Diversification in Children*

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ABSTRACT

This paper develops a dynamic model of the decisions on the quantity and quality of children that is based on two premises: (1) the quality of children is uncertain when parents make a human capital investment decision, and (2) the quality distributions of two children of a woman are less correlated if they are fathered by different men than by the same man due to genetic inheritance. It naturally follows that a parent looks for hedging the risk of child quality by having children given birth to by different fathers, or by diversifying a portfolio of children. We derive and test discriminating propositions concerning child diversification and human capital investment in children. Consistent with these propositions, our empirical results indicate that women with less education, more income, and higher income uncertainty are more likely to diversify. We also show that human capital investment in a child fathered by a new mate is lower and higher income uncertainty increases investment.

Keywords: Fertility, Quality of children, Human capital, Diversification,

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I. Introduction

This paper develops a dynamic model on the quantity (fertility) and quality (human capital) of children which is based on two premises that are not in general deliberated in the literature. The first premise is that the quality of children as an outcome of human capital investment in children is uncertain when parents make the investment decision. Traditional models, static or dynamic, in the literature since the seminar paper by Becker (1960) have assumed for simplicity that parents know a priori what will be the outcome of human capital investment in children, i.e. the quality of children, when the decisions on fertility and human capital investment are made.

However, most dimensions of child quality as an outcome of human capital investment are not revealed at the point when parents make a decision on investment and are subject to various determinants which cannot be perfectly predicted when the investment decision is made. For instance, parents spend resources to have young children acquire skills needed afterwards for the labor market, but children's labor market performances can be influenced not solely by the parents' investment but also by other determinants such as unobservable abilities and the market price of the acquired skills when the children enter the labor market. An immediate implication of this premise is that parents maximize the *expected* utilities which are determined by children's quality realized in the future. In our model, we assume that parents have knowledge of at least the distribution of a child's quality in the future to form the expected utility, which pertains to the Knightian risk.

The second premise of the paper is that children from the same parent are not homogenous in terms of their quality. Children differ in quality due to different amounts of parental resources invested, but also due to different abilities genetically inherited by either of their parents. Put differently, each child has a different distribution of quality. The quality distributions of two children, however, may not be independent as long as they share parents. If two children have the same mother and father, their distributions are likely to be correlated because they inherit genes from the same pool. On the other hand, if two children of a woman were fathered by two different men, the correlation may be lower than in the case of the same father.

If parents are risk averse and their utilities are positively influenced by the qualities of children born (due to either altruism or financial support of children), the natural consequence of these two premises is that a parent have an incentive to hedge risk in children's qualities and diversify a portfolio of children: a parent reduces the risk in child quality by having children given birth to by different mates. This argument bears a close resemblance to the idea of asset diversification in the financial portfolio theory.

Evidences on the behavior of diversification in reproduction abound in nature and in human society. Instead of self duplication in reproduction, many species on this planet including mammals rely on sexual reproduction which itself is all about genetic mixing to diversify genes (Ridley, 1995). Throughout the animal kingdom, there are plenty of species which practice polygamy, especially polygyny (Cartwright, ?). In case of our species, many surveys have reported that the rate of "paternal discrepancy" or "misattributed paternity", as they call the case when a woman's husband is not her child's biological father, is sizable. Baker and Bellis (1990) estimate from the England survey data that the rate is between 6.9 and 13 percent. Using studies on the U.K., U.S., Europe, Russia, Canada, South Africa, South America, New Zealand, and Mexico from the 1950'ss through 2002 that mentioned paternal discrepancy, Bellis et al. (2005) find that paternal-discrepancy estimates vary wildly, from less than 1 percent to more than 30 percent, and the average paternal discrepancy is 3.7 percent. They report that the rates are higher for disadvantaged people, for those with more than one sex partner at a time, and for younger women. In our data (the details of the data set will be described later in section 3), 38.2 percent of American women 15-44 years of age in 1995 who have more than one child have two or more partners as the fathers of their children. This percentage is 56.9 % for blacks and 31.1% for whites. Among those children who have at least one sibling on the maternal side, only 54.6 percent are the case where all siblings have the same father.

Since the 1960's the fraction of out-of-wedlock births has grown steadily in the countries of Western Europe and in the U.S. (Hotz, Klerman, Willis, 1997; Willis 1999). In the U.S., the fraction of out-of-wedlock births reached a rate of 32.4 percent in 1997 when this fraction was 25.8 percent for whites, 69.1 percent for blacks, and 40.9 percent for Hispanics. The fraction of out-of-wedlock births had also increased during this period throughout Western Europe, but at different rates in different countries. The fraction was 2 percent in Italy in 1970, reaching 7 percent in 1992, while it had increased from 18 percent in 1970 to over 50 percent in 1992 in Sweden. Willis (1999) argues that prevalent out-of-wedlock births among blacks in the U.S. are primarily due to the sex ratio imbalance in the marriage market. This may be an important explanation for out-of-wedlock births among blacks or Hispanics. However, this explanation alone cannot well account for the existence of childbirths to unmarried white women in the U.S. or women in the Western European countries. In fact, the out-of-wedlock birth rate among white women in the U.S. has been rising even faster than blacks in the past few decades. This paper offers a different perspective on the issue of out-of-wedlock births. Women exercising child diversification may end up with out-of-wedlock births if the cost of remarriage is too steep regardless of the sex ratio balance in the marriage market.

This paper is organized as follows. Section 2 lays out a formal model of a parent's decisions on fertility and human capital investment in an environment in which the quality of children is uncertain and heterogeneous across siblings. Section 3 describes the data and explains our strategies for empirical investigation. We report our empirical findings in Section 4. Finally, Section 5 is the conclusion of the paper.

II. Model with Uncertainty in the Quality of Heterogeneous Children

Our model builds on the fertility model of Becker (1991) with consideration of both the quantity and quality of children. Each woman lives through two periods in this model: young adulthood and old age.[1] During young adulthood she makes decisions on own consumption and investment in her children whom can be fathered by different partners. For convenience we abstract from mating process and paternal decision on children's human capital investment. Our model, however, incorporates these aspects to the extent that we consider variations among children in the woman's productivity in children's human capital formation and in the cost of educating each child, due to differences in partner's characteristics. These variations are taken as exogenous to women. In old age, women bear no childrearing cost as children become independent, and thus consumption is the only decision to make.

The objective of the woman is to maximize expected lifetime utility function which depends on her own consumption and the quality of children that is measured by the human capital of children in adulthood:

$$(2.1) \qquad \underset{c_y, c_o, n, (H_i)_{i=1\ldots n}}{Max} \quad u(c_y) + E[W(c_o, H_1+H_2+ \cdots + H_n)],$$

where u and W denote the utilities when the woman is young and when old, respectively, and E represents expectations based on the information available in young adulthood. The control variables n and H_i represent the number of children in integer and the human capital ("quality") of the i-th child. c_y and c_o denote consumption opportunities for woman in young adulthood and in old age, respectively. For simplicity we assume that the mother's utility depends on the sum of human capital levels of all children. Moreover, the utility function W takes the following form:

$$(2.2) \qquad W(c_o, H_1+H_2+ \cdots + H_n) = w(\alpha c_o+H_1+H_2+ \cdots + H_n),$$

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[1] In fact, our model is squarely applicable to the decision-making of men, too.

where α is a positive constant. If the source of utility for old parents is financial support from adult children and wage rate of human capital is normalized to 1, $(1/\alpha)$ in this form can be interpreted as a constant fraction of earnings of each child that old parents receive, or the old-parent support rate. The functions u and w are assumed to satisfy the usual conditions: $u'(c)>0$, $u''(c)<0$, $w'(c)>0$, and $w''(c)<0$.

The human capital (or earning capacity in the labor market) of the i-th child is accumulated based on a production technology linking the mother's investment in the child's education with the child's human capital:

(2.3) $H_i = f(h_i \,|x_i) + \varepsilon_i$.

In equation (2.3), h_i denotes mother's investment in the child's human capital. The human capital production function, f, is a continuously increasing and concave function of h: $f'(h) > 0$ and $f''(h) < 0$. This production function also depends on variable vector x_i which captures the characteristics of the i-th child (for example, child's intelligence and diligence) as well as the characteristics of the partner who fathers the i-th child (his genetic constitutions and efforts in educating the child).

Equation (2.3) shows that human capital is not only determined exclusively by the mother's investment but also affected by the stochastic component ε that is revealed only in the old-age period after human capital investment is committed. This component reflects uncertainty in returns to mother's investment in children's human capital or earning capacity in the labor market, which is possibly due to several reasons. First, father's influences on children's earning capacity in adulthood through genetic inheritance cannot be known with certainty. Second, women cannot observe partner's efforts in the formation of children's human capital. Finally, earnings capacity in the labor market can be affected by fluctuations in production possibilities and the prices of goods and factors of production that are usually revealed only after children have received their educations and much of their other training and entered the labor market (Becker, 1991). This "risk" in returns to human capital investment in children is reflected by the stochastic term, ε, the distribution of which is known to women in young-adulthood period. Similar to Becker (1991), we assume that this stochastic term is additive.[2] Like the deterministic influence of the characteristics of children and fathers (x_i) on H_i, we expect this stochastic term also varies across children.

In equation (2.1), consumption in young adulthood c_y is given by

(2.4) $c_y = z_y - v_1 h_1 - v_2 h_2 - \cdots - v_n h_n$.

The parameter z_y denotes total income of the woman during her young adulthood, and v_i represents net cost of one unit of human capital investment in the i-th child that are borne by the mother. The net cost v_i can vary due to various reasons: (1) the cost of childrearing can change with parity, (2) the cost of searching and mating with partners can vary (i.e., v_i is lower when the woman's cost in searching a partner who fathers the i-th child is lower), or (3) the contribution of partners in children's human capital investment can be different (i.e., v_i is lower when the partner's contribution to the human capital formation for the i-th child is more). Old-age consumption of the woman in equation (2.1) is given by

(2.5) $c_o = z_o$,

where z_o is total income of the woman in old age. The old-age consumption is strictly equal to income since there is no childrearing cost in old age.

The value of human capital investment in children, h_i, that maximizes (2.1) is found from

(2.6) $-v_i\, u'(c_y) + E[f'(h_i)\, w'(\alpha c_o+H_1+H_2+ \cdots + H_n)] \leq 0$,

[2] Becker (1991) similarly considers two additive stochastic terms in determination of children's income which are called "endowed luck" and "market luck". ε in our model comprises both these terms.

with the optimal quantity of children, n, given. This condition implies that the ratio of marginal product between h_i and h_j should be equalized to the cost ratio as long as we have interior solutions for h_i and h_j:

(2.7) $f'(h_i) / f'(h_j) = v_i / v_j$.

Plugging the optimal value of h_i from (2.6) in (2.1), the maximized utility with n given is

(2.8) $V(n) \equiv u(z_y - v_1h_1(n) - \cdots - v_nh_n(n)) + E[w(\alpha z_o + f(h_1(n)) + \varepsilon_i + \cdots + f(h_n(n)) + \varepsilon_n)]$,

where $h_i(n)$ is the solution of condition (2.6) with equality. The optimal value of the quantity of children, n, should satisfy

(2.9) $V(n+1) - V(n) \leq 0 \leq V(n) - V(n-1)$.

2.1 Uncertainty and Diversification in Children

In general, differences in the characteristics of children as well as fathers can result in variations in x_i, ε_i, and v_i. Focusing on the issue of diversification in children under uncertainty, or childbearing with different partners, we take several simplifying assumption on these variables. We assume that all the variations in these variables are strictly due to the heterogeneity among partners. Moreover, we assume that all the variations in partners' characteristics are manifested only through the cost side (v_i) but not through the production side (x_i, ε_i). More specifically, our assumptions are:

(i) v_i and v_j are the same as long as the i-th and j-th children are fathered by the same partner.

(ii) The marginal product of x_i in f is zero.

(iii) For all i, ε_i takes a binomial distribution where ε_i is either ε_H (with probability p) or ε_L (with probability (1−p)), $\varepsilon_H > \varepsilon_L$, and $p \in [0,1]$.

(iv) The value of ε_i is identical for all children from the same father. On the other hand, ε_i and ε_j are independent when the i-th and j-th children have different fathers.

The rationale for the identical distribution in quality among children regardless of their fathers (assumption iii) is that we ignore the effect of quality heterogeneity on the model's implications and focus on the impact of uncertainty in child quality.[3]

With the symmetry in our utility function and human capital production function among children (see equation 2.1 and assumptions ii and iii), women maximize utility by bearing children with the lowest values of v_i. Without loss of generality, we henceforth assume that $v_1 \leq v_2 \leq \cdots \leq v_n$.

Our analysis does not require for its main implications an assumption as strong as (iv). In fact, we only need to assume that the correlation of qualities of two children from the same father is higher than that of two children from different fathers. That is, two children from the same father are more alike than two from different fathers. For simpler exposition of our result, we take assumption (iv) that the former correlation is 1 and the latter is zero. If we assume instead that the correlation of qualities between any two children is identical independent of the children's fathers, a woman will end up with only one partner with the lowest v, which makes our model similar to traditional fertility models. We note that the sole way to diversify the children's quality under uncertainty is to have multiple partners in our model.

Assumptions (i) – (iv) yield the straightforward implication that the number of children fathered by a partner with lower v is greater than or equal to that with higher v. Since time cost of search in the marriage market rises with woman's age and women are more likely to get married first to a man with whom she can gain the most benefit of marriage, it is quite plausible that the sequential order of partners is related to the cost of childbearing v in a monotonically increasing fashion. Consistent with this story, for those women who completed childbearing in

[3] In a dynamic, sequential fertility model, the quality of a child born before period *t* may be revealed to some extent before the decision on the next partner is made in period *t*. Some aspects in child quality, however, cannot be known with certainty at the early ages so that quality uncertainty cannot be completely resolved before the decision on the next partner (for example, a child's performance in labor market).

the 1995 National Survey of Family Growth data, the average numbers of children per woman with the first, second and third partner are 1.56, 0.37, and 0.08, respectively.

What is the effect of uncertainty in child quality on human capital investment in children? Suppose a woman has the lowest cost v_i with partner 1 and the second lowest cost with partner 2. Consider the following two cases: having two children with partner 1 (case A), and having the first child with partner 1 and the second with partner 2 (case B). Comparing the first-order optimality condition for h between case A and B, we have

$$(2.10)\quad E[w'(\alpha z_o + f(h_{1a}) + f(h_{2a}) + \varepsilon + \varepsilon)] / E[w'(\alpha z_o + f(h_{1b}) + f(h_{2b}) + \varepsilon + \varepsilon')]$$

$$= [u'(z_y - v\, h_{1a} - v\, h_{2a}) / u'(z_y - v\, h_{1b} - v'\, h_{2b})]\, [f'(h_{ib}) / f'(h_{ia})] \quad (i = 1, 2),$$

where subscripts a and b indicate case A and B, respectively, and

$$(2.11)\quad E[w'(\alpha z_o + f(h_{1a}) + f(h_{2a}) + \varepsilon + \varepsilon)] = p\, w'(\alpha z_o + f(h_{1a}) + f(h_{2a}) + \varepsilon_H + \varepsilon_H)$$

$$+ (1-p)\, w'(\alpha z_o + f(h_{1a}) + f(h_{2a}) + \varepsilon_L + \cdot \varepsilon_L),$$

$$(2.12)\quad E[w'(\alpha z_o + f(h_{1b}) + f(h_{2b}) + \varepsilon + \varepsilon')] = p^2\, w'(\alpha z_o + f(h_{1b}) + f(h_{2b}) + \varepsilon_H + \varepsilon_H)$$

$$+ 2p(1-p)\, w'(\alpha z_o + f(h_{1b}) + f(h_{2b}) + \varepsilon_H + \varepsilon_L) + (1-p)^2\, w'(\alpha z_o + f(h_{1b}) + f(h_{2b}) + \varepsilon_L + \varepsilon_L).$$

Note that the stochastic terms and the prices for two children are the same in case A while they are different and independent in case B since two children in case B are fathered by different partners.

Proposition 1. (i) In case A, human capital investment in both children will be the same, $h_{1a} = h_{2a}$. (ii) In case B, the first child will receive more investment than the second child, $h_{1b} \geq h_{2b}$. (iii) If the third derivative of w is positive, $w'''(c)>0$, so that there is a precautionary motive for saving, the second child in case A receives more investment than the second child in case B, $h_{2a} \geq h_{2b}$.

Proof. See Appendix [to be added].

The reasons for result (i) and (ii) are straightforward from equation (2.7). Since both children have the same price in case A, they receive the same amount of investment. In case B, the first child has a lower cost than the second child, and thus gets higher investment. As for result (iii), higher cost of children for the second child in case B than in case A generates two familiar effects: income and substitution effects. Lower income in case B will result in less investment in both children than in case A. With the substitution effect, the investment in the first child in case B will be higher than in case A while the investment in the second child in case B will be lower than in case A. Besides these two effects, uncertainty in this model generates an additional effect on the investment decision. Since it is less likely in case B to have the worst outcome where both children draw ε_L so that the rate of returns to human capital investment is the highest, more is invested in children as a precautionary measure in case A. With all three effects considered, we can show that $h_{2a} \geq h_{2b}$. It is, however, not unambiguous whether investment in the first child will be higher in case A than case B.

To analyze the decision on child diversification, we take the difference between the expected utility from diversifying with two partners (case B) and that from having children with a single partner (case A):

$$(2.13)\quad \Delta \equiv \{u(z_y - v\, h_{1b} - v'\, h_{2b}) + E[w(\alpha z_o + f(h_{1b}) + f(h_{2b}) + \varepsilon + \varepsilon')]\}$$
$$- \{u(z_y - v\, h_{1a} - v\, h_{2a}) + E[w(\alpha z_o + f(h_{1a}) + f(h_{2a}) + \varepsilon + \varepsilon)]\}$$

Arranging this equation,

$$\Delta = \{E[w(\alpha z_o + f(h_{1b}) + f(h_{2b}) + \varepsilon + \varepsilon')] - E[w(\alpha z_o + f(h_{1b}) + f(h_{2b}) + \varepsilon + \varepsilon)]\}$$
$$- \{u(z_y - v\, h_{1b} - v\, h_{2b}) - u(z_y - v\, h_{1b} - v'\, h_{2b})\}$$
$$+ \{u(z_y - v\, h_{1b} - v\, h_{2b}) + E[w(\alpha z_o + f(h_{1b}) + f(h_{2b}) + \varepsilon + \varepsilon)]$$
$$- u(z_y - v\, h_{1a} - v\, h_{2a}) - E[w(\alpha z_o + f(h_{1a}) + f(h_{2a}) + \varepsilon + \varepsilon)]\}$$
$$\equiv \{\Delta_1\} - \{\Delta_2\} + \{\Delta_3\}.$$

The terms in the first and the second brace (Δ_1, Δ_2) pertain to the benefit and the cost of diversification, with human capital investment held constant. Δ_1 is the gain from reducing the risk in child quality by producing children with two partners instead of a single partner, which is positive as long as $w'(c)>0$ and $w''(c)<0$. Cost term Δ_2 is due to higher price for the second child (v'). The last term Δ_3 results from differences in human capital investment between two cases. The following propositions investigate the effects of changes in income and in the price of children on the decision of child diversification.

Proposition 2. Falling cost of children fathered by a different partner (v') will unambiguously raise the incentive for child diversification.

Proof. See Appendix [to be added].

It is intuitive that falling cost in v' will make the choice of diversification more attractive. It is noted that remarriage has become less costly economically and psychologically for divorcees in most societies due to erosion of social stigma on remarriage and expanding remarriage market with more participants. This should result in a fall in v' and thus more cases of child diversification.

Proposition 3. If total investment cost of children's human capital in case B is more than that in case A ($vh_{1b}+v'h_{2b} > vh_{1a}+vh_{2a}$), a simultaneous increase in v and v' either by the same proportion or by the same amount will reduce the incentive for child diversification. If $vh_{1b}+v'h_{2b} < vh_{1a}+vh_{2a}$, the change in v and v' will raise the incentive for child diversification.

Proof. See Appendix [to be added].

This proposition follows from the concavity of utility function u. For example, if total cost of human capital investment is higher in case B, consumption in young adulthood is then lower in case B than in case A. With the utility function concave with respect to consumption, a simultaneous increase in v and v′ will lower utility more in case B (with lower consumption level), which makes child diversification less likely.

Proposition 4. If total investment cost of children's human capital in case B is more than that in case A ($vh_{1b}+v'h_{2b} > vh_{1a}+vh_{2a}$), higher income in young adulthood (z_y) will raise the incentive for child diversification. Otherwise, it will lower the incentive.

Proof. See Appendix [to be added].

The intuition here is the same as in proposition 3. When $vh_{1b}+v'h_{2b} > vh_{1a}+vh_{2a}$, consumption in young adulthood is lower in case B, which makes the marginal utility of income higher. Higher income will therefore increase Δ. A testable implication from the last 2 propositions is that the effect of prices v and v′ will have an opposite direction to that of income z_y.

Proposition 5. If the outcome of human capital investment in case A, $f(h_{1a})+f(h_{2a})$, is not more than in case B, $f(h_{1b})+f(h_{2b})$, an increase in income in old age (z_o) will reduce the incentive for child diversification. Otherwise, the effect is ambiguous.

Proof. See Appendix [to be added].

If the outcome from human capital investment in children were held constant regardless of whether agents diversify or not, the expected utility gain from less uncertainty in child quality through diversification becomes smaller when income in old age is higher because utility function w is concave. This implies that rising income in old age lowers the incentive to diversify in children with human capital outcome held constant. If the outcome from human capital investment is not more in case A than in case B, i.e. $f(h_{1a})+f(h_{2a}) \leq f(h_{1b})+f(h_{2b})$, the marginal utility of income in old age is greater in case A due to the concavity in utility function w, which implies rising income further reduces the incentive to diversify. If $f(h_{1a})+f(h_{2a}) >$

$f(h_{1b})+f(h_{2b})$, however, rising income will produce two opposing effects on diversification and the net effect is ambiguous.

2.2 Income Uncertainty

How will uncertainty in income affect the decision on child diversification? Suppose that agents in young adulthood are uncertain about income in old age and know a priori its distribution which is independent of the risk in child quality, ε:

$$z_o = z_{oH} \quad \text{with the probability } \pi$$
$$\quad = z_{oL} \quad \text{with the probability } (1-\pi),$$

where $z_{oH} > z_{oL}$ and $\pi \in (0,1)$. The difference between the utility from the case of child diversification (case B) and that from the case of one partner (case A) is defined as

$$\text{(2.14)} \quad \Delta^* = \pi\, \Delta(z_o = z_{oH}) + (1-\pi)\, \Delta(z_o = z_{oL}),$$

where $\Delta(z_o = z_{oH})$ is the term defined in (2.13) when z_o is realized to be z_{oH}. In the following proposition, we consider the effect of rising income uncertainty on child diversification.

Proposition 6 Assume that $w'''> 0$, which ensures precautionary saving. Consider an increase in income uncertainty in the sense that the distribution of z_o becomes wider with its mean intact. This change will unambiguously raise the benefit of diversification if the outcome from human capital investment in case B is not less than that in case A, (i.e. $f(h_{1b})+f(h_{2b})\geq f(h_{1a})+f(h_{2a})$). Otherwise, the effect is ambiguous.

Proof. See Appendix.

The intuition here is simple. If the outcome from human capital investment in children were held constant regardless of whether agents diversify or not, rising income uncertainty will raise the incentive to diversify in children because it is better to reduce one type of risk (in child quality) when there is an increase in another type of risk (in income). If human capital outcome is different in the case of child diversification from the case of child concentration with one partner and $f(h_{1b})+f(h_{2b})\geq f(h_{1a})+f(h_{2a})$, there is an added incentive to diversify with rising income uncertainty: Rising income uncertainty reduces the expected utility more with child concentration as long as utility function w is concave (i.e. agents have risk aversion) and the utility level of w for the child concentration case is lower since $f(h_{1b})+f(h_{2b})\geq f(h_{1a})+f(h_{2a})$. If $f(h_{1b})+f(h_{2b})<f(h_{1a})+f(h_{2a})$, the opposite is true, which leaves the net effect of rising income uncertainty on child diversification ambiguous.

The next two propositions address the effects of income uncertainty on the quantity and quality of children. We assume in these propositions that $w''' > 0$.

Proposition 7 The increase in future income uncertainty will raise fertility if the aggregate human capital level $(H_1+H_2+ \cdots + H_n)$ rises with the number of children.

Proof. See Appendix [to be added].

The reason is essentially that rising income risk reduces the expected utility more when the level of utility in old age is lower, that is, when you have a fewer kids. This effect of income uncertainty on fertility has been discussed by several authors. Cain (1983) argues that each child provides an expected transfer to the parents in old age and risk-averse parents treat the transfer as insurance under risk to parental income. If the risk rises, parents will then increase the number of children. Portner (2001) shows in a formal model without human capital investment in children that a mean-preserving spread of future parental income leads to higher fertility. Proposition 7 generalizes this effect in a model with human capital investment.

Proposition 8 An increase in future income uncertainty will raise human capital investment in children with the number of children given constant.

Proof. See Appendix [to be added].

Human capital investment in children will increase with rising income uncertainty because the increase in income uncertainty will raise the rate of return on children's human capital investment as long as the parent's utility function is concave and parents have a motive for precautionary saving.

III. Empirical Implementation

We test the model's propositions against individual longitudinal data from the National Survey of Family Growth (Cycle 5, 1995), which cover 10,847 women 15-44 years of age and contain an interviewee's detailed history of childbearing, marital and cohabitation status, and employment in the labor market as well as information on socio-economic variables like education level, age, residence, race, religion and occupation.

In Table 2, we test our theoretical implications in Propositions 2-6 using a binary choice model. Although our theory deals with a static decision on child diversification, we test the implications in a dynamic setup in order to utilize the longitudinal information in the data. The dependent variable is a binary variable (NEWDAD) that takes one if a woman gives birth to a child whose father is different from the father of the last child born, and zero if she gives birth to a child with the same father of the last child. Our data set contains three pieces of information to use for constructing this variable: (1) time elapsed since the conception in the last childbirth until the conception in the current childbirth, (2) father's age in the last childbirth at the time of conception, and (3) father's age in the current childbirth at the time of conception. We identify as the same father both the father in the last childbirth and that in the current childbirth if the father's age in (3) equals to the sum of (1) and (2).[4] Our basic specification in Table 2 is a probit model with woman-specific random effects:

$$(3.1)\quad NEWDAD_{it} = 1 \quad \text{if } \lambda' X_{it} + u_i + \varepsilon_{it} > 0,$$

$$NEWDAD_{it} = 0 \quad \text{if } \lambda' X_{it} + u_i + \varepsilon_{it} \leq 0,$$

where u_i is the random-effects term for woman i, normally distributed i.i.d. with mean zero, and the error term ε_{it} is normally distributed i.i.d. with mean zero. X_{it} is a vector of woman i's characteristics at the time of the t-th childbirth, which includes a measure of woman's education level, age, earnings, future income uncertainty, binary variables for urban residency, religion and race, and the number of children already born.

We include a woman's schooling years (EDUC) as an explanatory variable to control for the price of children. Higher wages for more educated women imply higher opportunity cost of time-intensive childbearing (Becker, 1991). A woman's age at the time of conception (AGE) is also included as an explanatory variable to control for the price of children since it is well documented in the literature that the age-earnings profile takes an inverted-U shape (Murphy and Welch, 1990). At the same time, AGE may control for marriage market condition as older women have more eligible partners for child diversification in the remarriage market.

The earnings in the year of conception (INC) are estimated from the regression result of the reported average monthly earnings in the survey year. The average monthly earnings from the last jobs for those women who worked in the survey year are regressed on such explanatory variables as education level, age, and binary variables for occupations, industries, residential areas, and races. Then, the average monthly earnings in the year of conception are projected, based on the regression coefficients and the values of the explanatory variables in that year. This variable thus measures the level of income in young adulthood. We proxy income uncertainty by

[4] We have verified the validity of this method independently by checking whether at the time of conception in the current childbirth the woman was living together with (either cohabitating with or married to) the same man with whom she had lived together at the time of conception in the last childbirth.

the number of changes in labor market status (either job finding or separation) after the t-th childbirth as a ratio to the number of months elapsed since the t-th childbirth until the survey month (INC_RISK). This variable approximates the probability of the woman's future status change in the labor market in one month. The construction of this variable is based on the assumption that women have rational expectations on future changes in labor market status.

Our explanatory variables include a couple of binary variables for residential area: whether living in the central city of a Standard Metropolitan Statistical Area (CITY), or in the suburb of a SMSA (SUBURB). The cost of raising children may be higher in urban areas, because the housing price in urban areas is higher and children in rural areas can be helpful in agriculture. Moreover, the cost of partner search may be lower in urban areas.

We also include as regressors binary variables for Protestantism (PROTST), for Roman Catholicism (ROMAN), for blacks (BLACK), and for whites (WHITE). Religion can influence fertility and marriage decisions because, for example, the psychological cost of divorce may be higher for Roman Catholics due to the Catholic Church's teachings against divorce. The binary variables for races are introduced to account for differences in unobserved variables, including different marriage market situations by race. In order to control for the starting state, we also include the number of children already born to a woman (PARITY) as an explanatory variable. We prefer a log transformation for all the regressors in X_{it} except binary variables, variables with possible zero values, and the age variable (AGE). A linear and a square term of AGE are included as regressors to account for possible non-monotonic influence on the dependent variable as demonstrated in the age-earnings profile. For variable construction and sample statistics, see Table 1.

Partner selection and changes in marriage or cohabitation may be determined independently for other reasons than child diversification (e.g. taste for variety). As an alternative specification for testing the model's implications, we estimate in Table 3 a duration model to see how a woman's likelihood of childbirth is affected by the model's parameters and by whether she has a new mate, using information on the number of months elapsed since the last pregnancy and the time when a woman has a new partner. Our base specification is a parametric hazard model:

(3.2) $h(t) = h_0(t) \exp(\gamma' X_{it})$,

where t is duration, $h_0(t)$ is the baseline hazard, and γ is a vector of parameters to estimate. X_{it} is a vector of covariates that includes all the variables in equation (3.1) as well as a binary variable for whether a woman has a mate different from the one who fathered the last child (SWITCH). We estimate the parameters using the Cox proportional hazard model which imposes no parametric restriction on the baseline hazard. The baseline hazard in the Cox model is an individual-specific constant, and it accounts for individual heterogeneity. Alternatively, we use other parametric specifications such as the Weibull model where $h_0(t) = pt^{p-1}$.

Another way to account for heterogeneity at the level of an individual woman is to model heterogeneity in a parametric way. We introduce heterogeneity in the duration model to accommodate the lack of independence of the failure times in multiple failure data for each woman. Even though we have individual specific covariates, systematic individual differences can remain after the observed effects are accounted for, and this can create a problem of incomplete specification. If unobserved heterogeneity is assumed to take a multiplicative form, we have

(3.3) $h(t) = \theta_k h_0(t) \exp(\gamma' X_{it})$

where θ_k is an unobserved random variable for each woman k that is assumed to be independent of X_{it}. We later report the estimation result of this model where the unobserved individual heterogeneity effect takes a gamma distribution.

In Table 4, we test the implications on human capital investment in Propositions 1 and 8. The dependent variable is the number of weeks during which a woman breastfed a child (BRSTFEED). We take this variable as a proxy for human capital investment in children because the short-term and long-term health benefits of breastfeeding to children are well documented in the medical science and breastfeeding is time-intensive and thus costly for women. Studies have found that breast milk is associated with lower rates of various diseases such as urinary-tract and respiratory-tract infections, diarrhea, allergies, bacterial meningitis, and botulism (Lawrence, 2000; Haider et al., 2003 for the literature review). In addition to these physiological health benefits, breast milk also improves children's cognitive and academic abilities (Horwood and Fergusson, 1998). The empirical results in Blau et al. (1996) show that breastfeeding until age six months has large and positive impacts on child's weight and height.

Our basic specification is a linear model with woman-specific random effects:

(3.4) $\text{BRSTFEED}_{it} = \beta' X_{it} + u_i + \varepsilon_{it}$,

where u_i is the random-effects term for woman i, normally distributed i.i.d. with mean zero, the error term ε_{it} is normally distributed i.i.d. with mean zero, and X_{it} is a vector of woman i's characteristics at the time of the t-th childbirth, which includes all the regressors in Table 2. We also include as regressors the birth weight of a child (BABYWT), and a binary variable for whether a woman or a baby experienced physical or medical difficulties such as illness and insufficient milk production while the baby was breastfed (MEDICAL). In one model, we include NEWDAD as an additional regressor to see if a child fathered by a new partner gets less investment (see result (iii) in Proposition 1).

An alternative dependent variable used in Table 4 is a woman's schooling years (EDUC). To obtain years of schooling completed, we use a subsample of women age 25 and over. The specification in this table is a linear model only with cross-sectional data in the survey year. This model includes as regressors education levels of a woman's parents, her age, binary variables for her residency and race, binary variables for religions in which she was raised, and the number of children who were born to her mother (including herself). Income of a woman's parents is not available in our data and thus excluded in this specification. We include as an added regressor a binary variable for whether the woman's mother has remarried at least once (M_REMARRY) to check if children of remarried mothers have less human capital as predicted in Proposition 1.

IV. Empirical Findings

4.1. Child Diversification: Dynamic Binary Choice Model

Table 2 shows our estimation results of the first specification in equation (3.1). Models (columns) 1 and 2 present estimates from a probit and a logit model, both with random effects, respectively. Model 3 includes as an additional regressor the number of weeks for breastfeeding (BRSTFEED) to control for human capital investment. In model 4, a binary variable for marital status (MARRIED) is added to the specification as a regressor. A currently married woman should have a higher cost in childbearing with a new partner than singles, possibly due to the loss of marriage-specific human capital (Becker, ?).

Both EDUC and INC are shown in Table 2 to have significant effects on diversification. Moreover, the estimated coefficients associated with the two variables have opposite signs: women with less education or more income are more likely to have a different partner to father her next child. If EDUC and INC proxy the net cost of one unit of human capital investment (v) and income in young adulthood (z_y), respectively, this result is consistent with Propositions 3 and 4, which indicates that total cost of human capital investment in children (which includes the cost of partner search and mating) is higher when women diversify.

The results in models 1-3 indicate a U-shaped association between a woman's age (AGE) and diversification where diversification hits the bottom at age 25 which means that 57% of the observations lie below this age level. However, the relationship is shown monotonically positive, albeit not significant, in model 4 when the binary variable for marital status (MARRIED) is included. Not surprisingly, the coefficient associated with MARRIED is negative: those married have a lower probability of diversification because of higher cost of diversification. Since the probability of being married rises with age in our data, this channel of the age effect will produce a negative relationship with age and diversification. On the other hand, older women have more eligible partners for child diversification in the remarriage market, which can generate a positive relationship. When marital status is controlled for in model 4, the age variable, therefore, takes up only the latter effect and shows a positive relationship with diversification.

The effect of income uncertainty (INC_RISK) on diversification is shown in Table 2 to be statistically significant and positive in all models. According to proposition 6, this result can be due to the incentive to reduce one type of risk in child quality when there is an increase in risk of another type (risk in income). The result in Table 2 supports this story.

Table 2 points out that diversification in children is less likely in urban areas. This is consistent with the estimated coefficient associated with EDUC if the binary variables, CITY and SUBURB, account for higher cost of childrearing in urban areas as EDUC proxies higher cost of childrearing for more educated women. We find Roman Catholics and Protestants have a lower likelihood of having a different partner for the next child although the effects are marginally significant. The reason may be that Christians, especially Catholics, have a higher cost of divorce or remarriage than non-Christians (possibly people with no religion) due to the Christian Church's teachings against family resolution.

The results in Table 2 indicate that blacks have a significantly higher probability of childbearing with a new partner and whites are less likely to have a new partner than the control group (mostly Hispanics). It is well documented that black and Hispanic females are in excess supply in the marriage market because higher incarceration rate and unemployment rate among black and Hispanic males greatly reduces eligible participants in the marriage market.[5] This leads to higher cost of mating for black and Hispanic women and thus to higher tendency of child diversification for them (see proposition 3). Willis (1999) argues that prevalent out-of-wedlock births among blacks are mainly due to the sex ratio imbalance in the marriage market. This may be an important explanation for out-of-wedlock births among blacks or Hispanics. However, this explanation alone cannot well account for the existence of childbirths to unmarried white women. In fact, the out-of-wedlock birth rate among white women has been rising even faster than blacks in the past few decades. This paper offers a different perspective on the issue of out-of-wedlock births. Women exercising child diversification may end up with out-of-wedlock births if the cost of remarriage is too steep regardless of the sex ratio balance in the marriage market.

The cost of childbearing and mate search for the next child can vary with the number of children already born to a woman. Table 2 shows a significant and adverse effect of the parity of children on child diversification. This result suggests that the cost of new mate search rises with the parity and reduces the likelihood of child diversification.

Most of our testable implications on diversification are derived with human capital investment in children given constant. In model 3, we thus include the number of weeks for breastfeeding (BRSTFEED), a proxy for human capital investment in children, as an additional regressor. Supporting proposition 1 (iii), the result in this model indicates that breastfeeding period for a child fathered by a new partner is significantly shorter.

4.2. Childbirth: Duration Model

[5] The number of jail inmates per 100,000 people in 2005 is 166 for whites, 800 for blacks, and 268 for Hispanics (Bureau of Justice Statistics, Prison and Jail Inmates at Midyear 2005). The unemployment rate is 4.8% for whites, 10.4% for blacks, and 7.0% for Hispanics in 2004 (US Census Bureau, Statistical Abstract of the United States, 2006).

Table 3 reports the estimation results of the duration model in equation (3.2). Column 1 is our base model with the Cox proportional hazard model. To ensure the robustness of our specification, we estimate a model with the Weibull distribution in column 2. Other parametric models using the Gompertz, exponential, lognormal, and log-logistic distributions are estimated but not reported in Table 3 because the results from these models are qualitatively similar to the result in column 2. In column 3, we estimate a model where the unobserved individual specific term has a gamma distribution.

In general Table 3 confirms the findings in previous empirical studies on fertility in static and dynamic settings: EDUC as a proxy for the cost of children exhibits a significantly adverse effect on childbirth, and INC as a proxy for income in young adulthood shows a positive effect on childbirth. The age variable (AGE) shows an inverted-U-shaped relationship with the childbirth probability with the latter variable peaking at age 24 in all models (58% of the observations lie below this age). Women at very young ages are less likely to give birth because of schooling while higher wages and lower fecundity of older women are expected to lower the childbirth probability.

The measured effect of income uncertainty is significant and consistent with proposition 7: higher INC_RISK raises a birth hazard rate. The effect of INC_RISK is distinct from the positive impact of the income level, INC.

Residing in urban areas lowers the childbirth probability for it would raise the cost of rearing children. This effect is confirmed in Table 3. The coefficients associated with CITY and SUBURB are significantly negative. We find Roman Catholics and Protestants have a higher childbirth probability than others, and that whites are significantly less likely to give birth. With the diminishing marginal utility of children, the probability of childbirth will be adversely affected by the number of children, which is confirmed in Table 3 by a significant and negative coefficient associated with PARITY.

Table 3 shows that a binary variable for whether a woman has a mate different from the one who fathered the last child (SWITCH) has a significant and positive effect on childbirth. This finding is generally consistent with our story that women who change mates are motivated to produce children for the diversification purpose.

4.3. Human Capital Investment in Children: Linear Panel Model with Random Effects

The estimation results of the specification in equation (3.4) are reported in models 1 and 2 of Table 4. Model 2 of this table includes as an additional regressor a binary variable for child diversification (NEWDAD) in addition to the regressors included in model 1 which is our base model.

The estimated effects of child diversification and income uncertainty on children's human capital investment reported in Models 1 and 2 are consistent with the predictions in Propositions 1 and 8. The effect of NEWDAD is shown to be significantly negative, which implies that investment in a child fathered by a new mate is lower as predicted in proposition 1. Table 4 also shows that INC_RISK has a positive impact, albeit marginally significant, which confirms the prediction in proposition 8: higher income uncertainty in the future will increase human capital investment in children.

Mother's education level and age are shown in Table 4 to have positive impacts on the duration of breastfeeding. This might be due to the fact that health benefits of breastfeeding have become widely recognized only in the last few decades and the later cohorts of women are more educated. These variables are shown in Roe et al. (1999) which uses the U.S. data collected by the Food and Drug Administration to have the same qualitative effects on breastfeeding.

Table 4 shows that Roman Catholic or Protestant women living in rural areas are likely to breast feed their children for a shorter period of time. Our result indicates that black women have a short duration of breastfeeding, which is also found in Roe et al. (1999). Babies who were heavier at birth are likely to have a longer duration of breastfeeding. We find that babies are breastfed for a shorter period of time when a woman or a baby experience physical or medical difficulties such as illness and insufficient breast milk production.

In models 3 and 4 of Table 4, the dependent variable is a woman's schooling years as a proxy for her human capital level. We find that a binary variable for whether the woman's mother had remarried at least once (M_REMARRY) has a significantly adverse effect on the woman's education. The finding that children of remarried mothers have less human capital is supportive of our prediction in proposition 1. These models indicate that women with more educated parents, women who live in urban areas, women who were raised in Roman Catholicism or Judaism, and women with fewer siblings tend to have higher educational level. Among ethnical groups, Hispanic women are least educated in our data.

V. Concluding Remarks

[To be added]

Appendix for proposition 6

Proof Differentiating D in (2.3′) with respect to $\bar{y}$, with the condition that $\pi d\bar{y} + (1-\pi)d\underline{y} = 0$,

$$\partial D/\partial\bar{y} - \pi/(1-\pi)\ \partial D/\partial\underline{y} = \pi\ [\partial D_1(\bar{y})/\partial\bar{y} - \partial D_1(\underline{y})/\partial\underline{y}] - \pi\ [\partial D_2(\bar{y})/\partial\bar{y} - \partial D_2(\underline{y})/\partial\underline{y}],$$

where the term in the first bracket pertains to the effect on the benefit of diversification, and the term in the second bracket shows the effect on the cost of diversification. The term in the first bracket is

$$[\partial D_1(\bar{y})/\partial\bar{y} - \partial D_1(\underline{y})/\partial\underline{y}]/\pi p(1-p)$$

$$= [\ u'(\alpha\underline{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\bar{q} + \bar{q}) - u'(\alpha\bar{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\bar{q} + \bar{q})\ ]$$

$$-\ [\ u'(\alpha\underline{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\bar{q} + \underline{q}) - u'(\alpha\bar{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\bar{q} + \underline{q})\ ]$$

$$-\ [\ u'(\alpha\underline{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\underline{q} + \bar{q}) - u'(\alpha\bar{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\underline{q} + \bar{q})\ ]$$

$$+\ [\ u'(\alpha\underline{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\underline{q} + \underline{q}) - u'(\alpha\bar{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\underline{q} + \underline{q})\ ],$$

which is positive as long as $u'' < 0$. The term in the second bracket is

$$[\partial D_2(\bar{y})/\partial\bar{y} - \partial D_2(\underline{y})/\partial\underline{y}]/\pi$$

$$= p\ [\ u'(\alpha\underline{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\bar{q} + \bar{q}) - u'(\alpha\underline{y} - \alpha v_1 n_1 - \alpha v_1 + n_1\bar{q} + \bar{q})\ ]$$

$$-\ p\ [\ u'(\alpha\bar{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\bar{q} + \bar{q}) - u'(\alpha\bar{y} - \alpha v_1 n_1 - \alpha v_1 + n_1\bar{q} + \bar{q})\ ]$$

$$+\ (1-p)\ [\ u'(\alpha\underline{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\underline{q} + \bar{q}) - u'(\alpha\underline{y} - \alpha v_1 n_1 - \alpha v_1 + n_1\underline{q} + \underline{q})\ ]$$

$$-\ (1-p)\ [\ u'(\alpha\bar{y} - \alpha v_1 n_1 - \alpha v_2 + n_1\underline{q} + \underline{q}) - u'(\alpha\bar{y} - \alpha v_1 n_1 - \alpha v_1 + n_1\underline{q} + \underline{q})\ ],$$

which is positive if $u'' < 0$ and $u''' > 0$, or negative if $u'' < 0$ and $u''' < 0$. ■

This proposition indicates that a woman with higher uncertainty in income will have higher benefit from the diversification in children. However, diversification in children lowers consumption due to higher cost v_2, and increasing uncertainty in income further lowers utility if the third derivative in the utility function is positive, which is more commonly assumed in models for savings under uncertainty.[6] The net effect of income uncertainty thus depends on the magnitudes of these two opposing effects.

[6] If $u''' \leq 0$, we have an unconvincing case of behavior towards risk: increasing absolute risk aversion. That is, a willingness to pay to avoid a given dispersion of consumption rises as wealth increases.

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Table 1 Variable Descriptions and Summary Statistics

Variable	Description	Mean	Std. Dev.
NEWDAD	= 1 if a woman gives birth to a child whose father is different from the father of the last child born, or = 0 if she gives birth to a child with the same father of the last child.	0.3036	0.460
EDUC	Years of schooling	11.918	2.957
AGE	Age at the time of conception	24.958	4.895
INC	Average monthly earnings in the year of conception	1370.6	435.2
INC_RISK	Number of changes in labor market status after a childbirth as a ratio to the number of months elapsed since the childbirth until the survey month	0.0181	0.024
CITY	= 1 if living in the central city of a SMSA	0.3582	0.479
SUBURB	= 1 if living in the suburb of a SMSA	0.4231	0.494
PROTST	= 1 for Protestants	0.5768	0.494
ROMAN	= 1 for Roman Catholics	0.2952	0.456
BLACK	= 1 for black women	0.2758	0.447
WHITE	= 1 for white women	0.6621	0.473
PARITY	Number of children already born	1.5975	0.960
BRSTFEED	Number of weeks for breastfeeding	13.487	24.94
MARRIED	= 1 if currently married	0.7271	0.445
SWITCH	= 1 if having a mate different from the one who fathered the last child	0.0856	0.279
BABYWT	Birth weight of a child in ounces	119.21	20.73
MEDICAL	= 1 if a woman or a baby had medical difficulties such as illness and insufficient milk production during breastfeeding	0.0960	0.295
F_EDU	Schooling years of the father of a woman	11.112	4.200
M_EDU	Schooling years of the mother of a woman	11.117	3.640
P_PROT	= 1 if a woman was raised in Protestantism	0.5603	0.496
P_ROMAN	= 1 if a woman was raised in Roman Catholicism	0.3567	0.479
P_JEW	= 1 if a woman was raised in Judaism	0.0130	0.113
HISPANIC	= 1 if a woman is a Hispanic	0.1332	0.340
SIBLING	Number of children who were born to the mother of a woman	4.6153	2.800
M_REMARRY	= 1 if a woman's mother had remarried at least once	0.1355	0.342

Table 2 Childbearing with a New Partner: Binary Choice Model

Dependent variable: NEWDAD　　　　Random Effects Model

	(1) Probit	(2) Logit	(3) Probit	(4) Probit
EDUC	-0.1475	-0.2512	-0.1499	-0.1127
	-8.96	-8.89	-8.86	-7.04
AGE	-0.0725	-0.1230	-0.0786	-0.0111
	-2.18	-2.18	-2.24	-0.33
AGE^2	0.0015	0.0025	0.0016	0.0005
	2.38	2.39	2.45	0.84
LnINC	0.5537	0.9437	0.5978	0.4086
	3.09	3.08	3.25	2.33
INC_RISK	2.7162	4.5969	2.2191	2.0596
	3.27	3.26	2.56	2.52
CITY	-0.1320	-0.2274	-0.1264	-0.2062
	-2.13	-2.16	-2.00	-3.39
SUBURB	-0.2697	-0.4624	-0.2769	-0.2576
	-4.33	-4.34	-4.35	-4.23
PROTST	-0.1126	-0.1852	-0.1104	-0.0612
	-1.81	-1.74	-1.73	-1.00
ROMAN	-0.1192	-0.2021	-0.1264	-0.0659
	-1.75	-1.73	-1.81	-0.99
BLACK	0.5395	0.9092	0.5297	0.2434
	5.77	5.72	5.47	2.64
WHITE	-0.1596	-0.2731	-0.1499	-0.1093
	-1.85	-1.86	-1.68	-1.30
PARITY	-0.1016	-0.1754	-0.0994	-0.1224
	-4.51	-4.56	-4.25	-5.49
BRSTFEED			-0.0032	
			-3.63	
MARRIED				-0.8838
				-18.05
Log likelihood	-4121.79	-4121.98	-3937.62	-3940.88
Wald χ^2 (d.f.)	383.70 (12)	361.61 (12)	381.84 (13)	637.02 (13)
Observations	7,223	7,223	6,930	7,223

Table 3 Exit to Childbirth: Duration Model

	(1) Cox	(2) Weibull	(3) Cox with hetero
EDUC	-0.1691	-0.1703	
	-22.55	-22.48	
AGE	0.6587	0.6634	
	50.53	50.50	
AGE^2	-0.0135	-0.0136	
	-51.13	-51.07	
LnINC	0.7526	0.7572	
	9.03	9.00	
INC_RISK	2.1918	2.2044	
	7.23	7.11	
CITY	-0.1750	-0.1756	
	-6.04	-6.00	
SUBURB	-0.2145	-0.2159	
	-7.39	-7.36	
PROTST	0.1684	0.1673	
	5.41	5.32	
ROMAN	0.1786	0.1778	
	5.45	5.37	
BLACK	0.0585	0.0602	
	1.25	1.27	
WHITE	-0.1336	-0.1332	
	-3.12	-3.08	
PARITY	-0.0859	-0.0859	
	-7.42	-7.35	
SWITCH	0.4410	0.4589	
	14.74	15.07	
Log pseudolikelihood	-166307.9	-59692.7	
Wald χ^2 (d.f.)	5296.8 (13)	5292.3 (13)	
Observations	206,094	206,094	

Note: Rows show the estimated coefficient and the ratio of coefficient to standard error for each independent variable. Standard errors are calculated based on the Huber/White estimator of variance with the assumption that observations are independent across individuals but not necessarily within individuals.

Table 4 Human Capital Investment

Dep. variable	BRSTFEED			EDUC	
	(1) OLS w/ RE	(2) OLS w/ RE		(3) OLS	(4) OLS
EDUC	0.7258	0.6765	F_EDU	0.1739	0.1769
	2.74	2.54		18.63	19.07
AGE	-0.6858	-0.6880	M_EDU	0.2128	0.2114
	-1.48	-1.48		17.79	17.74
AGE^2	0.0219	0.0221	AGE	-0.0456	-0.0536
	2.56	2.58		-0.69	-0.81
LnINC	4.0892	4.2547	AGE^2	0.0012	0.0013
	1.39	1.44		1.25	1.33
INC_RISK	21.6246	22.2918	CITY	0.3696	0.3734
	1.60	1.65		4.51	4.59
CITY	2.0842	2.0529	SUBURB	0.2774	0.2846
	2.03	2.00		3.82	3.95
SUBURB	-0.3288	-0.4077	P_PROT	-0.0294	-0.0361
	-0.32	-0.40		-0.25	-0.31
PROTST	-2.6412	-2.6769	P_ROMAN	0.2742	0.2326
	-2.59	-2.62		2.26	1.94
ROMAN	-4.4066	-4.4494	P_JEW	1.6689	1.5814
	-3.96	-4.00		6.66	6.39
BLACK	-12.1845	-12.0011	BLACK	-0.7353	-0.6893
	-7.57	-7.45		-3.84	-3.61
WHITE	-1.5481	-1.5998	WHITE	-0.7964	-0.7326
	-1.04	-1.08		-4.39	-4.05
PARITY	-0.0683	-0.1141	HISPANIC	-1.1521	-1.0952
	-0.22	-0.36		-5.59	-5.34
LnBABYWT	6.4362	6.4547	SIBLING	-0.1037	-0.1102
	4.86	4.88		-8.85	-9.41
MEDICAL	-5.8047	-5.8038	M_REMARRY		-0.7457
	-6.82	-6.82			-10.02
NEWDAD		-1.0647			
		-1.95			
R-squared	0.0876	0.0890	R-squared	0.3046	0.3127
Observations	6,887	6,887	Observations	7,216	7,216