Risk Aversion and Fertility: Implications for Child Outcomes and Investment in Childrens' Education

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ABSTRACT

There is a large empirical literature on the impact that the availability of abortion has on child outcomes, yet very little underlying theory explaining the process. To fill this void, this paper presents a model of childbearing and investments in the quality of children under uncertainty. Its applicability is not just confined to abortion which is only one of several methods that improves control over fertility. It is also useful in understanding how childhood immunization programs and other improvements in health care that reduce mortality can influence fertility and parents' investment in the human capital of their children.

We show that reductions in uncertainty can in fact increase the number of children and not decrease it as is generally expected. Secondly, we find that increases in income lead to an increase in the expected number of children regardless of the degree of risk aversion of the parents. Finally, it is shown that policies which increase the ability to control fertility will be more effective than income transfers aimed at improving child outcomes if families have a low degree of risk aversion. We find that for families with a high degree of risk aversion neither policy will be effective in improving child outcomes.

I. Introduction

This paper examines the relationship between the fertility decisions of parents and their investments in the quality of their children in an environment characterized by uncertainty. Over the last several years there has been a substantial amount of empirical work addressing the interaction between the quantity and quality of children. This research explores the effects that the availability of birth-control in general, and abortion in particular has on children's outcome, including their likelihood to live in poverty, be born with adverse health conditions, be maltreated or commit crimes (see e.g., Gruber, Levine and Staiger, 1999; Grossman and Joyce, 1990; Seiglie 2004; Donohue and Levitt, 2001; and Pop-Eleches, 2006. Most of this research presents no formal model and instead, the argument presented is that access to birth control methods permits a selection process that can increases the average quality of children via the quantity/quality tradeoff or improve the timing of births which allows for increases in parental human capital and therefore, the quality of their offspring (see e.g., Angrist and Evans, 1999). Again, birth-control including abortion, provides the technology to reduce the uncertainty regarding family size but how this affects family size will depend upon the degree of risk-aversion of the parents as we demonstrate.

The relationship between quantity and quality of children is also central to the economic growth literature, namely through the interaction between the fertility decision of parents and their investment in the human capital of their children. Some of the literature on the determinants of fertility and its interaction with parental investments in their children's human capital and a country' economic growth include Becker et al., (1990), while others account for the effects of child mortality on fertility and as a consequence on parent's investments in children's human capital (see e.g., Galor and Weill 2000; Kalemli-Ozcan, 2000; Kalemli-Ozcan et al., 2000; Boldrin and Jones, 2002; and Soares, 2005). With the exception of Kalemli-Ozcan (2000), in most of this work there is no uncertainty regarding the number of children that parent's desire and survive. For example, Soares (2005) allows child mortality to enter into the preferences of parents and proceeds to analyze an exogenous reduction of this on demographic transition. Yet in reality, how many children survive, i.e., mortality rates along with how many are actually born is uncertain. Medical advances can increase the expected number surviving and birth-control can reduce the variance surrounding family planning, but how this reduction in uncertainty affects parental decisions is far from obvious as this paper shows. In the next section, we derive the conditions under which reductions in uncertainty can reduce the demand for children and increase their quality. We also compare the efficacy of government policies aimed at improving the quality of children through birth control versus income transfers to families which they can spend on improving the education of their children.

II. A Model of Fertility Choice and Investment in Children Under Uncertainty

The framework employed is a modified version of the model introduced by Becker and Lewis (1973), Becker (1981) and Willis (1973). In the beginning of the period, parents adopt a lifetime plan for childbearing by choosing the desired number of children in the household. Once this is chosen, parents then determine the amount they desire to spend on their children, and on the other commodities that provide satisfaction to the parents. More specifically, families are assumed to have preferences regarding the number of children they desire, $\overline{n}$, the quality per child q/n which is assumed to be equal across all children in the household, and a composite commodity, z, unrelated to children.

The parents' utility function is given by:

$$U[n,q,z] = n\phi\left[\frac{q}{n}\right] + k\phi(z) \tag{1}$$

where n is the number of children, q is the total resources allocated to enhance children 's quality and therefore, q/n is the average quality per child and z is the parent's consumption of other goods.

We use the same function ϕ to capture the impact that the quality per child $\left(q/n\right)$ and other goods, z, has on an individual's utility. Without this specification, the relative magnitude at which the marginal utility of these two goods decreases will influence the results. In the absence of a good theory of why one marginal utility decreases faster than the other, the current specification seems like a reasonable starting point. However, this assumption does not imply that from the individual's point of view the two goods are completely symmetrical. A person with a large value of k attaches more significance to the consumption of other goods (z) and will allocate a larger share of her budget to the purchase of those goods.

The function ϕ is assumed to be increasing and to be strictly concave. As it has been pointed out that when using this type of utility function, it is convenient to assume that there is a number α, greater than zero, such that $\phi(\alpha) = 0$. With this assumption one can rule out the possibility that it may be optimal to have an infinite number of children. This is so because when q/n is very low the marginal utility of an extra child is always negative.

In general, the utility function can be made to depend upon the sum of the utility generated by each child. Let q_i be the resource allocated to the ith child. The total utility derived from all children is given by

$$\sum_{i}^{n} \phi(q_i) \qquad i = 1, \ldots, n. \tag{2}$$

Letting $q = \sum q_i$, results in this formulation being identical to (1) because the concavity of ϕ implies that each child will be assigned the same quality. The interaction between quality and quantity described in (1) has been used extensively in the literature on optimal population growth (see Dasgupta, 1969 and Rodriguez, 1988).

Choosing units so that the relative prices of *q* and *z* are one, the budget constraint can be written as:

$$q + z = I \tag{3}$$

where we denote income by *I*. Once the value of *n* is chosen, the parents maximize utility by choosing *q* and *z* in such a way that

$$\phi'\left[\frac{q}{n}\right] = k\phi'[I - q]. \tag{4}$$

i.e., so that the marginal utility derived from an additional unit increase in quality is equal to the marginal cost as measured by the foregone consumption of commodity *z*. Since the number of children that will be born or survive is uncertain, we assume a function ϕ with constant relative risk aversion, CRRA, so that

$$\phi[\ .\ ] = \frac{A}{1-\theta} + \frac{[\ .\ ]^{1-\theta}}{1-\theta}, \qquad \theta > 0, \qquad A < 0. \tag{5}$$

The level of consumption α that makes ϕ equal zero is given by $-A^{\frac{1}{1-\theta}}$. Figure 1 depicts two cases of the utility function associated with different values of θ. When θ is smaller than one utility is unbounded, but when θ is greater than one as c approaches infinity utility approaches $\frac{-A}{1-\theta}$. In the figure the value of A was made equal to -1 so in both cases α equals one. Substitution of (5) into the first order condition (4) yields the following expression for q:

$$q(n) = \frac{k*n}{1+k*n} I , \quad \text{where } k* = k^{-\frac{1}{\theta}} \quad . \tag{6}$$

Therefore, the average child's quality is equal to

$$\frac{q}{n} = \frac{k*I}{1+k*n} = R(n) . \tag{7}$$

As expected it decreases with n and with the index of appreciation of other goods k. The derivatives of R are given by:

$$R'(\bar{n}+\varepsilon) = \frac{dR}{d(\bar{n}+\varepsilon)} = -R^2 \frac{k^*}{I} < 0 \tag{8}$$

$$R''(\bar{n}+\varepsilon) = \frac{2R^3 k^{*2}}{I^2} \tag{9}$$

The parents target the number of children that maximizes their expected utility. The actual number of children n is equal to $\bar{n}$ which is chosen by the parents, plus ε a random term. It is assumed that the random variable ε takes values in the interval $[x_o, x_1]$ and that it has a expected value μ. Thus the expected number of children is $\bar{n}+\mu$. Given the density function $f(\varepsilon)$, the parent's expected utility from equation (1) is given by

$$E[U] = \int_{x_0}^{x_1} \left[(\overline{n}+\varepsilon)\phi\left[\frac{q(\overline{n}+\varepsilon)}{\overline{n}+\varepsilon}\right] + k\phi\left[I - q(\overline{n}+\varepsilon)\right]\right] f(\varepsilon)d\varepsilon \,.$$

$$= \int_{x_0}^{x_1} [(\overline{n}+\varepsilon)\phi[R(\overline{n}+\varepsilon)] + k\phi[1-(\overline{n}+\varepsilon)R(\overline{n}+\varepsilon)] f(\varepsilon)d\varepsilon \qquad (10)$$

The parent maximizes expected utility by choosing the value of $\overline{n}$ in equation (10) such that $E\left[\frac{\partial U}{\partial \overline{n}}\right]$ equals zero. Using (4), (7) and (8) the first order condition can be written as:

$$\int Y(\overline{n}+\varepsilon) f(\varepsilon)d\varepsilon = 0\,, \qquad (11)$$

where,

$$\begin{aligned} &Y(\overline{n}+\varepsilon) = \phi[R(\overline{n}+\varepsilon)] + (\overline{n}+\varepsilon)\phi'[R(\overline{n}+\varepsilon)]R'(\overline{n}+\varepsilon) - \\ &k\phi'[I-(\overline{n}+\varepsilon)R(\overline{n}+\varepsilon)]\big((\overline{n}+\varepsilon)R'(\overline{n}+\varepsilon) + R(\overline{n}+\varepsilon)\big) \\ &= \phi[R(\overline{n}+\varepsilon)] - R(\overline{n}+\varepsilon)\phi'[R(\overline{n}+e)] \end{aligned} \qquad (12)$$

It is assumed that there is an interior solution a condition.

The second order condition for maximization is always fulfilled since the function Y is decreasing in its argument (from (8) and (12) it follows that its first derivative is equal to $-\phi''RR' = \frac{k^*}{I}\phi''R^3 < 0$). However, the second derivative which is given by $\left(\frac{k^*}{I}\right)^2 R^4\left(3\phi'' + \phi'''R\right)$ has an ambiguous sign. The sign turns out to be quite important.

To carry out the analysis it is convenient to rewrite the first order condition as requiring that $\int -Yf(\varepsilon)d\varepsilon = 0$. The advantage of considering this equality is that since (-

Y) is a monotonically increasing function one can use the results of Rothschild and Stiglitz (1970) to consider effects of a reduction in uncertainty due to the introduction of birth-control or a reduction in child mortality. Holding $\bar{n}$ constant, their results imply that the integral $\int -Yf(\varepsilon)d\varepsilon$ increases in value if -$Y(\bar{n}+\varepsilon)$ is concave. For the class of utility functions defined in (5), ϕ''' is always positive so -Y is concave if and only if

$$\left|\frac{3\phi''}{\phi'''R}\right| = \frac{3}{\theta+1} < 1. \qquad (13)$$

In other words, -*Y* is concave if the coefficient of constant relative risk aversion θ exceeds two. The fact that a decrease in risk increases the value of the integral $\int -Yf(\varepsilon)d\varepsilon$ implies that in order to maintain the integral equal to zero, $\vec{n}$ must go down [Recall that -Y is increasing on n]. When θ exceeds two, then -*Y* is convex and the results are reversed.

Proposition I. A decrease in uncertainty decreases (increases) the targeted number of children $\bar{n}$ *if the coefficient of relative risk aversion is less (greater) than two.*

Given the values of the coefficient of relative risk aversion that are considered plausible in the literature[1] it is likely that a decrease in risk will be associated with a lower value of $\bar{n}$.

[1] Kydland and Prescott, 1982 find that it should be between zero and one to be consistent with macro data, while Kockerlakota, 1996 shows that much higher estimates are needed to be consistent with the equity premium puzzle. Schechter, 2007 calculates measures from experimental data using an approach we follow.

The effect of an income transfer (an increase of *I*) on the expected number of children can be analyzed as follows. Differentiation of (10) yields

$$\int \left[\frac{\partial Y(\bar{n}+\varepsilon)}{\partial I} + \frac{\partial Y(\bar{n}+\varepsilon)}{\partial \bar{n}} \frac{\partial \bar{n}}{\partial I} \right] f(\varepsilon) = \int \left[\phi'' \frac{R^2}{I} \right] f(\varepsilon) d\varepsilon + \int \left[\frac{\partial Y(\bar{n}+\varepsilon)}{\partial \bar{n}} \frac{\partial \bar{n}}{\partial I} \right] f(\varepsilon) = 0 \tag{14}$$

Since $\frac{\partial Y}{\partial I}$ is clearly negative, the sign of $\frac{\partial \bar{n}}{\partial I}$ must be negative.

Proposition II. Regardless of the degree of risk aversion an income transfer results in a decrease of the expected number of children.

The result of Proposition II will be strengthened if the size of the transfer is positively related to the number of children as some transfers are.

Finally, we consider the effects of a change in risk or an income transfer on child outcomes. We define poor child outcomes when the quality invested in a child falls below an exogenously given basic level, K_0 (see Seiglie, 2004). For example, providing insufficient years of schooling, health care or neglecting a child are examples where parents choose to provide expenditures on quality less than the basic needs level. We assume that choosing quality below this level leads to a higher probability of criminal behavior and other adverse social outcomes on the part of children. Recalling equation (7), the probability of this occurring is

$$\text{Prob}\left[\frac{q}{n} < \text{K}_0\right] = \text{Prob}\left[\frac{k*I}{1+k*(\bar{n}+\varepsilon)} < K_0\right] \tag{15}$$

This can be written as

$$\text{Prob}\left[\varepsilon > \frac{I}{K_0} - \frac{1}{k*} - \bar{n}\right] \tag{16}$$

Assuming $\frac{I}{K_0} - \frac{1}{k^*} - \bar{n}$ is greater than μ, the probability of low investment in children is the probability of ε being in the upper tail of the probability distribution. An increase in risk that gives more weight to the tail tends to increase the probability of this occurring. When the coefficient of risk aversion is less that two, this effect is reinforced by the fact that $\bar{n}$ increases and thus the lower limit of integration goes down. The opposite case occurs when the coefficient of risk aversion is high; the probability of low investments in children is not very sensitive to changes in risk because the change in the area under the tail is offset by a change in the limits of integration.

Regarding the effects of income transfers on increasing parent's investment in their children above some basic need level, an increase in I has an ambiguous effect regardless of the degree of risk aversion. The total effect depends on how a change in I affects the limit of integration in equation (16). The increase in the term $\left(I/K_0\right)$ raises the limit of integration and therefore increases child quality but this is offset by the fact that $\bar{n}$ also goes up. The following proposition summarizes the results concerning government policies.

Proposition III. Let A be a policy designed to improve child outcomes such as educational attainment through income transfers. Let B be a policy designed to improve *child outcomes by reducing uncertainty by making birth-control including abortion more accessible or equivalently, a policy that lowers infant mortality by prenatal intervention. For families with small degree of risk aversion, Policy B seems to be more effective and it is likely to have a significant impact. For families with high degree of risk aversion none of the two policies is likely to succeed.*

The results concerning the families with high risk aversion are not very worrisome. There is less need to help those families because their cautious behavior makes them unlikely to be in a situation where they have to provide their children with less than basic quality. Therefore, policies aimed at reducing uncertainty whether it be in mortality rates or fertility will be more effective in improving child outcomes, including those resulting from greater investment in children's human capital.

III. Conclusions

There has been extensive research showing the importance of human capital to economic growth. When life expectancy rises, the returns to human capital increases. Therefore, declines in mortality rates are expected to raise the investment in the education of children as its expected return increases. Similarly, it is presumed that when parents have greater control over fertility they will have less children. This reduction in the number of children is expected to raise the expenditures on the quality of children, including their education. This paper shows that these results are not obvious when one introduces uncertainty. In fact, we demonstrate that reductions in uncertainty can in fact lead to an increase in the number of children and not a decrease. If this is the case, then a reduction in uncertainty will also reduce parents' expenditures on their children.

Secondly, we find that increases in income lead to an increase in the expected number of children regardless of the degree of risk aversion of the parents. Finally, it is shown that policies which increase the ability of parents to control fertility will be more effective than income transfers aimed at improving child outcomes if families have a low degree of risk aversion. We find that for families with a high degree of risk aversion neither policy will be effective in improving child outcomes. The empirical implications of some of these finding include that child outcomes will be sorted by the distribution of the degree of risk-aversion of the population. If some groups are very risk averse and others are not, then access to medical advances or to birth control methods will result in one group increasing the number of desired children and subsequently reducing their expenditures on the quality of their children, while the other will decrease planned births and spend more on their childrens' quality. Over time, this leads to inequality in observable child outcomes that have been sorted by the risk aversion of these children's parents.

Furthermore, sound public policy should strive to provide information on family planning as a means of improving child outcomes in the long run, instead of a dependency on income transfers and in-kind programs to address this objective. Finally, we propose that a first step in evaluating these propositions can be accomplished by reviewing fieldwork and household surveys in developing countries for agricultural and microfinance projects and comparing the behavior of the respondents to their fertility behavior. One should observe that those farmers or borrowers that exhibit low degrees of risk aversion should also be those whose fertility declines when family planning methods are introduced.

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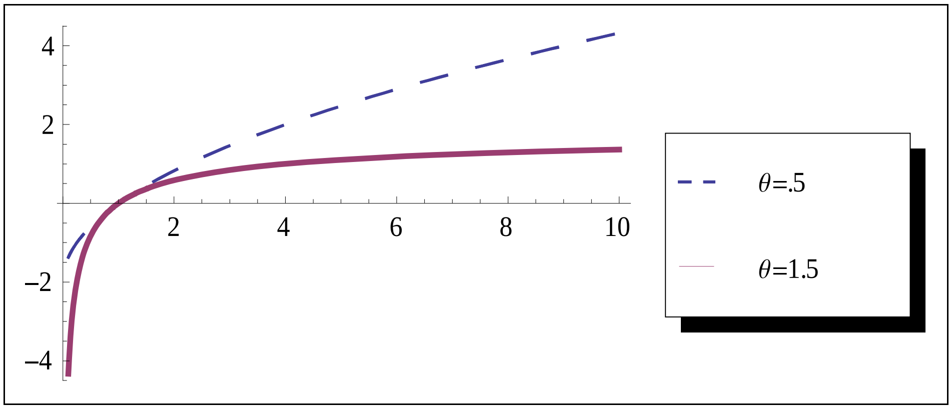

Figure 1