Marriage in the time of Aids epidemic: an empirical analysis of Brazil

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February 15, 2019

Abstract

In this paper we investigate if marriage gains were affected by the uprising of HIV/AIDS epidemic in the 1980's. We explore two time span – 1982-1991 and 1999-2010 – using Brazilian data to verify if those gains changed over time as the Brazilian government has freely distributed antiretrovirals from 1996. Our results corroborate the hypothesis that HIV/AIDS influenced past marriages, which seem to have worked as a safeguard against the disease (marital surplus increased 3.2% by additional HIV/AIDS case per one hundred inhabitants). However, we also find that marital surplus decreased by one third after the distribution of antiretroviral drugs by the government and the subsequent reduced mortality risk due to the treatment.

JEL codes: D1, J12, I1.

Keywords: marriage market, family economics, HIV/AIDS, antiretroviral treatment.

*FEA/USP. Contact: lhakak@usp.br. The authors wish to acknowledge the comments from Pierre-AndrÃ© Chiappori, Rodrigo Soares, Emerson Marcal, Sergio Firpo, Vladimir Ponczek, Cezar Santos and Raphael Corbi. Our remaining errors are responsibility of the authors.

"It is a truth universally acknowledged, that a single man in possession of a good fortune must be in want of a wife", said Jane Austen in her famous book "Pride and Prejudice" in 1813.

1 Introduction

Marriage has always been an important subject for young adults. During the twentieth century, in most countries, marriage decisions were in majority left to young couples based on their own preferences, which was an important evolution mainly for women. Previously, their future were decided by parents or matchmakers.

From the 60s, women were even more empowered due to entrance of new contraceptive methods in the market. Women average age of marriage increased and the number of children fell. Sexual freedom, once enjoyed only by men, is allowed for women as well. (Chiappori et al. (2009), Goldin and Katz (2002), Stevenson and Wolfers (2007), Hakak (2016))

In the mid-1980s, HIV/AIDS – a sexually transmitted disease – raised changing the *status quo*. It was a turmoil in sexual freedom and people were afraid to get infected with an unknown disease that has no cure.

Preferences for marriage that depend on several traits might have incorporated one more variable. In this paper we want to understand if this new disease changed preferences for marriage. The hypothesis behind is that a stable relationship become a safeguard, although not perfect, against uncertainty generated by relationships with different partners. In this sense, single people might seek protection by looking for a life partner and, therefore, anticipating the decision of marriage. In this case, the utility of remaining single decreases whereas marital surplus increases. Incentives for marriage might change and as in Becker (1991), "an efficient marriage market develops "shadow" prices to guide participants to marriages that will maximize their expected well-being."

We also investigate in the paper the possible heterogeneity in the reaction of men and women. Our analysis provides a way of measuring how people respond to non-monetary incentives in relation to their marriage decision.

The literature about marriage and HIV/AIDS are mostly based on experiments fields and theoretical models. Dupas (2011) developed a randomized field experience in Kenya where the information provided to teenager girls about HIV/AIDS men status in different ways generate different behavior from girls. Greenwood et al. (2017) developed a choice-theoretic general equilibrium search model in order to study Malawian epidemic. They analyze the impacts of two different experiments in HIV/AIDS prevalence rates: one policy that encourages marriage, and the other that dissuades divorces. Both policies result in lower HIV/AIDS prevalence rates compared to control groups.

Angelucci and Bennett (2017) construct a model of assortative matching with two traits, one observable, attractiveness, and the other, sexual safety, hidden. They predict that removing the asymmetric information about sexual safety change the timing of decision about marriage and pregnancy for safe respondents, and even more if they have the other attribute (attractiveness). To remove asymmetric information, in this case, is to increase frequency of HIV testing, which may allow safe people to signal and screen, increasing the probabilities of marriage and fertility.

In this paper, we choose to study individual's marriage behavior in Brazil because the country was stringly affected by HIV/AIDS from the mid-80 (as Figures 1 to 5 show). Moreover, the disease spreads so rapidly that the Brazilian government was the first to provide, free of charge, antiretroviral drugs (ARV) to fight against HIV/AIDS from 1996 on. We construct an annual panel of municipalities using Brazilian Census and civil registries in two different time spans (1982-1991 and 1999-2010).

We estimate the effects of HIV/AIDS reported cases on the surplus of marriage using instrumental variables. The instruments for the first period of analysis are a health quality variable (number of hospital beds per inhabitant) and a measure of access to HIV/AIDS (the distance from the closest municipality that reported any HIV/AIDS cases). As the disease dynamics of the second period is different, we use as instruments the deaths caused by tuberculosis per inhabitant (tuberculosis is an opportunistic disease associated with AIDS) and the distribution of ARV per inhabitant (which was freely distributed according to the reported cases). We also included other controls and year and municipality fixed effects, as well as a state-specific trend to deal with other common aggregate shocks in the period.

Our results show that marital surplus increased due to HIV/AIDS epidemic, mainly in the first period. The decision of marriage for both genders seems to be in the same direction, reaching an increase of 3.2% of the marital surplus per additional HIV/AIDS case (our of 100,000 people) from 1982 to 1991. In the second period analyzed – 1999-2010 – we estimate whether the effect of HIV/AIDS over marital surplus persisted. We find that the impact of HIV/AIDS, after the free provision of ARV, is still positive but smaller (1.1%) than the former period, probably because of the access and efficacy of the treatment. The perception about the harmful effects of the disease was different in the 1980's when compared to the subsequent decades. The treatment efficacy changed the perception that HIV/AIDS was a death sentence to be considered a chronic disease. While in 1996 the life expectancy for a 20-year-old person with HIV was 39 years, in 2011 the life expectancy bumped up to about 70 years (**?**). Our results reflect this perception and indicate that HIV/AIDS epidemic changed preferences for marriage, producing an incentive to people get married.

We organize the paper as follows. Section 2 briefly describes the fight against HIV/AIDS in Brazil. In the Section 3 we describe the data and descriptive statistics of the data. Section 4 presents the methodology and identification strategy. In Section 5 we present the main results of the paper followed by robustness analysis. Section 6 discusses the results and highlights the main contributions of the paper.

2 HIV/AIDS treatment in Brazil

The first HIV/AIDS case in Brazil happened in 1982 and the infection rates climbed very fast since then. In 1990, 10,000 new cases were reported in the country. As Figure 3 shows, Southern regions of the country were more affected. However, the Brazilian government response to the epidemic improved in the 90s. From 1992, using both domestic funds and World Bank loans, Brazilian government started to finance the cost of HIV/AIDS treatment. The country challenged the pharmaceutical companies to produce generic versions of the ARV drugs. Mainly due to this policy, Brazil is worldwide recognized from the universal and free of charge provision of ARVs for people infected by HIV since 1996. In 1999, 85 thousand people received ARV treatment in Brazil and the number increased to 404 thousand people receiving the treatment in 2014. According to et al. (2015), the government spent 400 million dollars in the drug provision that year.[1]

Together with the drug distribution, the free provision of condoms and the awareness of condoms importance were also important policies that helped the control of AIDS in the country since 1994. Information on disease transmission was also transmitted to sex workers (Dourado et al. (2015)). Another relevant intervention was the neddle exchange program, which stimulated drug users not to share neddles (Levi and Vitória (2002)). Since 2005, the Brazilian Ministry of Health has also been providing rapid tests to diagnose AIDS.

Due to the combined policies to fight against HIV/AIDS, which had strong civil society participation, AIDS-related deaths decreased sharply after 1996 as shown in Figures (4) and

[1] More on the Brazilian policy against AIDS in Levi and Vitória (2002).

(5), specially in Southeast region, where most cases are recorded. However, from 2000 on, in some regions, there is an upward trend in the growth of deaths.

In 2017 in Brazil there were 860 thousand people living with HIV/AIDS (13,000 of them were children aged 0 to 14), 60% of the infected adults are on antiretroviral treatment.[2] The fight against HIV/AIDS is still active in Brazil, mainly focused on higher risk groups (such as young homossexual men), where the rate of infection tripled from 2006-2015. Recently, the country – together with other Latin American countries – established the "90/90/90" targets.[3]

From 2017, Brazilian public health service is also offering the pill Truvada, which reduces the risk of contracting HIV/AIDS when taken daily, to higher risk groups (men who have sex with men, transgender people, and prostitutes).[4]

3 Data

We analyze two different time spans (1982-1990 and 1999-2010) to understand if the effect of HIV/AIDS spread in the country changed with the introduction of the antiretrovirals in 1996. We present the data separately as the available information changed over time and, therefore, our identification strategy also is related to the data availability.

3.1 HIV/AIDS epidemic start: 1982-1990

To access data on marriage surplus we use the 1990 Brazilian Census, collected by the Brazilian Bureau of Statistics (IBGE).[5] In the census we observe the year a person gets married at first time. This information is crucial for constructing our dependent variable. As we focus on marriage decision, we exclude widowers, widows or divorced individuals from the sample. Thus, the sample is composed by men and women from 18-40 years who remain single (who never married and is not currently married), or married (for the first time only) between 1982 and 1990. We chose these years because they consider the before and after the rise in the HIV/AIDS epidemic in Brazil, which began between 1985 and 1986. [6]

Between 1980 and 1991 more than 500 new municipalities were created in Brazil. Therefore, we use the minimum comparable areas (amc) from 1970 to 2000, constructed by IBGE,

[2] Avert (2018)

[3] 90% of people living with HIV/AIDS knowing their HIV status; 90% of them receiving antiretroviral therapy; and 90% of people on treatment virally suppressed by the year 2020 (UNAIDS, 2015).

[4] Darlington (2017)

[5] www.ibge.gov.br.

[6] We use sampling weights to balance the data.

which represent the more disaggregated measure that makes possible to compare municipalities.[7] Thus, the municipalities are grouped by amcs.

We use the number of reported cases of HIV/AIDS by municipality and year from the Ministry of Health database from 1980 to 1991, except for year 1981 which is not available.[8]Then, we calculate the number of cases per hundred of inhabitants using the total population by municipality and year from IBGE.

We construct two different instruments. First, we consider the number of hospital beds per hundred of inhabitants. The number of hospital beds is available by municipality and year from the Medical-Sanitary Assistance Survey from 1981-1990 (except in 1988), collected by the Ministry of Health. This variable is understood as a proxy of health system quality in each municipality and does not correlate with the decision of marriage. [9]

Second, we propose a measure of accessibility to HIV/AIDS by calculating the logarithm of the geographic distance of each municipality of the country is from the closest city that has HIV/AIDS cases in the previous year. This distance is constructed using the municipality centroids. We believe that such accessibility is related to the disease but not to the decision of marriage. [10]

All the instruments were chosen and tested due to their possible relationship with cases of HIV/AIDS. Moreover, these variables are not identified as determinants of marriage decision by the literature.

3.2 After ARV free distribution: 1999-2010

The marriage surplus is calculated using the Brazilian Census of 2000 and 2010 and the civil registry data, both collected by IBGE. In the more recent censuses we observe single people but not when a person gets married at first time (as we observe in 1991 census). Therefore, we use data from civil registries by municipality and year to collect information about first marriages from 1999 to 2015. Again, we exclude widowers, widows, and divorced people from the sample. The final sample includes men and women from 20 to 39 years old who remain

[7]This variable is available in the website ibge.gov.br. There are 3658 amcs, while the number of municipalities in 1991 is 4491.

[8] Data is collected by the Notification System (SINAN) of the Ministry of Health. Website consulted on December 2018: http://www2.aids.gov.br/cgi/deftohtm.exe?tabnet/br.def

[9]The data of 1988 and 1991 are not available due to change in the questionnaires (1988) and collection problems (1991). The website was consulted on September 2018 at http://tabnet.datasus.gov.br/cgi/deftohtm.exe?ams/cnv/amsobr.def

[10]For the year of 1982 we use data from 1980, as 1981 data are not available.

Latitude and longitude coordinates of municipalities' centroids are collected from IBGE.

single (never married and is not currently married), or married (first unions only) between 1999 and 2010.[11] We analyze the period from 1999 to 2010 as the marriage dataset is available from 1999 by municipality and we are able to construct the baseline data for single individuals only until 2010. This period is also posterior to the free distribution of ARV in Brazil.[12]

The reported cases of HIV/AIDS by municipality and year are also collected by Notification System (SINAN) of the Ministry of Health from 1999 to 2010 and we use IBGE data to calculate the incidence per hundred of inhabitants.

To analyze this second period, we construct two instrumental variables. The first one is the quantity of antiretrovirals per hundreds of inhabitants. This information is only available by Brazilian state (27 states). Therefore, we use the same instrument for municipalities within the same state. As Section 2 shows, the distribution of antiretrovirals is a federal public policy in Brazil since 1996 which allowed universal access to the antiretrovirals. Anyone who is infected by HIV/AIDS has access to the antiretrovirals.

The second instrument is the number of death per 100.000 inhabitants caused by tuberculosis in each municipality and year from the Mortality System of the Ministry of Health. The tuberculosis is one of the causes of death by people infected by HIV/AIDS but can also affect individuals not infected by HIV/AIDS. We believe the mortality from the disease is closely related to AIDS but not to the decision of marriage. [13]

3.3 HIV/AIDS evolution in Brazil

Figure 1 shows the evolution of marriages in Brazil from 1984 to 2016. We observe a decrease in total marriages during the 1990's. In the beginning of the 2000's the number of marriages increased in Brazil, mostly due to the raise in adult population from the baby boom from the end of 1970's and beginning of 1980's. The total marriages and reported cases of AIDS seem to be negative correlated over time. However, we cannot impose a causal link by observing those trends.

Figures (2) and (3) show the number of reported Aids cases in Brazil by gender and by region. The number of HIV/AIDS infected individuals is higher for men of the Southeast region of the country. Figures (4) and (5) show the number of deaths caused by HIV/AIDS (total deaths and deaths per 100.000 inhabitants) from 1980 to 2010. We observe that after

[11] We follow the age division of the dataset.

[12] http://www2.datasus.gov.br/DATASUS/index.php?area=0203id=6930 and https://sidra.ibge.gov.br/acervo/S/RC/A/4/T/Q

[13] We also testes as instrument the geographic distance from the closest municipality where HIV/AIDS cases are notified, but the explanatory power of this variable vanishes as the disease spreads all over the country.

1996 the absolute and relative deaths caused by the disease decreased in all Brazilian regions, especially in the Southeast region, where the disease had a higher prevalence in almost all period of data.

4 Methodology

4.1 The decision of marriage

We estimate a marriage matching function considering that men and women have different traits, following Choo and Siow (2006) and McFadden (1973).

Consider a society with a large number of I types of men and J types of women where types can be specified as level of schooling, age, religion, race, ethnicity, geographic location etc. Men and women can choose between get married or remain single. To specify the person each man or woman will marry, it will depend on I (J) preferences parameters. The overall preferences parameters are 2 x I x J. In the data it is possible to observe each type m_i of man in the marriage market and the same for women (w_i). The total numbers observed are $I + J + I$ x J, where I x J are the married couples and $I + J$ are the amount, m_i, of i types of men and, w_j, j types of women in the marriage market. In the case where $I, J > 2$, we will need to use a reduced-form in order to solve the identification problem. This reduced form will appear in the form of marriage matching functions and the objective is to estimate the behavior of the whole marriage market. Consider that marital output of men with trait i and women j depends only of i and j.

Consider two disjoint groups of men and women. The vector M composed of available men with types m_i for all $i = 1, ..., I$ and W represents the vector composed of available women with types w_j for $j = 1, ..., J$. Also, we define Π as a matrix of parameters.

A marriage market function is defined as a I x J matrix $\mu(M, W; \Pi)$ which must satisfy the following constraints:

$$\mu_{0j} + \sum_{i=1}^{I} \mu_{ij} = w_j \quad \forall j, \tag{1}$$

$$\mu_{i0} + \sum_{j=1}^{J} \mu_{ij} = m_i \quad \forall i, \tag{2}$$

$$\mu_{i0} + \mu_{0j} + \mu_{ij} \geqslant 0 \quad \forall i, j. \tag{3}$$

where μ_{ij} is the amount of men of type i married to women of type j, μ_{i0} is the number of unmarried men of type i and μ_{0j} is the number of single women of type j.

The equilibrium in marriage market with transferable utility is characterized by the maximization of the sum of marital marriage output and it is not necessary to estimate men and women parameters separately. The output depends on the partnership resulted in the marriage, which is formed by men of type i and women of type j, resulting in I x J marital outputs whereas there is $I + J$ outputs resulted of unmarried types.

In the framework of transferable utility a man of type i to marry a j type of woman must transfer to her an amount of income represented by τ_{ij}. In this market we shall have I x J marriages. This market clears when, given the equilibrium transfers τ_{ij}, the supply and demand of men and women are equal, that is, men of type i equal the number of women of type j and vice-versa, considering all i, j.

In order to estimate the model described above we will follow the extreme-value (Logit) random utility model of McFadden (1973) used also by Choo and Siow (2006).

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

The shares u_{gj} and v_{ig} that women and men receive are determined endogenously and we can write them as:

$$v_{ig} = \max_{j} \{v_{i0g}, ..., v_{ijg}, ..., v_{iJg}\} \tag{4}$$

$$u_{gj} = \max_{i} \{u_{0jg}, ..., u_{ijg}, ..., u_{I0g}\} \tag{5}$$

where

$$v_{ijg} = \widetilde{\alpha}_{ij} - \tau_{ij} + \theta_{ijg} \tag{6}$$

$$\alpha_{ij} = \widetilde{\alpha}_{ij} - \widetilde{\alpha}_{i0} \tag{7}$$

$$v_{i0g} = \widetilde{\alpha}_{i0} + \theta_{i0g} \tag{8}$$

$$u_{ijg} = \widetilde{\gamma}_{ij} + \tau_{ij} + \theta_{ijg} \tag{9}$$

$$\gamma_{ij} = \widetilde{\gamma}_{ij} - \widetilde{\gamma}_{0j} \tag{10}$$

$$u_{0jg} = \widetilde{\gamma}_{0j} + \theta_{i0g} \tag{11}$$

The utility received from man i married to woman j is v_{ijg}. The utility, showed in equation 6, is divided in two parts, one is the same to all men type i married to women type j, $\widetilde{\alpha}_{ij} - \tau_{ij}$, and the second part, θ_{ijg}, is an idiosyncratic gain, which is independently and identically distributed random variable with type I extreme-value distribution.

In equation 7, we have the share a man receives from the systematic return from marriage, where the output is the gain from marriage discounted by the value he gains if he remains single. The equation 8 shows the payoff man g receives from remaining unmarried.

Consider μ_{ij}^d the number of marriages demanded by type i man with women type j and μ_{i0}^d the amount of single type i men. There are some results showed in Choo and Siow (2006):

$$\ln \mu_{ij}^d = \ln \mu_{i0}^d + \alpha_{ij} - \tau_{ij} \tag{12}$$

Equation (12) is the quasi demand equation for men of type i who are married to j type women. Following it is shown also the quasi supply equation of women with type j who are married with men of type i.

$$\ln \mu_{ij}^s = \ln \mu_{0j}^s + \gamma_{ij} + \tau_{ij} \tag{13}$$

Considering that market clears when $\mu_{ij}^s = \mu_{ij}^d$ and from equations (12) and (13), we have the following result:

$$\ln \mu_{ij} - \frac{\ln \mu_{i0} + \ln \mu_{0j}}{2} = \frac{\alpha_{ij} + \gamma_{ij}}{2} \tag{14}$$

If we consider $\pi_{ij} = \ln \Pi_{ij} = \frac{\alpha_{ij}+\gamma_{ij}}{2}$, the equation (14) can be written as:

$$\Pi_{ij} = \frac{\mu_{ij}}{\sqrt{\mu_{i0}\mu_{0j}}} \tag{15}$$

And the equation above is the marriage matching function that the authors estimate. Applying log in the right side of the equation (??) give the marital surplus of the couple type i, j compared to the gain of each partner to remain single. In the case there are more men of type i and women j in the population and using geometric average in the number of unmarried partners of types i and j, it is possible to control for these effects.

Considering equations (12), (13) and π_{ij}, we can identify the shares $u_{gj} - \widetilde{\gamma}_{0j} = \gamma_{ij} + \tau_{ij}$ and $v_{ig} - \widetilde{\alpha}_{0j} = \alpha_{ij} - \tau_{ij}$.

$$\ln\left(\frac{\mu_{ij}}{\mu_{i0}}\right) = \alpha_{ij} - \tau_{ij} = n_{ij} \tag{16}$$

$$\ln\left(\frac{\mu_{ij}}{\mu_{0j}}\right) = \gamma_{ij} + \tau_{ij} = N_{ij} \tag{17}$$

In this study, the authors calculate equations 15, 16 and 17 and then aggregate the results municipality. In addition, we estimate the impacts of HIV/AIDS epidemic on the decision of marriage with both spouses considering age between 18 and 40 years old.

4.2 Identification Strategy

To estimate the effect of the HIV/AIDS epidemics on marriage decisions, we estimate the following model using Brazilian data

$$Marriage_{mt} = \theta_m + \theta_t + \theta_s t + \ \tau_1 AIDS_{mt} + \tau_2 age_{mt} + \varepsilon_{ijcm} \tag{18}$$

In which *marriage* represents the marriage surplus, according to equations 15, 16 and 17, m, and t index the municipality and year, respectively, θ_m is municipality fixed effect, θ_t is year fixed effect, $\theta_s t$ represents a state-specific trend, age is the mean age by municipalities. $AIDS$ denotes the reported cases of HIV/AIDS per 100.000 inhabitants by municipality and year. We also tested a potential delay effect on marriages by considering the first lag of cases of AIDS in the model ($AIDS_{m,t-1}$). The intuition is that there might be a lag between the decision to get married and the date of the marriage and we have data on the latter.

We are interested in estimating τ_1, but we believe that there are other determinants of marriage that are changing over time, are unobserved and potentially correlated with the increase in HIV/AIDS cases. One example is the change in individual's behavior during the 1980's and 1990's. As mentioned in Section 1, the sexual liberalization of the period and the change in women behavior regarding marriage might be correlated with infection by HIV/AIDS. In this sense, we propose instrumental variables that are correlated with HIV/AIDS cases but do not determine the marriage decisions. Due to data availability and feasibility of the analysis, we construct different instruments for the period from 1982 to 1991 and 1999 to 2010, Equations 19 and 20 presents the first stage equations for 1982-91 and 1999-2010 periods, respectively.

$$AIDS_{mt} = \alpha_t + \alpha_m + \alpha_s t + \rho_1 ln(d_{m,t-1}) + \rho_2 hospitalbeds_{mt} + \varsigma_{mt} \tag{19}$$

$$AIDS_{mt} = \gamma_m + \gamma_t + \gamma_s t + \beta_1 arv_{mt} + \beta_2 tuberc_{mt} + \varrho_{mt} \tag{20}$$

In which *hospitalbeds* is the number of hospital beds per 100.000 inhabitants, $Tuberc$ represents the number of tuberculosis death per 100.000 inhabitants and arv is the amount of antiretrovirals per 100.000 inhabitants. The variable $d_{m,t}$ represents the minimum distance between one municipality without cases of aids and another with the disease in the previous year. The variable can also be defined as

$$d_{m,t} = Min_{j \neq m}[d_{jm} \times I(AIDS_{j,t-1} > 0)] \tag{21}$$

We also present some robustness results of the instruments, such as falsification tests in Section 5.3 (considering the number of tuberculosis cases in $(t-10)$ or considering the distance to closest municipality with cases of HIV/AIDS notified in $(t+10)$, for example).

5 Results

5.1 HIV/AIDS epidemic start: 1982-1990

Table 1 shows the first stages results for the period between 1982 and 1990. All the instrument tested are statistically significant – both individually and jointly. The joint test of the instruments show that both of them are strongly correlated with the cases of HIV/AIDS per inhabitant (F-statistics of 308.8), especially the logarithm of distance to closest municipalities with AIDS cases. The sign of the variables are according to expected: the closer the HIV/AIDS cases are from the municipality, the higher the incidence of the disease; and more hospital beds *per capita* are also negatively correlated with HIV/AIDS cases.

Table 2 presents the results of the main equation. Columns (1) to (4) present the OLS results without controls and Columns (5) to (8) present the instrumental variable results (with muncipality and year fixed effects and state-specific trends) including AIDS cases in the same time period of the marriages and also exploring the delay in marriages. Note that Columns (1) to (4) show that cases of HIV/AIDS and marriage surplus are negatively correlated (as we can also observe in Figure 1). However, after including the control variables and considering instrumental variables, we find a positive effect of the increase of HIV/AIDS cases on the marriage surplus. The effect is statistically significant at 1% only for cases of AIDS in the same period – Column (5), indicating that the contemporaneous effects is more relevant than the delayed effect of the disease on marriage surplus. The total gain to marriage per partner increased 3.2% by additional case of HIV/AIDS per 100,000 inhabitants. The Sargan-Hansen test results suggest that the instruments are exogenous for all specifications.

The same behavior is observed when we compare the marriage gains for men and women separately. The marital surplus for women relative to being single increased 3% while for men 2,74%, as shown in columns (4) of Tables 4 and 3, respectively.

5.2 After ARV free distribution: 1999-2010

Table 5 shows the first stage results for the period after the free distribution of antiretrovirals. We observe that the instruments are statistically significant, both individually and jointly. The sign of the relation between the instruments and the HIV/AIDS cases is also as expected: number of deaths by tuberculosis relates positively with the HIV/AIDS notifications, and the distribution of antiretrovirals is larger in regions where there is more HIV/AIDS infected individuals. The weak instrument test shows that both instruments seem to be strong instruments (Column 3).

Table 6 present the results for the main equation. We included only the contemporaneous HIV/AIDS cases as we identify, for the first period, that the decision to get married and the marriage itself occur simultaneously. Between 1999 and 2010 we can observe that the correlation between marriages and HIV/AIDS cases is positive (Column (1) of Table 6 and Figure 1). Once we include controls, the correlation becomes negative. The instrumental variable regression, on the other hand, shows that the effect is positive (significant at 10% level). The Hansen test indicates that the instruments can be considered exogenous. Thus, in the second period, after the universal distribution of antiretrovirals as part of a public policy in Brazil, the effect in marital surplus from HIV/AIDS epidemic is about 1.2% (by additional case of HIV/AIDS per 100,000 inhabitants). This result suggests that the perception that men and women had about HIV/AIDS risks before and after the antiretrovirals distribution, which increased life expectancy of HIV patients, changed the behavior in relation to marriage. Again, the results do not change much when we considered the marital surplus for women separately (see Table 7).

In the next subsections we elaborate robustness checks to verify the consistency of the estimated results.

5.3 Robustness checks

5.3.1 Falsification test

We performed two falsification tests. First, we test the robustness of the distance instrument for the period between 1982-1991 by considering the same variable in the future (10 years ahead). Table 8 shows that the relationship between the instrument and cases of aids is positive which is counter intuitive. Second, we test if the tuberculosis cases of the past (10 years before) explains the HIV/AIDS cases from 1999-2010. Table 9 shows that, once fixed effects are included, there is no correlation among the past and current variables (Column (2)).

5.3.2 Other marriage determinants

The idea of this robustness check is to test our model on a different dependent variable that is a determinant of marriage earnings. In this case, we use the percentage of the unemployed as a measure of economic progress to verify if AIDS may have affected the income of the individuals and, through this channel, the gain of the marriage. If this effect makes sense, we could be estimating the effect of AIDS as a confounder and we should note a positive causal effect of AIDS on unemployment.

As the rate of unemployment is a proportion, we calculate the logarithm of the odds ratio to linearize the regression. Table 10 shows the results for the period from 1982 to 1990. We find a non-significant effect, which indicates that HIV/AIDS cases in the municipality is not affecting the local economies. This result corroborates the channel that HIV/AIDS influences marriage surplus as marriage can be seen as an safeguard, and not through income.

6 Final Remarks

HIV/AIDS epidemic seems to have affected preferences for marriage of adults in Brazil, especially during the 1980's. Our results suggest that the epidemic increased the surplus of marriage, both for men and women. They opt to anticipate the decision of marriage.

We find that the impact of HIV/AIDS on marital gains are limited due to the efficacy of the treatment and easy of access in Brazil. When individual's perception about the disease risks changed, marital gains decreased by one third. A stable relation and monogamy seems to have worked as a defense against a serious illness which is sexual transmitted. The result is especially interesting as the number of HIV/AIDS cases in Brazil is greater for men than women. However, the probability a man transmits the disease to his partner is much higher than a woman transmits to hers.

Our results are in accordance with the literature that finds a relationship between marriage and HIV/AIDS, including that an increase in marriage can be seen as an imperfect protection against the virus. Greenwood et al. (2017) find that an increase in marriage rate reduces the incidence of HIV/AIDS. Our paper also contributes to the literature by measuring the role played by non-monetary incentives in marriage decision.

Compliance with Ethical Standards

Funding: This study is based on Lorena Hakak's posdoctoral research at Sao Paulo University. The author received financial support from Coordenacao de Aperfeicoamento de Pessoal de Nivel Superior - Brazil (CAPES) for pursuing her posdoctoral studies.[14] The authors declare that they have no conflict of interest.

[14]Finance Code 001

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Appendix A - Tables and Figures

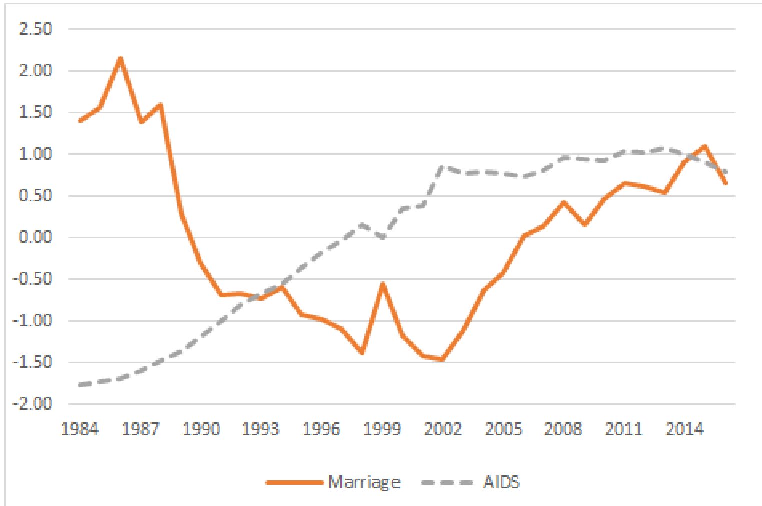

Figure 1: HIV/AIDS cases and total marriages in Brazil, 1984 to 2016

Sources: IBGE and Notification System of the Ministry of Health.

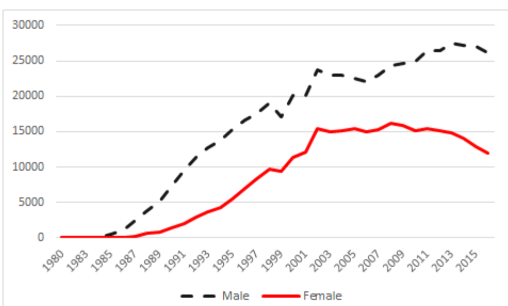

Figure 2: Reported cases of HIV/AIDS by gender, 1980-2016.

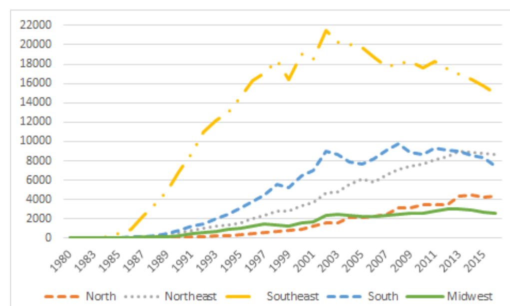

Figure 3: Reported cases of HIV/AIDS by region, 1980-2016.

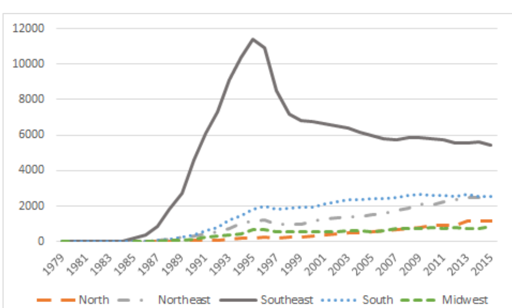

Figure 4: Number of deaths by HIV/AIDS per Brazilian macroregion, 1980-2016.

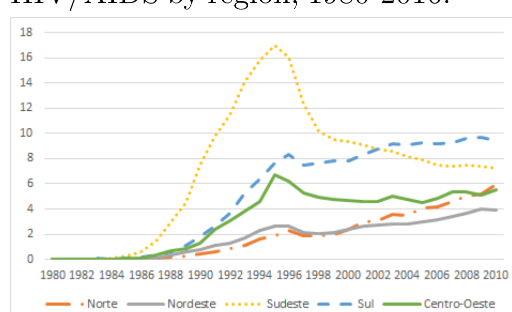

Figure 5: HIV/AIDS deaths by 100.000 inhabitants per Brazilian macroregion, 1980-2010.

Table 1: First stage results, 1982-1990.

	(1) HIV/AIDS cases	(2) HIV/AIDS cases	(3) HIV/AIDS cases
Log of dist. to cities	-0.280***		-0.275***
	(-22.65)		(-22.20)
Hosp. Beds per inhab.		-0.000737***	-0.000670***
		(-11.05)	(-10.12)
Observations	29272	29272	29272
F-stat	513.1	122.2	308.8
p-value	1.75e-112	2.43e-28	3.14e-133

t statistics in parentheses

Notes: HIV/AIDS cases are the number of cases of AIDS per 100.000 inhabitants. Log. of dist. to cities is the logarithm of distance between cities without HIV/AIDS cases from cities with notifications of the disease. Hosp. beds is the number of hospital beds per 100.000 inhabitants. All models include year and muncipality fixed effects. Standard errors are clustered by municipality.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Second stage results, 1982-1990.

	(1) Surplus - All	(2) Surplus - All	(3) Surplus - All	(4) Surplus - All	(5) Surplus - All	(6) Surplus - All
AIDSt	-0.00667***		-0.00442**	0.0315***		0.0331
	(-4.53)		(-2.31)	(2.78)		(1.62)
AIDSt-1		-0.00553***	-0.000934		0.0238**	-0.0131
		(-2.78)	(-0.37)		(2.08)	(-0.66)
Observations	39870	36245	32621	28980	28988	21728
Hansen Statistics				1.718	0.848	1.795
p-value				0.190	0.357	0.407

t statistics in parentheses

Notes: Surplus is calculated by equation 15. AIDS represents the number of cases of HIV/AIDS per 100.000 inhabitants. Columns (1) to (4) are OLS regressions without any control variables. Columns (5) to (8) are instrumental variable regressions using distance to cities with HIV/AIDS and hospital beds as instruments and also include municipality and year fixed effects, state trends and controls (average age of the married individuals). Standard errors are clustered by municipalities.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Second stage results for men surplus, 1982-1990.

	(1)	(2)	(3)	(4)	(5)	(6)
	Surplus - Men	Surplus - Men	Surplus - Men	Surplus - Men	Surplus - Men	Surplus - Men
AIDSt	-0.00468***		-0.00342*	0.0274**		0.0331
	(-3.08)		(-1.72)	(2.46)		(1.54)
AIDSt-1		-0.00248	0.00135		0.0103	-0.0225
		(-1.20)	(0.51)		(0.88)	(-1.10)
Observations	39925	36300	32682	29020	29043	21762
Hansen Statistics				0.349	0.917	1.671
p-value				0.555	0.338	0.434

t statistics in parentheses

Notes: Men Surplus is calculated by equation 16. AIDS represents the number of cases of HIV/AIDS per 100.000 inhabitants. Columns (1) to (4) are OLS regressions without any control variables. Columns (5) to (8) are instrumental variable regressions using distance to cities with HIV/AIDS and hospital beds as instruments and also include municipality and year fixed effects, state trends and controls (average age of the married individuals). Standard errors are clustered by municipalities.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Second stage results for women surplus, 1982-1990.

	(1) Surplus - Women	(2) Surplus - Women	(3) Surplus - Women	(4) Surplus - Women	(5) Surplus - Women	(6) Surplus - Women
AIDSt	-0.00664***		-0.00528***	0.0297***		0.0102
	(-4.38)		(-2.68)	(2.58)		(0.50)
AIDSt-1		-0.00570***	-0.00111		0.0173	0.00682
		(-2.78)	(-0.43)		(1.49)	(0.34)
Observations	39870	36245	32621	28980	28988	21728
Hansen Statistics				1.992	1.527	3.728
p-value				0.158	0.217	0.155

t statistics in parentheses

Notes: Men Surplus is calculated by equation 17. AIDS represents the number of cases of HIV/AIDS per 100.000 inhabitants. Columns (1) to (4) are OLS regressions without any control variables. Columns (5) to (8) are instrumental variable regressions using distance to cities with HIV/AIDS and hospital beds as instruments and also include municipality and year fixed effects, state trends and controls (average age of the married individuals). Standard errors are clustered by municipalities.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: First stage results, 1999-2010.

	(1) HIV/AIDS cases	(2) HIV/AIDS cases	(3) HIV/AIDS cases
Tuberculosis Death	0.0538**		0.0528**
	(2.37)		(2.35)
Antiretrovirals		0.367***	0.365***
		(4.50)	(4.54)
Observations	43908	43908	43908
F-stat	5.614	20.23	11.15
p-value	0.0179	0.00000709	0.0000149

t statistics in parentheses

Notes: HIV/AIDS cases are the number of cases of AIDS per 100.000 inhabitants. Tuberculosis Death represents the number of tuberculous deaths per 100.000 inhabitants. The number of antiretrovirals distributed is informed by state and, therefore, the variable represents the number per state inhabitants. All models include year and muncipality fixed effects, as well as state-specific trends. Standard errors are clustered by municipality.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Second stage results, 1999-2010.

	(1) Surplus - All sample	(2) Surplus - All sample	(3) Surplus - All sample
AIDSt	0.00922***	-0.000718**	0.0119*
	(29.53)	(-2.18)	(1.78)
Observations	42178	42178	42172
Hansen Statistics			1.447
p-value			0.229

t statistics in parentheses

Notes: Surplus is calculated by equation 15. AIDS represents the number of cases of HIV/AIDS per 100.000 inhabitants. Column (1) shows the simple OLS regression. Column (2) includes municipality and year fixed effects and controls (average age of the married individuals), and Column (3) estimates the instrumental variable regressions using deaths by tuberculosis and number of ARV distributed per state inhabitant. Standard errors are clustered by municipalities.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Second stage results, 1999-2010.

	(1) Women surplus	(2) Women surplus	(3) Women surplus
AIDSt	0.00903***	-0.000654**	0.0121*
	(28.77)	(-2.06)	(1.80)
Observations	42178	42178	42172
Hansen Statistics			1.424
p-value			0.233

t statistics in parentheses

Notes: Surplus is calculated by equation 17. AIDS represents the number of cases of HIV/AIDS per 100.000 inhabitants. Column (1) shows the simple OLS regression. Column (2) includes municipality and year fixed effects and controls (average age of the married individuals), and Column (3) estimates the instrumental variable regressions using deaths by tuberculosis and number of ARV distributed per state inhabitant. Standard errors are clustered by municipalities.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Results: First Stage T+10 (1982-1990)

	(1) AIDS	(2) AIDS	(3) AIDS
Log of dist. to cities	0.0377***		0.0254***
	(6.72)		(4.84)
Hosp Beds per inhab.		-0.000556***	-0.000557***
		(-2.83)	(-2.84)
Observations	36590	29272	29272

t statistics in parentheses

Notes: Cases of Aids: number of cases of aids per 100.000 inhabitants, Log of dist. to cities: the logarithm of distance between cities without aids cases from cities with aids in t+10. Hospital beds per inhab.: number of hospital beds per 100.000 inhabitants. 2) Year fixed effects are not shown in table.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Robustness test: Instrumental variable = tuberculosis deaths in (t-10), 1999-2010.

	(1)	(2)
	HIV/AIDS cases	HIV/AIDS cases
Tuberculosis Death (t-10)	0.0731***	0.00289
	(4.53)	(0.19)
Observations	35052	35052
F-stat	20.52	0.0370
p-value	0.00000591	0.847

t statistics in parentheses

Notes: HIV/AIDS cases are the number of cases of AIDS per 100.000 inhabitants. Tuberculosis Death represents the number of tuberculous deaths per 100.000 inhabitants 10 years before. Column (1) is the OLS simple regression and Column (2) includes year and municipality fixed effects, as well as state-specific trends. Standard errors are clustered by municipality.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Second stage results for unemployed individuals, 1982-1990.

	(1)	(2)	(3)
	Odds ratio - unempl.	Odds ratio - unempl.	Odds ratio - unempl.
HIV/AIDS cases	0.0116***	-0.000146	-0.00466
	(3.92)	(-0.12)	(-0.74)
Observations	28424	28424	28424

t statistics in parentheses

Notes: Dependent variable is the logarithm of odds ratio calculated over the percentage of unemployed individuals in the municipality. AIDS represents the number of cases of HIV/AIDS per 100.000 inhabitants. Column (1) is the OLS regression without controls. Column (2) includes municipality and year fixed effects and state-specific trends. Column (3) estimates include the following instrumental variables: logarithm of the distance to cities with HIV/AIDS and hospital beds and controls (average age of the married individuals). Standard errors are clustered by municipalities.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$