Contraceptive Use in the Shadow of an HIV Epidemic:

Individual and Community Effects of Education in Zambia, 1996-2007

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Abstract

Countries characterized by high fertility and low educational attainment have the potential to increase the adoption of modern contraceptive methods by increasing provision of education. This study investigates the association between contraceptive use and women's education at the individual and community level in Zambia, by using data from two Demographic and Health Survey (DHS) waves (1996 and 2007). We situate the study in the context of the ongoing HIV/AIDS epidemic since the risk of infection influences decisions regarding fertility and contraception. Logistic regression results confirm that individual education is positively associated with the use of modern contraception but the impact is decreasing over time, while community education is increasing in importance. Community education matters more for condom use than for use of hormonal methods. Expanding provision of education will increase the individual woman's use of modern contraception and, through her influence, contraceptive use among others in her nearby community.

Key words: Contraception, education, community effects, Zambia, HIV, DHS, logit regression

First draft!

1. Introduction

The secular decline in fertility that has taken place in many countries over the past couple of centuries is a defining event in demographic history of great consequence for economic growth as well as social and familial relations. While some countries have subsequently experienced the so called second demographic transition (Lesthaeghe, 2010), most Sub-Saharan African (SSA) countries have yet not completed the first demographic transition, and there is even evidence suggesting that the slow fertility decline has stalled in the past decade (Bongaarts, 2008; Shapiro & Gebreselassie, 2008). Moreover, progress is by no means uniform across the region. While a number of Southern African countries have attained total fertility rates (TFR) as low as 2.4, others remain at levels above six or seven children per woman (United Nations, 2013). The conditions for fertility decline in SSA today appear to be very different from what they were when the transition began in Europe in the late 19th century. Effective methods of birth control have been available for decades and knowledge about them is widely spread, yet there is still substantial unmet need for contraception in high-fertility contexts. As barriers in the form of direct access to contraception have been removed, mental barriers such as lack of knowledge, social and familial disapproval, and fear of side effects oftentimes remain (Biddlecom & Kaona, 1998; Cleland et al., 2006).

Women's education has been frequently studied as a determinant of fertility (e.g. Cochrane, 1979; Caldwell, 1980; Singh & Casterline, 1985; Castro Martín 1995; Bongaarts, 2010). One of the mechanisms through which education can influence fertility is the adoption of new and more effective contraceptive methods. For many years there was an emphasis on the schooling of the individual as a determinant of contraceptive behavior, implicitly assuming that a woman's behavior is unrelated to her social context. This seems implausible. We all live in a social reality and we are influenced by and learn from people around us. If knowledge, attitudes, and norms are spreading in societies, we do not only benefit from own education but also from the education of people around us (Rogers, 1962; Montgomery & Casterline, 1996; Bongaarts & Watkins, 1996; Behrman, Kohler & Watkins, 2002). The general level of education in a community surrounding a person may in that way affect the fertility and contraceptive choices a person makes, irrespective of her own schooling. If there is a causal relationship between a woman's propensity to adopt modern contraceptive behavior and the level of contextual education where she resides, these externalities of education must be included in a cost-benefit analysis of investments in education (Kravdal, 2002). Women's education has the potential not only to improve economic circumstances, but also to promote ideational development around fertility and women's role in society. The literature on gender equality and women's empowerment and autonomy with their potential influence on contraceptive use has

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become substantial (e.g. Dyson & Moore, 1983; Folbre, 1983; Mason, 1987; Basu, 1992; Hashemi, Schuler & Riley, 1996; Mason, 2001). Women's education and position in society constitute two of the strongest influences on fertility reduction, and although there are empirical exceptions, they, by and large, serve to reinforce rather than weaken the case (Basu, 2002).

In this study we examine the association between education and the adoption of contraception in Zambia. More specifically we investigate whether the amount of education of a whole community combined has an association with contraceptive use. If such *community-level education* turns out to be related women's use of contraception, beyond their *individual-level schooling*, this could help us better understand the link between education and fertility. It would also help us to target people for education investments and to look differently at the gains from investments in education. The decision to contracept also involves a choice of method, which, given the range of effectiveness of methods, may have important implications for fertility. In this study we also investigate to what extent individual and contextual education matters for the choice of contraceptive method.

Our case is Zambia, which is interesting, with a high total fertility rate that only has decreased slowly, despite the geographical proximity to low-fertility countries such as Botswana and Zimbabwe. Enrolment in primary education has lately become nearly universal, but secondary education remains low and higher education is negligible, thus there is great scope for increasing provision of education. We situate our study in the Zambian HIV/AIDS epidemic in that it is conceivable that decisions regarding fertility and contraception are influenced by the threat of the epidemic. Half of all HIV infections in Zambia occur within marriage (Dunkle et al., 2008). To study women's or couples' contraceptive behavior without controlling for issues relating to protection against infection, or studying condom use without considering its simultaneous function as a pregnancy prophylactic, could lead us to draw spurious conclusions. This warrants attention in the analysis of contraceptive use, yet the existing literature has largely failed to do so.

We exploit micro-level data drawn from the 1996 and 2007 Zambia Demographic and Health Surveys (DHS) to perform logistic regression analysis of current use of modern contraception on community-level education in a first stage, and in a second goes some length in bridging the gap between studies of contraceptive use and the HIV/AIDS epidemic by distinguishing condom use from hormonal methods of contraception. Findings confirm that education is an important determinant of contraceptive use, both on the individual and community level. The externalities of education are increasing over time. These are particularly important for condom use, which indicates

that neglecting to consider condom use as separate from use of hormonal methods confounds estimates of the association between education and use of modern contraceptives.

The paper is organized as follows. In the second section, we briefly review the empirical and theoretical literature on education and contraceptive use that has bearing on our research objective. We describe the context within which the results should be understood in Section 3. Section 4 presents the data and our analytical strategy. Results are reported in Section 5 and discussed in Section 6. Section 7 concludes.

## 2. Previous research and theoretical considerations

### 2.1 Contraceptive use and fertility

In 1979, Cochrane stated that "education has positive effects on attitudes towards contraception, knowledge of contraception, and communication between husband and wife and, through other variables, on contraceptive usage" (Cochrane, 1979: 9). Earlier contributions devoted to explaining fertility decline at the macro level were largely focusing on how modernization, urbanization, and mass education changed the economic value and costs of children (e.g. Notestein, 1953; Coale & Watkins, 1986). Then, the focus shifted to the micro level and the economic determinants of supply and demand for children (e.g. Becker, 1960, to which women's human capital investments has become an important feature (e.g. Michael, 1973; Gardner, 1973; Ketkar, 1978). More recent studies of the Western world have likewise shown that access to higher education and improved economic prospects influence fertility and fertility preferences through increased use of contraceptive methods (e.g. Goldin & Katz, 2002; Kohler, Billari & Ortega, 2002; Bailey, 2006). A positive association between high socioeconomic status in general and women's propensity to choose a highly efficient contraceptive method has also been documented (Grady, Klepinger & Billy, 1993). In spite of empirical evidence showing that education leads to fertility decline, this has not happened everywhere. Developing countries that have gone through a fertility transition since the 1960s have done so at very different levels of socioeconomic development. The absence of marked fertility decline in most Sub-Saharan African countries in spite of improved socioeconomic conditions, reduction in mortality rates, increase in unmet need for contraception, and improved provision of family planning services, sent researchers looking for alternative proximate determinants of fertility. Women's education has remained among the factors hypothesized to influence fertility, but the focus on the economic character of the influence has been challenged.

Alauddin declared that "village-level knowledge [of contraceptive methods] has a strong positive association with individual knowledge of contraceptive methods" (Alauddin, 1979: 11). There is no mutual exclusion between this statement and Cochrane's above, but Alauddin's conclusion implies a different perspective on how knowledge might influence fertility. An important finding from studies of recent transitions is that countries that are geographically close tend to transition together. Although the most developed country in the region generally transitions first, the others follow suit despite being at lower levels of development (Bongaarts &Watkins, 1996). The finding led scholars to return to an idea that was brought up earlier in connection to the European fertility transition, proposing that there is a diffusion of information and ideas about birth control taking place among regions, communities, and individuals (e.g. Rogers, 1962; Knodel & van de Walle, 1979; Montgomery & Casterline, 1996). This diffusion of knowledge about contraceptive practices among people, as well as spread of attitudes to fertility and family planning in general, has been shown to influence people's behavior in these areas. Examples of findings include how health concerns about oral contraceptives and the IUD spread in the United States in the 1960s and 1970s and impacted the use of these methods (Beniger, Westoff & Jones, 1980), women in Kenya become dissuaded to adopt and continue modern contraception by "myths and rumors" about dangers of these methods, in spite of having been given information at health clinics (Rutenberg & Watkins, 1997), US women living in communities with high socioeconomic status are more likely to use efficient methods of contraception, because these communities uphold norms that support consumption of quality of children rather than quantity (Grady, Klepinger & Billy, 1993). A woman's probability of taking up modern contraception is equal to the share of users in her social network (Kohler, 1997), illustrating that the surrounding community is important for contraceptive behavior. Aggregate education is thought to be one of the important contextual factors that influence community members in their decisions. This link between individual and community effects of education and contraceptive use through diffusion has been treated in a number of studies. Aggregated data from Sub-Saharan Africa shows that average educational level in a community is associated with significantly lower odds of a birth, above and beyond a woman's own education (Kravdal, 2002). Analyses of country-specific data have made it clear that whether the relationship can be identified or not has largely been dependent on the country that is examined (Stephenson et al., 2007). Aggregate level education is found to be positively related to use of modern contraceptive methods in Ghana (Benefo, 2006) and Tanzania (Stephenson et al., 2007), but not in for instance Zimbabwe (Kravdal, 2002).

Cultural practices and social norms were early on suggested to influence fertility by restraining women's ability to make decisions over their own reproduction. Examples are low age at first

marriage (Jeffrey & Basu, 1996), religious prohibition of fertility regulation (Caldwell & Caldwell, 1987), male child preferences (Dyson & Moore, 1983), patriarchy in family structures (Folbre, 1983; Mason, 2001), and a greater esteem for large families than for small. Women's position or gender relations in society in general are likewise governed by social structures and widely cited as an obstacle to demographic change (e.g. Balk, 1994: Morgan & Niraula, 1995; Hashemi, Schuler & Riley, 1996; Blanc, 2001). Power imbalance has implications for fertility if spouses' fertility preferences differ and contraceptive use has been found to be greater when women are able to conceal it from their husbands (Ashraf, Field & Lee, 2014). While the link between contraceptive use and women's autonomy has been documented in numerous contributions, the association between education and women's autonomy has become increasingly questioned. The link is commonly suggested, or even taken for granted, in the formulation of large development programs such as the Millennium Development Goals (UN, 2000). At the UNFPA conference in Cairo in 1994 an action plan was adopted stating that "education is one of the most important means of empowering women with the knowledge, skills and self-confidence necessary to participate fully in the development process" (UNFPA, 1995: 23). Studies have implied however, that contextual factors matter for whether women's education will improve autonomy or not, or in which sense autonomy will improve. Educated women in Bangladesh were for example more likely to participate in household decisions, but due to the practice of seclusion of women education did not lead to improved physical autonomy (Balk, 1994). Basu (2010) has contributed to this particular debate by cautioning against the focus on primary education, suggesting that the strong link between education and empowerment should be expected only when secondary and post-secondary education becomes more widespread. Many studies have however found evidence in favor of an important association between women's education and autonomy. Jejeebhoy (1995) summarizes findings of a large number of studies by stating that educated women have better access to reproductive health services, more control over resources and ability to move around outside their homes, are better at intimate communication with their spouses which allows them to express their opinion on family planning, and ability to make better decision regarding adoption and continuation due to their wider knowledge.

*2.2 Contraceptive use and HIV/AIDS*
The HIV/AIDS epidemic in Sub-Saharan Africa has considerable influence over people living in this region, and is an aspect to consider in many decisions, not least in reproductive choices. The perceived risk of infection has bearing on choice of contraceptive methods, because the methods that most effectively prevent pregnancy (hormonal methods such as the birth control pill and injectable contraceptives) do not protect against infection. It has indeed been suggested that use of hormonal

methods is associated to increased acquisition of the virus (World Health Organization, 2010). Moreover, it has been shown that not only the decision regarding contraception is affected by HIV risk, but that there also is a link to fertility preferences (Trinitapoli & Yeatman, 2011). This interaction between fertility preferences and the HIV/AIDS epidemic should be considered in studies of reproductive decisions, something that is frequently neglected (Adetunji, 2000). In this study the relationship between contraceptive use and education will be investigated while taking the duality of condom use as a contraceptive method and as protection against disease transmission into account.

*2.3 Theoretical considerations*

2.3.1 Neoclassical theory of fertility

Economic theory of fertility behavior emerged from neoclassical models of consumer demand, where household behavior is analyzed in a choice-theoretic framework. This was first outlined in the pioneering works by Becker (1960) who modelled fertility choice as an outcome of a utility maximization problem and a cost-benefit analysis given a set of tastes and preferences, level of income, prices, and the supply of commodities, one of which is children. Michael (1973) extended Becker's framework into a model of fertility control, placing more weight on the relationship between parents' preferences for children relative to other commodities and their capacity to affect probability of another birth (see Appendix A1). This point is material to Michael's extension; the decision to reduce probability of a birth is different from deciding not to have another child in Becker's basic model, because the probability may still not be zero. If net benefit of having another child is negative, parents will take action to reduce probability of a birth, which is commonly done by some method of contraception. The probability is still going to be positive unless the parents choose to prevent a birth by abstinence or by aborting a pregnancy (Medoff, 1988). The couple thus faces a utility maximization problem where they must decide on an optimal level of birth control, which will land where marginal cost of contraception is equal to marginal benefit.

The case of abortion brings to light that costs of birth control that a woman considers in the cost-benefit analysis may be non-monetary. It can be considered a psychic cost to live with the disapproval of family or community, or indeed one's own disinclination toward abortion or contraception. Religious affiliation potentially exerts a powerful influence and may impose psychological sanctions against a woman who has had an abortion. Birth control could be physically unpleasant while it is applied, obviously so in the case of abortion, or due to side effects of for instance hormonal methods. Abstaining from sex as a method for limiting or spacing births is another type of cost. In contexts where contraception or indeed abortion are illegal an additional dimension of

costs are incurred, since a ban does not mean that abortion cannot be obtained, just that costs will be higher. A woman will try to come as close to her preferred number of children as possible, but whether she will land at that particular parity or not depends on her ability to pay the price of limiting and spacing births. Her education could be a factor of her ability to achieve her desired parity.

One of Easterlin's (1975, 1978) contributions to the economics of fertility was to integrate economic theory with a sociological approach, which commonly focuses on the production side rather than the demand side of fertility. While economists emphasize income and price as the primary determinants of fertility via demand, sociologists consider how fertility is determined by cultural and physiological factors that influence natural fertility and costs of fertility regulation. Innovation in schooling potentially has both increasing and depressing effects on the production side. On the one hand, improvements in personal hygiene and food care raise natural fertility, and so may the undermining of some cultural practices such as intercourse taboo during lactation. On the other hand, education tends to lower time and money costs of fertility regulation by providing information about fertility control that was previously costly, and subjective costs may decrease as traditional norms that are adverse to fertility control are challenged. Reduction in market and psychic costs should increase the amount of fertility regulation a couple adopts. The supply and demand sides of fertility are linked by tastes and preferences, which both influence desired family size and the sociological determinants of fertility regulation; motivation, attitudes, and access. Because of a lack of an economic theory of formation of tastes and preferences economists often pay limited attention to how the utility function may be influenced by for example education (Michael, 1973). The production side is particularly important, Easterlin argues, when analyzing a pre-modern society, because excess demand is a more common situation than excess supply, and excess demand is a feature not only of preferences, but of low natural fertility levels. This is by no means the case today, but nevertheless that cost of fertility regulation remains an important determinant of fertility compared to price.

As captured by Michael's model, the cost-benefit analysis of a birth is not only a matter of deciding whether to contracept or not, but of choosing the ideal amount of protection. This point is of particular importance when making a distinction between contraceptive methods, such as is done between hormonal methods and condoms in this study. Levine (2007) recognizes this by incorporating a measure of contraceptive intensity in the neoclassical model of fertility behavior, which is defined as the level of protection against pregnancy some method provides. Likelihood of pregnancy decreases with intensity, while marginal cost of contraception on the other hand increases with contraceptive intensity, reflecting that a woman only chooses the method that provides an

optimal level of protection, no more and no less. When the cost of contraception or the cost of having another child changes, a woman will adjust her contraceptive intensity accordingly. This is graphically illustrated in Figure 1. A woman will choose the level of contraceptive intensity where reducing the probability of a birth with one additional unit is as costly as having another child; point C in panel A. and B. If the cost of contraception decreases, for example because a woman is informed about injectable contraceptives that will require fewer trips to the health clinic and are less bothersome to administer than for example condoms, the marginal cost of contraception curve in panel A. becomes flatter (MC is reduced to MC*). This change leads to a new level of optimal contraceptive intensity at point C*. Adopting an innovative and more effective contraceptive method may have prohibitively high psychic costs, but could decline with better information or along a normative transition brought about by higher levels of education. Similarly, if the cost of a birth increases, and again costs may be of non-monetary character such as status loss and stigma, this will also increase the optimal level of contraceptive intensity, point C* in panel B. A change in community attitude in favor of lower fertility potentially increases the cost of another birth in form of others' disapproval, and this changes the outcome of the cost-benefit analysis. In monetary terms, an increase in community-level education could change women's labor market opportunities by admitting them into occupations that were previously restricted to men, resulting in higher opportunity costs. Providing a woman in a developing country with schooling could both reduce the marginal cost of contraception, thereby increasing her ability to prevent pregnancy, and increase the cost of another birth, thus making her want fewer children.

Figure 1 about here

Education potentially influences fertility at all stages of the cost-benefit analysis. Higher educational attainment affects tastes and preferences so that (potential) parents' utility functions and indifference curves shift, for example toward from consumption of quantity toward consumption of quality of children. This may shape fertility by increasing income, leading to an income effect and/or a substitution effect on demand. The supply of children could increase if education improves the mother's health during pregnancy leading to fewer miscarriages and stillborn children, or if it brings down child mortality by improving parents' child rearing abilities. Education potentially also affects the time constraint couples face when they choose fertility through its influence on age at marriage and life expectancy. The connection between education and adoption of contraceptive methods could occur either indirectly via the cost-benefit analysis leading to a reduced demand for children, or through a number of direct paths. Education may provide knowledge of previously unknown methods

of contraception that are more effective in preventing a birth. Education could affect income positively, making more effective methods affordable.

2.3.2 Diffusion models of fertility behavior

Although neoclassical theorists lately have been incorporating cultural and psychological factors into their models of fertility in the form of non-monetary costs, the static representation of relationships in the neoclassical model only allows for implicit analysis of the process through which the influence occurs. Diffusion theory in essence describes how "an innovation is communicated through certain channels over time to members of a social system" (Rogers, 1973: 71), and an 'innovation' could in the case of adoption of contraceptive methods for example be an innovative behavior or a new fertility preference. A social system, or a community, has a social structure that defines the statuses and positions of the members relative to each other. Communication within the system is often conditional upon the social structure, following a pattern that determines who interacts with whom and under what circumstances. Structures can facilitate or obstruct diffusion of an innovation so that two individuals from different communities, who in all other respects appear identical, will have different rates of adoption owing to their adherence to different social structures. An important feature of a social structure is the prevailing norm system that guides members of the community into an established pattern of tolerable behavior. A progressive norm system may boost diffusion and adoption of an innovation, whereas a conservative system could constitute a barrier to change.

Empirical evidence suggests that transfer of knowledge and attitudes occurs within a social network, making it is necessary to reflect over how and when this occurs. Evaluation of family planning programs focus on the spread of birth control techniques vertically from family planning worker to potential user, but horizontal communication between peers is a more common form of interaction and thus an important channel for transmission. Talk of family size preferences and family planning between women in social networks is happening and that information is provided through these channels. Such an informal chat allows women to assess new contraceptive methods based on actual experiences of others as well as the degree of acceptability of contraceptive behavior. Social interaction between peers can consist of exchange of information and ideas, evaluation of ideas and practices, as well as of social influence encouraging or constraining action, all of which are likely to be relevant for fertility change (Bongaarts & Watkins, 1996). When fertility is within the calculus of conscious choice, lack of information of methods for fertility control or ideas about the benefits that lower fertility can bring about constitute barriers to change. Social interaction is potentially important channel for transfer of information and ideas. A more complex process than simple information

sharing is the evaluation of ideas. Talking over experiences and ideas has the potential to give new meaning to old ideas or justify a change of behavior. Social interaction has an element of social influence whereby peers gauge the approval or disapproval of ideas and practices, and may modify their behavior as a consequence. Social influence generally works to reinforce existent norms, so that early in a fertility transition social influence is likely to be a barrier to fertility decline and the reverse later in the fertility transition when more peers have adopted the innovative behavior. The influence of the education of the individual on diffusion of innovative ideas of contraceptive use is that it adds to the stock of information, ideas, and attitudes that are available for diffusion in her network. Schooling may additionally make the individual more receptive to innovations and able to evaluate them, as well as more likely to seek out new information. Correspondingly, a higher community-level education should embody a larger stock of information that can be disseminated throughout the network, also, and here is a crucial point, to members who have little schooling.

It is however probable that not all communities are conducive environments for circulation of information and sharing of thoughts and opinions. Family planning ideas and adoption of contraceptive methods are taboo topics in many contexts, or may be communicated only to certain people in the community, for instance between individuals who perceive each other as similar with respect to certain important characteristics. Diffusion theory is concerned with identifying the mechanisms that determine whether transmission will occur or not. Transfer of ideas takes place most frequently between individuals who are alike in certain aspects, such as social status, beliefs, language, and education. Homophily, that is the degree to which communicating individuals share such similar attributes, is therefore an important concept in diffusion theory. There is however a critical trade-off in homophily-heterophily; communication is more effective between homophilous partners because less effort is required for comprehending the other, but compared to heterophilous communication the informational potential is lower (Rogers, 1973: 54). In a homophilous network the chance is smaller that there is any information to transmit, exactly because of individuals are identical in many respects and therefore unlikely to possess dissimilar knowledge. For that reason heterophily on certain variables is essential for diffusion of an innovation, while homophily on others is required to ensure that the message is delivered and understood. From this follows that in a community where all women have the same length of schooling, diffusion of knowledge and attitudes should be more efficient than in one where variation in educational attainment is great. Large community variation in levels of schooling could thus have either positive of negative net effects on diffusion because of opposing influences of homophily and heterophily.

2.3.3 Gender systems and women's autonomy

A growing literature connects demographic patterns to women's social position, arguing that gender and power relations between women and men constrain women in choosing fertility behavior and contraceptive use. Women's social position potentially influences fertility through all intermediate levels; supply may be affected through women's age at first marriage, frequency of remarriage, and breastfeeding practices; demand could be influenced by gender preferences for children and the value and cost of children; and cost of fertility regulation finally may be influenced if the use of contraception is somehow constrained or altered by societal or household power relations. Shifts in women's position, control over resources, or status relative to men that operates through female education is often cited as influential at all the intermediate levels (see e.g. Mason, 1987). When it comes to contraceptive use a more appropriate term than women's social position is women's autonomy, since it implies choice and action.[1]

There are a number of mechanisms through which education may influence fertility behavior via improved autonomy. Jejeebhoy identifies five dimensions of how women's education might influence women's autonomy and thereby have bearing on reproductive behavior (Jejeebhoy, 1995: 8). *Knowledge autonomy* refers to how education leads to greater understanding of and exposure to the outside world, giving a person opportunity to obtain information and consider options she otherwise would have been ignorant of. Knowledge of contraceptive methods and how to use them is of course the obvious example. Education potentially affects *decision-making autonomy* by strengthening a woman's, and others', confidence in her abilities. As far as her desired fertility is lower than that of her husband, her influence over household decisions should result in greater take-up of contraceptive methods. *Physical autonomy* is expanded directly for someone otherwise confined to the home if education is attained outside the home. Education may indirectly affect physical autonomy by allowing a person to rely more on her own faculties in contact with society and thus make her more likely to interact with society and make use of available services, such as family planning facilities. Education may also influence *emotional autonomy*. In societies where great

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[1] There is a wide variety of terms used in this literature to denote concepts similar to what I refer to here as "women's autonomy". They include "status of women", "women's position", "gender inequality", "female empowerment", "sexual stratification", etc. The terms are sometimes used interchangeably, which at times causes confusion, and are other times referring to different aspects of a larger body of gender structures. Women actively making decisions, for example regarding contraceptive use, and being free to move around and to interact with the outside world is something entirely different from women's high status in the sense of being accorded great esteem. Dyson and Moore (1983) define autonomy as "the ability - technical, social, and psychological - to obtain information and use it as the basis for making decisions about one's private concerns and those of one's intimates", which is the kind of capacity this study is concerned with.

loyalty is given to the extended family and kin, fertility decisions will more often be made based on wishes of the community than on the fertility desires of the spouses (Dyson & Moore, 1983). Education may increase intimacy between spouses and thus change the balance of loyalty in favor of the immediate family, so that decisions regarding fertility and contraception will be less influenced by pressure from outside. Finally, *economic and social autonomy* is enhanced by education if it strengthens acceptance in business relations and attachment to the labor market. Access and control over economic resources as well as greater ability to engage in economic relations will allow a woman to rely less on others for support and increase others' regard for her capabilities. A woman that contributes financially to the household has more leverage in fertility decisions and there may also be an opportunity cost of childbearing to take into account. In addition, she is more likely to be concerned with the cost of children in terms of money and time.

*2.4 Analytical framework and hypotheses*

The connection between community-level education and use of contraception may be represented by extending Michael's (1973) model, in which community-level education may be thought of as a kind of informal education that supplements individual schooling.[2] Some theoretical and empirical contributions that have been brought up above imply that this informal education may even magnify the positive effects of individual schooling. From this follows that a formal expression of the choice of probability of conception $P$ could be formulated:

$$P = f(x_p, T_p; Z, F, E), \qquad (1)$$

where $x_p$ and $T_p$ are money and time spent to alter the probability of conception, $Z$ is coital frequency, $F$ is unadjusted fecundity, and $E$ is education. Education $E$ thus represents total education which is a sum or a product of individual schooling $S$ and informal education $I$:

$$E = S + I, \quad \text{or} \quad E = SI. \qquad (2)(3)$$

Whether the components should be added or multiplied can be tested by interaction effects.

In essence, community-level education can be thought of as an extension and reinforcement of individual-level education. Individual-level education can influence contraceptive use through a large number of plausible mechanisms which are outlined in the previous section. We know that people

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[2] A more detailed account of Michael's model is outlined in Appendix 1.

talk to each other about fertility and family planning, and we know that they share the knowledge they have received about these matters from education. They also share what they have learned in other conversations. The community-level of schooling is a measure of the total stock of accumulated information in a community. The larger the stock, the more knowledge there is that can be diffused throughout the community and the more likely is it that it reaches a given woman. In a community with a small stock of knowledge it would take much greater effort to transfer it to all community members. People do not only share knowledge, they also express their opinions and values about fertility and family planning. We think that education has the potential to change norms by exposing people to alternative ways of thinking. High community-level of education could mean that more people are discussing new ideas, and that more is spilling over on the rest of the community.

Based on the theoretical discussion above, we make the following conjectures regarding the association between education and women's use of modern contraceptive methods:

1. A woman's education is expected to be positively related to the use of modern contraception.
2. Community-level education is expected to be positively associated with the use of modern contraception.
3. Community-level education is expected to be more important as it reaches higher levels, and its estimated relationship with contraceptive use should therefore be greater as educational provision in general increases. Similarly, community-level education is expected to be more important at higher levels of individual education and its relationship with contraceptive use should therefore be greater as the educational distribution shifts upwards. This implies that the relationship is better represented by equation (3) than equation (2).
4. Living in a community where more women are or have ever been using modern contraception is expected to be associated with a higher probability of the individual woman being a user of modern methods.
5. A high degree of homophily in a community should to be positively related to current contraceptive use, if community-level ever-use of modern contraception is high. If contraceptive ever-use is low, heterophily in a community is expected to be positively associated with current use.
6. Taking the HIV/AIDS epidemic into account by distinguishing condom use from hormonal methods of contraception is expected to alter the estimated relationship between community education and use of other methods. Both HIV prevalence and educational attainment are higher in urban areas, higher education should thereby pick up some of an increase in condom

use that is likely to follow a higher risk of infection. Separating between the methods is thus expected to decrease the estimated association between education and hormonal methods.

These hypotheses are formed with allowance for availability of data, which restricts the feasibility of finding evidence of causal effects in the analysis. While we may believe that increasing women's educational attainment significantly *causes* an increase in their propensity for using modern methods of contraception, and on the propensity of women in their network to be users, this study will make no such claims.

## 3. The Zambian context

*3.1 Fertility and education in Zambia*

Zambia is a landlocked Sub-Saharan African country with borders to eight other countries. It is divided into nine provinces of which two, Lusaka and Copperbelt, are predominantly urban, and the remaining seven (Central, Eastern, Northern, Luapula, North-Western, Western, and Southern Zambia) are predominantly rural. The main economic activity continues to be copper mining, and investments in mining drive other sectors, especially construction, transport, and energy (OECD/AfDB/UNDP, 2014). Zambia experienced a period of economic stagnation during the 1990s and even declined during the period 1998–2001 when world market prices of metal and agricultural products collapsed. In 2002 the situation turned and prices picked up again so that by 2005 the price of copper had grown by over 100 per cent. During the period 2002 to 2005 real GDP grew by 4.8 per cent annually, exceeding the four per cent target set in the Poverty Reduction Strategy Paper implemented during the same period, and income per capita grew at 2.3 per cent per year. In spite of the positive growth an estimated 68 per cent of the population still fell below the national poverty line in 2004. This was still a slight improvement compared to 1998 when poverty stood at 73 per cent after a period of deterioration between 1991 and 1998, primarily affecting the poorest non-farm households (IMF, 2007). Recent numbers and projections of growth are substantially higher at around seven per cent per annum. Between the mid-1990s and the mid-2000s substantial progress in poverty reduction was achieved, but improvements were unevenly distributed across regions. Poverty is an overwhelmingly rural phenomenon; the moderate poverty rate in rural areas in 2010 was 74 per cent compared to the urban rate of 35 per cent, which is all the more relevant since two thirds of the population live rurally. Income inequality has increased between 1996 and present day with the 2010 Gini index measured to 57, which is in line with the concentration of economic growth to the urban economy (World Bank, 2012; OECD/AfDB/UNDP, 2014). The worldwide economic crisis hit Africa in 2008 with sharp increases in food and oil prices increasing poverty throughout the region, but

since the most recent data used in this study was collected before 2007 the analysis will not be affected by these events.

The total fertility rate (TFR) in Zambia continues to be high; higher than the Sub-Saharan average with growing differences over time. Despite a decline from 7.4 births per woman in the 1969 census, the 2010 census reported total fertility rate at 5.9 children per woman (7.0 and 4.6 for urban and rural areas, respectively). Fertility varies substantially across provinces with the lowest TFR (4.6) in the Lusaka province (where the capital city is situated), and the highest (7.3) in Luapula in the north, bordering the Democratic Republic of the Congo. The population size was according to the 2010 census 13.1 million, of which about 60 per cent live in rural areas. The population growth rate during the inter-censal period 2000-2010 was 2.8 per annum. Most of the increase took place in urban areas and the Lusaka province was the fastest growing (CSO, 2010). As the impact of rapid population growth on economic, social, and health indicators was recognized, a national population policy was implemented in 1989. More recently the agenda of the Zambian Development Vision set out to decelerate annual population growth to a rate below one per cent by 2030. If high fertility continues the population is projected to reach 33 million by 2037, two and a half times its current size. Marriage is universal with 99.2 per cent of women aged 45-49 are ever married (UNDP, 2012).

Zambia is predominantly Christian and between seventy and 80 per cent of the women in the four surveys in this study are of a protestant faith, while the remaining share consists almost entirely of catholic women. Muslims and other religions make up a minor share of the population.

Before the early 1990s about 50 per cent of Zambian women over 15 years of age had no education, but during the first half of that decade enrolment increase substantively and in 1995 less than twenty per cent of women had no education. Somewhat surprisingly the share of uneducated rose yet again the decade following 1995, but was in 2010 back below twenty per cent (Barro-Lee/WDI). The largest changes are found in enrolment in primary education, probably as a result of the 2002 Free Basic Education Policy that was introduced as a response to the Second Millennium Development goal, stipulating that all children should be able to complete a full course of primary education by 2015. The share of women with completed primary education increased from fifteen per cent in 1985 to 40 per cent in 2010 (ibid.), and net enrolment increased from 68.1 per cent in 2000 to 92.3 per cent in 2005 (MONFP, 2010). Still only a small share of women has completed secondary education, an increase from just under five per cent in 1985 to 7.5 per cent in 2010, and a negligible share has completed tertiary education; 0.3 per cent in 2010 (Barro-Lee/WDI).

*3.2 The Zambian HIV/AIDS epidemic*

The HIV epidemic in Zambia is one of the most severe in sub-Saharan Africa and the world. UNAIDS 2013 report on the AIDS epidemic estimates the adult prevalence (ages 15-49) to 12.7% in 2012, the sixth highest in the region. The prevalence increased steadily since the 1980 when the epidemic got a foothold in Zambia as in other parts of the world, reached a peak of 15.6% in 1997-1998, and then began to decline. HIV incidence has declined every year since 1990 from 2.50 to 0.79 in 2012 (UNAIDS, 2013). Prevalence is twice as high in urban than in rural areas, from which follows that the more urbanized regions of Lusaka and the Copperbelt are more severely hit than for example the rural Northern Province. The low prevalence in Northern Province is additionally attributed to lower frequency of extramarital sex among both men and women, because of the matrilineal culture that distinguishes that province (Kimuna & Djamba, 2005). Most infections are reported to occur at casual heterosexual sex, directly or with higher probability transferred by a partner who has had casual sex, or through mother-child transmission during pregnancy, delivery or through breastfeeding. Women are infected to a greater extent than men.

4. Data and methods

*4.1 The data*

The importance of individual and community-level education for women's decision to use modern contraception is investigated by using data from the Zambia Demographic and Health Surveys (CSO, et al., 1997; CSO, et al., 2009). The samples were drawn in two stages from the Censuses of Population and Housing of the Republic of Zambia (CPH) conducted in 1990 for the first wave (DHS-III 1996) and in 2000 for the second wave (DHS-V 2007). The first stage consisted of dividing Zambia's nine provinces into urban and rural areas, resulting in eighteen sampling strata, and across these strata selecting a number of clusters with probability proportional to the size of the cluster. As clusters Standard Enumeration Areas (SEAs) were used; SEAs are subdivisions of provinces into geographical areas that are convenient for censuses. There are approximately 16,500 SEAs each consisting of an average of 130 households and 600 individuals.

Certain restrictions to the samples were made to ensure that the observations do not differ in ways that predictor variables will not be accounting for. The two datasets initially consist of a combined total of 15,167 observations distributed over in total 632 clusters (that may overlap across surveys), with the number of observation per cluster ranging from three to ninety-nine. Only women who were married were included in the sample and women who were pregnant, post-partum amenorrheic or

sterilized (or whose husband was sterilized) were removed. Women who never had sexual intercourse or had not had sexual intercourse over the past six months were taken out of the sample[3], as anyone who reported not knowing of any effective method of contraception. After removing observations due to missing values for important variables, the remaining sample size was 1,997 (DHS III, 1996) and 1,996 (DHS V, 2007); a total of 3,993 women.

*4.2 Variables and definitions*

4.2.1 Dependent variable

The first stage of the analysis is based on testing of a binary dependent variable that takes on the value 1 if a woman currently uses a modern method of contraception and 0 if otherwise, and does thus not distinguish between using a traditional method and being a non-user. As has been discussed, male condoms are problematic in the context, being the only contraceptive method that also provides protection against sexually transmitted diseases (STDs). If condom use for protection against infection is driven by different factors than condom use for avoiding pregnancy, results from models that make no distinction beyond modern and traditional methods are going to be biased. To address this risk the independent variable in the second stage of the analysis is multinomial, where women currently using condom form a separate third category. An additional motivation for distinguishing between use of condom and use of hormonal methods is that there is a gap in effectiveness between the two. The contraceptive methods that women report to be using and their classification into modern and traditional methods are presented in Table 1. The table also reports the World Health Organization's estimates of risk of unintended pregnancy, assuming "typical use" of the method rather than perfect use (WHO, 2004). The least effective hormonal method is the birth control pill, which with an eight per cent risk of unintended pregnancy still carries only about half the risk associated with condom use. While recognizing the crucial role of condom as contraceptive method in casual sexual relations, many unwanted pregnancies resulting from intercourse between healthy long-term partners could be avoided by adoption of hormonal contraceptive methods.

Table 1 about here

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[3] Using six months as the threshold for sexual relations appears reasonable given that a woman who travels for seasonal work or whose husband does, could still be considered sexually active although abstaining for such a period.

Between 1996 and 2007 the share of women reporting to be non-users decreased by about 20 percentage points, while use of hormonal methods increased by approximately the same. Condom use also increased slightly.

### 4.2.2 Community-level variables

The main explanatory variable is community-level education. Education can be operationalized in several ways and the method must be chosen based on theoretical and practical judgment depending on purpose. Community-level education is operationalized as a continuous variable indicating average years of schooling in the community. This method is beneficial since it permits distinction between communities that have very similar attainment, but also has a drawback in that is assumes that the relationship between community-level education and use of modern contraceptives is linear. To account for the possibility of a non-linear association community-level education will also be tested as a categorical variable. The average community-level education has increased by one year between 1996 and 2007, from 5.45 years to 6.45.

To reduce the risk of misestimating the true level of educational attainment within clusters, clusters containing ten or fewer observations were removed, which meant dropping 41 clusters and 333 observations. The choice of a minimum of eleven observations per cluster was made by examining standard deviations of the cluster education averages, which showed that for clusters with ten observations or less the standard deviations frequently exceeded six months of education. Because it is uncertain whether the variation stems from large true education differentials within the cluster or from outliers being randomly selected into the clusters causing an over- or underestimation of the average, these clusters were removed. It could be argued that such outliers and their network partners are of particular interest to this study, because they constitute examples of the influence of heterophily on innovative behavior. There are however other cases of large variation within clusters that carry lower risk of misestimating the true community average.

The variable is calculated for each woman individually by taking the average number of years of schooling of all other women in the community, where community is proxied by survey cluster. Not including the woman's own schooling in the average is appropriate because our interest lies in the character of her surroundings. An example of the importance of this distinction is a rural village where the female population has very little schooling, but where there also is a trained schoolteacher living in the community. The women in the community may benefit from the teacher's high level of education via social interaction. In contrast, any benefit the teacher herself may have from those same

years of schooling (i.e. her own education) is not incurred through the network, as it is for women around her, but via her personal characteristics. Thus, while the schoolteacher's presence raises the average education in the village, the network surrounding the schoolteacher remains characterized by a low level of education. Moreover, as individual education enters the model as a separate variable, including it in the community average would cause multicollinearity.

For the purpose of retaining as much information as possible about education at the community level, this variable was created before any restrictions to the sample were made. Removing observations from the dataset before creating the community-level education variable may introduce a bias, if the observations removed are not random with respect to education. If, for instance, women who are removed from the estimation sample because they have no knowledge of a modern method of contraception, on average have lower education than women who do have this knowledge, the community average education will be higher when these women are not included.

Women who live in communities where use of contraceptive methods is more common are likely to have higher propensity for adopting contraception themselves, irrespective of the educational situation. A variable measuring community-level ever-use of modern contraceptive methods was therefore constructed, taking on a value between 0 and 1 representing the share of other women in the community who have ever used a modern method of contraception. This indicator has changed from about 31 per cent in 1996 to 53 per cent in 2007. The reason for selecting ever-use and not current use is that current use may be influenced by the distribution of women in the cluster over for example age and parity, or at what particular point in time data was collected. If at the time of the survey many women in a community happen to be older and at high parities they may be more likely to be current users, compared to an otherwise identical community where women are young and at low parities. Community ever-use should be less biased by such distributional effects. The variable is created before sample restrictions were made.

A variable equal to the standard deviation of individual schooling in the cluster is created to test whether variation in education among community members matters for their likelihood of being users of modern contraception. The cluster variation will be a proxy for community homophily versus community heterophily in the analysis. Table 2 reports minimum and maximum values of the variation for each survey wave, with less variation in the second survey wave.

Community HIV prevalence is proxied by the share of sampled individuals that test positively for a HIV infection. As mentioned, the sample of individuals constituting the base for this variable is not the same as the base sample for other community-level variables. 15 per cent of the tests came out positive for HIV, which is close to the peak level estimated for the period around year 2000.

The railroad traversing Zambia from the south to the northeast constitutes an important mode of transportation. Most gainful economic activities, especially in the modern urban sector, are concentrated near the rail line, and provinces located along its way enjoy better access to health services (CSO, 2012; AfDB, 2006). Other variables control for wealth and distance to health facilities, but it can be conjectured that the rail line transports information as well as people and commodities, and thus that people living near the rail may be subjected to innovations earlier than those who live elsewhere. Among the demographic variables is therefore an indicator of whether an individual lives in a province that is traversed by the rail line.

Table 2 about here

4.2.3 Individual-level variables

The greatest share of individuals in both waves have completed primary education and the main difference over the time period has been an upward shift in the distribution so that a smaller share has no education and a larger has completed secondary or higher education in 2007 than in 1996.

Interesting differences between the survey waves include a substantially lower share of women reporting that they want to have another child within two years in 2007; about 25 per cent compared to just over 43 per cent in 1996. Not wanting to have another child soon ought to constitute a strong positive influence on use of contraception and is thus likely to account for an important share of the increase in use that women report.

An integral part of a woman's surroundings is of course her partner, whose influence over contraceptive use is likely to be considerable. Educational attainment of the husband is therefore included as part of the socioeconomic variables. Husband's occupation was also tested but found insignificant and was therefore not included in the final models. Other noteworthy variables that have been excluded after regression results revealed insignificant relationships with the dependent variable are religion and age at first marriage. Marriage patterns constitute a very important proximate factor of fertility and a possible cause for the insignificance of results is that the average age at marriage has

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risen only by about six months between the waves. The largest religious groups by far are Catholics and Protestants (together over 98 per cent of the sample) and no correlation whatsoever is found between religious affiliation and contraceptive use (a Pearson's *r* of -0.008).

*4.3 Analytical strategy*

Our research question is concerned with the relationship between two variables that are changing over time. Looking at how the variables have changed over time in relation to each other should therefore provide a more accurate picture of their association. Using two survey waves collected in the same country a decade apart provides a time dimension to the analysis, but is not enough to draw causal inference. The comparison across survey waves will however illustrate how the association between the variables has changed and whether they appear to be changing in a certain direction.

Models are tested in two stages using binary and multinomial multivariate logistic regression techniques that model the log odds of the outcome, contraceptive use, as a linear combination of the predictor variables. In other words, it models the probability of a positive outcome. The first stage regresses a dichotomous dependent variable of current use of a modern contraceptive method on the predictor and control variables for the two survey waves separately. In the second stage I will fit a multinomial logistic model, where a third category of the outcome variable will separate the category of users of modern methods into two, distinguishing women who report use of condom from those using a hormonal method of contraception. The second stage is designed to test whether different predictors drive use of these two types of methods (condom and hormonal), leading to deceptive results from the binary regression. By comparing the regression output from the two stages it should be possible to identify whether modern methods of contraception can be treated as one group, or if the two types of methods have dissimilar relationships with education and other regressors. Regression results are presented as odds ratios.[4]

Equations (2) and (3) in Section 4 suggest that total education may be a sum or a product of individual-level and community-level education. If the true relationship is represented by equation (3), it is necessary to consider in the analysis that community-level education has different

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[4] Odds ratios represent the odds of an outcome occurring given a particular exposure, compared to the odds of that the outcome will occur in absence of that exposure. An odds ratio equal to 1 tells us that the odds of an outcome does not change with exposure to a predictor, an odds ratio <1 tells us that the odds of the outcome is lower in case of exposure compared to no exposure, and odds ratio >1 means that exposure increases the odds of the outcome occurring compared to no exposure.

importance at different levels of individual education. This possibility will be addressed with interaction effects. Interaction effects will identify whether women with more schooling benefit more from community-level education, in terms of higher odds of being users, than women with less schooling do from the same amount of community-level education.

All estimation is conducted in a stepwise manner, which permits looking at the effect each additional predictor has on the estimates from the previous step.

## 5. Results

### 5.1 Binary logistic regression results

In the first stage of analysis the model of the individual woman's current use of a modern method of contraception rather than no method or a traditional method is estimated in a stepwise manner for the waves 1996 and 2007 respectively. Results are presented by wave in Tables 3 and 4.

Models A.1 and B.1 regress current use of modern contraception on individual level education as the only predictor and it is clear that the association is substantial and significant in the basic model. The odds of a woman with completed primary education being a user of a modern method are about 60 per cent (0.361) higher than those of a woman who has some education in 1996, and about 40 per cent higher in 2007 (0.589). The difference in odds between one educational category and the next are larger at higher levels of education, but more so in 1996 than in 2007. The inclusion of community-level education in Models A.2 and B.2 changes the importance of individual education appreciably and especially so in the first wave. The 1996 community-level education estimate says that each additional year of community-level education is associated with an increase in the individual woman's odds of being a user compared to a non-user of over 24 per cent, and is only marginally lower in 2007. Both estimates are significant at the one per cent level. The categorical representation of community education in models A.3 and B.3 addresses the possibility that community-level education is not linearly related to use of modern contraception. The two top categories in 1996 indicate that the relationship is strengthened at higher levels of community-level education, but such a pattern is less clear in 2007. Significance levels are stronger at higher levels, but the increase is linear.

It becomes obvious in Models A.4 and B.4 that the association between community ever-use of modern contraception and current individual use is strong; the odds of being a user are 32 per cent higher for every ten per cent increase in community ever-use in 1996, and 26 per cent higher in 2007.

Interestingly, comparing with models A–B.3, the inclusion of community ever-use strengthens the magnitude and significance of individual-level education odds ratios. Models A.5 and B.5 show that community-level education and community ever-use are robust to "each other"; they remain significant at the one per cent level both in the first and the second survey wave.

In the following step the results begin to differ more between the waves. Both magnitude and significance of the first wave estimates for contextual education is sensitive to the inclusion of control variables in Model A.6, especially household wealth influences the result. Also community-level ever-use loses statistical significance. In contrast, Model B.6 shows that the estimates of community-level education as well as community ever-use are robust to control variables. Socioeconomic characteristics and in particular wealth modify the odds of being a user somewhat, but the significance level of results remains unchanged. Individual-level education on the other hand changes in the opposite direction between the waves; in Model A.6 control variables alter neither the magnitude nor the significance of the relationship between contraceptive use and schooling, while in Model B.6 individual schooling is no longer significant at the ten per cent level. Models A–B.7 are identical to Models A–B.6 but allow community-level education to behave in a non-linear way (compare with Models A–B.3). Whereas community-level education in Model A.6 is insignificant, some significance remains at the higher levels of community education in Model A.7. Especially noteworthy is the category consisting of communities with an average community education of six to seven years, which is the level indicating completed primary education. Women living in such a community have odds of being users of modern methods that are nearly doubled and this is significant at the five per cent level. There is no such clear result in 2007.

Models A–B.8 test the hypothesis that variation in the educational attainment among community members matters for the uptake of modern contraception. The positive odds ratios in both survey waves suggest that if anything, greater variation in education is associated with higher odds of being users, but results are not significant even at the 15 per cent level.

The first stage of the analysis is concluded by Model B.9 of Table 4. This model tests whether HIV prevalence in the community is related to contraceptive use, but no such connection that is statistically significant is discovered.

Although it is clear that the magnitude of the coefficients of individual level education are greatly reduced by the inclusion of community-level education, the possibility that the schooling of the

individual simply captures the association between community-level education and contraceptive use must be considered. If this were the case, the inclusion of the community variable is pointless, because the basic model has already described the full relationship between education and contraceptive use. To test whether this is true, we estimate predicted probabilities of being a user of modern contraception at education levels observed in the African country that currently has the highest literacy in Sub-Saharan Africa: Zimbabwe. The Zimbabwean educational distribution is captured in the form of weights equal to the proportion of women in each of the four educational categories. The community-level education differentials between the two countries were estimated over urban and rural areas, and a new fictitious community-level education was created for Zambia to these higher levels (from on average 5.1 to 8.2 years in rural communities and from on average 8.1 to 10.2 years in urban). The test is only intended to warrant the inclusion of community education in the models by separating individual educational attainment from community-levels.

When community education is excluded, the predicted education-specific probability of being a user of modern contraception in the 2007 survey wave is 0.30, 0.38, 0.51, and 0.61 for the four education categories (beginning with no education), which gives an average of 0.45. Still excluding community average but applying the educational distribution for Zimbabwe, the simulated average probability of being a user is five per cent higher, that is a probability of 0.50. When including the community-level education with the original Zambian distribution the average probability is naturally nearly identical to the base line probability, 0.45. Keeping the community average and simulating new probabilities again applying the Zimbabwe distribution as weights, again results in an average probability of being a user that is five per cent higher. Finally, using the fictitious community-level education based on Zimbabwean communities with the Zimbabwean educational distribution on Zambian data simulates educational category specific probabilities of 0.39, 0.49, 0.62, and 0.71, which with the Zimbabwean distribution gives an average probability of use of 0.60. This test simulates that if individual-level education in Zambia was to increase so that women were distributed across educational categories as Zimbabwean women are, without the simultaneous increase in community-level education, average use of modern contraception would increase from 45 to 50 per cent. But when the community average education of Zambia is replaced with that of Zimbabwe, probability of use is predicted to be an additional ten per cent higher, which indicates that it is indeed insufficient to only include individual education to capture the full effect of education.

*5.2 Multinomial logistic regression results*

The second stage of analysis is based on multinomial logistic regressions results where condom use is distinguished from other modern method of contraception so that the dependent variable is categorical with three possible outcomes; non-use or use of traditional methods, use of condom, or use of a modern and hormonal method. The results are presented in Table 5 for the 1996 survey wave and in Table 6 for the 2007 survey wave.

The strong association between individual-level education and modern methods of contraception in A–B.1 of course remains in C–D.1. The 1996 results are driven mainly by use of hormonal methods, while in 2007 condom use has the greater magnitude. Having completed primary education is strongly and positively connected to being a user of hormonal methods all the way through Models C.1–8, and the odds ratio scarcely changes at all. At the inclusion of community-level education in Model C.2 the statistical significance between women having incomplete primary education and condom use, compared to women with complete primary, disappears and remains absent throughout the estimation. At the highest level of educational attainment significance reappears, but it should be noted here that the proportion of women belonging to this group is small.

Tables 3 and 4 about here

Results for individual-level education in the second survey wave similarly demonstrate that the distinction between modern and traditional methods in the first stage provide insufficient information, though less clearly than in the first wave. The magnitude as well as the significance of individual-level education decreases when community-level education is added in Model D.2 (odds ratios become closer to 1). Individual-level education is sensitive to the inclusion of socioeconomic control variables in Model D.6, but while some marginal significance remained in the first stage (Model B.6) that is absorbed by the separation of methods in the second stage.

Community-level education is added in Models C–D.2 and show that use of both condom and of hormonal methods have positive associations with community level education. One more year of average education among other women in the community in 1996 is related to odds of being a user of modern methods that are 25 per cent higher (1.246). The significance of the association disappears however in subsequent steps; condom use is sensitive to community ever-use (Model C.5) and hormonal method use to socioeconomic characteristics (Model C.6). In 2007 the association with condom use is slightly stronger than with use of hormonal methods (1.257 compared to 1.223). The relationship between community-level education and condom use continues to be somewhat stronger

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than for use of hormonal throughout the stepwise estimation, but both remain significant at the one per cent level. The categorical community-education variable in Model C–D.3 tests for non-linearity in the relationship with contraceptive use. Model C.3 shows that in 1996, the relationship between community-education and use of hormonal methods is steeper than for condom use, and is more significant. This cannot be seen by looking at the continuous representation in Model C.2. A similar situation is discovered for 2007 in Model D.3. Odds of use of hormonal methods increase more steadily with community-level education than odds of condom use, and significance is much greater. Compared to the first wave however, the increase is less steep.

The distinction between condom and hormonal methods shows that the marginal significance of ever-use in the first stage of the analysis in 1996 (Models A.4–8) is driven entirely by association with condom use. A ten per cent higher community-level of ever-use of a modern method of contraception, is related to odds of a woman using a condom that are over 42 per cent greater (Model C.6). The odds of being a user of a hormonal method on the other hand do not change at all with community ever-use. In the second survey wave this has changed; hormonal methods and condom have similar relationships with ever-use throughout the testing (Table 6).

The categorical community-level education estimates (Models C–D.7) reveal interesting results for both survey waves. The primary schooling level (6 – 7 years) appeared important in Model A.7 and this pattern is the same in Model C.7, but now specifically for hormonal methods of contraception. Women in communities in this group have odds of use that are the greatest among all categories (2.075) and significant at the five per cent level. As earlier, the continuous representation of community-level education (Model C.6) hides this interesting finding. The 2007 survey wave shows that odds of condom use are greater where the level of community education is higher, but for hormonal methods there are almost no significant differences between the categories. It appears the continuous specification is sufficient to describe the relationship in the case of hormonal methods.

The separation of modern methods into condom and hormonal reveals that variation around the mean of individual-level education in a community in fact is related to contraceptive use. In contrast to Model A.8, Model C.8 shows that variation matters; if the variation (measured as the standard deviation of the mean years of schooling) is larger by one year, the odds of a woman being a user of hormonal methods is about 37 per cent higher, while her odds of being a condom user are 34 per cent lower. The results are significant at the one and five per cent levels, respectively. This interesting relationship has, however, disappeared by the second survey wave (Model D.8).

The community prevalence of HIV is included in Model D.9. The high odds ratio of 5.689 indicates that there is some positive relationship between HIV prevalence and condom use, although not significant at the ten per cent level (p-value 0.154). HIV prevalence has no connection with use of hormonal methods according to these results.

Tables 5 and 6 about here

*5.3 Sensitivity analysis*

Data that is collected in surveys such as the Demographic and Health Surveys have certain characteristics that must be accounted for in an analysis to ensure that estimates are robust. The reason is that the design of the survey and procedure of data collection differs from collection of other types of data, because the survey is conducted with specific intentions and requirements. Sampling is random but not with equal probability for all cases, either by design, because of different response rates or because a certain number of observations is required for inference, or by chance. To adjust for the differences in probability of selection and get standard errors right, sample weights, clustering, and stratification of the survey are considered in the analysis. If this is not done estimated standard errors are likely to be smaller than they should.

The expectation underlying the separation of modern and traditional methods of contraception is that education increases a woman's propensity to use modern methods, beyond any effect that education has on the use of *any* type of method. Results from binary logistic regressions show that the association between community-level education and being a user of any method are smaller than when traditional methods are classified as "non-use". Results from a multinomial logistic regression of the likelihood of being a non-user, a user of a traditional method, or a user of a modern method are also in line with expectations. The odds of being a user of a traditional method are negatively associated with community-level education, compared to being a user of a modern method.

A number of alternative specifications of the main predictor, community-level education, were tested to ensure it robustness (results not shown). The potential influence of outliers in the data was reduced by omitting highest and lowest values of individual-level education (as well as the two and three highest and lowest) in the construction of the variable. Aside from some attenuation of the estimated odds ratios, the results are not sensitive to outlier values.

*5.4 Limitations*

It may be that impacts of community-level education are overestimations if the formation of communities is not random. Interview responses suggest that people are homophils in their choice of network partners and choose to interact with people who are similar to themselves, or that they choose partners strategically if they seek support for a specific behavior. It follows that network partners may have similar propensities ceteris paribus of being users, as well as a similar educational attainment, which could cause the effect of social networks to be overestimated (Behrman et al., 2002). This is unlikely to be problematic in this study however where the level of analysis is the community. Communities are larger entities than social networks and the power the individual woman has to choose community members is limited to her influence over her place of residence and probably negligible. It may be argued that a community is too large an entity to be a good proxy for social network, but because of the just mentioned risk of non-random network formation it may in fact be a favorable alternative. Although a woman does not interact with all other women in the community, it is reasonable to think that networks are connected in a way that unites the community.

This study focuses on education of and social interaction between women, an intra-gender comparison, but it should be noted that husbands play a material role in decisions concerning fertility and contraceptive use. Husbands' education has been accounted for in this study as a socioeconomic characteristic of the household, but can also be thought of as applying a gender perspective in the sense that it places a wife's education in relation to her husband's. There are of course numerous other partner characteristics that are omitted when we study wives only, not least the social network of the husband where diffusion of information and ideas also takes place (Behrman et al., 2002). An interesting approach related to this would be to apply a household bargaining model on the topic of education and contraception, where the relative bargaining power of spouses determines the solution to the bargaining problem (Manser & Brown, 1980). The woman's education could readily be incorporated as a determinant of her bargaining power and thus of her threat point. Although other factors may be at play, it is likely that a woman who has knowledge of and desire to control fertility is more likely to do so, and I therefore limit myself to studying women's characteristics.

We acknowledge the limitation with modelling survey data. Calculating the coefficient of determination, or a pseudo-R2 when fitting a maximum likelihood logit model, is not possible because the stratifying and clustering of the data means that the observations are not independently and identically distributed, which is an assumption when the pseudo-R2 is computed. An alternative for assessing goodness-of-fit in the case of design-based models is a Hosmer-Lemeshow F-adjusted

mean residual test. This tool is used throughout the estimation process in this study, but not without reservation due to the ambiguity of test results. In addition to the Hosmer-Lemeshow test that sometimes has low power, a specification link test that regresses the dependent variable on its predicted value and the prediction squared is used.

## 6. Discussion

A first conclusion is that the association between individual-level education and use of modern contraception remains positive and significant throughout the analysis, which is in accordance with our first hypothesis. Women who have higher educational attainment are more likely to be using modern methods of contraception.

There is also evidence in favor of the second hypothesis; when community-level education is included in the model, the size of the association between individual schooling and use of modern contraception diminishes considerably both in 1996 and 2007. The simulation of contraceptive use in Zambia using the Zimbabwean educational distribution and community-level average in section 7.1 likewise supports that education is important above and beyond the schooling of the individual. However, what appears to have happened over the period between the two surveys waves is that the association between individual-level education and women's use of modern methods of contraception has become weaker, whereas community-level education has become more strongly related to use.

In line with our third hypothesis, contextual education increases in importance as it reaches higher levels. There was a general upward shift in the entire educational distribution in Zambia in the period studied. The macro-indicators of education in Zambia presented in section 5.1 describe a steady increase in the share of women with completed primary education (approximately eleven percentage points between 1995 and 2010) and the share of women with no education in the 2007 sample is about four percentage points smaller than in 1996. Figure 2 plots simulated contraceptive use at increasing levels of community-level education while all other variables including individual schooling remain unchanged, similar to the test exploiting Zimbabwean levels of education. It is clear that the 2007 simulated relationship is steeper than that for 1996 indicating that Zambian women are not only more likely to be using modern contraception at every level of community education, but that they also have a higher marginal benefit from an increase. The econometric analysis provides some evidence in favor of the hypothesis 3 when it comes to hormonal methods of contraception. Although the relationship does appear to be linear, the association becomes more significant at higher levels of community-level education (Models C–D.3). Kravdal (2002) made a similar finding when

looking at the effects of average educational level in a village on women's birth rates; the odds of having a birth decreased in a linear way as average education increased, but the significance was greater at higher levels of average education (and greater for higher-order births). The steeper increase in 1996 compared to 2007 could be interpreted as a consequence of the overall increase in average education over this period. Think of it like this: as more communities gather at the higher levels of average education, the spread of other characteristics related to high use becomes greater in these high-level groups. Whereas a high level of community-education was more strongly connected to wealth and place of residence in 1996, this changed when several poor communities in rural areas had reached this high level in 2007. Wealth and place of residence are related both to use of contraception and to education, and there are other factors like that, many of which are difficult to capture in an econometric model. Examples of such factors are women's autonomy, cultural practices and social norms, etcetera, and these are aspects of society that all else equal influence choices regarding family planning. As national educational provision becomes broader, communities with traditional values begin to be represented among the highly educated, but if their traditions are not obliterated they will still be less likely to adopt modern methods of contraception in comparison with more progressive communities. Such a development would attenuate the estimated effect of community-level education. Yet another possibility is that the general increase in women's education has impacted society more broadly. As women on the whole acquire higher education they may become increasingly involved in politics and civic life, as well as more often seen in business relations, media, and other power positions. When women's participation in society increases they become more influential in setting the political agenda and could steer political discussions and decisions in new directions more favorable for women or that women often are parties to (Chattopadhyay & Duflo, 2004). Women may for instance promote improved provision of family planning information and services. When women are visible in power positions they can have a potent impact simply as examples for other women as well as for men of that women have the same capabilities as men, with potential implications for household decisions in the long run. Having said this, however real these effects are they occur over time and may not be important in a rural developing setting with limited connections to urban political spheres. If existent, the effects would work at the local level only, where the number of power positions is likely to be limited and therefore more unattainable. Another possible explanation for this finding is that the increase in individual-level education between 1996 and 2007 has made more women receptive to the new information and ideas that are circulating in their network. As mentioned, the entire educational distribution has shifted to the right between 1996 and 2007, and Table 2 reports that the foremost change has been a

growth in the top category (from 3.5 to 10.5 per cent). This is indicative of a stronger association between contraceptive use and community-level education at higher levels of individual schooling.

Figure 2 about here

The expectation that a woman's propensity to adopt modern contraception is greater if a large share of other women in her community have used a modern method at some time in their lives is only partly met. The association is clear in 2007, but the 1996 results are ambiguous. The distinction between use of condoms and hormonal methods shows that what appeared as an insignificant relationship in the first stage of the analysis (Table 3), in fact is a large difference that becomes visible when the category is split. In communities where rate of adoption has been higher, a woman is more likely to be using condoms as contraceptive method, but her probability of using a hormonal method is unaffected. This is contrary to expectations. By 2007 this has changed and use of both condoms and hormonal methods is more common in communities where previous use has been higher. It thus seems as if women in 2007 took the experience of others into consideration when they made decisions regarding contraception to a greater extent than women did in 1996. There is a possibility, albeit small, that the results are a consequence of the fairly small share of condom users in the sample, just over five per cent that can have caused a bias in the estimate. Another possibility is that because the 1996 DHS coincided with a peak in the HIV/AIDS prevalence, condom use would have been strongly advocated at family planning clinics. Communities with high ever-use are likely to be among those that have had better access to family planning services. If women in these communities also were more likely to be reached by such campaigns, they should have had a higher probability to adopt use of condom.

The variation in educational attainment within a community has proven interesting in this study, as hypothesized. While the level of education and the general rate of adoption of modern contraception in a community have become more important between the first and the second survey waves, diversity in years of schooling has become less important. The degree of variation in years of schooling can be interpreted as a measure of how similar community members are to each other; what Rogers (1973) refers to as the degree of homophily in a social network (see section 3.3). The result for 1996 is that in heterophilous communities, communities where members are more different from each other, women are more likely to be users of modern contraception. In 2007 neither heterophily nor homophily appear to be of consequence for use. Table 2 reports that the variation is a little lower in 2007 than in 1996, both the smallest and the largest values have become lower, but the

difference does not appear large enough to have caused such a change of results. One interpretation of this finding is that variation in schooling is not a good measurement of homophily-heterophily in the sample. Education is commonly thought of as a major factor of social stratification, but the measure would become sharper if other factors could be considered. Another possibility is that variation no longer matters when use of contraception has reached some threshold because the information and experience has diffused to all networks, also those where ever-use and variation is lowest. A third possibility is that there are social boundaries in societies that are impermeable to diffusion (Kohler, 1997). It is not sufficient to convince people on one side of the boundary of the benefits of modern contraceptive methods and expect that by diffusion people on the other side will adopt these methods. Such a boundary may exist between religious groups, which are not believed to be an issue in this population, but if another boundary is at work separating users from non-users, that could explain why heterophily no longer matters.

The sixth hypothesis addresses the possibility that the HIV/AIDS epidemic complicates the analysis of contraceptive use in Zambia. The separation of the modern methods category into male condom and hormonal methods allows for any differences in the relationships between predictors and these methods to become visible, and the results confirm that relationships indeed do differ. As was expected, the odds of being a user of condoms compared to no method increase more with community-level education than the odds of being a user of hormonal methods (see Model D.6). It is possible that this is related to the higher prevalence of HIV and provision of reproductive health services, as well as higher community-level education, in urban areas. The categorical definition of community-level education similarly shows that the trajectories of the estimates are not the same for condoms and hormonal methods. An interesting observation is the unmistakable upward change in odds ratios of use of hormonal methods in communities that have aggregate education levels above six years, which is primary schooling level. The shift is most clearly observable in 1996 and far less apparent for condom use. There is also a marked difference between the hormonal methods and condoms when looking at the association with community ever-use, and very clearly so for community variation in schooling (Model C.8). Taken together, these findings support the hypothesis that condoms and hormonal methods of contraception ought not to be treated as one group. The extent to which this is an effect of the HIV epidemic or not is however a matter that requires further research. The measure of community-level HIV tested in Model D.9 gives an indication of differences in odds of condoms use between communities with different HIV prevalence. Noteworthy here is that controlling for the disease environment does not alter the significance or the odds ratio of community level education, indicating that education remains important for use in areas that are more

as well as less affected by the epidemic. The measure employed in this study is however an approximation of cluster HIV/AIDS prevalence and is likely to have some drawbacks. For instance, as was described above, the sample on which the HIV measure is based is to some degree different from the main sample. This does not necessarily result in a bias, but the true cluster HIV/AIDS prevalence would naturally have provided more dependable results.

7. Conclusion

This study examined the association between women's education and their adoption of modern contraceptive methods, investigating the potential influence of externalities of education on other women in a social network. The study used DHS data from Zambia collected at two points in time, which has given a time dimension to the study and allowed for comparison of changes that have occurred over time. Zambia is a country that has been hit hard by the HIV/AIDS epidemic and an additional purpose of the study has been to incorporate the epidemic in the analysis because of expectations of an association between risk of infection and contraceptive use.

We cannot assume that individuals make decisions in social isolation. Even when we are free to make decisions, the choices we make are conditional upon our ability to imagine alternative circumstances, on the knowledge we possess or can gather about our alternatives, and the availability of tools needed to achieve our goals. In our social networks we are steered by formal and informal institutions as well as by the people who share our reality. They are channels through which knowledge, ideas, and attitudes are diffused in a population, and can shift, alter or introduce norms and practices. This study has found that a woman's education is not associated only with her propensity to use contraception, but also with the contraceptive use of other women in the community. This indicates that the dissemination of knowledge and attitudes within a community is substantial, and that the value of education in shaping reproductive behavior goes beyond what we can see at the individual level. This has implications for decisions concerning the provision of education in high fertility countries and suggests that the returns to education are higher than previously thought. It was also found that the association between contraceptive use and community effects of education has increased in importance over time, suggesting that contraceptive use may increase exponentially with the share of the educated female population for some time to come. This study has furthermore found that if modern methods of contraception are treated as one uniform group in analyses there is a risk of misinterpreting estimated associations. The serious HIV/AIDS epidemic in Zambia has increased the risk of infection as well as the promotion of methods for protection against infection, such as condoms. These factors could make the breakdown of method categories even more essential than in

an analysis of a less affected setting. When it comes to judging the size of the influence of the disease environment on contraceptive use, this study has but scratched the surface.

In these concluding remarks we wish to make a note on the potential risks over overestimating the causality between mass schooling and development. The international development and research communities have over a number of decades advocated universal and compulsory education as a means toward global economic, social, and political goals; the second of the Millennium Development Goals is a manifestation of this campaign. But there are voices cautioning against relying too heavily on mass education for attaining these goals. Basu (2010) argues that channels mediating the positive and probably causal relationships between education and development indicators must be better understood. It has often been assumed that education operates on development indicators, such as lower birth rates, through cognitive improvement and personal empowerment, while other channels are sidelined. Furthermore, despite extensive investments in education impacts are not entirely established. Education is a human right that is important as such as well as positive for development through multiple channels, but the past decades have shown that the impact of education differs across settings. For that reason it is necessary to complicate the prescription of increased provision of education in order to maximize its effects on development.

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Figure 1. Contraceptive intensity and costs of contraception and birth.



a.

b.
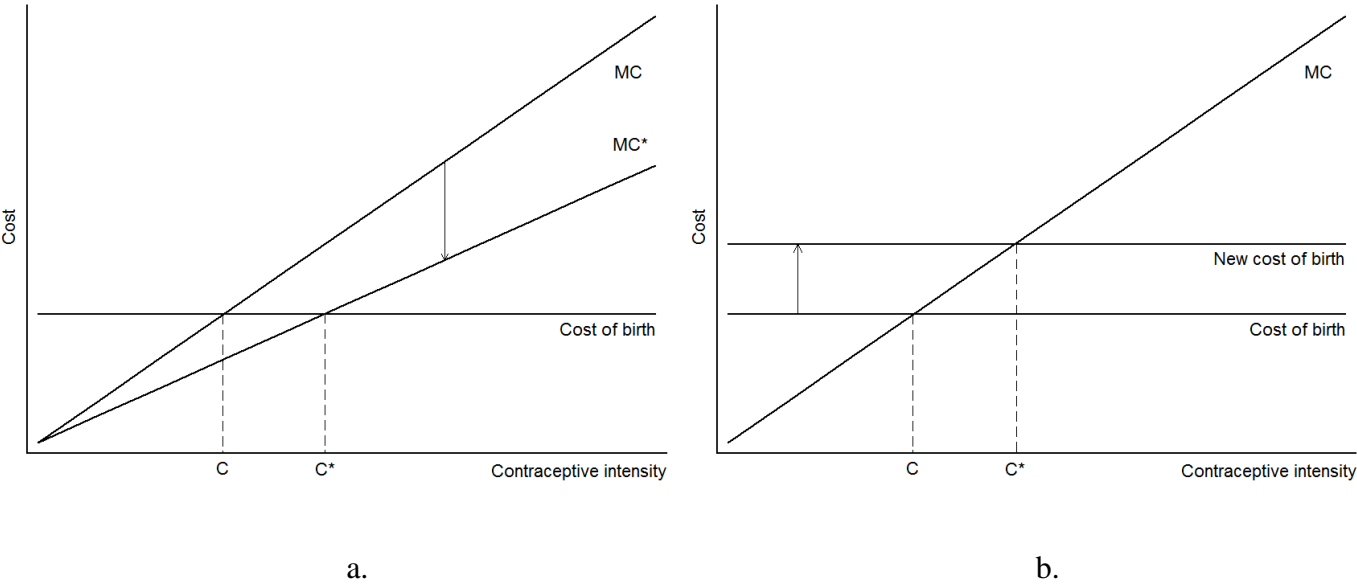
Source: Adapted from Levine 2007.

Figure 2. Simulated contraceptive use at increasing levels of community-level education, 1996 and 2007.
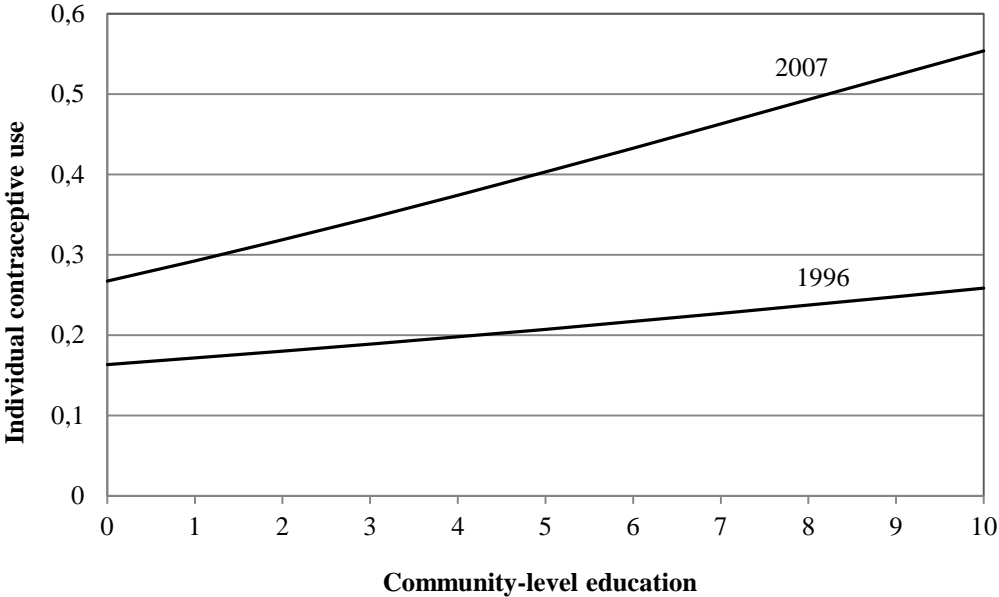
Table 1. Classification of contraceptive methods and their effectiveness.

| Modern methods | Other methods |
| --- | --- |
| Pill (8%) | Female condom (21%) |
| Intrauterine device (IUD) (0.1%-0.8%) | Diaphragm (16%) |
| Injectables (3%) | Periodic abstinence (25%) |
| Implants (.05%) | Withdrawal (27%) |
| Male condom (15%) | Spermicides (29%) |
| | Lactational amenorrhoea method (LAM) |
| | Other methods (herbs, strings, etc.) |

Note: Risk of unintended pregnancy in parentheses.

Source: Own computations from Zambia Demographic and Health Surveys (CSO, et al., 1997; CSO, et al., 2009).

Table 2. Summary statistics of sample distribution across variables (standard deviations).

| | | 1996 | | 2007 | |
|---|---|---|---|---|---|
| **The dependent variable** | Use of contraceptive methods | | | | |
| | Non-user | 0.634 | | 0.433 | |
| | User of ineffective method | 0.128 | | 0.120 | |
| | User of condom | 0.053 | | 0.072 | |
| | User of hormonal method | 0.184 | | 0.375 | |
| **Community-level variables** | Community-level education (mean) | 5.46 | (0.048) | 6.46 | (0.049) |
| | Community-level education, categorical | | | | |
| | Less than 3 years | 0.112 | | 0.048 | |
| | 3 - 4 | 0.130 | | 0.088 | |
| | 4 – 5 (r) | 0.137 | | 0.147 | |
| | 5 - 6 | 0.172 | | 0.148 | |
| | 6 - 7 | 0.174 | | 0.195 | |
| | 7 - 8 | 0.131 | | 0.164 | |
| | 8 - 9 | 0.065 | | 0.066 | |
| | 9 - 10 | 0.038 | | 0.084 | |
| | 10 or more | 0.041 | | 0.060 | |
| | Variation around the mean of education | [1.405 ; 4.770] | | [0.938 ; 4.463] | |
| | Community-level ever-use of modern methods | 0.307 | (0.004) | 0.527 | (0.004) |
| | Community-level HIV prevalence | n/a | | 0.150 | (0.002) |
| | Living in urban areas | 0.460 | | 0.433 | |
| | Rail line province | 0.687 | | 0.687 | |
| **Individual-level variables** | Individual-level education | | | | |
| | No education | 0.139 | | 0.105 | |
| | Incomplete primary | 0.366 | | 0.372 | |
| | Completed primary (r) | 0.459 | | 0.418 | |
| | Completed secondary/higher | 0.035 | | 0.105 | |
| | Age | | | | |
| | 15-24 | 0.316 | | 0.246 | |
| | 25-34 | 0.386 | | 0.427 | |
| | 35-49 | 0.299 | | 0.328 | |
| | Wealth quintile | | | | |
| | Poorest | 0.218 | | 0.167 | |
| | Poorer | 0.136 | | 0.169 | |
| | Middle | 0.172 | | 0.178 | |
| | Richer | 0.243 | | 0.238 | |
| | Richest | 0.232 | | 0.247 | |
| | Living Children | | | | |
| | 2 or less | 0.469 | | 0.416 | |
| | 3 – 5 | 0.333 | | 0.402 | |
| | 6 or more | 0.198 | | 0.182 | |
| | Has health facility nearby | n/a | | 0.592 | |
| | Woman's occupation | | | | |
| | Does not work | 0.481 | | 0.372 | |
| | Agriculture | 0.170 | | 0.294 | |
| | Other | 0.349 | | 0.333 | |
| | Husband's education | | | | |
| | No education | 0.064 | | 0.050 | |
| | Some education | 0.420 | | 0.450 | |
| | Completed primary | 0.423 | | 0.401 | |
| | Completed secondary/higher | 0.093 | | 0.130 | |
| | Wants another child within 2 years | 0.433 | | 0.246 | |
| **Observations** | | 1,997 | | 1,996 | |

Table 3. Results of binary logistic regression of current use of modern method of contraception on individual- and community-level education in 1996 presented as odds ratios.

| | Model A.1 | Model A.2 | Model A.3 | Model A.4 | Model A.5 | Model A.6 | Model A.7 | Model A.8 |
|---|---|---|---|---|---|---|---|---|
| Individual-level education | | | | | | | | |
| No education | 0.215** | 0.358** | 0.366** | 0.294** | 0.349** | 0.407** | 0.416** | 0.394** |
| | (0.049) | (0.084) | (0.085) | (0.067) | (0.081) | (0.108) | (0.110) | (0.103) |
| Incomplete primary | 0.361** | 0.519** | 0.519** | 0.478** | 0.530** | 0.551** | 0.544** | 0.544** |
| | (0.049) | (0.073) | (0.073) | (0.068) | (0.076) | (0.090) | (0.089) | (0.089) |
| Complete secondary/higher | 4.300** | 2.784** | 2.917** | 3.282** | 2.829** | 3.250** | 3.317** | 3.054** |
| | (1.149) | (0.868) | (0.879) | (0.954) | (0.876) | (1.131) | (1.179) | (1.051) |
| Community-level education | | 1.242** | | | 1.135** | 1.070 | | 1.069 |
| | | (0.039) | | | (0.048) | (0.054) | | (0.054) |
| Variation around the mean | | | | | | | | 1.116 |
| | | | | | | | | (0.126) |
| Community-level education, categorical | | | | | | | | |
| Less than 3 years | | | 0.713 | | | | 0.625 | |
| | | | (0.406) | | | | (0.400) | |
| 3 - <4 | | | 1.201 | | | | 1.016 | |
| | | | (0.335) | | | | (0.285) | |
| 5 - <6 | | | 1.516† | | | | 1.284 | |
| | | | (0.381) | | | | (0.316) | |
| 6 - <7 | | | 2.617** | | | | 1.901* | |
| | | | (0.642) | | | | (0.497) | |
| 7 - <8 | | | 2.620** | | | | 1.441+ | |
| | | | (0.514) | | | | (0.340) | |
| 8 - <9 | | | 2.503** | | | | 1.147 | |
| | | | (0.546) | | | | (0.329) | |
| 9 - <10 | | | 4.336** | | | | 1.684+ | |
| | | | (0.971) | | | | (0.579) | |
| 10 or more | | | 5.805** | | | | 2.058* | |
| | | | (1.431) | | | | (0.748) | |
| Community-level ever-use of effective methods[a] | | | | 1.320** | 1.182** | 1.106+ | 1.105+ | 1.096 |
| | | | | (0.052) | (0.065) | (0.070) | (0.069) | (0.071) |
| Demographic characteristics | no | no | no | no | no | yes | yes | Yes |
| Socioeconomic characteristics | no | no | no | no | no | yes | yes | Yes |
| Fertility preference variables | no | no | no | no | no | yes | yes | Yes |
| Constant | 0.474** | 0.109** | 0.175** | 0.160** | 0.104** | 0.223** | 0.238** | 0.170** |
| | (0.038) | (0.025) | (0.030) | (0.029) | (0.024) | (0.083) | (0.084) | (0.084) |
| Observations | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 |

** $p<0.01$, * $p<0.05$, † $p<0.1$, + $p<0.15$. Standard errors in parentheses.

[a] Community-level ever-use is measured in ten per cent increments to simplify interpretation.

Notes: Reference category for the dependent variable is being a non-user or using an ineffective method of contraception. Reference categories for independent variables are "Complete primary" for individual-level education, and "4 - <5" for community-level education. Demographic characteristics include age (three categories), an urban-rural dummy, and number of living children. Socioeconomic characteristics include wealth quintile, whether the rail line traverses the province of residence, respondent's

occupation, and husband's occupation. Fertility preference indicates whether the respondent wants to have another child within two years, and whether a health clinic is within convenient distance (included in 2007 model).

Table 4. Results of binary logistic regressions of current use of modern method of contraception on individual- and community-level education in 2007 presented as odds ratios.

| | Model B.1 | Model B.2 | Model B.3 | Model B.4 | Model B.5 | Model B.6 | Model B.7 | Model B.8 | Model B.9 |
|---|---|---|---|---|---|---|---|---|---|
| Individual-level education | | | | | | | | | |
| No education | 0.412** | 0.650* | 0.686* | 0.488** | 0.651* | 0.722+ | 0.711† | 0.700† | 0.724+ |
| | (0.077) | (0.114) | (0.123) | (0.085) | (0.114) | (0.143) | (0.144) | (0.139) | (0.144) |
| Incomplete primary | 0.589** | 0.767* | 0.770* | 0.653** | 0.773* | 0.823+ | 0.808+ | 0.817+ | 0.827 |
| | (0.069) | (0.092) | (0.094) | (0.077) | (0.094) | (0.111) | (0.109) | (0.110) | (0.113) |
| Complete secondary/higher | 1.460† | 0.969 | 1.061 | 1.315 | 0.994 | 1.084 | 1.051 | 1.056 | 1.091 |
| | (0.298) | (0.203) | (0.221) | (0.280) | (0.209) | (0.296) | (0.288) | (0.288) | (0.299) |
| Community-level education | | 1.228** | | | 1.163** | 1.157** | | 1.164** | 1.158** |
| | | (0.034) | | | (0.032) | (0.046) | | (0.047) | (0.046) |
| Variation around the mean | | | | | | | | 1.122 | |
| | | | | | | | | (0.110) | |
| Community-level education, categorical | | | | | | | | | |
| Less than 3 years | | | 0.338** | | | | 0.560+ | | |
| | | | (0.135) | | | | (0.207) | | |
| 3 - <4 | | | 0.681+ | | | | 0.929 | | |
| | | | (0.174) | | | | (0.238) | | |
| 5 - <6 | | | 0.870 | | | | 0.929 | | |
| | | | (0.181) | | | | (0.186) | | |
| 6 - <7 | | | 1.418† | | | | 1.168 | | |
| | | | (0.253) | | | | (0.213) | | |
| 7 - <8 | | | 1.438† | | | | 1.025 | | |
| | | | (0.265) | | | | (0.230) | | |
| 8 - <9 | | | 2.174** | | | | 1.413 | | |
| | | | (0.630) | | | | (0.504) | | |
| 9 - <10 | | | 2.262** | | | | 1.496+ | | |
| | | | (0.577) | | | | (0.405) | | |
| 10 or more | | | 2.415** | | | | 2.289* | | |
| | | | (0.586) | | | | (0.760) | | |
| Community-level ever-use of effective methods[a] | | | | 1.263** | 1.190** | 1.167** | 1.178** | 1.160** | 1.162** |
| | | | | (0.041) | (0.039) | (0.043) | (0.044) | (0.042) | (0.043) |
| Community HIV prevalence | | | | | | | | | 1.439 |
| | | | | | | | | | (0.894) |
| Demographic characteristics | no | no | no | no | no | yes | yes | yes | Yes |
| Socioeconomic characteristics | no | no | no | no | no | yes | yes | yes | yes |
| Fertility preference variables | no | no | no | no | no | yes | yes | yes | yes |
| Constant | 1.032 | 0.249** | 0.743† | 0.289** | 0.140** | 0.237** | 0.478* | 0.172** | 0.233** |
| | (0.085) | (0.051) | (0.120) | (0.057) | (0.033) | (0.081) | (0.161) | (0.077) | (0.080) |
| Observations | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 |

** $p<0.01$, * $p<0.05$, † $p<0.1$, + $p<0.15$. Standard errors in parentheses.

[a] Measured in ten per cent increments.

Notes: See Table 3.

Table 5. Results of multinomial logistic regressions of current use of modern method of contraception on individual- and community-level education in 1996 presented as odds ratios.

| | Model C.1 | | Model C.2 | | Model C.3 | | Model C.4 | | Model C.5 | | Model C.6 | | Model C.7 | | Model C.8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | condom | hormonal | condom | hormonal | condom | hormonal | condom | hormonal | condom | hormonal | condom | hormonal | condom | hormonal | condom | hormonal |
| **Individual-level education** | | | | | | | | | | | | | | | | |
| No education | 0.219** | 0.214** | 0.353$^\dagger$ | 0.360** | 0.340* | 0.376** | 0.324* | 0.286** | 0.337* | 0.353** | 0.417$^\dagger$ | 0.403** | 0.429$^\dagger$ | 0.412** | 0.500 | 0.365** |
| | (0.118) | (0.0480) | (0.189) | (0.0833) | (0.167) | (0.0893) | (0.175) | (0.0634) | (0.178) | (0.0818) | (0.206) | (0.110) | (0.198) | (0.118) | (0.243) | (0.0985) |
| Incomplete primary | 0.496** | 0.326** | 0.697 | 0.472** | 0.699 | 0.471** | 0.712 | 0.422** | 0.727 | 0.478** | 0.781 | 0.480** | 0.799 | 0.467** | 0.845 | 0.462** |
| | (0.125) | (0.0527) | (0.185) | (0.0764) | (0.185) | (0.0752) | (0.184) | (0.0703) | (0.195) | (0.0785) | (0.241) | (0.0865) | (0.244) | (0.0843) | (0.261) | (0.0834) |
| Complete secondary/higher | 4.246** | 4.314** | 2.824$^\dagger$ | 2.771** | 2.715$^\dagger$ | 2.972** | 3.018* | 3.362** | 2.940* | 2.797** | 2.774$^\dagger$ | 3.446** | 2.753$^\dagger$ | 3.526** | 3.474* | 2.885** |
| | (2.263) | (1.153) | (1.564) | (0.883) | (1.504) | (0.915) | (1.625) | (0.990) | (1.573) | (0.894) | (1.654) | (1.268) | (1.673) | (1.315) | (2.045) | (1.075) |
| **Community-level education** | | | 1.225** | 1.246** | | | | | 1.027 | 1.170** | 1.058 | 1.071 | | | 1.081 | 1.062 |
| | | | (0.0823) | (0.0387) | | | | | (0.0805) | (0.0566) | (0.0994) | (0.0542) | | | (0.104) | (0.0535) |
| Variation around the mean | | | | | | | | | | | | | | | 0.663* | 1.373** |
| | | | | | | | | | | | | | | | (0.124) | (0.161) |
| **Community-level education, categorical** | | | | | | | | | | | | | | | | |
| Less than 3 years | | | | | n/a$^b$ | 1.014 | | | | | | | n/a | 0.841 | | |
| | | | | | | (0.596) | | | | | | | | (0.570) | | |
| 3 - <4 | | | | | 1.714 | 0.986 | | | | | | | 1.506 | 0.797 | | |
| | | | | | (0.960) | (0.385) | | | | | | | (0.789) | (0.293) | | |
| 5 - <6 | | | | | 1.545 | 1.505 | | | | | | | 1.350 | 1.250 | | |
| | | | | | (0.720) | (0.466) | | | | | | | (0.658) | (0.386) | | |
| 6 - <7 | | | | | 1.593 | 3.049** | | | | | | | 1.302 | 2.075* | | |
| | | | | | (0.659) | (0.948) | | | | | | | (0.601) | (0.722) | | |
| 7 - <8 | | | | | 1.981+ | 2.888** | | | | | | | 1.461 | 1.394 | | |
| | | | | | (0.924) | (0.748) | | | | | | | (0.780) | (0.415) | | |
| 8 - <9 | | | | | 2.109+ | 2.675** | | | | | | | 1.432 | 1.050 | | |
| | | | | | (0.966) | (0.757) | | | | | | | (0.718) | (0.387) | | |
| 9 - <10 | | | | | 3.014* | 4.873** | | | | | | | 1.964 | 1.591 | | |
| | | | | | (1.522) | (1.350) | | | | | | | (1.248) | (0.619) | | |

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| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 or more | | | | | 5.362** | 6.043** | | | | | | | | | 2.436 | 1.927† |
| | | | | | (2.729) | (1.695) | | | | | | | | | (1.694) | (0.761) |
| Community-level ever-use of effective methods[a] | | | | | | | 1.428** | 1.290** | 1.397** | 1.124† | 1.423** | 1.016 | 1.371** | 1.032 | 1.455** | 0.983 |
| | | | | | | | (0.116) | (0.0534) | (0.139) | (0.0740) | (0.156) | (0.0746) | (0.147) | (0.0734) | (0.156) | (0.0722) |
| Demographic characteristics | no | | on | | no | | no | | no | | yes | | yes | | yes | |
| Socioeconomic characteristics | no | | on | | no | | no | | no | | yes | | yes | | yes | |
| Fertility preference variables | no | | on | | no | | no | | no | | yes | | yes | | yes | |
| Constant | 0.0486** | 0.122** | 0.0173** | 0.0398** | 0.0316** | 0.0603** | 0.0168** | 0.0590** | 0.0157** | 0.0393** | 0.0156** | 0.101** | 0.0185** | 0.102** | 0.0438** | 0.0447** |
| | (0.00901) | (0.0166) | (0.00721) | (0.00872) | (0.0120) | (0.0128) | (0.00591) | (0.0102) | (0.00650) | (0.00847) | (0.0109) | (0.0372) | (0.0130) | (0.0407) | (0.0393) | (0.0214) |
| Observations | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 | 1,997 |

** p<0.01, * p<0.05, † p<0.1, + p<0.15. Standard errors in parentheses.

[a] Measured in ten per cent increments.

[b] Zero observations in this category.

Notes: See Table 3.

Table 6. Results of multinomial logistic regressions of current use of modern method of contraception on individual- and community-level education in 2007 presented as odds ratios.

| | Model D.1 | | Model D.2 | | Model D.3 | | Model D.4 | | Model D.5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | condom | hormonal | condom | hormonal | condom | hormonal | condom | hormonal | condom | hormonal |
| Individual-level education | | | | | | | | | | |
| No education | 0.456* | 0.403** | 0.757 | 0.630* | 0.752 | 0.672* | 0.545$^†$ | 0.477** | 0.760 | 0.631* |
| | (0.161) | (0.0823) | (0.261) | (0.122) | (0.283) | (0.131) | (0.191) | (0.0913) | (0.263) | (0.121) |
| Incomplete primary | 0.463** | 0.613** | 0.623* | 0.795$^†$ | 0.647$^†$ | 0.792$^†$ | 0.517** | 0.680** | 0.629* | 0.801$^†$ |
| | (0.105) | (0.0772) | (0.141) | (0.104) | (0.151) | (0.104) | (0.117) | (0.0863) | (0.142) | (0.105) |
| Complete secondary/higher | 1.823$^†$ | 1.387+ | 1.156 | 0.929 | 1.191 | 1.033 | 1.633+ | 1.251 | 1.185 | 0.953 |
| | (0.619) | (0.281) | (0.404) | (0.198) | (0.391) | (0.226) | (0.549) | (0.269) | (0.408) | (0.205) |
| Community-level education | | | 1.257** | 1.223** | | | | | 1.191** | 1.158** |
| | | | (0.0710) | (0.0350) | | | | | (0.0672) | (0.0333) |
| Variation around the mean | | | | | | | | | | |
| Community level education, categorical | | | | | | | | | | |
| Less than 3 years | | | | | 0.498 | 0.295** | | | | |
| | | | | | (0.327) | (0.134) | | | | |
| 3 - <4 | | | | | 0.392$^†$ | 0.753 | | | | |
| | | | | | (0.194) | (0.208) | | | | |
| 5 - <6 | | | | | 0.490+ | 0.964 | | | | |
| | | | | | (0.214) | (0.212) | | | | |
| 6 - <7 | | | | | 0.812 | 1.568* | | | | |
| | | | | | (0.336) | (0.302) | | | | |
| 7 - <8 | | | | | 0.903 | 1.571* | | | | |
| | | | | | (0.375) | (0.327) | | | | |
| 8 - <9 | | | | | 1.938 | 2.225** | | | | |
| | | | | | (0.927) | (0.658) | | | | |
| 9 - <10 | | | | | 2.853* | 2.086** | | | | |
| | | | | | (1.292) | (0.561) | | | | |
| 10 or more | | | | | 1.844 | 2.558** | | | | |
| | | | | | (0.897) | (0.626) | | | | |
| Community-level ever-use of effective methods[a] | | | | | | | 1.281** | 1.259** | 1.200** | 1.189** |
| | | | | | | | (0.0757) | (0.0427) | (0.0710) | (0.0412) |
| Community HIV prevalence | | | | | | | | | | |
| Demographic characteristics | no | | no | | no | | no | | no | |
| Socioeconomic characteristics | no | | no | | no | | no | | no | |
| Fertility preference variables | no | | no | | no | | no | | no | |
| Constant | 0.0792** | 0.528** | 0.0217** | 0.170** | 0.102** | 0.467** | 0.0228** | 0.167** | 0.0118** | 0.0972** |
| | (0.0153) | (0.0455) | (0.0089) | (0.0324) | (0.0336) | (0.0769) | (0.0084) | (0.0326) | (0.0058) | (0.0215) |
| Observations | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 |

** p<0.01, * p<0.05, $^†$ p<0.1, + p<0.15. Standard errors in parentheses.

[a] Measured in ten per cent increments.

Notes: See Table 3.

Table 6. Continued.

| | Model D.6 | | Model D.7 | | Model D.8 | | Model D.9 | |
|---|---|---|---|---|---|---|---|---|
| | condom | hormonal | condom | hormonal | condom | hormonal | condom | hormonal |
| Individual-level education | | | | | | | | |
| No education | 0.894 | 0.687† | 0.872 | 0.675† | 0.861 | 0.667† | 0.921 | 0.687† |
| | (0.347) | (0.146) | (0.359) | (0.145) | (0.336) | (0.142) | (0.355) | (0.146) |
| Incomplete primary | 0.729 | 0.838 | 0.769 | 0.813+ | 0.723 | 0.833 | 0.746 | 0.840 |
| | (0.180) | (0.120) | (0.192) | (0.116) | (0.179) | (0.119) | (0.182) | (0.122) |
| Complete secondary/higher | 0.937 | 1.121 | 0.912 | 1.079 | 0.909 | 1.093 | 0.956 | 1.126 |
| | (0.365) | (0.311) | (0.344) | (0.304) | (0.354) | (0.303) | (0.372) | (0.313) |
| Community- level education | 1.254** | 1.138** | | | 1.262** | 1.144** | 1.261** | 1.138** |
| | (0.0856) | (0.0481) | | | (0.0874) | (0.0490) | (0.0880) | (0.0482) |
| Variation around the mean | | | | | 1.144 | 1.117 | | |
| | | | | | (0.183) | (0.118) | | |
| Community-level education, categorical | | | | | | | | |
| Less than 3 years | | | 0.971 | 0.480† | | | | |
| | | | (0.613) | (0.205) | | | | |
| 3 - <4 | | | 0.579 | 1.013 | | | | |
| | | | (0.272) | (0.287) | | | | |
| 5 - <6 | | | 0.570 | 1.005 | | | | |
| | | | (0.254) | (0.214) | | | | |
| 6 - <7 | | | 0.963 | 1.208 | | | | |
| | | | (0.403) | (0.244) | | | | |
| 7 - <8 | | | 1.152 | 1.017 | | | | |
| | | | (0.489) | (0.253) | | | | |
| 8 - <9 | | | 2.666† | 1.293 | | | | |
| | | | (1.364) | (0.492) | | | | |
| 9 - <10 | | | 3.854** | 1.240 | | | | |
| | | | (1.971) | (0.358) | | | | |
| 10 or more | | | 3.118† | 2.233* | | | | |
| | | | (1.862) | (0.757) | | | | |
| Community-level ever-use of effective methods[a] | 1.213** | 1.159** | 1.205* | 1.172** | 1.204** | 1.153** | 1.181* | 1.159** |
| | (0.0846) | (0.0436) | (0.0885) | (0.0455) | (0.0837) | (0.0433) | (0.0848) | (0.0444) |
| Community HIV prevalence | | | | | | | 5.689 | 1.104 |
| | | | | | | | (6.911) | (0.722) |
| Demographic characteristics | yes | | yes | | yes | | yes | |
| Socioeconomic characteristics | yes | | yes | | yes | | yes | |
| Fertility preference variables | yes | | yes | | yes | | yes | |
| Constant | 0.0145** | 0.186** | 0.0571** | 0.320** | 0.0099** | 0.135** | 0.0135** | 0.185** |
| | (0.0089) | (0.0611) | (0.0352) | (0.102) | (0.0074) | (0.0606) | (0.0083) | (0.0610) |
| Observations | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 | 1,996 |

** $p<0.01$, * $p<0.05$, † $p<0.1$, + $p<0.15$. Standard errors in parentheses.

[a] Measured in ten per cent increments.

Notes: See Table 3.

Appendix A1. Michael's analytical framework

In the neoclassical model parents choose a quantity of children to 'consume' according to their tastes and preferences for children and other goods, described by their utility function

$$U(Z) \qquad Z = (Z_i) \qquad i = 1, \dots, n,$$

where $Z$ is the amount of the $n$ vector of commodities consumed. Each of the commodities $Z_i$ are produced according to a household production function

$$Z_i = f_i(x_i, T_{ij}) \qquad j = 1, \dots, m,$$

where $x_i$ denotes goods and services purchased in the market and $T_{ij}$ represents the time spent in production of commodity $i$ by household member $m$. Utility is maximized subject to the constraints of production technology in the production function, to an income constraint

$$\sum_{i=1}^{n} x_i \, p_i = \sum_{j} [W_j(Tw_j) + V_j],$$

and to a time constraint,

$$\sum_{i=1}^{n} T_{ij} + Tw_j = T$$

for all $j$, where $p_i$ is the market price of good $x_i$, $W_j$ is real wage rate of household member $j$, $Tw_j$ is the time spent in the labour force, $V_j$ is non-wage income, and $T$ is total time available to each member $j$.


Two commodities in the utility function that will affect the supply of children are household production of "family life", $Z_1$, and of "sexual gratification", $Z_2$. $Z_1$ is a function of the input of time and goods provided by the parents and of a flow of "child services", which in turn is a function of the number of children in the household and their quality. The flow of "child services" is determined by $C = \alpha N$, where $N$ is number of children and $\alpha$ is the rate of flow per child. The rate of flow is related to what Becker refers to as the *quality* of children, $Q = \Phi(\alpha)$, and is produced according to $Q = \theta(x_Q, T_{Qj}; e)$, where $x$ and $T$ are inputs of goods and time, and $e$ is the household environment. Parents' education may influence the production of $Z_1$ via income and substitution effects.


The level of production of $Z_2$ is related to number of children, $N$. Couples who have no knowledge of or access to modern contraceptive technology can limit or space births only by adjusting their coital frequency, which is identical to the production of $Z_2$. But as contraceptive methods are introduced the scope for decision-making increases and, in Becker's words, the decision to control fertility is

separated from the decision to engage in coition. The probability of conception $P$ is the outcome of the production process

$$P = f_1(x_p, T_p; Z_2, F),$$

where $x_p$ and $T_p$ are money and time spent to alter the probability of conception, and $F$ is unadjusted fecundity, which is exogenously determined by individual characteristics such as age and health. The decision to control fertility is made through a cost-benefit analysis of an additional child and if net benefit is found to be negative the couple will seek to reduce the probability of conception to the point where marginal benefit is equal to marginal cost (which may not be at zero probability).