

Statistical analysis of female education in income: study case for Brazilian states

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The current research is inserted in the quarrel of gender and income in the Brazilian reality. The main objective of this work was to have a previous scenario of how factors such: marital status, age, and education affect the income of both genders (masculine and feminine) in each Brazilian State (UF). Expanding the comprehension of the gender subject within the context of inequalities among regions can be understood as a second goal. In order to achieve the targets proposed, this article used data from the Brazilian Institute of Geography and Statistics (IBGE) of 2010 and multiple linear regressions. Followed by its statistical validations and discussions about the limitations of the model. For the year studied the gender inequality between education, income, and age was verified. The results are in agreement the previous quarrel within the same area and highlighted the impact of marital state in inequality.

Gender Inequality, Income, Education, Women, Marital Status.

1. Introduction

Based on a study developed by Rosemberg (2001) about gender inequality, or the differences between men and women related to access to education. This article aims to make an analysis using 2010 data about the education and income of men and women to build a statistical model about the influence of feminine education on income and therefore in the quality of life. Beyond that, the influence of marital status, age and data were explored and analyzed by each Brazilian state.

Broadly, it is known that the increase in feminine education has a positive effect, reducing childhood mortality and fertility rate, beyond the increasing quality of life and economic productivity (UNICEF, 1991). Thus, aiming to utilize the data available by the Brazilian Institute of Statistical Geography (IBGE), by statics means, to complement studies previously performed in the area:

Gender inequality related to salary and education (PSACHAROPOULOS; PATRINOS, 2002);

The income inequality of single parents compared to married parents (PSACHAROPOULOS; PATRINOS, 2002);

The increase in education directly related to the increase in income (KEISTER, 2000).

Highlighting the gap between Brazilian research. In the area, there are researches about inequality in education by gender observed by Rosemberg (2001), with statistical analysis of data. The reflection of inequality by a social vision, considering the economic factor, according to Santos (2008). Moreover, Porto (2011) delineates a historic of gender inequality, reflecting its origin and how it influences nowadays.

The main source of data in the area is provided by the government, by IBGE. The analysis' main sources are institutions such as The United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations Children's Fund (UNICEF).

2. Literature Review

The UNFPA (2016) presents data related to the feminine presence in primary and secondary education. There are smaller enrollments of women compared to the boys, in many cases justified by the dedication to domestic roles or the beginning of a marriage, which includes having children and taking care of the house (UNFPA, 2016; SPERLING; WINTHROP, 2016).

The UNESCO Institute for Statistics (2016) presents the amount (in millions) of children outside school by gender in sub-Saharan regions, south of Asia and the rest of the world. It can be observed that the larger number of children outside school (boys and girls) is located in sub-Saharan Africa. Moreover, in all the regions analyzed, the number of girls outside the school is larger than the boys. In sub-Saharan Africa there is a strong influence of terrorist Islamic groups, among them, the most known is Boko Haram. There can be assumed relation between the lack of education (for both genders) and the growth of power and influence of extremist religious groups.

The relation between the power and lack of education has already been studied by the terrorist Palestinian group Hamas (BERREBI, 2007) and Hezbollah (KRUEGER; MALECKOVA, 2003). Brockhoff, Krieger, and Meierrieks (2014) analyzed the role of education to fight domestic terrorism in 133 countries between 1984 and 2007. The results point that the effect of education is not trivial. Lower education numbers tend to promote terrorism in countries where socioeconomic, political and demographic conditions are adverse, while higher educational levels reduce terrorism in countries where these conditions are favorable. The authors conclude that improvements in those conditions must be accompanied by higher education levels for both genders as an efficient way of fighting terrorism. The mismatch of sex in education contained in the UNESCO Institute for Statistics (2016), being the first about school evasion in primary education and the second in secondary, reinforcing the conclusions in UNFPA (2016) data. Beyond gender inequality, there is a difference in intellectual development, which can be explained by a higher rate of women evasion in school, compared to the masculine rate. Despite the higher evasion in school, it is an advantage to educate girls by the reduction in childhood mortality and birth rates, increasing economic productivity, the quality of life (UNICEF, 1991; ROSEMBERG, 2001) and terrorism fight (BROCKHOFF; KRIEGER; MEIERRIEKS, 2014).

From the health point of view, a better education reduces children's malnutrition, beyond increasing the possibility of the mother to be immune to serious diseases, prevented by knowledge. In addition to better care for their children, reduction of birth rate, for Brazil, the comparison between mothers with secondary education and illiterate is 1,14 against 3 children, on average. Making it possible to have a bigger investment in the health of each child (BRASIL, IBGE, 2010; LLOYD et al., 2009; AKMAN, 2002).

The reduction in birth rate is translated to economic benefits to the country, by bringing the transition demographic profile, or, an increase in the economic active population (AKMAN, 2002; OLMOS, 2011). This might result in

advanced economic growth, since an increase in 1% of female education increases the average level of gross domestic product (GDP) in 0,3 percentual points, to countries with high initial education (DOLLAR; GATTI, 1999). This is due to an increase in the quality of labor, leading to higher competitiveness among them, and therefore, higher efficiency (LAWSON, 2008).

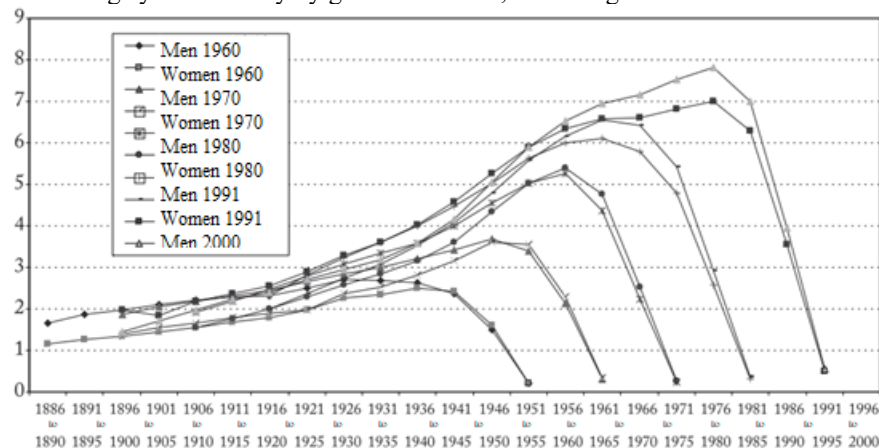
Another important factor is the increase in income, followed by a bigger education. With data from 98 countries, ranging from 1959 until 1998, considering some among them are samples containing smaller time available, on average, women have better returns of investment in education. Though, considering primary education, men present a better return, 20% compared to 13% for women. There is an inversion in secondary education, making it 18% against 14% to men (PSACHAROPOULOS; PATRINOS, 2002). It is expected to observe a similar effect in Brazil, provided by the data analyzed in this article.

The education of mothers is directly related to their children, having more impact than male education. According to a study held in India, the children of mothers that went to school studied two hours more than those whose mothers did not go to school (LEWIS; LOCKHEED, 2008; HERZ; SPERLING, 2004).

Thus, investing in women's rights protection and human capital is especially beneficial, because a woman and their healthy children build a more prosperous society (ONARHEIM et al., 2016). Also, female education presents a better return of investment, considering that women reinvest 90% of their income in the family, compared to only 30% male investment (LAWSON, 2008; FORTSON, 2003). It is also expected to verify in Brazil a similar effect to the study performed by Yamokoski and Keister (2006). This study proves the existence of higher income to people without children, compared to those that have children. Highlighting the lower-income to single mothers than single fathers. Despite that, it is necessary to highlight that the research was performed in the USA with data between 1979 and 2000. The context could have changed in that country and can not be similar to the Brazilian economy and diverse culture.

Considering the data from Keister (2000), the increase in education is directly related to the increase in income. This is explained by the fact that with higher education, people tend to save more, facilitating the acquisition of actives and properties in the future. Another reason would be the better financial decision making, taking less debt, saving more and opting for investments with higher return rates. Thus, with the increase in education levels, it is expected to have an increase in income.

Graphic 1. Average years of study by gender in Brazil, according to birth between 1960 and 2000.



Source: IBGE. Demographic census 1960, 1970, 1980, 1991 e 2000. Beltrão and Alves (2009).

Considering the study of Keister (2000) and Graphic 1, it is expected to have a superior feminine income compared to the male. This is due to the long years of study, considering this amount as a direct influencer in income (KEISTER, 2000), the natural would be an increase proportional to the income. It is important to observe that the data of this article is from 2010, and the presented in Graphic 1 goes until 2000, following the increased tendency, used to orient this case.

Though, this tendency can not correspond to reality, according to statistics of the USA, shown in Table 1. Thus, there is the possibility that the increase in age, there is a reduction in feminine income. Just after a broad statistical analysis, it will be possible to determine, since education must also be considered as an influencing factor in these results.

Table 1. Average week income in the USA, considering an integral salary, by age, in dollars, and the annual average of 2015.

Age	16 to 24	25 to 34	35 to 44	45 to 54	55 to 64	65 or more
Women	450	690	804	799	784	740
Men	510	770	983	1040	1064	1003

Source: STATISTICS, (2015).

To define the variables used in the statistic model, previous studies were considered. The first, of Psacharopoulos and Tzannatos (1992) focus on women on the labor market, though the male comparative is superficial since is not the focus of the work. The second, of Yamokoski and Keister (2006), considers the marital status as relevant in the results comparing income for both genders. And finally, the third of Psacharopoulos and Patrinos (2002), shows the existence of differences between age and level of education.

3. Methodology

A regression of censored data by winsorization was performed, for each Brazilian state is the sample of the population by state provided by the census of 2010, which was available by IBGE. The number of observations analyzed is thirty-four thousand for the least populated state and a million and seven hundred thousand to the most populated being Acre and São Paulo respectively. The variables contemplated were the following, according to IBGE:

- The income of individuals represents the gross sum, in reais, of all the works measured in the time of the research;
- Age of each person is measured by completed years in the day of the referred research;
- Education is a ordinal dummy variable which denotes 1, no instruction and primary school incomplete; 2, primary school complete and secondary school incomplete; 3, the high school completed and graduation incomplete; 4 graduation is complete; 5, undetermined;
- Marital status: 1, married; 2, separated; 3, divorced; 4, widowed; 5, single.

To trace a profile of the population, statistics were used as a tool, more specifically the Ordinary Least Squares Method (OLS).

The econometric analysis by OLS is broadly used in several areas of knowledge, overall, in social studies (FIGUEIREDO FILHO et al., 2011). According to Hair et al. (2009), multiple regression is a statistical technique to study the relation between a dependent variable and multiple independent variables, making it possible to evaluate with regression the dissociation degree among these variables and with that predicts the values of the dependent variable. In the regression by ordinary least squares, the model is adjusted in a way that the square of the residuals is minimized. In the regression model, the change in the dependent variable caused by each independent variable is given by their respective coefficient, meanwhile the residual represents the part unexplained by the model proposed. The analysis of the relation between income and the qualitative variables and the age of the individual is given by linear regression, whose main objective is to estimate the average linear conditional. The traditional ordinary least squares method minimizes the squared error (u_i) by the proposed model, as can be seen in Equation 1:

$$\ln(Renda_i) = \hat{\beta}_1 + \hat{\beta}_2(Educação_i) + \hat{\beta}_3(Idade_i) + \hat{\beta}_4(Idade_i^2) + \hat{\beta}_5(Estado Civil_i) + \hat{u}_i \quad (1)$$

For the regression to be effective this study assumed the following of the estimated errors, according to Cameron and Trivedi (2010):

- $E(u_i | x_i) = 0$ (exogeneity of the regressors);
- $E(u_i^2 | x_i) = \sigma^2$ (conditional homoscedasticity);
- $E(u_i u_j | x_i x_j) = 0, i \neq j$, (conditional observations non-correlated).

Under the assumptions above, the regression is fully functional. The exogeneity empowers the model by its consistency, meanwhile, the other assumptions entrust the bias. As a correlation between the error and the exogenous variables is given, in most part, by the time series models, thus detaching their relation, in the case of samples, therefore, there is no need to concern in cross-section samples. Consequently, there is the presence of heteroscedastic to bypass by using robust estimators.

According to the estimator proposed by White (1980), the robust estimator is used according to equation 2:

$$\hat{V}_{robust}(\hat{\beta}) = (X'X)^{-1} \left(\frac{N}{N-1} \sum_i \hat{u}_i^2 X_i X_i' \right) (X'X)^{-1} \quad (2)$$

Furthermore, there is the issue of the normality of data. Usually, the asymmetry and the kurtosis tend to derive predictions provided by estimated bias, due to regressions at a level that are just additive. For instance, the age of an individual in a certain profession tends to increase the income in a multiplicative way, or, for every ten years, on average, the income increases by 10%. Therefore, uses the log-normal model, where the dependent is transformed into a function logarithm natural.

The outlier observations were treated in a standard manner, by cutting 5% of two-tailed, also known as winsorization, a method to approximate the variations of the sample to a common value (OHLSON; KIM, 2015). The impact of this technique, allied to the logarithmic transformation, mitigates the efficiency problem originated by the non-normal distribution of the sample.

Finally, the model addresses the presence of the perfect multicollinearity among the variable dependents. Despite the presence of the exact relation between the exogenous variables, do not compromise the properties necessary by the estimator, the test of inflation of variables was used (equation 3) to verify the correlation between variables. This test is needed to verify which percentage of the coefficient is due to each variable, thus determining the significant variables (CRANEY; SURLES, 2002):

$$VIF = \frac{1}{(1-R_j^2)} \quad (3)$$

Where R^2 represents the squared explained about the total squares of the regression, which the dependent j is a function of the other variables. When this number is lower than 3,33 it means little multicollinearity, which treats the correlation among the variables of the model. For a higher value of this factor, there would be a compromise in the results obtained, they would be distorted (NETER; WASSERMAN, 1974; HOERL; KENNARD, 1970B; CARVALHO, 1995; COIMBRA et al, 2005).

The software Stata® was used for the analyses, due to its best compatibility with Excel for the exhibition of results. Another important point is the flexibility of the software related to analysis, or, the possibility of inserting code and obtaining deeper analysis with the same tool. Moreover, the interface is friendlier than other options available in the market, facilitating the interaction.

4. Results and Discussion

Considering the data summarized of all the Brazilian states in Table 2, the average education is higher for women than men (1,15 times higher). This suggests that education has a higher impact on female income. Analyzing the age, men present on average a coefficient of 1,27 higher, suggesting that older men earn more than older women, following the tendency of STATISTICS (2015).

The coefficients related to marital status present a negative sign for both genders, suggesting that it reduces with income. In the module, the women's coefficient is 3,05 times higher than men's, suggesting that single women win less than a single man. In other words, single women are more punished by their marital status.

Table 2. Summarized data of all the Brazilian states.

		Average	Minimum	State	Maximum	State
Man	Education	0,35118	0,2411263	MT	0,4363639	PI
Woman	Education	0,40414	0,2782634	SC	0,5146406	PI
Man	Age	0,05341	0,0430456	RJ	0,0688091	AP
Woman	Age	0,04214	0,0331925	RJ	0,0503941	PB
Man	Marital Status	-0,0441	-0,0530512	MS	-0,0339967	PE
Woman	Marital Status	-0,0144	-0,0235347	AP	-0,0046561	ES

Source: elaborated by the authors.

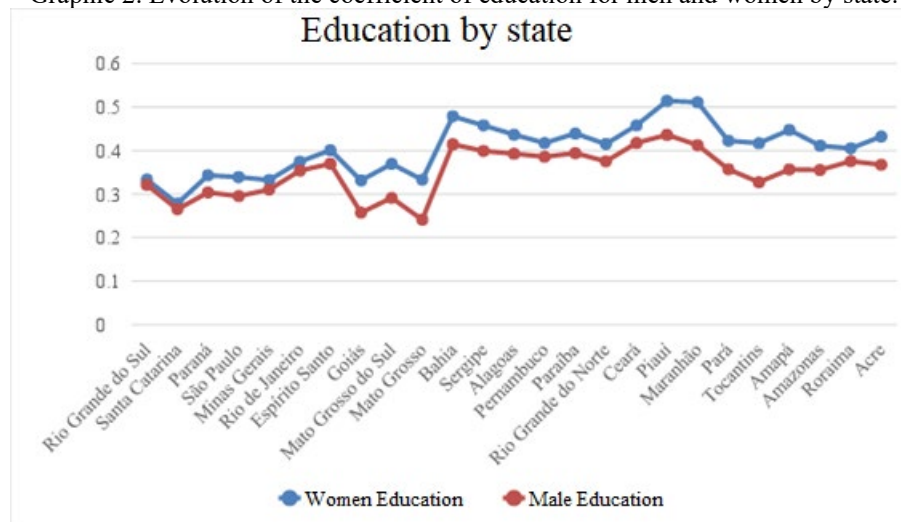
In Table 2, there is the minimum value for male education in Mato Grosso, and for the female in Santa Catarina. In contrast, the higher values for both genders are in Piauí. This means that in this state the education has a strong impact on income, independently of gender. By age, the lower coefficient, to both genders are in Rio de Janeiro, the higher for men is in Amapá and the higher for women is in Paraíba, meaning that younger women and men earn more in Rio de Janeiro.

Analyzing the marital status, the lower coefficient for men is in Mato Grosso do Sul and the higher is in Pernambuco. Since the sign is negative, it is understood that single men earn less in the first state than in the second. For females, a single woman has her income reduced 5,05 times due to her marital status in Amapá, compared to Espírito Santo. Moreover, the analysis by the Brazilian region, starting with the north region. The region is represented by Amapá and it is highlighted by the undermining of single women by that, at the same time, older men have a higher income. A similar situation in the south region happens, representing Santa Catarina. The region presents the worst reward of female education in income.

The northeast region, represented by Piauí, Pernambuco, and Paraíba, is highlighted by the high reward of education for both genders, moreover providing older women higher income and compromising fewer single men's income by their marital status. In opposition to region center west, represented by Mato Grosso and Mato Grosso do Sul. This region represents the lower reward by male education and the higher punishment of income by the marital status of single men.

In the southeast region represented by the states of Rio de Janeiro and Espírito Santo, presents the higher for young men and women and the less punishment for single women. It is also interesting to notice that, though São Paulo is the most economic representative state, its coefficients are not among the higher or lower, meaning it is not an outlier. Graphic 2 shows the evolution of the coefficient of education for men and women by state. As can be seen, the coefficients present similar behaviors for both genders by state, being female education above male education in all of the states. The lower coefficients for men are in the region center-west and for women in the region south. The higher coefficients for both genders are in the northeast. This way, this research found similar results as Psacharopoulos and Patrinos (2002), which showed the impact of education higher in female income than in the male.

Graphic 2. Evolution of the coefficient of education for men and women by state.

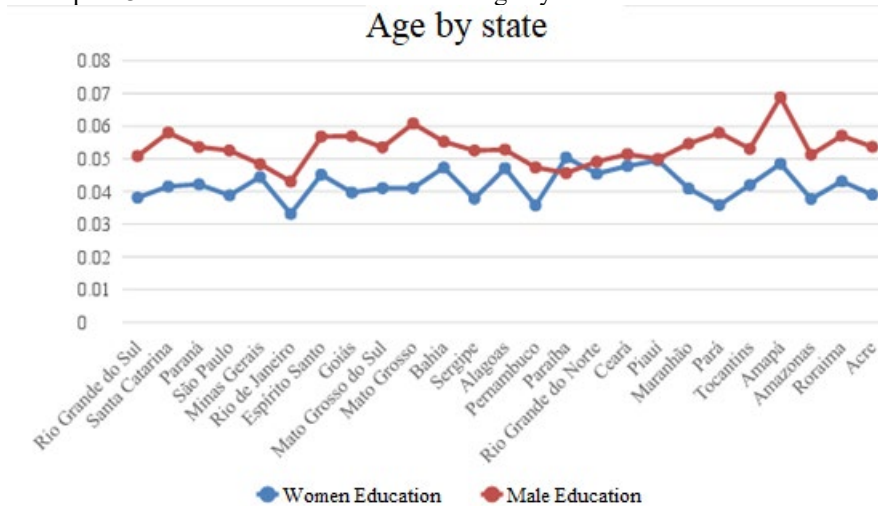


Source: elaborated by the authors.

Graphic 3 presents the evolution of the coefficient by age and state for both genders. In opposition to the previous case, the behavior is not similar in all the states. The coefficient is higher for men, suggesting that older men earn more than older women, to most of the states, consenting with STATISTICS (2015). However, there are exceptions: in Paraíba, the opposite happens (older women earn more) and, in Piauí, the performance is equal for both genders. Visually, the higher differences are in states Pará, Amapá, Mato Grosso, and Santa Catarina.

The results obtained are according to the researches of Psacharopoulos and Patrinos (2002) and Yamokoski and Keister (2006). The first study defines a higher return for an investment in female education as their education levels rise, comparing to the male proportion. The second study presents a higher income to single women without children, other factor presented is the reduction of income when both present children for women.

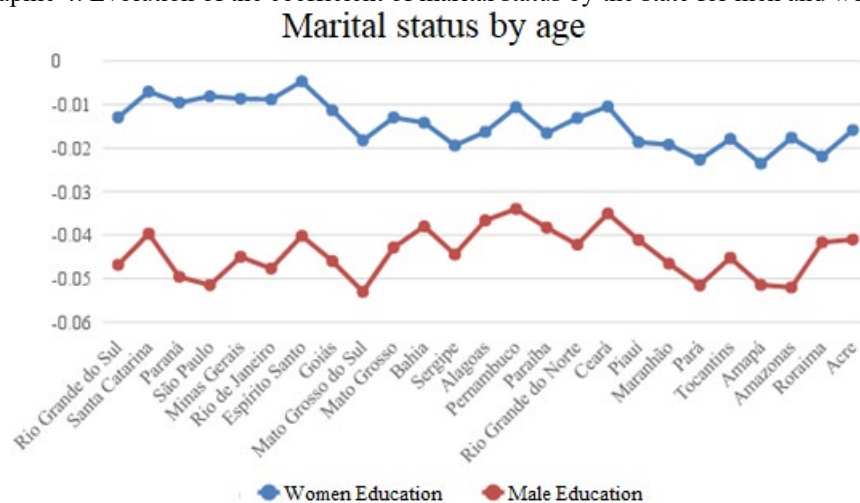
Graphic 3. Evolution of the coefficient of age by the state for men and women.



Source: elaborated by the authors.

Graphic 4 presents the evolution of the coefficient by marital status and state for men and women. In this case, for all the states the coefficient for men is broadly higher than for women (in a module). This behavior is similar to the observed by Yamokoski and Keister (2006) in the USA between 1979 and 2000, suggesting that single mothers have their income most harmed (facing more difficulties to care for their children) than single fathers also true for Brazil in 2010.

Graphic 4. Evolution of the coefficient of marital status by the state for men and women.



Source: elaborated by the authors.

To facilitate the understanding, table 3 illustrates the impact for the states of Espírito Santo (higher point in graphic 4 for women) and of Amapá (lowest point for women). In Espírito Santo, single women receive -0,02328, while in Amapá, they receive -0,11767, meaning and impact of 5,05. Meanwhile, for single men, the difference of impact in income for both states is 1,71.

Visually, graphic 3 can be interpreted as less favorable for single women in regions north and northeast, meanwhile, single men are less favorable in Mato Grosso do Sul and in Pará (there is not a pattern for the region considering this variable). Observing the country as a whole, marital status is a coefficient with a higher amplitude for men and women.

Table 3. Descriptive of the higher coefficient (Espírito Santo) and the lowest (Amapá), obtained in table 2, now compared by marital status.

		Espírito Santo		Amapá	
		Men	Women	Men	Women
<i>Coefficient</i>		-0,0402	-0,00466	-0,05144	-0,02353
<i>Married</i>	1	-0,0402	-0,00466	-0,05144	-0,02353
<i>Separated</i>	2	-0,08039	-0,00931	-0,10288	-0,04707
<i>Divorced</i>	3	-0,12059	-0,01397	-0,15431	-0,0706
<i>Widowed</i>	4	-0,16078	-0,01862	-0,20575	-0,09414
<i>Single</i>	5	-0,20098	-0,02328	-0,25719	-0,11767

Source: elaborated by the authors.

5. Final Remarks

This article described and analyzed the panorama of the relationship between education and income for both genders by the Brazilian state in the year of 2010. Thus, assisting to consolidate the literature of a scarce theme, considering the national context. Besides, a consistent analysis of the relationship between marital status, age, and income, with a high data sample was performed. Beyond that, with the increase of elders in the population, it is relevant to investigate the impact of age on each gender's income. This way, this article contributes to a scarce theme and a better comprehension by region of each Brazilian state.

Analyzing the Brazilian' data in 2010 showed a bigger return relation between education and income to women, compared to men. This result is similar to the observed in the literature for the research made in 98 countries (PSACHAROPOULOS; PATRINOS, 2002). Also, the bond between marital status and income presented as unfavorable to single mothers compared to single fathers, as already observed by Yamokoski and Keister (2006).

In the analysis by state, the most economic representative state is São Paulo, which does not present higher or lower coefficients. By this means, there is a balance in this state related to the income among gender. Similarly, in the southeast region, there is a higher income among youngsters, highlighting Rio de Janeiro state, independently of gender and the least reduction of income to single women.

For single mothers, the worst possible state in Amapá, where there is a reduction of 5,05 times in income compared to the best-case scenario, Espírito Santo. Also, in Amapá, there is a higher income to the older man, being the most unequal in income. The researchers could not conclude about the north region since their states present distinct behaviors among themselves.

The region northeast has a high reward for education, having older women the highest income and single men the least reduction in income, highlighting Paraíba state. The least unequal relation between gender and income. It is also observed that in Piauí state the education has a high impact on income, independent of gender, being the less unequal relation of Brazil.

The south region presents the worst reflex of female education. In opposition is the regional center west, with the worst reflex of male education and higher punishment by their marital state. Highlighting the state of Mato Grosso do Sul following the tendency of a single man earning less than the women in the same situation.

Considering the coefficients of education for men and women by state, the behavior is similar for both genders. Despite that, the results follow the predisposition of Beltrão and Alves (2009), and the IBGE data from 1960 until 2000, observing the higher amount of years in the female education, compared to the male, in all states.

According to the data analyzed, a higher increase of female education in income and also the relation between the single parents, with women earning less than men. Beyond that, the age influences the income, with an increase of age men earn more than women. Thus, there is a higher influence of age-related to female income, compared to the male.

The research performed had the expected result, though with limitations of the statistics base. The first of them is the winsorization, which presents a cut of collected data for all the states, that might interfere in the results, such as in cases of the inconclusive regions. This cut was performed to eliminate the people with zero income, under the poverty line, and not considered in this analysis.

Another limitation would be the use of data, of a single year and country. Despite that, it was possible to compare the results of previous studies and obtain a valid result. Considering the methodology used as valid only for linear relations, there would be a restriction in this model, which could not capture linear relations. Beyond that, the

variables income and education considered exogenous, or, undefined by the determined model. Thus, future research would be the application of another statistical method, comparing with the results of this article.

Despite some tendencies' confirmation by the results, there are researches to perform in the area. It is believed that the comparative analysis using older statistical data in Brazil, enables a comparison among countries. Besides, a comparative between developed and underdeveloped countries should be made to verify the difference among results of previous researches related to the influence of age, gender and education. There is still a significant gap in gender inequality, it is expected that this article contributes to reducing it.

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