Marriage as a risk factor of HIV-infection: the Role of Female Empowerment

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Abstract

This paper examines the role of woman's empowerment on the individual risk of HIV-infection. In particular, we investigate how married women can reduce their own risk of infection by investing in female empowerment. In a simple theoretical model, it is demonstrated that woman can invest in empowerment with a view to reducing her husband's demand for extramarital sex, and hence reducing her own risk of becoming infected. Using data from the Demographic and Health Surveys collected in Malawi, Zambia and Zimbabwe, empirical findings confirm the infection risk reducing-effect of female empowerment among a sample of married women aged 15-49 years old, controlling for endogeneity.

1 Introduction

In recent years, woman empowerment in developing countries has become a policy goal per se and for the long-run benefits it confers to women and their family. Increasing female empowerment has been shown to increase the use of prenatal and delivery care services in Indonesia (Beegle *et al*, 2001), to influence investments in children and other family members (Reggio, forthcoming), to improve woman's status on the labor market (Hendy and Sofer, 2009). In the context of the HIV/AIDS epidemic in Sub-Saharan Africa, woman's lack of power has been often pointed out as the main cause of woman's vulnerability to the risk of being HIV-infected, by

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non-governmental organizations and associations involved in the fight against AIDS. Women are found to be vulnerable to the risk of HIV-infection for biological reasons, but also due to poverty and because they are found to have little or not any control over the use of condoms. Previous studies have documented the particular case of women who are vulnerable to HIV-infection because they are forced to engage in formal or informal prostitution to make both ends meet. Recently, Robinson and Yeh (2010) have shown that if commercial sex workers are facing shocks they are more likely to engage in unprotected sex with their clients. Gertler *et al* (2003) found that in Mexico, the price of an unsafe sexual intercourse is higher than the price of protected sex such that poor women might decide to bear the additional risk of HIV-infection to receive the risk premium.

Only a few research papers investigate the consequences of female empowerment while most of them investigate the determinants of female empowerment or analyze its consequences from a theoretical viewpoint. Similarly, there has been no empirical work directly examining the consequence of female empowerment on the risk of infection in a direct way nor the case of married women. Even though being married is often seen as reducing the risk of HIV-infection in the sense that the risk is mastered since each spouse knows each other and have been living together for a while, it is still of special importance to study married women who represent the vast majority of women in the society, because sex within marriage is not as safe as it is supposed to be. Existing papers have investigated the case of migrant workers or long-distance truck drivers and suggested that if men are geographically separated from their wife and family staid at home when they are traveling for their job, they are very likely to engage in casual sex (e.g. Oruboloye *et al*, 1993; Rakwar *et al*, 1999; Gouws and Ramjee, 2002; Ferguson and Morris, 2007; Meekers, 2000; Adaji Nwokoji and Ajuwon, 2004). This is seen as a pathway through woman's infection

with HIV. The fact that the man is a migrant worker or a truck driver is not a necessary condition to see this mechanism operate. The same mechanism can work in any household as soon as the man is engaging in extramarital sex. Of course, the likelihood of extramarital sex is higher for the former group, but it is not necessarily null for the men who work and stay with their family. Clark (2004) questions the persistent perception that sex within marriage is safe, comparing the risk of infection of young women aged 15-24 depending on their marital status. Using data from Kenya and Zambia collected in 1997 and 1998, she found that married young women are more likely than sexually active unmarried girls to be infected with HIV. Being married increases their probability of infection by between 58 and 91%. Kelly *et al* (2003) also suggest that men are the predominant source of HIV-infection within stable unions, especially for young women who marry older men.

The aim of this paper is to investigate the role of female empowerment in the woman's risk of HIV-infection. We first theoretically model how empowering woman might reduce their probability of infection by influencing her husband's demand for casual sex and then provide some empirical supportive evidence. In this paper, the focus of analysis is the married women who might decide to invest in their empowerment with the view to decreasing her husband's level of extramarital sex, and hence reducing their own risk of becoming infected with HIV. The cost of such an investment is decreasing with the woman's family background. We also examine empirically whether being empowered prevents women from catching HIV by estimating the effect of female empowerment in the likelihood of being infected with HIV. Using data from the Demographic and Health Surveys, we find that female empowerment reduces the individual risk of being HIV-positive among a sample of 9,870 married women aged 15-49, even controlling for endogeneity. Increasing the degree of female empowerment by one standard deviation is found to reduce the risk

of HIV-infection by 0.14 percentage point. Empirical evidence suggests that this risk-reducing effect of female empowerment is robust to a number of checks.

Data from the Demographic and Health Surveys (DHS, hereafter) allows us to estimate the relationship of interest since it gathers information about gender issues and tests for HIV a subsample of its respondents. Most research identifies female autonomy with relative measures such that earnings, education, social status between husbands and wives. Here we are able to exploit a dataset that gathers broader information about gender issues. Indeed, the concept of female empowerment is multifaceted and using the DHS, various dimensions that constitute female empowerment can be taken into account. Specifically, to capture to which extent women can make independent choices/decisions and can be respected, four dimensions are used in this paper, namely, education, woman's decision making power within the household across different items, self-perceptions about domestic violence and freedom.

The next section of the chapter develops the simple theoretical model underlying the link between female empowerment and the individual risk of infection. The subsequent sections propose some empirical tests of its predictions. Section (4.3) describes the data used in the analysis and the estimation strategy. Section (4.4) presents and comments the primary results and some robustness checks. Section (4.5) concludes.

2 The Model

2.1 The Setting

A simple model is sufficient for capturing the effect of female empowerment on the risk of being HIV-infected and its mechanism. A woman might decide to invest in

female empowerment, mainly through education, in order to influence her husband's behavior, and then reduce her own risk of HIV-infection. The model discussed next illustrates this point.

There are two players: a woman (F) and a man (H), who are married or live together, and we assume that both of them were HIV-negative at the time of the union. This assumption is grounded on the fact that the situation in which both partners are HIV-negative at the time of the union is the dominant case although one could not omit the cases in which one of the partners is already infected from a previous partnership. This benchmark assumption allows us to bring out more clearly the logics of the mechanism and the role of female empowerment in the HIV-risk, but in the empirical analysis below we will extend the setting and discuss in more details this assumption.

The man chooses the level of extramarital sex he is willing to satisfy. We model the man's strategy as a continuous choice, such as the choice of the number of extramarital partners (weighted by how unsafe the intercourse he has with them). The woman decides how much to invest in female empowerment taking into account that her decision will have an impact on her husband's choice of extramarital sex.

The model presented here is based upon three stylized facts: (i) it is most likely that married woman does not negotiate towards sexual affairs within the couple, and especially, does not have the final decision about condom use[1]; (ii) Condoms are seldom used within a stable partnership[2]; (iii) Married men are likely to have

[1]Blanc and Wolff (2001) surveyed 1,356 married women and their husband in Uganda and asked both of them "Who has more influence over sex?". 60% of both men and women reported that it was the man, and 2% of men and 8% of women reported it was the woman. See also Bauni and Jarabi (2003), Drezin *et al* (2007).

[2]See Blanc and Wolff (2001), Population Action International (2002), Drezin *et al* (2007).

extramarital sex[3] and they are more likely than married women to do so [4]. The fact that the husband may have casual partners induces a risk of infection both for himself and for his spouse. It is of particular interest for the fight against AIDS to investigate how the woman can reduce her own risk of HIV-infection if condoms are not used within her couple. One indirect strategy is to induce her husband to reduce his demand for casual sex. And female empowerment can contribute to reduce this demand for extramarital partnerships because investing in empowerment confers the woman a higher contribution within the household such that the man might be willing to reduce his demand for casual sex in order to satisfy his wife and to avoid a separation.

Therefore, with a view to reducing her own risk of being HIV-contaminated by their husband, the woman has the possibility of investing in empowerment. Two mechanisms can explain why female empowerment can influence man's behaviors and thus, have a negative effect on the risk of infection. Firstly, female empowerment confers woman more power in the society and within the couple, such that she can expect to find a job more easily and to hold a job that is better paid. Likewise, she is less dependent upon her husband as far as purchasing power is concerned. An empowered woman has a higher outside option from being single such that she can initiate a separation if she is not satisfied within her relationship more easily than a less empowered woman. Secondly, her husband benefits from a higher total household welfare to be shared with the other household members when being married to an empowered woman since she can bring money at home. Likewise he might decide to adjust his behaviors in order to keep his wife, and hence to reduce

[3]In Zambia Demographic and Health Survey, a much larger proportion of married men than women reported having more than one sexual partner in the last 12 months. 19.2% percent of married men reported having two or more partners in the 12 months preceding the survey compared with only 0.5% of married women (Central Statistical Office *et al*, 2009). See also Smith (2007).

[4]See among others, Glynn *et al* (2001)

his demand for casual or extramarital sex. By reducing his number of extramarital partners, he reduces his own risk of HIV-infection and hence the probability of contaminating his wife.

As seen above, previous literature suggests that once married, men are more likely to engage in extramarital sex than women. Given this feature, we assume that the only way HIV can enter the household is through the man. In other words, assuming that both spouses were susceptible when they get married, the only way woman can catch HIV is by being infected by her husband. The man chooses his level of unsafe sex or extramarital sex, denoted by x. If he chooses a level of extramarital sex, x, he becomes HIV-infected with a probability $p(x)$ which is increasing and convex in x and equal to zero if x is null. The convexity of the probability of infection comes from the fact that having multiple concurrent sexual partners increases the risk of infection (see Morris and Kretzschmar, 1995, 1997; Mah and Halperin, 2010); In other words, having concurrent partnerships is riskier than having serial partnerships. We consider that if the man becomes HIV-infected which occurs with a probability $p(x)$, there is a risk that the woman becomes HIV-infected as well equal to π, which is independent of the level of extramarital sex chosen by her husband. Hence the total probability of infection for the woman is $p(x)\pi$. Here to simplify, suppose that π is exogenous and identical for all women. One might argue that the woman's risk of HIV-infection, π, depends upon the level of female empowerment because the probability of getting HIV from having a unprotected intercourse with an infected partner is sensitive to the infection from other sexually transmitted infections and whether the STIs have been cured might depend on the female's ability to go to the health facilities.

The man derives utility, U^H, from extramarital sex and from consumption. Denote by $v(x)$ his utility from having extramarital sex, which is increasing and concave

in x, and equal to zero if the man decides to have no casual partner. The man who chooses a level of extramarital sex, x, remains HIV-negative with probability $1-p(x)$ in which case he appropriates a certain consumption $\tilde{c}_H$. Note that to simplify, we consider that if the man becomes HIV-infected from unsafe sex, he will die and then, derive no utility from consumption in the future. These elements are captured by assuming that man seeks to maximize the following utility function:

$$U^H = (1 - p(x))\tilde{c}_H + v(x) \tag{1}$$

Assume then that the woman is prepared to incur the cost of investing in female empowerment if it shows some effectiveness in reducing the risk of becoming HIV-infected. She derives utility from consuming $\tilde{c}_F$ and bears the cost of investing in female empowerment. The unit cost of producing this level of female empowerment is denoted $\delta(b)$, which is a decreasing function of her family past investment in human capital. The latter captures all investments her family made in building her own empowerment, in investing in her education, health, etc. We assume that family investment provides a strong background in such a way that having grown up in a family who puts much emphasis, for instance, in educating the girls lowers the cost of being empowered. The woman must choose her level of female empowerment, denoted E, that maximizes the following expected utility function:

$$U^F = (1 - p(x))\tilde{c}_F + p(x)(1 - \pi)\tilde{c}_F + p(x)\pi\tilde{c}_F - \delta(b)E \tag{2}$$

In the right-hand side, the expected utility from consumption consists of three terms that stand for three different states of the world: (i) both man and woman remain HIV-negative, i.e. with probability $1-p(x)$ the man is HIV-negative and with probability one, the woman remains susceptible; (ii) the man catches HIV while the

woman remains susceptible; (iii) both of them become HIV-infected which occurs with probability $p(x)\pi$. To each state is associated a particular level of consumption, that is detailed below.

We assume that consumption is derived from labor earnings, such that man and woman earn a wage denoted w_H and $w_F(E)$ respectively. The respective level of wage might be equal to zero if one does not work. Note that the woman's level of income is an increasing function of her female empowerment. This feature is grounded upon previous works showing how female empowerment is positively correlated with the woman's own income[5] (e.g. Anderson and Eswaran, 2009). We assume that married man and woman share their income such that the sum of man's and woman's consumption is equal to the sum of their wages, i.e. $\tilde{c_H} + \tilde{c_F} = w_H + w_F(E)$. Note that the total household welfare is increasing with female empowerment. The man benefits from his spouse's investment in female empowerment via an increase in total earnings. This latter generates incentive for the man to keep his wife satisfied and to adjust his demand for casual sex in order to avoid the breakdown of their union. It is most likely that if a man marries an empowered woman, he gets a higher utility and a higher total consumption than if he marries a less empowered woman who does not work or who would expect a lower wage. In such a case, the empowered woman's husband might choose to adapt his behavior in order to satisfy his spouse and to keep her in the household, especially by avoiding getting HIV-infected and avoiding having extramarital partnerships.

The level of each consumption is determined within the couple following social norms, there is no bargaining power modeled here. Following social norms, man and woman get a level of consumption denoted by $\tilde{c}_H$ and $\tilde{c}_F$ respectively such that:

[5]Although it has been shown that the causality goes in the other direction (i.e. earned and unearned income are increasing the degree of female empowerment), what is fundamental here is that both are positively related.

$$\tilde{c}_H = \alpha[w_H + w_F(E)], \alpha \in [0;1] \tag{3}$$

$$\tilde{c}_F = (1-\alpha)[w_H + w_F(E)], \alpha \in [0;1] \tag{4}$$

As mentioned above, $\tilde{c}_H$ is set equal to zero if the man is HIV-infected and dies from AIDS. $\tilde{c}_F$ can take three different values depending on the HIV-status of both partners, as follows:

$$\tilde{c}_F = \begin{cases} (1-\alpha)(w_H + w_F(E)) & \text{with probability } 1-p(x) \\ w_F(E) & \text{with probability } p(x)(1-\pi) \\ 0 & \text{with probability } p(x)\pi \end{cases} \tag{5}$$

With probability $1-p(x)$ the man remains susceptible and hence the man and the woman share the total income. With probability $p(x)(1-\pi)$, the man becomes HIV-infected and the woman remains HIV-negative; thus, the man earns and consumes nothing and the woman consumes alone her own wage. With the probability $p(x)\pi$, both man and woman become HIV-infected, and thus, the woman consumes nothing. Consequently, from (2), (4) and (5), woman's utility function can be re-written:

$$U^F = (1-p(x))[(1-\alpha)(w_H + w_F(E)] + p(x)(1-\pi)w_F(E) - \delta(b)E \tag{6}$$

2.2 Nash-Equilibrium Extramarital Sex and Female Empowerment

If man and woman are making their decision without any coordination between them, the level of extramarital sex and the level of female empowerment will be determined by the Nash equilibrium of the game, where each player takes the other player's strategy as given. The time line of the game is as follows: (i) the woman

chooses her preferred level of female empowerment; (ii) the man decides upon his level of extramarital sex. This game can be solved by backward induction. We first derive the man's best response function, as a function of his spouse's level of empowerment. Then, in the first stage the woman's decision about female empowerment, E, is considered, taking into account the outcomes of stage two, i.e. her husband's optimal level of extramarital sex.

Second Stage The man chooses his level of extramarital sex, x, with a view to maximizing his utility :

$$(1 - p(x))\alpha[w_H + w_F(E)] + v(x) \tag{7}$$

where α, E, $w_F(E)$ and w_H are perfectly known. In equilibrium, the man equalizes the marginal utility of having one additional unit of extramarital sex and its respective marginal cost in terms of consumption. Then his best-response function $x^* = x(\alpha, w_H, E)$ may be derived from the first-order condition $v'(x^*) = p'(x^*)\tilde{c}_H$ or $v'(x^*) = p'(x^*)\alpha[w_H + w_F(E)]$

Proposition 1 *The level of extramarital sex chosen by the man can be written as the following best-response function:*

$$x^* = x(\alpha, w_H, E) \tag{8}$$

such that

$$\frac{\partial x}{\partial \alpha} = \frac{p'(x)(w_H + w_F(E))}{v''(x) - p''(x)\tilde{c}_H} < 0; \tag{9}$$

$$\frac{\partial x}{\partial w_H} = \frac{p'(x)\alpha}{v''(x) - p''(x)\tilde{c}_H} < 0 \tag{10}$$

$$\frac{\partial x}{\partial E} = \frac{p'(x)\alpha w'_F(E)}{v''(x) - p''(x)\tilde{c}_H} < 0; \tag{11}$$

Proof. Proposition 1 is established by maximizing man's utility function. The first-order condition of this problem yields $v'(x) = p'(x)\tilde{c}_H$ and its second-order condition: $v''(x) - p''(x)\tilde{c}_H < 0$. The total differentiation of the first-order condition yields

$$[v''(x) - p''(x)\tilde{c}_H]dx = p'(x)[\alpha dw_H + \alpha w'_F(E)dE + (w_H + w_F(E))d\alpha] \tag{12}$$

From (12), we obtain all the partial derivatives of Proposition 1. The second-order condition and the fact that $p'x)$, α and the labor earnings are positive give us the sign of the partial derivatives in Proposition 1. ■

The most interesting property of the man's best-response function is that he will decrease his demand for casual sex along with an increase in female empowerment. Figure 1 below depicts this negative relationship between the husband's optimal level of extramarital sex and his spouse's level of female empowerment. Note also that the level of extramarital sex chosen by the man is decreasing with the proportion of the total welfare that he gets for his own consumption.

First Stage In this stage the woman must choose her level of female empowerment taking her husband's decision, x^*, as given. She maximizes her utility $(1-p(x))[(1-\alpha)(w_H+w_F(E)]+p(x)(1-\pi)w_F(E)-\delta(b)E$ subject to $x = x^*$. Of particular interest in this setting is to analyze how the woman's utility varies with E and x.

To have a positive marginal utility from being empowered, we need to make two additional assumptions: (i) α should be larger that π, meaning that the share of total revenue that goes to the husband needs to exceed her own probability of getting

HIV if her husband is already infected; (ii) the unitary cost of empowerment, $\delta(b)$ should be smaller than $[1-\alpha+p(x)(\alpha-\pi)]w'_F(E)$. This second assumption tells us that the marginal cost of female empowerment needs to be lower than the direct benefit from empowerment (neglecting its effect via her husband's extramarital sex). The higher the family investment in the girl's empowerment, the lower is the cost of empowerment and hence, the more likely is this assumption satisfied.

Regarding the relationship between woman's utility and her husband's level of casual sex, we find that woman's utility decreases with x if $(1-\alpha)[w_H+w_F(E)] > (1-\pi)w_F(E)$. This inequality means that the shared consumption needs to exceed the expected value of consumption if she is widowed, that is to say if her husband dies from AIDS. The woman's utility decreases with her husband's level of extramarital sex if the shared consumption is higher than what she would get if he died from AIDS. In other worlds, if the woman does not gain from being in couple through an increase in economic welfare, she prefers her husband to have many girlfriends and die quickly. This assumption is reasonable since it assesses that it should be worth being married.

The following proposition records the effects on the Nash equilibrium of an increase in the woman's cost of investing in empowerment.

Proposition 2: *In Equilibrium, an increase in woman's cost of empowerment : (a) decreases the amount she devotes to building her degree of female empowerment, and hence she enjoys a lower level of empowerment; (b) increases her husband's level of extramarital sex.*

The figure below illustrates this proposition.

Figure 1 describes how the man determines his best-response function, $x^* = x(\alpha, w_H, E)$, by maximizing equation (7) while taking α, w_H, E as given. The dash

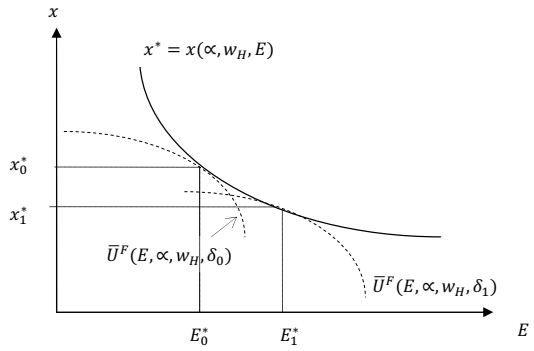

Figure 1: Nash-Equilibrium

lines depict the woman's indifference curves when the man's level of extramarital sex is at its equilibrium value, x^*. The two concave curves correspond to two different costs of investing in female empowerment. A decrease in the cost of empowerment (or an increase in b) induces a move from the benchmark equilibrium (E_0^*, x_0^*) to the equilibrium (E_1^*, x_1^*) where the level of female empowerment will be higher, and hence the woman will have to bear a lower level of unfaithfulness from her husband, and thus a lower risk of HIV-infection. This figure gives us the two empirical predictions to be tested in sections (4.3) and (4.4): (i) increasing family background leads to a higher degree of female empowerment; (ii) a rise in female empowerment goes with a decrease in the husband's optimal level of extramarital sex.

2.3 The Search for a Structural Equation

The empirical analysis aims at testing the two main predictions of the model derived in the previous section. We do not estimate the number of extramarital sexual partners because this indicator suffers from large misreporting bias in surveys as suggested in Gersovitz *et al* (1998) and Gersovitz (2005). We will instead observe the married woman's HIV-status and model her individual risk of being HIV-infected as a function of her degree of female empowerment. In the model, the probability of

being HIV-infected for a married woman whose husband chooses a level of extramarital sex, x, is equal to $p(x)\pi$, where $p(x)$ is increasing in x. Proposition 1 shows that when maximizing the man's utility function, the optimal level of extramarital sex is decreasing with female empowerment. We can conclude that $p(x)$ is decreasing with E, and then the woman's total probability of infection should be decreasing with her level of female empowerment.

The next sections test our predictions using data from the most recent Demographic and Health Surveys and focus on the married women interviewed and tested for HIV in Malawi, Zambia, and Zimbabwe. As explained below, these countries were selected by applying three requirements: (i) the geographic homogeneity, (ii) the blood sample collection to test for HIV, and (iii) the questions about gender issues. We will estimate the likelihood of being HIV-infected as a function of female empowerment and other covariates, controlling for female empowerment endogeneity. Accordingly, we will adopt a two-step approach, first predicting the level of female empowerment, and second, estimating the risk of HIV-infection. This two-step approach allows us to perform two tests of interest with one equation, namely (a) female empowerment has a significant negative impact on one's own risk of being HIV-infected, and (b) women are actively investing in empowerment with a view to reducing the risk that they are facing from their husband's behavior. The cost of investing in female empowerment is mostly determined by the woman's family background captured by the parameter b in the model, thus measures of family background will be used to explain woman's observed degree of empowerment.

3 Data and Methods

3.1 Data and Sample Construction

Data for the analysis come from the Demographic and Health Surveys. The Demographic and Health Surveys are nationally representative household surveys collected in developing countries. The primary sampling unit of the DHS is the sampled cluster that is either a village in rural areas or a city block in urban areas. In each cluster, a maximum of 48 households is selected for interview. Within sampled households, all women aged 15-49 who are either usual residents or visitors present in the household on the night before the survey are eligible to be interviewed. The data contains detailed information on the socioeconomic characteristics of individuals and households. Although the wide range of the data collected in the DHS are standardized across countries, additional modules are added in some of the DHS. The selection of countries is based upon the geographic homogeneity first, and secondly upon the availability of the required data.

The first restriction concerns the geographical homogeneity. The Demographic and Health Surveys collect data on most African countries and provide individual-level data that are comparable across those countries since the questionnaire and the sample design are standardized. However it is still of particular importance to pool individual data from countries that are homogeneous. Countries that are geographically close and with similar levels of HIV prevalence are good candidates for such an analysis. Especially Malawi, Zambia and Zimbabwe are suitable for the analysis since they are neighboring countries, all located in Southern Africa that is the region the most affected with HIV in the world. UNAIDS (2008) estimates that in 2007, the prevalence reaches 11.9%, 15.2% and 15.3% in Malawi, Zambia and Zimbabwe respectively.

The second constraint comes from the data availability. Although the majority of the DHS contains a module about HIV/AIDS that gathers information about the respondents' level of knowledge about the means of transmission and protective devices, and about their HIV-related behaviors, only some of the most recent surveys include a blood sample collection to test for HIV. A sub-sample of respondents is tested for HIV/AIDS in such a way that we observe whether the respondents are infected with HIV at the time of the survey. This information is crucial not only to test the predictions of the model, but also because it makes more sense to study the role of female empowerment on the probability of being HIV-infected than on HIV-related behaviors. When studying HIV-related behaviors, either condom use or extramarital sex can be used as dependent variables. However in the DHS, most women report to have their last sexual intercourse with their spouse and the use of condom within the couple is seldom, especially because of the willingness to have children and the feeling that the risk of infection is limited. Predicting the use of condoms within the couple gives more information about their willingness to use contraceptives than about their willingness to self-protect against the risk of infection.

Information about female empowerment is also crucial for the analysis. In a subset of DHS, married women were asked numerous questions aiming to capture their degree of independence or autonomy within the couple through questions on decision making, violence and freedom. The selection of the countries used in the paper is constrained by the inclusion of these questions in the survey data, along with the HIV test. Even though Kenya and Democratic Republic of Congo include a HIV testing and are geographically close to Southern Africa, the DHS collected there do not ask women questions about freedom.

Hence, we use the data from three countries: Malawi (2004)[6], Zambia (2007)[7] and Zimbabwe (2005/06)[8]and limit our sample to the 9,870 married women who have nonmissing data for HIV-status over the three countries. Over a total of 9,870 married women interviewed and tested for HIV, the vast majority is living with her spouse (82%), and for those living with their husband, they are living in a nuclear-type of unions since 89% of married women have their husband as household head.

3.2 Female Empowerment

To define female empowerment, we refer to Ashraf *et al* (2010) and Anderson and Eswaran (2009) where female autonomy is defined as *"the ability of women to make choices/decisions within the household relative to their husbands"*. Accordingly, both papers use woman's decision making within the couple as proxy for female empowerment. Anderson and Eswaran (2009) use seven items on which women self-report to have at least some say in the decision, such that the decision about whether to purchase cooking oil, ice cream, children's clothes or saree for themselves. They estimate the effects of earnings on each of these seven decisions taken separately. In the last section of their paper, they propose alternative measures of female autonomy that capture women's freedom such as having meals with their husband or wearing a burqua. Similarly Ashraf *et al* (2010) use answers to who has the final decision about nine domains (e.g. expensive purchases, giving assistance to family members, family purchases, schooling of children, and use of family planning).

We propose to go beyond Anderson and Eswaran (2009) and Ashraf *et al* (2010) in the definition of female empowerment by taking additional dimensions that are education, freedom and the self-perceptions of domestic violence. Likewise, the

[6]For details, refer to National Statistical Office [Malawi] and ORC Macro (2005)
[7]see Central Statistical Office *et al* (2009)
[8]see Central Statistical Office [Zimbabwe] and Macro International Inc. (2007)

female empowerment index proposed in this paper captures four dimensions: (1) educational attainment, (2) involvement in household decision making, (3) relative freedom, and (4) domestic violence. Firstly, the education component is equal to the number of years of formal education. Table 1 reports how the questions were formulated in the questionnaire. Secondly, economic decision making consists of questions on whether women themselves are involved in decisions about their own health care, about large or small household purchases, about visits to family or relatives. Thirdly, relative freedom involves questions regarding the relationship within the couple and especially the relative control of the husband over his spouse. One additional module included in the surveys used here concerns the domestic violence. This module gathers information about the women's perceptions about domestic violence in several contexts. Specifically, women are asked whether they think it is acceptable that a man hits or beats his wife if she goes out without telling him, if she neglects the children, if she argues with him, if she refuses to have sex with him or if she burns the food.

Table 2 summarizes the proportion of married women according to their answers to the relevant questions listed in Table 1. Over the whole sample of married women tested for HIV, 64% and 74% of women reported to be involved in the decisions about making major purchases or purchases for daily needs respectively. 65% said that they usually made the decisions about their own health care either alone or with their husband. They were 76% to declare that they took part in the decisions regarding visiting her family or relatives. Some differences across countries are worth mentioning here. Over all the four questions about intra-couple decision making, Malawi is the country where the husband mostly handles all decisions. In Malawi, 73% of the married women report that their husband is making the decisions regarding her own health care. Husbands have also the control over the

purchase of goods, both over the purchase of durable goods and over the purchase of goods to satisfy the daily needs since 82% and 69% report that their husband alone has the final say about large and daily purchases respectively. On the other hand, Zimbabwe is found to be the country over the three countries of the sample where all the decisions are mainly made jointly within the couple and when the decision is not jointly made it is more likely that the woman makes it alone than the other way round. This remark is true for the four decisions: health care, large purchases, daily purchases and family visits.

Panel B gives the proportion of married women who declared that their husband restricts somehow their freedom of moving and having the control over money. Over the three countries, more than half of women (58%) reported that their husband was jealous or angry if she talked to other men, and 18% of women replied that their husbands did not trust them with money. 53% declared that their husband insisted on knowing where she was at any time, while they were only 12% in Zambia. 26% reported to be frequently accused of being unfaithful. This dimension also asks women whether their husband tries to limit her contact with her family. Even though only 15% of the women over the whole sample declared that they did not have full control over family visits, they were up to 60% in Zimbabwe.

The last dimension concerns the perceptions about domestic violence. In Panel C, 21% declared that a man was justified in hitting or beating his wife if she burned the food. They were 30% to think that this was acceptable if the wife refused to have sex or if she argued with her husband. About 35% of the women reported that beating one's wife was acceptable if she went out without informing her husband, or if she neglected the children. If the countries had to be ranked according to this dimension, we could say that Malawi is the country where domestic violence is perceived as the least acceptable, followed by Zimbabwe and lastly Zambia.

The summary statistics suggest a wide heterogeneity in the level of autonomy over the four dimensions listed above and across countries. To incorporate all these elements in one indicator we perform a principal component analysis. Note that before running the principal component analysis each variable from the freedom and domestic violence dimensions have been recoded such that the value one means freedom and zero limited freedom. Accordingly for every variable used in the index, a higher value means more freedom or more power. Here we are comparing women with different degrees of power and freedom within their couple. Every question within each dimension are weighted according to the principal component analysis' techniques to construct a female empowerment index. Note that in Jensen and Oster (2007) and Ashraf *et al* (2010), the principal component analysis is also performed to generate a measure of female autonomy; and that this method is widely used to construct wealth indexes (see Filmer and Pritchett, 2001).

3.3 Estimation Strategy

To assess the causal effect of female empowerment on the individual risk of HIV-infection, we use family background indicators, i.e. the morbidity among siblings and the likelihood of father-to-mother violence as instrumental variables for the index of female empowerment. In Africa, where the degree of empowerment is traditionally conditioned upon the education and the choice of husband, both determined by the family, the differences in family background generate exogenous variation in girls' lack of power within the couple. Information on family background is collected in a survey module about siblings. Women are asked about the number of siblings they ever had and for each sibling, they are asked to report their survival status and for those who died, the age at death and its cause, especially whether female siblings' deaths are related to pregnancy and delivery. The fact that the father

has ever beaten or hit the mother and the probability of having dead siblings will be used to capture family background and possible investment in their daughter's empowerment.

Identification of the IV model requires a strong correlation between female empowerment and family background, especially father-to-mother violence. As the pattern in figure 2 illustrates, this requirement is well satisfied in the DHS. Figure 2 shows the distributions of female empowerment index according to father-to-mother violence and reveals a significant shift in the empowerment with this indicator. For the women who declare that their father has never beaten her mother, the distribution of the female empowerment index is shifted towards the right, i.e. towards higher levels of female empowerment compared to women who declare the opposite. Table 3 reports the summary statistics of the variables used to constitute the female empowerment index, by father-to-mother violence. Broadly speaking, women who report father-to-mother violence has a lower female empowerment index than their counterparts and the difference is statistically significant, suggesting that father-to-mother violence could be a strong determinant of female empowerment. However there are differences across the dimensions used in the analysis. Firstly, concerning the decision making dimension, the difference between women who declare a father-to-mother violence and those who do not is not statistically significant in two cases over four. In the remaining two cases, the differences are significant and go in the other direction, meaning that women who grew up in a household with domestic violence are significantly more likely to take part in the decisions about large and daily purchases, compared to their counterparts who declared no violence. Secondly, regarding the freedom dimension and the questions about whether domestic violence is acceptable, women are significantly more likely to be free in their couple and to declare that domestic violence is not acceptable when their father has never beaten

their mother.

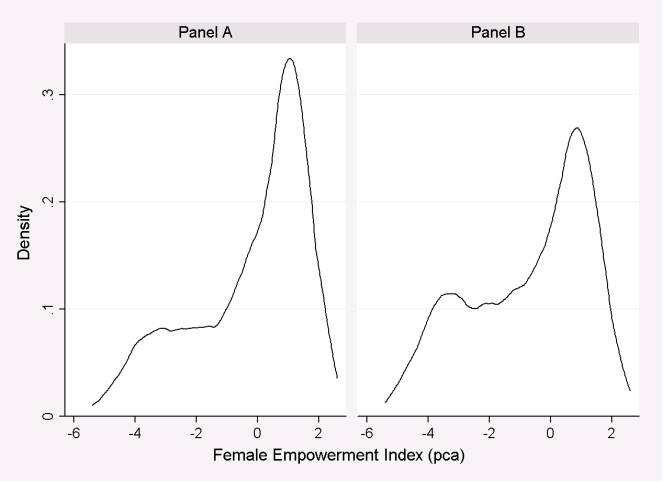

Figure 2: Female empowerment index and father-to-mother violence. Data are taken from the 2004 MWI, 2007 ZMB, 2006 ZWE. The sample includes married women between 15 and 49 with nonmissing values for HIV status. Panel A: subsample of women who declare no father-to-mother violence, Panel B: subsample of women who declare father-to-mother violence. Epanechnikov kernel density.

The IV approach involves estimating a two-stage model of the following form, where Y_i is the outcome of interest, $FemEmp_i$ is individual i's degree of female empowerment, and Z_i is i's family background characteristics, the instrument used to identify the first-stage equation:

$$Y_i = \alpha_0 + \alpha_1 FemEmp_i + \alpha_2' X_i + \varepsilon_i, \forall i \tag{13}$$

$$FemEmp_i = \beta_0 + \beta_1 Z_i + \beta_2' X_i + \nu_i, \forall i \tag{14}$$

Once estimating Equation (14) through Ordinary Least Squares, we include its estimated residuals in the right-hand side of Equation (13) to test whether the variable of interest, $FemEmp$, is endogenous in this equation and to control for endogeneity. Equation (13) is thus re-written as follows and estimated through a probit specification:

$$Y_i = \alpha_0 + \alpha_1 FemEmp_i + \alpha_2' X_i + \alpha_3 \hat{\nu}_i + \varepsilon_i, \forall i \tag{15}$$

As soon as α_3 is found statistically different from zero, the variable $FemEmp$ is endogenous and its effect on the risk of infection, α_1, is consistently estimated (Rivers and Vuong, 1988).

In each estimation, X includes the following set of control variables: age, number of years since marriage, number of children ever born, i's educational attainment, i's husband's educational attainment, a dummy variable indicating whether individual i is living in a urban area, a wealth index, HIV/AIDS-knowledge, religious affiliations, country-specific effects. Robust standard errors are used in the analysis to correct for clustering at the sampled cluster level. Summary statistics are presented in table 4. Over the whole sample, the HIV prevalence is equal to 17%, ranging from 14% in Malawi to 20% in Zimbabwe. We measure the declared HIV/AIDS-knowledge at the individual level using six questions[9]. For each question, we observe whether the individual answers correctly, wrongly or if she does not know, and we construct a measure of HIV/AIDS-knowledge equal to the percentage of right answers. Summary statistics reveal that on average, 80% of the six statements are rightly known, and the level of knowledge is somehow homogeneous across countries since the mean HIV/AIDS knowledge is 75% in Malawi, 82% in Zambia and 81% in Zimbabwe.

Respondents are 30 years old on average. 27.60% of the sample are living in urban areas. On average the married women have been married for about 12 years and have 3.5 children ever born. While over the whole sample, 12% have no formal education,

[9]The questions are as follows: 1) *"Can people reduce their chances of getting the AIDS virus by using condom every time they have sex?"*; 2) *"Can people reduce their chances of getting the AIDS virus by having just one partner who is not infected and who has no other partners?"*; 3) *"Can people reduce their chance of getting the AIDS virus by not having sex at all?"*; 4) *"Is it possible for a healthy-looking person to have the AIDS virus?"*; 5) *"can a person get the AIDS virus from mosquito bites?"*; 6) *"Can people get the AIDS virus by sharing food with a person who has AIDS?"*

this proportion ranges from 5% in Zimbabwe to 26% in Malawi. 51% and 34% have reached a primary and secondary educational attainment respectively. Husbands are more educated than their wife since 43% have a secondary educational level. As far as religious affiliations, 75% of the respondents are protestant, 15% catholic and 4% muslim. The highest proportion of muslims is found in Malawi, where 16% of the respondents declare themselves to be muslim, while they represent less than one percent of the married women in Zambia and Zimbabwe.

Regarding the family background, 38% of the sampled women declared that their father had ever beaten her mother, this proportion varies from country to country and ranges from 31% in Malawi to 41% in Zambia. Information on family background was also collected in a survey module administered to women, where they were asked about details of their sibling's survival. We use this information to approximate the living and health-related conditions at childhood. We measure the probability of having dead siblings for each married woman. We divide the number of dead siblings over the number of siblings ever born. Three probabilities are computed: the probability of having a dead sibling for any age at death, the probability of having a sibling dead before reaching 5, and the probability of having a sibling dead before reaching 18. The standard deviations are high, suggesting that the situation varies a lot, even within the countries. The average probability of having a sibling dead is equal to 17% over the three countries, and goes up to 22% in Malawi. The worst scores regarding the sibling mortality for any of the three probabilities is found in Malawi.

4 Estimation Results

4.1 Primary Results

Results from the first-stage regression with and without the full set of controls, and country-specific effects are presented in table 5. In the first-stage estimation, the dummy variable indicating whether i's father has ever beaten her mother is used as instrumental variable. Col. 1 and 2 restrict the estimation sample to the subsample of married women tested for HIV in the DHS. Results suggest that the degree of female empowerment decreases significantly with father-to-mother violence. For the specification with the full set of covariates (col. 2), women who declared that their father has ever beaten her mother have a level of female empowerment 0.29 lower than the women who report no father-to-mother violence, with a standard deviation of 0.047. Results are robust to a sampled cluster fixed-effects model. In Column 3, all married women surveyed are used in the estimation sample to see whether the results are specific to the women tested for HIV. Evidence suggests that the negative and statistically significant relationship between female empowerment and father-to-mother violence is robust whether the married women with missing HIV-status are included or excluded from the sample.

When we control for the full set of controls that appear in the estimation of HIV prevalence, we find that the index of female empowerment is negatively related to the numbers of years since marriage. The longer women are married, the lower is their power within the couple. This does not seem to be related with the fact that older women have a lower bargaining power than the younger cohorts because we also find that female empowerment increases with age. The woman's educational attainment influences her empowerment while the education of her spouse does not. One could have argued that the number of children ever born has a positive effect

on the level of female empowerment since motherhood is crucial in most African society and often confers a role to women in the society. However in the two last columns, the number of ever born children has no predictive power on the level of female empowerment. We control for wealth by using the quintiles that the data provider computed through a principal component analysis based on durable goods ownership. Results suggest that even though the effect of wealth on female empowerment is not linear, the highest quintile always exhibits the highest level of female empowerment.

The second-stage estimation is reported in Table 6. The residuals from the first-stage estimation are controlled for as right-hand side variables in addition to the degree of female empowerment and other covariates. Columns 1 and 2 use the residuals computed from the estimations reported in Table 5, in columns 2 and 3 respectively. The evidence found in this table suggests two novel findings. Firstly, the role of female empowerment on the likelihood of being HIV-infected is found statistically significant and negative. Empowered married women are less likely to become HIV-infected than their counterparts who have less freedom and bargaining power within their couple. An increase in female empowerment by one standard deviation would lead to a decrease in the risk of HIV-infection by 0.14 percentage points. Secondly, the degree of female empowerment is found to be endogenous since the residuals from the first-stage estimation turn out to be statistically significant, whatever the residuals are computed on the whole sample of surveyed married women (col. 2) or on the subsample of surveyed women tested for HIV (col. 1).

Marital stability is found to play a role in the likelihood of HIV-infection. The number of years since marriage and the number of children ever born appear to reduce the risk of infection and their estimated effects are high. One more year of

marriage reduces the risk of infection by 1.7% while having one more child reduces the risk by 9.6%. Old women and women living in a urban area are more likely to be HIV-infected than their counterparts who are younger or who live in rural parts respectively. Woman education and her husband's education have no statistically significant effect on the probability of being infected with HIV. The wealthier the women, the higher is their risk of living with HIV. In Column 2, catholic and protestant people are found less likely to be HIV-infected than muslims while these effects are no more statistically significant in the other estimations.

The counterintuitive effects of two other covariates are worth commenting. Firstly, HIV-AIDS-knowledge is found to have a statistically significant and positive effect on the likelihood of being HIV-infected. This means that people aware of the ways HIV is transmitted and of the self-protective devices are more likely to be found infected with HIV than their counterparts who have a weaker level of knowledge. One could argue that this positive effect is due to the fact that infected people have been tested, diagnosed and thus they received a counseling reminding them with the protective measures. It seems less likely to this scenario is validated by the data since most of the married women of our sample had never been tested for HIV (73% over the whole sample and 67% over the analytic sample). Secondly, empirical findings suggest that the number of children ever born is negatively related to HIV-infection. This observed relationship is interesting in the sense that one could argue that the number of children ever born is a good candidate to proxy the level of condom non-use in the couple and then the likelihood of infection. Here it goes in the other direction, which is in favor of the female empowerment argument. Indeed, fertility is very critical in most African societies in such a way that having children confers the women a place in the society and in the family. This dimension had not been taken into account in our index of female empowerment. It is most likely

that a fertile woman is more empowered than a unfertile one so that the number of children ever born plays a role similar to our female empowerment index.

When we replicate col. 1 and introduce the quadratic female empowerment index, the latter has a negative effect on the likelihood of being HIV-infected but this effect fails to be statistically significant (not reported here). This empirical finding suggests that the reductive effect of female empowerment on the HIV risk is decreasing.

The last two columns in Table 6 examine whether the effect of female empowerment on HIV prevalence is sensitive to the number of years since marriage and to the urban residence. One might argue that the role of female empowerment on the risk of HIV-infection might depend upon the number of years since marriage because women might have been infected before getting married. Column 3 shows that the effect of female empowerment is decreasing with the number of years since marriage as we find a negative effect of female empowerment and a positive effect of the interaction term between female empowerment and the number of years since marriage on the risk of HIV-infection. However the effect of female empowerment can not become positive because it becomes positive only after 160 years since marriage, which is not a feasible value. We also interact the female empowerment index with the dummy variable indicating whether the woman is living in an urban area (see col. 4). Both the effect of female empowerment and its interaction with urban residence are negative and statistically significant. The effect of female empowerment in reducing the risk of HIV-infection is slightly greater in urban area than in rural area. The point estimates of the effect of female empowerment on the risk of infection are equal to -0.292 for urban women and to -0.287 for rural women.

Table 7 investigates whether the effects of female empowerment on the risk of

HIV-infection are heterogeneous across countries. Panel A replicates the baseline estimation for each country. Even though the negative relation between female empowerment and HIV-infection persists for all the countries of the sample, the magnitude of the effect varies from country to country. The largest effect is in Malawi, followed by Zambia and Zimbabwe. However the effect fails to be statistically significant even though in Malawi and Zambia, the p-value of the coefficient is just above 10%. Panel B re-estimates the estimations using different measures of female empowerment. In panel A, the measure used was the female empowerment index computed from the principal component analysis performed over the whole sample of married women. In Panel B, we compute the index of female empowerment for each country separately and re-estimate the first stage estimations accordingly. Panels A and B provide similar results since the effect is negative but fails to be statistically significant.

4.2 Falsification Tests and Robustness Checks

The evidence found above suggests that female empowerment protects married women against the risk of being HIV-infected in Malawi, Zambia and Zimbabwe. In this section, we perform falsification tests and some robustness checks testing whether our previous empirical results are robust to the choice of instrumental variables used in the first-stage estimation and to the definition of female empowerment. Note that the forthcoming estimations will be compared to the benchmark estimation which is displayed in Table 6 column 1. Note also that the first-stage estimations use the sample of married women who were tested for HIV during the survey.

Falsification Tests

Table 8 presents three falsification tests. The first falsification test, displayed in column 1, concerns the fact that we consider the effect of female empowerment

instead of a pure income effect on the husband's choice of extramarital sex. In the theoretical model, the effect of female empowerment on man's utility function comes from the increase in the size of the cake to be shared between the two spouses that results from an increase in female empowerment. One could argue that it is not the effect of female empowerment that has to be investigated but the effect of wealth on woman's risk of HIV-infection instead, and hence that the woman's level of income should have a negative effect of the risk of infection.

This assertion is not validated by the data for two reasons. On the one hand, in every second-stage estimation, the set of control variables includes dummy variables for wealth quintiles and we found that women who belong to the three poorest wealth groups are less likely than the richest women to be HIV-infected. This means that wealth is associated with an increased HIV risk. On the other hand, we reestimate the baseline equation (Table 6, col.1) except that we use a continuous measure of wealth[10] instead of the female empowerment index, we do not control for endogeneity and we do not control for wealth quintiles any more since we use the continuous level of wealth instead. Empirical finding suggests that the level of wealth has no statistically significant impact on the likelihood of HIV-infection. Nevertheless, the DHS do not ask women about their own assets, thus the wealth index is computed based on the assets owned by the household such that we are controlling for the total household welfare which is also consistent with the theory. Even though we do not observe woman's own assets, we know whether the woman is currently working. When we add this dummy variable in the benchmark regression, the dummy variable fails to be statistically significant while the effect of female empowerment remains negative and significant (not reported).

The second falsification test comes from two assumptions set in the model that

[10]The variable provided by DHS that performs a principal component analysis on a number of durable good ownership and that is used to generate the five wealth groups.

go together: (1) both husband and wife are HIV-negative at the time of the union, (2) HIV enters the household through the man who has extramarital sex. Since de Walque (2007) and other papers on sero-discordant couples, we know that among serodiscordant couples, there is a large fraction of couples in which the woman is HIV-infected and the husband is HIV-negative, while we argued that the only way woman can catch HIV is by being infected by her husband. In this literature, it has been shown that in most cases, the woman gets HIV before being married and this explains why when we study couples at one point in time while already married we find couples in which the woman is infected with HIV while the husband is not. What affects the validity of assumption (1). In an effort to rule out the possibility that HIV infection before marriage is driving the results, we generate a dummy variable that takes the value one if the couple have been married or living together for ten years or less, and we interact this dummy variable with the index of female empowerment. In other words, to check for the validity of our reasoning and results in our sample, we propose to distinguish two groups of married women: the women who got married less than 10 years ago and those who got married strictly more than 10 years ago. Ten years is used as a threshold because in the absence of antiretroviral treatment, ten years is roughly the median period between HIV infection and death, so it is most likely that if a woman is infected after more than ten years in union, the infection occurred during the union.

In Table 8 column 2, both the dummy variable for being married less than 10 years ago and its interaction with the degree of female empowerment are controlled for. Empirical results suggest that the interaction does not play a statistically significant role on the risk of HIV-infection while the dummy has a negative and statistically significant impact on this risk. The negative sign of the coefficient is suggestive of the fact that older women or at least women who got married more

than ten years ago were not infected before the union (otherwise they would not have been alive anymore nor included in the sample) and hence their infection occurred during the union. Note that the coefficient of female empowerment keeps the same size and statistical significance as in the benchmark estimation.

In line with this argument, the third test consists in distinguishing among the sample of married women, the women who were in another union before marrying their current husband. In fact, it might be the case that some sampled women had more than one union and that they got infected before getting married or before living with their current partner in such a way that our assumptions (1) and (2) are violated. Furthermore, we do not observe what was their level of empowerment during their previous union(s), nor what was its effect on their previous probability of infection. In the Demographic and Health Surveys, women are asked whether they have been in union once (i.e. the current one) or more than once. We generate a dummy variable that takes the value one if the woman has been previously married and zero otherwise, and an interaction term between this dummy variable and the index of female empowerment.

Empirical results are displayed in column 3. In this estimation the coefficient of female empowerment fails to be statistically significant in the standard range since the p-value is just above 10% at 0.104. The effect of ever being in a previous union is positive and statistically significant, suggesting that women who are in their second union or more are more likely to be infected with HIV than those who are in their first union. Regarding the interaction term, we found that having ever been in union before the current one reduces the effect of empowerment in reducing the HIV-risk. Indeed the effect of female empowerment is lower for the women who were in a union previously. It might be the case that they got infected before entering in their current union (as being previously in union is found to increase the likelihood

of being infected) and their degree of female empowerment in their current union does not matter as much.

Robustness Checks

In Table 9 we perform similar estimations in which alternative instrumental variables are used in addition to the dummy variable indicating whether i's father has ever beaten her mother. Column 1 adds the probability of having a sibling dead, columns 2 and 3 a sibling dead before reaching 5 and 18 years old, respectively. This table provides evidence consistent with previous findings indicating that female empowerment has a negative effect on the HIV-risk of infection and is endogenous. In these estimations the effect is smaller in magnitude compared to the benchmark estimation (Table 6, col. 1). With these alternative IVs, we obtain that the effect of empowerment fails to be statistically significant in one case over three.

Alternative measurements of female empowerment are used while reestimating Equations (14) and (15) in Table 10. Rather than introducing other dimensions of female empowerment, we propose to formulate in an alternative way how the index is constructed. Firstly, col. 1 and 2 aim at restricting the degree of empowerment to the intra-couple decision making as in Anderson and Eswaran (2009) and Ashraf *et al* (2010). Moreover as in Ashraf *et al* (2010) we propose to use an index based on mean calculation along with the one based on the principal component analysis method. Accordingly, in column 1 the variable of interest is the index from the principal component analysis of the four variables (decision in terms of large/small purchase, health care and family visits) and in column 2 we use the mean of these four dummy variables reflecting whether the woman is taking part in the decision (alone or jointly with her husband). These alternative independent variables provide exactly the same qualitative results since female empowerment has a statistically

significant negative impact on the woman's probability of being infected with HIV and that female empowerment is found endogenous.

Secondly, col. 3 uses as independent variable the mean of the variables used in the principal measure of female empowerment that captures the four dimensions. When using the mean instead of the principal component analysis similar empirical results are found.

Thirdly, col. 4 and 5 take into account another feature that appears in Ashraf *et al* (2010) that consists in distinguishing for each decision, whether the decision is made by her husband alone, by the respondent alone or by both. In such a case, the female is considered as more empowered if she makes the decision alone rather than jointly with her husband. For each question, the score is equal to 0 if her husband makes the decision alone, 1 if they make the decision jointly and 2 if she makes the decision alone. To check whether our results are robust to this formulation, we generate a score accordingly for the whole set of questions used and generate a new index based on the principal component analysis. This index is the new variable of interest in Column 4, while in Column 5, we take the mean of the new scores instead of the component. The negative and statistically significant relationship between female empowerment and the likelihood of HIV-infection is robust to these two alternative definitions. Note that whether the index is based on dummy variables or categorical variables for decision making (Table 6, col. 1 vs col. 4; or col. 3 vs 5), the size of the coefficient does not vary.

5 Conclusion

In this paper, we analyze the risk of HIV-infection within marriage and in particular, the effect of female empowerment on their own HIV risk in Southern Africa. We

first set out a simple model to illustrate the role of female empowerment in the individual risk of HIV-infection for married women and the mechanism through which the effect occurs. It appears that if women can not negotiate over the use of condom, they are able to invest in their empowerment in order to induce their partner to reduce his demand for extramarital sex and thus reduce the risk of HIV-infection for both of them. We found evidence from the most recent Demographic and Health Surveys collected in Malawi, Zambia and Zimbabwe that are supportive of the fact that female empowerment plays a statistically significant role in reducing woman's likelihood of being infected with HIV among a sample of married women aged 15-49 years old. The empirical findings of this paper also suggest that women are internalizing the impact of their empowerment on their future risk of HIV-infection when making their decision about how much to invest since their degree of female empowerment is found to be endogenous when estimating the likelihood of HIV-infection. This suggests that women are at least aware that being empowered would affect their partner's attitudes that will affect them in turn somehow.

As we think about policy, it is worth noting that the effects estimated in this paper are reflecting the situation of the average married women who are currently living in Malawi, Zambia and Zimbabwe. The effects might be different in West or Eastern Africa where the HIV prevalence rates are much lower than in Southern Africa and where the religious and cultural contexts also differ. However we found that empowerment highly contributes to reduce the probability of becoming infected with HIV. Freedom, low acceptance of domestic violence, education and participation to the household decision making all together contribute to make woman be less vulnerable to the risk of infection.

Although this paper focuses on the case of married women, this issue could be tackled in a broader perspective. It would be worth exploring the effect of female

empowerment among single women, even though one concern would be to find an appropriate way to measure their empowerment.

References

[1] Adaji Nwokoji, U., Ajuwon, A.J., 2004. Knowledge of AIDS and HIV Risk-related sexual Behavior among Nigerian Naval Personnel. BMC Public Health 4 (24).

[2] Anderson, S., Eswaran, M., 2009. What determines female autonomy? Evidence from Bangladesh. Journal of Development Economics, 90(2), 179-191.

[3] Ashraf, N., Karlan, D., Yin, W., 2010. Female Empowerment: Impact of a Commitment Savings Product in the Philippines. World Development, 38(3), 333-344.

[4] Bauni, EK., Jarabi, BO., 2003. The Low Acceptability and Use of Condoms within Marriage: Evidence from Nakuru District, Kenya. African Population Studies, 18(1), 51-65.

[5] Beegle, K., Frankenberg, E., Thomas, D., 2001. Bargaining Power Within Couples and Use of Prenatal and Delivery Care in Indonesia. Studies in Family Planning, 32(2), 130-146.

[6] Blanc, AK., Wolff, B., 2001. Gender and Decision-Making over Condom Use in Two Districts in Uganda. African Journal of Reproductive Health 5(3), 15-28.

[7] Central Statistical Office (CSO), Ministry of Health (MOH), Tropical Diseases Research Centre (TDRC), University of Zambia, and Macro International Inc., 2009. Zambia Demographic and Health Survey 2007. Calverton, Maryland, USA: CSO and Macro International Inc.

[8] Central Statistical Office (CSO) [Zimbabwe] and Macro International Inc. (2007). Zimbabwe Demographic and Health Survey 2005-06. Calverton, Maryland: CSO and Macro International Inc.

[9] Clark, S., 2004. Early Marriage and HIV Risks in Sub-Saharan Africa. Studies in Family Planning 35(3), 149-160.

[10] Drezin, J., Torres, M.A.,Daly, K., 2007. Barriers to Condom Access: Setting and Agenda. ICASO Advocacy Briefing. International Council of AIDS Service Organizations (ICASO).

[11] Ferguson, A.G., Morris, C.N., 2007. Sexual and Treatment-Seeking Behaviour for Sexually Transmitted Infection in Long-Distance Transport Workers in East Africa. Sexuall Transmitted Infections 83, 242-245.

[12] Filmer, D., Pritchett, L., 2001. Estimating Wealth Effects without Expenditure Data - or Tears: An Application to Educational Enrollments in States of India. Demography, 38 (1), 115132.

[13] Gersovitz, M., 2005. The HIV Epidemic in Four African Countries Seen through the Demographic and Health Surveys. Journal of African Economies, 14 (2), 191-246.

[14] Gersovitz, M., Jacoby, HG., Dedy, FS., Gozé Tapé, A., 1998. The Balance of Self-Reported Heterosexual Activity in KAP Surveys and the AIDS Epidemic in Africa. Journal of the American Statistical Association, 93 (443), 875-883.

[15] Gertler, P., Shah, M., Bertozzi, S., 2003. Sex Sells, But Risky Sex Sell for More. Draft, January 30, 2003.

[16] Glynn, J. R., Carael, M., Auvert, B., Kahindo, M., Chege, J., Mubanga Musonda, R., Kaona, F., Buve, A., 2001. Why do young women have a much higher prevalence of HIV than young men? A study in Kisumu, Kenya and Ndola, Zambia. AIDS, 15(Supplement 4), S51-S60.

[17] Gouws, E., Ramjee, G., 2002. Prevalence of HIV Among Truck Drivers Visiting Sex Workers in KwaZulu-Natal, South Africa. Sexually Transmitted Diseases 29 (1), 44-49.

[18] Hendy, R., Sofer, C., 2009. Within Resource Allocation in Egyptian Couples: Do Distribution Factors Matter?. Mimeo, January 2009.

[19] Jensen, R., Oster, E., 2007. The Power of TV: Cable Television and Women's Status in India. NBER Working Paper 13305.

[20] Kelly, R.J., Gray, R.H., Sewankambo, N., Serwadda, D., Wabwire-Mangen, F., Lutalo, T., Wawer, M.J., 2003. Age Differences in Sexual Partners and Risk of HIV-1 Infection in Rural Uganda. Journal of Acquired Immune Deficiency Syndromes, 32(4), 446-451.

[21] Mah, T., Halperin, D., 2010. Concurrent Sexual Partnerships and the HIV Epidemics in Africa: Evidence to Move Forward. AIDS and Behavior, 14(1), 1116.

[22] Meekers, D., 2000. Going Underground and Going After Women: Trends in Sexual Risk Behaviour among Gold Miners in South Africa. International Journal of STD and AIDS 11, 21-26.

[23] Morris, M., Kretzschmar, M., 1995. Concurrent partnerships and transmission dynamics in networks. Social Networks, 17(3-4), 299-318.

[24] Morris, M., Kretzschmar, M., 1997. Concurrent partnerships and the spread of HIV. AIDS, 11, 641648.

[25] National Statistical Office (NSO) [Malawi], and ORC Macro, 2005. Malawi Demographic and Health Survey 2004. Calverton, Maryland: NSO and ORC Macro.

[26] Oruboloye IO, Caldwell P and Caldwell JC. 1993. The role of high-risk occupations in the spread of AIDS: truck drivers and itinerant market women in Nigeria. Inter Fam Plann Persp 19, 43-48.

[27] Population Action International, 2002. Condoms count. Meeting the need in the era of HIV/AIDS. The PAI report card (2002).

[28] Rakwar, J., Lavreys, L., Thompson, M.L., Jackson, D., Bwayo, J., Hassanali, S., Mandaliya, K., Ndlinya-Achola, J., Kreiss, J., 1999. Cofactors for the Acquisition of HIV-1 among Heterosexual Men: Prospective Cohort Study of Trucking Company Workers in Kenya. AIDS 13, 607-614.

[29] Reggio, I., 2010. The Influence of the Mothers Power on her Childs Labor in Mexico. Journal of Development Economics, forthcoming (Available online 23 July 2010).

[30] Rivers, D., Vuong, QH., 1988. Limited Information Estimators and Exogeneity Tests for Simultaneous Probit Models. Journal of Econometrics, 39, 347-366.

[31] Robinson, J., Yeh, E., 2010. Transactional Sex as a Response to Risk in Western Kenya. American Economic Journal: Applied Economics, forthcoming.

[32] Smith, D.J., 2007. Modern Marriage, Mens Extramarital Sex, and HIV Risk in Southeastern Nigeria. American Journal of Public Health, 97(6), 997-1005.

[33] UNAIDS, 2008. 2008 Report on the global AIDS epidemic. UNAIDS/WHO, July 2008.

[34] Walque de, D., 2007. Sero-Discordant Couples in Five African Countries: Implications for Prevention Strategies. Population and Development Review 33(3), 501-523.

Appendix

TABLE 1: Measures of Female Empowerment

Measures of Female Empowerment

Variable	Full text questions
Panel A: Decision making	
"Who usually makes decisions..."	
Health care	*"About health care of yourself?"*
Large purchases	*"About making major household purchases?"*
Daily purchases	*"About making purchases for daily household needs?"*
Family visits	*"About visits to your family or relatives?"*
Panel B: Freedom	
"Please tell me if these [statements] apply to your relationship with your husband"	
Jealous	*"He is jealous or angry if you talk to other men"*
Accuses	*"He frequently accuses you of being unfaithful"*
Not meet friends	*"He does not permit you to meet your female friends"*
Not family	*"He tries to limit your contact with your family"*
Where you are	*"He insists on knowing where you are at all times"*
Money	*"He does not trust you with any money"*
Panel C: Violence	
"In your opinion, is a husband justified in hitting or beating his wife in the following situations"	
Outside	*"If she goes out without telling him"*
Children	*"If she neglects the children"*
Dispute	*"If she argues with him"*
Sex	*"If she refuses to have sex with him"*
Food	*"If she burns the food"*

TABLE 2:
Variables used in the component of Female Empowerment

Variables		All	Malawi	Zambia	Zimbabwe
Panel A					
Health care	Husband alone	34.60	73.01	32.48	17.76
	Husband and respondent	41.75	9.76	35.59	62.09
	Respondent alone	23.66	17.23	31.93	20.15
Large purchases	Husband alone	36.07	82.34	42.10	9.01
	Husband and respondent	47.14	10.22	44.41	67.08
	Respondent alone	16.79	7.45	13.50	23.91
Daily purchases	Husband alone	25.88	69.04	18.47	10.93
	Husband and respondent	33.73	12.57	19.25	55.65
	Respondent alone	40.39	18.39	62.28	33.41
Family visits	Husband alone	23.63	38.29	31.74	9.89
	Husband and respondent	57.44	38.44	44.94	76.86
	Respondent alone	18.93	23.27	23.32	13.25
Panel B					
Jealous		58.19	53.19	65.55	54.72
Accuses		26.14	17.89	35.80	22.58
Not meet friends		20.15	23.23	24.36	14.92
Not family		14.62	23.81	12.21	59.88
Where you are		52.94	60.26	11.61	43.08
Money		17.54	21.24	21.34	12.30
Panel C					
Outside		35.26	15.29	45.54	36.78
Children		34.23	18.03	44.77	33.71
Dispute		30.72	12.85	43.10	29.54
Sex		30.13	16.19	40.46	28.73
Food		20.65	12.90	34.75	13.19

TABLE 3:
Proportions according to the IV

	"Did your father ever beat your mother?"		
Variables	No	Yes	Difference
	(1)	(2)	(1) - (2)
Health care	.6424	.6374	.0049
Large purchases	.6116	.6385	-.0270**
Daily purchases	.7142	.7458	-.0316***
Family visits	.7502	.7521	-.0019
Jealous-Emp	.4426	.3726	.0700***
Accuses-Emp	.7620	.6948	.0672***
Not meet friends-Emp	.8070	.7785	.0285***
Not family-Emp	.8550	.8489	.0061
Where you are-Emp	.4899	.4259	.0640***
Money-Emp	.8295	.8097	.0198**
Outside-Emp	.6866	.6042	.0824***
Children-Emp	.6925	.6179	.0746***
Dispute-Emp	.7255	.6504	.0750***
Sex-Emp	.7318	.6517	.0801***
Food-Emp	.8158	.7519	.0639***
FemEmp component	-.2565	-.7082	.4516***

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

TABLE 4:
Summary Statistics

Variables	Obs.	All	Malawi	Zambia	Zimbabwe
HIV/AIDS					
HIV-infected	9,870	.1679	.1392	.1504	.1957
HIV/AIDS-knowledge	9,583	.8005	.7513	.8195	.8082
		(.195)	*(.200)*	*(.178)*	*(.200)*
School's outcomes					
nb of years of educ.	9,869	6.2202	4.0739	5.8420	7.5610
		(3.567)	*(3.529)*	*(3.578)*	*(2.940)*
no education	9,870	.1234	.2618	.1272	.0534
primary educ.	9,870	.5109	.6366	.5932	.3846
secondary educ.	9,870	.3386	.0987	.2395	.5336
higher educ.	9,870	.0271	.0029	.0401	.0284
Spouse's education					
no educ.	9,858	.0705	.1453	.0660	.0379
primary educ.	9,858	.4295	.6348	.4553	.3098
sec. educ.	9,858	.4290	.2065	.3698	.5835
higher educ.	9,858	.0610	.0105	.0943	.0589
Family background					
Father-to-Mother violence	7,456	.3769	.3060	.4140	.3850
prob sibling dead	9,617	.1736	.2164	.1811	.1469
		(.224)	*(.253)*	*(.229)*	*(.200)*
prob sibling dead before 5 y.o.	9,587	.0562	.1121	.0507	.0336
		(.134)	*(.189)*	*(.128)*	*(.095)*
prob sibling dead before 18	9,587	.0791	.1462	.0780	.0475
		(.161)	*(.220)*	*(.157)*	*(.115)*
Marital history					
Nb children ever born	9,870	3.5225	3.7420	4.0526	2.9945
		(2.521)	*(2.628)*	*(2.686)*	*(2.210)*
Nb of years since marriage	9,870	11.679	11.7206	12.2738	11.1857
		(8.700)	*(8.720)*	*(8.711)*	*(8.652)*
Religious affiliations					
catholic	9,860	.1531	.2148	.1828	.0998
protestant	9,860	.7453	.6210	.7998	.7623
muslim	9,860	.0375	.1551	.0047	.0067
other religion	9,860	.0059	.0024	.0128	.0021
no religion	9,860	.0067	0	.0952	
Other controls					
urban	9,870	.2760	.1140	.3705	.2793
age	9,870	30.1279	29.3381	30.5784	30.152
		(8.388)	*(8.503)*	*(8.186)*	*(8.465)*

Note: For continuous variables, standard deviations are reported in parentheses.

TABLE 5

First-Stage OLS Estimates

Dependent variable: Index of Female Empowerment

	(1)		(2)		(3)	
IV= 1 if her father ever						
beat her mother	-0.337***	(0.048)	-0.285***	(0.047)	-0.266***	(0.034)
nb of years of marriage			-0.0244***	(0.007)	-0.0178***	(0.005)
HIV/AIDS-knowledge			0.873***	(0.117)	0.577***	(0.086)
no education			-0.442***	(0.168)	-0.549***	(0.122)
primary educ			-0.729***	(0.145)	-0.745***	(0.112)
secondary educ			-0.570***	(0.138)	-0.620***	(0.105)
husband no education			0.0882	(0.134)	-0.0414	(0.094)
husband primary educ			-0.0007	(0.104)	-0.0932	(0.081)
husband secondary educ			-0.0446	(0.096)	-0.113	(0.075)
age			0.0338***	(0.007)	0.0294***	(0.005)
urban			-0.0218	(0.106)	0.107	(0.074)
wpoorest			-0.480***	(0.120)	-0.330***	(0.074)
wpoorer			-0.639***	(0.112)	-0.429***	(0.067)
wmiddle			-0.611***	(0.114)	-0.388***	(0.069)
wricher			-0.335***	(0.082)	-0.246***	(0.055)
catholic			0.0359	(0.091)	-0.179***	(0.062)
protestant			0.154**	(0.073)	-0.0748	(0.051)
other religion			0.269	(0.382)	0.197	(0.244)
children ever born			0.0005	(0.015)	-0.0132	(0.010)
1 if Zambia	-1.787***	(0.087)	-1.863***	(0.095)	-1.903***	(0.079)
1 if Zimbabwe	-1.178***	(0.065)	-1.268***	(0.080)	-1.321***	(0.062)
constant	0.815***	(0.047)	0.386	(0.246)	0.945***	(0.186)
Observations	7,031		6,807		12,356	

Note: In parentheses robust errors clustered at the sampled cluster-level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Respondent's occupation is also controlled for

Omitted dummies: higher education, rural, muslim, Malawi

Column 3 extends the sample to the married women independently of the HIV testing in the DHS

TABLE 6

Second-Stage Probit Estimates

Dependent variable: Likelihood of HIV-infection

	(1)		(2)		(3)		(4)	
Fem. Empowerment	-0.306**	(0.138)	-0.326**	(0.148)	-0.336**	(0.141)	-0.287**	(0.139)
inter FemEmp × yearsincemar					0.0021*	(0.001)		
inter FemEmp × urban							-0.0460*	(0.024)
nb of years of marriage	-0.0184**	(0.008)	-0.0169**	(0.007)	-0.0180**	(0.007)	-0.0182**	(0.008)
HIV/AIDS-knowledge	0.472***	(0.160)	0.397***	(0.134)	0.483***	(0.161)	0.469***	(0.160)
no education	-0.257	(0.187)	-0.299	(0.195)	-0.263	(0.188)	-0.265	(0.186)
primary educ	-0.232	(0.192)	-0.252	(0.197)	-0.238	(0.192)	-0.237	(0.191)
secondary educ	-0.206	(0.174)	-0.233	(0.180)	-0.211	(0.174)	-0.213	(0.173)
husband no education	0.103	(0.122)	0.0639	(0.122)	0.102	(0.122)	0.105	(0.122)
husband primary educ	-0.0350	(0.094)	-0.0640	(0.095)	-0.0386	(0.094)	-0.0327	(0.094)
husband secondary educ	0.0222	(0.087)	0.000007	(0.089)	0.0178	(0.087)	0.0214	(0.087)
age	0.0449***	(0.008)	0.0442***	(0.008)	0.0453***	(0.008)	0.0445***	(0.008)
urban	0.128**	(0.063)	0.168***	(0.065)	0.131**	(0.063)	0.104	(0.0640)
wpoorest	-0.297***	(0.112)	-0.260**	(0.102)	-0.296***	(0.112)	-0.308***	(0.111)
wpoorer	-0.290**	(0.123)	-0.237**	(0.106)	-0.289**	(0.123)	-0.301**	(0.122)
wmiddle	-0.231**	(0.113)	-0.174*	(0.095)	-0.230**	(0.113)	-0.244**	(0.113)
wricher	-0.0731	(0.076)	-0.0521	(0.071)	-0.0732	(0.076)	-0.0902	(0.076)
catholic	-0.101	(0.082)	-0.168**	(0.085)	-0.102	(0.082)	-0.101	(0.082)
protestant	-0.0520	(0.075)	-0.120*	(0.070)	-0.0497	(0.075)	-0.0502	(0.075)
other religion	0.0770	(0.345)	0.0598	(0.345)	0.0688	(0.346)	0.0849	(0.347)
children ever born	-0.0919***	(0.013)	-0.0961***	(0.013)	-0.0912***	(0.013)	-0.0919***	(0.0126)
firststage residuals (2)†	0.293**	(0.138)			0.300**	(0.139)	0.288**	(0.138)
firststage residuals (3)‡			0.313**	(0.148)				
1 if Zambia	-0.629**	(0.269)	-0.680**	(0.292)	-0.642**	(0.270)	-0.613**	(0.269)
1 if Zimbabwe	-0.347*	(0.192)	-0.389*	(0.211)	-0.354*	(0.192)	-0.321*	(0.193)
constant	-1.492***	(0.239)	-1.309***	(0.265)	-1.509***	(0.239)	-1.473***	(0.239)
Observations	6,807		6,807		6,807		6,807	

Note: In parentheses robust errors clustered at the sampled cluster-level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

† 1st stage residuals computed over the subsample of married women tested for HIV (col.2 table 5)

‡ 1st stage residuals computed over the whole sample of married women (col.3 table 5)

Omitted dummies: higher education, rural, muslim, Malawi

Respondent's occupation is also controlled for

TABLE 7

Second-Stage Probit Estimates, country-by-country analysis

Dependent variable: Likelihood of HIV-infection

	(1) Malawi	(2) Zambia	(3) Zimbabwe
Panel A			
Fem. Empowerment	-0.610	-0.468	-0.216
	(0.373)	(0.292)	(0.220)
	[0.102]	[0.108]	[0.328]
firststage residuals MWI	0.611		
	(0.372)		
firststage residuals ZMB		0.449	
		(0.293)	
firststage residuals ZWE			0.216
			(0.219)
Observations	1,546	2,422	2,834
Panel B			
Fem. Empowerment(MWI)	-0.733		
	(0.450)		
	[0.103]		
firststage residuals MWI (2)	0.747*		
	(0.448)		
Fem. Empowerment(ZMB)		-0.425	
		(0.264)	
		[0.107]	
firststage residuals ZMB (2)		0.399	
		(0.265)	
Fem. Empowerment(ZWE)			-0.162
			(0.166)
			[0.329]
firststage residuals ZWE (2)			0.152
			(0.165)
Observations	1,546	2,422	2,834

Note: Robust clustered standard errors in parentheses. P-values into brackets

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

Omitted dummies: higher education, rural, muslim, Malawi

Panel A uses the female empowerment index computed over the whole sample

Panel B uses the female empowerment index computed country-by-country

TABLE 8
Second-Stage Probit Estimates, falsification tests
Dependent variable: Likelihood of HIV-infection

	(1)		(2)		(3)	
wealth (continuous)	0.0000	(0.000)				
Fem. Empowerment (a)			-0.304**	(0.139)	-0.231	(0.142)
1 if married less 10 years ago (b)			-0.313***	(0.066)		
interaction term (a) times (b)			-0.0055	(0.019)		
1 if previously married (c)					0.706***	(0.048)
interaction term (a) times (c)					0.0367*	(0.022)
nb of years of marriage	-0.0126**	(0.005)	-0.0333***	(0.008)	-0.0282***	(0.008)
HIV/AIDS-knowledge	0.177**	(0.084)	0.476***	(0.161)	0.443***	(0.165)
no education	0.0409	(0.147)	-0.246	(0.188)	-0.257	(0.190)
primary educ	0.160	(0.133)	-0.231	(0.194)	-0.179	(0.196)
secondary educ	0.142	(0.125)	-0.208	(0.175)	-0.150	(0.177)
husband no education	-0.0489	(0.100)	0.0987	(0.122)	0.0247	(0.122)
husband primary educ	-0.105	(0.076)	-0.0409	(0.093)	-0.0569	(0.093)
husband secondary educ	-0.0707	(0.069)	0.0145	(0.087)	0.0219	(0.087)
age	0.0330***	(0.005)	0.0447***	(0.008)	0.0436***	(0.008)
urban	0.164***	(0.056)	0.136**	(0.064)	0.134**	(0.065)
catholic	-0.0591	(0.069)	-0.0994	(0.082)	-0.0678	(0.083)
protestant	-0.0667	(0.060)	-0.0513	(0.075)	-0.0423	(0.076)
other religion	0.164	(0.220)	0.0844	(0.342)	0.0530	(0.372)
children ever born	-0.0866***	(0.010)	-0.0955***	(0.013)	-0.0817***	(0.013)
wpoorest			-0.294***	(0.112)	-0.320***	(0.114)
wpoorer			-0.293**	(0.123)	-0.293**	(0.125)
wmiddle			-0.229**	(0.113)	-0.240**	(0.115)
wricher			-0.0736	(0.076)	-0.0886	(0.078)
firststage residuals			0.294**	(0.139)	0.208	(0.142)
1 if Zambia	-0.0511	(0.056)	-0.636**	(0.270)	-0.453	(0.277)
1 if Zimbabwe	0.0481	(0.057)	-0.351*	(0.193)	-0.175	(0.198)
Constant	-1.689***	(0.196)	-1.138***	(0.253)	-1.638***	(0.244)
Observations	9,539		6,807		6,803	

*Note:*Robust standard errors in parentheses, clustered at the cluster level
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Omitted dummies: higher education, rural, muslim, Malawi

TABLE 9

Second-Stage Probit Estimates, with alternative IVs

Dependent variable: Likelihood of HIV-infection

	(a)		(b)		(c)	
Fem. Empowerment	-0.229	(0.141)	-0.265*	(0.138)	-0.251*	(0.138)
nb of years of marriage	-0.0162**	(0.008)	-0.0174**	(0.008)	-0.0170**	(0.008)
HIV/AIDS-knowledge	0.395**	(0.163)	0.431***	(0.163)	0.418**	(0.162)
no education	-0.183	(0.186)	-0.206	(0.186)	-0.198	(0.186)
primary educ	-0.141	(0.190)	-0.168	(0.190)	-0.156	(0.190)
secondary educ	-0.137	(0.170)	-0.157	(0.170)	-0.149	(0.170)
husband no education	0.0723	(0.123)	0.0774	(0.123)	0.0761	(0.123)
husband primary educ	-0.0563	(0.094)	-0.0598	(0.094)	-0.0596	(0.094)
husband secondary educ	0.0069	(0.088)	0.0024	(0.088)	0.0033	(0.088)
age	0.0418***	(0.008)	0.0435***	(0.008)	0.0430***	(0.008)
urban	0.130**	(0.063)	0.125**	(0.063)	0.125**	(0.063)
wpoorest	-0.264**	(0.112)	-0.282**	(0.112)	-0.275**	(0.111)
wpoorer	-0.242**	(0.121)	-0.266**	(0.120)	-0.256**	(0.120)
wmiddle	-0.178	(0.112)	-0.207*	(0.111)	-0.198*	(0.111)
wricher	-0.0565	(0.077)	-0.0671	(0.076)	-0.0622	(0.076)
catholic	-0.105	(0.083)	-0.109	(0.083)	-0.109	(0.083)
protestant	-0.0688	(0.076)	-0.0659	(0.075)	-0.0682	(0.075)
other religion	-0.126	(0.318)	-0.119	(0.318)	-0.122	(0.318)
children ever born	-0.0925***	(0.013)	-0.0919***	(0.013)	-0.0918***	(0.013)
1 if Zambia	-0.480*	(0.271)	-0.554**	(0.268)	-0.526**	(0.267)
1 if Zimbabwe	-0.243	(0.195)	-0.292	(0.192)	-0.272	(0.192)
firststage residuals (a)†	0.214	(0.140)				
firststage residuals (b)‡			0.250*	(0.138)		
firststage residuals (c)§					0.235*	(0.138)
constant	-1.497***	(0.239)	-1.494***	(0.239)	-1.498***	(0.239)
Observations	6,626		6,608		6,608	

Note: In parentheses robust errors clustered at the sampled cluster-level

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

Omitted dummies: higher education, rural, muslim, Malawi

† IV: dummy equal to 1 if her father ever beat her mother + proba of having a sibling dead

‡ IV: dummy equal to 1 if her father ever beat her mother + proba of sibling dead before reaching 5

§ IV: dummy equal to 1 if her father ever beat her mother + proba of sibling dead before reaching 18

TABLE 10

Second-Stage Probit Estimates, with alternative measures of Female Empowerment

Dependent variable: Likelihood of HIV-infection

	(1) Index 2 Factor	(2) Index 2 Mean	(3) Index 3 Mean	(4) Index 4 Factor	(5) Index 4 Mean
Simplified Fem. Empowerment (pca)	-1.9618**				
	(0.942)				
firststage residuals (1)	1.9763**				
	(0.942)				
Simplified Fem. Empowerment (mean)		-8.011**			
		(3.848)			
firststage residuals (2)		8.070**			
		(3.850)			
Fem. Empowerment (mean)			-2.597**		
			(1.175)		
firststage residuals (3)			2.572**		
			(1.176)		
Fem. Empowerment_012 (pca)				-0.286**	
				(0.129)	
firststage residuals (4)				0.270**	
				(0.129)	
Fem. Empowerment_012 (mean)					-2.884**
					(1.304)
firststage residuals (5)					2.942**
					(1.305)
Observations	7,048	7,048	6,807	6,807	6,807

Note: In parentheses robust errors clustered at the sampled cluster-level
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Same control variables and IVs as in Table 6.
The dependent variables in Col. 1-2 are based on decision making variables exclusively and are computed through the PCA method or taking the mean respectively.
The dependent variables in Col. 3-5 are based on the same variables as the standard index used in the previous table, except that in col 3 the mean is used instead of the PCA, in col. 4 and 5, the decision making variables are recoded 0, 1 or 2 as in Ashraf *et al* (2010) and we use either the PCA (col. 4) or the mean (col. 5) to compute the index.