

$$\frac{\delta w_t^H}{\delta \frac{H_t}{L_t}} < 0,$$

that is, an increase in the relative labour supply of high-skilled workers pushes down the wages of this skill group as these become relatively more abundant in the labour market. Analogously,

$$\frac{\delta w_t^L}{\delta \frac{H_t}{L_t}} > 0,$$

an increase in the relative labour supply of high-skilled workers increases the wages of low-skilled ones as a consequence of the imperfect elasticity of substitution between skill types. Second,

$$\frac{\delta w_t^H}{\delta a_t} > 0, \qquad \frac{\delta w_t^H}{\delta b_t} > 0,$$

and

$$\frac{\delta w_t^L}{\delta a_t} > 0, \qquad \frac{\delta w_t^L}{\delta b_t} > 0;$$

that is, a technological change increases the labour earnings of both skill types. Combining equations (4) and (5), we obtain the relative wage between high and low-skilled workers as a function of their corresponding relative labour supply at time t:

$$\frac{w_t^H}{w_t^L} = \frac{\alpha_t}{1-\alpha_t} \left[\frac{a_t}{b_t} \right]^{\frac{\eta-1}{\eta}} \left[\frac{H_t}{L_t} \right]^{-\frac{1}{\eta}}. \tag{6}$$

Taking logs of (6):

$$\ln\left(\frac{w_t^H}{w_t^L}\right) = \ln\left(\frac{\alpha_t}{1-\alpha_t}\right) + \left(\frac{\eta-1}{\eta}\right)\ln\left[\frac{a_t}{b_t}\right] - \frac{1}{\eta}\ln\left[\frac{H_t}{L_t}\right]. \tag{7}$$

Rewriting (7):

$$\ln\left(\frac{w_t^H}{w_t^L}\right) = \frac{1}{\eta}\left[D_t - \ln\left(\frac{H_t}{L_t}\right)\right], \tag{8}$$

where $D_t = \eta\ln\left(\alpha_t/(1-\alpha_t)\right) + (\eta-1)\ln\left(a_t/b_t\right)$ indexes shifts in the relative labour demand for high-skilled workers. The term in brackets in equation (8) shows that the relative wage or skill premium depends on the magnitude of changes in the relative labour demand for and the supply of skills. The aggregate elasticity of substitution between skill types, η, determines the magnitude of a change in the skill premium given a change in the relative supply of skills. An increase in the log relative labour supply decreases the log skill premium by $1/\eta$. Thus, the larger η is, the smaller the effect of a change in the relative supply of skills on the skill premium will be and vice versa. The effect of the relative labour demand on the skill premium also depends on the elasticity of substitution between skill types and is given by $(\eta-1)/\eta$. If $\eta > 1$, then an increase in the relative skill-biased augmenting technology, a_t/b_t, leads to an increase in the skill premium because a higher demand for skills always pays off when technology is skill-biased. If $\eta < 1$, a rise in a_t/b_t lowers the skill premium because it increases both the relative productivity of high-skilled workers and the relative demand for low-skilled ones as these are complementary in production.

As the ratio a_t/b_t in the labour demand term is not directly observable, most of the literature assumes that this can be captured by a linear time trend of the form $\ln\left(a_t/b_t\right) = \beta_0 + \beta_1 t$. Setting $\alpha_t = 1/2$ as in Acemoglu and Autor (2011), equation (8) can be rewritten as

$$\ln\left(\frac{w_t^H}{w_t^L}\right) = \left(\frac{\eta-1}{\eta}\right)\beta_0 + \left(\frac{\eta-1}{\eta}\right)\beta_1 t - \frac{1}{\eta}\ln\left(\frac{H_t}{L_t}\right). \tag{9}$$

Equation (9) allows us to explain how changes in labour market factors affect the skill premium. We can estimate the model by using specification (10) which includes the log of the real minimum wage, $\tilde{m}$, as an explanatory variable:

$$\ln\left(\frac{w_t^H}{w_t^L}\right) = \beta_0 + \beta_1 t + \beta_2\ln\left(\frac{H_t}{L_t}\right) + \beta_3\tilde{m}_t + \epsilon_t. \tag{10}$$

The coefficient β_1 provides information on the trend growth in the skill premium per year and β_2 provides an estimate for the elasticity of substitution between skill types, η. Empirical literature on the subject for more developed countries suggests that η ranges between 1 and 2.5. Manacorda et al. (2010) find an elasticity of substitution between high-school graduates and primary educated workers of 2.3

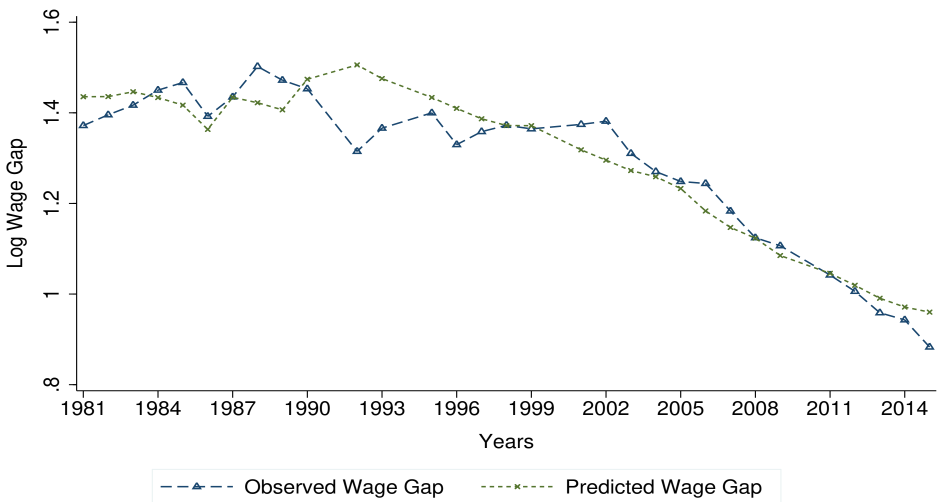
by using data from the largest economies in Latin America, while Gasparini et al. (2011) find elasticities of substitution within tertiary and non-tertiary educated workers for 16 Latin American economies that range between 4 and 6. Figure 12 shows the observed Tertiary/Non-Tertiary and Secondary/Primary wage gap and the corresponding predicted wage gaps obtained from specification (10).

The model does a good job capturing the evolution of the wage gap for different skill types except for the tertiary/non-tertiary wage gap in the early 1990s. As the growth in the relative supply between these skill types slowed down in the early 1990s, the model over-predicts the skill premium in this period. This can be easily observed in Figure A-7 in the Appendix which plots wage gaps and relative labour supplies deviated from a linear time trend. After the inflationary period, deviations in relative labour supplies from linear time trends explain well those of the corresponding detrended skill premiums, particularly over the 2000s. Figure A-7 underscores the relationship between skill premiums and relative supplies of skills as this depicts the remarkable growth in the relative supply between tertiary/non-tertiary educated workers along with the sharp fall in their wage gap over the 2000s. Similar behaviour can be observed between the secondary/primary relative supply and the corresponding skill premium in the 2000s, however, there is a deceleration in their respective patterns in the last years of the sample. Table 3 shows the estimates obtained from regression models for different skill premiums by using specification (10).

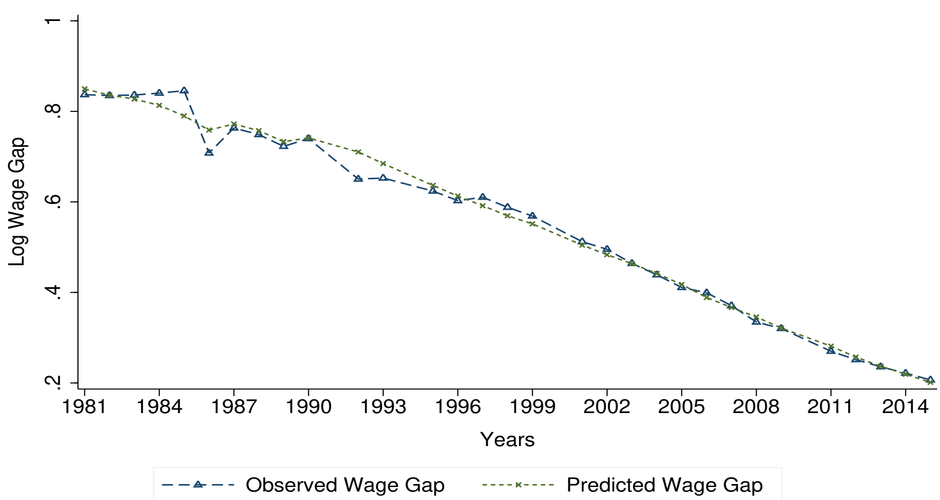
The first, third and fifth columns in Table 3 show the coefficients of a basic specification that accounts for a constant, a linear time trend and the corresponding measure of relative supply for all, males and females, respectively. The overall elasticity of substitution between workers with tertiary/non-tertiary education, η^T_{NT}, is 1.43 ($\eta^T_{NT} = 1/0.699$) which is similar to that among males, while among females this is much larger approximate 1.8. These values are significantly smaller than those found from a pooled sample of Latin American economies in Gasparini et al. (2011). The difference in the estimates may arise for the heterogeneity of Latin American labour markets and the inclusion of additional years of data.

Low elasticities of substitution imply a significant effect of the relative labour supply on the skill premium. The inclusion of the log real minimum wage in the model lowers the explanatory power of the relative supply and increases η^T_{NT} to 2.4 among males and 3.8 among females. The negative coefficient of the log real minimum wage suggests that an increase in 1 percent in the real minimum wage decreases the tertiary/non-tertiary wage gap in approximately 0.18 percent.

The other panels repeat the same exercise for skill types that are closer substitutes for each other. As expected, the elasticity of substitution between secondary and primary educated workers, η^S_P, is high, approximately 5.4 ($\eta^S_P = 1/0.185$). The coefficient suggests that an increase in 1 percent in the secondary/primary labour supply decreases the corresponding skill premium in 0.19 percent. Manacorda



(a) Tertiary/Non-Tertiary



(b) Secondary/Primary

Source: PNAD and MTE data from 1981 to 2015. The predicted skill premium is obtained by regressing the log of the composition-adjusted wage gap between skill types on a constant, linear time trend, the corresponding log relative supply in efficiency units and the log of the real minimum wage (equation (10)). See the notes of figures 4 and 5 on how to obtain composition-adjusted wages and efficiency units of labour supply.

Figure 12. Observed Vs. Predicted Skill Premium

Table 3. OLS Estimates for Skill Premiums

	All		Males		Females	
Tertiary/Non-Tertiary						
Relative Supply	−0.699***	−0.371**	−0.718***	−0.412**	−0.561***	−0.265**
	(0.112)	(0.155)	(0.116)	(0.183)	(0.097)	(0.121)
Log Real Minimum Wage		−0.177***		−0.164**		−0.185***
		(0.062)		(0.070)		(0.065)
Time	0.004	−0.001	0.002	−0.002	−0.001	−0.005**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
Constant	0.262	0.956***	0.215	0.922**	0.743***	1.266***
	(0.219)	(0.311)	(0.252)	(0.410)	(0.157)	(0.194)
R-squared	0.892	0.925	0.903	0.928	0.892	0.921
Secondary/Primary						
Relative Supply	−0.185***	−0.023	−0.179***	−0.030	−0.149**	0.015
	(0.043)	(0.059)	(0.031)	(0.040)	(0.056)	(0.096)
Log Real Minimum Wage		−0.072***		−0.074***		−0.083*
		(0.024)		(0.018)		(0.048)
Time	−0.009***	−0.017***	−0.009***	−0.017***	−0.014***	−0.021***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.004)
Constant	0.568***	0.899***	0.600***	0.949***	0.794***	1.053***
	(0.086)	(0.114)	(0.070)	(0.090)	(0.088)	(0.146)
R-squared	0.989	0.992	0.992	0.995	0.982	0.984
Tertiary/Secondary						
Relative Supply	−0.677***	−0.538***	−0.625***	−0.511***	−0.667***	−0.480***
	(0.063)	(0.083)	(0.057)	(0.077)	(0.085)	(0.113)
Log Real Minimum Wage		−0.091**		−0.085**		−0.120**
		(0.042)		(0.040)		(0.058)
Time	−0.008***	−0.005***	−0.012***	−0.008***	−0.003***	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.939***	0.962***	0.994***	1.014***	0.919***	0.958***
	(0.016)	(0.019)	(0.015)	(0.020)	(0.024)	(0.025)
R-squared	0.693	0.765	0.680	0.753	0.558	0.663

Note: Columns one, three and five show the coefficients obtained from regressing the log of the composition-adjusted wage gap on the corresponding log relative supply in efficiency units, a constant term and a linear time trend for all, males and females, respectively. The remaining columns show the coefficients obtained from using equation (10). Robust standard errors in parentheses. Significant at 1 percent ***, at 5 percent **, and at 10 percent *.

Source: PNAD and MTE data from 1981 to 2015.

et al. (2010) found a much smaller elasticity of substitution for these workers, approximately 2.3 implying that secondary/primary relative supply plays a significant role in the determination of the skill premium. However, Manacorda et al. (2010) use a sample that excludes the 2000s in which the relative supply between these skill types grew rapidly, as can be seen in Figure 5. The inclusion of the log real minimum wage in the model diminishes the effects of the relative supply on the skill premium. In fact, this is no longer significant, as can be seen in Table 3. Conditional on the inclusion of the real minimum wage, primary and secondary educated workers are basically perfect substitutes, thus changes in the relative supply between these skill types do not affect their wage gap. On the other side, the coefficient for the time trend seems to play a more significant role in the compression of this skill premium which falls 1.7 percent among males and 2.1 percent among females per year.

Finally, the bottom panel in Table 3 shows the skill premium between tertiary and secondary educated workers which has been used as a measure of the skill premium for developed countries. The elasticity of substitution for these skill types, η_S^T, is around 1.48 ($\eta_S^T = 1/0.677$) which is similar to the one estimated for tertiary and non-tertiary educated workers. Notice that the inclusion of the log real minimum wage seems to have a smaller effect on η_S^T in this specification than in previous ones. This suggests that the minimum wage plays a more significant role in the evolution of the labour earnings of workers with less than a high-school diploma. The trend decline in the skill premium per year is smaller than that of the secondary/primary skill premium. Thus, most of the decline in the tertiary/secondary skill premium is driven by changes in their relative labour supply and the real minimum wage.

Up to now, we have assumed that workers with different years of potential experience are perfect substitutes within each educational group. Figure A-1 in the Appendix showed that most of the decline in the skill premium is concentrated among the youngest workers, those with 0-9 years of potential experience. Following Autor et al. (2008), I extend the basic specification in (10) to account for experience-group relative supplies within each educational group. Formally,

$$\ln\left(\frac{w_{et}^H}{w_{et}^L}\right) = \beta_0 + \beta_1\left[\ln\left(\frac{H_{et}}{L_{et}}\right) - \ln\left(\frac{H_t}{L_t}\right)\right] + \beta_2 \ln\left(\frac{H_t}{L_t}\right) + \beta_3 \tilde{m}_t + \gamma_e + \gamma_e \times t + \upsilon_t, \quad (11)$$

where e indexes experience groups; γ_e and $\gamma_e \times t$ are experience-group fixed effects and specific time trends. Equation (11) arises from an aggregate CES production function as in equation (3), where educational groups are themselves CES sub-aggregates of the corresponding skill type. Under this specification, β_1 provides information on the elasticity of substitution between workers with different years of potential experience within the same educational group. Table 4 shows the estimates from this specification for the tertiary/non-tertiary skill premium which unlike the secondary/primary skill premium seems to be affected by the increase in the relative labour supply even when the real minimum wage is included in the model.

The first two columns in Table 4 show the estimates from specification (11) for the pooled sample of experience groups and the remaining columns, those from separate regressions by experience group. The coefficients reveal a small, but significant effect of the experience-group relative supply on the evolution of the skill premium, particularly among women. For instance, as seen in Figure A-1 in the Appendix, the tertiary/non-tertiary wage gap among females with 0–9 and 20–29 years of experience fell by 58 and 44 log points from 1981 to 2015, respectively. Over the same period, the relative supply for these experience groups, as seen in Figure A-2 in the Appendix, grew by 90 log points for the former and 138 log points for the latter. Thus, using the coefficient for the experience-group relative supply among females from Table 4, approximately one-third of the larger decrease in the skill premium for the least experienced females ($0.083 \times 48 \approx 4$ log points out of 14 log points) is explained by the relatively slower growth in their relative supply.

Among males, the estimates for the pooled specification suggest that experience groups are perfect substitutes within the same educational group. However, a closer inspection to the data reveals that this is not the case among the least experienced males, as can be seen in the third column of Table 4. Trend demand changes have a small effect on the skill premium, except for the most experienced workers. Thus, most of the variation in the tertiary/non-tertiary skill premium is given by changes in the relative supply of skills and the real minimum wage.

5. Conclusions

The decline in income inequality has been a recent phenomenon in the history of Latin America, which has been considered one of the most unequal regions of the world. Brazil reached a turning point in its income inequality trend in the late 1980s after years of four-digit inflation rates and economic instability. Following the economic growth triggered by the boom in the commodity prices in the 1990s and the early 2000s, the improvement in trade conditions and the adoption of a steadier currency in the mid-1990s, the country experienced a long-lasting decline in income inequality which accelerated over the 2000s reaching its lowest point in more than 30 years in 2015. This paper provides a detailed account of the factors behind the evolution of wage inequality from 1981 to 2015 in Brazil.

I use a counterfactual wage distribution to estimate the effects of changes in the demographic composition and the wage structure on wage inequality. The results suggest that changes in the composition of skills and demographic characteristics have unequalizing effects on the wage distribution, thus most of the decline in wage inequality is driven by changes in the returns to those characteristics. Changes in the prices of education and age/experience explain the decline in upper-tail inequality,

Table 4. OLS Estimates for Tertiary/Non-Tertiary Skill Premium by Experience Groups

	Pooled		Years of Potential Experience 0–9	10–19	20–29	30–39
All						
Exp. Group minus Agg. Supply	−0.088 ***	−0.084 ***	−0.108 ***	−0.029	0.013	0.068 **
	(0.028)	(0.028)	(0.026)	(0.027)	(0.029)	(0.032)
Aggregate Supply	−0.663 ***	−0.338 ***	−0.473 ***	−0.397 ***	−0.332 ***	0.022
	(0.034)	(0.027)	(0.055)	(0.045)	(0.054)	(0.073)
Log Real Min. Wage		−0.175 ***	−0.127 ***	−0.170 ***	−0.222 ***	−0.182 ***
		(0.007)	(0.020)	(0.016)	(0.019)	(0.025)
Time	0.003 ***	−0.002 **	0.000	0.000	−0.000	−0.011 ***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)
Constant	0.180 **	0.867 ***	0.461 ***	0.842 ***	1.133 ***	1.914 ***
	(0.071)	(0.056)	(0.108)	(0.094)	(0.107)	(0.154)
R-squared	0.879	0.895	0.918	0.916	0.891	0.805
Males						
Exp. Group minus Agg. Supply	−0.001	0.001	−0.080 ***	0.006	−0.012	0.067 **
	(0.035)	(0.035)	(0.022)	(0.026)	(0.025)	(0.028)
Aggregate Supply	−0.708 ***	−0.397 ***	−0.367 ***	−0.496 ***	−0.544 ***	−0.091
	(0.027)	(0.027)	(0.060)	(0.050)	(0.054)	(0.076)
Log Real Min. Wage		−0.167 ***	−0.144 ***	−0.125 ***	−0.187 ***	−0.204 ***
		(0.006)	(0.022)	(0.017)	(0.019)	(0.026)
Time	0.001	−0.003 ***	−0.003 ***	−0.0001	0.003 **	−0.006 ***
	−0.001	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.048	0.768 ***	0.630 ***	0.649 ***	0.727 ***	1.756 ***
	(0.065)	(0.061)	(0.131)	(0.112)	(0.116)	(0.171)
R-squared	0.873	0.887	0.916	0.916	0.898	0.769
Females						
Exp. Group minus Agg. Supply	−0.083 ***	−0.082 ***	−0.098 ***	−0.040	0.042	0.018
	(0.015)	(0.015)	(0.030)	(0.025)	(0.027)	(0.024)
Aggregate Supply	−0.484 ***	−0.191 ***	−0.479 ***	−0.266 ***	−0.060	0.167 **
	(0.044)	(0.036)	(0.053)	(0.040)	(0.055)	(0.078)
Log Real Min. Wage		−0.183 ***	−0.116 ***	−0.209 ***	−0.259 ***	−0.131 ***
		(0.013)	(0.023)	(0.018)	(0.024)	(0.034)
Time	−0.002 **	−0.007 ***	−0.001	−0.003 ***	−0.009 ***	−0.019 ***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)
Constant	0.726 ***	1.244 ***	0.719 ***	1.217 ***	1.722 ***	2.110 ***
	(0.064)	(0.054)	(0.087)	(0.068)	(0.091)	(0.138)
R-squared	0.862	0.878	0.901	0.919	0.871	0.779

Note: Coefficients in the first two columns are obtained by using equation (11) with 1,240 observations (corresponding to 40 single-year experience groups and 31 years). Workers with more than 40 years of experience were excluded from the specification, as these seem to be not affected by changes in the relative labour supply. The remaining columns show the estimates from separate regressions by individual experience groups. Standard errors in parentheses are clustered by experience group (Pooled sample). Significant at 1 percent ***, at 5 percent **, and at 10 percent *.

Source: PNAD and MTE data from 1981 to 2015.

while the fall in lower-tail inequality is also attributed to changes in the returns to minimum wage workers and female labour market participants.

To link changes in wage structure to the observed changes in the skill composition of the labour market, I use a two-factor CES production function with imperfect substitution among different educational and experience groups. I found that the secular increase in the relative supply of skills is key to explaining changes in the tertiary/non-tertiary skill premium. I also find a small but significant effect of the relative supply of workers with different years of experience within the same educational group on their respective skill premium, particularly among the youngest. This implies that these workers are not necessarily perfect substitutes within their educational category. Skill demand shifts have small but significant effects on the declining pattern of the skill premium, which may be related to trade liberalization policies over the 1990s, which according to the literature on the subject has contributed to the growth of low-skill-intensive sectors and thus, the labour opportunities of low-skilled workers. However, a closer inspection of the changes in occupations and sectoral structure shows that the labour earnings of workers employed in low-skill occupations grew in spite of their declining employment participation, particularly in agriculture.

The decrease in the return to skills among young workers and the remarkable increase in the labour earnings of workers employed in low-skill occupations, personal services and agriculture, which are mostly performed by high-school graduates and dropouts suggest that minimum wage policies might have played a significant role in the decline of the skill premium and wage inequality. The increase in the relative supply of skills seems to lose explanatory power when controlling for changes in the minimum wage. In fact, the estimates for the secondary/primary skill premium suggest that the relative labour supply between these skill types is not responsible for its decline. In other words, these workers are assumed to be perfect substitutes in production, thus the decline in the secondary/primary skill premium is mostly attributable to changes in the minimum wage. This finding seems to be opposed to most of the literature on the subject for Latin American economies as most of the empirical work available uses cross-sectional data from several Latin American economies and despite the obvious advantages of accounting for individual effects, there is also a substantial heterogeneity among Latin American countries as far as minimum wage policies are concerned. The estimates of the minimum wage on wage inequality also suggest a significant effect on the compression of both lower and upper-tail inequality. Although we can argue that the latter is likely to be the result of a spurious relationship, this may also be a legit relationship given by spillover effects of the minimum wage which are not accounted for by wage inequality decompositions as the one performed in this study.

References

Acemoglu, D. (1998). Why do new technologies complement skills? Directed technical change and wage inequality. *The Quarterly Journal of Economics*, *113*(4), 1055–1089. http://dx.doi.org/10.1162/003355398555838

Acemoglu, D. (2007). Equilibrium bias of technology. *Econometrica*, *75*(5), 1371–1409. http://dx.doi.org/10.1111/j.1468-0262.2007.00797.x

Acemoglu, D., & Autor, D. (2011). Skills, tasks and technologies: Implications for employment and earnings. In O. Ashenfelter & D. Card (Eds.), *Handbook of labor economics* (Vol. 4, pp. 1043–1171). Elsevier. https://economics.mit.edu/files/5571

Autor, D. H., & Dorn, D. (2013). The growth of low-skill service jobs and the polarization of the US labor market. *American Economic Review*, *103*(5), 1553–97. http://dx.doi.org/10.1257/aer.103.5.1553

Autor, D. H., Katz, L. F., & Kearney, M. S. (2008). Trends in U.S. wage inequality: Revising the revisionists. *The Review of Economics and Statistics*, *90*(2), 300–323. http://dx.doi.org/10.1162/rest.90.2.300

Autor, D. H., Katz, L. F., & Krueger, A. B. (1998). Computing inequality: Have computers changed the labor market? *The Quarterly Journal of Economics*, *113*(4), 1169–1213. http://dx.doi.org/10.1162/003355398555874

Barros, R., Carvalho, M. d., Franco, S., & Mendonça, R. (2010). Markets, the state, and the dynamics of inequality in Brazil. In L. F. López-Calva & N. C. Lustig (Eds.), *Declining inequality in Latin America: A decade of progress* (pp. 134–74). Washington, DC: Brookings Institution Press.

Behrman, J. R., Birdsall, N., & Székely, M. (2007). Economic policy changes and wage differentials in Latin America. *Economic Development and Cultural Change*, *56*(1), 57–97. http://dx.doi.org/10.1086/520556

Berman, E., Bound, J., & Machin, S. (1998). Implications of skill-biased technological change: International evidence. *The Quarterly Journal of Economics*, *113*(4), 1245–1279. http://dx.doi.org/10.1162/003355398555892

Bértola, L., & Williamson, J. (2017). *Has Latin American inequality changed direction? Looking over the long run*. Springer.

Bustos, P., Caprettini, B., & Ponticelli, J. (2016). Agricultural productivity and structural transformation: Evidence from Brazil. *American Economic Review*, *106*(6), 1320–65. http://dx.doi.org/10.1257/aer.20131061

Card, D., & DiNardo, J. E. (2002). Skill-biased technological change and rising wage inequality: Some problems and puzzles. *Journal of Labor Economics*, *20*(4), 733–783. http://dx.doi.org/10.1086/342055

Caselli, F. (1999). Technological revolutions. *American Economic Review*, *89*(1), 78–102. http://dx.doi.org/10.1257/aer.89.1.78

Cornia, G. A. (2014). *Falling inequality in Latin America*. Oxford, Oxford University Press.

Cruces, G., García Domench, C., & Gasparini, L. (2014). Inequality in education: Evidence for Latin America. In G. A. Cornia (Ed.), *Falling inequality in Latin America* (pp. 318–339). Oxford, Oxford University Press.

Cunningham, W. (2007). *Minimum wages and social policy: Lessons from developing countries*. Washington, DC: The World Bank. https://openknowledge.worldbank.org/handle/10986/6760

DiNardo, J., Fortin, N. M., & Lemieux, T. (1996). Labor market institutions and the distribution of wages, 1973–1992: A semiparametric approach. *Econometrica*, *64*(5), 1001–1044. http://dx.doi.org/10.2307/2171954

Dix-Carneiro, R., & Kovak, B. K. (2015). Trade liberalization and the skill premium: A local labor markets approach. *American Economic Review*, *105*(5), 551–57. http://dx.doi.org/10.1257/aer.p20151052

Firpo, S., Fortin, N., & Lemieux, T. (2018). Decomposing wage distributions using recentered influence function regressions. *Econometrics*, *6*(2), 28. http://dx.doi.org/10.3390/econometrics6020028

Fritz, B., & Lavinas, L. (2016). *A moment of equality for Latin America? Challenges for redistribution*. Routledge.

Gasparini, L., Cruces, G., & Tornarolli, L. (2008). *Is income inequality in Latin America falling?* CEDLAS, Universidad Nacional de La Plata.

Gasparini, L., Galiani, S., Cruces, G., & Acosta, P. (2011). *Educational upgrading and returns to skills in Latin America: Evidence from a supply-demand framework, 1990–2010* (Discussion Paper No. 6244). IZA. http://ftp.iza.org/dp6244.pdf

Goldberg, P. K., & Pavcnik, N. (2007). Distributional effects of globalization in developing countries. *Journal of Economic Literature*, *45*(1), 39–82. http://dx.doi.org/10.1257/jel.45.1.39

Goldin, C., & Katz, L. F. (2007). Long-run changes in the US wage structure: Narrowing, widening, polarizing. *Brookings Papers on Economic Activity*, *38*(2), 135–168. https://www.brookings.edu/wp-content/uploads/2007/09/2007b_bpea_goldin.pdf

Green, F., Dickerson, A., & Arbache, J. S. (2001). A picture of wage inequality and the allocation of labor through a period of trade liberalization: The case of Brazil. *World Development*, *29*(11), 1923–1939. http://dx.doi.org/10.1016/S0305-750X(01)00071-7

Griliches, Z. (1969). Capital-skill complementarity. *The Review of Economics and Statistics*, *51*(4), 465–468. http://dx.doi.org/10.2307/1926439

Kahhat, J. (2010). Labor earnings inequality: The demand for and supply of skills. In L. F. López-Calva & N. C. Lustig (Eds.), *Declining inequality in Latin America: A decade of progress* (pp. 25–38). Brookings Institution Press.

Katz, L. F., & Autor, D. H. (1999). Changes in the wage structure and earnings inequality. In O. Ashenfelter & D. Card (Eds.), *Handbook of labor economics* (Vol. 3, pp. 1463–1555). Elsevier.

Katz, L. F., & Murphy, K. M. (1992). Changes in relative wages, 1963–1987: Supply and demand factors. *The Quarterly Journal of Economics*, *107*(1), 35–78. http://dx.doi.org/10.2307/2118323

Keifman, S. N., & Maurizio, R. (2014). Changes in labour market conditions and policies, and their impact on wage inequality during the last decade. In G. A. Cornia (Ed.), *Falling inequality in Latin America* (pp. 251–273). Oxford, Oxford University Press.

Krusell, P., Ohanian, L. E., Ríos-Rull, J. V., & Violante, G. L. (2000). Capital-skill complementarity and inequality: A macroeconomic analysis. *Econometrica*, *68*(5), 1029–1053. http://dx.doi.org/10.1111/1468-0262.00150

Lee, D. S. (1999). Wage inequality in the United States during the 1980s: Rising dispersion or falling minimum wage? *The Quarterly Journal of Economics*, *114*(3), 977–1023. http://dx.doi.org/10.1162/003355399556197

Levy, F., & Murnane, R. J. (2005). *The new division of labor: How computers are creating the next job market*. Princeton University Press.

López-Calva, L. F., & Lustig, N. C. (2010). *Declining inequality in Latin America: A decade of progress?* Brookings Institution Press.

Manacorda, M., Sánchez-Páramo, C., & Schady, N. (2010). Changes in returns to education in Latin America: The role of demand and supply of skills. *ILR Review*, *63*(2), 307–326. http://dx.doi.org/10.1177/001979391006300207

Parro, F. (2013). Capital-skill complementarity and the skill premium in a quantitative model of trade. *American Economic Journal: Macroeconomics*, *5*(2), 72–117. http://dx.doi.org/10.1257/mac.5.2.72

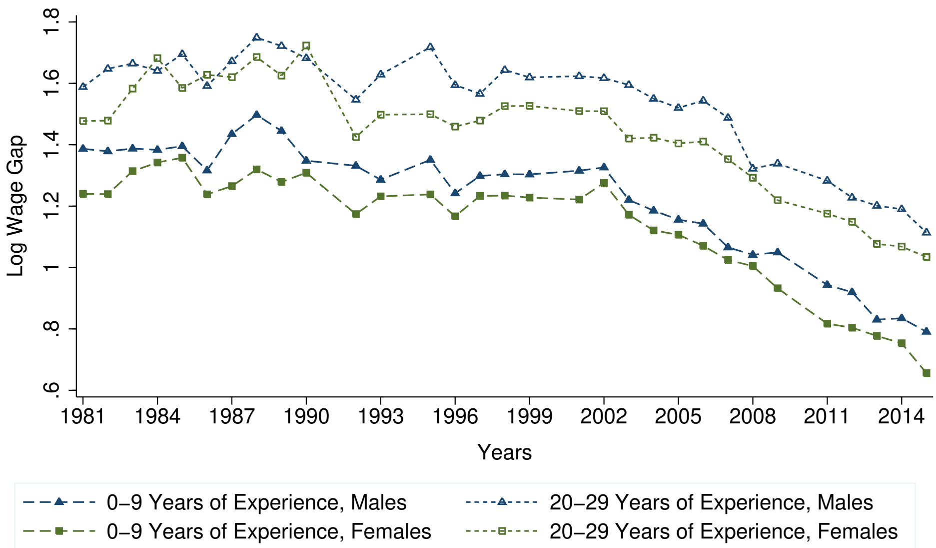
Robertson, R. (2004). Relative prices and wage inequality: Evidence from Mexico. *Journal of International Economics*, *64*(2), 387–409. http://dx.doi.org/10.1016/j.jinteco.2003.06.003

Sánchez-Páramo, C., & Schady, N. (2003). *Off and running? Technology, trade, and the rising demand for skilled workers in Latin America*. Washington, DC: The World Bank. https://openknowledge.worldbank.org/handle/10986/18256

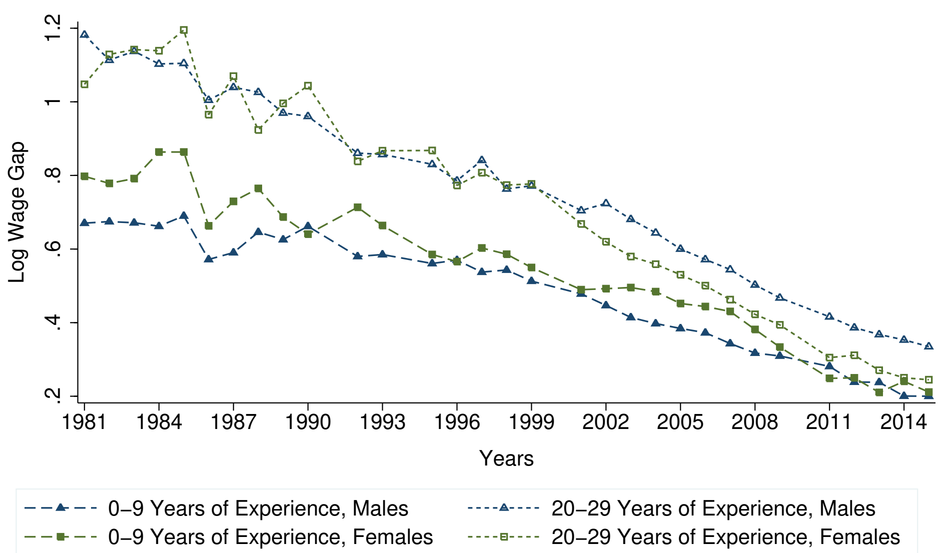
Teulings, C. N. (2003). The contribution of minimum wages to increasing wage inequality. *The Economic Journal*, *113*(490), 801–833. http://dx.doi.org/10.1111/1468-0297.t01-1-00163

Tinbergen, J. (1974). Substitution of graduate by other labour. *International Review for Social Sciences*, *27*(2), 217–226. http://dx.doi.org/10.1111/j.1467-6435.1974.tb01903.x

Appendix.



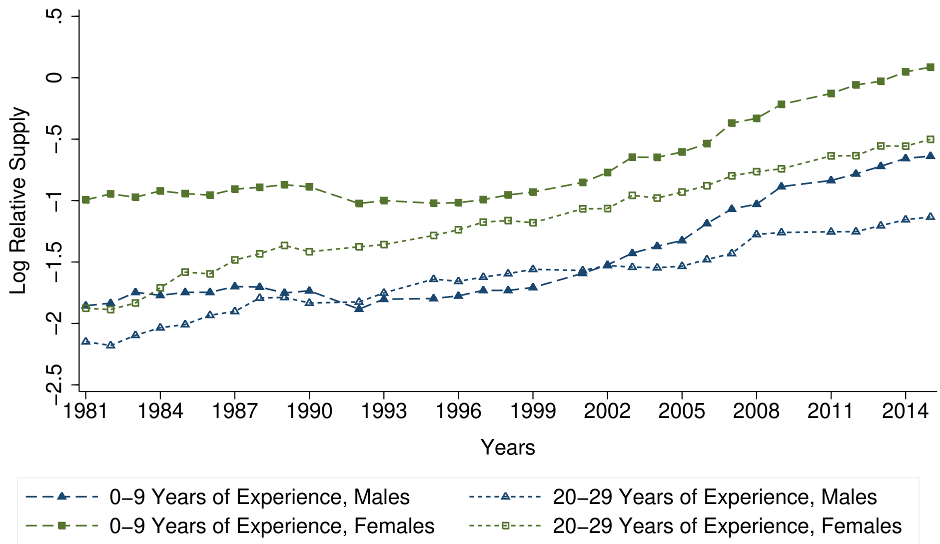
(a) Tertiary/Non-Tertiary



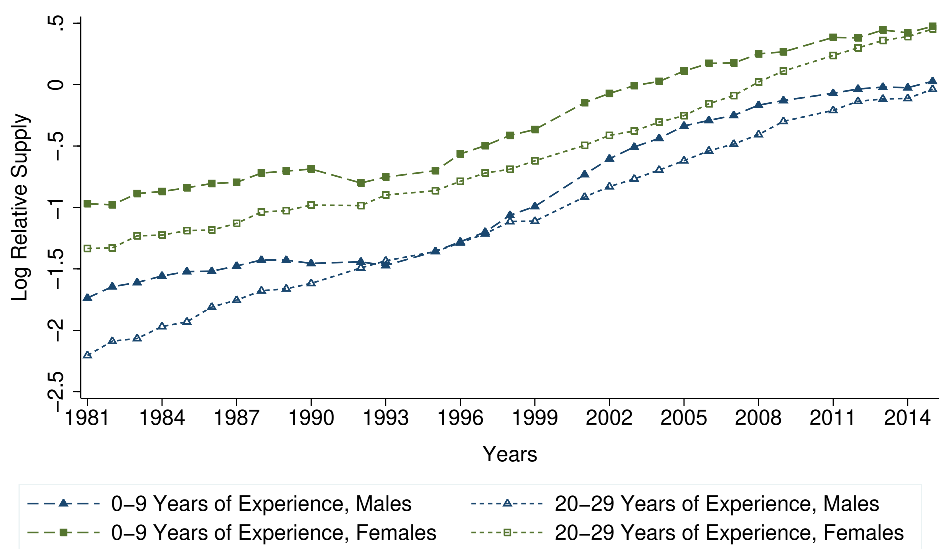
(b) Secondary/Primary

Source: PNAD data from 1981 to 2015. Tertiary/non-tertiary and secondary/primary wage gaps are given by the ratio between the weighted average of the composition-adjusted log wages of the corresponding education and experience categories. See Figure 4 notes for more details.

Figure A-1. Skill Premium by Gender and Years of Potential Experience



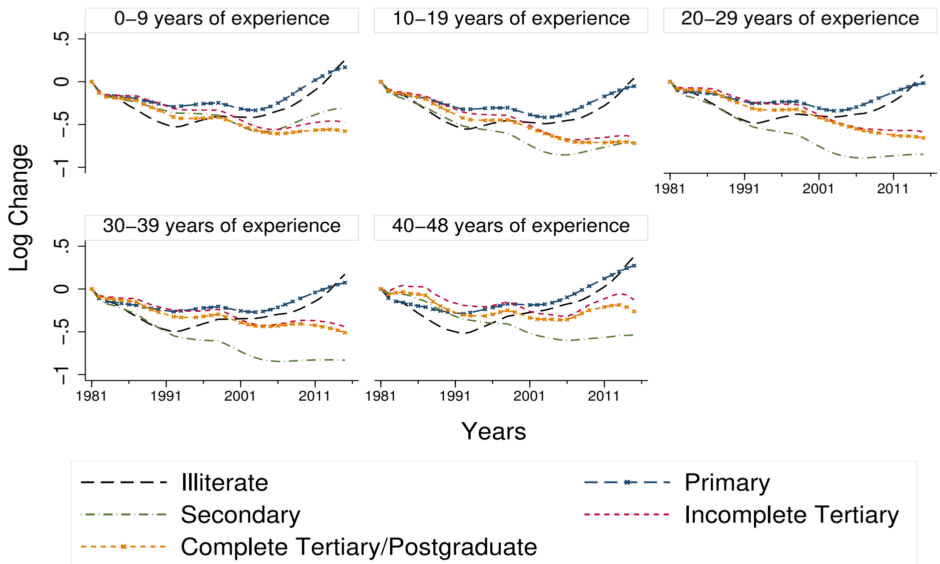
(a) Tertiary/Non-Tertiary



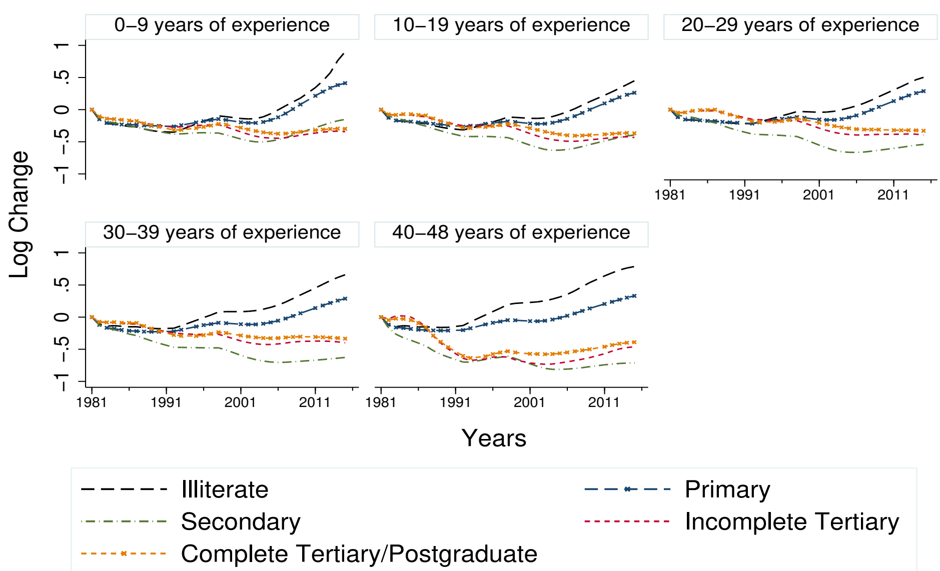
(b) Secondary/Primary

Source: PNAD data from 1981 to 2015. Log tertiary/non-tertiary and secondary/primary labour supplies are given by the ratio between the weighted average of efficiency units of labour supply of the corresponding education and experience categories. See Figure 5 notes for more details.

Figure A-2. Relative Labour Supply by Gender and Years of Potential Experience



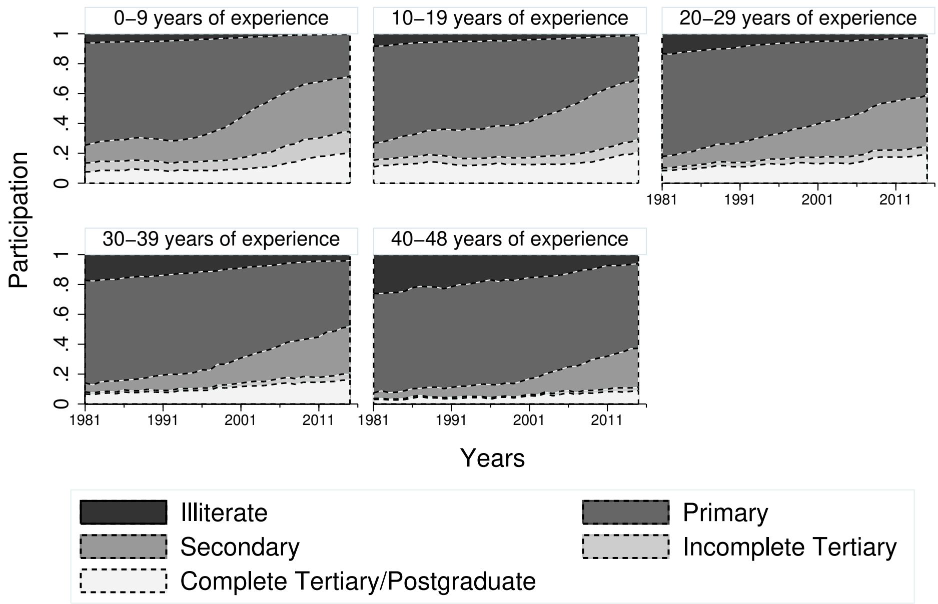
(a) Males



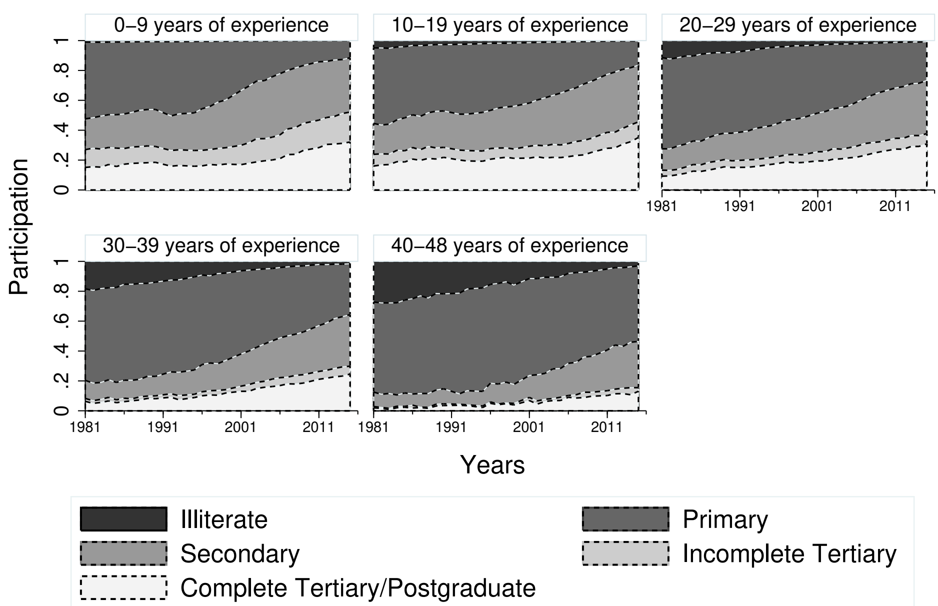
(b) Females

Source: PNAD data from 1981 to 2015. Composition-adjusted log hourly wages for full-time workers are the weighted average of the predicted log wages in each one of the 490 gender-education-experience groups. Each series is normalized at zero in 1981. Figure A-3 plots changes in composition-adjusted log hourly wages using a weighted smoothing regression with a bandwidth of 0.4. See Figure 4 notes for more details.

Figure A-3. Composition-Adjusted Log Hourly Wages by Educational and Experience Groups



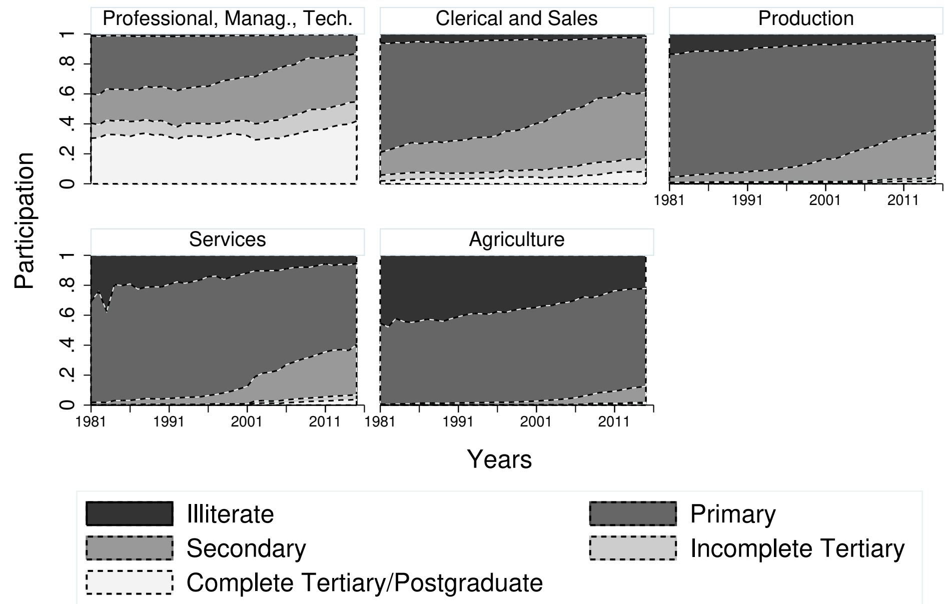
(a) Males



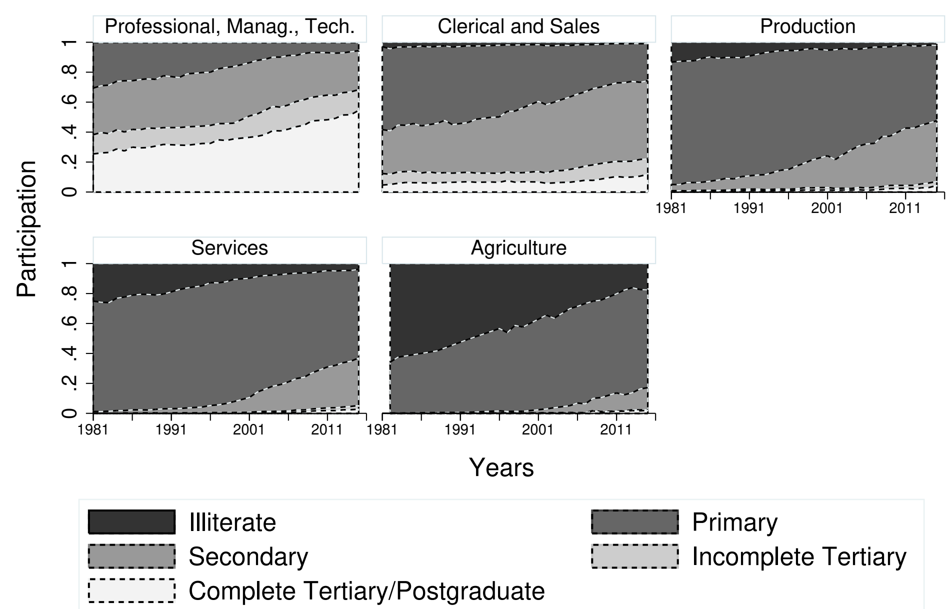
(b) Females

Source: PNAD data from 1981 to 2015. Efficiency units of labour supply are given by the weighted average of the employment participation of 490 gender-education-experience groups. See Figure 5 notes for more details.

Figure A-4. Efficiency Units of Labour Supply by Educational and Experience Groups



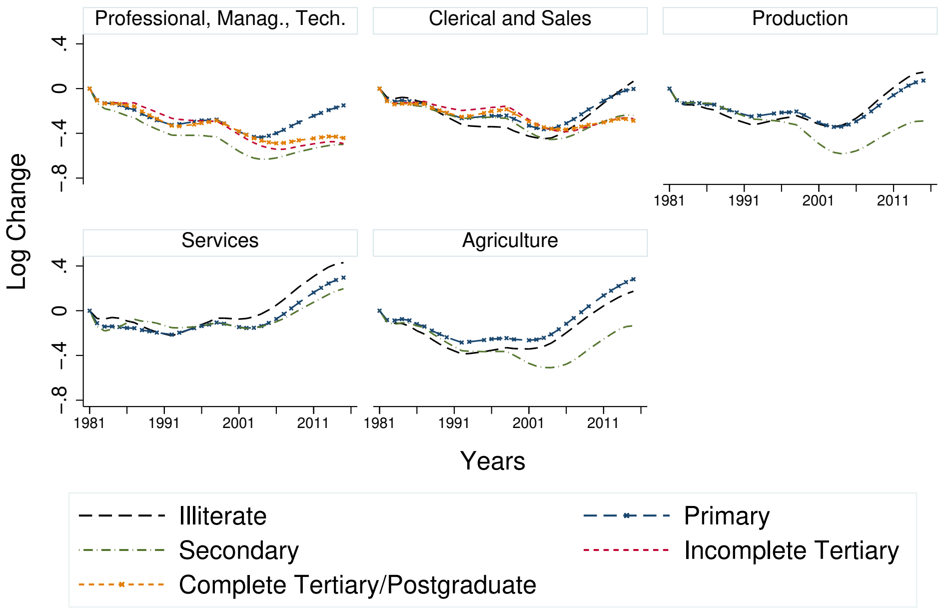
(a) Males



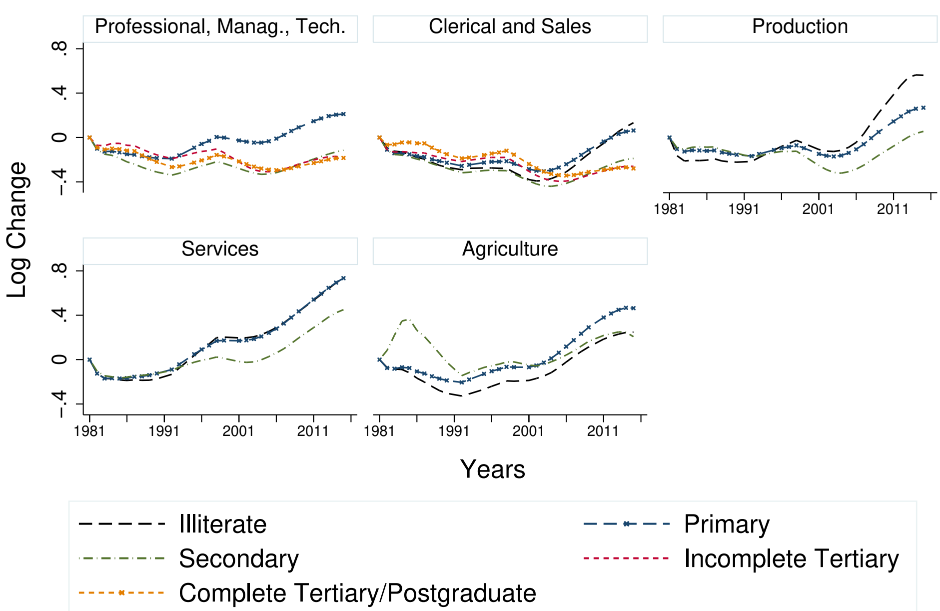
(b) Females

Source: PNAD data from 1981 to 2015. Sample comprises salary/wage workers and self-employed, aged 18–65 years old. Workers employed in the military are excluded from the sample. See Figure 8 notes for more details on occupational categories.

Figure A-5. Employment Shares in Occupational Categories by Educational Groups



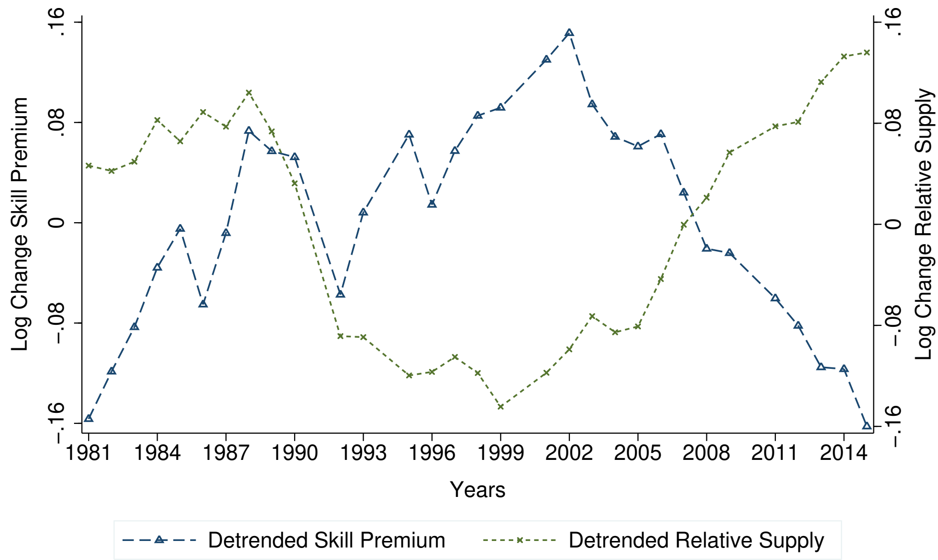
(a) Males



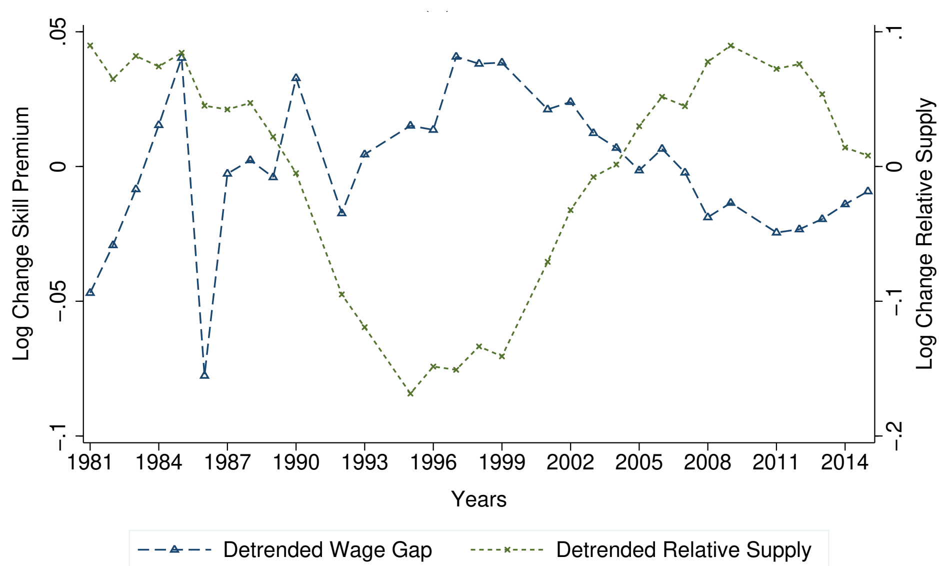
(b) Females

Source: PNAD data from 1981 to 2015. Log hourly wages of salary/wage workers and self-employed excluding those in the military, aged 18–65 years old. Each series is normalized at zero in 1981. Figure A-6 plots changes in log hourly wages using a weighted smoothing regression with a bandwidth of 0.4. Educational groups with less than 1 percent of employment participation within each occupational category are not plotted. See Figure 8 notes for more details on occupational categories.

Figure A-6. Log Hourly Wages in Occupational Categories by Educational Groups



(a) Males



(b) Females

Source: PNAD data from 1981 to 2015. Detrended skill premiums and relative labour supplies are the residuals obtained from separate regressions of the composition-adjusted wage gap and the relative labour supply in efficiency units on a constant and a time trend term. See the notes of figures 4 and 5 on how to obtain the composition-adjusted wages and efficiency units of labour supplies, respectively.

Figure A-7. Detrended Changes in Skill Premium and Relative Labour Supply