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The gender gap in intergenerational mobility: Evidence of educational persistence in Brazil

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The gender gap in intergenerational mobility: Evidence of educational persistence in Brazil*

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Abstract

This paper employs mobility matrices, univariate regressions and multivariate econometric techniques based on the recently published nationally representative household survey (PNAD-2014) from Brazil to investigate the relevance of the gendered patterns in the intergenerational transmission of educational attainment between parents and their descendants. The empirical evidence from these three different approaches is absolutely unanimous: In Brazil there is a significant variation in degree of mobility across genders, with a higher mobility level for daughters than for sons. The reason for this gender gap in mobility lies in the chances of attaining the educational levels: regardless of the educational background of the parents, females have a lower chance of remaining without school certificate and a greater probability to achieve a tertiary education. The results of this paper point out also that the educational attainment of children is strongly associated with the education of their most educated parent, regardless of their gender and this correlation is higher for female than for male. Concerning the evolution of the persistence in education over time, the findings indicate for both sexes a significant increase in intergeneration mobility over the last decades. However this positive evolution is much more modest when the relative deviation in education across generations is excluded from the investigation. Finally, this study has demonstrated that parental occupation levels and individual characteristics (race, locality of residence and year of birth) also have a statistically significant effect on the prospects for mobility.

Keywords: Intergenerational Mobility, Educational Persistence, Gender gap, Brazil
JEL Codes: J62, I21, J16

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1 Introduction

Intergenerational persistence in economic outcome contributes to the perpetuation and aggravation of the resource gap between rich and poor. For this reason, the political and scientific interest in intergenerational mobility has increased sharply during the last years (Blanden and Macmillan, 2014; Corak et al., 2014; Corak, 2013; Aaronson and Mazumder, 2008). Increasing access to data about the economic status of children and their parents, together with the development of new methodological tools for estimating mobility, has provided society with worrying empirical evidence: a person's chances of economic success are highly dependent on their family background (Chetty et al., 2014; Corak, 2006; Black and Devereux, 2010) and this dependence has grown in recent decades in some countries (Corak et al., 2014; Mazumder, 2015; Hertz, 2007; Lee and Solon, 2009).

However, the growing research into this topic has not led to an equal distribution of empirical evidence on intergenerational mobility around the globe. While a significant number of studies with a focus on mobility in United States and Europe have been published in international journals, empirical investigations about the intergenerational correlation of economic outcomes in developing countries are still heavily underrepresented in the literature, thus making it more difficult to track international differences and trends with this social indicator(Hertz et al., 2007; Ferreira and Veloso, 2006).[1]

The gender-specific aspect of the intergenerational mobility is another topic that has not yet been widely discussed in the economic literature (Fessler and Schneebaum, 2012; Spielauer, 2004). While early empirical works were focused on the intergenerational transmission of economic outcome between fathers and sons (Taubman, 1985; Solon, 1992; Dunn, 2007; Björklund and Jäntti, 2009; Corak et al., 2014; Black and Devereux, 2010; Björklund and Roemer, 2011), a more recent wave of studies have presented evidence of mobility among daughters (Azam, 2016; Minello and Blossfeld, 2014; Chadwick and Solon, 2002). However the investigation of the mobility gap between both genders still remains a promising field of study.

This work has integrated these two research gaps and contributes to the literature in two main ways. First, I present empirical evidence of intergenerational educational mobility in an important developing country based on the most current data about mobility available for Brazil (PNAD-2014). In addition, this paper produces an innovative investigation of this mobility, focussing on the relevance of the gendered patterns in the intergenerational transmission of education. The main aim of this study is to identify a possible mobility gap between sons and daughters in Brazil and investigate the role of the parent's gender in determining the differences in the intergeneration persistence in education.

In order to generate robust estimates of educational mobility across generations, this paper applies three different empirical approaches for the measures: mobility matrices (Jäntti et al., 2006), univariate regressions (Hertz et al., 2007) and multivariate econometric techniques (Bauer and Riphahn, 2007). The reason for investigating intergenerational mobility on the basis of educational attainment lies in the strong association between education and earnings, with the former playing a vital role in the persistence of inequalities between generations.(Solon, 2004; Gregg et al., 2007; D'Addio, 2007; Haveman and Wolfe, 1995). Hence the research into the development of education dispersion is of fundamental importance to understanding the current trends in income mobility (Blanden and Macmillan, 2014; Hoffmann and de Oliveira, 2014; Macmillan and Gregg, 2010).

[1] Some notable, relatively recent exceptions for the research of intergenerational mobility in developing countries are the works of Azam and Bhatt (2015) for India, Gong et al. (2012) for China, Piraino (2015) for South Africa and Neidhöfer et al. (2017) for a set of 18 countries in Latin America.

In this context, the recent developments in Brazil's educational system provide the basis for an extremely promising area of research: A nationwide reform of the educational system in 1971 extended compulsory schooling from four to eight years. However, this new legislation did not produce a universalization of primary education in the short term. The figure 1 plots the continuing educational expansion in Brazil and the gender gap in education between male and female.

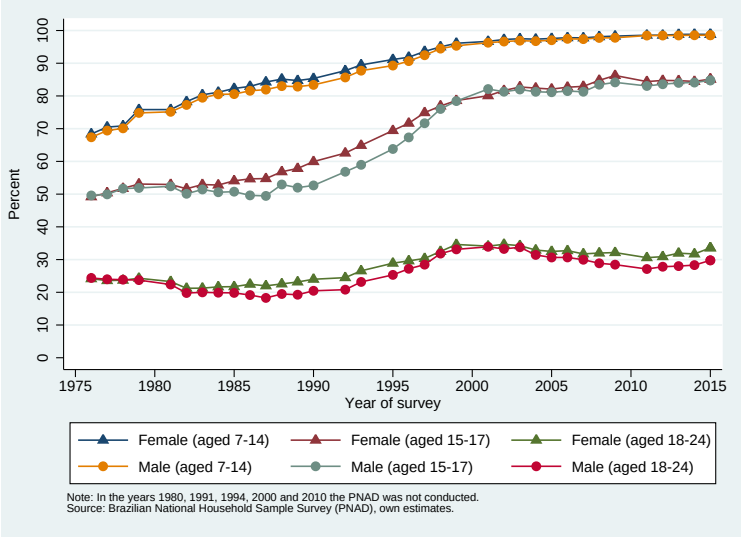


Figure 1: Net enrolment rate, by level of education and gender

In the mid-seventies, the share of children age 7-14 enrolled in school remained close to 70% and it increased constantly in the following years, achieving however a level above 95% only in 1999. During this period the enrolment in secondary education has also increased significantly. In this way, it is expected that a significant quantity of parents have attended different levels of compulsory education as their children, thereby creating an interesting precedent for the reseach of intergenerational mobility.

The remainder of this paper is organized into six parts: I begin with some background information concerning intergenerational education mobility and its related literature. Section 3 provides a description of the Brazilian National Household Survey (PNAD-2014) used for the estimates and the following section points out the most relevant descriptive statistics for this study. Section 5 deals with the empirical estimations of intergenerational mobility, first by calculating the transition matrices and its subsequent mobility indexes. This is followed by the estimation of the regression and correlation coefficients based on univariate regressions. Finally, in the section 5.3, this work applies marginal effects from a Probit Model to investigate the influence of control variables on the prospects for mobility. Section 6 ends with some concluding remarks.

2 Background information and literature overview

Intergenerational mobility can be depicted as the social class movement from one generation to the next within the same family. In this case the focus of the research is on the persistence between parents' and children's outcomes (Corak, 2013; Black and Devereux, 2010; Fields and Ok, 1999).

The model of Solon (2004) – which is based on the theoretical approach of Becker and Tomes (1979, 1986) – provides the theoretical foundation in the economic literature to understand the possible causes of the variations in intergenerational mobility across

families. In this model, education has a positive effect on earnings and family is viewed as an intergenerational decision-maker. The first generation (parents) must divide their lifetime earnings between own consumption and investment in the human capital of their children (second generation). In the future the children will then use this human capital to generate earnings for the family. So the parents tend to maximize a utility function in which the two goods are present parental consumption and spending on children's education (also called expected future children's income). Solon (2004) showed that under these conditions, higher-income parents (1) have a higher capacity to invest in the human capital of their children, and (2) they have also a higher incentive for this investment if the earnings return on human capital investment increases over time.[2]

The Solon model underlines the effects of labor market inequality in the intergenerational transmission of economic outcome. Besides the labor market, Corak (2013) highlights the importance of two further institutions which can affect the mobility chances: the family and the state. According to Solon (2004) the different incentives for investing in the education of children across families are not restricted only to financial resources, but also include "non-economic factors". These include components as personality traits, values and attitudes which are genetic or transmitted to the children in the family environment. These components are determined by the reputation and connections of families and can also strongly affect the children's educational development (Gregg et al., 2007; Heckman et al., 2006; Becker and Tomes, 1979; Bowles et al., 2001).

In addition, the state has an important role to play in defining the degree of mobility in a country. Through "progressive" public intervention in the educational system the state can reduce the dependence of financial resources on human capital investment, providing an enabling environment for a more meritocratic society in which mobility will be more associated with ability and efforts than family background (Blanden and Macmillan, 2014; Corak, 2013; Fessler and Schneebaum, 2012; D'Addio, 2007).

In Brazil, the federal constitution states that education is a fundamental right of the citizen and a duty of the state, therefore all levels of education are available for free at public institutions. In addition, private institutions are allowed at all educational levels and offer the same curriculum as normal state schools, based on the National Education Guidelines and Framework Law from 1996.[3]

Seeking to improve the level of education in the country, the Brazilian government changed the legislation on compulsory education in the early 1970s, increasing the obligatory minimum educational term from 4 to 8 years. With this reform the educational system in Brazil shifted on from a 4+4+3+4 to a 8+3+4 structure (i.e., eight years of primary education, three years of secondary education, and in general four years for a bachelor's degree).[4] After finishing their undergraduate courses students can pursue postgraduate courses, with programs offering a master's degree or specialization courses (MBAs) in two years and doctorate in four years. Additionally, completing vocational and technical courses of one or two years' duration is possible after the compulsory education.[5]

The growing empirical interest in the investigation of intergenerational mobility in recent years has made cross-country comparison possible. In the light of the cross-country studies carried out, a clear trend can be observed: Latin American countries generally present the lowest mobility between generations, while Scandinavian countries tend to be

[2]For a more detailed presentation of the mathematical approach see Solon (2014).

[3]Data from the National Household Sample Survey (PNAD 2014) show that in Brazil the percentage of students enrolled in private institutions reached 14% in primary, 13% in secondary and 75% in tertiary education.

[4]In 2010 a new political reform (constitutional amendment N° 59) was adopted and set a deadline of 31 December 2015 for the increase of compulsory education to 9 years, creating a 9+3+4 structure.

[5]For a more detailed description of the education system in Brazil see Table 6 in the Annex.

found on the other end of the scale with a high level of mobility (see Jäntti et al., 2006; Chevalier et al., 2003; Corak et al., 2014; Hertz et al., 2007; Ichino et al., 2011).

The issue of intergenerational mobility has already been the object of empirical studies in Brazil (see Bourguignon and Ferreira, 2007; Dunn, 2007; Ferreira and Veloso, 2006; Pastore and Silva, 2000). The vast majority of these works made use of the Brazilian National Household Survey (PNAD) from the year 1996 for the estimation of intergenerational mobility and have reached similar conclusions. In Brazil there is a strong intergenerational persistence of inequality, or in other words: the descendant's economic outcome correlates strongly with the outcome of their parents. Not by coincidence, Brazil occupies the lowest positions in the international rankings of intergenerational mobility.[6]

To the best of my knowledge and information, the studies on intergenerational mobility in Brazil are primarily focused on the correlation between fathers and sons, replicating in this sense the bias found in the international literature.[7] This literature bias could be explained by the low labor participation of married women. Because in many countries a significant quantity of women leaved the labor market after marriage, their earnings will not correspond their actual economic status, which may result in sample selection bias (Chadwick and Solon, 2002). However, the increase in the women's labor force participation in the past decades has led to an recent increase in the investigation of social mobility for females (Minello and Blossfeld, 2014). For many countries it is already possible to find empirical evidence of mobility for daughters (see Azam, 2016; Chadwick and Solon, 2002; Olivetti and Paserman, 2015; Daouli et al., 2010; Minello and Blossfeld, 2014)

Notwithstanding this recent trend, only a very limited number of papers have investigated the gender gap in intergenerational mobility (see Schneebaum et al., 2016; Fessler and Schneebaum, 2012; Dardanoni et al., 2008; Dearden et al., 1997). These studies have estimated intergenerational mobility based on parents' and children's educational attainment to counterbalance the problem of statistical bias by the estimation of the lifetime income for women. Compared to earnings, the assessment of mobility based on educational status tends to be less exposed to life-cycle biases, because (1) the educational phase ends not later than mid-twenties and (2) unemployment or (temporary) variations of income will not result in distortions of the estimations (Black and Devereux, 2010).

Fessler and Schneebaum (2012) conducted a detailed and unique study on the gendered patterns in the intergenerational education mobility in Austria. With the use of the Household Survey on Housing Wealth (HSHW) from the year 2008, a cross-sectional survey conducted by the Austrian Central Bank, they concluded that the educational attaining of children is more affected by the schooling of fathers. Subsequently the authors found evidence that the intergenerational education correlation between same-sex pairs (fathers/sons and mothers/daughters) is stronger than between cross-gender pairs.

Dardanoni et al. (2008) used data from the National Child Development Survey (NCDS), a longitudinal data source containing all the people born in the United Kingdom between the 3rd to the 9th of March 1958, to investigate the effects of parents' schooling on the educational attainment of their children. They analyzed subsamples of sons and daughters separately and came to the conclusion that only the father's education has a statistically significant effect, and only on the education of their sons. The authors highlighted however in the conclusion the age of the interviewees, indicating that the results

[6] Across the 42 individual countries reported by Hertz et al. (2007), Brazil had the fifth largest educational persistence between parents and children. Based on a recent set of harmonized household survey data for 18 Latin American countries, Neidhöfer et al. (2017) found out however that the degree of intergenerational mobility in Brazil lies above the average level for this group.

[7] Black and Devereux (2010) and Blanden (2013) present an extensive and valuable summary of the literature on intergenerational mobility in different countries.

reflect patriarchal and outdated gender roles in the society of the nineteen-seventies.

3 Data

The analysis of intergenerational mobility in this work is supported by the supplement about social mobility from the Brazilian National Household Sample Survey (PNAD) developed in 2014. In principle, this supplement could cover 50 percent of all households selected by PNAD-2014 and it was conducted with only one person over 16 years of age per household. Given survey sampling, I will apply a calibration adjustments of the sample weights in order to ensure fit econometric models. Based on the weights presented as a additional variable in the data, each observation for the mobility supplement will be weighted by the inverse of its probability of being sampled. (IBGE, 2016; Press et al., 2007)

The survey contains no information on the earnings of parents, but incorporates questions on the educational level and professional occupation of the interviewees and both of their parents.[8] In this study we are working with two dependent variables for the descendants, namely years of schooling and level of education (no school certificate, primary, secondary and tertiary education).

It is important to mention that the PNAD-2014 does not provide the number of years of schooling for the parents, but only the education classified by levels. For the purposes of using international comparable measures I had to convert the educational level of fathers and mothers into years of education. Secondly, due to the reforms in the education system in Brazil in recent decades, it is necessary to standardize the levels of education across both generations. For purposes of simplification, this work will assume primary education as the compulsory school attendance for all children at the time of the respective schooling.[9]

The explanatory variables used in this paper refer to parental educational level, individual characteristics of the descendants and occupational categories of the parents. For the latter variable, the 400 different professional occupations from the PNAD-2014 were classified into 6 categories (low inferior, low superior, medium inferior, medium, medium superior and high) based on the Brazilian Classification of Occupations and the theoretical approach proposed by Ferreira and Veloso (2006).[10]

The PNAD's sample for mobility consisted of $31,208$ women and $26,688$ men in the age range between 16 and 118 years. Because c. 60 percent of young individuals (between 16 and 24 years old) were still attending school, training or university in 2014, we established a minimum age of 25 years for the measure of mobility. In addition, persons aged over 75 years were also excluded from the analysis due to the positive relationship between education and life expectancy.[11] Among the remaining sample involving $46,051$ interviewees, 4.47% were also students. Because this work is interested in the final education level, we will input information about the still unconcluded schooling, assuming

[8] These variables relate the levels of parental education and occupation when the interviewee was 15 years old.

[9] For a more detailed description of the codification of years of schooling and standardization of the educational levels see Tables 6 and 7 in the Annex.

[10] Table 8 in the Annex presents for each category the main professional occupations and their respective average work income and years of schooling. The overall picture which emerges from the table is a positive association between schooling and occupation ranking (Spearman's rho achieves 0.5715 at the 0.01 level of significance). However, from the data goes that 29% of the descendants employed in the highest occupational level have no college degree, suggesting that for the empirical model the occupational level can capture cognitive skills necessary for the mobility prospects which are not necessary transmitted exclusively through formal education, as already mentioned by Ferreira and Veloso (2006).

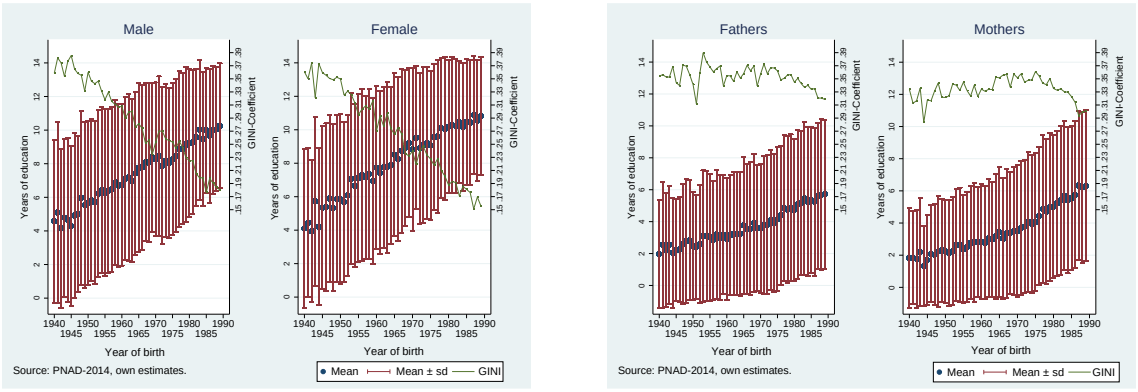
[11] According to IBGE, the life expectancy in Brazil came to 75.2 years in 2014.

that these students will finish their current education level.[12]

4 Descriptive Statistics

In the further course of this paper we focus the investigation on the population aged between 25 and 74 years old at 31 December 2014. As the survey was conducted in 2014, the data contain information about individuals who were born between 1940 and 1989.

Figure 2 plots the evolution of average educational attainment, the standard deviation and the inequality in education and highlights the constant and significant increase over time in the average years of schooling in Brazil.



(a) Descendants (b) Parents

Figure 2: Development of education

While descendants born in 1940 have on average four years of education, the average education for the individuals born in year 1985 is around 10 years. Furthermore, we can observe in figure 2a that in general women are more educated than men in Brazil.[13] Another relevant finding is that the dispersion and the inequality in education have visibly been reduced over time.[14]

Figure 2b shows that the same trend cannot be observed for the parents of descendants; for them the value of average education ± standard deviation has become greater and the Gini coefficient has remained virtually unchanged.[15] In addition, the figure above shows that (both) parents also experienced a steady expansion of educational attainment, but this expansion was stronger for mothers. As a consequence, in the parents' generation the fathers were more educated than mothers up to descendants born in 1972, the year in this trend was reversed.

The existing literature about the gender gap in intergenerational mobility is focused on a purely gendered distribution between fathers and mothers and its effect on the educational attainment of children (Dardanoni et al., 2008; Dearden et al., 1997; Fessler and Schneebaum, 2012). In this work I expand this analysis including a new category for a better understanding of the pattern of mobility across generations, the level of education of the most educated parent. This approach will be useful in the further course of this

[12] Table 5 in the Annex presents the descriptive statistics from the mobility supplement of PNAD-2014.

[13] Note that only in years 1940, 1941, 1942, 1944, 1948 and 1951 do men have higher average education than women.

[14] The value of the standard deviation decreased from 5.012 for people with 74 years of age to 3.355 for 25-year-old individuals. While the Gini coefficient declined from 0.359 to 0.156

[15] The standard deviation in years of education of the fathers of the 75-year-old interviewees was for example 3.713, while this value for the fathers of younger individuals (25 years old) increased to 4.487.

paper to investigate whether the educational level of children tends to converge more on the schooling of the most educated parent, regardless of their sex.

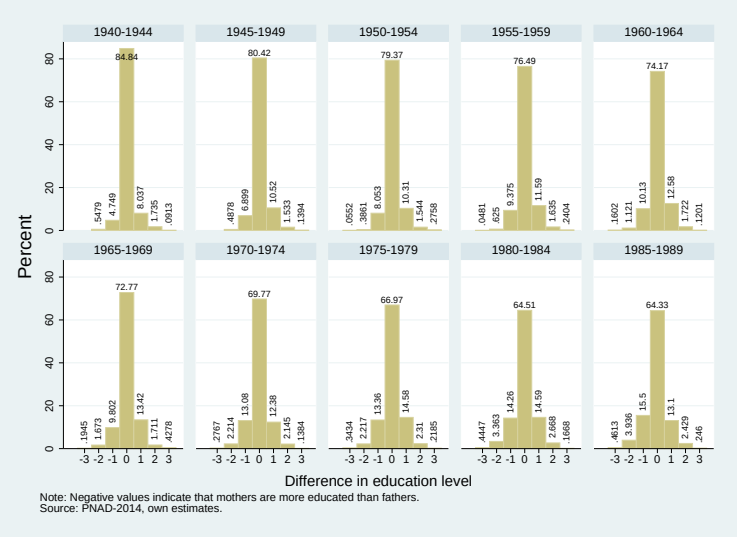


Figure 3: Assortative Mating on Education

The figure 3 presents the assortative mating on education[16]and indicates that the Brazilians are more likely to have children from partners with a similar education level, although this trend is declining over time. Note that the proportion of " Intra-educational parent sets" decreased from 84.84% in the birth cohort 1940-1944 to 64.33% in the 1985-1989.

5 Empirical results

The focus of this empirical investigation lies on the measurement of a particular form of immobility: the time dependence, which calculates the extent to which individual economic outcomes at present can be determined by the economic outcomes in the past. In this case, the measurements of mobility used in this section aim to estimate the extent to which the educational level of parents determinates the educational attainment of their descendants (Bazzi et al., 2017; Frühwirth-Schnatter, 2006; Fields, 2002).

5.1 Transition matrices

Transition matrices are in widespread use in applied econometric studies for the measurement of time dependence immobility in aggregated data (Bazzi et al., 2017; Fields, 2002). To apply this approach I first divide the educational level attainment of parents (generation t-1) and their descendants (generation t) into four different categories (states), namely: no school certificate, primary, secondary and tertiary education.

When the educational outcome of both generations are crossed, we create a 4×4 transition matrix (P) in which $i, j \in [0, 4]$ and the value $\rho_{i,j}$ represents the probability of the educational level moves from state i in the generation of the parents to state j in the

[16]The assortative mating on education was calculated by subtracting the education level of the respective fathers and mothers using an ordered educational attainment ranging between 0 (no school certificate) and 3 (completed tertiary education).

younger generation (Daouli et al., 2010; Fields, 2002).

$$\mathrm{P} = \begin{bmatrix} \rho_{11} & \cdots & \rho_{1j} \\ \vdots & \ddots & \vdots \\ \rho_{i1} & \cdots & \rho_{ij} \end{bmatrix} \tag{1}$$

Given that $0 \leq \rho_{i,j} \leq 1$, then we have $\sum_{j=1}^{r} \rho_{i,j} = \sum_{j=1}^{r} \mathrm{P}(\mathrm{X}_{m+1} = K|\mathrm{X}_m = 1) = 1$ indicating that the sum of any row from the matrix (P) achieves a value of one (Bazzi et al., 2017; Frühwirth-Schnatter, 2006; Fields, 2002). To illustrate this method, Table 1 presents the transitional matrixes using the pooled sample aged between 25 and 74 years divided by gender.

Table 1: Intergenerational transition matrices

Parent	**Descendants (Male)**				**Parent**	**Descendants (Female)**			
	No school	Primary	Secondary	Tertiary		No school	Primary	Secondary	Tertiary
No school	0.5303	0.2243	0.1945	0.0509	No school	0.4588	0.2326	0.2270	0.0816
Primary	0.2079	0.2366	0.3915	0.1640	Primary	0.1527	0.2091	0.4093	0.2288
Secondary	0.0640	0.1042	0.4575	0.3743	Secondary	0.0507	0.0747	0.3752	0.4994
Tertiary	0.0205	0.0345	0.2516	0.6935	Tertiary	0.0258	0.0375	0.1777	0.7591

Note: Estimation based on educational attainment of decendants and their most educated parent.
Source: PNAD-2014, own estimates.

The transition matrices shown in table 1 highlight the strong intergenerational persistence of education in Brazil. Children from parents with a tertiary education have around 70% of chance to attain a university degree. The same chance for descendants from parents with only a primary education falls to less than 25%. These prospects are even worse for children from parents with no school certificate. Only 5% of the sons and 8% of the daughters rose from the bottom to the top quintile of the family educational levels. Offspring of parents with a tertiary diploma have more than a 93% of chance of holding at least a second level degree, while around the half of children from parents with no school certificate remain without education, with this persistence being stronger for sons than for daughters.

In order to summarize the degree of mobility implicit in a transition matrix and, as a consequence, make possible a cross-gender comparison, I will follow Daouli et al. (2010) and estimate the transition matrixes for different birth cohorts and gender pairs. After that, I will calculate three types of mobility indicators (conventional mobility indices, indicators of relative opportunities and immobility and upward–downward mobility indicators) to compare the mobility levels across the education matrixes.

5.1.1 Conventional mobility indices

In order to address questions concerning the ranking of mobility across different groups in the society, such as for example whether females are more or less mobile than males, it is necessary to use empirical uniform indicators, which map the matrix (P) into a scalar $M(\mathrm{P})$ and measure all the mobility behavior presented in a transition matrix (Geweke et al., 1986).

The estimated indexes of mobility $M(\mathrm{P})$ are continuous real scalar valued functions $M(\cdot)$ within the set of intergeneration transition matrices Φ (Altzinger and Schnetzer, 2010; Formby et al., 2004; Shorrocks, 1978), hence the range of mobility takes the form of:

$$0 \leq M(\mathrm{P}) \leq 1 \qquad \forall \qquad \mathrm{P} \in \Phi \tag{2}$$

where a value equal to one corresponds to full mobility in educational status between parents and children, while zero represents a situation of full education persistence in which all the entries outside the main diagonal of the transition matrix are zero. Based on the estimated $M(\mathrm{P})$, P^1 is more mobile than P^2 if $M(\mathrm{P}^1) > M(\mathrm{P}^2)$.[17]

We start with the investigation based on $M(\cdot)$ estimating the second eingenvalue index ($M1$) proposed by Sommers and Conlisk (1979), which is closely associated with the estimation of half-life presented by Shorrocks (1978) and can be expressed as:

$$M1(\mathrm{P}) = 1 - |\lambda_2| \tag{3}$$

The second largest eigenvalue (λ_2) can be calculated from the transition matrix (P) if there is a vector $X \in \mathbb{R}^n \neq 0$ such that for some scalar λ, with $\lambda_1 > \lambda_2 > ... > \lambda_n$. In this case λ represents the eigenvalues of P with corresponding eigenvector X. Let I be the identity matrix, then the eingenvalues can be estimated as:

$$(\mathrm{P} - \lambda I)X = 0 \tag{4}$$

And consequently, with the help of Cramer's rule the solution of the equation (3) is presented as:

$$det(\mathrm{P} - \lambda I) = 0 \tag{5}$$

This index illustrates how far removed the transition matrix is from a situation of perfect equality of opportunities (the ""invariant matrix"" as it is called). If the assumption of equality of opportunities holds true, λ_2 assumes a value of 0. In this case, the probability to achieve even one of the educational levels for the descendants is independent of the educational attainment of their parents (Chevalier et al., 2003).

The following $M(\mathrm{P})$ used in the analysis refers to the Prais-Shorrocks mobility index (M_{PS}) which can be calculated by the trace ($Tr(\mathrm{P})$) and the number of states (n) from the transition matrix and is defined as:

$$M_{PS}(\mathrm{P}) = \frac{n - Tr(\mathrm{P})}{n - 1} \tag{6}$$

The third indicator for mobility presented in this section refers to the determinant index (DET), calculated on the basis of the determinant from the 4×4 transition matrix.

$$DET(\mathrm{P}) = 1 - |det(\mathrm{P})|^{\frac{1}{n-1}} \tag{7}$$

In conclusion, this section will use the absolute average jump (AAJ) proposed by Altzinger and Schnetzer (2010) to measure the mean number of states moved inside the transition matrix, which its in mathematical notation is:

$$AAJ(\mathrm{P}) = \frac{\sum_{i=1}^{N} |rank_{i,t} - rank_{i,t-1}|}{N} \tag{8}$$

where the first term corresponds to the educational level of individuals i from generation t and the second one to the education level of their parents. Because we are working with an ordered educational attainment ranged ranging between 0 (no school certificate) and 3 (completed tertiary education), the closer the value of $AAJ(\mathrm{P})$ to three, the higher the mobility in the transition matrix, given that $AA(\mathrm{P}) \in [0, 3]$.

[17] Given that all the eingenvalues calculated from the respectively transition matrices are real non-negative values, the estimated $M(\mathrm{P})$ have satisfied the criteria of persistence, convergence and temporal aggregation proposed by Geweke et al. (1986); Shorrocks (1978).

The results from the four mobility indicators are summarized in table 2. Because the primary research interest lies in the gendered patterns in the intergenerational transmission of education, I calculated the transition matrixes for all individuals aged 25 to 74 years divided by gender pairs of parents and children, and then, to facilitate the visualization of the ranking, we sorted the table by the level of intergeneration persistence specified in brackets.

Table 2: Conventional mobility indices

Gender pairs	**Mobility measures**				
	Observations	$M1(P)$	M_{PS}(P)	$DET(P)$	$AAJ(P)$
Most educated and sons	16.567	0.3990 (1)	0.6940 (1)	0.7860 (2)	0.7702 (1)
Fathers and sons	12.834	0.4224 (2)	0.6978 (2)	0.7796 (1)	0.8264 (2)
Mothers and sons	15.072	0.4400 (3)	0.7314 (3)	0.8246 (5)	0.8419 (3)
Most educated and daughters	19.19	0.4747 (4)	0.7326 (4)	0.8069 (3)	0.9089 (4)
Mothers and daughters	17.879	0.5054 (5)	0.7615 (6)	0.8256 (6)	0.9909 (5)
Fathers and daughters	14.407	0.5236 (6)	0.7543 (5)	0.8173 (4)	1.0034 (6)

Note: Ranking in parentheses (1 = the highest level of intergenerational persistence in education)
Source: PNAD-2014, own estimates.

Three main findings can be read from table 2. First, the results are fairly unanimous in pointing to a higher mobility of daughters than sons. In addition, for all indicators the values for the pair fathers/sons are lower than for mothers/sons, illustrating in this form a higher intergenerational persistence in education for the (male) same-gender pair. This same-gender-specific aspect however cannot be confirmed for the case of daughters. Based on the eigenvalue index and the absolute average jump, the educational outcomes of daughters are more dependent on the education of their mothers, while the Prais/Shorrocks and determinant indicators indicate the opposite.

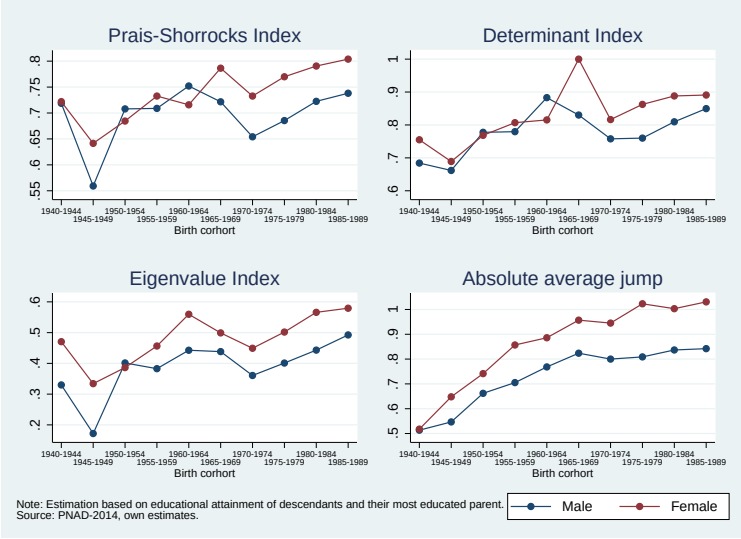


Figure 4: Conventional mobility indices

As described previously, this paper expands the existing empirical studies about the gender gap in intergenerational mobility to include a new variable for the investigation. The estimation of the mobility indicators based on the most educated parent provides supplemental information to the literature, showing that the educational outcomes of children tend to converge more on the education of their most educated parent, regardless of his/her gender. As can be seen in Table 2, the mobility level from the rows 1 and 4

is lower than the respective two subsequent rows, indicating a higher intergenerational persistence in education between the descendants and their most educated parent.

Figure 4 focus the investigation on the development over time of the gender gap in intergenerational education mobility and illustrates two main findings. First, as already mentioned before, daughters are more mobile than sons. Note that particularly after 1965 all the indicators point out to this fact. Second, the growth in the AAJ-Gap indicates that between females and males the distance of the movement inside the transition matrix is getting larger or, in other words, the difference in mobility across them is increasing over time.

5.1.2 Relative opportunities mobility

Relative opportunities mobility indicators were proposed by Bauer and Riphahn (2007) to show how equally distributed are the educational prospects across children from parents with different educational backgrounds. The closer the ratio is to one the lower is the dependence of the parent's education on the educational attainment of their descendants.

Figure 5 presents two indicators of relative opportunities: the ratios for tertiary (ROM_T) and secondary education (ROM_S) which are defined as:

$$ROM_T = \frac{\Pr(\frac{Children^T}{Parents^T})}{\Pr\ (\frac{Children^T}{Parents^N})} \qquad and \qquad ROM_S = \frac{\Pr(\frac{Children^S}{Parents^S})}{\Pr\ (\frac{Children^S}{Parents^N})} \tag{9}$$

where the value of the numerator refers to the probability of children from parents with tertiary (secondary) education achieving a graduate degree (secondary education), while that the denominator results from the likelihood of the descendants attaining the same tertiary (secondary) education, given that their parents have not completed the primary education.

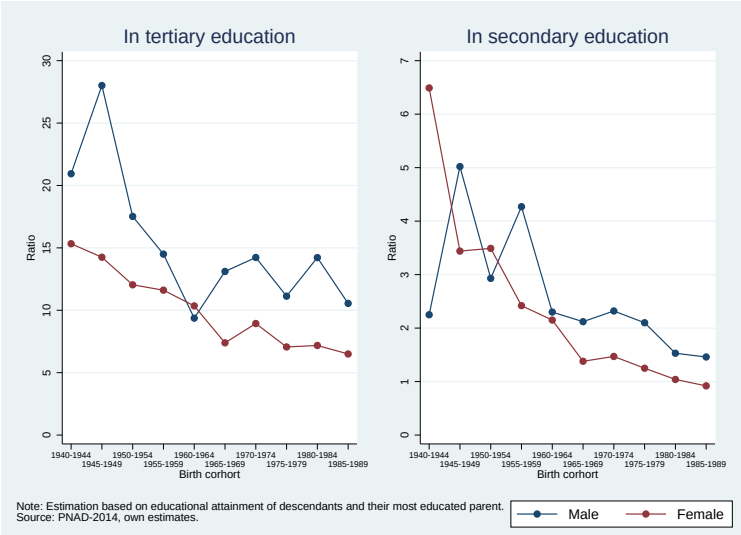


Figure 5: Relative opportunities mobility

Both illustrations from figure 5 clearly show lower probabilities values for daughters than for sons, indicating again that the educational mobility across generations tends to be higher for females compared to males. The chart on the left illustrates the inequalities in tertiary educational opportunities. Note that a son born in the period 1940–1944 from a parent with tertiary education have around a 21-times higher probability of attaining a college degree than a son from parents without a school certificate. For daughters this value achieves 15-times. Although this ratio went down over time for both genders, the

data indicate for the latest generation as well a considerable inequality of opportunities. Females born between 1985 and 1989 from parents with tertiary education are seven times more likely to achieve a university degree than daughters from parents without education. For sons this ratio increases to eleven. In contrast, the ratios for the secondary education has presented – since the birth cohort 1965-1969 for females and since 1980-1984 for males – values close to one, suggesting that Brazil has made substantial progress in equalizing the relative opportunities in secondary education.

5.1.3 Immobility ratio and upward–downward mobility

In order to display the direction of the intergenerational mobility within the transition matrices we estimate the indicators for immobility and upward–downward mobility proposed by Heineck and Riphahn (2007). The immobility ratio (ImR) presents the proportion of children who reached the same educational level as their parents and can be calculated based on the sum of all values from the trace of a 4×4 matrix, divided by the number of possible states in the matrix (n). While that the upward (downward) mobility refers to the sum of all elements above (below) the main diagonal of the square matrix divided by n.

$$ImR = \frac{Tr(\mathrm{P})}{n} = \frac{\sum_{i=1}^{n} \rho_{ij}}{n} = \frac{\rho_{11} + \rho_{22} + \rho_{33} + \rho_{44}}{n} \tag{10}$$

The chart 6 reports the results of this exercise. With the exception of two birth corhorts (1950-1954 and 1960-1964) all other cohorts present a greater immobility level for males than females, demonstrating once again that the educational level of daughters is less associated with the schooling of their parents as compared with sons. The upper and lower parts of the stacked bar chart indicate that daughters achieve at the same time a higher upward mobility and a lower downward mobility than sons.

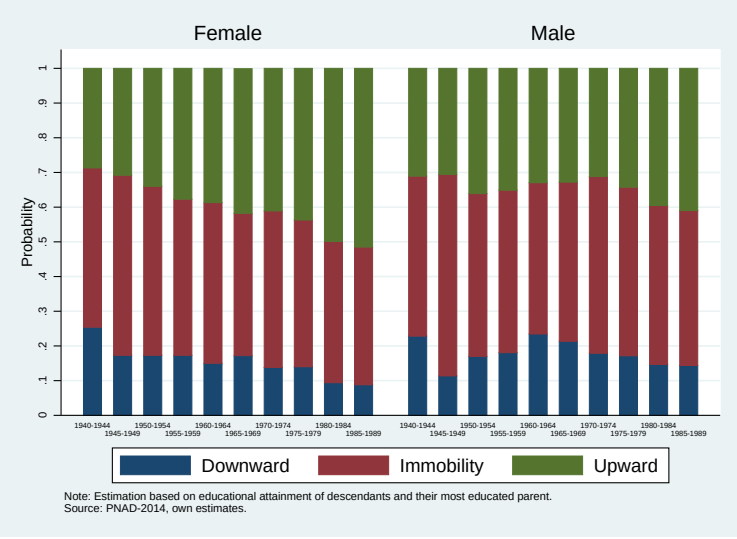


Figure 6: Immobility ratio and upward–downward mobility

5.2 Regression and Correlation Coefficients

The second approach used in this paper investigates the time dependence immobility based on univariate regressions, in which the number of years of schooling from offspring is taken as a dependent variable and the years of education of their parents as an independent

variable. Compared with the transition matrices this approach has the advantage that it takes into account the changes over time in the education inequality (Chetty et al., 2014; Torche, 2013; Hertz et al., 2007; Chevalier et al., 2003; Fields, 2002). The conceptual framework is given by:

$$Y_{i,t} = \alpha + \beta Y_{i,t-1} + \epsilon_i \qquad \forall \qquad i = 1, 2, ...N \tag{11}$$

Where t denotes the generation of children and $t-1$ the parents' generation. In this Model the educational attainment of the child from family i ($Y_{i,t}$) is expressed as the average educational attainment of all children from generation t (α) and two additional factors that determine the deviation from this average: a fraction of parental education ($\beta Y_{i,t-1}$) and all other determinants (ϵ_i) that are not correlated with the education of parents.

Given the sample selection bias by the mobility supplement from PNAD-2014 the error terms are not normally distributed and the merit function from (11) will not present maximum likelihood parameter estimations. For this reason, this paper takes the presence of heteroskedasticity into account and applies the method of weighted least squares (WLS) for the empirical estimations, assuming that the errors have the distribution $\epsilon_i \sim N(0, \sigma_i^2/\omega_i)$. In this case, we include in each term in the WLS the additional weight (ω_i), presented in the PNAD-2014, and estimate the parameter β that minimizes the weighted sum-of-squared residuals:

$$S(\beta) = \sum_{i=1}^{n} \omega_i (y_i - x_i' \beta)^2 \tag{12}$$

In equation (11) the value of beta (β) corresponds to the "regression coefficient" and summarizes the grade of persistence between parents' and children's educational attainment, whereby the higher the value of the β, the higher is the intergenerational persistence of education (or the lower is the mobility across generations).

The decrease over time in the regression coefficient can be interpreted a priori as an increase in equality of opportunity, i.e. the educational attainment of children becoming less associated with education of their parents. However, the regression coefficient captures not only the variation in the parents-children educational transmission, but also the relative deviation in education across generations caused by the average increase of schooling or changes in compulsory education (Checchi et al., 2013; Black and Devereux, 2010).

To take into account the differences in standard deviations of educational attainment over time, we will estimate an additional measure of persistence, namely the "correlation coefficient" (γ), which is also called in the literature "standardized persistence", and is defined by the following expression:

$$\gamma = \beta \frac{\sigma_{t-1}}{\sigma_t} \qquad with \qquad \sigma = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_1 - \mu)^2} \tag{13}$$

with β being the regression coefficient from equation (11) and σ_t and σ_{t-1} representing respectively the standard deviation of educational attainment in the generation of the descendants and the parents. The correlation coefficient takes values between 0 and 1, where zero denotes no intergenerational persistence (or full mobility) and one indicates the highest level of intergenerational persistence (Azam and Bhatt, 2015; Black and Devereux, 2010).

Table 3: Regression and correlation coefficients (aged 25-64 years old)

Indicator	Children/ Most educated	Sons/ Most educated	Daughters/ Most educated	Sons/ Fathers	Sons/ Mothers	Daughters/ Fathers	Daughters/ Mothers
Grade of persistence	**0.597*** **	**0.605*** **	**0.592*** **	**0.628*** **	**0.620*** **	**0.590*** **	**0.615*** **
Standard errors	-0.00512	-0.00725	-0.00721	-0.00869	-0.00811	-0.00863	-0.00799
Standard deviation (t)	4.817	4.786	4.832	4.786	4.786	4.832	4.832
Standard deviation (t-1)	4.448	4.490	4.409	4.294	4.257	4.244	4.145
Standardized persistence	**0.551**	**0.568**	**0.540**	**0.563**	**0.551**	**0.518**	**0.527**
R-squared	0.301	0.317	0.291	0.307	0.300	0.262	0.278
Observations	35,757	16,567	19,190	12,834	15,072	14,407	17,879

Note: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$
Source: PNAD-2014, own estimates

Table 3 reports the results of the grade of persistence (β) and standardized persistence (γ) for the whole sample, highlighting the gender gap in intergeneration mobility. The first important result is that the estimated intergenerational regression coefficient of educational attainment in Brazil for the year 2014 was 0.597. The second finding shows that the intergenerational persistence in education is higher for sons than for daughters, indicating that women are more mobile than men.

With respect to the gender role in the intergenerational transmission of education, the standardized persistence levels in Table 3 confirm also for Brazil the results of previous studies indicating a stronger intergenerational education correlation between same-sex pairs (fathers/sons and mothers/daughters) than between cross-gender pairs. However, the persistence in education across generations achieved its highest level when the gender division of parents is relativized by the inclusion of "the most educated parent", indicating that the educational attainment of children is more associated with the schooling of the most educated parent, independent of their gender. This tendency is less pronounced for male than for female, because the educational level of sons is more dependent on the schooling of their fathers.

Based on the regression and correlation coefficients, figure 7 allows us to investigate the evolution over time of the mobility in Brazil. Between 1940 and 1989 there was a steady and strong reduction in the degree of persistence, which suggests a constant increase in educational mobility across cohorts in Brazil. However, the development of standardized persistence over time has been much more modest.[18] The correlation coefficient decreased initially, reaching its lowest level in the generation born between 1965 and 1969 and it increased for the generations born after 1969.

In this context it is important to emphasize the difference between educational expansion and educational mobility: the first captures the generally positive development in average years of education in a society, while the second refers exclusively to the dependence of the educational attainment of children on their parent's education (Azam and Bhatt, 2015). Figure 7 suggests that the constant increase in the net enrolment rate has made a considerable contribution to the decrease in the grade of persistence over time, but it caused a lower change in the dependence of educational outcome of children on their parents' education, measured by the standardized persistence.

These findings are intuitive and complement earlier work by Ferreira and Veloso (2006): In the past, a substantial proportion of Brazilians – especially those from educationally disadvantaged families – had no access to education, and at that time the variance of education was very high. However, the increase in the net enrollment rate inevitably lead

[18] These findings are consistent with previous research. Hertz et al. (2007) e.g. measured regression and correlation coefficients for 43 countries and found empirical evidence for a tendency to reduction in the degree of persistence of education over time. However for the standardized persistence the authors could not confirm any trend. For Brazil Hertz et al. (2007) find evidence for a decrease in the degree of persistence from 1.1 to 0.74, while they related a changed in standardized persistence from 0.61 to 0.57.

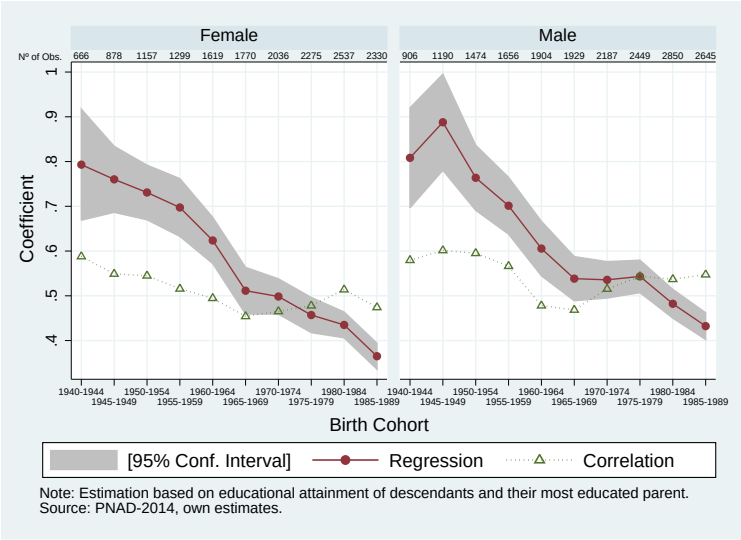


Figure 7: Regression and correlation coefficients

to a reduction in standard deviation in education. As long as the variance of education in the parent's generation is lower than in the children's, then the ratio of the standard deviation of parents' education to that of their descendants' will be less than one, and consequently, the value of the regression coefficient will be higher than the correlation. In this way, as the analysis moves in the direction of younger individuals, the ratio will be linearly closer to one and after a certain point, it becomes greater than one. Consequently the standardized persistence exceeds the grade of persistence.

5.3 Multivariate analysis

There is a solid set of studies and empirical evidence showing the importance of other environmental variables besides the parents' schooling in determining education mobility (see Black and Devereux, 2010, for a comprehensive review). For this reason, this section will follow as closely as possible the theoretical approach of Schneebaum et al. (2016); Daouli et al. (2010); Bauer and Riphahn (2007) applying multivariate ordered logit estimations to the investigation of intergeneration education transmission.

In this model, the chances of the descendant i to attain any of the four educational levels j (0 is no school certification, 1 is primary, 2 is secondary and 3 is tertiary education) correspond to a binary individual outcome. Descendants have concluded a certain education level ($\Upsilon_i = 1$) or no ($\Upsilon_i = 0$)

$$\Upsilon_j = \begin{cases} 0 & if \quad \Upsilon_i^* \leq 0 \\ 1 & if \quad \Upsilon_i^* > 0 \end{cases} \tag{14}$$

The likelihood of ending in any educational outcome j is basically dependent on the observable variables, which in our empirical approach refer to parental education PE sorted in levels j_k with $k = 1$ for father and $k = 2$ for mother; and parental occupational PO, classified into 6 categories c_k as listed in table 5. In addition, the estimated model depends on the individual characteristics of the descendant, being associated with dummy variables for gender GE_i (0 if male; 1 if female) and locality of residence LR_i (0 if urban; 1 if rural), and factor variables for race RA_i, region of residence RR_i, migration decision MD_i and bith cohort BC_i.

In order to obtain a robust indicator of the impact's magnitude of the control variables in the model, with a focus on the gender issue, we will estimated from the WLS-Outputs

the marginal effects. Given that Π, θ, Γ, Ψ, Λ, ξ and Δ are the coefficients, the econometric model estimated in this section assumes the following form:

$$\begin{aligned} \Upsilon_i^* &= Pr(\Upsilon_i^{EL} = j) = \\ &= f(\Pi PE_k + \theta GE_i + \Gamma LR_i + \Psi RA_i + \Lambda RR_i + \xi MD_i + \Delta PO_k) \end{aligned} \tag{15}$$

Formally the marginal effect presents e.g. how much the probability of a descendant to attain a tertiary education changes when the educational level of their parents changes from no education to primary education, holding all other regressors unchanged by the same values.

Table 4 reports the marginal effects calculated for the entire PNAD-Sample for mobility. To highlight the effect of the control variables in the model, I followed Daouli et al. (2010) in presenting the estimations for the full model as shown in equation 15, and also for a restricted model in which only the educational outcome of parents and children are included in the specification.

Based on the Pseudo $R2$ presented in table 4 we observe that the model 2 with individual's characteristics and parental occupation level can explain better the variation in education between descendants. Furthermore, the model 2 indicates the statically significant importance of individual characteristics and parental occupational level to the estimation of intergenerational educational mobility. Note that the values of marginal effects are ever higher in model 1 than in 2, suggesting an over-estimation of the effects of parental education by the restricted model 1.

Table 4: Marginal effects for the ordered logit estimations

Variables	Descendants education							
	No certificate		Primary		Secondary		Tertiary	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Parental education								
Father, no certificate (reference)	-	-	-	-	-	-	-	-
Father, primary	-0.184***	-0.0991***	0.00604	-0.00224	0.0951***	0.0545***	0.0927***	0.0430***
Father, secondary	-0.281***	-0.161***	-0.0932***	-0.0577***	0.0692***	-0.0354*	0.244***	0.121***
Father, tertiary	-0.294***	-0.150***	-0.135***	-0.0951***	-0.103***	-0.144***	0.453***	0.240***
Mother, no certificate (Reference)	-	-	-	-	-	-	-	-
Mother, primary	-0.194***	-0.153***	-0.0260***	0.00256	0.132***	0.101***	0.101***	0.0525***
Mother, secondary	-0.273***	-0.216***	-0.136***	-0.0928***	0.101***	0.0495**	0.264***	0.150***
Mother, tertiary	-0.321***	-0.214***	-0.167***	-0.135***	0.00355	-0.00107	0.399***	0.196***
Parental occupational level								
Father, low inferior (reference)	-	-	-	-	-	-	-	-
Father, low superior	-	-0.118***	-	0.00739	-	0.0449**	-	0.0605***
Father, medium inferior	-	-0.113***	-	0.0225*	-	0.0708***	-	0.0190
Father, medium	-	-0.139***	-	-0.00600	-	-0.0311	-	0.151***
Father, medium superior	-	-0.220***	-	0.0157	-	0.0614**	-	0.0798***
Father, high	-	-0.205***	-	-0.0182	-	0.0220	-	0.122***
Mother, low inferior (reference)	-	-	-	-	-	-	-	-
Mother, low superior	-	-0.0433***	-	0.00247	-	0.0518***	-	0.0307**
Mother, medium inferior	-	-0.103***	-	-0.0235	-	0.0922***	-	0.0683***
Mother, medium	-	-0.154***	-	-0.0649**	-	0.0331	-	0.107***
Mother, medium superior	-	-0.0997***	-	-0.0579**	-	0.0506*	-	0.112***
Mother, high	-	-0.188***	-	-0.0315	-	-0.00239	-	0.145***
Individual characteristics								
Female	-	-0.0603***	-	-0.00717	-	0.00869	-	0.0593***
Rural area	-	0.130***	-	-0.0122	-	-0.103***	-	-0.0891***
Southeast (reference)	-	-	-	-	-	-	-	-
Northeast	-	0.0747***	-	-0.0444***	-	-0.00673	-	-0.00655
North	-	0.0619***	-	-0.0396***	-	0.00256	-	0.00634
South	-	-0.00637	-	0.0517***	-	-0.0180	-	-0.00462
WestCentral	-	0.0223	-	0.0147	-	-0.0474***	-	0.0349**
White (reference)	-	-	-	-	-	-	-	-
Black	-	0.0186	-	0.0123	-	-0.0125	-	-0.0158
Mixed (Black/White)	-	0.0735***	-	0.000251	-	-0.0201*	-	-0.0524***
Asian	-	-0.122**	-	0.0267	-	-0.0545	-	0.166**
Indigenous	-	0.177**	-	0.0472	-	-0.168***	-	-0.0419
Number of observations	24,435	12,759	24,435	12,759	24,435	12,759	24,435	12,759
LR chi2	(6) 2433.20	(41) 2237.88	(6) 469.41	(41) 501.69	(6) 750.23	(41) 1176.63	(6) 3151.41	(41) 2256.75
Pseudo R2	0.1702	0.2727	0.0391	0.0668	0.0363	0.1149	0.2048	0.2998
Log likelihood	-31940254	-15478095	-30309305	-15194330	-37653033	-17390794	-26278905	-11551020

(Continued)

Table 4: Continued

Variables	Descendants education							
	No certificate		Primary		Secondary		Tertiary	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
No Migrant (reference)	-	-	-	-	-	-	-	-
From north	-	-0.0749*	-	0.000352	-	0.0712	-	0.0115
From northeast	-	0.0549**	-	0.00602	-	-0.00755	-	-0.0565***
From southeast	-	-0.0310	-	0.0310	-	-0.0153	-	0.0152
From south	-	-0.0507*	-	0.0225	-	0.0134	-	0.0189
From west central	-	-0.0811*	-	-0.0101	-	0.0372	-	0.0541
From foreign country	-	0.00374	-	-0.0537	-	0.226**	-	-0.0685**
Birth cohort 1940-1944 (reference)	-	-	-	-	-	-	-	-
Birth cohort 1945-1949	-	-0.0609*	-	-0.000264	-	0.0309*	-	0.0324
Birth cohort 1950-1954	-	-0.113***	-	0.0166	-	0.0769***	-	0.0281
Birth cohort 1955-1959	-	-0.159***	-	0.0227	-	0.0881***	-	0.0649***
Birth cohort 1960-1964	-	-0.146***	-	-0.0624**	-	0.182***	-	0.0677***
Birth cohort 1965-1969	-	-0.115***	-	-0.109***	-	0.191***	-	0.0795***
Birth cohort 1970-1974	-	-0.150***	-	-0.0963***	-	0.218***	-	0.0742***
Birth cohort 1975-1979	-	-0.157***	-	-0.106***	-	0.236***	-	0.0751***
Birth cohort 1980-1984	-	-0.252***	-	-0.112***	-	0.301***	-	0.0890***
Birth cohort 1985-1989	-	-0.311***	-	-0.0977***	-	0.331***	-	0.103***
Number of observations	24,435	12,759	24,435	12,759	24,435	12,759	24,435	12,759
LR chi2	(6) 2433.20	(41) 2237.88	(6) 469.41	(41) 501.69	(6) 750.23	(41) 1176.63	(6) 3151.41	(41) 2256.75
Pseudo R2	0.1702	0.2727	0.0391	0.0668	0.0363	0.1149	0.2048	0.2998
Log likelihood	-31940254	-15478095	-30309305	-15194330	-37653033	-17390794	-26278905	-11551020

Notes: (i) *** p¡0.01, ** p¡0.05, * p¡0.1; (ii) Standard errors in parentheses; (iii) All predictors at their mean value.
Source: PNAD-2014, own estimates.

Table 4 presents several findings of interest. First, descendants from fathers with a tertiary education have *ceteribus paribus* a 15% lower chance of attaining no school certification and a 24% higher chance of achieving a college degree, compared to the reference group (fathers without education). Having a mother with a primary education, instead of no education, decreases the chance of the children to remain without education by 15.3% and increases the probability of a tertiary education by 5.25%. For all four descendants' levels of education, the estimated marginal effects present the expected signs, suggesting that the higher the education level of parents, the higher the schooling of their children.

The occupational level of parents has a similar effect as their schooling on the educational mobility of descendants. Children from parents employed in higher professional levels have a statistically significant greater probability to conclude the educational system with a college degree and they will also have a lower chance of leaving school without any qualification.

Living in rural areas in Brazil has an adverse impact on the chances of mobility, increasing the chance to leave the school without obtaining a qualification by 13% and decreasing the probability to achieve a secondary and tertiary educational degree (-10.3% and -8.91%, respectively). Similarly, people living in the north and northeast regions in Brazil have a greater likelihood to attain no education, compared with inhabitants in southeast of the country (-7.49% and -5.49%). Moreover, the year of birth plays also a crucial role for the mobility chances. The younger the people are, the greater the probablity to obtain a higher education.

Finally, the table 4 indicates that the intergenerational education mobility is correlated with the self-identified race/ethnicity. People of mixed race (Black/White) have a higher probability of achieving no school certificate (7.35%) and a lower chance of attaining a secondary (-2.01%) and tertiary education (-5.24%) when compared to the reference category (white). While the Brazilian of Asiatic descent have a lower likelihood to leave the educational system without any diploma (-12.2%) and a greater probability of holding a university degree (-16.6%)

Regarding the effects of gender on the mobility, the findings from Table 4 are clear: Females have a statically significant higher probability to achieve a tertiary education

(5.93%) and a lower chance of remaining with no school certificate (−6.03%) when compared with men. Figure 8 plots the evolution over time of the gender gaps in no school certification and tertiary education and confirms that these gaps exists for all birth cohorts.

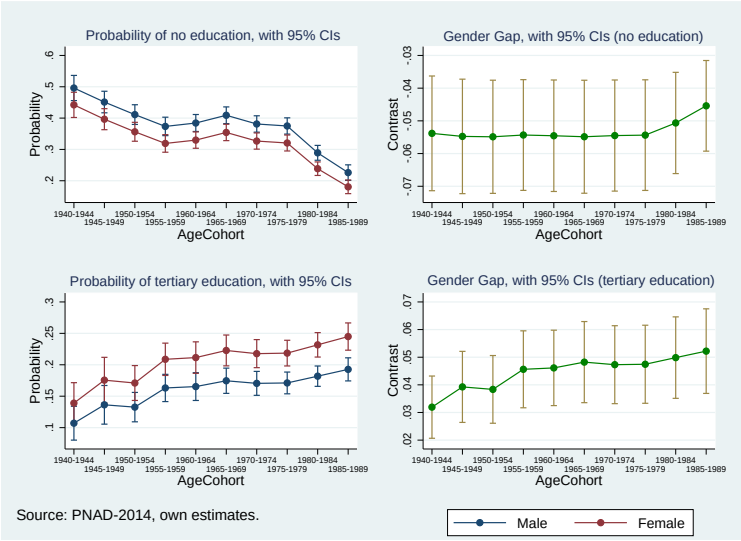


Figure 8: Predictive margins by educational level

Although the probability to end up with no school-leaving qualification dropped considerably for both sexes between 1940 and 1989, the gender gap remained practically unchanged at −5.5% up to the generation born in 1979 when it had a relatively small decrease, achieving a value of −4.5% for the individuals born in 1989. Conversely, the gender gap in tertiary education became bigger over the period considered. A female born between 1940 and 1944 has a 3% higher probability to obtain a university degree, compared with a male born in the same cohort. This difference, however, rose to 5% for the individuals born between 1985 and 1989.

6 Conclusions

This paper has investigated the intergenerational transmission of educational attainment across parents and their descendants born between 1940 and 1989 with a focus on its gendered patterns. To the best of my knowledge, this paper provided the first empirical evidence of intergenerational persistence in education based on the most recent available data of PNAD-2014 and at the same time the first empirical investigation focused on the gender gap in educational mobility in Brazil. Thus the results described above presented a detailed portrait of the chances of social mobility in contemporary Brazilian society.

In line with prior research (Bourguignon and Ferreira, 2007; Dunn, 2007; Ferreira and Veloso, 2006) this study confirmed a strong positive association between economic outcomes of parents and children in Brazil, indicating that the chances of attaining higher education for children depend heavily on the educational background of their family. In addition, the current study provided compelling empirical evidence showing that daughters present higher levels of mobility in comparison with sons. This finding is especially robust because it is derived from three different approaches, namely mobility matrices, univariate regressions and multivariate econometric techniques.

The multivariate ordered logit estimations had demonstrated that the reason for this mobility gap lies in the chances of attaining the educational levels; regardless of the

educational background of the parents, females have a lower chance of remaining without school certificate and a greater probability to achieve a tertiary education.

As already confirmed for other countries in the previous literature (Fessler and Schneebaum, 2012), the investigation conducted in this paper has also shown for Brazil a stronger persistence in education for same-gender pairs than for cross-gender pairs. The findings reported in this study, however, expand the understanding of this process and contribute to the literature showing the effects of the most educated parent on the intergenerational transmission of education. The educational attainment of children is stronger associated with the education of their most educated parent, regardless of their sex and this effect is stronger for female than for male.

The other important purpose of this paper was the analysis of the intergenerational persistence in education over time. The investigation based on different birth cohorts has made it possible to summarize and understand the evolution of mobility and its gender aspects in the recent decades. In Brazil, particularly for children born after 1965, daughters are more mobile than sons and this gap in mobility is getting larger over time.

In addition, as already reported by (Ferreira and Veloso, 2006), this paper confirmed a significant increase in intergenerational mobility for both genders over time in Brazil, measured by the regression coefficient of educational attainment. However, in contrast to existing studies, the findings reported in this paper expand the understanding of this positive evolution, presenting robust evidence that it occurred primarily as a result of the overall increase in years of schooling in the Brazilian population as a consequence of the universalization of primary education ("a elevator effect") and not due to the changes in the parents-children educational transmission. As before, educational attainment of children remains highly dependent on the education of their parents.

Finally, the findings obtained from the multivariate analysis highlight the fact that individual's characteristics and parental occupation level can also explain the variation in education mobility between descendants, i.e. men, rural residents, elderly people and migrants from the northeast region have a statistically significantly lower probability of upward mobility.

The results presented in this paper provide fertile ground for further research into the gender-specific aspects of intergenerational transmission of education between parents and children. In summary, the available findings have demonstrated that the reason for the gender mobility gap lies in the chances of attaining the educational levels: regardless of the educational background of the parents, females have a lower chance of remaining without school certificate and a greater probability to achieve a tertiary education. It follows that the use of more accurate and complete data could contribute to improving our understanding on the reasons for this difference in educational attainment levels between sons and daughters. In this context, an other important question that has to be answered is why the daughter's education is more strongly correlated with the education of the most educated parent than the education of sons.

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A Appendix

Table 5: Marginal effects for the ordered logit estimations, by gender

Variables	Male		Female	
	Observ.	Percent	Observ.	Percent
Descendants education (dependent)				
No certificate (reference)	7,969	37.53	7,967	32.10
Primary education	4,378	20.62	4,982	20.08
Secondary education	5,813	27.37	7,163	28.86
Tertiary education	3,075	14.48	4,704	18.96
Parental education				
Father, no certificate (reference)	7,264	34.21	8,120	32.72
Father, primary	3,695	17.40	4,154	16.74
Father, secondary	1,200	5.65	1,409	5.68
Father, tertiary	675	3.18	724	2.92
Father, missing	8,401	39.56	10,409	41.94
Mother, no certificate (reference)	8,409	39.60	10,211	41.15
Mother, primary	4,330	20.39	5,122	20.64
Mother, secondary	1,677	7.90	1,856	7.48
Mother, tertiary	656	3.09	690	2.78
Mother, missing	6,163	29.02	6,937	27.95
Parental occupational level				
Father, low inferior (reference)	7,047	33.19	7,402	29.83
Father, low superior	1,840	8.67	2,252	9.08
Father, medium inferior	4,530	21.33	5,115	20.61
Father, medium	448	2.11	469	1.89
Father, medium superior	801	3.77	877	3.53
Father, high	1,134	5.34	1,313	5.29
Father, missing	5,435	25.59	7,388	29.77
Mother, low inferior (reference)	4,645	21.87	5,114	20.61
Mother, low superior	3,344	15.75	4,377	17.64
Mother, medium inferior	877	4.13	1,228	4.95
Mother, medium	337	1.59	414	1.67
Mother, medium superior	510	2.40	655	2.64
Mother, high	647	3.05	728	2.93
Mother, missing	10,875	51.21	12,300	49.56
Individual characteristics				
Rural area	3,257	15.34	2,935	11.83
Southeast (reference)	6,642	31.27	7,753	31.24
Northeast	5,722	26.95	6,975	28.11
North	2,992	14.09	3,263	13.15
South	3,637	17.13	4,170	16.80
WestCentral	2,242	10.56	2,655	10.70
White (reference)	9,054	42.64	11,086	44.67
Black	2,266	10.67	2,368	9.54
Mixed (Black/White)	9,734	45.84	11,126	44.83
Asian	94	0.44	123	0.50
Indigenous	87	0.41	113	0.46
No Migrant (reference)	17,968	84.61	21,177	85.33
From north	275	1.30	303	1.22
From northeast	1,342	6.32	1,506	6.07
From southeast	849	4.00	905	3.65
From south	440	2.07	544	2.19
From west central	279	1.31	327	1.32
From foreign country	82	0.39	54	0.22
Birth cohort 1940-1944 (reference)	909	4.28	1,243	5.01
Birth cohort 1945-1949	1,191	5.61	1,583	6.38
Birth cohort 1950-1954	1,550	7.3	2,006	8.08
Birth cohort 1955-1959	1,717	8.09	2,145	8.64
Birth cohort 1960-1964	2,153	10.14	2,477	9.98
Birth cohort 1965-1969	2,305	10.85	2,500	10.07
Birth cohort 1970-1974	2,612	12.3	2,809	11.32
Birth cohort 1975-1979	2,891	13.61	3,181	12.82
Birth cohort 1980-1984	3,109	14.64	3,609	14.54
Birth cohort 1985-1989	2,798	13.18	3,263	13.15

Source: PNAD-2014, own estimates.

Table 6: Structure of Brazilian educational system

Year	Level	Duration (in years)	Age group	Compulsory
Until 1971	Pré-escola (Pre-school)	3	4 to 6	No
	Escola primária (Primary school)	4	7 to 10	Yes
	Ginásio (Lower high school)	4	11 to 14	No
	Colégio (High school)	3	15 to 17	No
	Ensino superior (College)	variable	≥ 18	No
1971 to 1995	Pré-escola (Pre-school)	3	4 to 6	No
	1º grau (1st Degree)	8	7 to 14	Yes
	2º grau (2nd Degree)	3	15 to 17	No
	Ensino superior (College)	variable	≥ 17	No
Since 1996	Educação infantil (Early childhood education)	7	0 to 6	No
	Ensino fundamental (Primary education)	8	7 to 14	Yes
	Ensino médio (Secondary education)	3	15 to 17	No
	Ensino superior (College)	variable	≥ 17	No

Source: Law 4.024 of 20.12.1961, Law 5.540 of 28.11.1968, Law 5.692 of 11.08.1971 and Law 9.394 of 20.12.1996.

Table 7: Codification of years of schooling for parents

$$
Years\ \ of\ \ Education = \begin{cases}
00 & if \quad \text{Pre-primary education} \\
00 & if \quad \text{Went to school, but never completed } 1^{st} \text{ grade} \\
02 & if \quad \text{Completed } 1^{st} \text{ grade but didn't complete all grades up to } 4^{th} \text{ grade (before 1971)} \\
02 & if \quad \text{Uncompleted literacy classes (young people and adults)} \\
03 & if \quad \text{Attended literacy classes (young people and adults), but do not know completed it)} \\
03 & if \quad \text{Attended primary school, but do not know if all grades up to } 4^{th} \text{ grade were completed (before 1971)} \\
04 & if \quad \text{Completed up to } 4^{th} \text{ grade} \\
05 & if \quad \text{Completed literacy classes (young people and adults)} \\
05 & if \quad \text{Completed } 1^{st} \text{ grade but didn't complete all grades up to } 8^{th} \text{ grade (after 1971)} \\
06 & if \quad \text{Completed } 5^{th} \text{ grade but didn't complete all grades up to } 8^{th} \text{ (before 1971)} \\
07 & if \quad \text{Attended } 1^{st} \text{ degree, but do not know if all grades up to } 8^{th} \text{ grade were completed (after 1971)} \\
07 & if \quad \text{Attended lower high school, but do not know if all grades up to } 8^{th} \text{ grade were completed (before 1971)} \\
08 & if \quad \text{Completed up to } 8^{th} \text{ grade} \\
09 & if \quad \text{Completed } 9^{th} \text{ grade but didn't complete all grades up to } 11^{th} \\
10 & if \quad \text{Attended } 2^{nd} \text{ degree, but do not know if all grades up to } 11^{th} \text{ grade were completed (after 1971)} \\
11 & if \quad \text{Completed up to } 11^{th} \text{ grade} \\
13 & if \quad \text{Completed } 1^{st} \text{ year in college/university, but didn't graduate} \\
14 & if \quad \text{Attended college/university, but do not know if graduated} \\
15 & if \quad \text{Graduated college/university} \\
16 & if \quad \text{Incomplete master or doctorate} \\
17 & if \quad \text{Attended master's or doctoral studies, but do not know if completed it} \\
19 & if \quad \text{Completed master's or doctorate}
\end{cases}
$$

Table 8: Occupational categories

Category	Professional occupations	Observ.	Average age	Work income (R$)			Education		
				Median	Average	SD	Median	Average	SD
Low Inferior	Agricultural labourers	4270	47.5	300	653	1656	4	4.2	3.9
Low Superior	Sales workers, service providers and services workers	9694	42.1	800	1045	1120	8	7.9	4
Medium Inferior	Maintenance workers and workers in production of goods and services	7399	41.7	1200	1433	1150	8	7.4	3.8
Medium	Clerical workers	2636	37.9	1200	1632	1704	11	11.7	2.9
Medium Superior	Middle-level technicians, Armed and auxiliary forces occupations	2571	39.8	2000	2651	3040	11	12.1	2.9
High	Supervisory & Managerial Professionals	5235	41.5	2700	4292	5811	15	13.6	3.4

Source: PNAD-2014, own estimates.

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