Pre-Marital Testing and Behavior: Effect of testing rules on HIV transmission

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Abstract

Marriages are historically central to family formation and an institution that sanctions sexual activity between partners. Individuals in countries with the HIV/AIDS epidemic are exposed to infection if married to an infected spouse. In the past decade several countries have either instituted and many more considering legislating pre-marital testing laws. Much controversy and debate has ensued in the wake of such laws. This paper informs the debate by highlighting the motivating aspects of information disclosure on preventive behavior under a mandated pre-marital testing law compared to other testing regimes. The paper develops a simple model to show that mandated testing under certain conditions reduce institutional costs resulting in higher levels of testing, early treatment and lowered transmission. Besides bringing attention to the unintended motivating effects of compulsory testing, the paper offers a rubric for policy makers confronting trade-offs with such legislations.

Keywords: Marriage, sexual behavior, HIV, pre-marital testing

1. Introduction

Marriages are widespread in the recorded history of human societies (Westermarck, 1922). They can last a life-time[2] and key to pscyhological, sexual and overall well-being in adult life (Gove et al., 1983; Oppenheimer, 1988). Given the centrality of marriage in people's lives, considerable efforts are exerted in choice of partners by individuals. The laws and customs that regulate the marital institution varies across countries and cultures. Like any

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[2]Or atleast meant to be. Traditional marriage vows in most cultures signify this lasting nature of marriage with phrases like 'till death do us apart' in Christian weddings or circumamulating the fire according to Saptapadi rites in a Hindu marriage.

institution, the social and legal institution of marriage regulates the activity of its individual members within its purview. Economists have noted that uncertainties in health and other attributes of future partners significantly affect the outcomes in the marriage market (Becker, 1973). In the last three decades, the risk of HIV/AIDS [3] infection from a partner inside marriage has appended to a host of other risks(Bongaarts, 2007). For instance in India, a country with the second largest number of HIV infected individuals, an estimated 90% of women living with HIV acquired the virus from their husbands or long-term partner[4](Silverman et al., 2008). Recently, several governments across the world have stipulated mandatory testing as a pre-requisite for marriage[5]. A not-so-apparent consequence of such laws, if it increases testing is the reduced uncertainty in infection status of prospective marital partners. In this paper, we examine the incentives at work in three different institutional regimes that affect pre-marital sexual behavior, which consequently affects aggregate social welfare through preference for marriage, marriage timing, sorting, HIV stigma and transmission of HIV. We draw attention to the effect of information acquisition and transmission and the ensuing incentives in the three regimes which characterizes systems across countries 1) no HIV testing 2) voluntary pre-marital HIV testing of a prospective partner and 3) mandated pre-marital HIV testing of a partner. We highlight the efforts chosen at prevention of disease during the pre-marital period of sexual activity, sorting in marriage and its effect on incidence or new infections under different regimes. In addition to showing that efforts at prevention are higher in a mandated regime compared to "no testing regime", the paper brings attention to the interaction of cultural norms with fear of learning in the voluntary testing regime that may lead to an socially inferior outcome. The paper briefly traces the trade-offs for the individual and for the social-planner within each regime. The paper in part

[3]Acquired Immunodeficiency Syndrome (AIDS) is a disease caused by the Human Immunodeficiency Virus (HIV)

[4]It must be noted at the onset that empirical examination of people's "private lives" is extremely challenging and riddled with reporting and measurement errors. The source of errors in prevalence statistics include: the 'window period' when testing does not detect infection (Corbitt, 1999), non-comparability between regions with low testing rates with regions with higher testing, selection bias in voluntary testing and absence of testing. Bias in estimation of responses is to be expected due to underreporting by people indulging in risky sexual behavior.

[5] Local governments in India, China, Ethiopia; countries of Bahrain, Guinea, United Arab Emirates, Saudi Arabia among many other have enacted laws and policies mandating premarital testing

is about recognizing psychological costs (of resolving uncertainty) and the prevailing structure of social interaction for optimal institutional design.

In the next section we outline the history of pre-marital testing legislation, followed by a brief section on relevant literature. A simple expected utility model to determine the equilibrium efforts at prevention and the resulting outcomes under varying regimes follows. The discussion section introduces the idea, why voluntary testing may result in sub-optimal welfare compared to mandatory testing? We conclude with a section on the trade-offs confronting the social planner which can helpful in characterising some of the dimensions of the problem while legislating.

Background

Mandated testing: legal history

The judicial standpoint on mandatory testing across countries and within is neither uniform nor clear-cut. In the United States, the state of Illinois introduced mandatory HIV testing for acquiring marriage licences in the late eighties. The law stipulated that both parties to a proposed marriage inform each other of their test results with effect from January 1, 1988. Marriages in the state plummeted from 95,613 in 1987 to 78,302 in 1988. The Monthly Vital Statistics Report (1991) records that, "the number of Illinois brides who married in other states, particularly neighboring states, increased substantially, doubling and even more than tripling in some states". The state registered a drop of 22.5% in marriages in that period, 8 of 70,846 applicants for marriage licenses were found to be HIV positive and the total cost of the testing program for 6 months was estimated at \$2.5 million or \$312,000 (in 1989 dollars) per HIV positive individual identified (Turnock and Kelly, 1989). Another study estimated that mandatory premarital screening, if adopted nationally, would cost \$167,230,000 (Petersen and White, 1990). In neighboring Mexico, seven out of thirty two states had pre-marital HIV testing mandated as early as 1994. A prevalence of 0.03% was found in the regions and according to a study, "... premarital HIV testing is not only violates human rights but also an expensive public health measure useless in the control of the spread of HIV"(Del et al., 1994). Although the monetary costs of testing has fallen drastically, the drop in marriage rates in Illinois raises the issue of preference for mandated testing.

In the recent past, several state governments in India have passed mandatory HIV testing laws before marriage and the national government is evaluating adopting it countrywide(Malhotra et al., 2008). Malaysia mandated a HIV screening test nationally starting January 1, 2009 (India, 2008); several

Christian churches in Nigeria have required their members to test before marriage since 2007 (News, 2007); Roman Catholic churches in Burundi require HIV testing to precede the wedding ceremonies from 2006(News, 2006). Several local governments in countries including China have mandated compulsory testing laws for prospective marital partners. Nevertheless legal opinion is highly divided, bringing to fore concerns about human rights violation in the implementation of such laws. It is evident that stipulating a mandatory testing is highly controversial and requires scrutiny by social scientists besides legal scholars and human rights activists.

Related literature

The HIV epidemic has become the most feared and analyzed disease of the last two decades with over 34 million estimated infected in 2007(UN-AIDS, 2007). New infections of HIV occur primarily through sexual activity between individuals with different infection status(Dow and Philipson, 1996). Approximately ten percent of adults in Sub-Saharan Africa are infected with HIV and the primary mode of transmission in the region is heterosexual sex. Currently, the absence of cure for AIDS and the high costs of treatment has led policy makers to focus on interventions preventing further spread[6](Hogan et al., 2005).

Increasingly, voluntary counselling and testing (VCT) has been widely advocated intervention and used to increase awareness of HIV status and reduce risky behavior in affected countries (Sweat et al., 2000). Evaluation studies in many countries have reported that reduction in risky behavior and transmission due to VCT intervention is unclear(Glick, 2005). A recent paper finds that minor monetary incentives could increasing testing rates by 50%, and that individuals on learning their HIV positive status are three times more likely to purchase condoms(Thornton, 2008). Self selection in opting for voluntary counselling and testing admittedly is a serious limitation in evaluating its effects(Thornton, 2008). Universal mandatory testing does not suffer from such selection. Although a pre-marital testing law may have other implications such as change in preference for marriage itself, which may reintroduce bias.

The emphasis on HIV testing for prevention has underlying assumptions: first, the positive effects of learning HIV will prevent the spread of the

[6](Canning, 2006) has written a comprehensive literature review of the recent literature on the macroeconomic issues of HIV/AIDS. We restrict it to studies examining behavioral responses to incentives.

disease. In particular, it is implicitly assumed that those diagnosed negative will protect themselves from infection and those diagnosed positive will take precautions to protect others. Second, many believe that it is difficult to get people to learn their HIV status (due to psychological or social barriers like stigmatization), thus justifying expenditures on de-stigmatization and advertising campaigns(Thornton, 2008).

As we mentioned in the previous section, several countries have attempted to introduce, considering implementation or have already mandated testing. Besides a couple of case studies in the public health literature on the Illinois experience (Cleary et al., 1987; Turnock and Kelly, 1989) and cost-benefit analysis of mandatory syphillis testing in the US (Haskell, 1984), a careful examination of the economic implications of mandatory testing is required. A related study by economists has been analyzing the impact of public testing on HIV (Boozer and Philipson, 2000). Their paper estimates the behavioral responses to the type of information-intervention a public HIV testing program would typify using a demand for information model. Given the centrality of marriage, and the high costs of HIV, there is a need to examine the implications of mandated pre-marital testing. This paper examines the outcomes of mandatory testing laws, focussing on HIV transmission, and compares it to the case of "voluntary testing" and the base case "no testing". Additionally, the paper underscores the differences in institutional and psychic costs under the different regimes. The economic trade-offs are recognized in the different regimes of testing which vary with culture and structure of social interaction.

Theory

As outlined in the earlier section, legal institutions governing pre-marital testing rules differ across countries. In this section, we use a simple model to capture the incentive structure for individuals to prevent disease that are inherent in the different regimes of testing. The model presented here ignores several complexities in the real-world in the hope of elucidating the key insights. Another idea which we attempt to show is the interdependence between individual psychic costs of testing and the institutional environment, which exacerbates the costs of testing. Here again, the model allows us to easily recognize the interaction and thereby illuminates the (possibly surprising) outcome of the regimes that hinge on the institutional environment.

The expected utility model

Set up and assumptions:

Individuals live in two periods: One prior to marriage (period 1) and one inside marriage (period 2).

Information/Beliefs[7]: Common priors with homogenous beliefs or ex-ante heterogenous priors [two types: previously careful (PC), previously not careful/reckless (PR)] in period 0 (or before the start of period 1).

Efforts (e) are exerted to prevent infection in period 1 based on information in period 0.

$e \in [0,1]$

Personal probability of infection $p(e)$ depends on own efforts (e), conditional on the population infection rate, $\Pi(\dot{e}|\lambda,\beta) = \Pi(\dot{e})$. $p'(e) < 0$; $p''(e) = 0$ ($p(e)$ is linear and decreasing in efforts).

The population infection rate is a function of aggregate population efforts ($\widehat{e}$) determined by equilibrium individual efforts (e) and conditional on the infection rate in period 0 (λ), and the virulence of disease (β), a biological parameter. For simplicity, we assume $\beta = 1$. Efforts are costly (C(e))

$C'(e) > 0$; $C''(e) > 0$

Utility measure representation[8]:

U^{hh}: Utility of of being uninfected oneself and marrying an uninfected partner or a healthy-healthy match in marriage;

U^{ii}: Utility of an infected-infected match in marriage;

U^{hi}: Utility of being healthy oneself and marrying an infected partner or a healthy-infected match in marriage;

U^{ih}: Utility of an infected-healthy match in marriage.

I assume that a discordant marriage (one infected, one healthy) is equal in utility to an infected-infected marriage[9].

$U^{ih} = U^{hi} = U^{ii} = U^{I}$

and $U^{hh} = U^{H}$

We assume that a healthy marriage is preferred to an infected marriage.

$U^{H} > U^{I}$

[7]Beliefs, personal probability of infection and transition probabilities all belong to the subjective-expected-utility world of Savage (1954). In addition, I assume that the subjective probabilities overlap with objective probabilites in the aggregate.

[8]The assumptions have also been informed by previous studies. A 2007 Johns Hopkins study in Ethiopia reports that 96% of the respondents would cancel the marriage if premarital test was discordant and they tested healthy.

[9]This assumption can find some validity if infection is difficult to prevent inside marriage. So both partners are infected eventually in a discordant marriage.

If an individual chooses to stay single[10], We assume being a healthy-single is preferred to infected-single $\left[U^h > U^i\right]$. An expected-utility maximizer with a pre-determined utility measure in period 0 $\left(\bar{U}\right)$, will choose efforts (e) to maximize his returns from period 2 (expected marital health), given the prevailing infection rate (λ), costs of effort $C(e)$. Higher efforts (e) will lower his personal probability of infection[11] in period 1, if he were uninfected in period 0 but will be increasingly costly ($C(e)$ is convex). The trade-off is increased (expected) benefits from healthy marriage in period 2 (due to lowered probability of infection in period 1), and cost of preventing disease in period 1. The institutional environment (allowing, or in this case hindering information acquisition that affords choice of partner and thereby health inside marriage) is reflected with expected health in marriage determined by population infection transition probability (Π).

$$\underset{e}{Max} \quad \bar{U} - C(e) + \delta(1-\lambda)\left\{(1-p(e))\left[U^{hh}(1-\Pi(\widehat{e})) + U^{hi}\Pi(\widehat{e})\right] + p(e)\left[U^{ih}(1-\Pi(\widehat{e})) + U^{ih}\Pi(\widehat{e})\right]\right\}$$
$$+\delta\lambda\left\{U^{ih}(1-\Pi(\widehat{e})) + U^{hi}\Pi(\widehat{e})\right\}$$

No Testing regime

Common priors

Pre-determined utility at period 0, $\bar{U}$.

$$\underset{e}{Max} \quad \bar{U} - C(e) + \delta(1-\lambda)\left\{(1-p(e))\left[U^{hh}(1-\Pi(\dot{e})) + U^{hi}\Pi(\dot{e})\right] + p(e)\left[U^{ih}(1-\Pi(\dot{e})) + U^{ih}\Pi(\dot{e})\right]\right\}$$
$$+\delta\lambda\left\{U^{ih}(1-\Pi(\dot{e})) + U^{hi}\Pi(\dot{e})\right\}$$

First order condition:
$-C'(e) + \delta(1-\lambda)\left\{-p'(e)\left[U^{hh}(1-\Pi(\dot{e})) + U^{hi}\Pi(\dot{e})\right] + p'(e)\left[U^{ih}(1-\Pi(\dot{e})) + U^{ih}\Pi(\dot{e})\right]\right\} = 0$
which can be reduced to [See Appendix for details of derivation],

$$\Longrightarrow C'(e) = -\delta(1-\lambda)(1-\Pi(\dot{e}))\,p'(e)\left(U^H - U^I\right) \tag{1}$$

the familiar Marginal cost = Marginal benefit equation. The optimal efforts ($\bar{e}$) will be determined by equation 1[12].
$\frac{-C'(e)}{p'(e)} = \delta(1-\lambda)(1-\Pi(\dot{e}))\left(U^H - U^I\right)$

[10]Note that the health status in superscripts are in capitals for married individuals.

[11]High efforts in period 1 or the period of pre-marital sexual activity, for instance could be complete abstinence which would translate into efforts close to maximum ($e \to 1$) in the model.

[12]The (Kakutani) fixed point theorem gives us the proof of existence of an equilibrium.

Since we know that $\left(U^H - U^I\right) > 0$; $1 > (1 - \Pi(\dot{e})) > 0$; $(1-\lambda) > 0$ and $\delta > 0$, we have a positive term on the right side in the above equation.

$\frac{-C'(e)}{p'(e)} \geq 0$, as $C(e)$ is convex and $p(e)$ linear and decreasing in e. We arrive at $\bar{e} \geq 0$.

Ex-ante heterogenous priors

In the real-world, even with no testing availability it is likely people possess varying levels of information about their previous efforts and hold subjective beliefs of their infection status. Although continuity would generate a richer set of results, for simplicity we assume two types of individuals (1) previously careful (PC), with subjective probability[13] (belief) of infection λ_{pc} (2) previously not careful/reckless (PR) with subjective probability of infection λ_{pr}.

$\lambda_{pr} > \lambda_{pc}$

The maximization problem for previously careful and previously not careful involve identical expected utility models in their prior beliefs about infection [See details in appendix]. We derive $e^*_{pc} > e^*_{pr}$. As expected those previously careful will have higher level of efforts compared to previously reckless in the period before marriage (period 1).

A note on signalling equilibrium

If efforts were observable, under certain conditions (including single crossing property of the utility functions of the two types), a signalling equilibrium can result with previously careful, exerting a level of effort to distinguish themselves, a level that would not be optimal to the previously reckless if they were to choose it. This will result in previously careful matching in marriage with previously careful.

Mandatory testing regime

Common priors

Testing is assumed available in this regime. As pointed out in the literature review, studies in several countries find that people do not test for HIV/AIDS, even if free and easily accesible. It may be rational to not resolve uncertainty about one's infection status, for instance if there is no cure or the treatment is unavailable or prohibitively costly. Currently, there is no cure for HIV/AIDS and issues of lack of access to treatment and limited availability of free treatment is beginning to resurface in several countries in

[13] We assume that subjective probability overlap with actual probabilities

Africa. It may be crucial to therefore recognize the psychic costs of learning one's status by testing. Let $\overline{P}$ capture such psychic costs of testing which has to be overcome if one chooses to learn own infection status.

Under mandatory testing, partners are required by law to test, and each has to learn own and the other's status at the time of marriage. Since utility from marrying a healthy partner is higher than marrying an infected partner, if one is healthy, they would prefer to marry a healthy partner (we allow for rematching partner's at some cost). These rematching costs can be subsumed in the psychic costs of testing $\overline{P}$. An individual if healthy in a mandatory testing regime with low psychic costs will choose to test and marry a healthy partner. The other option is to test and remain single or not to test and remain single. For sufficiently large $P(.) > 0$, the test and remain single option may be dominated by 'do not test and remain single' (and 'if test, marry'). The maximization problem is to choose between 'do not test and remain single' and 'test and marry' a partner of equal or infected status.

'Test and marry' will be preferred to 'do not test, stay single' if the following condition holds:

$$\begin{aligned} &\underset{e}{Max} \quad \bar{U} - C(e_s) + \delta(1-\lambda)\Big\{(1-p(e_s))\,U^{hh} + p(e_s)U^{ii}\Big\} + \delta\lambda U^{ii} - P(.) \quad > \\ &\underset{e}{Max} \qquad \bar{U} - C(e_m) + \delta(1-\lambda)\Big\{(1-p(e_m))\,U^{h} + p(e_m)U^{i}\Big\} + \delta\lambda U^{i} \end{aligned}$$

Comparing the first order conditions, we derive the conditions to 'test and marry' under mandatory testing regime.

$$\frac{C'(e_s)}{\delta(1-\lambda)p'(e_s)\left(U^h - U^i\right)} = \frac{C'(e_m)}{\delta(1-\lambda)p'(e_m)\left(U^{hh} - U^{ii}\right)} \tag{2}$$

If we assume[14] that utility differential between having a healthy marriage and staying healthy but single is greater than being in an infected marriage and staying single and infected $[U^{hh} - U^h > U^{ii} - U^i]$, we arrive at $\overset{**}{e}_m > \overset{**}{e}_s$ from equation () . Efforts at prevention in period 1 are higher for those who choose to 'test and marry' compared to those who prefer to remain 'untested and single'.

[14]In several countries there is an increasing number of HIV positive marriage bureaus as infected people report that their lives would be much better with a partner. Therefore if we were to make an argument for the reverse inequality $U^{ii} - U^i > U^{hh} - U^h$, the interesting outcome $\overset{**}{e}_m < \overset{**}{e}_s$ results – i.e., those who choose to be single exert more effort than those choosing to marry.

Ex-ante heterogenous priors

The psychic costs of testing may be higher for the previously not careful $\left(\overline{P}_{pr} > \overline{P}_{pc}\right)$ since they expect a higher probability of being infected $\left(\lambda_{pr} > \lambda_{pc}\right)$. As a consequence the likelihood of the previously not careful not testing and remaining single in the mandatory testing regime is higher than the previously careful. Another result if both groups choose to test and marry is that the equilibrium efforts of the previously careful will be higher than the other group, derived below from the first order conditions (FOC).

c

As $\lambda_{pr} > \lambda_{pc} \Longrightarrow (1-\lambda_{pc}) > (1-\lambda_{pr}) \Longrightarrow \frac{C'(e_{pc})}{p'(e_{pc})} > \frac{C'(e_{pr})}{p'(e_{pr})}$. Since $p'(e_{pr}) = p'(e_{pc})$, we have $C'(e_{pc}) > C'(e_{pr}) \Longrightarrow \overset{**}{e}_{pc} > \overset{**}{e}_{pr}$.

"Mandatory testing" vs. "no testing"

A key outcome from mandatory testing is no cross-infections in marriage if healthy marry healthy. A less obvious result is that equilibrium efforts in period 1 are higher in mandatory testing compared to the no testing regime. Let us illustrate this result by comparing the FOC's in the two regimes with identical initial conditions and for all choosing to marry (since we assumed a strong preference for marriage, $[U^{hh} > U^h, U^{ii} > U^i]$). The "no testing regime" is on the left hand side of the equality and the "mandatory testing regime" on the right hand side.

$$\frac{C'(e)}{-\delta(1-\lambda)(1-\Pi(\dot{e}))p'(e)(U^H-U^I)} = \frac{C'(e)}{\delta(1-\lambda)p'(e)(U^H-U^I)} \tag{3}$$

Since $1 > (1-\Pi(\dot{e})) > 0$, we get $\overset{**}{e}_m > \bar{e}_m$ i.e., the efforts at prevention under mandatory regime ($\overset{**}{e}_m$) are higher than the efforts with no testing regime ($\bar{e}_m$). This is because of incentives under mandatory regime, which motivates people to stay healthy with high effort levels in period 1, by rewarding them healthy partners in marriage. A mandatory pre-marital testing law is akin to an insurance for healthy people who pay a higher premium in period 1 through efforts and are guaranteed a healthy marriage in period 2, with information about prospective partner's health. This is consequent of the possibility of knowing the infection status and choosing a healthy partner in mandatory testing.

Voluntary testing regime

Under this regime, testing is available but not enforced as is the case in most countries. People can voluntarily choose to learn own status and if cultural norms permit ask partner to test and share information. Norms vary across cultures and countries, and in some countries it is relatively costless to mutually exchange information on infection status. In some parts of the world it is taboo (very costly to learn partner's infection status), while in most countries there is at least some discomfort in bringing up the issue of exchanging test results. An analogy would be considering a pre-nuptial where issues about mistrust surfaces between couples before getting married. Prevalent marital customs and norms therefore affect costs of learning prospective marital partner's infection status. Therefore, such institutional/cultural norms are modeled as the cost of getting partner to test $\left(\overline{N}\right)$ have to be considered in addition to psychic costs of own testing $\left(\overline{P}\right)$ in voluntary testing regimes.

The options for an individual in a such a regime are (1) learn own status and stay single (2) learn own status and marry without mutally learning each other's status (3) marry with mutual learning of own and other's status (4) do not learn own status and stay single (5) marry without learning each and other's status.

With our earlier assumptions of preference for marriage, we can rule out option (1) and (2), if $\overline{P}$ is sufficiently high. One would choose to test only if the benefits or the expected utility from marriage outweigh the psychic and institutional costs of testing $\left[\overline{P}+\overline{N}\right]$ which is option (3) or to stay untested and single (4). Option (5) can be recognized as marrying without testing, akin to the "no testing regime". The level of efforts (e) at prevention in period 1, in the voluntary regime are similar to the no testing regime, if $\left[\overline{P}+\overline{N}\right]$are sufficiently large, where people choose to marry without testing or remain single. If $\left[\overline{P}+\overline{N}\right]$are small, the efforts will be similar to the mandatory testing regime. The mandatory regime removes the cultural norms as the impediment to testing [zero institutional (cultural) costs, ($\overline{N}=0$)], more people will choose to test and marry compared to voluntary regime. In the voluntary regime where people with preference for marriage will choose "no testing" and marry without testing option due to the absence of cultural norms of exchanging test status (or high institutional costs). An outcome of allowing individuals the choice of testing, as we shall argue in the next section, could result in a sub-optimal equilibrium with lower social welfare.

Results and discussion

A mandatory pre-marital testing law is an institution which sets specific rules for marriage. It specifies that all those who choose to marry (1) will be required to learn own status 2) will be guaranteed to learn prospective marriage partner's health status (3) and the marriage partner is in turn guaranteed information about an individual's health status. The regime negates the gamble of possibly marrying an infected partner as in the "no-testing regime" if one has incurred the costs of staying healthy. It imposes the psychic costs of learning own status on everybody choosing to marry. It motivates safe behavior by ensuring choice of healthy partner. The fear of having to learn that one is infected if one chooses to marry, may additionally motivate people to exert higher efforts at preventing disease in the period prior to marriage. This behavioral outcome is absent in voluntary testing regime, where individual members will still have a positive probability of finding another individual who similarly chooses not to test. The psychic costs of learning $\overline{P}$ are aggravated by the institutional costs $\overline{N}$, which further hinders mutual testing. The structure of social interactions may not evolve quickly to respond to prevalence of disease and the disease dynamics. Governments which may recognize any possibility of explosion of asymptomatic diseases like HIV have to contend with trade-offs. The benefits from higher effort levels at prevention are the resulting lowered incidence, lowered cross-infections in marriages due to higher likelihood of assortive matching. Such benefits may outweigh the imposed psychic costs on the population under a mandatory testing regime and increased marginal cost at prevention in the pre-marital period. If early treatment has benefits, this in turn will lead to higher welfare for the tested. I briefly make a case for a possible interesting fallout of mandatory testing – an increase in early testing, which improves the health of the already infected due to early treatment.

In this context, let us go back to the individual maximization problem and arrive at possible equilibria in the different regimes by introducing the benefits of early treatment.

Table 1, summarizes the trade-offs faced by an individual in the different regimes. In addition to the results from the earlier maximization problem, we include the benefits of testing. If tested before period 2, the early treatment increases the utility of the infected individuals from U^I to U^{I+} (if infected and tested at the end of period 1) or U^{I++}(if infected and tested before period 1). In the mandatory testing regime [Case 15 to 20 in Table 1], the expected utility maximizers choosing marriage over single will (stipulated testing) have to incur the psychic costs ($-\overline{P}_1$) at end of period 1. They also recognize the benefits of early testing (in period 0) which will yield them a higher utility if infected. As they prefer marriage they will necessarily have to submit to testing (prior to period 1), it may be beneficial to get tested even earlier (in period 0) if the benefits outweigh the costs (Case 17 to 20).

The trade-off[15] is the possibility of being infected in period 0 and exerting a higher marginal efforts at prevention rather than reaping the benefits of early treatment. With heterogenous priors, we can expect an increased likelihood of the previously reckless choosing early testing if the net treatment benefits are high.

The voluntary testing regime harbors the likelihood of being married without undergoing the psychological and institutional costs of testing. The fear of learning interacts with the cultural norms to result in an outcome of increased uncertainty in the marital institution. Individuals not mandated to test in the future, may choose not to recognize the benefits of early testing as well. Although the possibility of the outcome with high social welfare as in mandatory testing is possible [case 11 to 14], a choice in testing may result in the "tragedy of the commons" of lowered efforts in period 1 and lower expected returns in marriage, identical to the "no testing regime" outcome [case 7 or 8].

Conclusion

A social planner is confronted with trade-offs in mandatory and voluntary regimes. The parameters he must consider are the infection rate (prevalence λ), the disease dynamics (Π), the treatment availability, access and its costs ($-T$) (and benefits). Although he may not be able to influence the psychic costs immediately [16]if an aysmptomatic disease is expected to register an explosive growth, and the prevalent customs have been unable to evolve rapidly to respond with high levels of voluntary testing, a mandated law could undo some of the institutional costs of getting a partner to test [Table 2 provides a brief schema of social welfare]. As discussed a mandated law may encourage early testing and thereby segregate the infected and the healthy early. The planner will have to consider the possible discriminatory outcomes (and likely social sanction of the infected[17]) and compare it with

[15]Note that the psychic costs also subsumes the costs of stigma if infected

[16]Over time, stigma could be reduced by creating awareness. Besides, a mandated testing law removes the taboo from testing, which may considerably lower the psychic costs of going to test.

[17]Luginaah et al (2005) examine the impact of church mandated testing in Ghana. Their results reveal how broader social impacts of HIV testing for those planning to marry may extend beyond individuals or couples in different cultural contexts. The findings also support the view that programs for Ghana cannot be neutral to cultural values and need to be tailored for particular (ethnic) populations.

the increased efficiency of efforts[18]at prevention by those testing healthy in period 0 and the lowered incidence, lowered likelihood of cross-infections in marriage (period 1) and benefits of early treatment for the infected. It is possible that there may be cases where the psychic costs are prohibitively high and the population collectively choose not to resolve such uncertainty. A case may be where the incidence of HIV is extremely high, but people would be better-off without learning their status [Case 5 in Table 2].

The mandatory pre-marital testing law is controversial and human rights activists oppose it on grounds of privacy violation due to poor implementation. This paper brings an economic insight about the gains from reduced uncertainty due to mandatory testing. Governments have to carefully consider the trade-offs inherent in the legal institutions governing marriage. In developing a rough schema of trade-offs under different regimes and prevailing conditions, this paper informs the debate on mandated HIV testing.

[18]The early testing will result in a reallocation ofthe efforts are higher for those testing healthy. The infected will choose early treatment. The early testing results will further reallocate efforts of period 1 for healthy-healthy and infected-infected (low or no effort), and high efforts if healthy are in a relationship with infected.

Tables

Table 1: A comparative table of individual costs and benefits in regimes

Choice	Info.	Period 1	Incidence	S/M	Period 2	Case
No testing (CP)		MC	FC		Returns	
$\bar{U}$		$C'(\bar{e}_s)$		S	$(1-\lambda)\left[(1-p)\,U^h + pU^i\right] + \lambda U^i$	1
$\bar{U}$		$C'(\bar{e}_m)$		M	$(1-\lambda)\left\{(1-p)\left[(1-\Pi)U^H + \Pi U^I\right] + pU^I\right\} + \lambda U^I$	2
No testing (HP)						
Care: $\bar{U}_{pc}$		$C'(\bar{e}_s^{pc})$		S	$(1-\lambda_{pc})\left[(1-p)\,U^h + pU^i\right] + \lambda_{pc} U^i$	3
Care: $\bar{U}_{pc}$		$C'(\bar{e}_m^{pc})$		M	$(1-\lambda_{pc})\left\{(1-p)\left[(1-\Pi)U^H + \Pi U^I\right] + pU^I\right\} + \lambda_{pc} U^I$	4
No care: $\bar{U}_{pr}$		$C'(\bar{e}_s^{pr})$		S	$(1-\lambda_{pr})\left[(1-p)\,U^h + pU^i\right] + \lambda_{pc} U^i$	5
No care: $\bar{U}_{pr}$		$C'(\bar{e}_m^{pr})$		M	$(1-\lambda_{pr})\left\{(1-p)\left[(1-\Pi)U^H + \Pi U^I\right] + pU^I\right\} + \lambda_{pc} U^I$	6
Voluntary						
$\bar{U}$		$C'(\overset{*}{e}_s)$		S	$(1-\lambda)\left[(1-p)\,U^h + pU^i\right] + \lambda U^i$	7
$\bar{U}$		$C'(\overset{*}{e}_m)$		M	$(1-\lambda)\left\{(1-p)\left[(1-\Pi)U^H + \Pi U^I\right] + pU^I\right\} + \lambda U^I$	8
$\bar{U}$		$C'(\overset{*}{e}_s)$	$-\overline{P}_1$	S	$(1-\lambda)\left[(1-p)\,U^h + pU^{i+}\right] + \lambda U^{i+}$	9
$\bar{U}$		$C'(\overset{*}{e}_m)$	$-\overline{P}_1 - \overline{\mathbf{N}}$	M	$(1-\lambda)\left\{(1-p)\left[(U^H + U^{I+}\right] + pU^{I+}\right\} + \lambda U^{I+}$	10
$\bar{U}-\overline{P}_0$	H	$C'(\overset{*}{e}_s)$	$-\overline{P}_1$	S	$(1-\lambda)\left\{(1-p)\,U^h + pU^{i++}\right\} + \lambda U^{i++}$	11
$\bar{U}-\overline{P}_0$	H	$C'(\overset{*}{e}_m)$	$-\overline{P}_1 - \overline{\mathbf{N}}$	M	$(1-\lambda)\left\{(1-p)\,U^H + pU^{I++}\right\} + \lambda U^{I++}$	12
$\bar{U}-\overline{P}_0$	I	$-T$		S	$(1-\lambda)\left\{(1-p)\,U^h + pU^{i++}\right\} + \lambda U^{i++}$	13
$\bar{U}-\overline{P}_0$	I	$-T$		M	$(1-\lambda)\left\{(1-p)\,U^H + pU^{I++}\right\} + \lambda U^{I++}$	14
Mandatory						
$\bar{U}$		$C'(\overset{**}{e}_s)$		S	$(1-\lambda)\left[(1-p)\,U^h + pU^i\right] + \lambda U^i$	15
$\bar{U}$		$C'(\overset{**}{e}_m)$	$-\overline{P}_1$	M	$(1-\lambda)\left\{(1-p)\left[(U^H + U^{I+}\right] + pU^{I+}\right\} + \lambda U^{I+}$	16
$\bar{U}-\overline{P}_0$	H	$C'(\overset{**}{e}_s)$	$-\overline{P}_1$	S	$(1-\lambda)\left\{(1-p)\,U^h + pU^{i++}\right\} + \lambda U^{i++}$	17
$\bar{U}-\overline{P}_0$	H	$C'(\overset{**}{e}_m)$	$-\overline{P}_1$	M	$(1-\lambda)\left\{(1-p)\,U^H + pU^{I++}\right\} + \lambda U^{I++}$	18
$\bar{U}-\overline{P}_0$	I	$-T$		S	$(1-\lambda)\left\{(1-p)\,U^h + pU^{i++}\right\} + \lambda U^{i++}$	19
$\bar{U}-\overline{P}_0$	I	$-T$		M	$(1-\lambda)\left\{(1-p)\,U^H + pU^{I++}\right\} + \lambda U^{I++}$	20

Table 2: Schema of outcomes (trade-off table for social planner)					
Outcome	Structure	Efforts	Incidence	Social Welfare	Case
All marry	2, 8, 16	$\bar{e}_m = \overset{*}{e}_m < \overset{**}{e}_m$	$\Pi(\bar{e}_m) = \Pi(\overset{*}{e}_m) > \Pi(\overset{**}{e}_m)$	$2 = 8 < 16$	1
All single	1, 7, 15	$\bar{e}_s = \overset{*}{e}_s = \overset{**}{e}_m$	$\Pi(\bar{e}_m) = \Pi(\overset{*}{e}_m) = \Pi(\overset{**}{e}_m)$	$1 = 7 = 15$	2
Preference for marriage $\left[U^H > U^h, U^H > U^h\right]$, high institutional costs $\left(\overline{\mathbf{N}} > 0\right)$					
All marry	2, 8, 16	$\bar{e}_m = \overset{*}{e}_m < \overset{**}{e}_m$	$\Pi(\bar{e}_m) = \Pi(\overset{*}{e}_m) > \Pi(\overset{**}{e}_m)$	$2 = 8 < 16$	3
$\left[U^H > U^h, U^H > U^h\right]$, high institutional costs $\left(\overline{\mathbf{N}} > 0\right)$, low treatment cost and early treatment benefits					
All marry	2, 8, 18 or 20	$\bar{e}_m = \overset{*}{e}_m < \overset{**}{e}_m$ or $-T$	$\Pi(\bar{e}_m) = \Pi(\overset{*}{e}_m) > \Pi(\overset{**}{e}_m)$	$2 = 8 < 18$	4
$\left[U^H > U^h, U^H > U^h\right]$, high psychic costs $\left(\overline{P} > 0\right)$; high institutional costs $\left(\overline{\mathbf{N}} > 0\right)$					
M w/o test in VT & NT	2, 8,15		$\Pi(\bar{e}_m) = \Pi(\overset{*}{e}_m) = \Pi(\overset{**}{e}_m)$	$2 = 8 > 15$	5
Single in mandatory					

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Appendix

No testing regime

Common priors

$$\underset{e}{Max} \quad \bar{U} - C(e) + \delta(1-\lambda)\Big\{(1-p(e))\Big[U^{hh}(1-\Pi(\dot{e})) + U^{hi}\Pi(\dot{e})\Big] + p(e)\Big[U^{ih}(1-\Pi(\dot{e})) + U^{ih}\Pi(\dot{e})\Big]\Big\}$$
$$+\delta\lambda\Big\{U^{ih}(1-\Pi(\dot{e})) + U^{hi}\Pi(\dot{e})\Big\}$$

First order condition:

$$-C'(e) + \delta(1-\lambda)\Big\{-p'(e)\Big[U^{hh}(1-\Pi(\dot{e})) + U^{hi}\Pi(\dot{e})\Big] + p'(e)\Big[U^{ih}(1-\Pi(\dot{e})) + U^{ih}\Pi(\dot{e})\Big]\Big\} = 0$$
$$-C'(e) + \delta(1-\lambda)\Big\{-p'(e)\Big[U^{H}(1-\Pi(\dot{e})) + U^{I}\Pi(\dot{e})\Big] + p'(e)\Big[U^{I}(1-\Pi(\dot{e})) + U^{I}\Pi(\dot{e})\Big]\Big\} = 0$$
$$\Longrightarrow -C'(e) + \delta(1-\lambda)\Big\{-p'(e)\Big[U^{H}(1-\Pi(\dot{e})) + U^{I}\Pi(\dot{e})\Big] + p'(e)\Big[U^{I}\Big]\Big\} = 0$$
$$\Longrightarrow -C'(e) + \delta(1-\lambda)\Big\{-p'(e)U^{H}(1-\Pi(\dot{e})) - p'(e)U^{I}\Pi(\dot{e}) + p'(e)U^{I}\Big\} = 0$$
$$\Longrightarrow -C'(e) - \delta(1-\lambda)p'(e)\Big\{U^{H}(1-\Pi(\dot{e})) - U^{I}(1-\Pi(\dot{e}))\Big\} = 0$$
$$\Longrightarrow -C'(e) - \delta(1-\lambda)(1-\Pi(\dot{e}))p'(e)\Big(U^{H} - U^{I}\Big) = 0$$
$$\Longrightarrow C'(e) = -\delta(1-\lambda)(1-\Pi(\dot{e}))p'(e)\Big(U^{H} - U^{I}\Big)$$

Ex-ante heterogenous priors

The maximization problem for previously careful,

$$\underset{e}{Max} \quad \bar{U}_{pc} - C(e) + \delta(1-\lambda_{pc})\Big\{(1-p(e))\Big[U^{hh}(1-\Pi(\dot{e})) + U^{hi}\Pi(\dot{e})\Big] + p(e)\Big[U^{ih}(1-\Pi(\dot{e})) + U^{ih}\Pi(\dot{e})\Big]\Big\}$$
$$+\delta\lambda_{pc}\Big\{U^{ih}(1-\Pi(\dot{e})) + U^{hi}\Pi(\dot{e})\Big\}$$

The maximization problem for previously not careful,

$$\underset{e}{Max} \quad \bar{U}_{pr} - C(e) + \delta(1-\lambda_{pr})\Big\{(1-p(e))\Big[U^{hh}(1-\Pi(\dot{e})) + U^{hi}\Pi(\dot{e})\Big] + p(e)\Big[U^{ih}(1-\Pi(\dot{e})) + U^{ih}\Pi(\dot{e})\Big]\Big\}$$
$$+\delta\lambda_{pr}\Big\{U^{ih}(1-\Pi(\dot{e})) + U^{hi}\Pi(\dot{e})\Big\}$$

FOC for previously careful:

$$\Longrightarrow C'(e) = -\delta(1-\lambda_{pc})(1-\Pi(\dot{e}))\,p'(e)\big(U^H - U^I\big) \tag{.1}$$

FOC for previously not careful:

$$\Longrightarrow C'(e) = -\delta(1-\lambda_{pr})(1-\Pi(\dot{e}))\,p'(e)\big(U^H - U^I\big) \tag{.2}$$

The transition probability will be a function of the aggregate efforts of both the groups $\Pi(\dot{e}_{pc}, \dot{e}_{pr})$. Let us compare the effort levels for the two groups.

$$\frac{-C'(e_{pc})}{p'(e_{pc})\delta(1-\lambda_{pc})\big(1-\Pi(\dot{e}_{pc},\dot{e}_{pr})\big)\big(U^H-U^I\big)} = \frac{-C'(e_{pr})}{p'(e_{pr})\delta(1-\lambda_{pr})\big(1-\Pi(\dot{e}_{pc},\dot{e}_{pr})\big)\big(U^H-U^I\big)}$$

$\Longrightarrow \frac{-C'(e_{pc})}{p'(e_{pc})(1-\lambda_{pc})} = \frac{-C'(e_{pr})}{p'(e_{pr})(1-\lambda_{pr})}$

$\Longrightarrow \frac{C'(e_{pc})(1-\lambda_{pr})}{p'(e_{pc})} = \frac{C'(e_{pr})(1-\lambda_{pc})}{p'(e_{pr})}$

We know that $(1-\lambda_{pc}) > (1-\lambda_{pr})$, therefore

$\frac{C'(e_{pc})}{p'(e_{pc})} > \frac{C'(e_{pr})}{p'(e_{pr})}$

We know that $p(e)$ is linear. Therefore $p'(e)$ is a constant for all e, $p'(e_{pc}) = p'(e_{pr})$

$\Longrightarrow C'(e_{pc}) > C'(e_{pr})$

Since $C'(.) > 0$ and $C''(.) > 0$ we derive $e^*_{pc} > e^*_{pr}$