A Game Theoretic Model of Marital Infidelity and Divorce in the Presence of Sexually Transmitted Diseases: Implications for Social Welfare and Public Policy

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ABSTRACT

The purpose of this paper is to present a simple game that examines the decision a potentially promiscuous individual (which we refer to as the "husband") to cheat on his monogamous spouse (which we define as the "wife") in the presence of social, legal and epidemiological constraints. We also examine the wife's subsequent decision to sever ties (i.e., divorce) with her husband. Our findings (which concur with the empirical human rights literature) indicate that policies which increase the legal status of women improve the wife's welfare, and also make her more likely to divorce her husband. Concomitantly, policies geared toward educating the husband about HIV/AIDS and/or taxing prostitution reduce the likelihood of infidelity. Interestingly, policies intended to decrease the prevalence rate of HIV/AIDS (such as condom programs) may reduce or enhance infidelity and/or subsequent divorce, and thus may not be effective policy tools.

INTRODUCTION

The spread of HIV and AIDS is crucially dependent upon the choices people make. Heterosexual contact is the main means of transmission of the virus. A person puts their health at risk by engaging is risky sexual behavior. But, a person health is also at risk depending upon the sexual behavior of their partner. Fidelity practiced by only one spouse does not eliminate their risk of contracting a sexually transmitted disease. In Southern Africa where HIV prevalence rates can be as high as thirty-eight percent of the adult population, the choice to remain in a marriage with a spouse who engages in sex with multiple partners is on the surface perplexing (most recent prevalence estimates AIDS Epidemic Update 2003).What are the social and economic factors that would lead to the rational individual putting their health and potentially their life at risk by not divorcing a philandering spouse?

At its core this paper is about the power to escape an abusive and in the context of the AIDS epidemic, a potentially lethal relationship. Due to the lack of legal rights and economic opportunity, women, often treated as property in many patriarchal societies in the developing world, suffer-wide ranging types of abuse. Social norms that discriminate against non-traditional roles for women limit their access to property and restrict economic opportunity outside of marriage. Within marriage the unequal distribution of power in favor of the husband prevents the wife in negotiating condom use or refusing sex altogether. Human rights organizations and legal activists are working diligently to improve the legal status of women, but even in the cases where laws are promulgated, the lack of enforcement makes them less meaningful (Human Rights Watch, http://www.hrw.org/women/domesticviolence.html).

Gender inequality, in the epidemiological environment for HIV existing in southern Africa, is an obvious contributing factor in the spread of the virus. Recognizing the role of gender and more specifically gender inequality in the AIDS pandemic, UNAIDS is initiating a program, *The Global Coalition on Women and AIDS*, with five key aims, one being:

> To improve prevention for women and girls – To be effective, prevention programs must recognize the realities of women's lives. Women and girls….cannot choose to abstain from sex or

insist on condom use. In addition they are often coerced into unprotected sex, and are often infected by husbands in societies where it is common or accepted for men to have more than one partner. (UNAIDS, The Global Coalition on Women and AIDS, February 2004, http://www.unaids.org)

Recognizing the importance of the role of gender and gender inequality in the spread of the HIV virus is not new. However it is only recently that there is increasingly more effort in its incorporation in preventative programs. However, at least to the knowledge of the authors, there has not been a formal economic analysis of the social and economic factors that influence a wife's decision to dissolve a marriage due to spousal infidelity. These factors include but are not limited to the social stigma of divorce, its economic consequences and not least, increased risk of contracting a potentially fatal disease. Policies that mitigate the social and economic costs of divorce may provide a potential alternative for women to escape potentially abusive relationships, hence lower the exposure to risk of infection. The contribution that can be made by an economic analysis of this framework is to make clear how policy can not only influence the wife's decision making, but also what effect it may have on the husband's behavior.

The purpose of this paper is to present a simple game that examines the decision a potentially promiscuous individual (which we refer to as the "husband") to cheat on his monogamous spouse (which we define as the "wife") in the presence of social, legal and epidemiological constraints. We also examine the wife's subsequent decision to sever ties (i.e., divorce) with her husband. The model's solutions are used to make some policy prescriptions to improve the welfare of both partners, with particular emphasis on the wife's welfare. Because of the model's generality, we are also able to compare differences in the wife and husband's decisions in different cultures or socio-economic environments.

MODEL ASSUMPTIONS AND DEFINITIONS

Consider two rational individuals who are involved in a marriage contract. For simplicity, we refer to the first individual as the "husband" and the second as the "wife". We assume that the husband has promiscuous tendencies, which he may or may not act on. Conversely, the wife has no such tendencies, and is only interested in sexual activity with her spouse. The family is exogenously endowed with an amount of wealth Y, which the couple divides through some pre-determined arrangement, which may be a function of cultural and/or socio-economic considerations. Let α, represent the proportion of wealth allotted to the wife, and $(1-\alpha)$ be given to the husband, where $0 \leq \alpha \leq 1$. Each spouse uses their income to purchase goods for themselves and/or the household. The wife purchases a generic good C with her wealth and pays a price of P_c. Concomitantly, the husband may purchase a generic good S, or he may use his income to purchase a unit of sex G from a prostitute, who may or may not infected with a sexually transmitted disease.[1] Prices for these goods are denoted as P_s and P_G, respectively. For simplicity, we normalize G so that the husband purchases either zero or one unit of this good.

Each spouse has a utility function that they independently attempt to maximize subject to their budget constraint. The wife obtains utility (U^w) from purchasing units of C, from

[1] Note that the wife does not have a choice variable analogous to G, since she has not promiscuous tendencies. Additionally, we assume that the husband has sexual intercourse with his wife. As a result, if the husband purchases G, he is "two-timing" his wife, and therefore putting his wife at risk of catching the sexually transmitted disease. Relaxing this assumption makes the model's solutions slightly more complicated, but does not noticeably impact our solutions of policy implications.

her health stock, and from being involved in a monogamous relationship with her husband.[2] Defining H^w and M as the maximum amounts of the wife's health and (total family) marital happiness that exists from a monogamous relationship, respectively, we postulate that the wife's utility can be expressed as:

$$U^w = \omega_1 C + \omega_2 \left(H^w - \rho^w G\right) + (1 - \omega_1 - \omega_2)\left(M - \gamma G - \nu D - \tau DG\right) \tag{1}$$

where: ω_i, i = 1,2 represent relative utility weights (with $0 \leq \omega_i \leq 1$); D is a dummy variable that gives a value of 1 if the wife decides to divorce her husband and zero otherwise; ρ^w is a risk parameter (inclusive of the epidemiological prevalence and transmission rates) capturing the wife susceptibility to sexually transmitted diseases; and

γ, ν and τ are penalty parameters representing the sociological and psychological costs of cheating and/or divorcing, which may be positive or negative values.

Essentially, the wife achieves utility from a weighted average of consumption activity, net expected health and net martial happiness. The possibility that the husband may cheat and transmit a sexually transmitted disease lowers health from its maximum value. Similarly, if the husband cheats, if the wife decides to divorce the husband, or a combination of the two results, then M is reduced below its maximum value.

Based on this information, we can express the wife's optimization problem as:

$$\max_{C,D} \quad U^w = \omega_1 C + \omega_2 \left(H^w - \rho^w G\right) + (1 - \omega_1 - \omega_2)\left(M - \gamma G - \nu D - \tau DG\right) \tag{2}$$

$$subject \;\; to \;\; (\alpha + \beta D)Y = P_c C$$

The presence of β in the budget constraint (where $-\alpha \leq \beta \leq 1-\alpha$) represents a legally imposed re-distribution of wealth should the wife decide to divorce the husband. For example, in the U.S. this may represent the legal restriction that (in the absence of a pre-nuptial agreement) a wife is entitled to one-half of the family's wealth. Conversely, in some African countries, a wife who divorces her husband is entitled to none of the family wealth. In that case, beta would be non-positive. Solving the budget constraint for C and substituting this expression into the utility function yields the final version of the wife's optimization problem:

$$\max_{D} \quad U^w = \omega_1 \left(\frac{(\alpha + \beta D)Y}{P_c}\right) + \omega_2 \left(H^w - \rho^w G\right) + (1 - \omega_1 - \omega_2)\left(M - \gamma G - \nu D - \tau DG\right) \tag{2a}$$

The husband's decision problem is similar to the wife's, except that he also receives a non-negative utility from consuming extramarital sex. Additionally, if the husband and wife divorce, any legally imposed re-distribution of wealth to (from) the wife must be paid by (to) the husband:

$$\max_{S,G} \quad U^h = \mu_1 S + \mu_2 G + \mu_3 \left(H^h - \rho^h G\right) + (1 - \mu_1 - \mu_2 - \mu_3)\left(M - \gamma G - \nu D - \tau DG\right) \tag{3}$$

$$subject \;\; to \;\; (1 - \alpha - \beta D)Y = P_s S + P_g G$$

As before, solving the budget constraint for S and substituting the resulting expression into the utility function gives the final version of the husband's decision problem:

$$\max_{G} \quad U^h = \mu_1 \left(\frac{(1 - \alpha - \beta D)Y}{P_s}\right) - \mu_1 \frac{P_g}{P_s} G + \mu_2 G + \mu_3 \left(H^h - \rho^h G\right) + (1 - \mu_1 - \mu_2 - \mu_3)\left(M - \gamma G - \nu D - \tau DG\right) \tag{3a}$$

[2] Should one wish to include children in the model, one can assume that the wife purchases C for herself and her children. Similarly, the wife's health and martial happiness can also be considered inclusive of children.

At this point it is important to mention a pair caveats. First, we allow the husband and wife to experience different states of health and different risks of disease transmission. The former is obvious, while the latter comes from the epidemiological literature, which states that (holding all other risk factors constant) women face higher transmission rates than men do. Second, we impose the restriction that the husband and wife both receive the same amount net marital satisfaction. However, since the husband and wife do not share the same utility weights, this restriction may not result in the same contribution to each spouse's utility. By making this restriction, we explicitly link the husband and wife's utilities (and consequently their choices), without significantly limiting the generality of the model. Note that allowing the net marital happiness parameters to be spouse-specific would not qualitatively change the results of the model.

The Game and Its Solution

In its simplest form, the game is limited to a single period. In this case, all choice variables and model parameters can be considered as real, time discounted values over the life of the marriage. The single period is divided into two stages. In the first stage, the husband decides whether or not to cheat. In the second stage of the game, the wife decides whether or not to divorce the husband. Figure 1 shows the extensive form of the game, as well as the individual payoffs (expressed in terms of utilities) for each player and possible outcome.

We solve the game using backward induction, and look for the conditions under which each player has a specific dominant strategy.[3] We begin with the second stage of the game, and identify the conditions under which the wife has a dominant strategy to divorce her husband. Clearly, a sufficient condition for this to occur (assuming each of the utility weights are not zero) is when $\beta > 0$ and $\nu, \tau < 0$.[4] Alternatively, a sufficient condition for the wife not to divorce her husband is when $\beta < 0$ and $\nu, \tau > 0$. These results make sense. In the former case, the wife can increase her wealth and net happiness by dissolving the marriage. However, if $\beta < 0$ and $\nu, \tau > 0$, then not only does the wife lose monetary wealth (and the ability to support herself), but she also pays a high social price for dissolving the marriage. In such cases, it would not be in the wife's interest to do so, even if the husband is unfaithful (and possibly infects her with a sexually transmitted disease).

The wife's strategy is less clear when $\beta > 0$ and $\nu, \tau > 0$, or when $\beta < 0$ and $\nu, \tau < 0$. In these cases, the wealth effect and the socio-psycho effects offset each other. For example, in the former case, the wife divorces the husband if the increase in wealth, $\omega_1 \beta \frac{Y}{P_c}$ is larger than the sociological/psychological costs of divorcing her husband ($\omega_3(\nu + \tau)$), and does not divorce if the opposite is true. A similar argument can be made when $\beta < 0$ and $\nu, \tau < 0$, although the conditions for the wife to divorce or not divorce her husband are reversed.

Having discussed the factors influencing the wife's decision to divorce or not divorce her husband, we now examine the first stage of the game, and look for conditions that invoke a dominant strategy for the husband *taking as given the conditions that influence the wife's dominant strategy*. First, suppose that the wife's dominant strategy is to divorce her husband.

[3] We utilize this method of characterizing the game's solutions (instead of a mixed strategy approach) because we believe it provides a much simpler way of expressing the same information. Should one solve the game's mixed strategy solutions, the resulting probabilities would depend on the relative sizes and magnitudes of the conditions we are about to discuss.

[4] If these values are all equal to zero then the wife is ambivalent between divorcing and not divorcing her husband. For simplicity, we also assume that nu and tau are always of the same sign. Since both measure similar costs, this assumption seems innocuous.

Then whether or not the husband is unfaithful depends on the condition:

$$\mu_2 - \mu_1 \frac{P_G}{P_s} - \mu_3 \rho^h - \mu_4(\gamma + \tau) \qquad (4)$$

In this expression, μ_2 represents the extra utility the husband gains from extramarital sex.[5] Under general circumstances, the remaining terms in this expression represent the costs of infidelity. Clearly, if the benefits of infidelity outweigh the costs, so that $\mu_2 - \mu_1 \frac{P_G}{P_s} - \mu_3 \rho^h - \mu_4(\gamma + \tau) > 0$, then the husband's dominant strategy is to engage in extramarital sex.. If the inequality is reversed, so is the husband's dominant strategy.

Now suppose that the wife's dominant strategy is not to divorce her husband. In this case, the husband's dominant strategy depends on the following condition:

$$\mu_2 - \mu_1 \frac{P_G}{P_s} - \mu_3 \rho^h - \mu_4 \gamma \qquad (5)$$

The intuition behind this expression is similar to that of (4). In general, μ_2 represents the extra utility the husband gains from extramarital sex. Again, if this expression is positive (so the benefits of infidelity outweigh the costs) the husband cheats; otherwise he does not. Note that the difference between these last two expressions is the presence of $-\mu_4\tau$ in equation (4). Normally, we would expect both μ_4 and τ to be non-negative. As a result, the primary difference between the husband's two dominant strategies is that, if he knows the wife will not divorce him, then the expected costs of cheating are lower. Naturally, this will make it more likely that the husband will be unfaithful to his wife.

One interesting difference between the conditions determining the wife's dominant strategy versus her husband's is that the wife's dominant strategy depends on β (the legally imposed redistribution of wealth), while the husband's does not Another difference between the spouse's strategy conditions is that the husband's strategy choice is determined partly by the risk of acquiring and STD, while the wife's strategy choice is not. To some extent, this is a function of the game's setup: the wife has sex with the husband in the first period regardless, so whether or not he acquires an STD is essentially out of her control. As such, it is treated much like a sunk cost of marriage. However, given the extended incubation periods of HIV, as well as a possible lack of consistent testing and the failure of husbands to admit to extra marital affairs (unless they are caught), the setup of the game, at least in very general terms, mirrors reality.

IMPLICATIONS FOR GLOBAL PUBLIC POLICY

The most important goal of public policy in the context of this paper is improving the welfare of married women. Policies that provide an alternative to a marriage with the potential of being infected by HIV should diminish the rate of spread of the virus. These policies need to target legal and sociological structures in order to provide women more favorable values for β, and to a lesser extent τ and ν. The latter are also governed by individual specific factors, which may be out of the realm of policy. In patriarchal societies, including those in Africa or South Asia, the values for β are as negative as they can get. Additionally, the values for τ and ν typically are very large. This presents two different sets of policy recommendations. One is that it provides an economic rationale for income generating programs for divorced women many of whom have HIV. By increasing β (or Y depending on how the policy in question works) women would have the means to deal with the economic ramifications of divorce and/or a cheating husband. The interesting thing about this policy is that it changes the wife's behavior without noticeably

[5] Depending on the actual conditions that cause the wife to choose divorce as a dominant strategy, it is possible that tau is negative. In that case, tau would also be included as a benefit of cheating.

affecting the husband strategy choice. So enacting such a policy may even be a pareto superior move. The other is policy must be structured somehow to change people's perceptions of women in these countries. Policies that attempt to directly address gender relations are not widespread. Program usually targeting young males attempt to raise sensitivity and awareness of the plight of women and girls. Less directly, but arguably more effective, are policies that promote educational opportunities for women. Educational programs have an added bonus of potentially increasing β. Policies aimed at lowering τ and ν - the social and psychological cost associated with divorce - attempt the difficult task of changing societal norms and thus may be less successful than policies increasing β.

On the flip side, there are several possible policy options to try to induce the husband to remain monogamous. The husband's decision to engage in extramarital sex depended on the tradeoffs between its benefits and costs. Policy affecting this decision framework can either attempt to lower the perceived benefits or raise the costs of infidelity. In the former case, benefits may be reduced through programs aimed at redefining the societal acceptable perceptions of masculinity. This may be achieved through programs targeting young males, downplaying the masculine ideal centered on sexual prowess, shifting it to a model centered on devotion to family. Policies aimed at increasing the costs of extramarital sex include taxing prostitution.

Ironically, HIV/AIDS prevention programs may have a perverse effect in discouraging extramarital sex. Policies reducing transmission risks, such as social marketing programs for condoms, lowers ρ^h which from equations 4 and 5 (the husband's dominant strategies), reduces the costs of infidelity.

In this model both the husband and wife face the same social norms regarding divorce. Consequently, programs that try to lower the stigma of divorce work at cross-purposes. On the one hand, they facilitate a woman's decision to divorce a philandering spouse, thus lowering her risk of HIV infection. Alternatively, these programs lower the husband's cost of infidelity, encouraging extramarital sex.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The goal of this paper is to present a very simple model that examines a spouse's decision making in deciding to divorce their potentially unfaithful partner in the face of possible HIV infection as well as sociological and psychological constraints. We use a two-tiered game where initially a "promiscuous" husband chooses whether to engage in extramarital sex, or to remain faithful. In the second stage, the wife then determines whether to divorce her husband. We examine the model's policy implications using the game's dominant strategies for both the husband and wife. Our findings (which concur with the empirical human rights literature) indicate that policies which increase the legal status of women improve the wife's welfare, and also make her more likely to divorce her husband. Concomitantly, policies geared toward educating the husband about HIV/AIDS and/or taxing prostitution reduces the likelihood of infidelity. Interestingly, policies intended to decrease the prevalence rate of HIV/AIDS (such as condom programs) may reduce or enhance infidelity and/or subsequent divorce, and thus may not be effective policy tools.

While our model provides some interesting insights for policy, it makes a number of crucial simplifying assumptions. As such, it is intended only as a first step, and our findings should be viewed with caution. However, the simplicity of our model also highlights some areas for future research. The most obvious is that we are using a static model. If the decision processes at hand were modeled as a multi-period game, thereby allowing each spouse to fully anticipate and respond to the other, a much more detailed understanding of each spouse's decision process would be obtained. Another shortcoming is that we could allow the cheating to be more general. In particular, we could make the game more explicit, to allow the wife to determine with certainty whether or not the husband had exposed her to an STD before making the decision to divorce/not divorce him. So we wouldn't automatically assume that the cheating husband is having sex with two different women simultaneously. We could also make epidemiological conditions more explicit in the model, as well as add in a labor decision variable, so that income is not determined exogenously. Finally, one further improvement would be to make the social and psychological costs of divorce gender specific. While more realistic especially in patriarchal societies, it would also permit greater versatility in the model's policy implications.

Figure 1: The Game in Extensive Form

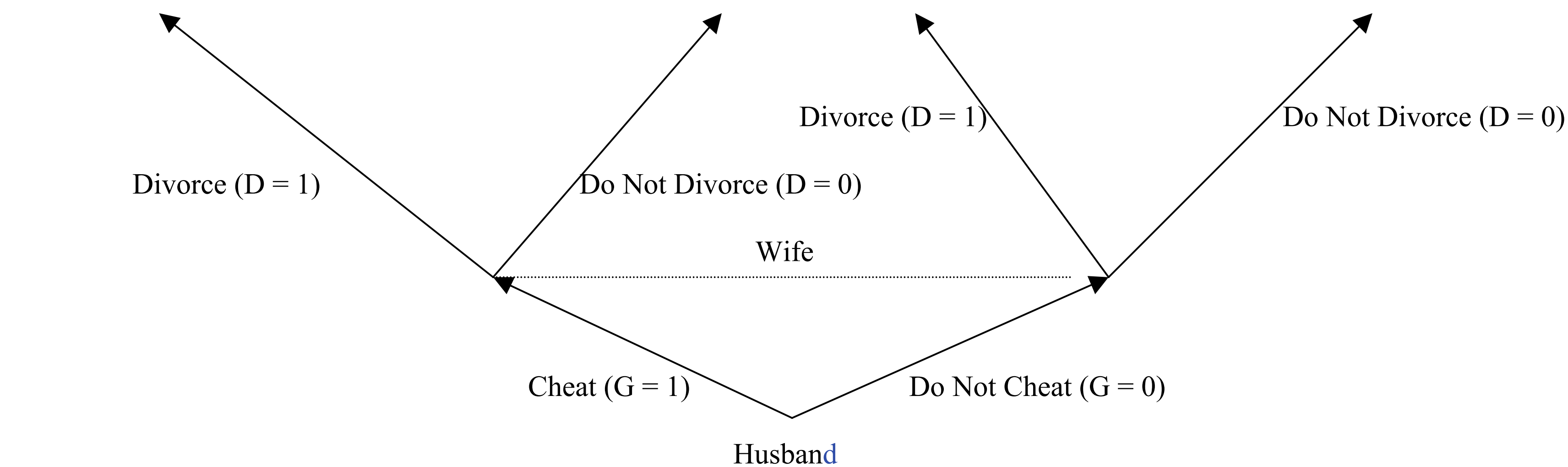
Note: for simplicity, we define $\omega_3 = 1 - \omega_1 - \omega_2$ and $\mu_4 = 1 - \mu_1 - \mu_2 - \mu_3$

$$\mu_1(1-\alpha)\frac{Y}{P_s} - \mu_1\frac{P_G}{P_s} + \mu_2 + \mu_3(H^h - \rho^h) + \mu_4(M-\gamma),$$
$$\omega_1\alpha\frac{Y}{P_c} + \omega_2(H^w - \rho^w) + \omega_3(M-\gamma)$$

$$\mu_1(1-\alpha)\frac{Y}{P_s} + \mu_3 H^h + \mu_4 M,$$
$$\omega_1\alpha\frac{Y}{P_c} + \omega_2 H^w + \omega_3 M$$

$$\mu_1(1-\alpha-\beta)\frac{Y}{P_s} - \mu_1\frac{P_G}{P_s} + \mu_2 + \mu_3(H^h - \rho^h) + \mu_4(M-\gamma-\nu-\tau),$$
$$\omega_1(\alpha+\beta)\frac{Y}{P_c} + \omega_2(H^w - \rho^w) + \omega_3(M-\gamma-\nu-\tau)$$

$$\mu_1(1-\alpha-\beta)\frac{Y}{P_s} + \mu_3 H^h + \mu_4(M-\nu),$$
$$\omega_1(\alpha+\beta)\frac{Y}{P_c} + \omega_2 H^w + \omega_3(M-\nu)$$



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