FUNDAÇÃO GETULIO VARGAS
ESCOLA DE ECONOMIA DE SÃO PAULO

LORENA HAKAK MARÇAL

ESSAYS ON ECONOMICS OF MARRIAGE

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Tese apresentada ao Programa de Pós-Graduação da Escola de Economia de São Paulo da Fundação Getulio Vargas, como requisito à obtenção do título de Doutor em Economia de Empresas.

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Ao Emerson e meus filhos, David e Sofia.

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ABSTRACT

Society has changed in the past decades raising questions to be asked by social scientists and their impacts on family units. In this thesis we aim to analyze how agents' decisions on marriage and education can be interconnected assuming that men and women have preferences for intra-group marriage. In our framework we find that preferences for intra-group marriage can increase the proportion of men and women who decide to get married and study. We also show that empirically for Brazilian data there is a positive assortative mating between people with same traits, such as, education, religion or race. In addition, married couples that share the same religion tend to have the same level of schooling. We investigate how changes in marital sorting, educational composition and returns to education that occurred in Brazil in the last years can impact in household income inequality. We calculate counterfactual scenarios for Gini Coefficient keeping one of these three variables fixed in one year and comparing the counterfactual values with the actual one. If marriage were formed randomly, the Gini Coefficient would be lower than the actual one. Keeping the returns to education fixed in year 2014 we also show that the counterfactual Gini would be lower than the actual one.

Keywords: Matching, marriage market, assortative mating, education, family economics, cultural traits, household income inequality.
JEL Classification: D13, D31, I21, I24, J12, Z1.

RESUMO

A sociedade mudou nas últimas décadas abrindo a possibilidade para cientistas sociais estudarem essas mudanças e analisar os seus impactos na unidade familiar. Nesta tese pretendemos analisar como as decisões dos agentes com relação a decisão de casar e estudar pode estar conectado considerando que homens e mulheres têm preferências pelo casamento intragrupo. No modelo estudado encontramos que as preferências para o casamento intragrupo podem aumentar a proporção de homens e mulheres que decidem se casar e estudar. Mostramos também que empiricamente há um positive assortative mating entre pessoas com as mesmas características, tais como, educação, religião ou raça. Além disso, a probabilidade de casais casados na mesma religião aumenta a probabilidade dos casais estarem casados dentro do mesmo nível de escolaridade. Considerando as mudanças em como os casais se formam, a composição educacional e os retornos da educação que aconteceram no Brasil nos últimos anos, investiga-se os impactos dessas mudanças na desigualdade de renda dos casais. Calculamos cenários contrafactuais para o Coeficiente de Gini mantendo uma dessas três variáveis fixas em um determinado ano, comparando o contrafactual estimado com o Gini real. Se o casamento for formado aleatoriamente com relação à educação, o Coeficiente de Gini seria menor do que o real. Mantendo os retornos da educação fixos no ano de 2014 encontramos um Gini contrafactual menor do que o real.

Palavras-chave: Matching, Mercado de casamento, assortative mating, educação, economia da família, características culturais, desigualdade de renda da família.
Classificação JEL: D13, D31, I21, I24, J12, Z1.

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Chapter 1

Investment in Education and the Marriage Market with Intra-group Preference

Abstract

This paper models how agents' marriage decisions and investment in schooling are related to ethnic intra-group preferences. The incentives of men and women to acquire education and get married can change depending on the preferences to marry with their own type. It is shown that under symmetric preferences over education, we have a unique equilibrium where agents have only incentives to marry within their groups. The proportion of agents who marry and study is larger than in Chiappori et al. (2009)´s framework due to the preference for marriage within his (her) own type. In equilibrium, men know they will get married with somebody of their own type and, by symmetry, there is a woman who share the same preferences. As marriage becomes more interesting with the preference for marriage within the group, education brings an extra surplus. Therefore, their best decision is to acquire education because they increase their marital surplus.

JEL classification: I21, J12, Z1,D13.
KEYWORDS: matching, marriage market, education, family economics, cultural traits.

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1.1 Introduction

The pattern of educational attainment has been changing in the last decades in many countries around the world. Women are acquiring more education than men on average. This reality contrasts with the pattern observed years ago. Men used to have a higher level of education than women. It used to be more common to observe marriages between educated and uneducated spouses. An anecdotal example is that male doctors used to marry more frequently with nurses whereas nowadays they marry more often with female doctors.[1]

The discussion along the role of men and women in households is connected with changes we observe in the last decades. As a consequence of these changes we can consider that the division of labor intrafamily and in the labor market is different in most Western societies. Until decades ago, women have devoted most of her time in childbearing and household work whereas men devoted his time in labor market. Comparative advantages that men and women have in their roles lead them to specialization and the search of being efficient in their duties.

Since women have achieved higher levels of education and they are inserted in the labor market, the division of labor intrafamily between husbands and wives has altered. Women are sharing childbearing and household work with men. Perfects substitutes migrated to complementarity, wives are becoming less specialized in household work whereas husbands are spending more time in household work and both are inserted in the job market. Those changes can have a consequence over homogamy marriage in education.[2]

The decrease in the gender educational gap raises the probability that an educated woman marries an educated man, even if the assortative pattern has not been changed. Considering the existence of complementarity between couples' traits in the production of utility, which is illustrated by a higher marital surplus, the incidence of homogamous marriage tends to increase even more. This tendency probably affects income distribution as well.[3] Freeman (1955),Finkel et al. (2012),Bisin and Verdier (2000)

The preference for homogamous marriage between spouses can be related not only to education but with other traits such as religion and ethnicity. There is a large literature that discusses the importance for a couple to transmit their traits to their children. One of the strongest mechanisms to achieve this goal is throughout marriage.[4]

In this paper, we intend to discuss how preferences for marriage with spouses of similar traits can affect investment in education and marriage. Moreover, in some situations, those that prefer to homogamous marriage can decide to invest in education in order

[1] Article "Sex, brains and inequality" published in 02/08/2014 by The Economist.
[2] Chiappori et al. (2009) and Becker (1991).
[3] Homogamous marriage can be defined as a marriage between people who are similar in cultural traits, educational level, religion, ethnicity, socioeconomic status, among others.
[4] Bisin and Verdier (2000).

to get married. This can happen because the greater the return to marriage between people of the same type, the greater are the incentives to study and marry. All in all, we are interested in analyzing the relationship between agents with different traits and its implication for education and marriage.

Under symmetric preferences we are able to show that agents will marry within his (her) own type and assortative in Education. We show that there is a unique equilibrium with homogamous marriage. Our model is based on Chiappori et al. (2009)'s work.

Chiappori et al. (2009) developed a model where the investment in education generates two different types of returns. The first one is in the labor-market and the second is in the marriage market. Moreover, both men and women can have different incentives to acquire education because they can have different household roles, which leads to different market wage.

They showed that a unique equilibrium exists even though it could be a "symmetric" equilibrium or mixed one.[5] It depends on whether there is gender equality in the labor market and it will be reflected in the share of utility that each spouse earns from the marriage.

Furthermore, there is a debate on how family values are transmitted throughout generations. Parents might not be indifferent to their children's preferences to religious, ethnic and cultural traits. Marriage can be an important mechanism to transmit those traits through family socialization and homogamous marriage. According to Bisin and Verdier (2000), social scientists in the first half of the 20th century used to agree that American society would become more homogeneous, that is, a melting pot hypothesis. The assimilation of immigrants would transform the American society, from their differences in ethnic, into a common culture whereas the evidence nowadays does not support this view anymore.

New York is an emblematic city that reflects the failure of a melting pot theory. The city is divided into different ethnic groups, such as, Italian, African Americans, Jews, Chinese, Latin, etc. Glazer (2000), Glazer and Moynihan (1963) suggest that the assimilation between different ethnic groups in New York has grown a little but it is far from ensure it is becoming a melting pot. In addition, we can share other examples outside the United States. Jews and Muslims around the world have remained attached to their cultural traits through the centuries. The Basques and Catalans in Spain too. Borjas (1994) presents a work which suggests that the performance of workers can be related not only to parental skills but also the nature of an ethnic externality and how it might operate. The paper shows that in the United States there is a strong evidence of residential segregation and ethnic externalities.

Lehrer (2004) examined the role of religiosity as a determinant of educational

[5]The returns of education are symmetric between men and women. And there is a positive assortative matching where educated men marry educated women and uneducated men marry uneducated women.

attainment within specific genders and faiths. The empirical analysis showed that women raised as conservative Protestants who attended religious services more than once a week when they were teenagers achieved one more year of schooling. She compared a more religious group of Protestants women with a less religious one. According to Sander (2010), the family religious background (Islam and Judaism) can interfere on educational attainment in United States agents. And the decision of acquiring more years of schooling has an important impact on income and economic mobility.

If this intergenerational transmission is considered an important legacy probably there will be search for marriage within the group type. In addition, a minority group can have more incentives to search for a homogamous marriage than a majority group because in a heterogamous marriage the minority type will have more difficulties to transmit their traits. The role models and peers will prevail from the majority group.[6] Moreover, Lehrer and Chiswick (1993), Waite and Lehrer (2003) and Becker (1991) showed that it is reasonable to assume that homogamous marriage tends to be more stable than mixed marriage, thus turning the homogamous marriage more attractive.

The marriage decision can influence the decision on education and the level of schooling can affect earning capacity and job opportunities in the labor market. Our model aims to analyze the possible interaction in homogamous marriage between men and women of the same type and education. We show that under symmetric preferences agents will marry within their own type and with the same level of schooling. There will be no incentives to marry outside their own type. We show there is a unique equilibrium with homogamous marriage both in type and education.

This paper is organized as follows. In the next section, we examine the related literature. The third section we develop our model and in the fourth we present the equilibrium. In the fifth section we present some limitations and possible extensions of our model. Finally, in Section 6 we present some final remarks.

1.2 The Model

Shapley and Shubik (1971) have solved the assignment game as a linear programming problem. We present a two-sided matching model with transferable utility and complete information based on Chiappori et al. (2009), where agents intend to maximize the aggregate marital surplus over all possible assignments considering they share different traits.

[6] Bisin et al. (2004)

1.2.1 Definitions

In the first part we will present an overview of Chiappori et al. (2009)'s framework. The model is based on the assumption that there are two equally large populations of men and women to be matched. Agents live for two periods. In the first period the agent chooses to acquire education or not, and in the second, if he (she) will get married and with whom. Wages are assumed to be exogenous.

There are two finite and disjoint sets of men and women, each of them represented by letters P and Q. Each set contains p and q players, respectively. The letters i and j will indicate agents of each set and a partnership of (i, j) in $P \times Q$ will generate a nonnegative marital surplus s_{ij}.[7]

The utility provided from marriage can be divided in two parts. The first one is defined as a material surplus and the second one is an emotional gain. Material surplus is generated by a material output ($\xi_{I(i)J(j)}$) formed by the union between husband i and wife j discounted by the output that each spouse produce when single, where $I_{(i)}$ and $J_{(j)}$ represents the level of education of each spouse. This material surplus depends on the level of education of both spouses which can be uneducated or educated, represented by 1 and 2 respectively.

Men and women choose whether they will study or not. If he (she) decides to study in the first period, he (she) works only in the second one and he (she) earns ξ_{20}. If he (she) chooses not to study, he (she) works in both periods and he (she) earns $2\xi_{10}$. The absolute return of education for men and women who never get married is represented by $R^P = \xi_{20} - 2\ \xi_{10}$ and $R^Q = \xi_{02} - 2\ \xi_{01}$.

The material surplus is:

$$Z_{I(i)J(j)} = \xi_{I(i)J(j)} - \xi_{I(i)0} - \xi_{0J(j)} \tag{1.1}$$

Emotional gains are idiosyncratic variables generated by preference for marriage represented by θ_i and θ_j. Investment in education is associated to idiosyncratic costs μ_i or μ_j. Agents search for partners in order to maximize their share in wedding surplus. It is assumed that the educational levels are complementary between agents in the marriage as in Becker (1973)'s definition of positive assortative mating, that is,

$$Z_{11} + Z_{22} > Z_{12} + Z_{21} \tag{1.2}$$

The matching output $Z(I_{(i)}, J_{(j)})$ is supermodular in $I_{(i)}$ and $J_{(j)}$ and it is considered that

$$Z_{12} = Z_{21} \tag{1.3}$$

In our work we consider that there are two equally large populations of men and women

[7]Notation follows Roth and Sotomayor (1990).

from types $\gamma \in \{A, B\}$ .The number of men and women within group is the same but can differ between groups. We add an idiosyncratic parameter, the type gains, represented by λ_i and λ_j. These parameters are generated by intra-group marriage. We assume that the idiosyncratic parameters θ_i , μ_i, and λ_i are independent from each other and across all individuals. We denote $G(\mu)$ as the distribution of μ, and $F(\theta)$ as the distribution of θ, symmetric around its zero mean. We denote by $H(\lambda)$ the distribution of λ which is continuous and defined on a positive interval. The probability distribution function (p.d.f.) $h(\lambda)$ will be zero outside this interval. The p.d.f. $f(\theta)$ is a distribution where the probability of the values decrease monotonically as they become more distance from the mean.

We consider in our model that men and women are completely symmetric in their preferences as defined as follow. Consider a type profile $t_i^\gamma = (\lambda_i, \theta_i, \mu_i)$. Men, reported by i, have a type profile $t_i^\gamma \in \Pi_p^\gamma$ which is the type space and women, reported by j, have a type profile $t_j^\gamma \in \Pi_q^\gamma$ (type space). We assume that:

$$\Pi_p^A = \Pi_q^A \tag{1.4}$$
$$\Pi_p^B = \Pi_q^B \tag{1.5}$$

The joint distribution of the three characteristics λ, θ, μ is described as a function Σ such that for all values of μ, θ, λ $(\Sigma : R \times R \times R^+ \to (0, 1))$,

The function is given by $\Sigma_{p(q)}^\gamma(\lambda, \theta, \mu) = H(\lambda).F(\theta).G(\mu)$ and we assume that:

$$\Sigma_p^A(t) = \Sigma_q^A(t) \tag{1.6}$$
$$\Sigma_p^B(t) = \Sigma_q^B(t) \tag{1.7}$$

The marital surplus (S_{ij}) depends on the educational levels of the partners and their types (A or B).

$$s_{ij} = \begin{cases} Z_{I(i)J(j)} + \theta_i + \theta_j \text{ if } \gamma_i \neq \gamma_j \\ Z_{I(i)J(j)} + \theta_i + \theta_j + \lambda_i + \lambda j \text{ if } \gamma_i = \gamma_j \end{cases} \tag{1.8}$$

The surplus s_{ij} will be distributed between the players and, under transferable utilities, woman j receives u_j and man i receives v_i.

1.2.2 Stability and Equilibrium Conditions

The definition of equilibrium in a matching model is based on stability and it has the following conditions:

$$u_j \geq 0, v_i \geq 0 \tag{1.9}$$

and

$$u_j + v_i \geq s_{ij} \forall (i,j) \ in \ P \times Q. \tag{1.10}$$

Stability requires that the conditions (1.9) and (1.10) be satisfied. Otherwise the outcome followed from the maximization problem is not feasible. In condition (1.9) is defined that men and women can always remain single if they want, so their payoff would be $u_j = 0$,$v_i = 0$. The condition (1.10) presents the notion that if a man i and a woman j decides to marry they will not have an incentive to deviate from this partnership. There will be no other partnership that formed with one of them that will lead to a higher payoff and block the original partnership.

Agents maximize their marital surplus considering that their peers are doing the same. The problem of linear programming developed by Shapley and Shubik (1971) shows that any stable matching between men and women emerges from the problem of maximization of the aggregate surplus among all possible assignments.

$$v_i = \max \begin{cases} \max_j \left\{ \left[Z_{I(i)J(j)} + \theta_i + \theta_j - u_j \right], 0 \right\} \text{ if } \gamma_i \neq \gamma j \\ \max_j \left\{ \left[Z_{I(i)J(j)} + \theta_i + \theta_j + \lambda_i + \lambda j - u_j \right], 0 \right\} \text{ if } \gamma_i = \gamma j \end{cases} \tag{1.11}$$

$$u_j = \max \begin{cases} \max_i \left\{ \left[Z_{I(i)J(j)} + \theta_i + \theta_j - v_i \right], 0 \right\} \text{ if } \gamma_i \neq \gamma j \\ \max_i \left\{ \left[Z_{I(i)J(j)} + \theta_i + \theta_j + \lambda_i + \lambda j - vi \right], 0 \right\} \text{ if } \gamma_i = \gamma j \end{cases} \tag{1.12}$$

The shares u_j and v_i are determined endogenously and we can write them as:

$$v_i = \max \left(V_I + \theta_i + \lambda_i, 0 \right) \tag{1.13}$$

and

$$u_j = \max \left(U_J + \theta_j + \lambda_j, 0 \right) \tag{1.14}$$

where V_I and U_J represent the material surplus husbands and wives earn from marriage. When agents search for their partners they already know V_I and U_J.

$$V_I = \max_J \left[Z_{IJ} - U_J \right] \tag{1.15}$$

and

$$U_J = \max_I [Z_{IJ} - V_i] \tag{1.16}$$

Education and Investment Decision

Men and women need to decide whether or not they will invest in education. Considering rational expectations, that is, in equilibrium husbands and wives know the shares they receive from material surplus. Their choice to invest in education depends on the shares provided from material surplus and the values of their idiosyncratic parameters θ, λ and μ. After that, they will be sure if they will get married or remain single in the second period conditional to their choice of be educated or not. According to conditions (1.19) to (1.24), men will be divided among the areas in Figure 1. Some of them will not get married and not study, others will not get married but invest in education or get married but not invest in education and part of them will marry and invest.[8]

Man i of type A(B) will invest in education if:

$$\xi_{20} - \mu_i + \max(V_2 + \theta_i + \lambda_i, 0) > 2\xi_{10} + \max(V_1 + \theta_i + \lambda_i, 0), \tag{1.17}$$

Woman j of type A(B) will choose to invest in education if:

$$\xi_{02} - \mu_j + \max(U_2 + \theta_j + \lambda_j, 0) > 2\xi_{01} + \max(U_1 + \theta_j + \lambda_j, 0), \tag{1.18}$$

Conditions and thresholds are described below:

Man i with

$$\theta_i < -(V_2 + \lambda_i) \tag{1.19}$$

will not marry. And he will invest in education if

$$\mu < \xi_{20} - 2\xi_{10} = R^P \tag{1.20}$$

Man i with

$$\theta_i > -(V_1 + \lambda_i) \tag{1.21}$$

will marry and will decide to invest in education or not if and only if

$$\mu < R^P + V_2 - V_1 \tag{1.22}$$

In this situation, man will always get married but he will decide to study if the return from education (R^P) adding the returns to schooling in marriage, which depends on his decision to study or not ($V_2 - V_1$), will be greater than his idiosyncratic cost of schooling μ.

[8] See appendix C for a numerical example. We present the thresholds in a similar way as in Chiappori, et al. (2009).

Finally, if

$$-(V_2 + \lambda_i) < \theta_i < -(V_1 + \lambda_i) \tag{1.23}$$

than man will marry only if he acquires education and the condition will be

$$\mu < R^P + V_2 + \theta_i + \lambda_i \tag{1.24}$$

The return from education adding the material share from marriage and the idiosyncratic emotional gain θ and the type gain λ must be greater than μ, otherwise man will not marry. These conditions hold for women too.

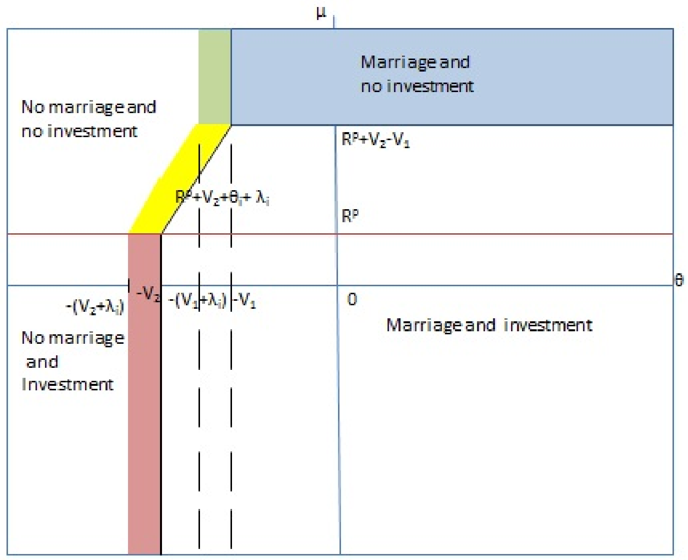

Figure 1.1: Regions for Marriage and Investment in Schooling

Which type men and women are going to marry with?

Agents need to decide whether or not they will get married within his (her) own type. Consider a market with men and women which satisfies the following two assumptions:

1. They have symmetric preferences (conditions (1.4) and (1.5)) and symmetry in gender (condition (1.3)) and
$$R^P = R^Q \tag{1.25}$$
2. The condition (1.2) holds.

   Consider that, in equilibrium, men and women know their material surplus and it is characterized by equal sharing, that is, $V_2 = U_2 = Z_{22}/2$ and $U_1 = V_1 = Z_{11}/2$. (See appendix A)

Lemma 1. *Men and women with the same characteristics* (λ, θ, μ) *have the same decisions about investing in schooling or not.*

Proof. Suppose man 1 has his type preferences θ_1, λ_1 and μ_1. According to conditions ((1.19) to (1.24)) he will decide to invest in schooling or not. Consider $\theta_1 > -(V_1 + \lambda_1)$ and suppose man 1 has $\mu_1 < R^P + V_2 - V_1$. In this case he will decide to study. By symmetry, there is a woman 2 with the same characteristics of man 1 (θ_1, λ_1 and μ_1), but she decides not to study. In this case her μ_1 should be greater than $R^Q + U_2 - U_1$. According to conditions (1.21), (1.22) and symmetry in gender, $\mu_1 < R^Q + U_2 - U_1$, a contradiction. □

Proposition 2. *(Preferences for intra-group marriage) If a man (or woman) wishes to marry then he (she) will marry with someone from his (her) own type.*

Proof. Consider a market with men and women who share the same preferences over education and marriage according to conditions ((1.4) , (1.5), (1.2) and $\lambda_i > 0$). We will show that couples formed by agents of the same type will result in equilibrium (in order to achieve equilibrium, conditions (1.13), (1.14), (1.15) and (1.16) must be satisfied). Suppose man A (B) solves his maximization problem and is assigned to woman B (A) and they receive from marital surplus $V_{I(1)} + \theta_1$ and $U_{J(2)} + \theta_2$ respectively. There is a woman A (B) who, from symmetry conditions ((1.4) and (1.5)), shares the same preferences of man A (B). Then by lemma 1, they have the same decision about schooling. Suppose she solves her maximization problem and is assigned to man B (A) and they receive from marital surplus $V_{I(2)} + \theta_2$ and $U_{J(1)} + \theta_1$ respectively. But if man A(B) marries woman A(B), together they will be better off. They will receive from marital surplus $V_{I(1)} + \theta_1 + \lambda_1$ and $U_{J(1)} + \theta_1 + \lambda_1$. The same holds for man and woman B. So, marriage between m_A and w_A and m_B and w_B blocks marriage between m_A and w_B and m_B and w_A. □

The proportion of men who decide to marry or remain single and decide to invest in schooling or remain uneducated.

According to proposition 2, there will not be mixed marriage between types ($\gamma \epsilon \{A, B\}$). So, in order to draw Figure 1, we can compute the proportion of men who marry, get educated, remain single or not invest in schooling by each type separately. The same holds for women.

The proportion of men of type A (B) who marry is:

$$\Lambda = \int_0^{+\infty} \int_{-(V_2+\lambda_i)}^{-(V_1+\lambda_i)} G(R^P + V_2 + \theta_i + \lambda_i) f(\theta) h(\lambda) d\theta d\lambda + \int_0^{+\infty} \{1 - F[-(V_1 + \lambda_i)]\} h(\lambda) d\lambda \tag{1.26}$$

where $G(R^p + V_2 + \theta_i + \lambda_i) = \int_{-\infty}^{R^p+V_2+\theta_i+\lambda_i} g(\mu) d\mu$ and $\{1 - F[-(V_1 + \lambda_i)]\} = 1 - \int_{-\infty}^{-(V_1+\lambda_i)} f(\theta) d\theta$. The left side of the equation represents the proportion of men who have their preferences for marriage (θ) between $-(V_2 + \lambda_i)$ and $-(V_1 + \lambda_i)$ and the right side

represents the proportion of men that have their preferences $\theta_i > -(V_1 + \lambda_i)$ for any μ or λ.

Proportion of men of type A (B) who invest in schooling is:

$$\begin{aligned}\Psi \quad = \quad & \int_0^{+\infty} G(R^P) F[-(V_2 + \lambda_i)] h(\lambda) d\lambda + \\ & \int_0^{+\infty} \int_{-(V_2+\lambda_i)}^{-(V_1+\lambda_i)} G(R^P + V_2 + \theta_i + \lambda_i) f(\theta) h(\lambda) d\theta d\lambda + \\ & \int_0^{+\infty} \{1 - F[-(V_1 + \lambda_i)]\} G(R^P + V_2 - V_1) h(\lambda) d\lambda\end{aligned} \tag{1.27}$$

The first part of the equation shows the proportion of men who invest in schooling because their is $\mu < R^p$ but their preferences for marriage $\theta_i < -(V_2 + \lambda_i)$. The next part of the equation represents the proportion of men who have their preferences for marriage (θ) between $-(V_2 + \lambda_i)$ and $-(V_1 + \lambda_i)$ and they invest in schooling because their cost of education $\mu < R^p + V_2 + \theta_i + \lambda_i$. And the right side represents the proportion of men who invest in schooling because their cost of schooling is $\mu < R^p + V_2 - V_1$ and their $\theta_i > -(V_1 + \lambda_i)$ for any λ.

The proportion of men of type A (B) who invest and marry is:

$$\Omega = \int_0^{+\infty} \int_{-(V_2+\lambda_i)}^{-(V_1+\lambda_i)} G(R^P+V_2+\theta_i+\lambda_i) f(\theta) h(\lambda) d\theta d\lambda + \int_0^{+\infty} \{1-F[-(V_1 + \lambda_i)]\} G(R^P+V_2-V_1) h(\lambda) d\lambda \tag{1.28}$$

where the left side of equation represents the proportion of men who have their preferences for marriage (θ) between $-(V_2 + \lambda_i)$ and $-(V_1 + \lambda_i)$ and they invest in schooling because their cost of education $\mu < R^P + V_2 + \theta_i + \lambda_i$ and the right side represents the proportion of men who invest in schooling because their cost of schooling is $\mu < R^P + V_2 - V_1$ and their $\theta_i > -(V_1 + \lambda_i)$ for any λ.

It is possible to divide men between those who decide to marry or remain single, and invest in schooling or not. Figure 1 brings the limits of integration and the thresholds (conditions (1.19 to 1.24) where we can see the proportion of those men who invest or not in schooling, get married or remain single. It is a three dimensional graph but in order to make easier to visualize the effects on the change in the areas caused by λ and compare to a similar picture from Chiappori et al. (2009), we represent the graph in a two-dimensional way (θ, μ) keeping λ fixed. As λ increases, the boundaries of the marriage area shifts to the left.

Suppose a constant $c \geqslant 0$ that multiplies the term λ. We intend to develop a comparative statics analysis with Chiappori et al. (2009)'s work in order to analyze the impacts of λ on the decision of marriage and education. Define the function (1.27) as Ψ'

where a parameter c multiplies λ. As we can check, when $c = 0$, we are in Chiappori et al. (2009)'s environment. It holds for functions (1.26) and (1.28) as well.

$$\Psi' = \int_0^{+\infty} G(R^P)F[-(V_2 + c\lambda_i)]h(\lambda)d\lambda + \int_0^{+\infty}\int_{-(V_2+c\lambda_i)}^{-(V_1+c\lambda_i)} G(R^P + V_2 + \theta_i + c\lambda_i)f(\theta)\,h(\lambda)d\theta d\lambda + \int_0^{+\infty}\{1 - F[-(V_1 + c\lambda_i)]\}G(R^P + V_2 - V_1)h(\lambda)d\lambda \quad (1.29)$$

$$\Lambda' = \int_0^{+\infty}\int_{-(V_2+\lambda_i)}^{-(V_1+\lambda_i)} G(R^P + V_2 + \theta_i + c\lambda_i)f(\theta)h(\lambda)d\theta d\lambda + \int_0^{+\infty}\{1 - F[-(V_1 + c\lambda_i)]\}h(\lambda)d\lambda \quad (1.30)$$

$$\Omega' = \int_0^{+\infty}\int_{-(V_2+\lambda_i)}^{-(V_1+\lambda_i)} G(R^P + V_2 + \theta_i + \lambda_i)f(\theta)\,h(\lambda)d\theta d\lambda + \int_0^{+\infty}\{1 - F[-(V_1 + \lambda_i)]\}G(R^P + V_2 - V_1)h(\lambda)d\lambda \quad (1.31)$$

Proposition 3. *(The role of intra-group type parameter λ in education and marriage) Using the equations (1.29), (1.30) and (1.31), it is possible to show that: The change in the proportion of men who wish to study or marry is a positive function of parameter c, $\frac{\partial\Lambda'}{\partial c} > 0$. The same holds for women.*

In the new context, there are three effects in the proportion of men who marry and study. According to Proposition 3, in the pink area, men who before were willing to study but not get married will change their decision and marry. In the green area, more men will decide to marry but they will not invest in schooling. As a effect of λ in these two regions men will decide to marry but will not change their decision to study, whereas, in the yellow area, the increase in λ will change their decision about schooling. In this region their decision to study will change because of the idiosyncratic type parameter λ and the preferences to marry within their own type. They will study in order to get married. The proportion of men who study and marry increases. The same holds for women. We can check these effects considering Proposition 3.

Case 1: Consider the function (1.30). We want to study the impacts on the marriage proportion given changes induced by c.

$$\frac{\partial \Lambda'}{\partial c} = \int_0^{+\infty} f\left[-(V_1 + c\lambda_i)\right]\left[1 - G(R^P + V_2 - V_1)\right]\lambda_i h(\lambda) d\lambda +$$
$$\int_0^{+\infty}\int_{-(V_2+c\lambda_i)}^{-(V_1+c\lambda_i)} g(R^P + V_2 + \theta_i + c\lambda_i)\lambda_i f(\theta) h(\lambda) d\theta d\lambda$$
$$+ \int_0^{+\infty} G(R^P) f(-V_2 - c\lambda_i)\lambda_i h(\lambda) d\lambda > 0 \quad (1.32)$$

The derivative is positive then as c increases, the proportion of men who get married rises.

We evaluate the derivative at point $c = 0$.

$$\frac{\partial \Lambda'}{\partial c}(c = 0) = \int_0^{+\infty} f(-V_1)\lambda_i h(\lambda) d\lambda \left[1 - G(R^P + V_2 - V_1)\right]$$
$$+ \int_0^{+\infty}\int_{-(V_2)}^{-(V_1)} g(R^P + V_2 + \theta_i)\lambda_i f(\theta) h(\lambda) d\theta d\lambda$$
$$+ \int_0^{+\infty} G(R^P) f(-V_2)\lambda_i h(\lambda) d\lambda > 0 \quad (1.33)$$

A marginal increase in c has an impact on the proportion of men who decide to marry, comparing with Chiappori et al. (2009)‘s environment where $c = 0$.

Case 2: Consider the function (1.31). We want to study the impacts on schooling and marriage caused by changes in c.

$$\frac{\partial \Omega'}{\partial c} = \int_0^{+\infty} f\left[-(V_1 + c\lambda_i)\right]\lambda_i G(R^P + V_2 - V_1) h(\lambda) d\lambda + \quad (1.34)$$
$$\int_0^{+\infty}\int_{-(V_2+c\lambda_i)}^{-(V_1+c\lambda_i)} g(R^P + V_2 + \theta_i + c\lambda_i)\lambda_i f(\theta) h(\lambda) d\theta d\lambda -$$
$$\int_0^{+\infty} G(R^P + V_2 - V_1) f(-V_1 - c\lambda_i)\lambda_i h(\lambda) d\lambda + \int_0^{+\infty} G(R^P) f(-V_2 - c\lambda_i)\lambda_i h(\lambda) d\lambda > 0$$

We evaluate the derivative at point $c = 0$.

$$\frac{\partial \Omega'}{\partial c}(c = 0) = \int_0^{+\infty}\int_{-V_2}^{-V_1} g(R^P + V_2 + \theta_i)\lambda_i f(\theta) h(\lambda) d\theta d\lambda + \quad (1.35)$$
$$\int_0^{+\infty} G(R^P) f(-V_2)\lambda_i h(\lambda) d\lambda > 0$$

Case 3: Consider the function (1.27). We want to study the impacts in schooling caused by changes in c.

$$\begin{aligned}
\frac{\partial \Psi'}{\partial c} &= +\int_0^{+\infty} f\left[-(V_1 + c\lambda_i)\right] \lambda_i G(R^P + V_2 - V_1) h(\lambda) d\lambda + \\
&\int_0^{+\infty} G(R^P) f(-V_2 - c\lambda_i)\lambda_i h(\lambda) d\lambda + \\
&\int_0^{+\infty} \int_{-(V_2+c\lambda_i)}^{-(V_1+c\lambda_i)} g(R^P + V_2 + \theta_i + c\lambda_i)\lambda_i f\left(\theta\right) h(\lambda) d\theta d\lambda + \\
&- \int_0^{+\infty} G(R^P + V_2 - V_1) f(-V_1 - c\lambda_i)\lambda_i h(\lambda) d\lambda - \int_0^{+\infty} G(R^P) f(-V_2 - c\lambda_i)\lambda_i h(\lambda) d\lambda \\
&= \int_0^{+\infty} \int_{-(V_2+c\lambda_i)}^{-(V_1+c\lambda_i)} g(R^P + V_2 + \theta_i + c\lambda_i)\lambda_i f\left(\theta\right) h(\lambda) d\theta d\lambda > 0
\end{aligned} \tag{1.36}$$

We can evaluate the derivative at point $c = 0$.

$$\frac{\partial \Psi'}{\partial c}(c = 0) = \int_0^{+\infty} \int_{-V_2}^{-V_1} g(R^P + V_2 + \theta_i)\lambda_i f\left(\theta\right) h(\lambda) d\theta d\lambda > 0 \tag{1.37}$$

The derivative of the area with respect to c is positive (1.32). An increase in c leads to a raise in the proportion of men who marry comparing to Chiappori et al. (2009)'s framework. This can be related directly to agents' preferences over marriage within their own type.

The same result is achieved by the proportion of men who marry and acquire education (condition (1.28)) and the proportion of men who study (function (1.27)) as shown in equations (1.34) and (1.36). [9]

The derivatives evaluated in $c = 0$ (equations 1.33 to 1.37) shows a comparative statics of our model in relation to Chiappori et al. (2009). It suggests that the introduction of a new idiosyncratic variable conditional to be part of a intra-group marriage can affect decisions of studying and getting married.

One interesting question that arises from our paper is how agents decisions about education and marriage are affected by changes in λ. As we can see from proposition (3), changes in $c\lambda$ can affect their decisions of schooling and marriage. There are two kinds of men. Part of them who wants to marry anyway, that is, they want to marry within their group or not. Their preference for marriage is high but they will end up married with someone from their own group because of the parameter λ. And part of them share a low preference for marriage. But as an effect of preference for marriage with someone of his own trait, they can marry. In equilibrium, they know they will get married with somebody of their own type and, by symmetry, there are some women who share the same

[9] The result achieved in proposition 2 may not hold if the limit of integration is not limited.

preferences. So, they decide to marry. And in order to achieve marriage, they can decide to acquire education. This result suggests that people can acquire education in order to marry his own type because they can increase their material surplus through education. The same result holds for women.

1.3 Equilibrium

In equilibrium, the proportion of husbands and wives of type A (B) who get married need to be equal.[10] From equation (1.26) and applying symmetry of $F(\theta)$, we present the following condition

$$\begin{aligned}\int_0^{+\infty}\int_{(V_1+\lambda_i)}^{(V_2+\lambda_i)} & G(R^P+V_2-\theta_i+\lambda_i)f(\theta)\,h(\lambda)d\theta d\lambda \\ & +\int_0^{+\infty}F(V_1+\lambda_i)\,h(\lambda)d\lambda \\ = & \int_0^{+\infty}\int_{(U_1+\lambda_j)}^{(U_2+\lambda_j)} G(R^Q+U_2-\theta_j+\lambda_j)f(\theta)\,h(\lambda)d\theta d\lambda \\ & +\int_0^{+\infty}F(U_1+\lambda_j)\,h(\lambda)d\lambda \qquad (1.38)\end{aligned}$$

where the left-hand of (1.38) represents the proportion of husbands and the right-hand side denotes the wives' side.

There will be only homogamous marriage, that is, educated men and women marry with each other and the same holds for uneducated men and women. From proposition 2, men of type A (type B) marry only women of type A (type B). Then, we can divide the group of men and women in four disjoint groups: men of type A (type B) and women of type A (type B). We split our problem in two subgroups: men and women of type A and men and women of type B. And we can show that in each market the equilibrium exists and is unique. In this situation, we have two markets composed by men and women of type A and men and women of type B.

Having positive assortative mating, we consider condition (1.26) so the proportion of educated (uneducated) men who marry must be the same of the proportion of educated (uneducated) women who marry. Using condition (1.28) and symmetry of $F(\theta)$, we have the following condition:

$$H(0)\{F(V_1+\lambda_i)[1-G(R^P+V_2-V_1)]\} = H(0)\{F(U_1+\lambda_j)[1-G(R^Q+U_2-U_1)]\} \quad (1.39)$$

[10]We present this section in a similar way as in Chiappori, et al. (2009).

where $H(0) = \int_0^{+\infty} h(\lambda)\, d\lambda$. The left side of the equation represents the proportion of uneducated men that get married. This area is represented in Figure 1.1 in the regions green and blue. The right side of the equation represents the proportion of uneducated women who get married.

In this condition we consider that we have an equal number of uneducated men and women who get married. The equilibrium, in this case, satisfies (1.39), (1.38),

$$U_1 + V_1 = Z_{11}$$

and

$$U_2 + V_2 = Z_{22}$$

. We show in Appendix B that there is a unique equilibrium with homogamous marriage in each group A and B.

1.4 Limitations and Possible Extensions

The present work analyzed marriage decision between people that belong to different groups and they have preference for intra-group marriage. In this framework, under symmetric preferences, we can show that there is a unique equilibrium with homogamous marriage. It will be very interesting to develop a model that could explain the mixed marriage between people from different types. What kind of asymmetry can induce mixed marriage? In addition, we can ask why there is an increasing trend in mixed marriage nowadays related with some minority groups than there was decades ago? Kalmijn (1998) One possible explanation can be related to a searching problem. Petrongolo and Pissarides (2001) In some countries, these minority groups no longer live in the same neighborhood or are isolated from the rest of society and that could explain why it is hard to find a match from the same type. [11]

The mechanism to transmit ethnic traits through marriage is still strong within some groups. Nevertheless, women household role changed in some countries and both men and women in those societies are feeling more free to search for their partners. Moreover, as social norms have changed, women are investing more in schooling and spending less time working at home.[12]

The changes in segregated neighborhoods, social norms and women household role can make more difficult for men (women) to find a match within their own type. In such both cases, if men and women intend to marry within their own type, best strategy should be improve educational level in order to increase his payoff and become more attractive to a potential partner. This could be a reason why some minorities have higher educational

[11] Bisin et al. (2004)
[12] Chiappori (2009)

attainment than majority groups.[13] And in the case they do not find someone from own type, with a higher educational level, they can be more competitive in the market and marry with an educated person. In both situations, they will earn a higher marital surplus.

1.5 Conclusion

In this work we model how agents' marriage and education decisions are related to ethnic intra-group preferences. Under symmetric preferences we are able to show that agents will marry within his (her) own type and assortative in Education. We show that there is a unique equilibrium with homogamous marriage.

Part of the agents wants to get married because their preference for marriage is high. So they want to get married anyway but they will end up married with someone from their own group because there is always a partner of his (her) own type (due to symmetry) that will accept to marry to gain the extra bonus from marrying someone of her (his) own type. So, they decide to marry. And, as they know they will get married, the channel to increase the return of marriage is to acquire education. This result suggests that people can acquire education in order to marry his own type. Men and women can increase their material surplus through education.

Comparing our model with Chiappori et al. (2009)'s framework we are able to show that agents will acquire education in order to improve their material surplus on the marriage. In this situation, he (she) wants to marry with someone of specific trait and he (she) knows, by symmetry, that there is a woman who will decide to study as well. So, the proportion of educated men and women are greater in our framework than in Chiappori et al. (2009).

We also show that there is no incentive to marry with mixed types. We left for future research to analyze the role of asymmetric returns in education over marriage market equilibrium in this framework.

1.A Appendix A

In our framework the material shares U_J and V_I do not depend on type A or B.[14] And it is possible to show this result.[15]

Consider men and women have symmetric preferences (1.4 and 1.5), symmetry in

[13]Sander (2010)
[14]This proof follows Chiappori et al. (2009).
[15]This part is available upon request.

gender (1.3 and 1.25) and condition (1.2) holds.[16]

The proportion of men who marry is:

$$2\left\{\begin{array}{c}\int_0^{+\infty}\int_{-(V_2+\lambda_i)}^{-(V_1+\lambda_i)} G(R^P+V_2+\theta_i+\lambda_i)f(\theta)h(\lambda)d\theta d\lambda \\ +\int_0^{+\infty}\{1-F[-(V_1+\lambda_i)]\}h(\lambda)d\lambda\end{array}\right\} \tag{1.42}$$

The proportion of men who marry and study:

$$2\left\{\begin{array}{c}\int_0^{+\infty}\int_{-(V_2+\lambda_i)}^{-(V_1+\lambda_i)} G(R^P+V_2+\theta_i+\lambda_i)f(\theta)h(\lambda)d\theta d\lambda \\ +\int_0^{+\infty}\{1-F[-(V_1+\lambda_i)]\}G(R^P+V_2-V_1)h(\lambda)d\lambda\end{array}\right\} \tag{1.43}$$

In the marriage market equilibrium, the proportion of men and women who marry have to be the same. Using equation (1.42) we can write the following condition:

$$\begin{aligned}&\int_0^{+\infty}\int_{-(V_2+\lambda_i)}^{-(V_1+\lambda_i)} G(R^P+V_2+\theta_i+\lambda_i)f(\theta)h(\lambda)d\theta d\lambda+\int_0^{+\infty}\{1-F[-(V_1+\lambda_i)]\}h(\lambda)d\lambda= \\ &\int_0^{+\infty}\int_{-(U_2+\lambda_i)}^{-(U_1+\lambda_i)} G(R^Q+U_2+\theta_i+\lambda_i)f(\theta)h(\lambda)d\theta d\lambda+\int_0^{+\infty}\{1-F[-(U_1+\lambda_i)]\}h(\lambda)d\lambda\end{aligned} \tag{1.44}$$

Considering strictly positive assortative mating, the proportion of men and women who are educated (uneducated) must be the same. In addition, we impose condition (1.44) and the number of men and women who marry and not study are the same. Using condition (1.43) and symmetry, we can derive this condition as

$$\int_0^{+\infty} F[(V_1+\lambda_i)]\}\left[1-G(R^P+V_2-V_1)\right]h(\lambda)d\lambda= \tag{1.45}$$

$$\int_0^{+\infty} F[(U_1+\lambda_i)]\}\left[1-G(R^Q+U_2-U_1)\right]h(\lambda)d\lambda \tag{1.46}$$

Considering conditions

$$U_1+V_1=Z_{11}$$

and

$$U_2+V_2=Z_{22}$$

, (1.44) and (1.45), they provide a system with four equations and four unknowns.

[16]Consider also:

$$\Pi_p^A = \Pi_p^B \tag{1.40}$$

$$\Pi_q^A = \Pi_q^B \tag{1.41}$$

Consider the four conditions (1.44), (1.45),

$$U_1 + V_1 = Z_{11}$$

and

$$U_2 + V_2 = Z_{22}$$

. As the model is completely symmetric, it holds condition (1.3) and (1.25). We have from (1.3) $U_1 + V_2 = U_2 + V_1$. Then,

$$U_1 - U_2 = V_1 - V_2 \tag{1.47}$$

Substituting (1.25) and (1.47) in (1.45), we have:

$$\begin{aligned} 2\left\{+\int_0^{+\infty} F[(V_1+\lambda_i)]\}\left[1-G(R^P+V_2-V_1)\right]h(\lambda)d\lambda\right\} &= \\ 2\left\{+\int_0^{+\infty} F[(U_1+\lambda_i)]\}\left[1-G(R^Q+V_2-V_1)\right]h(\lambda)d\lambda\right\} & \end{aligned} \tag{1.48}$$

To keep equality $\Rightarrow$

$$V_1 = U_1 \tag{1.49}$$

Substituting (1.49) in

$$V_1 + U_1 = Z_{11}$$

we have the following result:

$$V_1 = U_1 = Z_{11}/2 \tag{1.50}$$

Substituting (1.49) in (1.47) we have

$$V_2 = U_2 \tag{1.51}$$

So,

$$V_{22} = U_{22} = Z_{22}/2 \tag{1.52}$$

1.B Appendix B

A) We intend to show existence and unicity of equilibrium:

Our proof establishes existence of equilibrium and that it is unique in two steps. It follows very closely the proof in Chiappori et al. (2009).

Step 1:

Consider equation (1.28) and substitute for $U_2 = z_{22} - V_2$ and $U_1 = z_{11} - V_1$. Now define a function $\Phi(V_1, V_2)$ as

$$\begin{aligned}\Phi(V_1, V_2) &= \int_0^{+\infty}\int_{(V_1+\lambda_i)}^{(V_2+\lambda_i)} G(R^P + V_2 - \theta_i + \lambda_i) f(\theta)\, h(\lambda) d\theta d\lambda \\ &+ \int_0^{+\infty} F(V_1 + \lambda_i)\, h(\lambda) d\lambda \\ &- \int_0^{+\infty}\int_{(U_1+\lambda_j)}^{(U_2+\lambda_j)} G(R^Q + U_2 - \theta_j + \lambda_j) f(\theta)\, h(\lambda) d\theta d\lambda \\ &- \int_0^{+\infty} F(U_1 + \lambda_j)\, h(\lambda) d\lambda\end{aligned} \tag{1.53}$$

where $H(0) = \int_0^{+\infty} h(\lambda)\, d\lambda$

$$\Phi(V_1, V_2) = H(0)\left\{\begin{array}{c}\int_{(V_1+\lambda_i)}^{(V_2+\lambda_i)} G(R^P + V_2 - \theta_i + \lambda_i) f(\theta)\, d\theta + F(V_1 + \lambda_i) \\ -\int_{(U_1+\lambda_j)}^{(U_2+\lambda_j)} G(R^Q + U_2 - \theta_j + \lambda_j) f(\theta)\, d\theta - F(U_1 + \lambda_j)\end{array}\right\} \tag{1.54}$$

$$\Phi(0,0) = H(0)\left\{F(\lambda_i) - \int_{(U_1+\lambda_j)}^{(U_2+\lambda_j)} G(R^Q + z_{22} - \theta_j + \lambda_j) f(\theta)\, d\theta - F(z_{11} + \lambda_j)\right\} < 0 \tag{1.55}$$

and

Considering $z_{11} > 0$ implies that $F(z_{11} + \lambda_i) - F(\lambda_j) > 0$. By continuity, it is possible to consider that there is a set of pairs (V_1, V_2) for which $\Phi(V_1, V_2) = 0$.

Using the Implicit Function Theorem,

$$\frac{\partial\Phi(V_1, V_2)}{\partial V_1} = H(b)\left\{\begin{array}{c} f(V_1 + \lambda_i) - f(z_{11} - V_1 + \lambda_j) - G(R^P + V_2 - V_1 + \lambda_i) f(V_1 + \lambda_i) \\ -G(R^Q + z_{22} - V_2 - V_1 + \lambda_j) f(\theta)\, d\theta - F(z_{11} - V_1 + \lambda_j)\end{array}\right\} = \tag{1.56}$$

$$H(b)\left\{f(V_1 + \lambda_i)\left[1 - G(R^P + V_2 - V_1 + \lambda_i)\right] - f(z_{11} - V_1 + \lambda_j)\left[1 - G(R^Q + z_{22} - V_2 + V_1 + \lambda_j)\right]\right\} > 0$$

$$\frac{\partial\Phi(V_1, V_2)}{\partial V_2} = H(0)\left\{\begin{array}{c}\int_{(V_1+\lambda_i)}^{(V_2+\lambda_i)} g(R^P + V_2 - \theta_i + \lambda_i) f(\theta)\, d\theta + G(R^P) f(V_1 + \lambda_i) f(V_2 + \lambda_i) \\ +\int_{(z_{11}-V_1+\lambda_j)}^{(z_{22}-V_2+\lambda_j)} g(R^Q + z_{22} - V_2 - \theta_j + \lambda_j) f(\theta)\, d\theta(-1) + G(R^Q) f(z_{22} - V_2 + \lambda i)\end{array}\right\} > 0 \tag{1.57}$$

According to the Implicit Function Theorem, the derivative $\frac{\partial V_2}{\partial V_1}$ is negative so the function $\Phi(V_1, V_2)$ is a decreasing curve in the (V_1, V_2) plane.

Step 2:

Using (26), define $\Theta(V_1, V_2)$ as

$$\Theta(V_1, V_2) = H(0)\left\{F\left(V_1 + \lambda_i\right)\left[1 - G(R^P + V_2 - V_1)\right] - F\left(z_{11} - V_1 + \lambda_j\right)\left[1 - G(R^Q + z_{22} - V_2 - z_{11} + V_1)\right]\right\} \tag{1.58}$$

Note that Θ is continuously differentiable, the derivative of $\Theta(V_1, V_2)$ with respect of V_1 is increasing and decreasing with respect to V_2. In addition:

$\lim_{V_1 \to \infty} \Theta(V_1, V_2) = H(0)\{1 - 0\} - H(0)\{0\} = H(b)$

$\lim_{V_2 \to \infty} \Theta(V_1, V_2) = H(0)\{[F(V_1 + \lambda_i)\,0] - [F(z_{11} - V_1 + \lambda_j)(1 - 0)]\} = -H(0)F(z_{11} - V_1 + \lambda_j) < 0$

There is a locus that satisfies $\Theta(V_1, V_2) = 0$, considering continuity. From the implicit function theorem, it is possible to obtain an increasing curve in the (V_1, V_2) plane. Moreover, $\Theta(V_1, V_2) = A(V_1, V_2 - V_1)$ where $V_1 = V$ and $V_2 - V_1 = X$, where

$$A(V, X) = H(0)\left\{F(V + \lambda_i)\left[1 - G(R^P + X)\right] - F(z_{11} - V + \lambda_j)\left[1 - G(R^Q + z_{22} - X - z_{11})\right]\right\}$$

Since

$$\frac{\partial A(V, X)}{\partial V} = H(0)\left\{f(V + \lambda_i)\left[1 - G(R^P + X)\right] + f(z_{11} - V + \lambda_j)\left[1 - G(R^Q + z_{22} - X - z_{11})\right]\right\} > 0,$$

$$\frac{\partial A(V, X)}{\partial X} = H(0)\left\{-F(V_1 + \lambda_i)\,g(R^P + X) - F(z_{11} - V + \lambda_j)\,g(R^Q + z_{22} - X - z_{11})\right\} < 0,$$

from equation $A(V, X) = 0$ it is possible to define X as an increasing function ϕ of V.

Therefore,

$$\Theta(V_1, V_2) = A(V_1, V_2 - V_1) = 0$$

gives

$$V_2 - V_1 = \phi V_1$$

$$V_2 = V_1 + \phi V_1$$

(where $\phi'(V) > 0$)

$$\frac{\partial A(V, X)}{\partial V_1} = \frac{\partial A(V, X)}{\partial V}(1) + \frac{\partial A(V, X)}{\partial X}(-1)$$

$$\frac{\partial A(V, X)}{\partial V_2} = \frac{\partial A(V, X)}{\partial X}.\frac{\partial X}{\partial V_2} = \frac{\partial A(V, X)}{\partial X}.1$$

$$\frac{\partial V_2}{\partial V_1} = \frac{-\left(\frac{\partial A(V,X)}{\partial V} - \frac{\partial A(V,X)}{\partial X}\right)}{\frac{\partial A(V,X)}{\partial X}} = -\left(\frac{\frac{\partial A(V,X)}{\partial V}}{\frac{\partial A(V,X)}{\partial X}} - 1\right) > 1$$

where $\frac{\frac{\partial A(V,X)}{\partial V}}{\frac{\partial A(V,X)}{\partial X}}$ is negative.

The slope of the function $\Theta(V_1, V_2) = 0$ is positive and greater than one whereas the function $\Phi(V_1, V_2) = 0$ is decreasing. Both functions are intersect at the point (V_1^*, V_2^*) and it is unique.[17]

1.C Appendix C: A Numerical Example

We intend to motivate our model building up two illustrative examples. The first one, based on Chiappori et al. (2009), shows the decisions of marriage and schooling (agents are educated or uneducated) in a symmetric environment. While in the second, we introduce another idiosyncratic source between agents besides the preference for marriage. In this case, agents have preferences for marriage within his (her) own type.

The idiosyncratic preference for marriage (θ) is unconditional. It does not depend on whom you are marring but if the agent gets married. Whereas the marriage type (λ) is conditional with the decision of marriage because it depends with whom the spouse is getting marriage.

There is a unique optimal assignment in both examples.

1.C.1 Example 1: Chiappori Framework

Suppose we have two men and two women. We present, in the example 1, a benchmark model where there is symmetry in preferences and opportunities between agents. And both men and women belong to the same group ($\lambda_i = \lambda_j = 0$) as in Chiappori et al. (2009). The only difference between them is their decision about schooling and it depends on a cost of schooling μ. We consider that man A and woman A have an idiosyncratic cost of schooling equal to $\mu_A = 6$ and man B and woman B have an idiosyncratic cost of schooling equal to $\mu_B = 3$. Moreover, each agent has his/her idiosyncratic preference over marriage represented by the greek letter θ (man and woman A share the same θ and it is equal to $\theta_A = 1$ and man and woman B share the same θ and it is equal to $\theta_B = -4.2$. The returns from education are: $R^p = R^q = 1$.

Investment decision for men i depends on the conditions (1.19 and 1.24). These conditions hold for women too.

The marriage generates a material surplus Z_{IJ} which will be divided between the partners and the first step is to determine the share of each partner (conditions 1.15

[17] Chiappori et al. (2009).

and 1.16). The share of each spouse depends only if the agents are educated or not. For example, $Z_{12} = 4$ represents the material surplus of the marriage where the first subscription is related to men education (1 uneducated and 2 educated) and the second is related to women education.

The material gain is given below:

Table 1: Material Gain

Z_{11}	3
Z_{12}	4
Z_{21}	4
Z_{22}	10

Table 2: The payoff matrix Z_{IJ}.

	w_1	w_2
m_1	3	4
m_2	4	10

We can check that conditions 1.2 and 1.3 hold. There is symmetry because $Z_{12} = Z_{21}$ and consider $Z_{11} + Z_{22} > Z_{12} + Z_{21}$.

There are two possible partnerships that can be formed with these four players. The unique optimal assignment is the one which includes the pairs (m1, w1) and (m2, w2), that is, man and woman uneducated and man and woman educated.[18] The total payoff is $Z_{11} + Z_{22} = 13$. Each agent shares part of this payoff. Shares must respect conditions 1.9 and 1.10. In the case of marriage, condition 1.10 holds as equality.

In our example we can have more than one way to share the material gain between the spouses. One of the solutions can be spouses m1 and w1 share exactly half of their join payoff 3 which will be divided between $V_1 = 1.5$ (man share) and $U_1 = 1.5$ (woman share). So each of them keeps $V_1 = U_1 = 1.5$. And m2 and w2 shares exactly half of their joint payoff $Z_{22} = 10$, so $V_2 = U_2 = 10/2$. So, in equilibrium, agents know V_I and U_J, and they can decide whether they will invest in schooling or not.

The second step is to verify if the conditions for acquiring schooling are satisfied. Man and woman A share the same $\theta_A = 1$ and it is greater than $-V_1(-1.5)$. In this case, **they will marry** and in order to get educated μ_A should be smaller than $\mu = 4.5$[19]. But μ_A is greater than μ which indicates **they will decide not to invest in schooling**. Man and woman B share the same $\theta_B = -4.2$. In this case, they will get married only if they decide to invest in schooling. So μ_B should be smaller than $\mu' = 1.8$[20], in their case $\mu_B = 3$ is greater than μ' which indicates **they will not invest in education and not get married**.[21]

[18] 1 uneducated and 2 educated.

[19] $(\mu = R^p + V_2 - V_1)$

[20] $(\mu' = R^p + V_2 + \theta_i)$

[21] Conditions taken from Chiappori et al. (2009).

The third step is to calculate the share that each partner keeps from the marital surplus which includes the emotional gains from marriage (see condition 1.8). Consider that uneducated man and woman A have $\theta_A = 1$. So the payoff matrix s_{ij} is presented in table 3 and figure 1.1 brings the share u_j and v_i of each agent. The equilibrium is unique.

Table 3: The payoff matrix s_{ij}.

	w_{1A}	w_{1B}
m_{1A}	**5**	0
m_{1B}	0	0

Figure 1: Shares u_j and v_i of each agent.

$v_1 = u_1 = 1.5 + 1 = 2.5$
$v_2 = u_2 = 0$

1.C.2 Example 2: Our Framework: An Extension of Chiappori.

Suppose we have two men and two women. But in this case we have another idiosyncratic source between agents besides preference for marriage. The agents have preferences to marry within the group $\gamma \in \{A, B\}$ whereas in Chiappori et al. (2009), they did not. In this case if a woman of type A (B) marries man type A (B) they will earn λ_i and λ_j (where $\lambda > 0$), respectively.

In the example 2 we present a model where there is symmetry in preferences and opportunities between agents. (conditions (1.4), (1.5), (1.6), (1.7), (1.2) and (1.3)) The couple will share material gains from marriage adding the idiosyncratic components. The decision about schooling depends on the cost of education μ. We consider that man A and woman A have an idiosyncratic cost of schooling $\mu_A = 6$ and man B and woman B have an idiosyncratic cost of schooling $\mu_B = 3$. The returns from education are: $R^p = R^q = 1$.

Moreover, each agent has his/her idiosyncratic preference over marriage. Man and woman A share the same $\theta_A = 1$ and man and woman B share the same $\theta_B = -4.2$. In addition, man and woman A (B) share the same idiosyncratic type marriage $\lambda_i = \lambda_j = 1.5$ if they decide to marry within the group.

The decision of schooling and marriage depends on whether the conditions (1.19 to 1.24) are satisfied. The same holds for women j of type γ.

Consider the material gain (table 1). As there is symmetry between agents and the returns from schooling are the same, in equilibrium, with assortative marriage, one of the solutions is characterized by equal sharing. The agents m_2 and w_2 divide the payoff $Z_{22} = 10$. between them, $V_2 = U_2 = 5$. The same for m_1 and w_1, they divide the payoff $Z_{11} = 3$ between them, $V_1 = U_1 = 1.5$.[22]

[22](1 uneducated and 2 educated)

The second step is to verify whether the conditions for acquiring schooling are satisfied. Man and woman A share the same $\theta_A = 1$ and it is greater than $-V_1 = -(1.5+1) = -2.5$ (see condition 1.21). In this case, **they will marry** and in order to get educated $\mu_A = 6$ should be smaller than μ ($\mu = 1 + 5 - 1.5 = 4.5$) (see condition 1.22). But their $\mu_A = 6$ is greater than $\mu = 4.5$ which indicates **they will decide not to invest in schooling**. Man and woman B share the same $\theta_B = -4.2$ and it satisfies condition (1.23). In this case, they will get married only if they decide to invest in schooling. So $\mu_B = 3$ should be smaller than $\mu^{''}(\mu'' = 1 + 5 - 4.2 + 1.5 = 3.3)$ (see condition (1.24))[23], in their case $\mu_B = 3$ is smaller than $\mu^{"} = 3.3$ which indicates **they will get married because they decided to invest in schooling**.

The next step is to calculate the share that each partner keeps from the marital surplus which includes the emotional and type gains from marriage. Consider that an uneducated man and woman have $\theta_i = \theta_j = 1$ and educated man and woman have $\theta_i = \theta_j = -4.2$. So the payoff matrix s_{ij} is presented in table 4 and figure 2 brings the share u_j and v_i is of each agent. There is a unique optimal assignment.

Table 4: Payoff Matrix s_{ij} .

	w_{1A}	w_{2B}
m_{1A}	$Z_{11} + 2\theta_A + 2\lambda = \mathbf{8}$	$Z_{12} + \theta_A + \theta_B = 4$
m_{2B}	$Z_{21} + \theta_A + \theta_B = 4$	$Z_{22} + 2\theta_B + 2\lambda = \mathbf{4.6}$

Figure 2: Shares u_j and v_i of each agent.

$v_A = u_A = \frac{Z_{11}}{2} + \theta_A + \lambda = 4$
$v_B = u_B = \frac{Z_{22}}{2} + +\theta_B + \lambda = 2.3$

In our both examples we have symmetric agents who share their preferences and opportunities. However, in example B we have idiosyncratic preferences over types (λ_i) which are different from marriage preferences (θ_i). The latter is related with any marriage and the former is related to a marriage with a specific trait. The agent can decide to get married only if the partner shares a specific trait. His or her preference for marriage could be $\theta < 0$ and the spouse can decide to get marriage and acquire schooling only if the partner shares the same trait.

In this case, if conditions (1.24 and 1.23) hold the agent can decide to study in order to get marriage. So, if the agent has idiosyncratic preferences over types he can change his decision about marriage and schooling. Depending on his λ_i the spouse can be interested in marriage and in order to achieve marriage he needs to study.

In this situation, he knows he will get married with someone of his trait because by symmetry there is another woman who share the same preferences. So, they decide to study and increase their material surplus. So, his best decision is to acquire education.

[23] $\mu^{"} > \mu'$

Chapter 2

Household Income Inequality and Educational Assortative Mating in Marriage Market in Brazil: an empirical study.

Abstract

This paper aims to analyze the effects of changes in returns to education, educational composition and educational assortative mating in household income inequality in Brazil covering the period from 1992 to 2014. Our work follows Eika et al. (2014)‘s. The results suggest that changes in marital sorting parameters have little effect on household income inequality whereas returns to education have played a major role as in Eika et al. (2014)'s work. Comparing the counterfactual Gini with returns to education fixed in 2014 with the actual Gini shows that the household income inequality would be lower than what it really was during the period covered by the study. This effect can be explained by the decrease in returns to educations from 1992 to nowadays. If we keep fixed the educational composition of 1992, the counterfactual Gini is lower than the actual one. Both results are in the opposite direction from Eika et al., 2014's work. Finally, if marriages were formed randomlly across time the counterfactual Gini would be lower than the actual one from 1992 to 2014.

JEL codes: J12, D31, I24, I21.
KEYWORDS: household income inequality, assortative mating, marriage market, education, family economics.

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2.1 Introduction

The social norms in household patterns have changed and they have important implications in women's role at home, in the labor market and in the level of education. The family size has shrank over the past decades due to the decrease in fertility rates. Associate with this, time spent in household work has decreased due to technological progress. Female labor force participation has raised. Simultaneously, the increase in the rate of divorce and women labor force participation have reduced the fertility rate. (Becker (1991)).

As a consequence of all these events, women are studying more on average and there has been a change in the composition of marriages in relation to education in the last years. Brazil is not an exception. Educational composition has also changed and can affect several variables such as returns to education, the way couples are being formed, household income inequality, female's contribution to household labor income, number of children, among others. (Becker (1991), Chiappori et al. (2009) and Greenwood et al. (2014))

One important question is based on how marital sorting affects household income inequality. Greenwood et al. (2014) analyzed the assortative mating and income inequality for US data from 1960 to 2005. They estimate the pattern of assortative mating between husband's and wive's educational levels and compares actual Gini to a counterfactual one with random matching. They find that the difference between the actual Gini and the counterfactual was small in 1960 but was significant in 2005. In their work if the marital sorting in 2005 was the same of 1960 the Gini coefficient would drop from 0.43 to 0.35. They also analyzed the effect on income inequality considering that there was a change in female labor force participation. And the difference in the share that married woman caused in household income was greater in upper quantiles rather than in lower ones. The increase in female labor force participation in the last years is one reason that help the income inequality in US not to increase even more.

Over the last decades Brazilian society has changed in many aspects. During the 80's Brazilian economy faced hyperinflation, stabilization plans failures and public finance was disorganized. This period is known as the "lost decade". In the middle of the 90's, after an economic plan stabilization and reforms, economic environment improved. In addition, Brazilian new Constitution of 1988 generalized the right of free education up to fundamental level.

The access to college has grown since the end of the 90's along with the rise in public financial programs that together helped to reduce the number of uneducated people. Access to college increased by two channels: the number of colleges rose in the 90's and for lower middle class it was possible to obtain a college degree. Until that time colleges tuitions were too expensive and lower middle class or poor people had difficulty to access

public universities because they did not have grades for it. The second channel was the rise in public financial support for poor people to finance their studies. (Sampaio (2015))

On the other hand, returns to education in Brazil has decreased in the last years. (Barros et al. (2007),Menezes-Filho et al. (2007),Ferreira et al. (2014)) This change is key element to explain household income inequality. In Brazil, returns to education has been decreasing over time whereas in US they have been increasing. Household income inequality in both countries are following different paths. In US household income inequality is rising whereas in Brazil is decreasing. (Eika et al. (2014) and Greenwood et al. (2014))

Educational composition can have an impact in different aspects of society. One question that can rise is if changes in educational compostion can alter assortative mating pattern. And even if this pattern has remained stable, the increase in the number of educated men and women can raise the probability that a college degree man can marry a woman with a college degree.

Most of Brazilian society was constituted by uneducated people up to 1990 and most couples were formed by homogamous marriage (with uneducated mates). After that, a process of a slowly change took place, that is, the proportion of educated husbands and wives increased. As a possible consequence, this assortative mating pattern could have changed and it can have an impact over household income inequality.

The fall in the gender educational gap increases the probability that an educated wife marries an educated husband even if the pattern of assortative mating has not been changed. In this situation, homogamous marriage could increase because it leads to higher material surplus due to the existence of complementarity between couples' traits. In addition, this trend could affect household income distribution as well.

The goal of this paper is to investigate whether or not household income inequality has been affected by changes in returns to education, educational composition and marital sorting parameters. In this paper we follow Eika et al. (2014)'s work in order to estimate Gini Coefficient and counterfactual scenarios to Brazilian data. The authors estimate Gini coefficient for US and Norway from 1980 to 2007 building counterfactual scenarios to this variable and they analyze the importance of three factors (returns to education, educational composition and marital sorting parameters) in household income inequality.

The changes in household income inequality in Brazil over the last years brought an interesting question. Many events might explain household income inequality as changes in returns to education, educational composition and assortative mating. And how those changes in education can have an impact in household income inequality through couples, specially when assortative mating changes over time. In order to assess the impacts on household income inequality of all these factors we opt to construct a counterfactual analysis based on Eika et al. (2014) and DiNardo et al. (1996) works where they developed a decomposition method.

In this paper we want to analyze changes in Brazilian household income distribution through the channel of marriage market. In the first part we want to study the way couples are formed in Brazil in relation to education, that is, educational assortative mating pattern, and if it has changed over time. Moreover, we want to investigate if these patterns of assortative mating might, together with returns to education and educational composition, have a significant effect in household income inequality.

This paper is organized as follows. In this section, we provide the introduction. In the second section we present the methodology and in the third we present data set. In the fourth section we present the descriptive statistics and in the fifth we present the results. Finally, some final remarks are drawn.

2.2 Methodology

In this section we describe the methodology developed in the paper in order to estimate the marital sorting parameters and the counterfactual scenarios in household income inequality as developed by Eika et al. (2014) as an extension of DiNardo et al. (1996).

2.2.1 Assortative Mating: Marital Sorting Parameter

The first part of the empirical study developed in this chapter is based on Eika et al. (2014) work. In the paper authors estimate a ratio between joint probability of marriage in education and random marriage in education. We want to measure a marital sorting parameter between education levels of i and j as a joint probability that a husband with a level of education j is married with woman with the level i compared to the probability under random matching in education.

$$s_{ij} = \frac{\Pr(Wife = i \cap Husband = j)}{\Pr(Wife = i). \Pr(Husband = j)} \tag{2.1}$$

The marital sorting parameter (2.1) is a measure of independence in the decision of marriage. If s_{ij} is equal to one the decision to get married is independent from education. If s_{ij} is greater (less) than one, a positive (negative) assortative mating in education is expected, that is, the probability to marry someone considering his (her) level of schooling is more (less) expected than under a random marriage in terms of education.

Consider we want to measure the marital sorting between educated husbands and wives. In the numerator we calculate the frequency that educated couples marry with each other in relation to the total of couples. In the denominator we calculate the product of the frequency of educated men related to the total men in the sample and the frequency of educated women related to the total women in the sample. In the denominator we estimate what would be the joint probability if the events were independent in relation to education, that is, if we draw a man and a woman from our sample and the chance

that both are educated is the same as the numerator. If this happens we can say that the marital sorting parameter is one. From 1992 to 2014, we estimate the marital sorting parameters considering all possible combination of couples. We want to investigate the probability of marriage in education.

2.2.2 Decomposition Method

In order to measure the counterfactual household income inequality we use the decomposition method proposed by DiNardo et al. (1996) and extended by Eika et al. (2014). We will produce counterfactual scenarios considering three possible changes (one change at a time) in returns to educational, marital sorting parameters and educational composition and if these changes could have had some impacts in the household income distribution. We keep two of these variables varying over time and we hold the third variable fixed considering a base year, to create our counterfactual.[1]

We have a distribution $F(y, x, t)$ where y is the household income, x denotes the couples' educational attainment which is a combination (i, j) of husband's and wife's level of education and year t. The joint distribution of household income is denoted as $F_{Y,X}(y, x|t)$. The distribution of income in year t can be written as:

$$F_Y(y|t) = \int F_{Y,X}(y, x|t) = \int F_{Y,X}(y|x, t)dF_x(x|t) \tag{2.2}$$

where $F_Y(y|t)$ is the couples' income distribution and $F(x|t)$ is the distribution of spouses' level of education in year t. $F_{Y,X}(y|x, t)$ is the conditional distribution of income for couples with the level of education x in year t. This is the return to education.

To be able to estimate the counterfactual let consider t_{ij}, t_s and t_y. Let t_{ij} denotes the year where the couples' attributes of education are considered for estimation, t_s is the year when the marital sorting parameters are measured and the year t_y represents the period in which we measure the economic returns. The distribution of income under a counterfactual scenario can be written as:

$$F'(y|t_{ij}, t_s, t_y) = \int F_{Y,X}(y|x, t_y)\Psi_x(x|t_{ij}, t_s, t_y)dF_x(x|t_y) \tag{2.3}$$

where Ψ_x is a reweighting function and is defined as shown below:

$$\Psi_x(x|t_{ij}, t_s, t_y) = \frac{dF'_x(x|t_{ij}, t_s)}{dF_x(x|t_y)} \tag{2.4}$$

To understand the counterfactual, the numerator is the distribution of spouses' level of education if these individuals attributes would have remained at the same level of $t_{ij} = t_0$

[1]We follow very closely Eika et al. (2014)'s notation.

and the marital sorting parameters would have remained the same as in $t_s = t$. It is important to highlight that in the exercise we can change either t_{ij}, t_s and t_y but one at a time, that is, we change t_{ij}, t_s or t_y keeping the other two varying over time. The distribution of one factor is fixed in a base year while the others vary over time.

$$F'_Y(y|t_{ij} = 1992, t_s = t, t_y = t) = \int F_{Y,X}(y|x, t_y = t)\Psi_x(x|t_{ij} = 1992, t_s = t, t_y = t)dF_x(x|t_y = t) \tag{2.5}$$

Equation (2.5) shows the distribution with a counterfactual scenario where the income distribution is estimated considering the educational composition of 1992 and the other two factors, returns to education and marital sorting, are measured in year t. When we compare this counterfactual scenario with the actual income distribution in year t, we are able to measure the difference of what would have been the income distribution if the educational composition had remained the same as in 1992. So, we could estimate the impacts on household income inequality keeping fixed educational composition in 1992. We can do this counterfactual scenario to returns to education and marital sorting parameters as well.

To be able to measure the counterfactual, we need to estimate the reweighting function Ψ'_x.

$$\Psi_x(x|t_{ij}, t_s, t_y) = \frac{d\ F'_x(x|t_{ij} = 92, t_s = t)}{dF_x(x|t_y = t)} \tag{2.6}$$

The reweighting function is the ratio of the proportion of couples that would have been formed with educational attainment x if the marginal distributions of educational composition of men and women were formed in 1992 and marital sorting formed in t in relation to the proportion of couples with educational attainment x in year $t_y = t$.

Rewriting equation (2.6) as:

$$\Psi'_x(x|t_{ij}, t_s, t_y) = \frac{P'_x(t_{ij} = 92, t_s = t)}{P_x(t_y = t)} \tag{2.7}$$

To obtain the reweighting function Ψ'_x (and then the counterfactual household income distribution) we need to follow some steps as done in Eika et al. (2014). We need to estimate $P'_x(t_{ij} = 92, t_s = t)$.[2]

1) Draw one man from the marginal distribution of education of men and one woman from the marginal distribution of education of women in $t = 1992$. With probability

$$\Pr(Wife = i, t = 1992). \Pr(Husband = j, t = 1992) \tag{2.8}$$

[2]In the case of Di Nardo et al. they estimate the reweighting function Ψ_x using a Probit model.

we have a man and woman with level of education i, j.

2) Along with the product of the marginal distributions with the marital sorting parameter $s_{ij}(t)$, we decide if the couple will get married or not. So, to measure the counterfactual we need to draw a man and woman from the marginal distributions of education of men and women and estimate $s_{ij}(t)$. They will get married with probability:

$P\prime = \Pr(Wife = i, t = 1992).\Pr(Husband = j, t = 1992).s_{ij}(t)$.

3) If they get married, we draw them from the marginal distributions of education and measure the probabilities in equation (2.8) again without that couple. We need to measure the marginal distributions in every iteration. And then do the process again, until all couples are formed.

4) This procedure continuos until this $P\prime$ is stabilized. In the empirical work we run this procedure 10.000 times.

2.3 Data

We use Brazilian National Household Sample Survey (PNAD) for the years 1992, 1995, 1998, 1999, 2001 to 2014. We analyze couples with the mean of the husband's and wife‘s age is between 26 and 60 years old. The education level was divided in four mutually exclusive groups, similar as in Eika et al. (2014).

The first one is formed by people with no high school degree (less than 11 years of schooling). The second one, is formed by people with complete high school degree (11 years of schooling). The next one is formed by individuals with some college (12-14 years of schooling) and the last group is the college graduate (more than 15 years of schooling).

We use the family weight for balance the data except for the years between 1992 and 1995 where it is available only individual weights. In 2014, for example, we have a sample with 58.191 couples.

2.4 Descriptive Statistics

Table (2.1) shows the percentage of homogamous couples in each level of schooling. We can observe that there is a change in educational composition in the couples in Brazil from 1992 to 2014. In 1992, 73% of couples were formed by spouses with no high school degree, 4.7% with high school degree and 3.1% with college graduate. In 2014, these percentages change to 41%, 14.1% and 7%, respectively. The proportion of uneducated assortative couples decreased whereas the proportion of educated couples rose (see Figure 2.4).

As seen in Table (2.1) and Figure (2.4), the percentage of assortative couples has changed between 1992 and 2014, from 81% of total couples, in 1992, to 63%, in 2014, approximately. The decrease in the proportion of assortative couples in the last decades

can be an evidence of the change in educational composition in Brazil. In 1992, almost 80% of men and women in Brazil had no high school degree whereas in 2014 this proportion has changed to 50% for women and 58% for men as seen in Figure (2.4). In one hand, the chance to find an assortative uneducated couple was very high compared to nowadays.

On the other hand, the number of educated women grew more than men, as we can see in the Figure (2.3). The proportion of women with college degree increased meaningly from 6% to 15% and men raised form 6.5% to 11.5% in the same period. So there are more educated women then men and this can be seen as an evidence of the increase of mixed marriage in education as seen in Figure (2.4) where the percentage of assortative couples decreased from 81.1% in 1992 to 63% in 2014.

Couples formed with the same Level of Schooling, 1992 and 2014 (PNAD)

1992

Level of Schooling	**Couples**	**Percentage of assortative couples**	**Percentage of total couples**
No High School Degree	33178	89.9%	73.0%
High School Debree	2150	5.8%	4.7%
Some College	143	0.4%	0.3%
College Degree	1423	3.9%	3.1%
Total	36,894	100.0%	81.1%

2014

Level of Schooling	**Couples**	**Percentage of assortative couples**	**Percentage of total couples**
No High School Degree	23992	65.7%	41.2%
High School Debree	8218	22.5%	14.1%
Some College	282	0.8%	0.5%
College Degree	4051	11.1%	7.0%
Total	36,543	100.0%	62.8%

Table 2.1: Couples formed with the same Level of Schooling, 1992 and 2014 (PNAD)

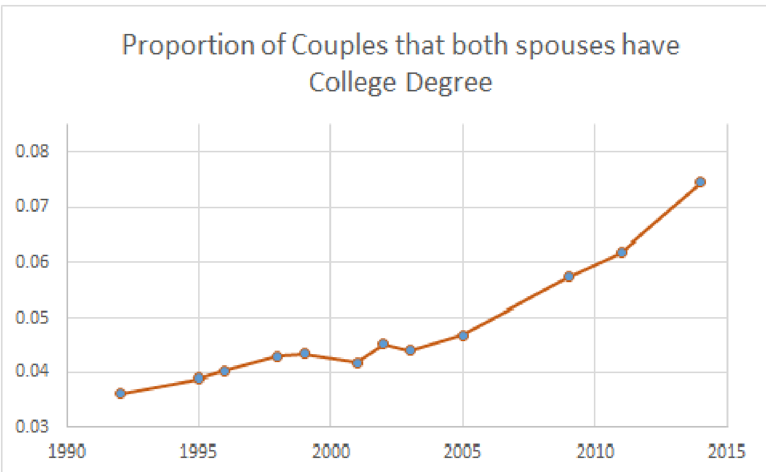

Figure 2.1: Proportion of couples that both spouses have College Degree (PNAD)

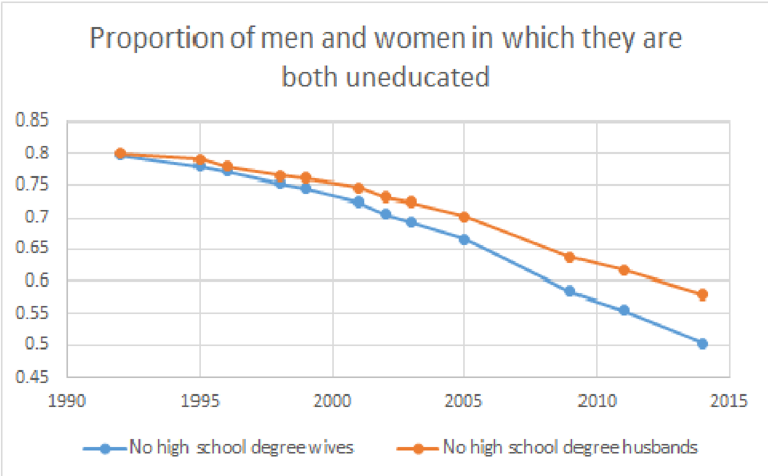

Figure 2.2: Proportion of uneducated men and women (PNAD)

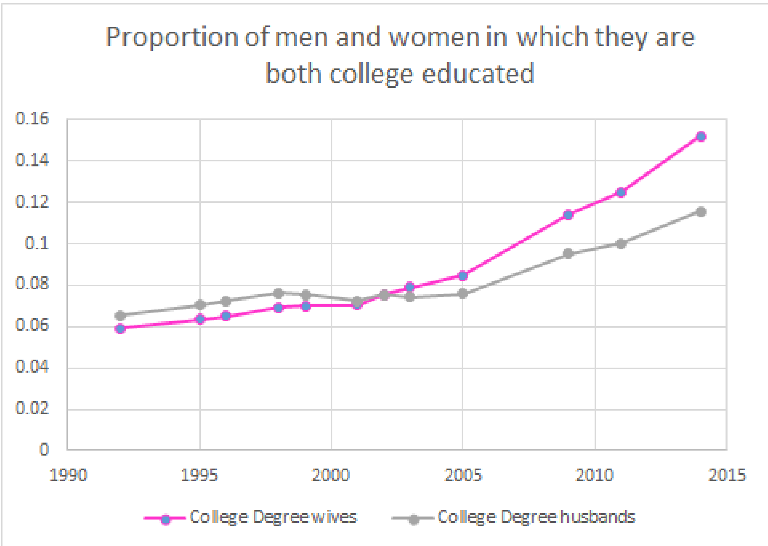

Figure 2.3: Proportion of men and women with College graduate (PNAD)

Figure (2.4) displays the proportion of husbands and wives with the same level of schooling, husbands more educated than wives and wives more educated than husbands. The proportion of wives more educated than husbands grew from, approximately, 9% in 1992 to 23.5% in 2014 but the number of husbands more educated than wives also increased from 9.7% to 13.7% in the same years respectively. Changes in the aggregate number of educated women and men can have an impact in the decision of who marries whom.

From table (2.2), we can observe many changes between husbands and wives in 1992 to 2014. The mean age for spouses has grown 5% for husbands and 7% for wives. The proportion of labor force participation of husbands and wives has changed specially for women from 51% to 70.5%. Perhaps as a reflection of this growth, the number of siblings

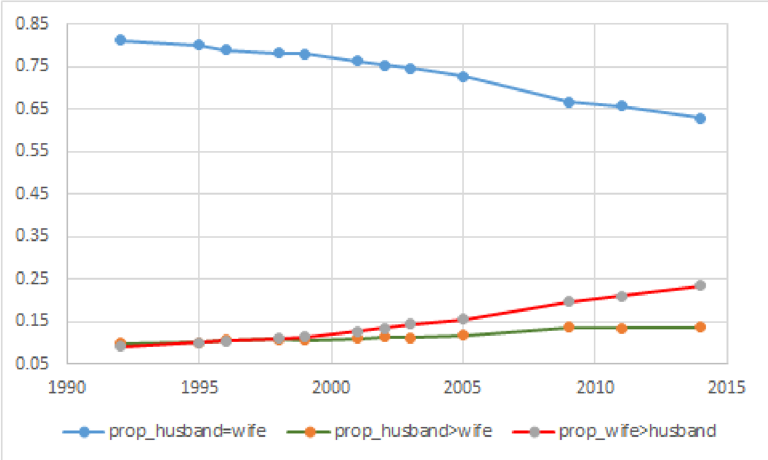

Figure 2.4: Proportion of Educational Attainment of wives and husbands (PNAD)

has decreased from 2.34 to 1.40 and the number of couples without children has grown from 11% to 24% in 22 years. The hours spent in household work by wives who participate in labor force is 24.7 hours per week and by husbands is 10.1 hours in 2014.

	1992		**2014**	
	Husbands	Wives	Husbands	Wives
Sample Means:[1]				
Age	41.5	37.5	43.6	40.1
Years of Schooling	5.6	5.5	8	8.9
Income (US$)[2]	4151	997	10739	5004
Labor Force part.	0.91	0.51	0.93	0.70
Number of Children	2.34		1.4	
Couples without children	0.11		0.24	
Number of Observations	45469		58191	

Table 2.2: Summary Statistics, 1992 and 2014 (PNAD)
[1] This table reports data from husbands and wives which couples' age considered here has the mean of husbands' and wives' age between 26 and 60 years. [2] Exchange Rate from 09/25/1992 and 09/026/2014.

Table 2.3 displays Ordinary Least Square (OLS) regression of log-income on educational levels (conditional on potential experience). It brings evidence on the decrease in returns to education in Brazil from 1992 to 2014. This result differs from US and Norway results reported in Eika et al. (2014).

	1992		2014	
VARIABLES	Husband	Wife	Husband	Wife
Intercept	13.64***	12.81***	6.876***	6.387***
	(0.0101)	(0.0126)	(0.00823)	(0.00860)
Potential Experience	0.0266***	0.0228***	0.0270***	0.0205***
	(0.00124)	(0.00173)	(0.00116)	(0.00142)
Potential Experience Squared	-4.51e-04***	-3.76e-04***	-6.38e-04***	-5.39e-04***
	(2.85e-05)	(3.95e-05)	(3.28e-05)	(4.63e-05)
High School Graduates	0.855***	0.930***	0.451***	0.457***
	(0.0189)	(0.0224)	(0.00953)	(0.00995)
Some College	1.254***	1.401***	0.812***	0.759***
	(0.0420)	(0.0545)	(0.0220)	(0.0212)
College Degree	1.707***	1.748***	1.353***	1.364***
	(0.0223)	(0.0267)	(0.0124)	(0.0114)
Observations	18,184	18,184	30,607	30,607
R-squared	0.319	0.255	0.312	0.338

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.3: Impacts of Levels of Education on Log-wages, 1992 and 2014 (PNAD)
Notes: This table reports OLS estimates of monthly log-income on educational level and potencial experience (linearly and squared). Each column is a separate regression. Potential experience is defined as years of work reported in the research. Excluded education level is no high school degree. Dependent variable is the monthly log-income. We drop couples with missing variables in data (log-income and potencial experience). Standard errors in parentheses.

2.5 Results

2.5.1 Assortative mating in education

We want to analyze whether there is a positive assortative in education in married couples. As we can see in Table (2.4) which reports combinations of all possible levels of education between a couple. In 1992, more educated couples were eight times as likely to be married to one another when compared with a possible random matching in education but in 2014 this number was about 4 times. Probably, one reason for this change was the increase in the number of educated men and women in the past years as shown in the Figure (2.3).

The denominator of the marital sorting parameter (s_{ij}) has increased because the proportion of educated men and women has grown. So, as a consequence, the marital sorting parameter is lower then it was years ago. The chance an educated man has to marry an educated woman comparing to a random matching is lower probably due to the fact that there are more educated people in our sample and the chance to find an educated person randomly is higher.

The point here is how to interpret this decline. Does it mean that less educated people are getting married with each other? The answer is no. We have a minority effect here. In 1992 only 3% of our couples were composed by educated men and wife. In 2014, this number increased to almost 7%. So, the chance to find an educated partner today randomly is greater than it was decades ago. The denominatior of marital sorting parameters has increased faster than the numerator. As a consequence, the positive assortative mating in some combinations of education is smaller today. However, the weighted average of marital sorting parameters along the diagonal rose 12,7% from 1992 to 2014 as displayed in table (2.5). This effect is due to the reduction of the proportion of uneducated couples in the period whereas the proportion of educated men and women increased.

At the bottom part of Table (2.4) displays the difference between marital sorting parameters in 1992 and 2014. In almost all combinations of education between husbands and wives, the parameters are smaller except in the first column of this table. It means that women in all levels of education has their marital sorting parameters in relation to uneducated husbands rising, that is, women are more likely to marry an uneducated men comparing to a random matching. Perhaps it is happening because the proportion of educated women is greater than men.

		1992		
Wives'Education Husbands' Education	**m1**	**m2**	**m3**	**m4**
w1	**1.15**	0.56	0.30	0.20
w2	0.54	**3.16**	2.74	2.27
w3	0.28	2.39	**11.13**	4.50
w4	0.23	1.83	4.01	**8.03**
		2014		
Wives'Education Husbands' Education	**m1**	**m2**	**m3**	**m4**
w1	**1.42**	0.56	0.22	0.17
w2	0.72	**1.66**	1.15	0.78
w3	0.40	1.49	**4.41**	1.93
w4	0.32	1.02	2.49	**3.97**
Difference between Marital sorting parameters in 1992 and 2014				
	+	=	-	-
	+	-	-	-
	+	-	-	-
	+	-	-	-

Table 2.4: Marital Sorting Parameters, 1992 and 2014 (PNAD)

Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some college and (4) College Graduate.

	1992	2014
Weighted average of marital sorting parameters along the diagonal	1.57	1.77

Table 2.5: Weighted average of Marital Sorting Parameters along the diagonal, 1992 and 2014 (PNAD)
Notes: This table reports weighted average of marital sorting parameters reported in table (3). The couples' age considered here has the mean of husbands' and wives' age between 26 and 60 years.

2.5.2 Household Income Inequality and their determinants

We estimate Gini Coefficients. If the coefficient is zero it means total equality in income distribution whereas a Gini coefficient equal to one means total inequality in household income distribution.

Household Income Inequality and Random Matching

Figure (2.5) shows the Gini coefficients in Brazil from 1992 until 2014. The actual Gini which measures household income inequality and the other one shows the counterfactual Gini if marriages in Brazil between husbands and wives occurred randomly matched in terms of education.

The difference between actual Gini (0,563) and counterfactual in 1992 (0,531) is 6,1% while in 2014 it raised 11,5% (0,495 to 0,444). This is an evidence that the educational assortative mating can have an impact on household income inequality. In addition, educational composition within couples has changed in Brazil and probably this is an explanation why there is an increase in the difference between the actual Gini and counterfactual in 2014 related to 1992. As we can see in Figure (2.4), the proportion of married couples where both are uneducated decreased while the proportion of educated married couples and mixed marriage increased.

Another difference is the fraction of married women inside the labor force. It increased from 51% in 1992 to 70% in 2014. Moreover, the years of schooling have grown for married men and women but faster for women. This can be an evidence that women's contribution to household income could have an impact on household income inequality. Greenwood et al. (2014)

The difference between the counterfactual Gini with random matching comparing to the actual Gini is negative similar to US and Norway results measured in Eika et al. (2014) but the trend in household income inequality in Brazil is downward.

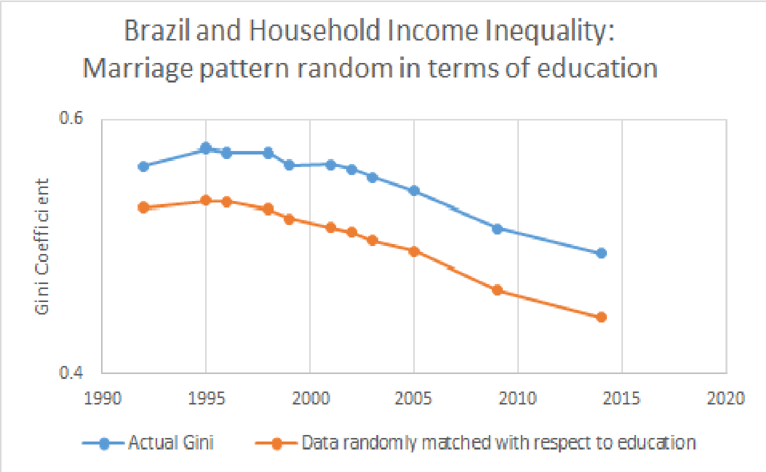

Figure 2.5: Brazil and household income inequality: Changes in Marital Sorting

Household Income Inequality and Marital Sorting

Figure (2.6) displays the actual Gini and the counterfactual of marital sorting measured in 1992 and 2014, that is, we use the distribution of probability in marriage as it was in 1992 and 2014 keeping couples' income and the levels of education of husbands and wives varying over the years to calculate the counterfactual Gini.

As we can see, the difference in 2014 counterfactual compared to actual Gini and 1992 counterfactual were about 1% smaller but this small difference has decreased in the following decade and all lines hardly differ at the end of the period. In 2014, the 1992 counterfactual is 0.8% smaller than the actual Gini.

Despite there is an evidence of a change in the assortative pattern in Brazil in the past few decades, Figure (2.6) suggests that the pattern of assortative mating do not have a major impact on household income inequality. This evidence is similar to US and Norway results measured in Eika et al. (2014).

Household Income Inequality and Educational Composition

Figure (2.7) shows the actual Gini and the counterfactual of educational composition measured in 1992 and 2014, that is, we use the distribution of educational composition prevailing in 1992 and 2014 keeping couples' income and the marital sorting of husbands and wives varying in these years to calculate the counterfactual Gini.

All lines in this figure hardly differ until mid-2000. In 1992 the actual Gini (0.563) and the 2014 counterfactual (0.549) differ from 2.7%. The change occurs between the actual Gini and the counterfactual 1992, suggesting that if the educational distributions of husbands and wives in the last years was the one prevailing in 1992, household income inequality would have decreased even more. The difference between the actual Gini (0.495) and the counterfactual 1992 (0.459) is about 7.8%.

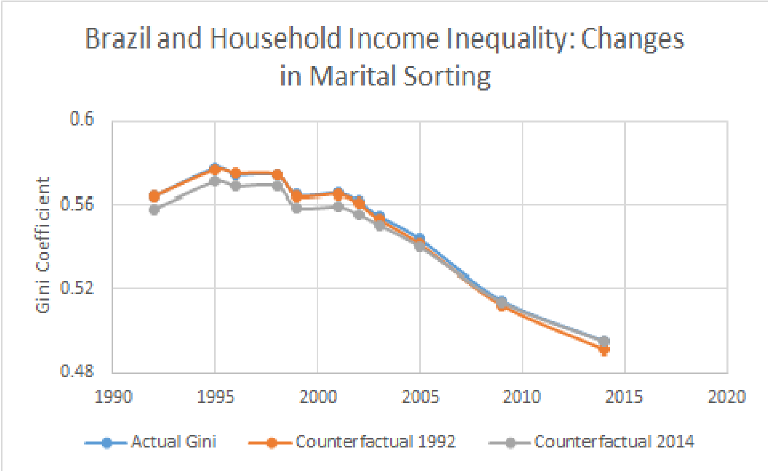

Figure 2.6: Brazil and household income inequality: Changes in Marital Sorting

In this exercise we hold fixed the educational composition and the returns to education and marital sorting parameters vary over time. This difference between the actual educational composition and counterfactual can affect the household income inequality as we have more or less heterogeneity between couples. In Brazil, in the most recent years, the proportion of educated couples raised significantly while the number of uneducated couples decreased strongly.

Brazilian results are different from US and Norway as analyzed by Eika et al. (2014), probably because educational composition in Brazil evolved differently from those countries. In US and Norway the counterfactual in 1980 shows that the household income inequality would have been greater than the actual Gini and the counterfactual in 2007 shows that the household income inequality would have been lower than the actual Gini. While in Brazil, if the educational composition has not changed actual Gini would be lower. In this case, a lower Gini does not mean an improvement in education because educational composition in Brazil in 1992 was composed by almost 80% of uneducated men and women. And in 2014 this proportion felt to 58% for men and 50% for women.

Household Income Inequality and Returns to Education

Figure (2.8) shows the actual Gini and the counterfactual of returns to education measured in 1992 and 2014, that is, we keep the distribution of returns to education as it was in 1992 and 2014, leaving couples' educational composition and marital sorting of husbands and wives varying in these years to calculate the counterfactual Gini.

As seen in Figure (2.8), there is a difference between the actual Gini and 1992 and 2014 counterfactuals. The difference between the actual Gini (0.564) and 2014 counterfactual (0.464) is about 21.5%. This can be seen as an evidence that in 2014 one year more of schooling is yielding less than in 1992. (Table 2.3) And as we can see in figures (2.3) and

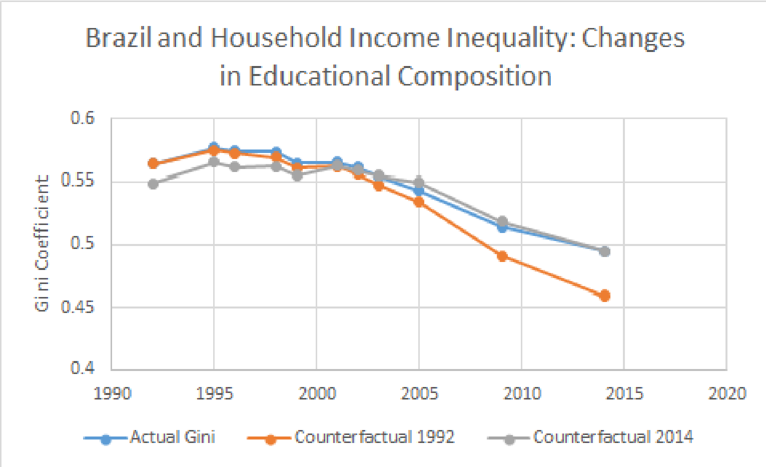

Figure 2.7: Brazil and household income inequality: Changes in Educational Composition

(2.4), the educational composition has changed from 1992 to 2014. The difference from 1992 counterfactual (0,548) and the actual Gini (0.495) is 10.8% in 2014. Despite the educational composition vary in each year, the return to education is different in 2014 comparing to 1992, so there is a significant impact in household income inequality when considering the returns to education fixed in 2014 level.

Brazilian results are different from US and Norway as shown in Eika et al. (2014), probably because the returns to education in those countries are increasing, differently as in Brazil. In US and Norway the counterfactual in 2007 shows that the household income inequality would have been greater than the actual Gini and the counterfactual in 1980 shows that the household income inequality would have been lower than the actual Gini.

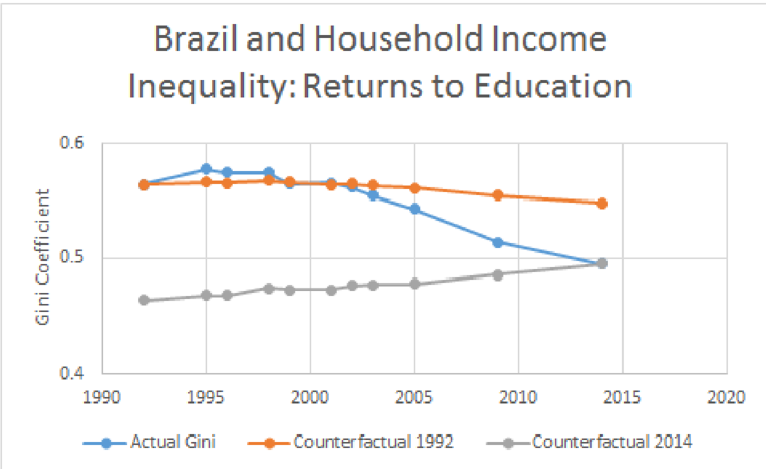

Figure 2.8: Brazil and household income inequality: Returns to Education

2.6 Conclusion

In this paper, we calculate educational composition of couples formed in Brazil from 1992 to 2014 using PNAD survey and investigate how changes in educational composition impact in educational assortative mating for this period. In addition, we investigate the impacts on Brazilian household income inequality due to changes in educational assortative mating patterns. We implement a decomposition method based on Eika et al. (2014) where we can assess the impacts of returns to education, educational composition and marital sorting parameters on household income distribution.

The proportion of educated married couples increased in Brazil from 1992 to 2014 while the proportion of uneducated couples decreased. The effect of these changes can be seen in the marital assortative parameters but also in household income inequality. Our results suggests that if marriages were formed randomly, household income inequality would be smaller than the actual Gini and the difference from the actual one and the couterfactual has been increasing over time. In addition, there is an evidence that we have more positive assortative mating between educated husbands and wives in Brazilian society because the difference in actual Gini and the counterfactual one with random matching has increased. This difference prevent household income inequality to fall even more during the last years. Moreover, the counterfactual Gini where the marital sorting parameters are fixed in a base year compared to actual Gini are slightly different. It is an evidence that the changes in marital sorting parameters have a small effect in household income inequality. Both results follow the same pattern as presented in Eika et al. (2014).

In Brazil, in the recent years, the returns to education have decreased probably due to the increase in the proportion of educated men and women whereas in US and Norway the returns to education raised. This difference between Brazil and US and Norway can be seen in the result of the exercise done in this paper when we fix the returns to education in our counterfactual and compared to actual Gini. In Brazilian case, if we estimate Gini with the returns to education fixed in year 2014, it would be lower than the actual one. In US and Norway, as seen in Eika et al. (2014) the result is the opposite.

We also find that the increase in the proportion of educated husbands and wives and the decreased in the proportion of uneducated husbands and wives lead to the change in educational composition between couples from 1992 to 2014. In our exercise we estimate our counterfactual with the educational composition in 1992 and if the educational composition was formed in 1992 our counterfactual Gini would be lower than the actual Gini. This can be an evidence of how homogeneous educational composition used to be in 1992 because most couples was formed by uneducated spouses. In 2014 we have more educated couples than in 1992 and the proportion of uneducated couples decreased strongly, leading us to a more heterogeneous educational composition.

Chapter 3

Intra-group Marriage Market in Brazil: an empirical evidence

Abstract

Marriage with their likes can be an important issue for different groups. It depends on which attributes they consider important when choosing their partners. It can be related to marital surplus or it can be connected to some attributes they want to share with their children. Therefore, marriage becomes a channel to transmit their cultural traits. This paper aims to test empirically the results presented in Chapter 1 where men and women decide if they are going to study and marry considering that they have preferences over other attributes such as religion, race or ethnicity and the implications of these attributes on their decisions. Our empirical results for Brazilian data show that preference for homogamous marriage between husbands and wives is strong in education, religion and race. When testing which trait is more important, there is some evidence that, in general, education is the most preferred attribute.

JEL classification: I21, J12, Z1, D13.
KEYWORDS: matching, marriage market, assortative mating, education, family economics, cultural traits.

Acknowledgements

The author wishes to acknowledge the comments from Daniel Monte and Sergio Firpo. Our remaining errors are responsibility of the author.

3.1 Introduction

The social norms in household pattern have changed in the last decades and, as we described in the two first chapters, it has some consequences in the role played by husbands and wives. As seen in Chiappori et al. (2009), women are spending less time in household work, studying more and the participation of husbands in children care has increased. One of the consequences can be seen in marriage. According to Eika et al. (2014) and Greenwood et al. (2014), the rate of positive assortative mating in education compared to random matching has increased between uneducated couples but decreased between educated ones in the last decades. In Brazil we find the same heterogeneous trend reflecting the rise in proportion of educated men and women.

As presented in chapter one, the preference for homogamous marriage between spouses can be related not only to education but with other traits such as religion and ethnicity. There is a large literature that discusses the importance for a couple to transmit their traits to their children. One of the strongest mechanisms to achieve this goal is throughout marriage.**?**BisinandVerdier2000)

The model developed in the first chapter is based on the relationship between marriage and specific traits, specifically, education and ethnicity. If there is a preference for marry your like and the transmission of cultural traits through generation is important, marriage can be a good channel. Considering the discussion in the Chapter 1, marriage with your like can be a reason why couples with the same attributes are formed. To study if there is an empirical evidence in favor of our hypothesis we decided to run an empirical exercise using Brazilian data.

In this paper, we intend to investigate if the preferences for marriage with spouses of similar traits, in education and religion (or race), can be connected with the decision of education and marriage. We are interested in testing the results achieved in Chapter One and we intend to analyze if there is a relationship between religion, race and education.

This can happen because the greater is the return to marriage between people of the same type the greater are the incentives to study and marry, also considering that the educational levels are complements between spouses. All in all, we are interested in analyzing the relationship between agents with different traits and its implication for education and marriage.

This paper is organized as follows. Besides this introduction, in the next section, we provide the methodology and in the third we present the data. In the fourth section we present the results. Finally, in Section 5 some final remarks are drawn.

3.2 Methodology

3.2.1 Assortative Mating: Marital Sorting Parameter

The first part of the empirical study developed in this chapter is an extension from Eika et al. (2014) work. In that paper the authors calculate a ratio between the joint probability of marriage in levels of schooling and random marriage in education. Firstly, we estimate the marital sorting parameters in education, race and religion. Secondly, we measure a double assortative, in education and religion. Considering that couples are already assortative in education (religion), we want to measure a marital sorting parameter between religion (education) levels of i and j as a joint probability that the husband with the religious level j is married with woman with the religious level i comparative to the probability under random random matching in religion (education). The same can be done between education and race.

$$s_{ij} = \frac{\Pr(Wife = i \cap Husband = j)}{\Pr(Wife = i).\Pr(Husband = j)} \tag{3.1}$$

The marital sorting is testing for independence in the decision of marriage. If s_{ij} is equal to one the decision to get married is independent from religion (education). If s_{ij} is greater (less) than one, a positive (negative) assortative marriage in religion is expected, the probability to marry someone considering his (her) religion (education) is more (less) expected under a random marriage in terms of religion (education).

In 2000, we estimate the marital sorting parameters considering all possible combination between the couples. Firstly, we divide the sample in couples considering husband and wife that share the same level of education (religion) and then we calculate the marital sorting in religion (level of education). We want to verify the probability of marriage in religion (education) considering that couples already married assortative in education (religion).

3.2.2 Data

We use for the analysis the Census Brazilian Data for the year 2000 and Brazilian national household sample survey (PNAD) for 1992 and 2014. We form couples in the range where the mean of the husband's and wife's age is between 26 and 60 years old. The education level was divided in four mutually exclusive groups following the same criterion in Eika et al. (2014).

The first one is formed by people with no high school degree (less than 11 years of schooling). The second one, is formed by people with complete high school degree (11 years of schooling). The next one is formed by individuals with some college (12-14 years

of schooling) and the last group is the college graduate (more than 15 years of schooling).

Religion groups were divided in fourteen mutually exclusive groups: (0) not religious, (1) Catholic faith, (2) Protestant, (3) Spiritism/Kardecist, (4) African Brazilian religion, (5) Jewish, (6) Hinduism, (7) Buddhism, (8) Oriental religions, (9) Islam, (10) Esoteric traditions, (11) Indigenous traditions, (12) other religions and (13) not stated.

To be able to calculate the marital sorting in religion we aggregate the religion groups in five mutually exclusive groups: (A) not religious, (B) Catholic faith, (C) Protestant, (D) Spiritism/kardecist, Jewish, Hinduism, Buddhism, Islam and African brazilian religion, (E) other religions.

The race groups are divided in five mutually exclusive groups: (1) White, (2) Black, (3) Asian, (4) Pardo, (5) Indigenous.[1] In 2000, we have a sample with 2.573.423 couples.

3.3 Descriptive Statistics

Among all couples in the sample, 87.2% are married with partners with the same religion. Table (3.1) describes the number of couples in each religion and Table (3.3) shows couples divided between race. The proportion of partners within the same race is almost 70.4% of the sample. Moreover, 74% of couples are married with partners that have the same level of schooling. (See Table 3.2)

Firstly, we try to understand these positive assortative mating in religion, race and education. As seen the proportion of married couples within the same religion is significant. We can split couples in two groups: majority and minority. The couples formed in catholic majority can be evidence that in majority groups the probability to find a match of the same type randomly is higher than in minorities groups. In this case, the marital sorting parameters is close to one. On the other hand, in minorities the search to find a match in the same group is more difficult. The marital sorting parameters is very high because minorities groups search for marriage within the group considering a random matching. It can be explained because couples want to transmit their cultural traits to their children and marriage can be used as a channel to achieve it.

3.4 Results

3.4.1 Assortative mating in education (four levels)

We want to analysis if there is a positive assortative in education in married couples. As we can check in Table (3.6) which reports combinations of all possible levels of schooling

[1]The race "pardo" is defined as people who descends from white and black, black and indigenous or white and indigenous parents.

Religion	Couples
0	73,110
1	1,819,776
2	313,006
3	23,551
4	4,614
5	915
6	34
7	1,941
8	1,447
9	326
10	480
11	155
12	5,459
13	415
Total	2,245,229

Table 3.1: Couples formed with the same religion (Census 2000)
Notes: (0) not religious, (1) Catholic faith, (2) Protestant, (3) Spiritism/Kardecist, (4) African Brazilian religion, (5) Jewish, (6) Hinduism, (7) Buddhism, (8) Oriental religions, (9) Islam, (10) Esoteric traditions, (11) Indigenous traditions, (12) other religions and (13) not stated.

between a couple. More educated couples are almost eight times to be married to each other when we compare to a random matching in education.

3.4.2 Assortative mating in religion (five groups)

We estimate the marital sorting parameters in religion in married couples, as we can see in Table (3.7) which reports the combinations of all five possible groups of religion between a couple. People who declare they do not have a religion has a probability to marry to each other ten times higher when comparing to a random matching. Between Catholic couples this possibility is 1.23 times comparing to a possible random matching in religion. The Catholics are the majority group in Brazil so the joint probability to a marriage occur between a Catholic man and a Catholic woman compare to a random matching between Catholics is almost the same.

Between couples with Protestant faith this possibility is four times comparing to a possible random matching. As we can check, the marital sorting estimates are 32 and 110 times as likely to be married within the group when we compare with a possible random matching from minority religion groups (D) and (E).[2] In one hand, this positive assortative mating can indicate that minority groups search for marriage with their likes

[2] D=Spiritism/Kardecist, Jewish, Hinduism, Buddhism, Islam and African brazilian religion and E=other religions

Level of Schooling	Couples
1	1,669,233
2	140,937
3	7,419
4	90,523
Total	1,908,112

Table 3.2: Couples formed with the same level of schooling (Census 2000)

Notes: (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

Race	Couples
White	1,152,673
Black	68,658
Asian	6,640
Pardo	581,404
Indigenous	3,099
Total	1,812,474

Table 3.3: Couples formed within the same race (Census 2000)

and the intergenerational transmission is important to them. On the other hand, there is a minority effect, that is, the proportion of couples formed in religions aggregated in groups (D) and (E) are small comparing with the total couples formed in the sample. However, the joint probability that a couple is formed in one of these groups (D) and (E) is greater than the probability that this marriage happens randomly.

3.4.3 Assortative mating in race

In this subsection we want to analyze if there is a positive assortative marriage in race between married couples. Table (3.8) reports all possible combinations of race to form a couple. People who declare they belong to the white group are almost 1.5 times more likely to marry a white person when we compare with a possible random matching. And with the pardo group this chance is almost twice compared with a possible random matching.

Between black couples this possibility is almost seven and a half times comparing to a possible random matching. As we can see, the marital sorting estimates are 112 and 102 times as likely to be married to one another when we compare with a possible of a random matching from minority race such as asian and indigenous groups.

Religion	Total Men and Women
0	289,982
1	3,893,623
2	834,515
3	76,297
4	15,424
5	2,709
6	114
7	5,794
8	4,671
9	972
10	1,813
11	372
12	16,640
13	3,920
Total:	5,146,846

Table 3.4: Total Men and Women in Religion Category (Census 2000)

Notes: (0) not religious, (1) Catholic faith, (2) Protestant, (3) Spiritism/Kardecist, (4) African Brazilian religion, (5) Jewish, (6) Hinduism, (7) Buddhism, (8) Oriental religions, (9) Islam, (10) Esoteric traditions, (11) Indigenous traditions, (12) other religions and (13) not stated.

3.4.4 Double assortative mating in religion (or race) and education

In order to estimate double assortative mating, we firstly divide the sample in couples who are married within the same level of education. Secondly, we estimate the marital sorting parameters in religion in married couples for all combinations of religions categories. In this case we divide the couples among five groups because our exercise was not possible to work in a large division as fourrteen types of religion because in some minority groups the denominator was almost zero and then the outcome was extremely high.

The results are shown in tables (3.12) and (3.13) in Appendix. As seen in those tables, there is a positive assortative in all groups of religion then the probability of marriage with someone with the same group of religion considering a random marriage in religion is greater than one in both, high and low, levels of schooling.

Moreover, we split the sample in couples who married within the same level of religion. In this case we classify the couples among thirteen groups and we estimate the marital sorting parameters in education in married couples for all combinations of levels of schooling conditional that they were married in the same faith. The results are shown in tables (3.14) to (3.18).

We see in these tables that we have a positive assortative in levels of schooling

Religion	Percentage
0	0.07
1	0.07
2	0.05
3	0.3
4	0.1
5	0.72
7	0.2

Table 3.5: Percentage of Educated Men and Women (College Degree) in Religion Category (Census 2000)

Notes: (0) not religious, (1) Catholic faith, (2) Protestant, (3) Spiritism/Kardecist, (4) African Brazilian religion, (5) Jewish and (7) Buddhism.

	m1	**m2**	**m3**	**m4**
w1	**1.15**	0.57	0.32	0.19
w2	0.62	**2.83**	2.34	1.93
w3	0.37	2.16	**7.59**	4.63
w4	0.25	1.76	4.40	**7.83**

Table 3.6: Marital Sorting Parameters in Levels of Schooling (Census 2000)

Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

conditional couples formed in the same religion. The most interesting result here is that, independently if people belong to majority or minority groups, the probability to get married in the same level of schooling compare with a possible random matching is greater than one.

The positive assortative is stronger when we face a minority group in levels of schooling, that is, the probability of an educated man is married an educated woman is eight times the probability to marry randomly. In catholic group educated husbands and wives represent only about **7% of all sample.** (SeeTable 3.5)

In the case of race, we divide the sample in couples who married within the same race group. Then we estimate the marital sorting parameters in education in married couples for all combinations of levels of schooling. The results are shown in tables (3.19) to (3.22).

The results' interpretation in the marital sorting parameters depend not only if the index is above or below one but the magnitude. If the index is above one we have a positive assortative matching. But the magnitude is important and it can reflect the value that a particular group gives to a specific trait along with the proportion that this group represent in the sample.

We can illustrate it with two different cases. In table (3.15) we can observe that the index is 1.15. It means that, conditional that husbands and wives are married in religion,

	m1	m2	m3	m4	m5
w1	**10.53**	0.19	0.42	0.74	0.71
w2	0.41	**1.23**	0.11	0.31	0.24
w3	1.52	0.31	**4.76**	0.17	0.43
w4	1.40	0.40	0.10	**32.57**	0.91
w5	1.45	0.38	0.51	0.70	**110.30**

Table 3.7: Marital Sorting Parameters in Religion (Census 2000)
Notes: The letter m represents men and w represents women. (1) not religious, (2) Catholic faith, (3) Protestant, (4) Spiritism/kardecist, Jewish, Hinduism, Buddhism, Islam and African brazilian religion, (5) other religions.

	m1	m2	m3	m4	m5
w1	**1.35**	0.49	0.65	0.55	0.59
w2	0.46	**7.38**	0.32	0.67	0.98
w3	0.50	0.38	**112.44**	0.32	1.04
w4	0.50	0.89	0.26	**1.83**	0.70
w5	0.60	0.99	0.59	0.65	**102.26**

Table 3.8: Marital Sorting Parameters in Race (Census 2000)
Notes: The letter m represents men and w represents women. (1) White, (2) Black, (3) Asian, (4) Pardo and (5) Indigenous.

the probability an educated man will marry an educated woman is 1.15 considering a random marriage in levels of schooling. How do we interpret it? The proportion of educated Jewish represents almost 72% of all their group. It means that the chance an educated Jewish man find an educated Jewish woman randomly is high. So the index is close to one. The chance an educated men or women are married to an uneducated person is less frequently than we could expect in random marriage (index below one).

Another example is the assortative mating between educated Black people as we can observe in Table (3.19). The minority people search to marry together in order to increase their marital surplus and considering complementarity between spouses, they will search for homogamous marriage.

In mixed marriage in religion, Tables (3.23) and (3.24), we can observe that the marital sorting parameters is more intense in minority groups according to the level of schooling. Educated Protestants and Catholics get married with each other but it appears they are not interested in marrying uneducated people when compared with a random matching. The same pattern we observe in Table (3.25) between Black and White people. The proportion of educated Catholics is 7.1% for women and 7% for men and the proportion of educated Jewish is 69% for women and 73% for men. If we observe Table (3.23), educated Jewish are married to educated Catholic.

In Table (3.9) we can observe positive assortative mating in race conditional to

Uneducated	1992		2014	
	m1	m2	m1	m2
w1	**1.49**	0.47	**1.60**	0.65
w2	0.42	**1.63**	0.62	**1.22**
Educated	1992		2014	
	m1	m2	m1	m2
w1	**1.07**	0.54	**1.18**	0.61
w2	0.51	**4.42**	0.53	**2.00**

Table 3.9: Double Marital Sorting Parameters in Race conditional to Education, 1992 and 2014 (PNAD)
Notes: (1) Uneducated level covers no high school degree and high school degree and Educated level covers some college and college graduate. (2) Race 1 includes white and asian groups and Race 2 includes black, mulatto and indigenous.

		1992	**2014**
Weighted average of marital	uneducated	1.21	0.94
sorting parameters along the diagonal	educated	1.17	1.04

Table 3.10: Weighted Average of Marital Sorting Parameters in Race conditional to Education, 1992 and 2014 (PNAD)

education. In this case we analyze Brazilian national household sample survey in 1992 and 2014 and we split our sample in two groups of education and two groups of race (1-White and Asian and 2-Black, Pardo and Indigenous). However, Table (3.10) shows that the weighted average of marital sorting parameters in race conditional to education is decreasing. This could be an evidence that shifts in the educational distribution specially in race 2 lead to more mixed marriage. However, there was a change in the proportion of self-reported answer for race 2, from 44% to 57%, in 1992 to 2014 and it may bias our estimates.[3]

3.4.5 What matters most: education or religion (race)?

We described in section 3.4.4 the results in double assortative in education and religion (race) and there is an evidence that men and women search for their likes. Although we do not know which trait is more important in this decision: education or religion (race). We calculate the educational assortative mating trying to disentangle this effect and unveil which effect is stronger between religion (race) and education.

The sample used in this case is different from above. For example, if we want to

[3] In 1992 3% men and women of race 2 were educated and in 2014 this proportion raised to 11%. In race 1 this proportions changed from 11.8% to 24%.

analyze which trait is more important to an educated Catholic men when he decides to marry, religion or education. We will analyze the marital sorting parameters in two different groups: one is composed by Catholic educated men and Protestant educated women and in the second case Catholic educated men and Catholic educated women.[4]

The result for the first case is 5.70, which means that educated Catholic men and educated Protestant women marry more frequently then we could expect under a random matching in terms of education. On the other hand, if we have a group of Catholic men and women and we want to estimate the educational assortative between educated Catholic men and uneducated Catholic women the result is 0,17. It means that educated Catholic men and uneducated Catholic women marry less frequently then we could expect under a random matching in terms of education.

Suppose we have a group of Black educated men and white educated women. If we want to estimate the educational assortative between them. The result is 5,6, which means that educated black men and educated white women marry more frequently then we could expect under a random matching in terms of education.

On the other hand, if we have a group of Black educated men and uneducated black women and we want to estimate the educational assortative between them. The result is 0,24, it means that educated Black men and uneducated Black women marry less frequently then we could expect under a random matching in terms of education.

According to Table (3.27) in Appendix, there is an evidence that men and women prefer to marry with their likes in education rather then religion (race) when facing both traits. Except for the case where we have educated Jewish women and uneducated Jewish men. Despite the education effect is strong between educated Jewish women and educated Catholic men, 12, the assortative in religion between educated Jewish women and uneducated Jewish men is 1.46, which could be an evidence that religion can be as much important as education for some groups.

3.4.6 Modelling the probability of married couples in education regarding they are assortative in religion using a Probit Model:

We estimate the probability to get married with someone from the same same level of schooling given that you are married within the same religion group (religions are divided in 14 groups), using Instrumental Variable Probit Model.

$$P(y = 1/x) = G(X\beta) \tag{3.2}$$

[4]Educated=college degree

Uneducated=high school dropouts

where X represents the vector of explanatory variables and the dependent variable y assume the value 1 or 0. The dependent variable is a dummy variable that indicates one if a husband and a wife share the same level of schooling and is zero otherwise. The independent variables are defined as follow:

- Dummy variable that indicates 1 whether a couple is married with the same religion group (14 groups).
- Dummy variable for men and women religion that indicates 1 if man is from religion i and zero otherwise. And is 1 if woman is from religion j and zero otherwise.
- Dummy variable that indicates 1 if man has the level of education i and zero otherwise. And is 1 if woman has the level of education j and zero otherwise.
- Dummy variable for federative unit of each couple is 1 if they belong to region m or zero otherwise.
- Man's age and woman's age
- Log of couples' income

The independent variable "couples married with the same religion group" could be correlated with the errors due to simultaneity between the dependent and independent variables. So we decide to estimate an IV Probit and we use religion as instrument. We assume that religion is pre-determinate and correlated with the dependent variable "couples married within same religion group". Therefore, it can be used as an instrument.

The results are shown in table (3.11). The sign of the variable "couples married within same religion group" is positive which is an evidence that couples married within the same religion has a higher probability to marry within the same level of schooling.

3.5 Limitations and Possible Extensions

The present work analyzed double assortative in education and religion (or race) using Brazilian Census 2000. It will be interesting to analyze how this measure evolve over time using Census 1991 and 2010.

The decomposition method developed in chapter two is an interesting method to analyzed changes in actual Gini and counterfactual scenarios. It would be interesting to use this method to try to analyze if changes in educational composition in race conditional to changes in education could have an impact over household income distribution considering counterfactual scenarios or if changes in religion composition may also generate an effect on income distribution.

IV Probit

VARIABLES	2000
Dummy of men with High School Degree	-0.881***
	(0.00266)
Dummy of women with High School Degree	-1.353***
	(0.00259)
Dummy of men with Some College	-1.455***
	(0.00693)
Dummy of women with Some College	-1.749***
	(0.00686)
Dummy of men with College Graduate	-0.407***
	(0.00415)
Dummy of women with College Graduate	-0.814***
	(0.00409)
Log of couple's income	-0.108***
	(0.00129)
Dummy of couple's religion	0.0492***
	(0.00507)
Constant	2.013***
	(0.0140)
Observations	2,476,461

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.11: IV Probit Results (2000)

3.6 Conclusion

In this paper we investigate if there is a positive assortative mating in both education and religion (or race) in order to test empirically homogamous marriage in these attributes as presented in Chapter 1. Therefore, we try to understand if not only education but cultural traits as well have an impact on marriage choices. Those traits can have an impact in material surplus and emotional gains which compose the marital surplus of marriage.

Education has an impact over material surplus regarding that the return of education of educated men (or women) is greater than uneducated ones. Considering there is complementarity between spouses, the material surplus of homogamous couples in education is greater than mixed couples. Moreover, if we consider that cultural traits are important and man and women want to transmitt them to their children, marriage is one important channel for it.

There is an evidence that we have double positive assortative in education and religion

(or race) in Brazil but as presented in Table (27), education plays the leading role in the assortativeness. When spouses face the choice between education and religion (or race), the results suggest that couples prefer education to others attributes. The only case that there is an evidence that religion is stronger than education is in the group of Jewish women.

3.A Additional Tables

	m1	m2	m3	m4	m5
w1	**10.16**	0.18	0.44	0.97	0.78
w2	0.39	**1.23**	0.10	0.33	0.24
w3	1.54	0.31	**4.62**	0.23	0.49
w4	1.64	0.41	0.11	**74.21**	0.70
w5	1.47	0.40	0.57	0.56	**130.00**

Table 3.12: Double Marital Sorting Parameters in Religion conditional to Education - Level 1 (Census 2000)
Notes: The letter m represents men and w represents women. (1) not religious, (2) Catholic faith, (3) Protestant, (4) Spiritism/kardecist, Jewish, Hinduism, Buddhism, Islam and African brazilian religion, (5) other religions.

	m1	m2	m3	m4	m5
w1	**9.34**	0.20	0.25	0.54	0.64
w2	0.50	**1.22**	0.23	0.31	0.29
w3	0.75	0.30	**8.83**	0.17	0.45
w4	1.18	0.38	0.14	**7.53**	0.59
w5	1.46	0.32	0.48	0.56	**73.02**

Table 3.13: Double Marital Sorting Parameters in Religion conditional to Education - Level 4 (Census 2000)
Notes: The letter m represents men and w represents women. (1) not religious, (2) Catholic faith, (3) Protestant, (4) Spiritism/kardecist, Jewish, Hinduism, Buddhism, Islam and African brazilian religion, (5) other religions.

	m1	**m2**	**m3**	**m4**
w1	**1.16**	0.55	0.30	0.17
w2	0.62	**2.74**	2.21	1.80
w3	0.38	2.12	**7.16**	4.28
w4	0.26	1.73	4.14	**7.28**

Table 3.14: Double Marital Sorting Parameters in Education conditional to Religion - Catholics (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	**m2**	**m3**	**m4**
w1	**6.55**	1.15	1.40	0.38
w2	1.57	**2.64**	0.97	0.73
w3	0.67	1.04	**1.56**	0.97
w4	0.14	0.61	0.91	**1.15**

Table 3.15: Double Marital Sorting Parameters in Education conditional to Religion - Jewish (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	**m2**	**m3**	**m4**
w1	**1.13**	0.63	0.38	0.26
w2	0.63	**2.53**	2.26	2.03
w3	0.39	2.01	**7.51**	5.18
w4	0.31	1.73	4.70	**8.60**

Table 3.16: Double Marital Sorting Parameters in Education conditional to Religion - Protestants (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	**m2**	**m3**	**m4**
w1	**1.29**	0.68	0.35	0.32
w2	0.58	**1.75**	1.71	1.54
w3	0.38	1.54	**3.38**	2.27
w4	0.33	1.15	2.63	**3.66**

Table 3.17: Double Marital Sorting Parameters in Education conditional to Religion - African Brazilian (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	m2	m3	m4
w1	**1.44**	0.79	0.43	0.31
w2	0.60	**1.71**	1.48	1.06
w3	0.46	0.98	**3.13**	1.69
w4	0.25	0.61	1.61	**3.20**

Table 3.18: Double Marital Sorting Parameters in Education conditional to Religion - Buddhism (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	m2	m3	m4
w1	**1.06**	0.60	0.42	0.31
w2	0.69	**3.81**	3.37	3.12
w3	0.54	3.21	**13.09**	8.73
w4	0.41	3.32	8.94	**16.57**

Table 3.19: Double Marital Sorting Parameters in Education conditional to Race - Black (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	m2	m3	m4
w1	**1.28**	0.58	0.31	0.17
w2	0.60	**2.24**	1.75	1.39
w3	0.36	1.58	**4.80**	2.85
w4	0.24	1.23	2.68	**4.58**

Table 3.20: Double Marital Sorting Parameters in Education conditional to Race - White (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	m2	m3	m4
w1	**2.13**	0.85	0.43	0.24
w2	0.60	**1.91**	1.10	0.84
w3	0.28	0.92	**2.70**	1.38
w4	0.18	0.53	1.27	**1.89**

Table 3.21: Double Marital Sorting Parameters in Education conditional to Race - Asian (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	m2	m3	m4
w1	**1.06**	0.57	0.40	0.28
w2	0.69	**3.65**	3.22	3.10
w3	0.53	3.30	**12.91**	8.65
w4	0.39	3.30	9.28	**17.23**

Table 3.22: Double Marital Sorting Parameters in Education conditional to Race - Pardo (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	m2	m3	m4
w1	**5.41**	1.81	1.13	0.42
w2	1.32	**2.68**	0.82	0.72
w3	0.63	0.17	**2.12**	0.99
w4	0.24	0.59	0.92	**1.16**

Table 3.23: Marital Sorting Parameters in Education between Jewish and Catholics (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	m2	m3	m4
w1	**1.12**	0.62	0.37	0.24
w2	0.68	**2.62**	2.19	1.90
w3	0.42	2.08	**8.52**	5.17
w4	0.31	1.76	4.79	**9.12**

Table 3.24: Marital Sorting Parameters in Levels of Schooling between Protestants and Catholics (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	m2	m3	m4
w1	**1.08**	0.62	0.45	0.30
w2	0.67	**3.08**	2.65	2.60
w3	0.51	2.32	**9.46**	6.82
w4	0.37	2.51	5.97	**11.32**

Table 3.25: Marital Sorting Parameters in Education between Black and White (Census 2000)
Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

	m1	**m2**	**m3**	**m4**
w1	1.82	0.87	0.57	0.33
w2	0.71	1.58	1.15	0.89
w3	0.46	0.80	2.55	1.35
w4	0.25	0.70	1.10	1.96

Table 3.26: Marital Sorting Parameters in Levels of Schooling between Asian and White (Census 2000)

Notes: The letter m represents men and w represents women. (1) High School dropouts, (2) High School degree, (3) Some College and (4) College Graduate.

Table 3.27: Marital sorting parameters with mixed couples, Census 2000.

	mblackE	mwhiteE	mcathE	mjewE	mparE	mparNE	mspiritE	mjewNE	mblackNE	mprotNE	mprotE	mcathNE	mislamE	mislamNE	mbuddistE
wparNE					0.2										
wwhiteE	5.6				6.47										
wcatholicNE			0.17												
wcatholicE				9.8			7.3				11.7	0.35	8.59		8.25
wprotestantNE															
wprotestantE			5.7							0.2					
wblackNE	0.24														
wjewishNE				0.41											
wjewishE															
wpardoE		5.48				0.08									
wspiritismNE							0.28								
wjewishE			12					1.46							
wblackE			5.48						0.07						
wislamE			28											0.58	
wislamNE													0.67		
wbuddistE			10											0.59	
wbuddistNE															0.27

Note: w=woman and m=man, E= College degree and NE=high school dropouts, par=pardo, prot=protestant.

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