1-2017

The Role of Marriage in Fighting HIV: A Quantitative Illustration for Malawi

Jeremy Greenwood
University of Pennsylvania

Philipp Kircher
European University Institute

Cezar Santos
Escola Brasileira de Economia e Finanças

Michéle Tertilt
University of Mannheim

The Role of Marriage in Fighting HIV: A Quantitative Illustration for Malawi

Abstract

How might policies that promote marriage and/or dissuade divorce help in the fight against HIV/AIDS? This question is addressed employing a choice-theoretic general equilibrium search model, using Malawi as a case study. In the framework developed, individuals can choose between married and single life. A single person can select among abstinence and sex with or without a condom. The results suggest that marriage-friendly policies can help to abate HIV/AIDS. The policy predictions that obtain from general equilibrium analysis are compared with those that arise from simulated synthetic field experiments and epidemiological studies.

Keywords

AIDS, circumcision, condoms, general equilibrium modeling, HIV, marriage, divorce, Malawi, sex markets

Disciplines

Behavioral Economics | Community Health and Preventive Medicine | Gender and Sexuality | Health Economics | Medicine and Health | Women's Health

1-2017

The Role of Marriage in Fighting HIV: A Quantitative Illustration for Malawi

Jeremy Greenwood
University of Pennsylvania

Philipp Kircher
European University Institute

Cezar Santos
Escola Brasileira de Economia e Finanças

Michéle Tertilt
University of Mannheim

The Role of Marriage in Fighting HIV: A Quantitative Illustration for Malawi

Abstract

How might policies that promote marriage and/or dissuade divorce help in the fight against HIV/AIDS? This question is addressed employing a choice-theoretic general equilibrium search model, using Malawi as a case study. In the framework developed, individuals can choose between married and single life. A single person can select among abstinence and sex with or without a condom. The results suggest that marriage-friendly policies can help to abate HIV/AIDS. The policy predictions that obtain from general equilibrium analysis are compared with those that arise from simulated synthetic field experiments and epidemiological studies.

Keywords

AIDS, circumcision, condoms, general equilibrium modeling, HIV, marriage, divorce, Malawi, sex markets

Disciplines

Behavioral Economics | Community Health and Preventive Medicine | Gender and Sexuality | Health Economics | Medicine and Health | Women's Health

The Role of Marriage in Fighting HIV: A Quantitative Illustration for Malawi

By JEREMY GREENWOOD, PHILIPP KIRCHER, CEZAR SANTOS AND MICHÈLE TERTILT*

The HIV/AIDS epidemic is a great health and development challenge. According to the World Health Organization (WHO), 36.7 million people were living with the HIV virus in 2015. Around 70 percent of those lived in Sub-Saharan Africa. It is well known that number of sexual partners matters for the transmission of HIV. To the extent that marriage reduces the number of partners that a person has it may play an important role in mitigating the transmission of HIV. Despite its significance, the literature has not provided models in which marriage provides a haven for safer sex. This paper investigates, using a calibrated choice-theoretic general equilibrium model, how policies aimed at increasing marriage rates affect HIV prevalence rates. The analysis highlights the role that marriage as an institution plays in the transmission of HIV. It also illustrates that policies aimed at marriage may have important effects.

Choice-theoretic models of infectious diseases are rare, and those entertaining marriage are virtually nonexistent. Epidemiological models do not incorporate rational, maximizing behavior by individuals. Kremer (1996) builds some behavior into an epidemiological model, but his framework is not designed for quantitative analysis. An exception is the choice-theoretic general equilibrium model by Greenwood et al. (2017). They develop a quantitative search model with various choice margins: marriage or short-term sexual relationships, the latter with or without a condom. Their model is calibrated to the Malawian data. It is used to understand the impact of "medical" interventions aimed at changing transmission risk and mortality: antiretroviral treatment (ART) and circumcision in particular. The analysis allows for feedback effects in equilibrium, arising from changing behavior and shifts in the prevalence of HIV. The current study extends their analysis to focus on a different set of interventions, which do not alter transmission risk in a medical sense, but instead target the institution of marriage. Specifically, it studies social interventions aimed at encouraging marriage and dissuading divorce.

I. Model Description

For the sake of space, only a brief description of the model is given here; for details, see Greenwood et al. (2017). Imagine an economy populated with men and women that are born each period as healthy individuals. They may engage in sex, which is a risky decision because of the presence of the HIV/AIDS virus. A person may have short-term or long-term relationships (aka marriages). A condom, which reduces the likelihood of contracting the virus, may or may not be used in a short-term relationship. Condoms are never used within a marriage. It is assumed that married individuals are faithful to their partners. In order to find a partner, a person must exert costly search effort. A person can always choose to be abstinent by not searching for a partner.

Individuals live for multiple periods, subject to a survival probability. They discount future utility. People are heterogeneous with respect to their discount factor; i.e., some individuals are patient and others aren't. In particular, as people age they may stochastically switch to becoming more patient. This feature captures the fact that young individuals are more inclined to engage in risky behavior than are older ones. The period utility depends on one's consumption and whether he or she had sex. Having protected sex

* Greenwood: University of Pennsylvania, Department of Economics, 3718 Locust Walk, Philadelphia, PA 19104-6297; Kircher: European University Institute and University of Edinburgh, Villa la Fonte, Via delle Fontanelle 18, 50014, San Domenico di Fiesole, Italy (email: philipp.kircher@eui.eu); Santos: FGV/EPGE - Escola Brasileira de Economia e Finanças, Praia de Botafogo, 190/1100, Rio de Janeiro, Brazil (email: cezar.santos@fgv.br); Tertilt: University of Mannheim, L7, 3-5, Department of Economics, 68131 Mannheim, Germany (email: tertilt@uni-mannheim.de). Kircher and Tertilt acknowledge support from the European Research Council (ERC) grants SH1-284119 and SH1-313719, respectively.

in the period (i.e., using a condom) yields instantaneous utility p. Unprotected sex is valued by the person at $u > p$. Following evidence from Malawi, all sex within long-term relationships is unprotected. Within marriage, an individual realizes extra utility (a benefit or cost) from the partnership, given by $l \gtreqless 0$, so that the instantaneous utility of sex is given by $u + l$. The parameter l plays a starring role in the story to be told; it controls the exogenous benefit from marriage.

When a healthy individual has sex with an infected partner, he or she may contract the virus. Following the medical evidence, the probability of infection is assumed to be higher for women than for men. This probability is lower for both genders when a condom is used. Moreover, men may be circumcised or not. Circumcised men are less likely to contract the virus.[1] For simplicity, after each period all individuals get tested for HIV. So, they know their infection status after one period. The results of the test are an individual's private information. An infected individual has a probability of developing HIV/AIDS symptoms. When symptoms develop, an individual has a higher chance of dying. Assume that people with symptoms are too sick to engage in sexual relationships.

Each person must exert effort in order to find a partner. Since there are different types of relationships, this search effort may be directed toward three different "markets." All participants in the first market are seeking a protected short-term relationship. In the second market, matched individuals engage in unprotected short-term relations. Finally, in the third market, people marry and form long-term partnerships. Search is costly in terms of utility. On this, it is presumed that finding a partner in the long-term market is more costly than finding a partner in one of the short-term markets. Each market is uniquely characterized by the types of people that enter it: healthy/sick women and healthy/sick men (who may be circumcised or not). People know the prevalence rate of HIV in each of the three markets, implied by the composition of the participants. An equilibrium transfer between men and women guarantees that each market clears. These transfers represent courtship costs. Individuals first search in the long-term market. If he or she is not matched, the person moves to the short-term markets where s/he may search simultaneously both in the protected and unprotected markets. If matched in the long-term market, the relationship can break up due to one of the spouses developing symptoms or due to an exogenous divorce shock that hits the couple with probability ϵ. This parameter is also central in the analysis because it governs the duration of a marriage. A person chooses their search behavior to maximize their expected discounted lifetime utility.

The analysis will focus on steady states. An equilibrium for this economy is a collection of prices, value functions, policy functions for search effort, and distributions of individuals in each market such that: i) each person maximizes his or her expected lifetime utility, given prices and prevalence rates; ii) prices adjust to clear all three sex markets; and iii) aggregate HIV rates in all markets are consistent with the behavior of men and women.

II. Calibration

Some parameter values for the model are chosen following evidence from the medical literature. These parameters are the female-to-male and male-to-female transmission rates for protected and unprotected sex, which can also vary depending upon whether the male is circumcised or not. The number of circumcised males is taken from the Malawian data. Other parameters (mostly related to preferences) are calibrated such that the moments generated from the dynamic stochastic general equilibrium (DSGE) model line up with their data counterparts. Statistics regarding sexual behavior and HIV prevalence rates in Malawi are used as data targets. The model fit is good in terms of targeted and non-targeted statistics, except for the marriage rate for young women. In particular, the model does a good job hitting life cycle and cross-country moments that were not used in the calibration. See Greenwood et al. (2017) for details.

III. Results

Table 1 presents the results. Column 1, Panel A, provides some data for Malawi regarding

[1] Another variable that affects the transmission of the HIV/AIDS virus is whether the individual is under ART. The analysis uses Malawian data for 2004, when virtually nobody was treated. So, ART is abstracted from here. See Greenwood et al. (2017) for an analysis of the impact of ART.

both HIV prevalence rates and some measures of sexual behavior. Women exhibit a higher prevalence of HIV/AIDS than men. This gender asymmetry arises because the male-to-female transmission rate is higher than the female-to-male rate. The benchmark model also displays such a pattern, albeit a little weaker, as can be seen in Column 2, Panel A. The fraction of casual encounters is 18 percent in the data, a number closely matched by the model. A condom is used in around one third of short-term relationships, both in the data and model. The fraction of singles in the population is slightly higher in the model (48 percent versus 33 in the data).

Two experiments will now be entertained; viz, an increase in l and a decrease in ϵ. Recall that l measures the exogenous extra period utility from being in a marriage. So, an upward movement in l can be thought of as a policy that encourages marriage. Such a shift should raise the flow into marriage. Designing tax and welfare system to support marriage are commonly mentioned policies. Promoting abstinence before marriage and providing marriage skills courses are others. Remember that ϵ controls the probability of divorce. Hence, a drop in ϵ corresponds to a policy that dissuades divorce. A fall in ϵ reduces the exit rate from marriage and therefore raises the duration of a long-term relationship. Providing marriage counselling services, promoting faithfulness through churches, or requiring divorced fathers to pay child support are examples of policies in this regard.

A. General Equilibrium Experiments

First, consider the impact of a policy that promotes marriage, or that increases l. The results for this experiment are reported in Column 3, Panel A. The fraction of singles decreases in the benchmark model from 48 to 44 percent. The HIV/AIDS prevalence rate drops to 8.4 percent. Second, entertain the impact of a policy that dissuades divorce, or that decreases ϵ. Now, for comparability purposes, the decline in ϵ is engineered to deliver the same drop in singles as the previous experiment. Note however that the HIV prevalence rate now falls by a smaller amount to 9.6 percent (Column 4, Panel A). So, promoting marriage appears to be more effective than dissuading divorce on this dimension.

One of the reasons for the discrepancy in prevalence rates across the two experiments is the timing of entry into marriage. Although, by construction, the number of singles decreases by the same amount in both experiments, the timing for a first marriage is different. Note that the fraction of married men and women by age 22 increases substantially in the promote-marriage experiment, whereas it does so by a much lower magnitude in the reduce-divorce counterfactual. Therefore, the young move faster into safer long-term relationships in the promote-marriage exercise. Consequently, they spend a shorter time as a young single. And, young singles tend to be more promiscuous and have a higher proclivity to engage in unprotected sex, because they have lower discount factors.

Condom usage increases in both experiments by about 1 percentage point. More of an individual's life will be lived in long-term relationships (where sex is assumed to be always unprotected). Hence, a person opts for a safer alternative while single, even though that brings less enjoyment.

B. Small Field Experiments

Small field experiments apply some sort of "treatment" to a small group of individuals and then examine the upshot. To mimic a small field experiment in the choice-theoretic general equilibrium model, shifts in the behavior of individuals are not allowed to affect the aggregate HIV/AIDS prevalence rates in the three types of markets for relationships. The idea here is that because a small field experiment is local in nature, it cannot have a global impact on economy-wide aggregates. Thus, a small field experiment is a partial equilibrium investigation.

Panel B of Table 1 presents the results for the small field experiments. Interpret these numbers as what happens to the small group of individuals who are subjected to the experiment; i.e., the "treated" group. The macro aggregates for society are not affected by the experiment because it applies to a measure zero set of individuals. Therefore, the macro aggregates remain constant at the benchmark model values (Column 2, Panel A).

Focus initially on the promote-marriage scenario in Column 3. Note that the HIV prevalence rate in the small field experiment drops (by slightly less compared with its equilibrium counterpart) from 10.3 to 8.7 percent (compare Column 2, Panel A, with Column 3, Panel B). Now, in the small field experiment the treated group is still interacting with a population at large that is just as risky as that in the benchmark equilibrium. The behavioral response of the treated group to the policy leads to a substantial reduction in the prevalence of the disease for the experimental subjects. In fact, these behavioral responses are stronger than in the equilibrium experiment (compare Column 3, Panel A with Column 3, Panel B). For instance, the number of singles decreases 1 percentage point further to 43 percent. In the small field experiment there are more infected people in aggregate than in the equilibrium experiment. Hence, people look harder for safer long-term relationships. Note also that, in comparison with the equilibrium experiment, the fraction of men and women married by age 22 increases by an even larger extent. Moreover, while single, individuals in the small field experiment also behave more cautiously. The fraction of people that use condoms rises by approximately 1 percentage point (over the equilibrium experiment) and the fraction of singles who had sex in the previous year declines slightly.

Now turn attention to the small field experiment for the reduce-divorce counterfactual (Column 4, Panel B). The HIV prevalence rate wanes from 10.3 to 9.6 percent (contrast Column 2, Panel A with Column 4, Panel B). In fact, this decline is very similar to what was obtained in the equilibrium experiment (Column 4, Panel A). This suggests that most of the effect from the reduce-divorce policy comes from behavioral changes and not from equilibrium effects, as will be seen in the next sub-section. Not surprisingly then, behavior in the small field experiment is very similar to the equilibrium version.

C. *Epidemiological Experiment*

Epidemiological studies typically hold human behavior fixed after shifts in public policy. To capture this, the search intensities in the three markets for various relationships are taken, for each type of individual, from the benchmark equilibrium model. These are then used in the epidemiological experiment. The epidemiological experiment can only be conducted for the reduce-divorce policy. To understand why, consider the promote-marriage scenario. Here, the utility benefit of marriage is increased. This can only operate through changes in behavior. If changes in behavior are shut down, then policies that promote marriage cannot have an effect. Turn attention now to the reduce-divorce policy. This does have effects beyond shifts in behavior. Changing the exogenous probability of divorce, ϵ, mechanically alters the duration of a marriage and consequently the flow of people from married into single life, even when behavior is held fixed. This has an impact on society's health.

The results for the epidemiological experiment for the reduce-divorce policy are reported in Column 4, Panel C. Here, the HIV prevalence rate only drops slightly from 10.3 to 10.1 percent (juxtapose Column 2, Panel A with Column 4, Panel C). To explain this, observe that the number of singles does not fall as much as in the equilibrium experiment (Column 2, Panel A versus Column 4, Panel C). The extra marriages that result in the equilibrium experiment are due to behavioral adjustments. If given the chance, individuals search harder for long-term relationships, because they know these will now last longer and this economizes on search costs.

As just discussed, the behavioral shifts in the equilibrium reduce-divorce experiment reinforce the mechanical effect on marriage due a decrease in the rate of divorce. This contrasts with the behavioral responses from medical experiments. Suppose some treatment makes an individual less likely to contract the virus. This mechanically induces a force that will reduce HIV, holding fixed behavior. When faced with the lower odds of contracting HIV, however, individuals will engage in riskier activities. This increase in risky sexual activity works to counteract the effect that the reduction in transmission risk has on HIV. See Greenwood et al (2017) for a discussion of these effects.

REFERENCES

Greenwood, Jeremy, Philipp Kircher, Cezar Santos and Michèle Tertilt. 2017. "An Equilibrium Model of the African HIV/AIDS Epidemic." working paper.

Kremer, Michael. 1996. "Integrating Behavioral Choice into Epidemiological Models of AIDS." *The Quarterly Journal of Economics* 111 (2): 549-573.

TABLE 1—DATA, BENCHMARK MODEL, AND EXPERIMENTS

	(1) Malawian Data	(2) Benchmark Model	(3) Marriage $l \uparrow$	(4) Divorce $\epsilon \downarrow$
Panel A: Equilibrium Experiments				
HIV/AIDS rate	11.8	10.3	8.4	9.6
-Men	10	8.6	7.1	8.1
-Women	13	12.1	9.8	11.2
Casual Sex	18	15.7	13.5	14.0
Casual Sex with condom	39	32.8	33.9	33.7
Singles, sex last year	37	53.5	54.2	54.2
Singles	33	48.0	44.0	44.0
Married by age 22, men	58	57.2	63.9	59.0
Married by age 22, women	90	62.6	68.4	64.5
Panel B: Small Field Experiments				
HIV/AIDS rate			8.7	9.6
-Men			6.8	8.0
-Women			10.7	11.4
Casual Sex			12.9	14.0
Casual Sex with condom			34.7	33.6
Singles, sex last year			54.0	54.7
Singles			43.0	43.6
Married by age 22, men			66.6	60.5
Married by age 22, women			66.8	64.0
Panel C: Epidemiological Experiment				
HIV/AIDS rate				10.1
-Men				8.5
-Women				11.9
Casual Sex				14.9
Casual Sex with condom				33.0
Singles, sex last year				54.3
Singles				45.4
Married by age 22, men				57.2
Married by age 22, women				62.6

Note: Column 1 shows the Malawian data. The results from the benchmark DSGE model are displayed in Column 2. Column 3 shows the results from a policy experiment aiming to promote marriage. This is operationalized by letting l rise from -4.8 to -4.2. The results from a policy experiment dissuading divorce are presented in Column 4. Here ϵ falls from 0.03 to 0.025. For the small field experiments the feedback loop is shut down from individual behavior to the aggregate prevalence rates in each of the three relationship markets. That is, the small field experiment is not allowed to affect economy-wide aggregates. Therefore, the results reported for the small field experiment are for the "treated" subjects only and are not the economy-wide aggregates, which remain the same as in Column 2. In the epidemiological experiment the search intensities, for each type of individual, from the benchmark DSGE model are used; i.e., individual behavior is not allowed to change. All numbers in the table are in percents.

Source: See Greenwood et al. (2017) for the Malawian data sources and a complete description of the DSGE benchmark model, together with a listing of all parameter values used.