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13. *Education and Fertility*

by Robert T. Michael

INTRODUCTION Both casual observation and more systematic empirical findings suggest that couples with more education have fewer children. This chapter is a progress report on a research project which offers analytical explanations for the negative relationship between education and fertility and which attempts to determine empirically the effects of education on fertility behavior when certain economic and demographic factors are held constant.

The analysis focuses on the role of education in household production¹ and its influence on effective use of contraception and on the couple's choices between number of children and child "quality." The empirical results to which the chapter refers were obtained from recent United States cross-sectional data sets. No attempt has been made to summarize the recent and rapidly growing literature pertaining to the economic analysis of fertility.

THE FRAMEWORK The analytical framework used in considering the effects of education on fertility is built upon the notion that households may be viewed as small firms. A firm purchases raw materials, equipment, and manpower and uses them to produce its product. In much the same way, the household purchases consumer-durable and con-

NOTE: This chapter was written as a progress report on a research project supported by the Carnegie Commission through NBER and was submitted for inclusion in this volume in January 1971. I have published two subsequent research papers (Michael, 1971, 1973). The present chapter has been only slightly revised.

I received useful suggestions on earlier drafts from Armen A. Alchian, Gary S. Becker, Barry R. Chiswick, F. Thomas Juster, John R. Meyer, Jacob Mincer, T. Paul Schultz, T. W. Schultz, and Robert J. Willis. Bonnie Birnbaum provided skillful research assistance.

¹ See Chap. 9 in this volume or Michael (1972).

sumer-nondurable goods and services and uses them, along with some of its own "manpower" or available time, to produce items which give it satisfaction. This approach emphasizes that the usefulness of most purchased consumer goods is related to how frequently and intensively they are used. Typically, the household produces a large number of products, and it is assumed that the choices among products and the decisions regarding the productive processes are made jointly by husband and wife.²

Suppose that one of the products from which the couple derives satisfaction is "child services," defined as quality-adjusted hours of their offspring. A child yields a flow of services to the household that depends, in part, upon the amount of time and goods the couple chooses to devote to that child.³ The larger the flow of services per child, the higher the child's "quality."⁴ In any period of time, the amount of child services available to the couple depends upon the number and quality of their children. The household can achieve a larger flow of services by raising either the number or the quality of its children and will choose that combination of the two which produces the desired level of services at the lowest cost. Since children remain in the household for a considerable length of time, they are typically described as durable goods, and in one form or another this basic framework of children as consumer durables is the standard one used in contemporary economic analyses of human fertility.

²The general approach used here was developed by Becker (1965). My other chapter in this volume discusses this model in greater detail. This "household production function" framework is also utilized in varying degrees in chapters in this volume by Ghez, Leibowitz, Mincer, and Solmon. It is a framework used with increasing frequency in studies of human fertility behavior.

³In a more precise formulation, one might argue that there is a distinction between time and goods used to affect the "quality" of the child and time and goods used to achieve satisfaction from a given level of quality (e.g., instructing the child in piano playing versus listening to the child perform at the piano). This distinction will not be made here.

One might also argue that child quality itself is an argument in the household's utility function. See Willis (1973).

⁴Just as a firm might use a certain raw material with larger quantities of capital equipment and more man hours to produce a higher-quality product, the household can raise the quality of its children by devoting relatively more of the couple's own time and more market goods to each child. The economist's use of the term *quality* is not intended to connote a normative judgment. The higher-quality unit typically represents a larger amount of the good per unit or a different combination of characteristics per unit and is generally obtainable at a higher cost per unit.

⁵The interested reader is referred to the fertility conference supplement to the *Journal of Political Economy* (see Schultz, 1973), which includes two articles

One aspect of treating children as consumer durables which is not frequently stressed and which distinguishes children from other durable goods is that the household must frequently expend resources to avoid having an additional child. The probability of conception is not independent of the household's level of production of another product from which it derives satisfaction—sexual gratification.⁶ Since sexual activity is desired in its own right and not simply as a means of having children, its effect on the probability of conception is a by-product, which may be desirable or undesirable, depending upon whether the household wants a child at that time. By comparing the costs of lowering the probability through contraception to the costs (through the risk of conception) of not lowering it, the couple determines its optimum expenditure on contraception and thereby selects its probability of conception.

The net value of a conception may be defined as the expected value of the difference between the monetary equivalent of the satisfaction from the prospective child and the net expenditure of time and money on the child (all properly discounted to convert into common units those benefits and costs which occur over time).⁷ If this "net value of a conception" is negative, the household benefits by lowering the probability of conception. The cost of reducing this probability by contraception includes such considerations as the direct expenditure of time and money and the indirect or psychic cost of forgone sexual gratification, impaired health, and conflict with religious beliefs. The couple lowers its probability of conception to the point at which the benefits from a further reduction in the probability are offset by the costs incurred in lowering it.

Two implications flow from this argument. First, since the costs of contraception and the negative benefits of risking additional pregnancies are attributable to the production of sexual gratifica-

dealing explicitly with the substitution between quantity and quality of children, as well as several other articles which also employ the theoretical framework used in the present chapter.

⁶ There is evidence that the probability is higher the greater the frequency of coition. In a comparison of husbands aged 25 to 29, using no contraception, the percentage of couples with conception occurring in less than six months rose from 32 percent to 71 percent as coital frequency rose from less than twice a week to four or more times a week. See MacLeod and Gold (1953). For additional evidence, see Potter, Sagi, and Westoff (1962).

Of course, the determination of these expenditures and benefits is not a simple matter, and to render this formulation of the problem operative analytically, some simplifying assumptions must be made.

tion, the higher these costs, the lower the level of sexual activity.⁸ Historically, one common form of contraception was abstinence, often effected by postponement of marriage. In the terminology of this chapter, the cost of risking an additional conception was sufficiently high to induce couples to forgo some sexual gratification.

Second, since it is costly to avoid having additional children, households will tend to have more than they would “desire” to have. Just as households consume less of a consumer good than they would if its price were zero, they consume more of an “unwanted” item than they would if the price of avoiding it were zero. Thus in light of the costs of avoiding unwanted children—costs in terms of contraceptive expenditures or forgone sexual gratification—the number of children the household effectively “demands” may exceed the number it “desires.”⁹

Graphic Interpretation

This second implication can be depicted graphically in a number of ways. Consider a household choosing its optimal probability of conception for, say, the following year. It must decide the extent of its contraceptive activity in light of the costs. Figure 13-1 represents this circumstance. The net benefit of a conception is indicated by the value B , which is negative in the figure.¹⁰ Thus, the expected value of the “benefit” at each probability of a conception is given by OB . The curve CC represents the cost of achieving each level of the probability through contraception, assuming that the

⁸ This is one application of the phenomenon of joint production in the household sector. For an analytical statement of the price effects of such production, see Grossman (1971).

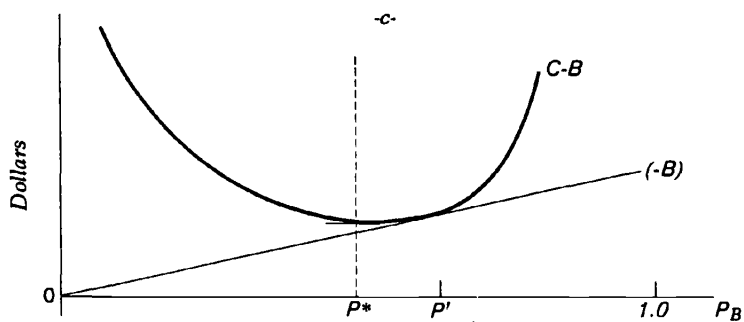
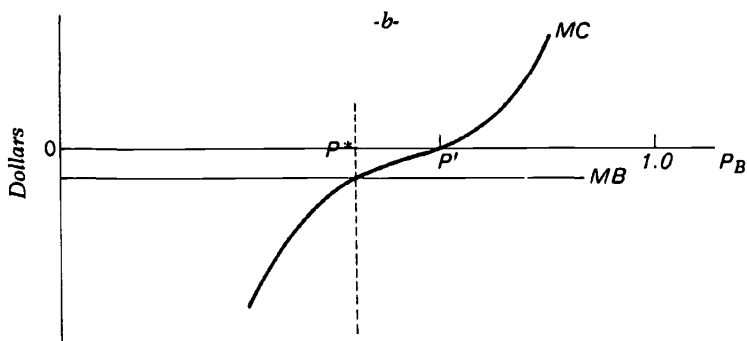
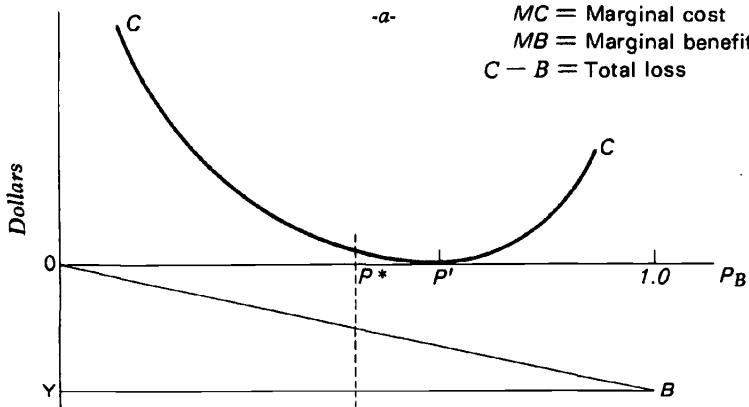
⁹ Some recent surveys have asked couples about the ideal and desired number of children, but unless the assumptions about costs and economic circumstances are specified precisely, the responses are very difficult to interpret. For example, ideally (in a utopian sense), one’s children will cost nothing to support, and so the ideal number may be quite large. Similarly, the number of children one wants may exceed the number one has, or expects to have, if he cannot afford all he wants. The point is that unless the assumed circumstances are fully specified, the responses to such questions will differ as respondents make different assumptions.

¹⁰ If B is positive, the couple will not employ contraception, but instead may expend resources to raise the probability of a birth. This paper focuses on the case of a negative value for B .

In order to determine (even in principle) the stream of benefits and costs which go into the term B , it is assumed that the household acts as if all subsequent additional conceptions can be prevented with certainty.

FIGURE 13-1 The optimal probability of birth P^*

- C = Total cost
- P_B = Probability of birth per period
- B = Total benefit
- MC = Marginal cost
- MB = Marginal benefit
- $C - B$ = Total loss



couple's level of sexual activity in the period would, in the absence of any contraceptive expenditure, imply a probability P' (Figure 13-1a).

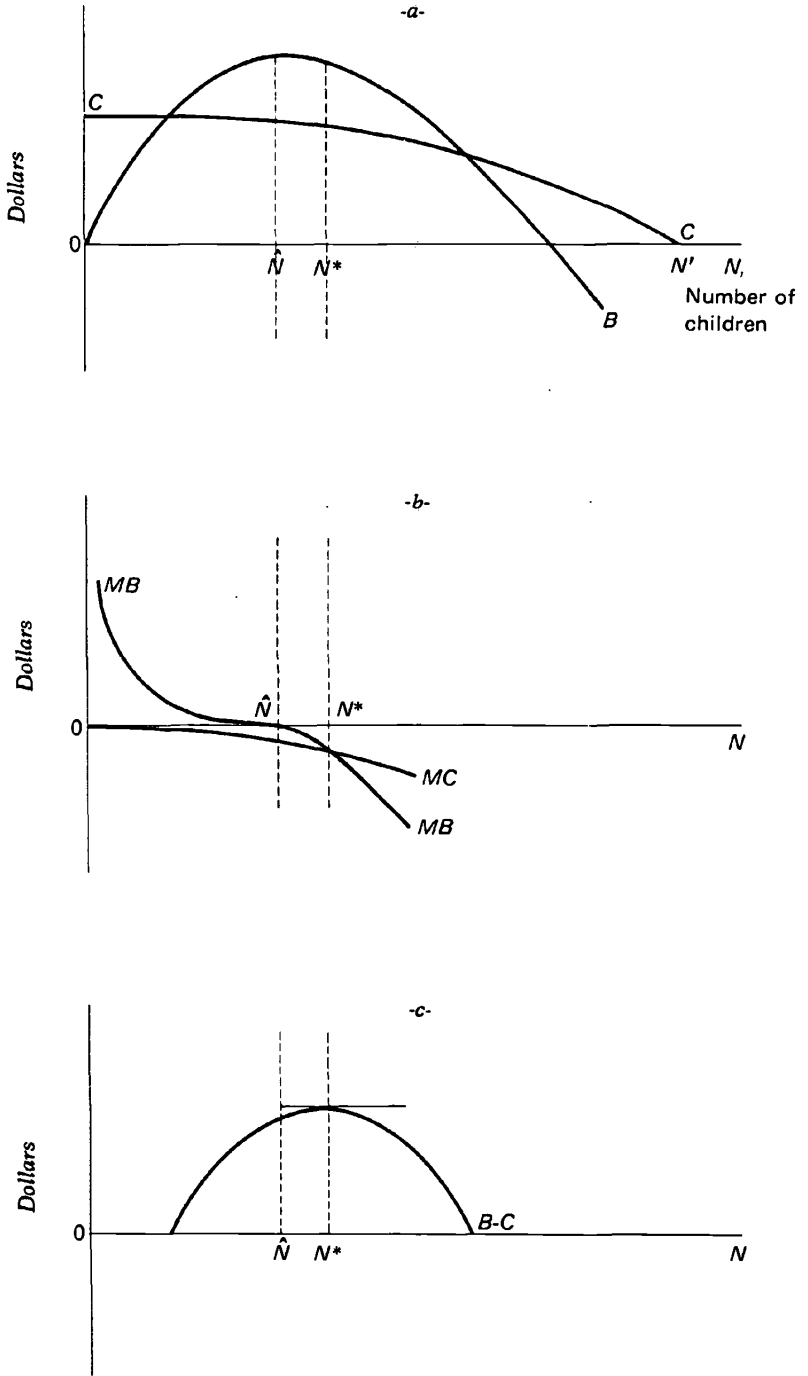
Here, the optimal level of the probability is indicated by the intersection of the marginal cost and marginal benefit curves (Figure 13-1b), which is equivalent to the minimum point on the total loss function (Figure 13-1c). As long as the net benefit of a conception is negative, and as long as it is sufficiently more costly to reduce the probability further (i.e., as long as $Y < 0$ and CC is sufficiently convex below P'), the optimal probability P^* will lie between zero and P' . Since the net benefit of an additional child is negative, the "desired" probability of conception for the period is zero; but in light of the cost of achieving that probability, the optimal probability (the level "demanded," given the costs) is positive. If the conditions reflected in Figure 13-1 persist for several years, the household can expect to have some number of children from whom the net benefit is negative; thus, a total number of children greater than would be "desired."

Another way of formulating this problem is to consider the household's decision regarding its total number of children without regard to the sequential nature of the process.¹¹ Figure 13-2 illustrates this case. The total net benefit curve OB depicts the benefits, net of all costs except those related to contraception, of having any number of children from none to N' (where N' is the number produced if the couple does nothing to prevent conception).¹² As it is drawn, the total benefits from children are greatest at the level \hat{N} , which might be considered the "desired" number for this household. The curve CC in Figure 13-2a represents the total contraceptive cost of having N children. This cost is zero at N' by definition and presumably is higher the more births are prevented. From these two functions, one can determine the optimal number of children, or the number "demanded," which is indicated in Figure 13-2b as N^* , the intersection of the marginal benefit and marginal

¹¹ I want to acknowledge suggestions made by Robert Willis on this formulation.

¹² In a more general framework, the household can also influence N' by its decisions about the timing of marriage and the frequency of coitus and, more indirectly, by decisions regarding the couple's own health. Throughout this chapter, the effects of infant and child mortality are ignored, although they could be incorporated.

FIGURE 13-2 The optimal number of children N^*



cost curves. (This is equivalent to the highest point on the curve *B-C* in Figure 13-2c.¹³)

**THE ROLE OF
ECONOMIC
FACTORS**

Since it is costly to prevent conception, households will choose a somewhat larger number of children than they would otherwise want. What, then, are the economic factors that affect the number of children households want? The standard economic analysis of fertility emphasizes the role of income and the price of time.

It has generally been argued that since the demand for most consumer goods rises with income, households with higher levels of income will choose to have more children. The theory does not suggest that the relationship between income and number of children across households must be positive, but only that it is quite likely to be.¹⁴ One of the important implications of Becker's more recent analysis of household production functions is the assertion that the source of the household's income affects its influence on behavior. For fertility analysis, this suggests that the relationship between income and family size is considerably more complicated than has previously been thought.¹⁵ It has also been suggested that as income rises, the price of quality of children falls relative to the price of quantity of children, regardless of the source of the income.¹⁶ This phenomenon would further complicate the relationship between income and number of children in the household. So although income is expected to affect fertility, the direction and magnitude of the effect depend crucially upon whether or not shadow prices in household production (as distinct from market

¹³ Again, the determination of the shape of benefit and cost functions is not considered here. The substantive conclusion that $N^* > \bar{N}$ follows as long as *CC* is negatively sloped throughout and *OB* is a smooth, continuous function rising monotonically to a peak somewhere between zero and N' and falling monotonically thereafter.

¹⁴ For a more thorough discussion of this argument and the original statement of the analysis of children as a consumer durable, see Becker (1960). On the basis of evidence for other durables, Becker argues that the responsiveness in the demand for quality of children to differences in income will probably be greater than the responsiveness in the demand for the number of children and that the latter may be quite small.

¹⁵ For a thorough discussion of this point, see Willis (1973) and Sanderson and Willis (1971).

¹⁶ See Michael (1973) for a discussion based on joint production in the home: If the "luxuries" consumed by wealthier households are complementary with expenditures on the quality of children, then the relative price of quality is negatively related to the proportion of total expenditure spent on luxuries.

prices of purchased goods and services) are being held constant. One would not expect—and does not observe—much similarity in the estimates of the effect of income on fertility in various cross-sectional studies which “hold constant” quite different sets of variables.

A second important economic factor influencing the demand for children is the price of the wife’s time. Since raising children requires a relatively large amount of her time, the cost of a child is relatively high for households in which the wife’s time value is relatively high. This suggests that the partial effect of the value of the wife’s time on the demand for children will be negative. Empirical research on economic determinants of fertility in the United States tends to support this hypothesis.¹⁷

An additional economic factor which is generally not included in the analysis of family size is the price of the husband’s time. If the husband’s time, as well as the wife’s, is used in achieving quality in children, the greater the value of his time, the higher the cost of high-quality children. This, too, may reduce the household’s demand for child services, but in addition may induce substituting quantity for quality in the production of child services, other things held constant.¹⁸

In light of the well-documented positive effects of education on wage rates and earnings (see Part One of this volume), probably the most important effects of formal education on household fertility are the indirect effects issuing from the household’s level of income and the value of the husband’s and wife’s time. It has often been observed empirically that the simple relationship between education and family size is negative, and this observation most likely reflects the higher value of time of couples with more education. But in addition, the husband’s and wife’s levels of education may influence their fertility behavior through several other channels. For example, schooling may alter the couple’s preferences for children or their attitude toward their desired family size, or education may affect the way in which household production takes place in such a way that it alters the price of children relative to

¹⁷ Several of the articles in the *Journal of Political Economy* supplement bear on this question (see Schultz, 1973). See also Chap. 7 in this volume for a related discussion; that chapter, however, does not focus on a fertility demand equation.

¹⁸ The asymmetry in the predicted direction of effects of the value of the husband’s and wife’s time follows from the assumption that child quantity is relatively time-intensive for the wife.

the price of other things. If so, couples with different levels of education would face different relative prices of children, and this would affect their fertility behavior.

Although we cannot rule out an education effect on preferences for children, neither can we rely on this explanation to yield hypotheses about observed behavior, since social scientists have no viable theory about the way in which preferences are formed or altered. After the fact, any observed behavior can be ascribed to a change in household preferences. But without a theory about the formation of preferences, one cannot analyze and predict *ex ante* how a factor such as education might affect behavior by altering preferences. Thus an explanation of observed behavior which is based on changes in preferences is usually tautological. We shall consider, instead, two channels through which education may alter the relative price of children and thereby affect observed behavior. These two channels do not result from changes in the price of time of the parents but, rather, from the assumed effect of education on different household production functions.

It was emphasized above that the household produces its optimal level of the probability of conception by using some market purchases (such as contraceptive appliances or medical advice) and some of its own time. More educated couples may be more efficient in this production—they may be able to lower the probability of conception more cheaply than less-educated couples. If education increases one's awareness of new consumer products and reduces the costs associated with acquiring and evaluating information about their characteristics and availability, more educated couples can be expected to use more effective processes of production and to adopt effective new techniques relatively rapidly.¹⁹ Since many contraceptive techniques of varying effectiveness are available at any given time and since relative effectiveness varies over time as new techniques become available, the selection of techniques seems a likely application of this alleged attribute of education.

If education increases one's receptivity to new ideas or increases one's willingness to reevaluate previously held points of view, the more educated can be expected to be less reluctant to engage in

¹⁹ This argument is made in the context of an economic growth model by Nelson and Phelps, who suggest that "education enhances one's ability to receive, decode, and understand information"—or, in short, that "educated people make good innovators" (1966). It is developed extensively by Welch (1970) as the "allocative effect" of education.

contraception, in general, and less reluctant to adopt certain contraceptive techniques, in particular. In the economists' terminology, the psychic costs of using contraceptive devices—costs in terms of conflicts with beliefs or exposure to embarrassment—may be lowered by education.²⁰

Another important aspect of production is the manner in which factors of production are utilized. If education increases one's ability to organize production effectively, the more educated not only would choose better techniques of production but also would use the chosen technique more proficiently. The effectiveness of many contraceptive techniques is notoriously sensitive to the care and regularity with which they are used. Education may therefore have a relatively large influence on the proficiency with which couples engage in fertility control.

Fortunately, over the past two decades demographers have collected a large amount of evidence shedding light on some aspects of education's influence on contraceptive use. Table 13-1 summarizes briefly some of this evidence from two independent surveys conducted in the United States in 1955 and 1960, each dealing with about 3,000 married women. The table indicates that the use of contraception is considerably greater among the more educated and that a smaller proportion of the more educated do not expect to use any contraception.²¹ Among Protestants, the attitude toward contraceptive use was appreciably more favorable at higher levels of education. Among Catholics, the attitude toward contraception was less favorable at higher levels of education, although the rate of contraceptive use was higher.

The table also suggests that the more educated adopt contraception at an earlier stage in their marriage, and other evidence supports this observed tendency. Demographic evidence from less-developed countries further supports the findings of a higher rate of use and an earlier adoption of contraceptives among the more educated. Furthermore, for countries in which the average level of

²⁰ This is an instance in which an influence of education on tastes or preferences can be translated into an effect on relative prices.

²¹ A couple was classified as expecting not to use contraception if the wife replied "no" to the question: Do you expect to use a method sometime later on to keep from getting pregnant? and *also* replied that she would not use contraception in response to these questions: If you never do anything later on to keep from getting pregnant, aren't you liable to have a child every two or three years until you are forty-five? Is this all right with you, or do you think you might do something later on to prevent pregnancy? See Whelpton et al. (1966, pp. 186-187).

TABLE 13-1 Percentage of couples of a given educational level with specified characteristics

Date of survey and source	Characteristic	Education of wife			
		Grade school	High school 1-3	High school 4	College
<i>Use of contraception</i>					
(1955, p. 128)	Users (wife aged 18-29)	48	66	74	85
(1955, p. 128)	Users (wife aged 30-39)	49	67	73	84
(1955, p. 109)	Users (Protestants)	53	70	80	90
(1955, p. 109)	Users (Catholics)	41	59	61	62
(1960, p. 217)	Having used contraception	66	78	83	88
(1960, p. 189)	Expecting <i>not</i> to use contraception (total)	28	15	10	7
(1960, p. 189)	Expecting <i>not</i> to use contraception (fecund couples)	7	4	2	2
<i>Attitude toward use</i>					
(1955, p. 166)	Unqualified approval (Protestants)	50	71	76	85
(1955, p. 166)	Disapproval (Protestants)	26	13	6	2
(1955, p. 167)	Unqualified approval (Catholics)	31	41	32	25
(1955, p. 167)	Disapproval (Catholics)	49	41	49	55
<i>Adoption of contraceptive (for couples with three pregnancies total)</i>					
(1960, p. 194)	Using prior to first pregnancy	18	23	42	55
(1960, p. 194)	Using prior to fourth pregnancy	76	79	92	92

SOURCES: For 1955, Freedman, Whelpton, and Campbell (1959); and for 1960, Whelpton, Campbell, and Patterson (1966).

education is quite low, there is also evidence that a larger percentage of the more educated women have some knowledge of contraception and are aware of more contraceptive methods.²²

Additional evidence from the 1955 and 1960 United States surveys suggests that among Protestants, more educated users tend to employ more effective contraceptive methods.²³ The earlier

²² For example, in a 1964 study of about 1,500 women of childbearing age in Barbados, the percentage of women with any knowledge of contraception rose from 46 percent of those with zero to three years of schooling to 82 percent of those with eight or more years. The average number of methods known, per woman who knew at least one method, rose from 2.5 methods to 3.9 methods for the same two education categories. See Roberts et al. (1967).

²³ Studies of the use-effectiveness of methods in use in the 1950s suggest that the rate of conception per 100 years of exposure was about 14 for the appli-

study indicated that the rate of use of appliance methods doubled from the grade school group (42 percent) to the college-educated group (84 percent), and a stronger relationship existed for a single method, the diaphragm, which was used by 17 percent of the grade school group and by 57 percent of the college-educated women. Similarly, in the 1960 survey, among contraceptive users the rate of use of the diaphragm more than doubled from the lowest education group to the highest. For Catholics, on the other hand, although the rate of use of contraception rose with education, the more educated tended to use the rhythm method more extensively, with only a slight increase in the rate of use of the diaphragm and a strong decrease in the rate of use of the condom.²⁴ Therefore, the more educated Protestants tend to use more effective methods of contraception, whereas among Catholics this does not appear to be the case.²⁵

Finally, a recent study, using a 1965 national survey of some

ance methods (condom or diaphragm) and approximately 40 for the less-effective rhythm or douche methods. See Tietze (1962).

²⁴ See Whelpton et al. (1966, p. 281).

²⁵ It should be stressed that most contraceptives are quite effective in a physiological sense and that the care with which they are used greatly affects their observed use-effectiveness. In light of the finding from another United States survey in 1960 that 32 percent of families using the rhythm method exclusively were classified as having incorrect knowledge of the ovulatory cycle, this method may be particularly sensitive to the precision with which it is used. See Westoff, Potter, and Sagi (1963, p. 52). Consequently, it is not possible to infer from the evidence cited that more educated Catholics are less-effective users of contraceptives; one can conclude only that they tend to use a method which, on the average, is less effective than other methods. This is particularly true since there is evidence that a larger proportion of Catholics than Protestants have correct knowledge of the ovulatory cycle when standardized by socioeconomic class (white-collar, blue-collar). See Potter et al. (1962, Table 2).

Nor can one conclude that education has no consistent effect on "efficiency" for Catholics. If conformity with religious principles is an objective, the more educated Catholic may be expected to be more aware of, and consequently to behave more consistently with, the Catholic Church's position on contraception. That is, the observed shifts toward the rhythm method and away from the condom for more educated Catholics is what one might expect with a broader definition of "efficiency," which includes for Catholics the nonmonetary costs of appliance methods of contraception. Given the debate among Catholic moralists on the oral contraceptive, the evidence of its relatively widespread use among more educated Catholics (see the text) is not inconsistent with this argument. (Jumping ahead, this point is further supported by the observation in Table 13-2 that in terms of fertility outcomes, more educated Catholics as well as more educated Protestants appear more successful in achieving their desired fertility.)

4,800 women in the United States, indicates that as of that time, the rate of use of the oral contraceptive was more than twice as high among college women than among those with eight or fewer years of schooling. This result held for Catholics and non-Catholics alike and persisted when standardized for age. Similarly, by 1965, the percentage of women who had ever used the oral contraceptive was more than three times as high among the highest education group as it was among the lowest education group. In addition, the report indicated that 14 percent of the grade school group and only 2 percent of those who had at least some high school training had never heard of the oral contraceptive.²⁶

Although there are admittedly other factors for which one should standardize in considering the effect of education on contraceptive behavior, this very brief summary of some of the relevant demographic literature clearly suggests that education has an appreciable influence on contraceptive use. The more educated non-Catholics are more receptive to the use of contraception (measured by their attitude toward its use), use contraception more extensively (measured by the percentage of users), adopt contraception at an earlier birth interval, tend to choose more effective methods, and appear to have adopted the new oral contraceptive more readily. The more educated Catholics use contraception more extensively and have adopted the oral contraceptive more widely (13 percent of Catholics with a grade school education, compared with 33 percent of college-graduate Catholics, had ever used the pill). But for Catholics, education appears to have been negatively related to the use of the condom and to a procontraception attitude during the 1950's. Evidence further suggests that at lower levels of schooling, general knowledge about contraception is also positively related to education. In short, the evidence is consistent with the argument that education lowers the psychic and/or transaction costs related to contraception. The more educated behave as if they are more aware of, more receptive to, and more effective in their selection of contraceptive techniques.²⁷

²⁶ See Ryder and Westoff (1971).

²⁷ The recently published report (Ryder & Westoff, 1971) on the 1965 National Fertility Survey, the sequel to the 1955 and 1960 GAF surveys utilized in Tables 13-1 and 13-2, offers additional supporting evidence. The report indicates that more educated Protestants and Catholics have a more favorable attitude toward fertility control (p. 101); more educated couples have a more approving attitude toward abortion (p. 274); and on an age-adjusted basis, more educated couples

Another interpretation of many of these findings, however, is that more educated couples simply want fewer children and, accordingly, have a greater incentive to engage in effective fertility control. In my 1973 article the choice of a contraceptive technique is considered in the context of an elementary stock-adjustment model for children. The 1965 National Fertility Survey data are used to study the relationship between the couple's level of education and the choice of a contraceptive technique, while holding constant the couple's current number of children (i.e., "parity") and the number of children the couple ultimately wants to have. *Within* parity-, race-, and age-specific groups, holding the wanted number of children constant, more educated couples quite systematically selected relatively effective contraceptive techniques. That is, holding constant a measure of the incentive to engage in fertility control, more educated couples used more effective contraceptive techniques.²⁸

In the context of Figure 13-1, if education lowers the cost of preventing conception, *ceteris paribus*, the discrepancy between the desired number of children and the quantity of children effectively "demanded" will be reduced. A reduction in the cost of preventing births should be reflected in a reduction in the number of unwanted pregnancies, or in the amount of "excess fertility."

The demographic literature is again useful in indicating the effect of education on these factors. The evidence in Table 13-2 pertains to the extent of completely planned fertility (the proportion of couples that, if the woman was ever pregnant, conceived only when contraception was stopped for that purpose) and to the extent of excess fertility (the proportion of couples that reported that before the last

have used contraception more extensively (pp. 110-112, 120, 249) and, in particular, have adopted the oral contraceptive more widely (pp. 146-150). Consequently, a larger portion of more educated couples have "completely planned" their fertility and have avoided "excess fertility" (e.g., pp.240-242).

This study also reports a revealing statistic that indicates an important difference by education in knowledge about the timing of the fertile period in the ovulatory cycle: The percentage of women "correctly informed" about the timing was 27 percent of respondents with less than four years of high school and 58 percent of respondents with four years of high school or more. These percentages differed by at least 100 percent for color- and religion-specific education groups as well (p. 130).

²⁸ One qualification should be emphasized. It is observed that more educated couples systematically use more effective contraceptive techniques. The results themselves cannot indicate whether these techniques are inherently more effective or whether they are observed to be more effective as a result of being used efficiently by more educated couples.

TABLE 13-2 Percentage of couples of a given educational level with specified characteristics

Date of survey and source	Characteristic	Education of wife			
		Grade school	High school 1-3	High school 4	College
	<i>Fertility-planning status</i>				
(1955, p. 130)	Completely planned (wife aged 18-29)	5	12	28	37
(1955, p. 130)	Completely planned (wife aged 30-39)	4	10	17	29
(1955, p. 130)	With excess fertility (wife aged 18-29)	19	12	6	4
(1955, p. 130)	With excess fertility (wife aged 30-39)	27	18	13	11
(1960, p. 247)	Completely planned (total)	6	13	24	35
(1960, p. 247)	Excess fertility (total)	32	21	14	11
	<i>Desired and expected children</i>				
(1960, p. 100)	Expecting the number wanted	35	46	52	55
(1960, p. 100)	Expecting <i>more</i> than the number wanted (total)	38	27	19	15
(1960, p. 100)	Expecting <i>more</i> than the number wanted (Protestants)	41	28	19	15
(1960, p. 100)	Expecting <i>more</i> than the number wanted (Catholics)	34	26	18	18
	<i>Unwanted pregnancies</i>				
(1960, p. 248)	Last pregnancy unwanted and occurring before any contraception used	15	5	2	0
(1960, p. 248)	Last pregnancy unwanted and resulting from irregular use of contraception	10	9	6	5
(1965, p. 1179)	Births between 1960 and 1965 which were "unwanted" (white)	21*		14	11
(1965, p. 1179)	Births between 1960 and 1965 which were "unwanted" (black)	42*		28	25

* These numbers represent a combination of the "grade school" and "high school 1-3" columns.

SOURCES: For 1955, Freedman et al. (1959); for 1960, Whelpton et al. (1966); and for 1965, Bumpus and Westoff, (1970).

conception occurred, the wife or husband "had not really wanted another child at any time in the future"). The observed increase across education groups in the proportion of couples who "completely planned" their fertility can be interpreted as reflecting a lower average probability of conception among more educated practitioners of contraception. Similarly, the decrease across education groups in the proportion of couples with excess fertility can be interpreted as reflecting the higher probability of conception among less-educated couples who desire no more children.

The figures in Table 13-2 pertaining to discrepancies between the number of children desired and the number expected can likewise be interpreted as reflecting the more educated couple's relative advantage in effectively preventing unwanted births. The table further indicates that unwanted pregnancies associated with both lack of use and irregular use of contraception differ by educational level. Such evidence emphasizes that the care with which contraceptive techniques are used greatly influences their effectiveness. Finally, the last two rows of Table 13-2 indicate the extensiveness of ineffective fertility control, measured by the percentage of births between 1960 and 1965 which were unwanted at the time of each pregnancy.

The empirical evidence summarized here is interpreted as offering support for the hypothesis that education favorably affects the proficiency with which couples control their fertility. The demographic evidence is weakened by the lack of more complete standardization for other relevant factors and by the vagueness of some of the concepts used. Yet the effects indicated in Tables 13-1 and 13-2 are quite strong in most cases. In nearly all cases they are stronger for one-way classifications by education than for similar one-way classifications by other variables. Furthermore, the education effects remain strong whenever a cross-classification by age and income is made.²⁹ The standardizations made in the within-cell multiple regressions discussed above appear to strengthen the evidence in support of this hypothesis.

Education and
the "Quality" of
Children

Although the discussion has focused on education's effect on family size through contraception behavior, this is not the only channel

²⁹ For example, the fertility-planning status for the 1955 survey is cross-classified by husband's income and wife's age and education, and although income shows no significant relationship, the education effect remains quite strong. See Freedman et al. (1959, Table 4-20, p. 130).

through which education may influence the number of children. In addition to affecting the costs of preventing unwanted children, education may alter the number of children desired. In the framework outlined above, the household produces both the number and quality of its children and selects the combination that minimizes the cost of achieving its desired level of child services. Economists do not, as yet, have an adequate definition of "quality" (see the discussion above), but one operational definition equates quality with human capital embodied in the child. If education has a relatively large effect on the proficiency with which one produces additional human capital in oneself, it may also have a disproportionately strong effect on the proficiency with which one produces human capital in one's children. That is, more educated parents may find it relatively inexpensive to produce any given level of child services with fewer, higher-quality children. If this shift toward higher quality is quantitatively more important than the related increase in the demand for child services, more educated couples will desire fewer children.

Considerable research has recently been begun on the determinants and consequences of preschool investments in children. Rather than summarizing some of these results here, I refer the reader to Leibowitz's chapter in this volume. One empirical measure of child quality may be the level of schooling the parents expect their children to complete. In my 1971 article I looked briefly at the relationship between the parents' level of schooling and the level of schooling expected to be completed by the oldest child in the household. The data used were from the NBER-Census Bureau's Consumer Anticipation Survey (CAS), a survey of some 4,500 households living in suburban Boston, Minneapolis, and San Jose conducted in May 1968.³⁰ The subsample consisted of households

TABLE 13-3
Regressions on
the number of
years of schooling
expected to be
completed by
the oldest child
(includes only
households
with one or
more children;
wife aged 35 to
39; 583
observations)

Means and standard deviation) of dependent variable	Education of husband	Education of wife	Income of husband (00)*	Standard error of estimate
(1)	.151 (.034)	.033 (.038)		(1.75)
15.7 (1.79)	(2)	.127 (.036)	.003 (.001)	(1.74)

* Measured in \$100 units.

³⁰ For a discussion of the CAS data, see Juster et al. (1969, pp. 216-227).

in which the husband and wife were both present, with the husband not self-employed, but working at a full-time job for 50 to 52 weeks in 1967, and with the wife under age 40. The latter criterion was necessary to avoid excluding older children, since the survey obtained information on the number (up to six), age, and schooling of children under the age of 22. Such a sample is clearly not a typical cross section of American families, since it is restricted to relatively young, suburban families in which the husband is employed full time, with average yearly earnings in 1967 of about \$13,000 and an average educational level in excess of 15 years.³¹

The regressions in Table 13-3 control for wife's age (all women included were between 35 and 39) and include only households with at least one child. The expected level of schooling for the oldest child is quite high (nearly 16 years), and the variation across households is rather small (the standard deviation is less than two years). The evidence here suggests that for this subsample, the higher the schooling level of the husband and the wife, the higher the expected level of schooling of the child. This effect persists when a measure of the households' money income is held constant. Since these regressions do not hold constant the number of children in the household, the results reflect the net effect of the husband's and wife's educational levels on the expected schooling level of the child (its quality) through substitutions in production (between quantity and quality) and through substitution in consumption (between child services and other commodities). It is possible to interpret the empirical results in this table in the context of these various substitution parameters,³² but far too little is known, as yet, to place

³¹ About 11 percent of the households had earnings of \$8,000 or below, with only 2½ percent having less than 12 years of schooling. The educational level of the wives averaged nearly 14 years, with about 3½ percent having attained less than 12 years of schooling.

By way of comparison, the Census Bureau reports that the median educational level of men aged 25 or above in 1968 was 12.1 years and that the mean income (not earnings) of men aged 25 or above in 1967 was \$7,418 (U.S. Bureau of the Census, 1970, *Consumer Income*, Tables A and B).

³² If education is technologically biased toward the production of quality in children, *ceteris paribus*, this would induce substitution toward quality with an increase in the educational level of either parent. If the wife's time is used relatively more and the husband's time is used relatively less in the production of children than in the production of other commodities, then the increase in the price of her time induces substitution away from child services, which can explain the observed difference in the relative strengths of the two education effects. Other explanations of these results can be offered, even in the same context of treating expected years of schooling as a measure of quality and assuming all children in a single household to be of equal quality.

much confidence in either the statistics themselves or any particular interpretation of them.

In the context of an economic framework of household fertility behavior, there are several reasons why the education levels of the parents may affect the quality of the children. The scant empirical evidence adduced to date suggests that the relationship between child quality and parents' schooling is positive; this evidence can be interpreted consistently in the context of that economic framework.

Education and the Quantity of Children

The remaining empirical research discussed here focuses on the relationship between the couple's education and the observed number of children in the household. The above discussion emphasized that the negative relationship observed between education and fertility probably reflects the indirect effect of education through the economic factors of income and value of couple's time. Beginning with this simple relationship, we can attempt to separate out the effects of income and the value of time to determine the direction and magnitude of any remaining effect of education on completed fertility. Both the hypothesis that education improves contraceptive proficiency (and thereby reduces the number of unwanted births) and the hypothesis that education increases the proficiency with which households produce quality in children (and thereby tends to reduce the number of desired births) imply a negative partial effect of education on the number of children. If the observed effect is in fact negative, additional information would be needed to distinguish between these two production effects—both suggest that the *relative* price of quantity of children rises with education, either through a reduction in the cost of preventing births or through a reduction in the cost of quality.

The observed effect of education on completed fertility depends upon what related factors are being held constant. By the restrictive definition of the CAS sample, the data used here have already been standardized for urbanization and for much of the effects of income, work history, and so forth. Likewise, by the nature of the sample the observed effects of education tend to reflect the influence of higher education. For the subsample of 513 households with completed fertility³³ and wife aged 35 to 39, the means, standard devia-

³³ "Completed fertility" in this instance is defined by a "no" response to the question: Do you think you are likely to have one or more (additional) children at some time in the future?

tions, and a simple correlation matrix of several variables are shown in the following table.

<i>Variable</i>	<i>Mean</i>	<i>Standard deviation</i>		
<i>Education of husband (years)</i>	15.2	2.5		
<i>Education of wife (years)</i>	13.7	2.2		
<i>Wage of husband (dollars per hour)</i>	6.30	2.28		
<i>Income of husband (dollars)</i>	15,885	6,355		
<i>Number of children</i>	2.94	1.20		
<i>Simple correlations</i>				
	<i>Education of wife</i>	<i>Wage of husband</i>	<i>Income of husband</i>	<i>Number of children</i>
<i>Education of husband</i>	.512	.360	.370	-.051
<i>Education of wife</i>		.170	.214	-.106
<i>Wage of husband</i>			.847	.053
<i>Income of husband</i>				.052

Table 13-4 indicates results for three regressions on the number of children in the household. In the first regression, the wife's education level is negatively related to fertility. A negative relationship between wife's education and fertility is frequently observed; this negative association persists at the relatively high levels of education found in this sample. The husband's education level has no statistically significant effect on fertility. However, an increase in the husband's education level, holding the wife's education level constant, implies a decrease in her potential market wage rate relative to his potential wage rate, and so the positive slope coefficient may reflect substitution induced by this relative-price effect.³⁴

³⁴ Suppose the appropriate variables for the regression were the wife's relative wage rate (a measure of her relative value of time) and the husband's education level. Since human capital theory suggests that the log of earnings is linearly related to the level of schooling, given certain assumptions, the wife's relative full-time earnings are proportionate to the absolute difference in the couple's educational levels:

$$\ln(Y_w/Y_h) = r(E_w - E_h)$$

where Y is income, E is number of years of education, r is the rate of return to education, and the subscripts denote wife and husband. Then, using the difference in their education levels to represent the relative value of the wife's time, the estimating equation would be:

$$N_i = a + b_1(E_{w_i} - E_{h_i}) + c_1(E_{h_i}) + e_i$$

TABLE 13-4
Regressions on
the number of
children in the
household
(wife aged
35 to 39;
completed
fertility; 513
observations)

	<i>Education of husband</i>	<i>Education of wife</i>	<i>Wage of husband*</i>	<i>Income of husband (00)†</i>	<i>Standard error of estimate</i>
(1)	.002 (.024)	-.060 (.028)			(1.191)
(2)	-.012 (.026)	-.062 (.028)		.002 (.001)	(1.189)
(3)	-.014 (.026)	-.061 (.028)	.018 (.044)	.001 (.002)	(1.190)

* Current hourly rate.

† Measured in \$100 units.

To control for the effects of income on fertility, the husband's full-time age-adjusted income³⁵ is included in regression 2 of Table 13-4. The implied income elasticity at the point of means is +.09.³⁶ The wife's education variable is again negative and statistically significant; the husband's education variable remains statistically insignificant.³⁷

To attempt to adjust for the husband's price of time and thereby determine its separate effect on fertility (distinguishing it from the effects of income and education), the husband's current hourly wage

where N is the number of children in the household. In a manner analogous to Mincer's discussion (1962) of estimating a labor supply function for married women, b_1 and c_1 can be estimated from

$$N_i = a + b_2 E_{w_i} + c_2 E_{h_i} + e_i$$

as $b_1 = b_2$ and $c_1 = b_2 + c_2$. So from regression 1 in Table 13-4, the coefficient for the husband's education level is -.058 (.026), a statistically significant negative effect. To put it verbally, as the husband's education rises in regression 1, the relative labor market value of the wife's time falls. The positive slope in the regression may reflect this substitution effect.

³⁵ The procedure used to estimate the age-adjusted income was to predict the husband's income at age 40 from his observed current income, basing the projected growth on information from United States age-income profiles for men with his educational level.

³⁶ Curiously, +.09 is also the income elasticity that Becker reported for couples who planned the number of their children, from the 1941 Indianapolis survey, and also for college graduates in the 1958 Consumers Union sample. See Becker (1960).

³⁷ By the interpretation suggested for the previous regression, regression 2 implies $c_2 = -.074$ (.028), again statistically significant.

rate was included in regression 3.³⁸ The estimated income elasticity at the point of means in regression 3 is $+.06$, although the coefficient is now not statistically different from zero. There is no appreciable effect on the negative coefficient for the wife's education variable. The direction of effect of the husband's education level is negative, and the estimated coefficient for an equal increase in both education levels (i.e., holding the wife's relative value of time fixed) is $-.074$ (with a standard error of $.028$). The husband's wage rate has a statistically insignificant positive effect on fertility.³⁹

These regressions suggest that for this sample of relatively wealthy, highly educated suburban families, the wife's education is negatively related to completed fertility. Controlling for the age of the wife, the negative effect persists when variables measuring the husband's education, wage rate, and age-adjusted income are held constant. It is not suggested that these regressions represent a well-specified, completed fertility demand equation, but rather that they indicate, with yet another data set, the persistent negative effect of education on fertility.⁴⁰ If such information were accessible, one

³⁸The reader may question why the wife's wage rate is not similarly used. On practical grounds it is observable only for women who work; moreover, even if it were measurable, the potential wage of nonworking women would not accurately reflect their true value of time. The current wage rate of working women is not independent of their previous work experience or of their hours worked, both of which are influenced by the woman's fertility. So instead of calculating or predicting the woman's wage rate, the procedure here uses her relative education as a measure of the wife's relative value of time. The husband's wage rate (which is not subject to the same complications) is the link between the price of time and the price of goods in the cross section, where the price of goods is presumed constant.

³⁹When entered without the husband's income variable, the coefficient for the husband's wage rate was $+.042$, with a standard error of $.025$. Consider the effect of the wage variable on the interpretation of previous estimates of a positive income elasticity of fertility. Even if it is presumed that the husband's time is not used in producing children, his value of time will affect the relative price of children. As his value of time rises, the cost of products which do use his time will rise relative to the price of children. This will induce an increase in the quantity of children demanded, implying a positive correlation between his value of time and the number of children in the household. In the absence of a "husband's value of time" variable, this effect is likely to be captured by the income variable, biasing its coefficient upward. Thus in cross-sectional studies which do observe a positive coefficient for the income variable, it is not clear that this reflects an income effect rather than a price-of-time effect.

⁴⁰Similarly, these regressions in Table 13-4 would not serve well as estimating equations for predicting household fertility. Only a small percentage (about 2

would want to look at the influence of the couple's educational level on their fertility, holding constant the household's income and the relevant price-of-time measures for both the husband and the wife. Regression 3 in Table 13-4 includes measures of the husband's income and wage rate; thus the wife's education variable presumably captures the effect of the price of her time, whereas the husband's education variable might be interpreted as capturing other effects of education on fertility. Although the latter variable has a negative sign, the coefficient is not nearly statistically significant. There are several statistical explanations for this, but it will suffice to conclude, at this time, that the empirical analysis is unable to distinguish between these several, closely related effects.

Of course, the observed insignificant effect of the husband's education in regression 3 is consistent with education's having no effect on fertility independent of its effect through income and the price of time. However, other evidence—such as the results discussed earlier pertaining to the relation between education and contraceptive choice and to one aspect of child quality—seems to suggest that education does influence several other dimensions of fertility behavior.⁴¹ These, in turn, would be expected to affect completed fertility. Clearly, these factors are not thoroughly sorted out as yet. As I said initially, this chapter constitutes a progress report on an ongoing research project, and it has dealt with relatively early results.

percent) of the observed variation is explained, although these sets of variables are statistically significant at about a 95 percent level of confidence. To predict fertility more effectively, additional variables could be added to the equations, but this was not done here. It is also well known that grouping the observations into homogeneous cells and estimating the equations on cell means would greatly raise the equations' "explanatory power," if that were of particular concern.

Another qualification which should be noted is that in these early regressions, the effects of these variables are presumed to be independent and linear. Willis's study (1973) emphasizes one important interdependence between measured income and value of time. Several studies have observed nonlinearities, for example, in the relationship between wife's years of schooling and the number of children—the negative relationship appears to be stronger at lower levels of schooling.

⁴¹ Although this chapter has not discussed the timing and spacing of childbearing, these dimensions of fertility behavior are also likely to be significantly influenced by the couple's level of education. As an example, it appears from these CAS data that more educated women begin childbearing at a later age and space their children somewhat more closely together. There is, furthermore, an indication from these data that more educated women space their children more evenly (i.e., at more regular intervals). (See Michael, 1971.)

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