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Author(s): Yoram Ben-Porath
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Fertility Response to Child Mortality: Micro Data from Israel

Yoram Ben-Porath

Maurice Falk Institute for Economic Research in Israel and The Hebrew University

I. The Issue

The relationship between fertility and child mortality has occupied a central place in demographic research. The "theory of demographic transition" focuses attention on the timing of declines in fertility and child mortality and has naturally invited speculation concerning possible causal links between them.

Some explanations stress the physiological aspects of fertility. But it is natural and potentially fruitful to operate within a framework where preferences concerning family size are given a primary role. This paper deals with the effect of child mortality on fertility; child mortality may also affect age at marriage and other aspects of household structure that have a bearing on fertility but which are not discussed here. More important, a complete interpretation of the child-mortality–fertility relationship should take account of the fact that child mortality may be an endogenous variable. The prevention of death via nutrition, mother care, and real expenditure on health is responsive to the level of income and relative prices: when the desired expenditure on children is large, the implications of mortality become more important. In this paper, however, the endogeneity of child mortality is not discussed and only the causation going from child mortality to fertility is analyzed.

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Hoarding and Replacement

The effect of mortality on fertility can be broken into two parts: first, we can assume that the preferred family life cycle is not affected by child mortality and ask what effects of child mortality on fertility are implied by the attempt to attain the preferred family size. Second, we can take into account the possible effects of child mortality on the choice of family size or life cycle.

The desired or preferred family life cycle is the desired number of surviving children by age of parents, with specifications of the relevant characteristics such as sex, education, labor force participation, and earnings. Obviously, mortality raises the number of births necessary to achieve a given number of surviving children.

Let us distinguish between two types of reaction to child mortality: "hoarding" and "replacement." Hoarding would be the response of fertility to *expected* mortality of offspring; replacement would be the response to experienced child mortality. This is similar to a distinction introduced by Schultz (1969). If the children die very young and the mother can have another child, the same life cycle can be approximated by replacement. Where the age profile of deaths is such that replacement can reconstitute the family life cycle, replacement is superior to hoarding as a reaction, since the latter involves deviations from what would be the optimum family life cycle in the absence of mortality. If preferences are such that people have a rigid target of a minimum number of survivors at a given phase in the life cycle, hoarding involves a large number of births and the existence of more children than necessary who have to be supported in other phases of the life cycle. Motivated by the old-age support argument, Heer and associates (Heer and Smith 1968; May and Heer 1968) explored the implications of various mortality tables for the goal of having at least one surviving son (with 95 percent probability) when the father is old, and showed that high rates of fertility are required for attaining such a goal. If children are replaced sequentially, fewer births are necessary.

The superiority of replacement is clear, but of course it is not always possible. The risks of mortality are often quite significant beyond infancy. Parents may be afraid of a possible loss of fecundity or some health hazard that will make late replacement impossible or undesirable. The reaction to mortality which is expected to come at a late phase of either the children's or the parents' life cycle may be partly in the form of hoarding.

Mortality Effects on Preferred Family Size and Life Cycle

Actual or expected death may also affect the optimum family life cycle and the desired number of children. That all the implications of increased mortality are absorbed by other activities and commodities (the general standard of living or children's education in particular) may be too strong an assumption, and it makes sense to consider the possibility that mortality, expected or experienced, also brings about a revision in the preferred number of surviving children.

Several studies by T. Paul Schultz (1969, 1973, 1975; Schultz and DaVanzo 1970) explore the association of infant mortality and fertility and indicate some of the relevant economic considerations. There is also an important study by O'Hara (1972) and discussions by Leibenstein (1957) and others (see Lorimer [1967] and the discussion in Simon [1974]). A recent study by Rutstein (1974) takes an approach similar to the one taken here. What follows will reflect some of this earlier work and will rely heavily on a model developed by Ben-Porath and Welch (1972, 1975). Some related empirical work is contained in Ben-Porath (1973*d*).

Should child mortality affect the desired number of children? O'Hara (1972) stresses the importance of the time profile and costs associated with children. Disregarding now the effect of the event itself, if benefits and costs were balanced period by period (on the margin) and if there were no difficulties in immediate replacement of children, there would be no clear reason for child mortality to affect the desired stream of child services. If most of the benefits and gratification derived from children precede expenditure, child mortality reduces the cost of child services. If expenditure (or discomfort) precedes the benefits, child services are more costly with child mortality. In terms of the complete family decision, these can be viewed as changes in the expected prices of children. If the case of early costs and late benefits is more prevalent, a decline in mortality will increase the desired family size; this will counterbalance the mechanical replacement relationship only if the demand for children is very elastic.

It should, however, be appropriate to take account of the fact that the price of children is not given. Expenditure on children is determined, at least in part, by the parents and may be affected by mortality. Lower mortality may make it worthwhile to invest in developing various traits in children (investment in human capital) and cause a shift from quantity to fewer, more educated children (see O'Hara 1972).

Take a simple model where

$$\max u[q(t, x)n, s] \tag{1}$$

subject to $\pi nx + s = y$, where t = indicator of survival, n = number of children, q = index of child quality, s = consumption of parents, y = full family income, x = inputs into children, and π = the price of one unit of x. Both optimum quality of children, q^*, and optimum expenditure on them, x^*, can be solved as a function of survival (t). The solution of (1) is (2) (see Ben-Porath 1973*c*):

$$\eta_{nt} = -\eta_{q^*t} + \eta_{n\pi}(\eta_{x^*t} - \eta_{q^*t}). \tag{2}$$

The first term represents a technical relationship: as children survive longer, parents have more child services ($\eta_{q^*t} > 0$) and need fewer children for a given volume of child services. The second term represents the effect of prices and expenditure. The term $\eta_{x^*t} - \eta_{q^*t}$ is equal to the elasticity with respect to survival of expenditure per unit of quality, $\eta_{(x^*/q^*)t}$. This term is likely to be positive and thus contribute a downward slant to the fertility-survival relationships via the negative price elasticity (see also O'Hara 1972). If expenditure were independent of survival, we would have the simple expression $\eta_{nt} = -(1 + \eta_{n\pi})\eta_{q^*t}$, which, like the analogous case of augmenting technical change, indicates that fertility will be directly associated with mortality if the demand for children is inelastic.

This analysis would be appropriate if children were all purchased at one time. Further aspects become clear once we take into account the fact that most infant and child mortality occurs when the mother can still respond to the death of a child by having more children if she wants to. We can think about this in the following terms:[1]

Compare two couples, A and B, equal in tastes and all the exogenous variables that determine desired family size, both sharing the same expectations with respect to mortality, and both having (e.g.) two children born. The difference is that B has lost one child. Assume now that A and B go on expecting the same survival rate for their remaining and future children. Couple B is worse off than couple A: it was hit in terms of children, while other activities were not disturbed. Adjustment means that B will try to restore some balance to its pattern of consumption—spreading the loss over various goods and services instead of losing it all in terms of children. If the demand for (surviving) children is income inelastic, B-like families will fully replace lost children; if the demand for children is somewhat responsive to income (or the degree of well-being), there will be only partial replacement. In other words, the extent to which B-like families respond to the loss of a child indicates something about the propensity to "consume" children out of income: absence of response would indicate a limited propensity, and full replacement would indicate zero income elasticity.

In the case just discussed, people are assumed to share the same expectations concerning future mortality irrespective of their own experience. But it may well be that both couples will modify their expectation concerning future survival as a result of the experience. This learning from experience would reflect the notion that, even if a group starts with a common prior probability of survival, when people realize that the risk

[1] What follows is a straightforward adaptation to this problem of Ben-Porath and Welch (1972, 1975).

of mortality differs between families they will use their own experience to learn or make inferences about how the true survival parameter relevant to their own children differs from the average for the population. This would fit a Bayesian paradigm with people starting with some prior probability which reflects the view held in the socially relevant environment; then, as they accumulate experience and as their own sample of children grows, they give greater weight to their own experience relative to the original prior probability. The inference from experience is the source of a substitution effect that is being added on to the income effect described earlier.

There are other considerations that this rudimentary model cannot handle explicitly. Pure risk aspects are not considered: in addition to the risks and experience of mortality, there are the risks and experience of unwanted births. Couples who find themselves with more surviving children than they want and are out of equilibrium will fail to replace a child who dies. This applies also to couples who choose a strategy of hoarding: obviously the strategies are substitutes, and if the stock of children was already planned on the expectation that some will die, the actual death of a child will not elicit a replacement response. Couples who fear (or choose a strategy that involves a high probability of) excessive births in the future may postpone replacement to the late phase in the childbearing period; except for such considerations, it is reasonable to assume that, since the demand for children is probably dated and since adding a new member to the family entails setup costs, people will try to replace children not too long after their death unless health or psychological problems interfere. To the extent that the demand for child services is somewhat reduced by child deaths, how is this reduction reflected in the length and timing of child service streams? What is the lag involved? These are questions that must be settled by empirical work.

Supply Considerations

Before turning to the evidence, I must remind the reader of the links between child mortality and fertility that do not derive from preferences with respect to family size. The link between breast-feeding and fertility has been widely discussed (see Potter 1963; Jain 1969; Jain.et al. 1970). In an environment where breast-feeding is practiced, there is a link between infant death and the mother's susceptibility to conception. In a context where (other) birth-control devices are for some reason not available, child mortality will reduce the length of the interval between births and will increase the number of births that a married woman will have during her fertile years. Thus, even this most mechanical explanation may have a behavioral element: it would work where breast-feeding is practiced and by what could be described as the elimination, by the death of an infant, of a (temporary) birth-control device.

A somewhat more general hypothesis was offered by Knodel (1968), who pointed out that the presence of a newborn in the household is likely to be associated with exhaustion of the mother and with sleeping arrangements that reduce the frequency of intercourse and consequently fertility. This is a more behavioral explanation that would increase the variability of response.

A clear supply case is one where fecundity is an affective constraint, when the desired number of children exceeds the possible number. In such a case, child mortality will reduce replacement that may be bounded again by the physiological constraints but is not modified by revised demand.

II. The Evidence

In this paper the evidence is restricted to (retrospective) cross-section micro data. Thus, it is quite clear that the bulk of what has been described as hoarding cannot be captured by comparing individuals. Expected mortality affects fertility differences among individuals if it is correlated (across individuals) with experienced mortality and the hoarding effect associated with learning is confounded with replacement. What micro data can indicate is whether replacement exists and how important it is. Two well-known problems in empirical work should be mentioned. First, mortality may be partly responsive to fertility—either as a direct corrective to excessive births or as an indirect consequence of the pressure of excess births on real income and thus on nutrition and health. Second, with micro data there is the ever-present possibility that left-out variables related to fecundity or to tastes affect both mortality and fertility, generating a spurious association between them.

The data to be considered here come from the special fertility section of a labor force survey held in 1971. This fertility questionnaire was a rider to the regular labor force survey sample and was administered to Jewish women up to age 64 who were married once and whose husbands were alive. The information used here is based on a list of all children born, giving their sex, month, and year of birth, and whether they were still alive at the time of the survey (there is no information on the date of death). Thus, it is not a history of pregnancies: pregnancies terminated by abortion or stillbirths are not recorded at all.

The unit of observation is a birth. The first dependent variable to be considered is the stopping probability—the probability that a given birth is a last birth. The sample was too small to be restricted to women past childbearing age, but it was possible to confine the analysis to births of women age 35+ at the time of the survey.

Two important features of the Israeli scene are relevant here. First, the majority of the women are foreign born. Given the variety of countries from which they immigrated, their experienced fertility and mortality have a variance that is usually hard to observe in a single country. Also, when they immigrated, many of these women shifted from a milieu of extremely high child mortality, which they had either experienced for themselves or learned to expect, to a country with a very low rate of child mortality. This is, of course, just one element in the changing conditions and expectations that affect subsequent family formation.

The independent variables should in principle be of the following kinds: (*a*) Variables that determine the long-term desired family size. This is the role of the mother's years of schooling in our analysis (WEC). In one way or another, we control throughout for mother's place of birth, which in part reflects otherwise unexplained differences in desired family size. (*b*) Variables that describe the family's demographic situation at the time of the birth—mother's age (WAC), birth order (ORD), etc. (*c*) Variables that describe the family's economic position at the time of birth. Regrettably, this is totally missing. (*d*) Variables that are directly relevant to the main question being asked here. Dummy variables indicate whether a child has died (D) and whether the preceding birth (D-1) or any birth of a lower order (D-2+) died. As already noted, we have no information on the time of death of children. The procedure by which fertility is related to the death or survival of preceding births makes sense if indeed it is true that death cannot have occurred after the response is presumed to have taken place. Indeed, infant mortality is relatively high compared with mortality at subsequent ages; nevertheless, prior mortality is measured with error, and in principle this should bias the corresponding regression coefficients toward zero.

There are significant fertility differences by mother's continent of birth; the higher fertility of women born in Asia or Africa is reflected in their lower stopping probability at any birth order (see panel B of table 3 below). There are also fairly large differences in child mortality by mother's continent of birth, with mothers born in Asia-Africa (AA) losing more children than those born in Europe-America (EA) or Israel (Is). Mortality is much higher for births that occurred abroad than for those that occurred in Israel. The proportion of boys who died is higher than that of girls (table 1).

Estimates based on the vital statistics for 1960–63 give infant mortality for births in Israel at 26.4 per 1,000 for AA women, 23.9 for EA, and 20.5 for Is (Peritz and Bialik 1968; Schmelz 1971). Data for the early 1950s suggest a similar rate for EA and a rate of close to 50 per 1,000 for AA,

TABLE 1

PERCENTAGE OF CHILDREN WHO DIED,* BY PLACE OF BIRTH AND MOTHER'S CONTINENT OF BIRTH

PLACE OF BIRTH OF CHILDREN	MOTHER'S CONTINENT OF BIRTH			
	Total	Asia-Africa	Europe-America	Israel
Total	5.2	6.5	4.1	2.9
Born abroad	11.0	12.4	8.3	N. R.†
Born in Israel	3.4	4.0	2.5	2.9
Males	6.1	7.2	5.4	3.1
Born abroad	12.3	13.5	10.1	N. R.
Born in Israel	4.1	4.5	3.6	3.1
Females	4.3	5.8	2.7	2.7
Born abroad	9.5	11.2	6.4	N. R.
Born in Israel	2.6	3.4	1.3	2.7

SOURCE.—This and subsequent tables are based on data of the Israel Central Bureau of Statistics Labour Force Survey (1971).
* Reported retrospectively in 1971.
† N. R. = Not Relevant.

which is declining fast (Kallner 1958). These numbers are not inconsistent with the data in our sample for births in Israel.

The death rate for children born abroad can be compared with figures given in the 1961 Census of Population for children born abroad who died before the age of 5. The estimates were 23.5 percent for children of AA women and 11.2 for EA women, significantly higher than what we have in our sample. The difference may be partly due to the change in the age-education composition of foreign-born women between 1961 and 1971, but probably also to increasing omissions (response error).

We can now review the evidence in two ways—contingency tables and regression results. For a given birth order, the stopping probability is lower where one of the preceding births ended in death. The magnitude of this differential diminishes as one moves to higher birth orders (see particularly women from Asia-Africa in panel B of table 2).

The lower panel of table 2 presents the *relative* decline in stopping probability associated with one death. This can be thought of as the average degree of replacement that takes place. At orders 2 and 3, more than 80 percent of lost children are replaced among AA. At higher orders there is a decline. The *relative* response is smaller among EA and Is; note that the initial level of STOP is higher in these groups. Similar patterns emerge when the probability of stopping at a given birth is related to the death (or survival) of that same birth. Among AA the effect of death is higher for births that took place in Israel than for births abroad. The relative effect is higher among AA women.

The treatment of each death as though it had occurred before the next birth, while in fact some deaths occurred later, imparts a downward bias

TABLE 2

STOPPING PROBABILITY (× 100) BY BIRTH ORDER, NUMBER OF DECEASED CHILDREN, AND MOTHER'S CONTINENT OF BIRTH (WOMEN AGE 35+ IN 1971)*

MOTHER'S CONTINENT OF BIRTH AND NUMBER OF DECEASED CHILDREN	BIRTH ORDER 2	3	4	5	6
	A. Stopping Probability				
Asia-Africa (2,267):					
0	14.4 (492)	24.0 (387)	28.3 (272)	27.2 (184)	32.1 (131)
1	1.8 (56)	5.1 (79)	14.5 (83)	20.8 (72)	27.8 (54)
2	0.0 (10)	5.3 (19)	0.0 (22)	8.3 (24)	39.3 (28)
Europe-America (1,155):					
0	62.5 (664)	70.4 (240)	59.1 (66)	46.2 (26)	42.9 (14)
1	39.1 (46)	48.4 (31)	63.2 (19)		
Israel (566):					
0	30.0 (223)	51.7 (149)	48.6 (70)	47.1 (34)	38.9 (18)
1		40.0 (15)	44.4 (9)		
	B. Difference in Stopping Probability between Women with 1 and 0 Deaths				
Absolute difference (percentage points):					
Asia-Africa	12.6	18.9	13.8	6.4	4.3
Europe-America	23.4	22.0	−4.1		
Israel		11.7	4.2		
Relative difference (%):					
Asia-Africa	87.5	78.8	48.8	23.5	13.4
Europe-America	37.4	31.3	−6.9		
Israel		22.6	8.6		

* Figures in parentheses are the number of observations (empty cells are those with fewer than 10 observations).

to the effect of death on subsequent fertility. On the other hand, the fact that a birth is last in my data does not guarantee that it was the last in reality, although the restriction of the sample to women age 35+ partly remedies this bias.

The difference in stopping probability associated with experienced mortality may be biased also because other variables which affect fertility and are correlated with mortality are not controlled. This is partly remedied in multiple regressions (table 3). Because the dependent variable takes a value of zero or unity, ordinary least-square estimates can be misleading and logit estimates are presented. The derivatives of the stopping probability with respect to the death of last and preceding births are

TABLE 3

LOGIT ESTIMATES OF EFFECTS OF CHILD DEATHS ON STOPPING PROBABILITY (WOMEN AGE 35+ IN 1971, BIRTH ORDER ≥ 2)*

	WOMAN'S CONTINENT OF BIRTH		
	Asia-Africa	Europe-America	Israel
Number of observations	2,278	1,155	566
	A. Derivatives†		
D	−.033 (1.3)	−.121 (2.6)	−.096 (1.3)
D-1	−.048 (2.0)	−.110 (2.9)	−.180 (2.3)
D-2+	−.015 (0.9)	−.010 (0.3)	.092 (1.5)
ORD	.040 (12.1)	−.005 (0.6)	.044 (4.5)
WEC	.017 (10.2)	.008 (2.6)	.015 (0.7)
$(WEC)^2$	−.000 (5.7)	−.000 (2.4)	.001 (0.7)
BISR	.098 (6.3)	.038 (1.3)	N. R.‡
NBAB	.002 (0.1)	−.052 (2.0)	N. R.
Likelihood ratio test	371.9	34.3	54.6
Degrees of freedom	8	8	6
$\bar{R}^2$	.225	.040	.124
	B. Means of Variables Used in Regressions		
Proportion of last births (STOP)	.241	.615	.408
Proportion of children who died (D)	.081	.041	.041
Proportion of births in Israel (BISR)	.622	.757	1.000
Proportion of children with no siblings born abroad (NBAB)	.368	.594	N. R.
Mean years of schooling WEC	3.5 (4.9)	9.4 (6.9)	9.6 (2.9)

* Figures in parentheses are t-ratios in panel A and the standard deviation in panel B. The notation is as follows: D = dummy variable taking the value 1 if the child died; D-1 = dummy variable taking the value 1 if the child in immediately preceding birth died; D-2+ = dummy variable taking value 1 if child in any preceding birth (other than immediately preceding) died; ORD = birth order; WEC = woman's years of schooling; BISR = dummy variable taking the value 1 if the birth occurred in Israel; NBAB = dummy variable taking the value 1 if the birth was not preceded by any birth abroad.

† The derivative of the stopping probability with respect to variable x_i is $\partial p/\partial x_i = b_i\bar{p}(1 - \bar{p})$, where b_i is the logit coefficient and $\bar{p}$ is the mean stopping probability.

‡ N. R. = Not Relevant.

significant. They are much smaller (in absolute terms) for AA than for EA and Is women. However, when the derivatives are divided by the stopping probabilities in each group, the difference between AA and EA disappears (see panel B of table 3).

The pattern of the coefficient of D, D-1, and D-2+ shows a distributed response over birth orders. In the contingency table (table 2), the effect of mortality on stopping probability declined fairly steeply as birth order increased. When the stopping probability is regressed on mortality plus other variables in each birth order separately, the decline becomes less obvious.

Closed Intervals

The other dimension of fertility of interest here is the relationship between closed intervals and child mortality. There are several reasons why we can expect birth intervals to respond to child mortality. It is reasonable to think of a preferred family life cycle in terms of children's and parents' ages. The random element in births means of course that preferences can be only crudely approximated in reality. Still, the death of a child does not only elicit eventual replacement but calls for some attempt to have the new child not too long after the death. If the response to a death consisted only of bringing the whole timetable of subsequent births forward, we would expect the first interval following a death to be shorter than otherwise and all subsequent intervals to be unaffected. If the response to a child death were only to bring forward the date of the immediately following birth, the first interval following a death would be shorter, the second interval *longer* by the same amount, and subsequent intervals unaffected. If there is a distributed response over dates of subsequent births, it should be reflected in a shorter first interval and diminishingly longer subsequent intervals.

In a milieu of imperfect birth control, it is quite reasonable to assume that a desire to stop births would be reflected in longer mean intervals between births even if the demand for children were concerned only with completed size. Thus, with the appropriate *ceteris paribus*, one can expect movements in the intervals to be correlated with movements in the desired number of children. In addition, we have of course the mechanism that relates intervals to location and which may have an element independent of preferences with respect to family size (see Knodel 1968; Jain 1969).

By construction, the estimated intervals do not measure intervals between pregnancies. They are based on data for month and year of birth of children reported retrospectively in 1971. They are thus subject to large measurement error. The reporting error on dates is likely to be large, and the selection of sample by availability of response may be a source of bias.

The estimated mean closed interval is 33 months for AA women, 50 months for EA women, and 43 months for the Israeli born (panel C of table 5). The mean interval in the three groups is smaller if the birth was preceded by the death of a child (table 4). The decline in the interval for second child (i.e., between first and second) is 10 (AA) to 15 (EA and Is) months. When other variables are controlled in a regression framework, it turns out that the relative, as well as the absolute, decline in the interval

TABLE 4

CLOSED INTERVAL BY BIRTH ORDER, NUMBER OF DECEASED CHILDREN, AND MOTHER'S CONTINENT OF BIRTH (WOMEN WITH INFORMATION ON TIMING OF BIRTHS)*

MOTHER'S CONTINENT OF BIRTH AND NUMBER OF DECEASED CHILDREN	BIRTH ORDER 2	3	4	5	6
	A. Closed Interval				
Asia-Africa:					
0	29.1 (17.0) (639)	37.9 (23.8) (418)	37.7 (28.5) (236)	34.0 (22.6) (128)	30.5 (22.5) (69)
1	19.0 (7.3) (22)	25.8 (16.7) (31)	27.2 (26.7) (37)	32.8 (18.6) (29)	25.8 (14.2) (20)
Europe-America:					
0	51.1 (32.2) (711)	55.9 (33.5) (238)	41.1 (23.2) (65)		
1	35.8 (21.4) (30)	42.9 (33.0) (21)	49.2 (20.9) (11)		
Israel:					
0	38.7 (22.4) (357)	48.7 (32.0) (183)			
1	23.3 (17.8) (10)	46.1 (18.3) (9)			
	B. Difference between 0 and 1 Death				
Asia-Africa	10.1	12.1	10.5	1.2	4.7
Europe-America	15.3	13.0	−8.1		
Israel	15.4	2.6			

* In months (means). Figures in parentheses are the standard deviation (first row) and the number of observations (second row). Empty cells are those with fewer than 10 observations.

is more pronounced among EA and Is women than among AA women (table 5; age at birth and birth order are associated with longer intervals, and so is schooling, among AA women).

The analysis of intervals raises a number of problems. Couples with many children are more likely than couples with few children to have shorter intervals on the one hand and more experience of child deaths on the other. This may create a spurious negative correlation between child mortality and closed intervals and exaggerate the effect of prior mortality on the intervals. As a remedy for biases coming from couple-specific effects on intervals, deviations of the interval for each birth from the mean interval of all births of the same mother were used as a dependent variable. This indeed reduces the estimated effect of prior mortality on the intervals but does not wipe it out (see the three right-hand columns in table 6).

TABLE 5

Two Regressions with Dependent-Variable Natural Logarithm of Closed Interval (Women with Information on Timing of Births)*

	Woman's Continent of Birth		
	Asia-Africa	Europe-America	Israel
Number of observations	1,767	1,141	695
	A. Regression I		
D-1	−.269	−.409	−.609
	(3.6)	(3.4)	(3.5)
D-2+	−.065	−.018	−.049
	(1.1)	(0.1)	(0.2)
BISR	.054	.157	N. R.†
	(1.4)	(2.8)	
ORD 3	.230	.057	.169
	(6.0)	(1.1)	(2.8)
ORD 4+	.160	−.274	.165
	(4.2)	(4.0)	(2.4)
WEC	.022	.004	−.000
	(5.0)	(0.6)	(0.0)
$(WEC)^2$	−.000	−.000	.000
	(3.1)	(0.8)	(0.2)
$\bar{R}^2$	.041	.032	.026
	B. Regression II		
D-1	−.188	−.319	−.558
	(2.7)	(3.1)	(3.6)
D-2+	.044	.100	.033
	(0.5)	(0.9)	(0.2)
WAC	.053	.073	.077
	(16.2)	(20.0)	(13.5)
	C. Means of Variables for Birth Order 2+		
Closed interval in months	32.8	50.1	42.7
	(22.0)	(32.0)	(27.0)
Mother's age at birth (WAC)	27.4	30.0	28.2
	(5.1)	(5.2)	(4.8)
Proportion of births preceded by death in preceding birth (D-1)	0.044	0.033	0.022

* ORD 3 and ORD 4+ are dummy variables taking the value 1 for, respectively, birth orders 3 and 4+; WAC is woman's age at birth of child. Other symbols as in table 3. Figures in parentheses are *t*-ratio in panels A and B and the standard deviation in panel C.
† N. R. = Not Relevant.

For EA and Is women, the effect of prior mortality on intervals rises steeply with mother's age (and with birth order), but there is no such clear trend among AA women (sample size and lack of statistical significance blur the picture).

We can understand the change with age of the effect of mortality on fertility if we assume that the mortality to which older women react also occurred at a later age. If the preferred family size is small and the preferred childbearing period limited (and, correspondingly, family planning is fairly widespread), the response to child death is likely to become more

TABLE 6

REGRESSION COEFFICIENTS OF CLOSED INTERVAL AND DEVIATION OF INTERVAL ON PAST SURVIVAL* (WOMEN WITH INFORMATION ON TIMING OF BIRTHS)

BIRTH ORDER AND WOMAN'S AGE WHEN BIRTH OCCURRED	CLOSED INTERVAL, MOTHER'S CONTINENT OF BIRTH			DEVIATION OF INTERVAL, MOTHER'S CONTINENT OF BIRTH		
	Asia-Africa	Europe-America	Israel	Asia-Africa	Europe-America	Israel
	Order 2+					
All women:†						
D-1	−6.7	−15.5	−14.0	−2.6	−5.8	−2.7
	(2.7)	(3.0)	(2.0)	(1.4)	(2.3)	(0.6)
	(1,767)	(1,141)	(695)			
Women under 25:‡						
D-1	−5.2	−7.7	−8.9	−1.0	−7.1	...
	(2.7)	(1.8)	(1.6)	(0.5)	(1.7)	
	(710)	(240)	(226)			
D-2+	...	6.9	12.6	3.5	5.8	23.4
		(1.1)	(1.3)	(1.7)	(0.9)	(2.3)
Women 26–34:‡						
D-1	−1.0	−9.0	−13.6	...	−2.1	−2.6
	(0.2)	(1.7)	(1.6)		(0.7)	(0.4)
	(876)	(674)	(391)			
D-2+	−3.8	...	−8.0	...	2.5	...
	(1.4)		(1.0)		(0.7)	
Women 35+ :‡						
D-1	−3.5	−38.8	−20.8	...	−12.7	−14.9
	(0.3)	(2.2)	(0.7)		(1.4)	(0.9)
	(181)	(227)	(78)			
D-2+	5.4	...	...	5.9	...	5.1
	(0.8)			(1.3)		(4.1)
	Order 3+					
All women:§						
D-1	−4.0	−28.2	−17.0	−2.4	−24.2	−8.0
	(0.9)	(2.6)	(1.5)	(0.7)	(3.0)	(0.9)
	(898)	(337)	(320)			
D-2+	1.4	...	−2.9	2.6	2.5	4.5
	(0.5)		(0.4)	(1.3)	(0.5)	(0.7)

* In months. Notation is as in tables 3 and 5. Figures in parentheses are t-ratios (first row) and number of observations (second row). The symbol ... indicates $t < 0.5$.
† Other independent variables are BISR, NBAB, WEC, $(WEC)^2$, ORD 3, and ORD 4+.
‡ Other independent variables as listed in preceding note, with the addition of WAC.
§ Other independent variables as listed in second note, with the addition of WAC and excluding BISR.

urgent as the woman gets older because of the desire to avoid extending the childbearing and raising period. The expectation of declining fecundity is one element in the tendency to avoid late replacement. When fertility is very high and the childbearing period long and near the maximum, there is a constraint on possible reduction of intervals, because the intervals are short and closer to the minimum. It should also be noted that in families with many children there is a greater likelihood that some of the children were not wanted or were born on the basis of expected mortality, and in such a case the death of a child will not call for replacement. These may be the reasons for the observed difference in response to child mortality over the life cycle between EA and Is women, the low-fertility groups, and AA, the high-fertility group.

Another issue of interest is the distribution of the effect of a given death on subsequent intervals. This is the reason for the distinction in the regression between D-1, indicating death in the immediately preceding birth, and D-2+, death in any earlier birth. Most of the coefficients of D-2+ are not statistically significant; they tend to be positive and smaller in absolute size than the generally negative coefficients of D-1. This would indicate that, when a death occurs and the next birth occurs earlier, subsequent births may not be shifted back by the full change in intervals, which is another way of saying that replacement is partial.

Finally, while we do not have a direct way of evaluating the importance of learning, we do have clear evidence that those who experience child mortality with first children are more likely to experience it in higher parities (not shown).

III. Summary and Conclusions

In the introductory discussion I suggested several issues bearing on the analysis of the mortality-fertility relationship. The demand for children is not just a matter of completed family size; the children's ages at different stages of the family life cycle may also be an important dimension. The nature of the preferred life cycle reflects the motives for having children and the external conditions. We can explore the implications of mortality for fertility where the preferred life cycle is assumed to be independent of child mortality, or we can take into account the possibility that the preferred life cycle and family size depend on child mortality. I distinguish two types of response to child mortality, hoarding and replacement. Hoarding is the response to expected mortality, and replacement is the response to experienced or prior mortality. I note that there might be a learning process in a sequential framework when experienced mortality affects expected mortality.

The empirical work presented here focuses on micro data of retrospectively reported births of Israeli women. Tabular and regression analyses show that experienced mortality reduces the probability of stopping at a given birth (i.e., raises the number of births) and reduces the intervals between births.

The analysis was carried out separately for Jewish women born in Asia or Africa (AA), whose completed fertility is high, and women born in Europe or America (EA) or in Israel (Is), with lower fertility. The relative decline in stopping probability at low birth orders is higher for AA than for EA and Is in a crude comparison. Once other variables are controlled in a regression, the absolute effect is greater among EA and the relative effect is fairly similar. The response in intervals is higher among EA than among AA. It rises steeply with age among EA and Is and does not vary much by age among AA. These findings are tentative.

The findings indicate that replacement is a significant phenomenon and that it occurs fairly quickly; the age patterns or response can be reasonably interpreted. But the analysis of micro data for one group cannot bring out the factors or variables common to the individual units. Thus, if expected mortality is to a large extent shared by the couples in the sample, hoarding cannot be studied. It should also be noted that hoarding and replacement are substitutes; if families have learned to expect high mortality and respond to it by hoarding, fertility should not respond strongly to actual mortality.

This ties with a more important issue—one which is not, of course, confined to this area: aggregate time-series data indicate a fairly sluggish response of fertility to infant mortality (see Kuznets 1973, 1974). How can this be reconciled with the findings of this and other studies based on micro data? Obviously, one would look for left-out variables that operate in one context and not in the other. One possibility would be that micro response is largely spurious, reflecting left-out variables operating simultaneously on fertility and mortality. Alternatively, even if it is biased upward, the micro response may provide a reasonable approximation to the partial effect of experienced child mortality on fertility, but in aggregate time series the trend in child mortality is associated with change in adult mortality affecting the parents' own fecund period and survival expectations, which may, respectively, increase the supply of and the demand for children, this in addition to aggregate developments other than mortality not captured in a cross section of individuals. It would also be important to see whether in micro data the response to infant mortality differs from the response to other child mortality.