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The Demand for Reproductive Health Care*

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Abstract

This research formalizes the interactions between the various determinants of a woman's reproductive health behavior during her reproductive years, and, using nonparametric control functions, examines those determinants. The theoretical model is developed from Grossman's (2000) model of health as a form of human capital, focusing on the cyclicality and volatility of fecundity, as well as the potential costs (such as lost wages and direct costs of purchase) and benefits (such as the ability to invest in her education and/or career) of being able to control or at least mitigate it. The empirical model, which controls for the endogeneity between sexual activity and contracepting decsions supports our theoretical model of reproductive health-seeking behavior.

Keywords: Health Production, Contraception Efficiency, Nonparametric Analysis

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1 Introduction

Poor reproductive health outcomes have long been blamed for being one of the main causes of economic hardships among women and their children (Schultz, 2008). It has been reported that sexual and reproductive health problems account for 18% of the total global burden of disease, and represent 32% of the burden among women of reproductive age (Singh et al., 2010). In this context, the potential for reproductive health care to improve living standards has led to renewed political momentum in the past decade, with policymakers increasingly linking reproductive health issues to development, human rights and gender equity. This momentum delivered changes to the configuration of the Millennium Development Goals, which now include a specific target on universal access to reproductive health care by 2015 (Say and Chou, 2011).

Unfortunately, despite the progress made towards making universally available reproductive health care, the achievement so far has fallen well short of expectations (Fathalla et al., 2006). While the shortfall may be linked to a lack of resources necessary for rolling out reproductive health programs in some countries, the delay experienced in achieving the objective might be symptomatic of how poorly understood are the factors driving the demand for reproductive health care. The limited attention the demand for reproductive health services has received in both the theoretical and empirical literatures bears testimony to this fact. The current body of knowledge is largely dominated by empirical investigations about the fertility effect of contraception in rich countries (Bailey, 2006, 2012), and the determinants of unmet need for family planning in poor countries (Casterline and Sinding, 2000). These two strands of literature do not explicitly analyze contraceptive behavior. By their definition, the numbers indicating unmet need for family planning, while useful as a measure of the perceived deficit in the provision of family planning services, they are void of behavioral content. In particular, knowing the proportion of women who have wanted to stop or delay childbearing, but are not contracepting, may be an indication of higher costs of access to family planning. However, it is not very informative about contraception choices that might be made if family planning services were available at reduced cost. Thus, the main objective of this study is to answer a basic question related to how people adjust their demand for family planning services, paying particular attention to the 'quality' of those services, following changes to the their levels of reproductive health capital and common socio-economic outcomes of interest.

The analysis herein describes a theoretical model of the demand for family planning services as a derived demand for reproductive health. In principle, an individual would determine the amount (and quality) of contraception she will use after balancing the benefits against the costs of a particular type of family planning 'service'. The costs of family planning services include both transaction costs, in the form of search and information costs, as well as the monetary and psychic costs associated with using a particular contraception method. Following the tradition started by Grossman (1972, 2000), we could consider family planning services to be both a consumption and investment good. As a consumer good, contraception is an economic 'bad' – it is potentially a source of discomfort at a particuarly inconvenient time – but it also leads to improvements in reproductive capital stock. As an investment in human capital, family planning services are an input to lifetime earnings (Ben-Porath, 1967; Kaestner, 2013) which people maximize, subject to the dynamic path of the stock of reproductive health capital.

However, we make two observations regarding the traditional model. First, while health care (as a final good) should enter an individual's utility function, health itself (as one of the multiple forms of human capital) should not be an argument in the individual's utility function. It can hardly be acquired as a final good (Ben-Porath, 1967; Kaestner, 2013). Thus, in our version of the pure consumption model, health care enters the individual's utility function, while health capital appears in the earnings function. Second, the human reproduction process is both cyclical and stochastic in nature; thus, a woman's capability to reproduce and her freedom to plan childbearing largely depend on both biological factors (such as the woman's natural ability to conceive and the characteristics of her partner's semen) and behavioral factors (such as her contraceptive behavior and sexual practice). It is then natural to postulate that, while being subjected to uncertain shocks stemming from the stochastic nature of the human reproductive process, the stock of reproductive health would improve with experience and knowledge, which come with age. In this setting, the role of family planning services, rather than being a direct investment into new reproductive health capital, is mainly to prevent stochastic 'deterioration' of the stock of reproductive health; we refer to deterioration in our model as increasing the probability that a woman becomes pregnant.

The behavioral implications of our model, wherein we explicitly incorporate the uncertanties surrounding the reproduction process, are twofold. Firstly, as expected, reproductive health care is inversely related to its marginal costs; there is substitution. Secondly, there is a positive relationship between the effectiveness ('quality') of a woman's contraceptive strategy, her natural fecundity rate and frequency of intercourse; increased possibilities of pregnancy are offset by improved contraceptive methods. These implications are empirically examined, using data from the 2010 Malawi Demographic and Health Survey (2010 MDHS). The theoretical analysis suggests that the relationship between family planning services, their marginal costs and the woman's latent ability to procreate could be nonlinear. Furthermore, within our structure, the frequency of intercourse is likely to be endogenous to the contracepting decision. Thus, we nonparametrically estimate our model of the demand for contraceptive efficiency using the nonseparable empirical framework described in Florens et al. (2008) and Imbens and Newey (2009). We find support for our theoretical model.

The rest of the work is organized as follows. The next section considers a version of Grossman's pure investment health demand model, and uses a path diagram to describe the interactions between medical care and the stock of health capital. Section 3 develops an empirical forumalation for testing that theory. The data used for the analysis are outlined in Section 4; the results for the analysis are discussed in Section 5. Section 6 concludes.

2 Pure Investment Model

Consequently, assuming imperfect control over the probability of falling pregnant, our analysis explicitly incorporates the uncertainties surrounding the human reproduction process. The equation of motion in reproductive health is modeled as being partly determined by the deterministic natural investment in reproductive health and partly by a random factor following a standard Brownian motion. The choice of a standard Brownian motion to drive fluctuations in the stock of reproductive health capital is well-suited to the continuous time setting of our model.[1] We then apply stochastic control theory to the pure consumer and investment models, in order to derive analytical solutions with behavioral content, and, thus,

[1] There are other stochastic extenstions. For example, Laporte and Ferguson (2007) discuss a case where the stochastic nature of health is driven by a random factor with a Poisson distribution, while Liljas (1998) and Picone et al. (1998) introduce uncertainty in the Grossman model through the incidence and size of illness.

policy implications. **Move some of these things to an Appendix?**

In the original Grossman model, health is treated as a form of human capital from which individuals derive both consumption and production benefits. It is also common to consider a pure investment version of the model. In principle, good health can be assumed to arise from a pure investment commodity, which determines income or wealth levels. In this context, good health solely determines the total amount of time available for market and nonmarket production activities (Grossman, 2000). As pointed out by Havemann et al. (1994), an important difference between these models is the ability to sign the relation between market wages and health.[2]

2.1 The Model

If good health can be assumed to give rise to more, or even 'better', time for wage earning opportunities, one could assume that an individual's money earnings function is given by a simple function of wages, that depends upon the ability to convert health capital into higher wages. With this in mind, we define the following earnings function

$$y(t) = w(t)q\big(k(t)\big),$$

where $w(t)$ is the wage rate and $q(k(t))$ is the working time production function, which is a function of a single input *health capital* (k). To allow for multiple periods, suppose that the stock of health capital (k) is long-lived and its evolution is determined by its initial value, $k(0)$, and by the person's demand for health care, m. We assume that k is produced with medical care m, which is a variable input, such that net investment in the stock of health, $\dot{k}$, equals the individual's gross investment in health care minus deterioration in k

$$\dot{k} = g\big(m(t)\big) - n\big(k(t)\big). \tag{1}$$

The differential equation in (1) describes the change in the stock of health capital k at each point in time, as a function of new investment in health, $g(\cdot)$, and deterioration in the current stock of health capital, $n(\cdot)$. The gross health investment adjustment costs are given

[2] In related work, we develop a mixed consumption-investment model with intuitive assumptions that mitigate the ambiguity, and, thus, gets past any concern about the differences in model structure.

by the following convex cost function

$$h\big(m(t)\big) \geq 0.$$

The gross adjustment costs are sunk costs constrained to be nonnegative, since health capital is attached to an individual and not resellable in the capital market (Grossman, 1972; Arrow, 2006). It follows that a person's return to investing in health at any time t is given by

$$v_t = w(t)q\big(k(t)\big) - h\big(m(t)\big).$$

Let R denote the total benefits from following an optimal health investment strategy over a finite horizon $[0, T]$. If t is a *stopping time* (Stokey, 2009), the individual's total rewards from consuming health care $m(t)$ can be thought of as the sum of two terms: expected reward over $[0, t)$ and the *continuation values* over $[t, T)$.

$$R = \text{ returns over } [0, t) + \text{ returns over } [t, T)$$

Now, suppose the person's objective is to maximize the present value of her returns to investment in health. Thus, the individual's problem becomes one of choosing the optimal level of investment in health, $g(\cdot)$, in order to maximize R, her total net benefit from avoiding the opportunity costs of ill health, while satisfying her resource constraint. It is assumed that the person discounts future benefits at a subjective constant discount factor r, and the labour market is characterized by perfect competition. Thus, given the information at the beginning of a work interval, $t = 0$, the person's finite horizon dynamic problem is

$$\begin{aligned}
\max_{m(t)} \int_{t=0}^{T} & e^{-rt} \left[w(t)q\big(k(t)\big) - h(m(t))\right] dt + e^{-rT} v(k(T)) \\
& \text{subject to} \\
& \dot{k} = g\big(m(t)\big) - n\big(k(t)\big) \\
& m(t) > 0 \quad \text{(control region)} \\
& k(0) > 0 \quad \text{(given)}
\end{aligned}$$

where T is the some point in time and $v(k(T))$ is the *continuation value* or the returns the individual can expect to derive from following an optimal health investment strategy in the future (after T).

In this dynamic problem $m(t)$ is the *control variable*, whereas $k(t)$ is the *state variable*. To derive analytical solutions, we first set up a Lagrangian. For convenience, each constraint is multiplied by the factor e^{-rt} to yield

$$\begin{aligned} L = & \int_{t=0}^{T} e^{-rt} \left[w(t) q\big(k(t)\big) - h(m(t)) \right] dt + e^{-rT} v\big(k(T)\big) \\ & - \int_{t=0}^{T} e^{-rt} \lambda(t) \big[\dot{k} - g\big(m(t)\big) + n\big(k(t)\big) \big] dt \end{aligned}$$

where the *adjoint variable* $\lambda(t)$ is associated with the dynamic constraint in (1). It is also called the *co-state variable* and represents the shadow price of k, or the value of a gift of a unit of health capital at time t (Arrow, 2006).

Next the Hamiltonian H is defined as:

$$H(\cdots) = \Big[w(t) q\big(k(t)\big) - h(m(t)) \Big] + \lambda(t) \Big[g\big(m(t)\big) - n\big(k(t)\big) \Big]$$

such that the Lagrangian can be re-written as

$$L = \int_{t=0}^{T} e^{-rt} H(m(t), k(t)) dt - \int_{t=0}^{T} e^{-rt} \lambda(t) \dot{k} dt + e^{-rT} v(k(T)).$$

Suppose that the adjoint variable is differentiable, then it follows that the second component of the right hand side of the preceding can be reweritten.[3]

$$\int_{t=0}^{T} e^{-rt} \lambda(t) \dot{k} dt = e^{-rT} \lambda(T) k(T) - \lambda(0) k(0) - \int_{t=0}^{T} e^{-rt} k(t) \dot{\lambda} dt + r \int_{t=0}^{T} e^{-rt} k(t) \lambda(t) dt,$$

[3]Note that

$$\int_{t=0}^{T} \big(\dot{x} z(t) + x(t) \dot{z} \big) dt = \int_{t=0}^{T} \frac{d}{dt} \big(x(t) z(t) \big) dt = x(T) z(T) - x(0) z(0),$$

where the first equality follows from the product rule ($\frac{d}{dt}(xz) = \dot{x}z + x\dot{z}$) and the second from the Fundamental Theorem of Calculus.

so that the Lagrangian can be now be restated as

$$L = \int_{t=0}^{T} e^{-rt}\big[H(\cdots) + k(t)\dot{\lambda} - rk(t)\lambda(t)\big]dt + e^{-rT}\big[v\big(k(T)\big) - \lambda(T)k(T)\big] + \lambda(0)k(0). \quad (2)$$

The *Maximum Principle* requires that, for stationarity, the Hamiltonian be maximized along the optimal path. In our setting, the set of necessary conditions for an optimal solution of the problem in (2), which relate to the optimal paths of $m(t)$ and $k(t)$, are given by

$$L_m = H_m(\cdots) = 0 \quad (3a)$$

$$L_k = H_k(\cdots) + \dot{\lambda} - r\lambda(t) = 0 \quad (3b)$$

$$L_\lambda = \dot{k} - H_\lambda(\cdots) = 0 \quad (3c)$$

$$L_{k(T)} = v_k(k(T)) - \lambda(T) = 0 \quad (3d)$$

Consider the necessary conditions in (3). After replacing for the expression, $H(\cdots)$, these conditions imply

$$\lambda(t) = \frac{h_m\big(m(t)\big)}{g_m(m(t))} \quad (4a)$$

$$\dot{\lambda} = -w(t)q_k\big(k(t)\big) + \big[n_k(k(t)) + r\big]\lambda(t) \quad (4b)$$

$$\dot{k} = g\big(m(t)\big) - n(k(t)) \quad (4c)$$

$$\lambda(T) = v_k(k(T)) \quad (4d)$$

where $\lambda(t)$ is the shadow price of health capital, $h_m\big(m(t)\big)$ is the marginal adjustment cost, $g_m(m(t))$ is the marginal benefit of health care, $q_k\big(k(t)\big)$ is the marginal production benefit of health capital, and $n_k(k(t))$ is the rate of natural deterioration of health capital.

From (4a), we derive the following expression of the growth rate for λ, the shadow price of health capital

$$\frac{\dot{\lambda}}{\lambda(t)} = \left[\frac{h_{mm}(m(t))}{h_m(m(t))} - \frac{g_{mm}(m(t))}{g_m(m(t))}\right]\dot{m},$$

which, when substituted into (4b), yields the following equation of motion for health care

$$\dot{m} = \frac{1}{\mu}\left[\Big(r + n_k(k(t))\Big) - w(t)q_k(k(t))\frac{g_m(m(t))}{h_m(m(t))}\right], \quad (5)$$

where $w(t)q_k(k(t))$ is the marginal revenue benefit of health capital. It represents the monetary value of the marginal production benefit of health capital, while $g_m\big(m(t)\big)/h_m\big(m(t)\big)$ is the shadow price of health care indicating the health benefit derived from the last unit of money spent on health care. The difference between the relative changes in the marginal adjustment costs and marginal health benefit of health care is captured by the coefficient

$$\mu = h_{mm}\big(m(t)\big)/h_m\big(m(t)\big) - g_{mm}\big(m(t)\big)/g_m\big(m(t)\big) > 0,$$

since $h_{mm}(\cdot) > 0$ and $g_{mm}(\cdot) < 0$.

The expression in (5) suggests that growth in health care use is positively related to the rate of natural health stock deterioration. Moreover, our health investment behavior model indicates that an increase in the marginal revenue benefit of health would reduce growth in health care use. This implies that, as healthier people earn more, they reduce their level of medical care use, which is consistent with one of the main predictions of the consumer health care model (Grossman, 2000), and much of the empirical literature (Wagstaff, 1986; Liljas, 1998; Zweifel, 2012).

2.1.1 Phase Space Analysis

The expressions in (4c) and (5) provide a convenient way to describe the demand for medical services in terms of the evolution of m and k. Using those expressions, the following analysis uses a phase diagram (Shone, 2002; Romer, 2006) to discuss the dynamics of a person's health investment strategy. We consider the solution to health-seeking behavior as a pair of functions $m(t)$ and $k(t)$ that can be represented by a path, which defines a locus in $(m, k)-$space with the steady-state at their intersection.

If we assume, for simplicity, that gross health investment is given by an identity function of the form $g(m(t)) = m(t)$, and that health capital deteriorates at a constant rate δ, so that $n(k(t)) = \delta k(t)$ (Grossman, 1972, 2000), then the first-order conditions stated in (4) simplify to

$$\lambda(t) = h_m\big(m(t)\big) \tag{6a}$$

$$\dot{\lambda} = -w(t)q_k\big(k(t)\big) + (\delta + r)\lambda(t) \tag{6b}$$

$$\dot{k} = m(t) - \delta k(t) \tag{6c}$$

$$\lambda(T) = v_k(k(T)) \tag{6d}$$

Condition (6a) implies that the shadow price of health capital evolves over time according to the following expression

$$\dot{\lambda} = h_{mm}\big(m(t)\big)\dot{m},$$

which, when substituted into (6b), yields

$$\dot{m} = \frac{(\delta + r)h_m(m(t)) - w(t)q_k(k(t))}{h_{mm}(m(t))}.$$

Therefore, the dynamics of the optimal health investment strategy would be characterized by the following pair of differential equations

$$\dot{m} = \frac{(\delta + r)h_m(m(t)) - w(t)q_k(k(t))}{h_{mm}(m(t))}, \tag{7}$$

$$\dot{k} = m(t) - \delta k(t). \tag{8}$$

The preceding differential equations divide the $(m, k)-$space into four regions; in each region, the paths of m and k have different trajectories.

The arrows in Figure 1 show the directions of motion of both m and k. The steady-state is characterized by simultaneously vanishing differentials, $\dot{m} = 0$ and $\dot{k} = 0$, wherein the stock of health capital deemed optimal, k^*, equates the cost of investment to the marginal returns

$$(\delta + r)h_m(m(t)) = w(t)q_k(k(t)),$$

and there is no net investment

$$m(t) = \delta k(t).$$

Various trajectories satisfy equations (7) and (8). However, for any positive initial value

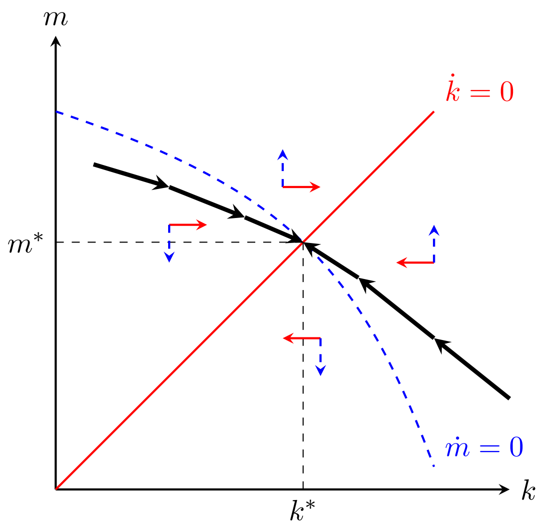

Figure 1: Optimal Health Investment Strategy.

of the health capital stock, k_0, there is a unique optimal path leading to the steady-state, while all other paths lead away from the equilibrium. Figure 1 describes how m and k must evolve over time to satisfy an individual's intertemporal optimization condition (7) and the dynamics of her stock of health capital, k, from (8).

The change in health care over time, $\dot{m}$, is zero when the marginal cost of medical services is equal to the marginal benefit of further investment in health care. When k exceeds the level that yields $\dot{m} = 0$, m is rising; when k is less than this level, m is falling. For $\dot{k}$ to be zero, investment in m must equal depreciation in k. Thus $\dot{k}$ is zero when $m(t)$ equals $\delta k(t)$. When m exceeds m^*, $\dot{k}$ is positive; when m is less than m^*, $\dot{k}$ is negative.

However, for any positive initial level of k, there is a unique initial value of m which allows the person to move along the *saddle path* to equilibrium. This unique initial value of m is consistent with the person's intertemporal optimization condition and the dynamics of her nonnegative stock of health capital k. Note that, to the right of the $\dot{k} = 0$ line and below the $\dot{m} = 0$ curve, $\dot{m}$ is negative and $\dot{k}$ is negative, suggesting that both m and k are falling, and so the arrows point down and to the left.

2.1.2 The Impact of Health Care Costs and Wage Movements

It is also possible to illustrate a number of health care issues under deterministic conditions using the phase diagram in Figure 1. For example, the following analysis addresses the implications of changes in the cost of health care and movements in the wage rate for a person's health investment strategy. Note that the evolution of k, as described in (8), depends neither on the cost of health care $h(m(t))$ nor on the wage rate w. Thus, a change in $h(m(t))$ or $w(t)$ will only affect the $\dot{m} = 0$ locus. Recall that the correspondence between m and k, where $\dot{m} = 0$, is defined by

$$(\delta + r)h_m(m(t)) = w(t)q_k(k(t)) \tag{9}$$

In this context, an increase in $w(t)$ will shift the $\dot{m} = 0$ locus upward at every level of k. At this point, the assumed convexity of the cost function $h(\cdot)$ implies that its second derivative $h_{mm}(\cdot)$ is positive, while the second derivative of the production function $q_{kk}(\cdot)$ is negative, because of the law of diminishing marginal returns. It follows that, in order to restore the equilibrium in steady-state after an increase in w, m^* has to rise at all levels of k^*, shifting upwards the $\dot{m} = 0$ curve as illustrated in Figure 2. Thus, in terms of the phase diagram, a permanent increase in the wage rate leads to a jump in the use of health care to a point on the new saddle path (Point $E^{'}$). Subsequently, k would rise and m moves down along the new saddle path to the new equilibrium (Point $E^{''}$). Thus, the permanent increase in the wage rate moves a person to a new permanent equilibrium, characterized by a high level of medical care and improved health.

In a similar fashion, it is straightforward to show that the steady state condition in (9) also suggests that a decrease in the marginal cost of medical services, $h_m(\cdot)$, will require a decrease in the marginal benefit of further investment in health care, in order to restore the equilibrium. This implies a rise in k^*, which causes the marginal benefit to fall, because of the diminishing marginal returns. Thus, a permanent decrease in the marginal cost of medical care will produce the same results as those described in Figure 2. In other words, more expensive medical services will discourage investment in health capital, while reducing the cost of health care will have the opposite effect, resulting in imporved levels of health capital.

2.2 Investment in Reproductive Health

In the previous subsection, we outlined the intuition from the human capital model applied generically to health care, focusing on a pure investment model. In this section, we apply

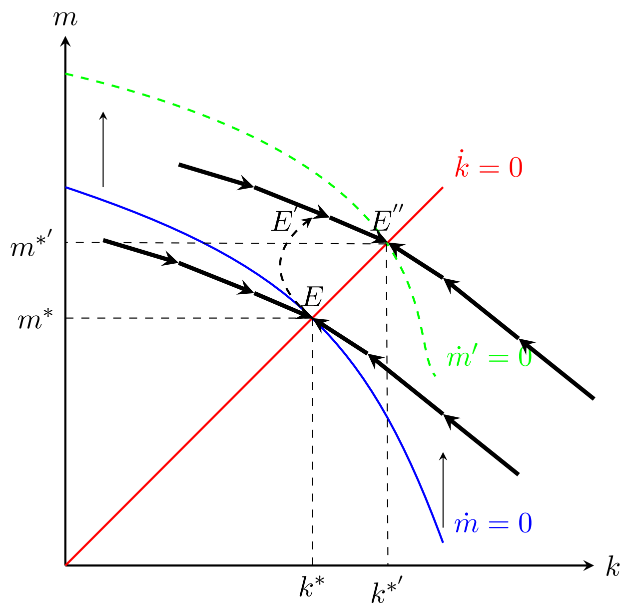

Figure 2: The Effect of a Rise in Wage Rate on Health Investment.

the pure health investment model to the analysis of the demand for reproductive health care. The theoretical framework we develop allows one to investigate the interactions between labour and reproductive health outcomes, assuming that childbearing and childrearing are time intensive activities. Thus, everything being equal, we assume that every fecundable and economically active woman would have an incentive to take control of her reproductive life by using reproductive health care, such as family planning services, although we also accept that, for a variety of reasons, not all women will be able to follow the optimal path derived below.

The view of *good reproductive health* espoused here is that it represents the capability to reproduce and the freedom to decide if, when and how often to give birth. In the case of a fecundable woman, this capability improves over time and is influenced by the random nature of the human reproduction process (Perrin and Sheps, 1964), and it is characterized by fluctuations in the woman's natural fecundity. We also suppose that these fluctuations can be controlled through a specific contraceptive behavior. The fact that the woman's rate of natural fecundity is explicitly incorporated into the model, not only accounts for heterogeneity among contracepting women, but also introduces uncertainty into the analysis. Thus, we have allowed for a stochastic evolution of reproductive health capital, as a result of uncertainty in the woman's natural fecundity (Heckman and Willis, 1976). In the rest of the analysis, we focus on reversible contraception, as a specific type of reproductive health care.

Consider a dynamic fertility model in which fluctuations in reproductive health capital depend on the woman's probability of getting pregnant; those fluctuations are driven by a standard Brownian motion $B = \{(B(t)), \mathcal{F}_t\}_{t\geq 0}$ defined on the probability space $(\Omega, \mathcal{F}_t, P)$. The standard Brownian motion is one of the most common forms of continuous random shocks in the literature, where the relevant variable is subjected to a continuous series of random disturbances, and the optimal time path of the control variables must continuously compensate for shocks (Laporte and Ferguson, 2007). We suppose that $\{\mathcal{F}_t\}_{t\geq 0}$ is the augmentation of filtration, and this drives the family formation process.

Assume, also, that a fecundable woman has some control over the fluctuations in the stock of reproductive health capital through her contraceptive behavior, such that k evolves according to the following stochastic process

$$d \log k(t) = g\big(k(t)\big)dt + \big(1 - m(t)\big)p(t)x(t)\sigma dB(t).$$

We define $g(k(t))$ as the natural improvement in the stock of reproductive health capital, while medical care in the reproductive health model captures contraception, specifically the control efficiency of contraception, and it must lie in the unit interval; thus, $0 \leq m(t) \leq 1$. Furthermore, the biological component of fecundity is defined as a rate, which also must lie in the unit interval; therefore, $0 \leq p(t) \leq 1$. Finally, $x(t)$ represents the frequency of sexual intercourse.[4]

In this setup, a contracepting woman's optimization problem becomes

$$\begin{aligned} V(t) = \max_{m(t)} \mathrm{E}_0 &\left[\int_0^t e^{-rt}\big[w(t)q\big(k(t)\big) - h\big(m(t)\big)\big]dt + e^{-rt}v\big(k(t)\big)\right] \\ &\text{subject to} \\ d \log k(t) &= g\big(k(t)\big)dt + \big(1 - m(t)\big)p(t)x(t)\sigma dB(t) \\ &0 < m(t), k(0) \end{aligned}$$

[4]Both perfect contraception (*i.e.* $m(t) = 1$) or infertility (*i.e.* $p(t) = 0$) would solve uncertainty in the dynamics of $k(t)$, and these are incorporated in the model.

where $h(m(t))$ represents the economic and non-economic costs of contraception to individuals. While economic costs would mainly include monetary expenses, there are significant non-economic costs for using birth control such as the fear of side effects, social disapproval and spousal resistance, as well as unnecessary medical barriers (Casterline and Sinding, 2000; Bongaarts, 2010).

If we assume that the woman's objective is to maximize the expected current flow of money earnings plus the expected change in future money earnings caused by the drift in and the volatility of her reproductive health capital (Stokey, 2009; Bjork, 2009), the value function V together with the optimal choice of $m(t)$ satisfy the Hamilton-Jacobi-Bellman (HJB) equation

$$rV = \max_{m(t)} \big\{ w(t)q\big(k(t)\big) - h\big(m(t)\big) + \big[g(k(t))\big]V_k + \frac{1}{2}\big[\big(1-m(t)\big)p(t)x(t)\big]^2\sigma^2 V_{kk}\big\},$$

where $V_k > 0$ and $V_{kk} < 0$.

The first order necessary condition provides an expression for the optimal contraceptive strategy: at the optimum, the marginal cost of contraception is equal to the marginal benefit of contraception, as measured by the reduction in the magnitude of the random shocks to the stock of reproductive health capital

$$h_m(m(t)) = -(1-m(t))p^2(t)x^2(t)\sigma^2 V_{kk}. \tag{10}$$

Assume that the woman's total cost of contraception has constant marginal cost π per unit of contraceptive efficiency such that

$$h(m(t)) = \pi m(t).$$

It follows that the optimal level of contraceptive efficiency for a sexually active woman would be derived from (10) as

$$m^*(t) = 1 + \frac{\pi}{p^2(t)x^2(t)\sigma^2 V_{kk}}. \tag{11}$$

Assuming differentiability, it is possible to approximate the value of V_{kk} using *exact* fixed-coefficient Taylor expansions of the general function $V(k(t))$ (Alghalith, 2009). Let us consider the value function $V(k(t))$. Its second order Taylor expansion around the average quantity of reproductive health capital is given by

$$V(k(t)) = V(\bar{k}) + V_k(\bar{k})(k(t) - \bar{k}) + \frac{1}{2}V_{kk}(\bar{k})(k(t) - \bar{k})^2 + \mathcal{R}(k(t)),$$

where $\mathcal{R}(k(t))$ is a remainder to be minimized using

$$\min_{k(t)} \left\{ \mathcal{R}(k(t)) = V(k(t)) - \left[V(\bar{k}) + V_k(\bar{k})(k(t) - \bar{k}) + \frac{1}{2}V_{kk}(\bar{k})(k(t) - \bar{k})^2 \right] \right\},$$

for which the first order necessary condition yields

$$V_k(k(t)) = [V_k(\bar{k}) - V_{kk}(\bar{k})\bar{k}] + V_{kk}(\bar{k})k(t),$$

where the marginal value is positive (*i.e.* $V_k(\cdot) > 0$) and the change in marginal value is negative (*i.e.* $V_{kk}(\cdot) < 0$), because of diminishing marginal returns dictating that the value function be a well-behaved concave function. We also derive the second order necessary and sufficient condition, which allows us to write that $V_{kk}(k(t))$ is a negative constant given by

$$V_{kk}(k(t)) = V_{kk}(\bar{k}) \equiv -\phi < 0.$$

In particular, plugging in (11) results in the following closed form solution for the demand of contraceptive efficiency

$$m_I^*(t) = 1 - \frac{\pi}{\phi p^2(t)x^2(t)}. \tag{12}$$

Other things being equal, the expression in (12) suggests that the efficiency of a woman's contraceptive strategy, $m(t)$, increases with natural fecundity, $p(t)$, and frequency of intercourse $x(t)$. Since natural fecundity is a cyclical event, it is possible that contracepting women will use more efficient contraceptive methods only during the time when they are more at risk of falling pregnant in the menstrual cycle. In this setting, women who frequently have intercourse are also more likely to use relatively more efficient contraceptive methods. Furthermore, the model explicitly takes into account the impact of the cost of family planning services on a woman's contraceptive behavior. In particular, equation (12) suggests that the efficiency of a woman's contraceptive strategy, $m(t)$, is negatively linked to the opportunity cost of contraception services, π. Faced with higher costs of family planning services, contracepting women will settle for less efficient contraceptive methods. The opposite is also true if family planning services are made more affordable. In the extreme case that the cost of family planning is zero, the model in (12) predicts that contracepting women will choose the most efficient contraceptive method available, $m(t) = 1$.

3 Empirical Analysis

The economic analysis of a woman's contraceptive behavior conducted, so far, yields an expression for the demand for contraception efficiency, $m(t)$, as a nonlinear function of the observed cost of contraception, $\pi(t)$, frequency of sexual intercourse, $\chi(t)$, and the latent woman's natural fecundity, $p(t)$, as described in (12). Thus, the main interest in our empirical analysis is the demand for family planning services derived from this expression. The analysis will be undertaken with household survey data.

The nonseparable relationship between the variables in (12) implies that the effect of random variation in one factor on contraception efficiency will vary with all the other covariates in the model (Chesher, 2003). In this context, nonseparability provides for the possibility that otherwise comparable women, in terms of one observable, will adopt contraceptive methods with different levels of efficiency, due to different interactions among the remaining variables in the model.

One of the important variables in the model is the frequency of intercourse, which captures a woman's sexual activity (Brown, 2000). We assume that frequency is also a choice, and, therefore, the frequency at which a woman has intimate intercourse is endogenous, in the sense that it may be taken jointly with the contracepting decision. We postulate that, while it is true that sexual activity is a *sine qua non* for human reproduction, sexual intercourse is also a source of pleasure and may even be a source of income (Moffat, 2005; Smith and Christou, 2009; Hakim, 2010). This implies that, otherwise identical women are likely to have different contraceptive strategies for the same level of coital frequency.

We argue that, as an instrument for human reproduction, sexual activity will be driven mainly by the ideal number of children. The higher the ideal family size, the higher the coital frequency and the lower the efficiency of the woman's contraceptive method. In contrast, we expect that, as a source of pleasure or earnings, coital frequency will be positively correlated with contraceptive efficiency. In this case, sexual activity is likely to be negatively linked to the woman's level of income, because, on one side, richer women are able to diversify their sources of entertainment, and, on the other side, an increase in income will reduce the need to rely on sexual activities as a source of current or future income.

In what follows we attempt to isolate the heterogeneous impact of the frequency of sexual activity on contraceptive efficiency by estimating an econometric model with essential heterogeneity in outcomes (Heckman et al., 2006). Furthermore, since the frequency of intercourse is considered to be a continuous treatment, we adopt the control variable approach, which estimates the demand for contraception efficiency based on a triangular simultaneous equation model. The identification and estimation of this type of model, with nonseparable disturbances, has been discussed at length in the literature (Chesher, 2003; Florens et al., 2008; Imbens and Newey, 2009).

A generalized econometric formulation of the economic models developed above is given by the following non-separable model

$$y = (X, \varepsilon), \tag{13}$$

where y is the logit of contraceptive efficiency m (Berkson, 1944), X is a vector of covariates including the endogenous frequency of sexual intercourse $d \equiv \chi(t)$, and ε is a general disturbance vector representing heterogeneous volatility in the value function. The model in (13) is equivalent to a treatment effects model, since it describes a nonseparable outcome model with a general disturbance.

Our empirical strategy is a multistep procedure, which closely follows the control variable technique discussed in Imbens and Newey (2009). In their analysis, the first step consists of building the control variable from the choice equation, before obtaining, in the second step, the conditional expectation of the outcome, given the endogenous variable and the control variable. Furthermore, Imbens and Newey (2009) show that, given a choice equation that is monotonic in a scalar disturbance, the conditional cumulative distribution function of the endogenous variable, given the instruments, is a control variable.

Therefore, we assume that the choice of sexual intercourse frequency is described by the following nonseparable treatment choice model

$$d = \varphi(Z, \epsilon), \tag{14}$$

where φ is a strictly monotonic function in Z and the scalar unobservable, ϵ, representing the woman's taste for intercourse. The instrument, Z, captures the observed socio-economic environment, which determines a woman's sexual behavior, but not her contraceptive behavior, while ϵ captures the latent taste for sexual intercourse. The strict monotonicity in ϵ implies that a heightened state of interest in intercourse will induce higher frequency of sexual contacts, and is essential to the derivation of the control variable. Imbens and Newey (2009) show that, under independence of (ϵ, ε) and Z, the conditional cumulative distribution function (CDF) of d, given Z, is a control variable

$$v = F_{d|Z}(d, Z) = F_{\epsilon}(\epsilon), \tag{15}$$

such that conditioning on the control variable v leads to the identification of structural effects of any change in X from the conditional distribution of Y, given X and v. Note that the CDF in (15) can be estimated using standard nonparametric procedures, such as the ones outlined in Li and Racine (2008).

In summary, our empirical strategy is carried out in two steps. The first step estimates the control variable from the choice equation, and in the second stage the estimated control variable is plugged into the outcome equation, as an additional covariate, in order to make any change in X causal. In other words, the second step involves estimating the output equation in (13) with the control variable estimates $\widehat{v} = \widehat{F}_{d|Z}(d|Z)$ from the first step in (15) as an additional co-variate. In particular, we nonparametrically estimate the following logistic outcome model

$$y = g(X, \widehat{v}) + \varepsilon, \tag{16}$$

where $y = \log(m/1 - m)$ and $g(\cdot)$ is an arbitrary function estimated from the data.

4 Data

The information we use for the empirical analysis comes from two modules of the 2010 Malawi Demographic and Health Survey (MDHS): the module on *Reproductive Behavior and Intentions* and the *Contraception* module. The module on reproductive behavior and intentions records answers to questions about fertility history, current pregnancy status, fertility preferences, and the future childbearing intentions of each woman. The contraception module documents answers about knowledge and use of specific contraceptive methods, source of contraceptive methods, exposure to family planning messages, informed choice, and unmet needs for family planning.

We measure contraceptive efficiency using contraceptive use histories collected in the contraceptive calendar of the 2010 MDHS. A standard DHS contraceptive calendar records, for each woman, information about contraceptive status, births, pregnancies, reasons for discontinuing a method, and marital status by calendar month over at least a sixty month period preceding the survey. This information can be used to analyze the efficacy and continuity of women's contraceptive use (Ali and Cleland, 2010; Ali et al., 2012). For our analysis, we derive the average efficiency of the woman's contraceptive strategy by first, matching each method with its published efficiency during "typical use" (Trussell, 2011; World Health Organization, Department of Reproductive Health and Research (WHO/RHR) and John Hopkins Bloomberg School of Public Health/Center for Communication Programs (CCP), Knowledge for Health Project, 2011), and then taking the average over the duration of the reproductive calendar. This operation produces contraception efficiency as a continuous variable taking values between 0 and 1: $0 \leq m \leq 1$.

Using data from the United States of America, Table 1 shows some standard contraceptive methods against its level of efficiency during "perfect use", when the method is used correctly and consistently (as directed) and during "typical use", which is how effective the method is during actual use. In our computation of the average efficiency of a woman's contraceptive strategy, we assume that, since the category "other folkloric contraceptive methods" as recorded in the DHS contains family planning methods with no scientific proof regarding their efficiency, using them is actually not different from not using any contraceptive method at all.

Table 1: Contraceptive Efficiency: Rates of Unintended Pregnancies per 100 Women during the First Year of Use

	Rates of Unintended Pregnancies per 100 Women	
Family Planning Method	**Perfect Use**	**Typical Use**
Total Abstinence	0	0
Implants	0.05	0.05
Male Sterilization	0.10	0.15
Female Sterilization	0.50	0.50
IUD	0.60	0.80
Lactational Amenorrhea Method	0.90	2
Injections	0.05	6
Pill	0.30	9
Diaphragm	6	12
Male Condom	2	18
Female Condom	5	21
Withdrawal	4	22
Periodic Abstinence/Rhythm	5	24
Foam and Jelly	18	28
Other Traditional Methods	85	85
No Contraception	85	85

Source: Adapted from Trussell (2011).

In what follows we present some statistics describing the structure of our data. We start by analyzing the trend in contraceptive efficiency at the aggregate level. Combining information on the effectiveness of standard methods in their typical use from Table 1, with data on contraceptive behavior from the 2010 MDHS reproductive calendar, suggests that women in Malawi are increasingly using more efficient contraceptive strategies. The percentages in Figure 3 show that the average efficiency of the contraceptive behavior of a woman of reproductive age in Malawi has increased from 2005 to 2010. In 2005 the average efficiency of contraception in the country stood at 28.16%. This percentage slowly progressed to 34.24% in 2008, before jumping up to 37.64% and 41.64% in 2009 and 2010, respectively.

Our theoretical model suggests that these dynamics in contraception efficiency are driven by individual contraceptive behaviors determined by factors, such as fecundity, frequency of intercourse and the cost of contraception. We approximate a woman's natural fecundity

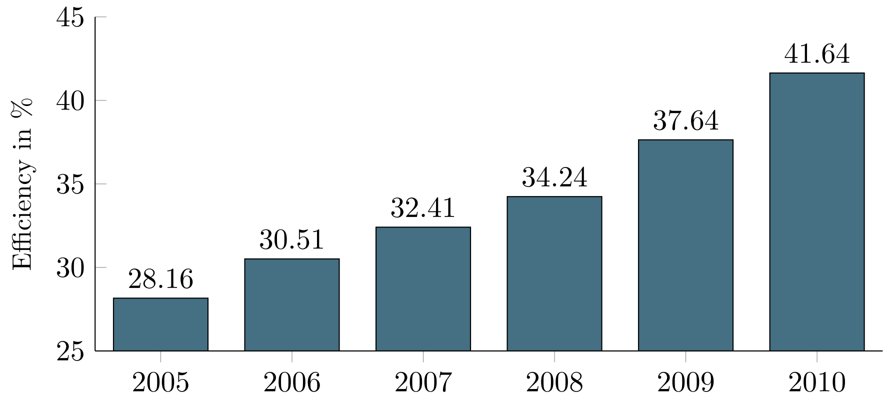

Figure 3: Average Contraceptive Efficiency in Malawi 2005-2010

by the time-to-first-pregnancy (TTFP), which is defined as the length of time from starting unprotected intercourse till first conception, where larger TTFPs imply less fecund women. The TTFP is mainly determined by biological fecundity, which makes it one of the most common methods for measuring human fecundity (Basso et al., 2000; Keiding et al., 2012). However, in order to control for the fact that the duration time to first pregnancy might also be influenced by the woman's contraceptive behavior, we restrict our sample to those married women, whose age at first intercourse coincides with or is higher than the age at the start of the reproductive calendar. The idea is that, since the primary objective of marriage is starting a family, contraceptive use among young married women is likely to be very low before their first pregnancy.

Another variable of interest in our analysis is the frequency of intercourse, which captures a woman's sexual behavior. As a measure of a woman's exposure to sexual activity, coital frequency can be measured by the number of sex episodes during the woman's last menstruation cycle, or by the length of time since the last episode of sex. The question about the number of sex episodes which appeared in previous DHS has been discontinued, and the current DHS only records the answer to the question probing coital recency. Thus, we use intercourse recency as a proxy for an individual's frequency of intercourse. Furthermore, in our triangular simultaneous equations set-up, coital frequency is an endogenous variable, which, in turn, would likely be determined by the ideal number of children, income, as well as the latent taste for sexual intercourse. We use the average years of education between the woman and her partner to approximate the couple's income, since it is not available in the

DHS and DHS wealth measures do not necessarily describe current flows.

Finally, another variable of interest in our model is the cost of contraception. Unfortunately, the DHS does not collect information on the cost of family planning services. However, one can infer an index for the combined economic and non-economic costs of contraception in a given geographical area by using the percentage of women with unmet need for contraception (Casterline and Sinding, 2000; Bongaarts, 2010). The demand for contraception in the DHS is measured by the level of contraceptive use that would prevail if every fecund woman, who wants to avoid pregnancy, were currently using contraception. Couples whose demand for contraception is not satisfied have an 'unmet need' for contraception, and the cost of contraception to individuals is the proximate determinant of the unmet need (Bongaarts, 2010). Thus, we assume that geographical variations in the percentage of women with unmet need for contraception reveals information about spatial contraceptive cost differentials. In the index, we combine both unmet need for spacing and limiting births. All the covariates used for estimation are summarized in Table 2, while correlation coefficients are presented in Table 3.

Table 2: Descriptive Statistics

	Statistics							
	N	**mean**	**min**	**max**	**cv**	**quantiles**		
Variable						p25	p50	p75
Efficiency	1797	0.25	0.15	0.94	0.53	0.15	0.19	0.31
TTFP	1797	17.79	0	100	1.39	0	0	33.33
Recency	1795	12.43	0	31	1.07	1	4	31
% of Unmet Need	1657	11.23	0	55	0.65	6	10	14
Ideal # of Kids	1797	5.76	0	10	0.41	5	6	8
Education	1614	22.95	15.5	44.5	0.13	21	22.5	24.5
Age	1797	3.52	0	7	0.31	3	4	4

Source: 2010 MDHS

5 Empirical Results

A preliminary inspection of the data reveals that its structure is consistent with predictions from our theoretical model of contraceptive behavior. In particular, the correlation coefficients in Table 3 suggest that a sexually active woman, who had spent a relatively long period of time before first pregnancy, is more likely to use less efficient contraceptive methods. This is also true for a woman who does not have frequent sexual contacts. Another factor that negatively impacts on the efficiency of a woman's contraceptive behavior is the level of unmet need for contraception, which is negatively correlated with contraceptive efficiency in our data. Although these correlation coefficients are supportive of the theory, further evidence is needed.

A key finding provided by the correlation matrix is the fact that the ideal number of kids is highly correlated with the frequency of intercourse, but it is not related to contraceptive efficiency. This is very important for our empirical strategy, which relies on an exclusion restriction to control for endogeneity. The positive sign of the correlation coefficient suggests that a woman, whose ideal number of children is very high, will use less efficient contraceptive methods, and *vice-versa* for a woman who prefers not to have a high number of children.

Table 3: Correlation Matrix: These results show only correlation coefficients that are significant at the 5/1% level.

	Efficiency	Unmet	Recency	TTFP	Education	Age	Kids
Efficiency	1						
Unmet	-0.126^a	1					
Recency	-0.105^a		1				
TTFP	-0.104^a	0.049^b		1			
Education	0.101^a		0.067^a		1		
Age	0.194^a				0.078^a	1	
Kids			-0.073^a		-0.118^a	-0.054^b	1

Source: 2010 MDHS, Significance: ^{b}–$p < 0.05$, ^{a}–$p < 0.01$

The correlation matrix also shows that education is positively related to both contraceptive behavior and sexual behavior in Malawi. The direct relation between education and contraceptive efficiency and intercourse recency is related to the opportunity cost of time:

more educated women have a higher opportunity costs of time, which is an incentive to avoid any unplanned exit from the formal labour market, due to accidental pregnancy. The data suggests that they achieve this by adopting more efficient contraceptive methods and reducing intercourse frequency. We also see that the ideal number of children is negatively related to the couple's education, with more educated couples having a lower ideal number of children.

The small correlation coefficients in Table 3 suggest that the relationship among the variables could very well be nonlinear, which is also suggested by the nonseparable expressions in equation (12), although endogeneity could also explain the small coefficients. To address these different possibilities, we undertake nonparametric estimation of our triangular simultaneous equation model of the demand for contraceptive efficiency. In the first step, we use the kernel estimator of Li and Racine (2008) to nonparametrically estimate the conditional cumulative distribution function (CDF) of the logarithm of recency, given the average education of the couple and the woman's ideal number of kids, with the latter used as an instrument.

The results of the kernel regression significance test suggest that the two explanatory variables are highly significant; see Table 4, which confirms the highly significant correlation coefficients reproduced in Table 3.

Table 4: Kernel Regression Significance Test for the Choice Equation.

	Type I Test IID Bootstrap (399 Replications)	
Variable	*Bandwidths*	*p-value*
# of Kids	0.535054	0.0075188
Education	1.110638	$< 2.22e\text{-}16$

Results from test of significance of regressors in nonparametric regression models, Racine (1997); Li and Racine (2008), estimated with npsigtest from the np package (Hayfield and Racine, 2008) developed for R (R Core Team, 2014).

Next, for the estimation of the outcome equation, we use local linear estimators as described in Li and Racine (2004), with fixed bandwidths automatically selected through the expected Kullback-Leibler cross-validation method. The results for the significance test in Table 5 show that all covariates are highly significant except for the log of recency.

We display partial regression plots in Figure 4, together with bootstrapped variability bounds, holding all other variables at their respective medians. The plots reveal that that

Table 5: Kernel Regression Significance Test for the Outcome Equation.

	Type I Test IID Bootstrap (399 Replications)	
Variable	*Bandwidths*	*p-value*
TTFP	3582543	< 2.22e-16
log(recency)	1959187	0.1553885
% Unmet Need	104.8947	< 2.22e-16
Age	3.67107	< 2.22e-16
Education	3.72385	0.0050125
vhat	68042.6	< 2.22e-16

Results from test of significance of regressors in nonparametric regression models (Racine, 1997; Li and Racine, 2008) estimated with npsigtest from the np package (Hayfield and Racine, 2008) developed for R (R Core Team, 2014).

less fecund women (those with longer TTFPs) are likely to use contraceptive methods with lower expected efficiency. Furthermore, contraceptive efficiency decreases with the percentage of unmet need of contraception (i.e. falls with our proxy of cost) and increases with the couple's average level of education. The partial regression plots also suggest that contraceptive efficiency first rises and then falls (maybe) with the average age of the couple, and is non-decreasing with the latent taste for intercourse (as measured by recency of last intercourse).

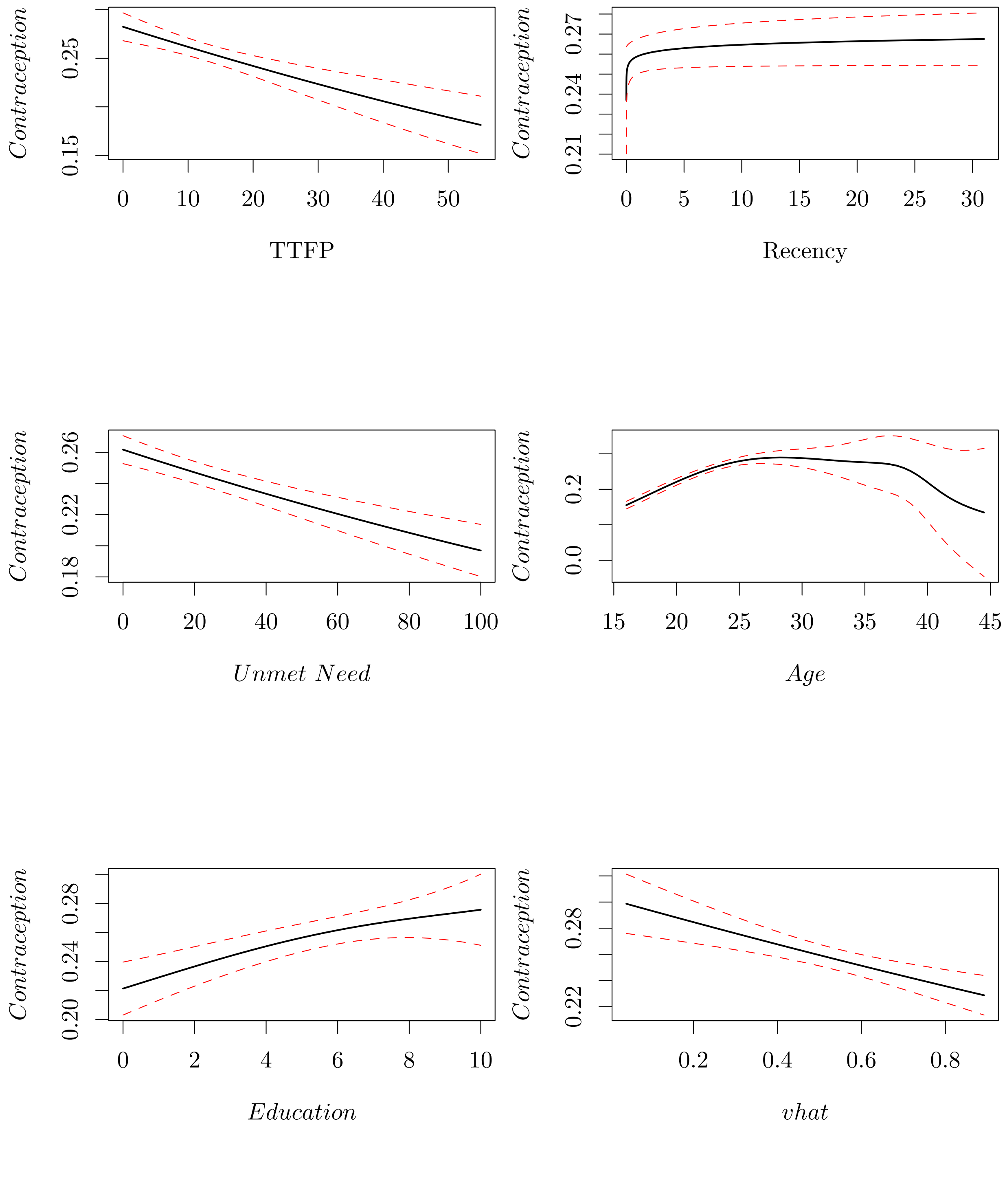

Figure 4: Partial Local Linear Nonparametric Regression Plots with Bootstrapped Pointwise Error Bounds

Table 6: Second Stage Significance Test

Variables	Bandwidths	Var Range	P	Sig
ttfp	232.101	55	0	***
lrec	1622223.448	12.6	0.14	
punmet	25849801.779	100	0	***
avage	3.703	28.5	0	***
avedu	0.915	10	0.11	
vhat	122011.823	0.9	0	***

Hello, this is a messy table? Let me see if it fits on a page.

6 Conclusion

Investment in reproductive health has the potential to reduce poverty and avert maternal and childhood deaths, especially in poor countries. In this context, knowledge of factors that affect an individual's reproductive health-related behavior is vital in order to understand how an individual values changes in her reproductive health, and creates a basis for normative evaluation of policy interventions aimed at increasing access to family planning and maternal health services. Here we focus on the factors which determine the demand for family planning services, as a particular form of reproductive health care.

Very little is known about the factors that determine individual contraceptive behavior. This is compounded by the fact that the link between medical care and health is a controversial issue in general. The majority of studies on contraception focus more on the fertility effect of contraception and the description of patterns of unmet need for contraception. These largely empirical studies pay little attention to the determinants of contraceptive behavior, and produce evidence largely dependent on ad hoc models of reproductive behavior and specific choices on the functional form of estimating equations. Hence, there appears to be a dearth of empirical content within the reproductive health agenda.

Therefore, this study introduces a theoretical reformulation of the original Grossman model, and applies it to the case of reproductive health. In the model, the choice of the optimal level of contraceptive efficiency is realized, subject to the equation of motion of reproductive health capital. The resulting expressions of the demand for family planning services can be used to reproduce some basic stylized facts about individual contraceptive behavior, specifically, that better (more efficient) contraception is more likely to be used if it is less costly to access and is expected to have greater benefits. For example, it is preferred (*ceteris paribus*) for women engaged in more sexual activity and believe they are naturally more fertile.

We test the theoretical predictions of our contraceptive behavior model by fitting individual-level survey data to a triangular simultaneous equations econometric model, with the ideal number of kids as an instrument. The inclusion of the latter is to correct for any possible endogeneity in sexual behavior. It is assumed that a person's contraceptive behavior may be influenced by her sexual practice. The theoretical predictions of our model are not rejected by the data. In particular, we confirm that contraceptive efficiency is positively related to our proxy for natural fecundity, but negatively related to our proxy of contraception costs. We also show that contraception efficiency first increases with age before falling, and that more educated people tend to use more efficient contraceptive methods. We contend this last result derives from the potentially larger opportunity costs of an unplanned pregnancy.

Access to reproductive health services affords women the opportunity to optimize their lifetime productive opportunities by lowering the costs of long-term career investments and reducing uncertainties regarding the timing of births (Goldin and Katz, 2002; Canning and Schultz, 2012). Thus, analysing the demand for reproductive health care provides a natural channel through which socio-economic factors can be expected to explain observed fertility outcomes. In future empirical work one may be interested in extending our framework to consider other components of reproductive health, namely maternal health care and child health care. It might also be possible to use our framework to analyze the provision of childcare services, as an input to the production function of active time in the formal labour market for working mothers.

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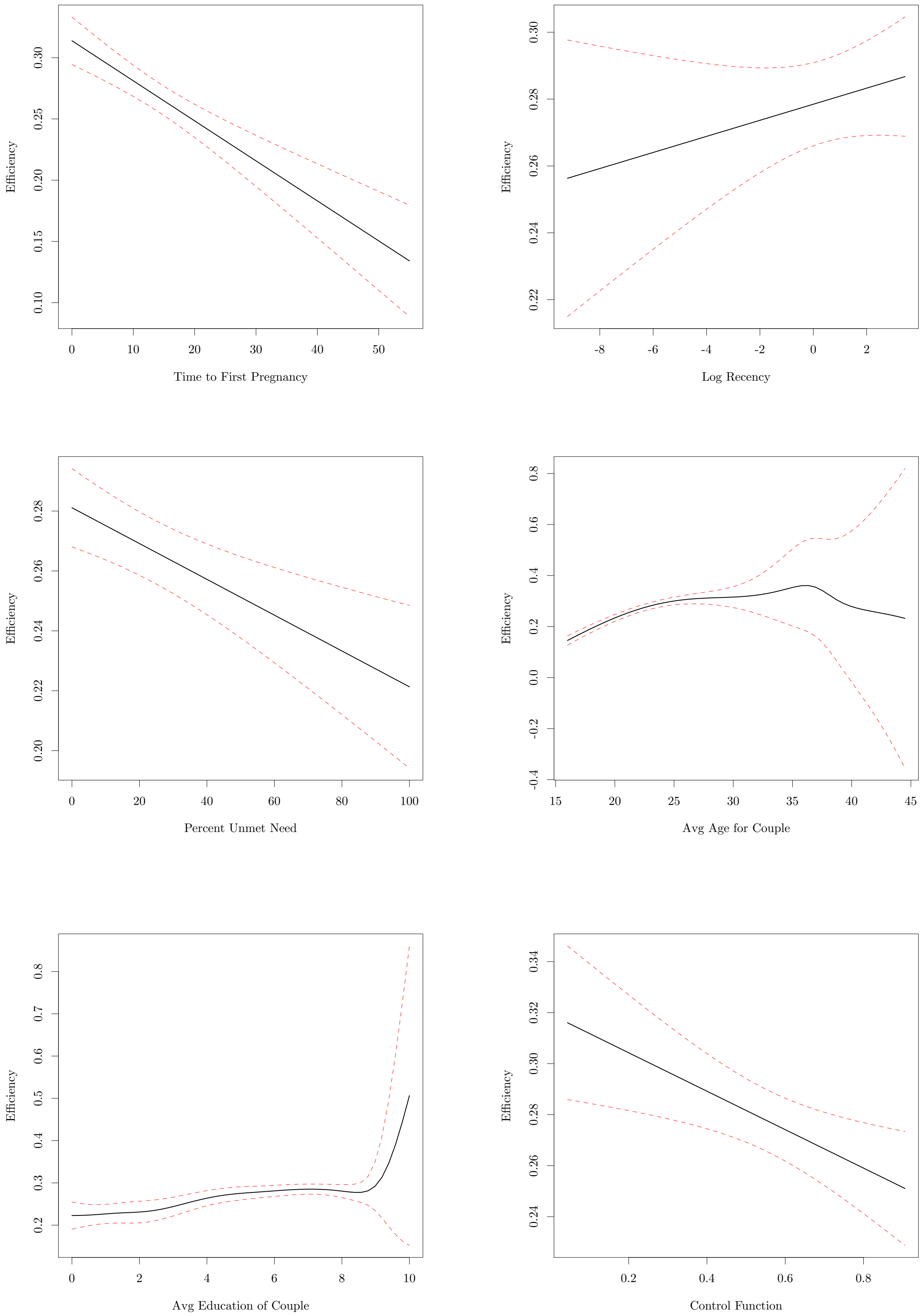
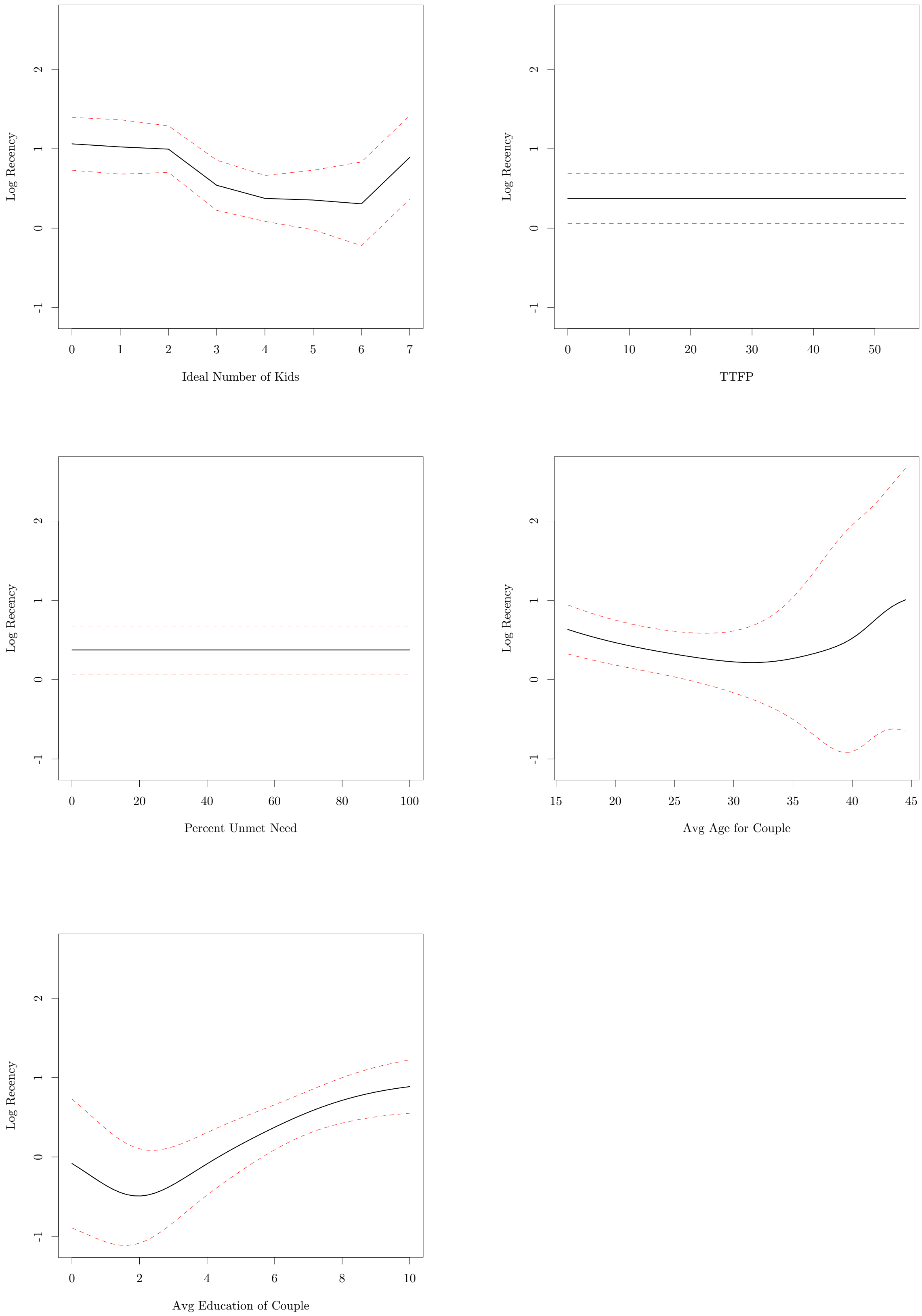
7 Nonparametric Regression of the First Stage

Table 7: First Stage Significance Test

Variables	Bandwidths	Var Range	P	Sig
idkid	0.244	7	0	**
ttfp	7427169.112	10	0.52	
punmet	36758203.195	55	0.09	.
avage	4.145	100	0.03	*
avedu	1.518	28.5	0	***

Hello, this is a messy table? Let me see if it fits on a page.


Efficiency
0.10 0.15 0.20 0.25 0.30
0 10 20 30 40 50
Time to First Pregnancy
Efficiency
0.22 0.24 0.26 0.28 0.30
-8 -6 -4 -2 0 2
Log Recency
Efficiency
0.20 0.22 0.24 0.26 0.28
0 20 40 60 80 100
Percent Unmet Need
Efficiency
-0.4 -0.2 0.0 0.2 0.4 0.6 0.8
15 20 25 30 35 40 45
Avg Age for Couple
Efficiency
0.2 0.3 0.4 0.5 0.6 0.7 0.8
0 2 4 6 8 10
Avg Education of Couple
Efficiency
0.24 0.26 0.28 0.30 0.32 0.34
0.2 0.4 0.6 0.8
Control Function


Log Recency
Ideal Number of Kids
Log Recency
TTFP
Log Recency
Percent Unmet Need
Log Recency
Avg Age for Couple
Log Recency
Avg Education of Couple