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Child mortality, fertility, and human capital accumulation

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Abstract This article analyzes the impact of decline in child mortality on fertility and economic growth. The study shows that the timing of mortality relative to education is crucial to implications of mortality decline. If child mortality is realized before education starts, an exogenous decline in child mortality leads to a decline in education—a finding that is opposite to those of studies that considered a decline in mortality after the cost of education has been incurred. The work also demonstrates the role of parental human capital in reducing child mortality and the causal link between rising education and declining child mortality.

Keywords Child mortality · Fertility · Human capital · Economic growth

JEL Classification O11 · O15 · J13

1 Introduction

This article studies one of the classical questions in demographic economics: What is the impact of mortality decline on fertility and growth? The particular feature that distinguishes this study from many existing papers in this context is the timing of mortality, which is assumed to occur before any education or human capital investment takes place. Since, empirically, the majority of child mortality is realized before children reach school, this assumption is entirely realistic relative to data. The major contribution of this paper is to show that the timing of mortality relative to education is crucial to implications of mortality decline. In particular, if child mortality is realized before education—a finding that is opposite to those of studies

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that considered a decline in mortality after the cost of education has been incurred. The intuition behind this result is that child mortality reduction lowers the cost of rearing surviving children in general, which makes child quantity more attractive relative to child quality. In contrast, if mortality is high, parents will concentrate their resources on providing good education for their surviving offspring, instead of attempting to increase the number of their children.

To examine the dynamic implications of the model presented here, child mortality is endogenized by linking it to parental human capital. The analysis shows that an exogenous decline in child mortality lowers fertility, increases population growth, and lowers education. Since lower education decreases children's human capital, mortality tends to rebound in the future and, thus, economic growth is negatively affected. As an alternative experiment, an increase in the productivity of human capital investments (or a decline in the cost of education) is considered. By assumption, there is no immediate effect on mortality, but education rises and, through quantity/quality tradeoff, fertility falls. As human capital starts to increase, it ultimately leads to endogenously lower child mortality.

The relationship between child mortality and fertility has occupied a central place in demographic research. Empirical studies generally conclude that child mortality reduction modestly decreases the number of births, increases the number of surviving children, and stimulates population growth.¹

Research on the effects of child mortality on fertility is not new in economics as well. A number of models have generated fertility decline as a consequence of exogenous mortality reduction under specific assumptions.² O'Hara (1975) was broadly criticized (e.g., Sah 1991; Cigno 1998) for analyzing fertility behavior under the assumption that either all children die in infancy, or all survive to maturity. Sah (1991) obtained this result under the assumption that marginal utility decreases and marginal cost increases as the number of children rises. Momota and Futagami (2000) assumed that the number of children born.³ Cigno (1998) and Blackburn and Cipriani (1998) endogenized child survival probability by putting offspring's mortality subject to parental choice. Most recently, Doepke (2005) quantitatively addressed the question in a Barro–Becker framework with exogenous child mortality.

¹See, for example, Preston (1978) for a collection of demographic essays that come to such conclusion and Palloni and Rafalimanana (1999) for a broad survey of literature; see also Rutstein (1974), Chowdhury et al. (1976), Balakrishnan (1978), Olsen (1980), and Olsen and Wolpin (1983). Exceptional results obtained by Schultz (1969)—that a decline in child death rate is associated with a fully compensating decline in birth rate—are suspect, since in his analysis of Puerto Rican data over the 1951–1957 period, crude death rate was used as a proxy for child death rate.

² Others (e.g., Becker and Barro 1988; Barro and Becker 1989; Dahan and Tsiddon 1998) suggest that exogenous mortality decline may increase fertility. Dyson and Murphy (1985) present an excellent survey of a predecline increase in fertility that many countries experienced in the fairly recent past.

³ In such a setting, a lower level of fertility actually implies a decrease in child survival probability. This assumption is not consistent with the large empirical literature that has overwhelmingly shown the positive effect of fertility reduction on children's survival chances (e.g., LeGrand and Philips 1996; Palloni and Rafalimanana 1999 and references therein).

This article discusses the issue in the context of a growth model with endogenous fertility, in which human capital distribution affects economic growth and population growth through transmission of human capital between successive generations.⁴ It contributes to previous literature by showing, under fairly general assumptions, the role of an increase in childbearing cost, as a consequence of child mortality reduction, in decreasing fertility. Such approach is consistent with a classical explanation in demographic theory postulated by Devis (1963) that moderate fertility reduction is an adjustment to the pressure brought on household resources by reduction in early child mortality.

To endogenize child survival, the model implies that, at low levels of income, a child's probability of survival positively depends on the level of parental spending in the early stages of the child's life. The child survival probability function postulated in the paper implies that, for any given fraction of parental income allocated to each child, the amount of real resources (nutrition, medical care, and others) consumed by the child—and therefore the resulting child survival probability—increases with the parental level of human capital. It also replicates empirical findings stating that, above a certain level of parental income, child mortality approaches zero. Such approach allows us to endogenize child survival probability without relying on an argument postulating that, at low levels of development, parents optimally choose high child mortality levels, as had been postulated, for example, by Olsen and Wolpin (1983); Cigno (1998), and Blackburn and Cipriani (1998).

The relationship between mortality and human capital accumulation has also been the subject of research in recent years. In this context, Ehrlich and Lui (1991) and Kalemli-Ozcan et al. (2000) modeled mortality reduction as an exogenous decline in the risk of death at every age. Tamura (2002) and Kalemli-Ozcan (2002, 2003) analyzed mortality decline among young adults just after completing all human capital investments. Since they used different timing assumptions, their results are different from that of the current paper. Doepke (2005), who also points out that mortality mostly affects children before the age at which education begins, came closest to the context of this paper. His analysis, however, is quantitative, not analytical, and focuses mostly on fertility. In contrast to the aforementioned literature, this article concentrates on mortality decline during early childhood, not on reduction in adult mortality or improvements in longevity in general, and provides a clear analytical framework.

⁴ The growth of literature on endogenous fertility has evolved through three phases. Initially, researchers developed models in which interactions between fertility and growth are consistent, with a negative relationship observed in cross-county growth regressions, as in Becker and Barro (1988), Barro and Becker (1989), and Becker et al. (1990). Subsequently, the focus switched toward models that discuss demographic transition and offer diverse explanations (e.g., Galor and Weil 1996; Dahan and Tsiddon 1998; Morand 1999). Later on, researchers focused on the long-term transition from stagnation to growth (e.g., Galor and Weil 2000). Most recently, Azarnert (2004) introduced an analysis of interactions between income redistribution, fertility, and growth in an economy that operates in an open world (see also, e.g., Galor and Moav 2001 for references).

By showing the causal link between rising education and declining child mortality, this paper also contributes to debates in development economics. As it is well-known, historically, declines in child mortality were associated with rising education and economic growth. An important issue that this strand of literature has yet to properly integrate is whether exogenous declines in mortality were causal for both observations, or whether a third factor accounted for them. This paper shows that reductions in child mortality alone cannot lead to more education and growth; in fact, they achieve just the opposite. On the other hand, if education becomes easier to obtain (or, equivalently, if return to education increases) and child mortality is endogenized in a plausible fashion, both trends can be explained jointly without referring to other factors. In addition, these findings can also have important implications to policies designed to achieve an increase in educational attainment along with a decrease in child mortality in presently developing countries.

2 The basic structure of the model

Consider an overlapping-generations economy that produces a single homogenous good in a constant-returns-to-scale technology using human capital as the only input. In each generation, agents live for two periods (childhood and adulthood) where childhood consists of two subperiods (early childhood and school age). Adulthood is the sole productive period. During adulthood, individuals become parents and bring up their offspring, who face a probability of dying during early childhood before any investment in their education has taken place. Parents must allocate a positive fraction of their time to feeding and raising all their children during early childhood and a fraction of their time to rearing their children who survive to school age. They may also invest in their surviving children's education.

2.1 The formation of human capital

During school age, children devote their entire time to the acquisition of human capital. The acquired level of human capital increases if their time investment is supplemented with parental capital investment in their education. However, even in the absence of real expenditure, individuals acquire one efficiency unit of labor —basic skills. The number of efficiency units of labor of a child, who becomes an adult at period t+1 (h_{t+1}), is an increasing function of real parental expenditure on the child's education in period t (e_t):

$$h_{t+1} = h(e_t).$$
 (1)

A particular form of human capital production function is specified below in Eq. 11.

2.2 Utility maximization

Agents derive utility from their own consumption during adulthood and from the total income of their surviving children. The utility function of an individual born at time t-1 is:⁵

$$U_t = (1 - \beta) \log C_t + \beta \log(I_{t-1}^N),$$
(2)

where C_t is an individual's own consumption and I_{t+1}^N is the total income of one's surviving offspring.

In every period *t*, adults are characterized by a skill level h_t and are endowed with one unit of time, which they allocate between childrearing and labor force participation. The cost of childrearing is measured in terms of work time foregone. The total cost of feeding and raising one's offspring consists of a fraction δ_1 of the parent's time spent on each child during early childhood and a fraction δ_2 spent on each surviving child during school age. A parent also may invest e_t units of wage per efficiency unit of labor *w* in each surviving child's education.

To maximize their utility function, adults simultaneously choose their current consumption C_t , the number of births B_t , and the level of educational investment in each surviving child e_t , subject to the following budget constraint:⁶

$$C_t + w[\delta_1 h_t + p_t(\delta_2 h_t + e_t)]B_t \le wh_t,$$
(3)

while the total income of one's offspring for a given survival probability is:

$$I_{t+1}^N = p_t w h_{t+1} B_t. (4)$$

The right-hand side of Eq. 3 is an adult's income, which is allocated between consumption and the total cost of all children born to a parent, for a given child survival probability p_t . The wage per efficiency unit of labor w is fixed over time (e.g., from the assumption of a single production factor in a CRS technology).

⁵ Morand (1999) justifies parental care spending from the total income of children by the old-agesupport motive. In fact, this formulation is equivalent to:

 $U_t = (1 - \beta) \log C_t + \beta \log(N_t w h_{t+1}),$

where N_{t+1} is the number of surviving children. This utility function has been recently used by, e.g., Galor and Weil 2000; Kalemli-Ozcan 2002, 2003; cf. also Galor and Moav 2002; Moav 2005.

⁶ The time constraint requires that $0 \le 1 - [\delta_1 + p_t(\delta_2 + (e_t/h_t))]B_t \le 1$.

2.3 Child survival probability function

A child's probability of surviving to school age is assumed to positively depend on the amount of resources consumed during early childhood. To capture this idea, the following child survival probability function is postulated:

$$p_t = \begin{cases} \left(\delta_1 h_t\right)^{1/\alpha}, & \text{if } h_t < 1/\delta_1\\ 1, & \text{if } h_t \ge 1/\delta_1, & \text{where } \alpha > 1, \end{cases}$$
(5)

and $\delta_1 h_t$ is the total parental spending on rearing each child (born at period *t*) during early childhood, measured in units of *w*.

Consistent with the large empirical literature (e.g., Preston 1975; Schofield et al. 1991; Fogel 1993), this particular form of child survival probability function implies that, at low levels of income, child survival chances increase with the level of parental spending in the early stages of the child's life. Moreover, this formulation implies that, for any given fraction of parental time allocated to each child, the amount of real resources (nutrition, medical care, and others) consumed by a child—and therefore the resulting child survival probability—increases with the parental level of human capital [$p_t(\cdot)>0$, $p'_{h_t}(\cdot) > 0$, $p''_{h_t}(\cdot) < 0$]. The positive association between parental human capital and child survival in the developing world has been well-documented by, for example, Caldwell (1979); Hobcraft et al. (1984); Sandiford et al. (1995), and Lam and Duryea (1999).

In this setting, public health measures to increase child survival probability can be formulated as an exogenous increase in α . As it has been commonly argued (e.g., O'Hara 1975), this assumption is a good approximation of the situation in presently developing countries, where public health programs have contributed substantially to child mortality decline. Immunization of children against infectious and parasitic diseases, which saves millions of young lives every year (e.g., World Bank 1993; UNICEF 2002), is a good example of public health intervention that is exogenous to households.

2.4 Quantity/quality tradeoff

An adult makes two simultaneous investment decisions. First, a parent decides how much consumption to forego during adulthood to rear a family. Given a fixed level of parental investment in each surviving child's education e_t , for a given child survival probability p_t , the marginal cost of an additional child born to a parent is equal to $w(\delta_1 h_t + p_t (\delta_2 h_t + e_t))$. To maximize utility, a parent chooses the number of births so that the discounted marginal increase in children's income balances the cost. Thus, investment in quantity, or choice of an optimal number of births B_t , is captured by the following first-order condition:

$$\frac{\mathrm{d}U}{\mathrm{d}C_t}[w(\delta_1 h_t + p_t(\delta_2 h_t + e_t)] = \frac{\mathrm{d}U}{\mathrm{d}I_{t+1}^N} \frac{I_{t+1}^N}{B_t}.$$
(6)

Second, a parent decides how much resources to invest in the education of his children who survive to school age to increase their skill level. For a given number of surviving children $p_t B_t$, the lost current utility associated with spend-

ing an additional unit of w on their human capital must be offset by gains in terms of higher incomes earned by children with superior skills. Thus, investment in quality (or investment in education) is captured by the first-order condition with respect to choices of e_i :

$$\frac{\mathrm{d}U}{\mathrm{d}C_t} w p_t B_t = \frac{\mathrm{d}U}{\mathrm{d}I_{t+1}^N} \frac{I_{t+1}^N}{h_{t+1}} \frac{\mathrm{d}h_{t+1}}{\mathrm{d}e_t}.$$
(7)

Denoting by $R_t(e)$ the rate of return on investment in children's human capital (i.e., quality) given a fixed number of surviving children and denoting by $R_t(B)$ the rate of return on the number of children born to a parent (i.e., quantity) for a given level of parental investment in education of surviving children:

$$R_t(B) = \frac{I_{t+1}^N}{[w(\delta_1 h_t + p_t(\delta_2 h_t + e_t))]B_t}$$
(8)

and

$$R_t(e) = \frac{I_{t+1}^N}{[wp_t B_t]h_{t+1}} \frac{\mathrm{d}h_{t+1}}{\mathrm{d}e_t}.$$
(9)

Optimal noncorner solutions for B_t and e_t must equate the rates of return on quantity and quality $R_t(B)$ and $R_t(e)$, respectively. With the two rates of return given above, a noncorner solution must be such that:

$$h_{t+1} = \left(\frac{\delta_1 h_t}{p_t} + \delta_2 h_t + e_t\right) \frac{\mathrm{d}h_{t+1}}{\mathrm{d}e_t}.$$
 (10)

However, if the rate of return on educational investment is below the rate of return on quantity, a corner solution ($e_i=0$) may exist as well. Given the child survival probability function specified in Eq. 5, "Choice of fertility and investment in education" discusses the exact solution to Eq. 10 for a particular form of human capital production function.

2.5 Choice of fertility and investment in education

To characterize optimal choices of fertility and investment in education, the following human capital production function is postulated:

$$h_{t+1} = \max\{1, \theta e_t^{\gamma}\}, \quad \text{where} \quad \theta > 0 \quad \text{and} \quad 0 < \gamma < 1.$$
(11)

This particular human capital production function implies that if θ is high enough, human capital levels increase over time. It also implies that the level of human capital is bounded from below by one unit.

Given this learning technology for a given child survival probability (Eq. 5), two solutions are possible:⁷

1. If $\max\{1, \theta e_t^{\gamma}\} = 1$, parents choose not to invest in the education of their offspring $(e_t=0)$. Therefore, according to Eq. 11, each surviving child gets one unit of human capital in period *t*+1. Since no resources are spent on surviving children's education, the desired number of births for parents with human capital levels lower than $1/\delta_1$ is simply the parent's income after consumption divided by the cost per child born to a parent:

$$B_t = \frac{\beta}{\delta_1 + \delta_2 (\delta_1 h_t)^{1/\alpha}},\tag{12}$$

so that the number of surviving children is:

$$N_{t+1} = \frac{\beta}{\delta_1 (\delta_1 h_t)^{-1/\alpha} + \delta_2} \tag{13}$$

2. If $\max\{1, \theta e_t^{\gamma}\} = \theta e_t^{\gamma}$, the optimal choices of fertility and investment in surviving children's education are as follows:

$$e_t = \begin{cases} \frac{\gamma}{1-\gamma} \left((\delta_1 h_t)^{\frac{\alpha-1}{\alpha}} + \delta_2 h_t \right), & \text{if } h_t < 1/\delta_1, \\ \frac{\gamma}{1-\gamma} ((\delta_1 + \delta_2) h_t), & \text{if } h_t \ge 1/\delta_1, \end{cases}$$
(14)

so that, according to Eq. 11:

$$h_{t+1} = \theta \begin{cases} \left(\frac{\gamma}{1-\gamma} \left(\left(\delta_1 h_t \right)^{\frac{\alpha-1}{\alpha}} + \delta_2 h_t \right) \right)^{\gamma}, & \text{if } h_t < 1/\delta_1 \\ \left(\frac{\gamma}{1-\gamma} \left(\left(\delta_1 + \delta_2 \right) h_t \right) \right)^{\gamma}, & \text{if } h_t \ge 1/\delta_1, \end{cases}$$
(15)

and

$$B_t = \begin{cases} \frac{\beta(1-\gamma)}{\delta_1 + \delta_2(\delta_1 h_t)^{1/\alpha}}, & \text{if } h_t < 1/\delta_1, \\ \frac{\beta(1-\gamma)}{\delta_1 + \delta_2}, & \text{if } h_t \ge 1/\delta_1. \end{cases}$$
(16)

The number of surviving children is thus:

$$N_{t+1} = \begin{cases} \frac{\beta(1-\gamma)}{\left(\delta_1/\left(\delta_1h_t\right)^{1/\alpha}\right) + \delta_2}, & \text{if } h_t < 1/\delta_1, \\ \frac{\beta(1-\gamma)}{\delta_1 + \delta_2}, & \text{if } h_t \ge 1/\delta_1. \end{cases}$$
(17)

⁷An assumption that $\theta > ((\gamma/(1-\gamma))(1+(\delta_2/\delta_1)))^{-\gamma}$ rules out the possibility that, in the starting period *t*, skilled parents with $h_t \ge 1/\delta_1$ will find it lucrative not to invest in their offspring's human capital.

Eq. 14 shows that the optimal choice of investment in the offspring's education—and hence the children's human capital level (Eq. 15)—is positively related to the parent's human capital level. Eqs. 12 and 16 show that, for parents with human capital levels smaller than $1/\delta_1$, the number of births is negatively related to the parent's level of human capital. Eqs. 13 and 17 display a positive relationship between parental human capital and the number of surviving children at low levels of human capital. For relatively skilled parents, the number of births and the number of surviving children coincide.

The following proposition summarizes the main result of the effect of an exogenous increase in child survival probability on fertility and human capital investments.⁸

Proposition 1: An exogenous mortality decline for the offspring of parents with human capital levels lower than $1/\delta_1$ (as modeled by an exogenous increase in the parameter α)

- (i) Decreases the number of births less than proportionally and, therefore, increases the number of surviving children. Proof Eqs. 12, 13, 16, and 17.
- (ii) Decreases educational investments of parents, who find it lucrative to invest in their offspring's skills before the increase in α, in each surviving child and, therefore, decreases the resulting children's human capital stock.⁹
 Proof Eqs. 14 and 15.

This result shows that the timing of mortality decline relative to education is crucial to the implications of mortality decline. If child mortality is realized before education starts, an exogenous decline in child mortality makes child quantity more attractive relative to child quality and leads to a decline in children's education. The resulting children's per-capita human capital levels decline. In contrast, if child mortality is high, parents will concentrate their resources on providing good education for their surviving children, instead of attempting to have many children.

Moreover, given a positive association between parental human capital and an offspring's survival probability, the model generates the following relationship between an exogenous decline in early child mortality at present and child mortality in the future:

Proposition 2: An exogenous decline in early child mortality at present negatively affects children's survival chances in the future.

The model therefore suggests that a premature public health intervention to reduce early child mortality, although in harmony with humanitarian approach in

⁸ For a better interpretation of this result, note that, in Europe during the Industrial Revolution, rapid economic growth coexisted with mortality increase (see, e.g., van de Walle 1986; Deaton 2001 and references therein).

⁹ Given that $h_{t+1} = \max \left\{ 1, \left(\frac{\gamma}{1-\gamma} \left(\left(\delta_1 h_t \right)^{\frac{\alpha-1}{\alpha}} + \delta_2 h_t \right) \right)^{\gamma} \right\}$ for the offspring of parents with human capital levels lower than $1/\delta_1$, an increase in α may also cause some parents to substitute investment in quantity for investment in both quality and quantity.

the short run, generates a mechanism that works against children's survival chances in the long run.

2.6 The dynamic system

This section analyzes the dynamic path of an economy, in which agents' human capital levels at the starting period are below the $1/\delta_1$ threshold, so that the children born during this period face some probability of dying during early childhood. Given the human capital production function postulated in Eq. 9, the economy evolves around one of the following two cases:

1. The human capital production function is not sufficiently productive (i.e., θ is not high enough) to assure increasing human capital from one generation to the next.

In such a case, regardless of the particular distribution of human capital among parents, their surviving children acquire human capital levels lower than those of their parents. As a consequence, in such an economy, the number of births and child mortality increase over time. If the productivity of learning technology is low enough, the economy ultimately converges toward identical agents with minimum human capital level ($h^{\min}=1$) who make no investments in their surviving children's education. The economy is therefore locked in poverty with a constantly high number of births:

$$B = \frac{\beta}{\delta_1 + \delta_2 \delta_1^{1/\alpha}},$$

and a corresponding number of surviving children:

$$N = \frac{\beta}{\delta_1^{\frac{\alpha-1}{\alpha}} + \delta_2}$$

2. The human capital production function is sufficiently productive (i.e., θ is high enough) to assure strictly increasing human capital levels from one generation to the next.

In such a case, skill levels increase across generations. As a result, the number of births and child mortality decrease over time. Along this path, once human capital levels of agents overtake the $1/\delta_1$ threshold, fertility decreases to:

$$B = \frac{\beta(1-\gamma)}{\delta_1 + \delta_2}$$

and all the children survive (N=B).

Given the results in "Choice of fertility and investment in education" on the impact of child mortality on private optimal choices, the following proposition summarizes the main effect of an exogenous increase in child survival probability in the short run on the economy's human capital growth in the long run.

Proposition 3: An exogenous decline in early child mortality (as modeled by an increase in the parameter α from α_0 to α_1) negatively affects society's human capital accumulation.

In detail, Proposition 3 implies that an exogenous increase in child survival probability:

- (i) Slows per-capita human capital growth if, for all j>0, h_{t+j}(α₁)>h_t(α₁).
 As a consequence, in such an economy, convergence toward a zero child mortality is postponed.
- (ii) Makes per-capita human capital slow down faster if, for all j>0, $h_{t+j}(\alpha_0) < h_t(\alpha_0)$.

As a consequence, such an economy converges faster toward a low equilibrium with high constant fertility and low child survival.

(iii) Causes a substitution of decreasing per-capita human capital levels for increasing per-capita human capital levels if, for all j > 0, $h_{t+j}(\alpha_0) > h_t(\alpha_0)$ and $h_{t+j}(\alpha_1) < h_t(\alpha_0)$.

As a consequence, such an economy is unnecessarily locked in poverty with high child mortality, instead of evolving into elimination of child mortality.

On the other hand, an improvement in the productivity of the human capital production function, as modeled by an increase in the technology parameter θ , although without an immediate effect on child survival chances in the short run, can offer the prospect of eliminating child mortality in the long run. As human capital starts to increase, it ultimately lowers child mortality endogenously. If the learning technology is not sufficiently productive (or, equivalently, if education is not easily obtainable) to assure strictly increasing human capital levels across generations, an economy stands no chance of leaving poverty associated with high child mortality. In addition, an increase in the productivity of human capital investments helps facilitate economic growth.

3 Conclusion

This article investigates the impact of a decline in child mortality on fertility and economic growth. The study shows that the timing of mortality relative to education is crucial to the implications of mortality decline. If child mortality is realized before education starts, an exogenous decline in child mortality leads to a decline in education—a finding that is opposite to those of studies that considered a decline in mortality after the cost of education has been incurred. To examine the dynamic implications of the model, child mortality is endogenized by linking it to parental human capital. The analysis demonstrates that an exogenous decline in child mortality lowers fertility, increases population growth, and lowers education. Since lower education decreases children's human capital, mortality tends to rebound in the future and economic growth is negatively affected. On the other hand, an increase in the productivity of parental investment in their surviving

offspring's human capital can ultimately offer the prospect of endogenously eliminating child mortality in the long run.

The model provides a joint explanation for declines in child mortality associated with rising education and economic growth, as has been observed historically. In addition, these findings may also have important implications for policies designed to achieve an increase in educational attainment along with a decrease in child mortality in presently developing countries.

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