MEN IN FAMILIES
When Do They Get Involved? What Difference Does It Make?

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Chapter 5

Human Parental Investment and Fertility: The Life Histories of Men in Albuquerque

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The reduction in fertility accompanying modernization poses a scientific puzzle yet to be solved. The problem has received wide attention by economists, sociologists, demographers, anthropologists and biologists, yet no discipline in the social or biological sciences has offered a full and coherent theory to explain the timing and pattern of fertility reduction in the developed or developing world. The inability to offer an adequate theory raises fundamental questions about the theoretical foundations of those disciplines. For example, although economics has made great strides in explaining consumer behavior, time allocation, and labor force participation through the recognition that the household is a fundamental organizational unit of human action, there is no adequate explanation of why households are mostly composed of men and women who marry and have children, why reproductive partnerships form such a fundamental organizational principle in human societies, nor why people have and want children in the first place. The very modest progress of economists in explaining long, medium, and short term trends in fertility highlights this weakness.

Evolutionary biology in its application to human fertility has fared no better. The core theoretical foundation of modern evolutionary biology is that differential reproductive success is the principal driving force determining evolutionary change and stability. A corollary proposition is that competition for the resources for reproduction is the primary determinant of differential reproductive success. Thus, the fact that people in modern industrial societies obtain access to and utilize more resources than ever before in human history and yet evidence the lowest fertility rates ever recorded presents a particularly critical challenge to evolutionary biology, at least in its application to humans (Vining, 1986).

This chapter presents the results of an in-depth study of fertility and parental investment using a representative sample of men from Albuquerque, New Mexico. Our goal is to develop and test a general theory of human fertility and parental investment, with a specific focus on explaining recent historical trends in family behavior within developed nations. We present a theoretical framework that unifies life-history theory, developed in biology, with human capital and household allocation theories, developed in economics. We then offer a specific theory of modern fertility reduction based on the emergence of skills-based competitive labor markets. This theory generates a set of empirical predictions that are tested with data derived from the sample of Albuquerque men. The empirical analysis focuses on age at first reproduction, completed fertility, the formation and dissolution of marital and quasi-marital relationships, investment in children, and child outcomes. The analysis examines both historical trends and variation among men within cohorts and time periods.

LIFE-HISTORY THEORY AND THE ECONOMICS OF THE FAMILY

Biological and economic theories of life histories and fertility decisions developed independently, yet they share some formal properties and substantive conclusions. They both assume that individuals act to optimize the allocation of limited resources through the life course so as to maximize some currency. Biological models assume that *fitness*, defined in terms of quantity of descendants or the instantaneous growth rate of genes, is the ultimate currency that individuals are designed to maximize. Economic models assume that utility or satisfaction is the ultimate currency. We consider first models of life history developed in biology and then compare them to economic models of investment in human capital and fertility.

Life-history theory grew out of the recognition that all organisms face two fundamental reproductive trade-offs (see Charnov, 1993; Kozlowski, 1992; Lessells, 1991; Roff, 1992; and Stearns, 1992, for general reviews; see Hill, 1993, for a review of the application of life-history theory to humans). The first trade-off is between current and future reproduction. The second is between quantity and quality of offspring. With respect to the former trade-off, early reproduction is favored by natural selection, holding all else constant. This is due to two factors. First, the production of offspring will be a positive function of the length of the reproductive span. Because the probability of death in any time period is always nonzero, earlier reproduction tends to increase the length of the reproductive period. Second, shortening generation length by early reproduction increases the total reproductive output of the lineage in growing populations.

These forces favoring early reproduction are balanced by benefits derived from investments in future reproduction. Those investments, referred to as *somatic effort*, include growth and maintenance. The allocation of time and energy to growth has three major benefits. Larger organisms often suffer lower rates of mortality. Therefore, growth can increase the length of the life span. Growth also can increase the efficiency of energy capture per unit of time allocated to food production or acquisition. Therefore, allocation of resources to growth can increase the total energy available for reproduction over the life course. Finally, larger body size can increase success in intra- and intersexual competition for mates, ultimately affecting reproductive rate. These three benefits to growth also accrue to investments in maintenance, because physical condition will depreciate through time if no effort is allocated to maintenance.

For each unit of energy acquired, the organism is assumed to face a choice between investing it in growth and maintenance, which increases future rates of surplus production, and investing it in reproduction. Natural selection is expected to shape the life history of those allocations so as to maximize the time-discounted surplus energy for reproduction over the life course (Charnov, 1993; Hill & Hurtado, 1996; Kozlowski, 1992; Kozlowski & Wiegert, 1986, 1987; Roff, 1986; Stearns & Koella, 1986). Because the costs and benefits associated with alternative allocations are likely to vary with phylogenetic history, local ecology, and individual condition, optimal distributions of effort to current versus future reproduction are likely to vary as well.

The second major life-history trade-off concerns the allocation of resources for reproduction between quantity and quality of offspring, given a specific solution to the allocation problem regarding current versus future reproduction. This trade-off is presumed to result from the fact that parents have limited resources to invest in offspring and that each additional offspring necessarily reduces average investment per offspring. Most biological models operationalize this trade-off as number versus survival of offspring (e.g., Lack, 1954, 1968; Lloyd, 1987; McGinley & Charnov, 1988; Rogers & Blurton Jones, 1992; Smith & Fretwell, 1974). Natural selection is expected to shape investment per offspring and offspring number so as to maximize offspring number times their survival. Optimal fertility and parental investment are also expected to vary with phylogenetic history, local ecology, and individual condition.

These two allocation problems have direct analogues in human capital theory and the theory of the family in economics. The first, intertemporal problem can be divided into two parts. One is the trade-off between present and future consumption and the other is the trade-off between present and future income. Given perfect lending markets, it is possible to separate the consumption problem from the income problem. If people can borrow and lend (or, save) at going interest rates, they can adjust consumption over time to maximize utility as long as the present value of total consumption equals the present value of total income. Therefore, the first problem that must be solved is the optimal investment in human capital to maximize the present value of lifetime income.

Human capital may be defined as a stock of attributes embodied in an individual, such as skills and education, that affect the value of time allocated to productive labor, and hence affect earnings. There are two kinds of costs associated with investment in human capital. There are the direct costs, such as school fees and books, and the indirect costs associated with time spent in training during which income is foregone. As in biological models, the same relationship exists between timing and rate of payoff, the sooner one enters the labor force the more years of earning will occur; however, the longer one trains, the higher the wage rate will be when one enters the workforce. The work of Ben-Porath (1967), Mincer (1974), and Becker (1975) showed that investment in human capital is at an optimum when the net rate of increase in earnings due to a unit of time invested in capital accrual (i.e., after direct costs of investment have been subtracted) is equal to the prevailing interest rate. Given that the present value of the lifetime income stream is maximized, consumption allocations through the life course may be shifted through borrowing and lending to maximize utility or satisfaction.[1] Thus, there is a direct equivalence between somatic effort and investment in human capital. Both are expected to maximize the effective resources available to the individual over the life course. The principal difference is that in biological models, those resources are utilized for reproduction to maximize fitness and in economic models resources are used for consumption to maximize utility. As a result of this equivalence, biological and economic models of investment in growth and human capital share many features. For example, both focus on the rate of return on investment and both recognize that the length of time over which the investment yields a return will be positively correlated with investments in the future. The third shared feature is analysis of the effect of timing on the value of the return. In biological models, the population growth rate is the primary determinant of temporal effects

[1]Although most economists would argue that the utility derived from investments in human capital probably includes such nonmonetary rewards as increased status and on-the-job satisfaction, most theoretical developments and empirical applications focus on income effects.

on the value of reproduction (Charlesworth, 1980; Rogers, 1993, 1994). If populations are growing, later reproduction has a smaller impact on relative gene frequencies than earlier reproduction, and vice versa if populations are shrinking. Thus, the payoff to investment in growth decreases with population growth rate. In economic models, the overall interest rate on investments determines the temporal effects of the earnings stream on the value of real income (i.e., adjusted for inflation). Again, the higher the interest rate, the lower the payoff to investment in human capital.

Becker (1975) also showed that under most conditions, the costs of human capital investment increase as capital is acquired. Human capital acquisition generally requires time inputs from the individual acquiring the capital. If investment extends over many time periods, then the time spent in capital acquisition becomes increasingly expensive as capital is acquired. This is also true of the biological growth models. As organisms grow, the opportunity cost of each unit of time dedicated to growth increases.

With respect to fertility regulation, the problem is also viewed as a quantity–quality trade-off by economists (Becker & Lewis, 1973; de Tray, 1973; Willis, 1973). Quality is considered to be an index of the human capital embodied in children. Thus, parents are expected to derive satisfaction from both child quality and child quantity, and to chose the combination of offspring number and offspring quality to maximize the satisfaction derived from children and other forms of consumption. Later models (e.g., Becker, 1991; Becker & Barro, 1988; Becker, Murphy, & Tamura, 1990; Becker & Tomes, 1986) explicitly treat fertility decisions in terms of an intergenerational utility function. The individual's optimization problem is to maximize satisfaction derived from the intergenerational consumption stream through the allocation of earnings to own consumption and investment in children.

These two approaches can be usefully unified to build on the strengths of each. A major strength of biological models is the causal closure provided by the theory of natural selection and the use of fitness as the currency to be maximized. The theory of evolution by natural selection specifies the causal processes by which the characteristics of organisms change and a justification for why organisms should be designed to maximize fitness. In contrast, the economic assumption that people maximize utility is not derived from a known causal process, but rather is maintained as a working heuristic because it seems to characterize human behavior. Thus, economic models are less specific about the nature of interpersonal utility functions. However, the theory of human capital in economics is much more developed than the corresponding theory of investment in somatic effort in biology.

Figure 5.1 unifies biological and economic approaches to life-history decisions by extending the economic concept of human capital to organisms in general (with the term, ***embodied capital***) and by utilizing biological

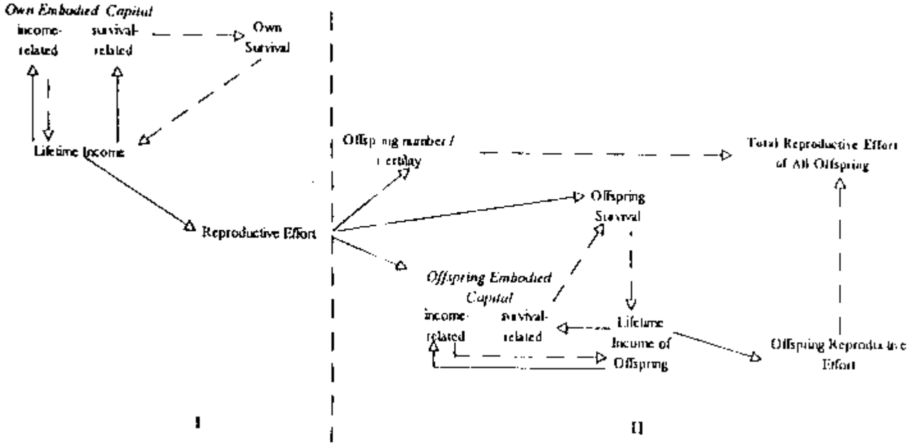

FIG. 5.1. Decision model for life history of investments.

fitness as the ultimate currency. Development can be seen as a process in which individuals and their parents invest in a stock of embodied capital. In a physical sense, embodied capital is organized somatic tissue. In a functional sense, embodied capital includes strength, immune competence, coordination, skill, and knowledge, all of which affect the profitability of allocating time and other resources to alternative activities such as resource acquisition, defense from predators and parasites, mating competition, parenting and social dominance. Because such stocks tend to depreciate with time due to physical entropic forces and to direct assaults by parasites, predators, and conspecifics, allocations to maintenance such as feeding, cell repair, and vigilance can also be seen as investments in embodied capital. Individuals may invest not only in capital embodied in their own soma, but in the capital embodied in offspring, other relatives, and in other individuals with whom they interact.

In the first part of Fig. 5.1, we begin with lifetime income. Income is defined here in the general sense of the total value of time allocated to alternative activities, such as resource acquisition, child care, rest, and so on. At each age, an individual's income will be a function of his or her embodied capital. Income can be invested directly in reproductive effort, or in embodied capital. Embodied capital, in turn, can be divided into stocks affecting the ability to acquire the resources for reproduction and stocks affecting the probability of survival.

The solid arrows depict investment options. The dotted arrows depict the impacts of investments. Investments in income-related capital, such as in growth, physical coordination, skills, and knowledge, affect lifetime income through the value or productivity of time in the future. Investments

in survival-related capital, such as immune-function, predator defense, and tissue repair, affect lifetime income through increasing the expected life span of earnings. However, an organism that does not reproduce leaves no descendants. Thus, the first optimization problem acted on by natural selection is to allocate lifetime income among investments in future income, survival and reproduction at each age so as to maximize the time-discounted surplus energy for reproduction over the life course.

The second part of the figure shows the relationships between investments and outcomes for two generations. Here, both the parent and the offspring can invest in the offspring's survival- and income-related capital. For parents, the optimal allocation between fertility and investments in embodied capital of offspring should maximize the total lifetime allocations by offspring to their own reproduction (summed over all offspring). This requires consideration not only of the effects of parental investment on offspring survival, but also on the adult income of offspring as well. If individuals in each generation allocate investments in their own and their offspring's embodied capital optimally, then the "dynastic" or multigenerational fitness of the lineage is maximized.

In this model the diversity of life histories is due to the fact that the shape of the relationships between investments and outcomes varies ecologically. For each major class of mortality (predation, disease, intraspecific violence, accidents, starvation), there will be variable relationships between the probability of dying from it and investments by the organism. There is also ecological variability in the benefits to investment in income-related capital. The relationships between body size and productivity depend on the feeding niche. The value of knowledge, skill, and information-processing ability depends on the type of foods exploited.

FERTILITY AND PARENTAL INVESTMENT IN TRADITIONAL HUMAN SOCIETIES: AN ECOLOGICAL MODEL

One of the most important problems in understanding contemporary demographic processes is that the proximate physiological and psychological mechanisms underlying fertility, parental investment, and family formation evolved primarily in the context of a hunting and gathering lifestyle. All but the last 10,000 years of evolution in the hominid line occurred among foraging populations. An understanding of the hunting and gathering lifestyle is essential to understand the evolved physiology and psychology governing fertility and parental investment. Because most people now live in environments radically different from our ancestral environment, we also require an understanding of what our minds and bodies are designed to do and how our evolved physiology and psychology respond to modern environments.

Compared to other primates and mammals, there are three distinctive characteristics of human life histories: (a) an exceptionally long life span with older nonreproductive individuals supporting their offspring's reproduction, (b) an extended period of juvenile nutritional dependence coupled with the provisioning of young of different ages, and (c) marriage and the involvement of men in the care and provisioning of children (Kaplan, 1996a; Lancaster & Lancaster, 1987). Because all well-studied hunting and gathering groups exhibit these three characteristics, it is likely that some fundamental features of the traditional human lifeway account for their evolution. We have proposed that those three features of the human life course are interrelated outcomes of a feeding strategy that emphasized nutrient-dense, difficult-to-acquire foods (Kaplan, 1996a, 1996b). The logic underlying this proposal is that effective adult foraging requires an extended training period during which production at young ages is sacrificed for increased productivity later in life. The returns to investment in training depend positively on adult survival rates, favoring increased investment in mortality reduction. An extended postreproductive, yet productive, period supports both earlier onset of reproduction by next-generation individuals and the ability to provision multiple dependent young at different stages of development.

There are two principal proximate determinants of fertility—age at weaning and net energy flow to women. They correspond to the constraints imposed by the different phases of the parental investment. Because humans almost never customarily nurse two infants at the same time, the intensity and length of infant investment is a critical decision variable determining fertility. The net energy flow to women represents the available energy for reproduction and investment, after accounting for the net productivity of children, postreproductive individuals, and adult men. Exposure to sex, a third proximate determinant, is probably most relevant to the onset of fertility in late-marrying populations, which, for reasons of length, is not treated here. With respect to the survival during the infancy period, there are two critical forms of parental investment, breast milk and direct care. It is useful to think of infancy in terms of a gradual transition from complete dependence on breast milk to complete dependence on other foods. The provision of breast milk increases during the first few months of life as the baby grows and then supplemental foods are introduced at about 4 to 6 months of age, providing an increasing proportion of food in the child's diet as his or her caloric needs increasingly exceed the energy its mother can provide with breast milk (Oftedal, 1984; Vitzthum, 1994; Whitehead & Paul, 1981). Ecological factors affect the

relationship between the rate of those transitions and offspring survival (Lee, Majluf, & Gordon, 1991; Vitzthum, 1994). The digestibility of available foods is one factor. The maturation of the child's digestive system will interact with the kinds of weaning foods available to eat in determining the optimal age to introduce new foods and the optimal proportion of milk to other foods in the child's diet at each age (Sheard & Walker, 1988). Disease organisms are another factor. The density and intensity of diseases that infect individuals through ingestion should be related to length of the breast-feeding period for two reasons. First, breast milk increases the child's immunocompetence (Hanson, 1982; Howie, Forsyth, Ogston, Clark, & du Florey, 1990). Second, babies that are sickly require the high-quality nutrition provided by breast milk (Sheard & Walker, 1988). On the other hand, the relative importance of diseases that are unaffected by diet should be related to acceleration in the rate of weaning, because breast milk will account for less of the variance in survival (Borgerhoff Mulder, 1992; Harpending, Draper, & Pennington, 1990; Pennington & Harpending, 1988). Because infancy and early childhood is also the period during which offspring require the most direct care, maternal food production, and hence her budget for reproduction, should be affected by ecological factors affecting the relationship between direct care and survival. The availability of safe spaces for children, which should be negatively associated with mobility, and the dangers in the environment should both affect the age-specific benefits of direct maternal care.

The age-specific productivity of children is also likely to depend on ecological factors. The dangers associated with acquisition of different food types should affect whether and how much children forage. This issue has received extensive treatment in a series of papers contrasting the foraging behavior of !Kung and Hadza children (Blurton Jones, Hawkes, & O'Connell, 1989; Blurton Jones, Hawkes, & Draper, 1994a, 1994b; Hawkes et al., 1995). In addition, as just discussed, the suite of resources available and the impacts of skill and strength on foraging return rates should determine both children's time allocation to productive labor and the total amount they produce (cf. Bock, 1995; Draper & Harpending, 1987; Hawkes, O'Connell, & Blurton Jones, 1995). Children also face a potential trade-off between early productivity and later adult production. Thus, the impacts of both productive labor and nonproductive practice on later adult productivity should also affect children's food production. For example, boys in many societies spend a good deal of time in nonproductive hunting practice. Among the Machiguenga, boys spend much time hunting small lizards and in target practice. They sacrifice the more immediately productive activities of helping their mothers in the garden and collecting wild foods, activities that their sisters perform.

The characteristics of potential food resources also affect the productivity of adults. Rates of return from hunting are likely to impact on men's food production (see Lancaster & Kaplan, 1992, for a discussion). The productivity of older people may also depend on the availability of foods that may require skill to extract, but do not require great strength or stamina. The productivity of the environment, relative to population density, is also likely to determine the net energy flow to women.

These two main constraints on reproduction, the length of the infancy period and the net energy flow to women, may vary in their importance in different ecological contexts. When food is abundant, the main constraint on fertility may be the health impacts of weaning. This would likely correspond to periods of maximum population growth rates (cf. Hill & Hurtado, 1996). When population density is high relative to the productivity of the environment, the net energy flow to women may be most important.

MECHANISMS UNDERLYING HUMAN RESPONSES TO ECOLOGICAL VARIATION

In order to adjust parental investment and fertility optimally in relation to ecological variation, humans must possess a set of mechanisms that translate environmental inputs into behavioral outputs. Many of these adjustments, especially those involving parental investment, may be accomplished through psychological processes that direct attention to functional relationships, aided by a store of cultural knowledge. Other adjustments, such as those governing fertility, may be accomplished by the physiological mechanisms discussed earlier.

The optimality conditions specified by the quantitative analysis of the model (Kaplan, 1996a) suggest that these psychological mechanisms must be able to detect diminishing returns to investments. It is the shape of the relationship between investments and outcomes that determines the optimal amount to invest. When returns to an extra unit of investment in offspring income or survival produces a smaller fitness improvement than a comparable investment in fertility, it no longer pays to invest more in the offspring, even if the investment is beneficial. Compared to observed investments, a slightly longer nursing period, a slightly lower work requirement for children, and slightly more food given to children would probably increase their survival or adult income. However, people should be selected to possess psychological mechanisms that detect diminishing returns and to adjust investment accordingly (Borgerhoff Mulder, 1992; Harpending et al., 1990; Pennington & Harpending, 1988).

To summarize, the proposal here is that selection acts on the coordinated outcome of mechanisms that both regulate parental investment and fertility. Investment may be regulated by psychological mechanisms that direct attention to fundamental relationships between investments and outcomes, and that detect diminishing returns to investment. Actual decisions will be the product of those mechanisms and some reliance of cultural norms that benefit from accumulated experience. The regulation of fertility, on the other hand, may involve little or no direct cognition, and be wholly regulated by physiological mechanisms responsive to breast-feeding regimes and net energy flow. This makes sense in the context of the theoretical model insofar as fertility is the passive result of optimal parental investment and an income budget for reproduction. If, after allocating investments to existing children, there is enough time and energy to support the next offspring, it should be produced.

PARENTAL INVESTMENT AND FERTILITY REDUCTION IN INDUSTRIAL SOCIETIES: THE COMPETITIVE LABOR MARKET THEORY

The Empirical Relationship Between Fertility and Fitness, and the Requirements for a Theory

There is mounting evidence that people in modern state societies in the developed world do not maximize fitness through their fertility decisions (e.g., Irons, 1983, 1990, 1993, 1995; Kaplan, Lancaster, Bock, & Johnson, 1995; Lam, 1986; Perusse, 1993; Retherford, 1993; Vining, 1986; but see Simons, 1974, for data suggesting a positive correlation among wealth and fertility within socioeconomic groups). Observed fertility behavior deviates from the predictions of fitness maximization in two ways. First, and most important, observed fertility is lower than would be predicted based on models of fitness maximization. For example, we showed that among men in Albuquerque, New Mexico, the number of third-generation descendants (i.e., grandchildren) is highest among those who produced the most (i.e., >12) children (Kaplan et al., 1995). This contrasts sharply with the observed modal fertility of 2 (Fig. 5.2). Higher parental fertility in modern developed societies is associated with lower achieved educational and economic status of offspring (Kaplan et al., 1995; see also Blake, 1989, and Downey, 1995, for reviews), but the lower earning capacity of children from large families does not decrease their fertility and so there is no apparent fitness reduction associated with lowered parental investment per child.

The second way in which modern behavior deviates from the predictions of simple budget constraint models of quantity–quality trade-offs is that higher earning adults produce no more children than their lesser earning counterparts, even in well-controlled studies. Whereas available data on

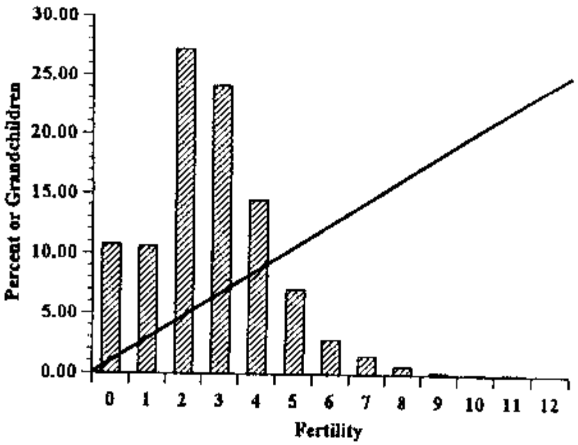

FIG. 5.2. Fertility and grandchildren. (The bars show the frequency distribution of fertility in percents for Anglo men born between 1920 and 1939. The solid line plots the OLS estimate of the relationship between number of children and number of grandchildren among Anglo men whose children have completed reproduction. Modal fertility is 2 children, but number of grandchildren is maximized with the highest number observed, 12.)

pre-industrial societies consistently exhibit a positive relationship between resources or power and reproductive success (Barkow, 1989; Betzig, 1986; Boone, 1986; Borgerhoff Mulder, 1987, 1988; Chagnon, 1988; Cronk, 1991a, 1991b; Flinn, 1986; Hughes, 1986; Irons, 1979, 1993, 1995; Kaplan & Hill, 1985; Low, 1990; Mealey, 1985; Turke & Betzig, 1985; Voland, 1990), studies of postdemographic transition societies either find no relationship or a negative one (Kaplan et al., 1995; Perusse, 1993; Retherford, 1993; Vining, 1986; as we found in this study, see Fig. 5.4).[2] The models presented here predict that under most conditions, fertility should be a monotonically increasing function of resources for investment in reproduction, and when wealth does not affect the value of parental investment, fertility should increase linearly with resources.

An adequate theory of the demographic transition must accomplish two things. First, it must specify the conditions that changed, leading to a reduction of fertility and the observed relationship between wealth and

[2]Studies of traditional small-scale societies suggest that fertility may be optimized to maximize the production of descendants over the long run (e.g., Blurton Jones, 1986, 1987, for the !Kung in Botswana; Blurton Jones & Sibly, 1978; also see Hill & Hurtado, 1996, for disconfirmation among the Ache). The abrupt change in the association between wealth and fertility that occurs at the same time fertility is reduced historically (Retherford, 1993) requires explanation.

fitness. Second, it must account for why those changes produced the observed responses within a larger theory of the determinants of fertility in general. In the context of the theory proposed here, it is necessary to specify the critical differences in the relationship between parental investment and child outcomes in pre- and postdemographic transition societies and to show why the suite of evolved, proximate mechanisms just discussed might produce the fertility and parental investment behavior observed in modern, post-industrial revolution labor markets.

In order for the theoretical models to explain the reduction in fertility, especially in the face of growing wealth, exogenous changes in the value of parental investment are required. The transition from high to low fertility requires that the marginal returns from parental investment decrease more slowly in modern societies than in traditional and peasant societies. In fact, the difference in the rates at which returns to parental investment must be great enough to more than compensate for the higher real wealth in post-transition contexts. We present an analysis (building on Becker's [1975] analysis of investment in human capital) that implies that, for a large part of the range of investments, investments in offspring income in skills-based competitive market economies exhibit either constant returns to scale or, with growing technology, increasing returns to scale (see Fig. 5.3).

Similarly, to account for the fact that, within modern societies, wealth is uncorrelated with fertility, the model requires that the shape of the functions relating parental investment to offspring income or survival must differ systematically with wealth. In particular, it requires that higher earning parents must be more effective at producing embodied capital in children than lower earning parents. This part of the analysis relies on the idea that the skills affecting productivity with modern technology are cu-

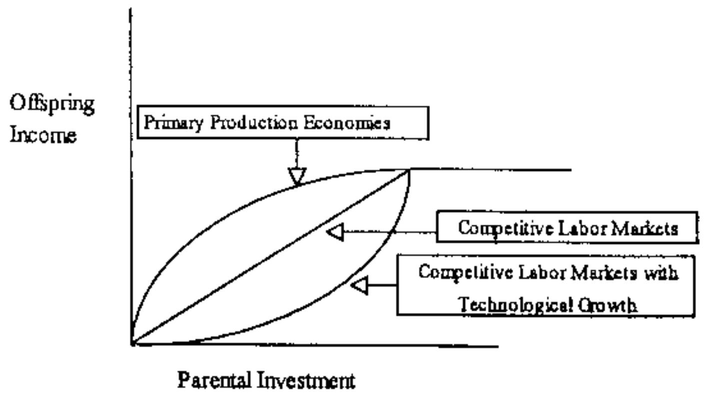

FIG. 5.3. Relationship between parental investment and offspring income as a function of the economy.

mulatively acquired and that the production of embodied capital in children depends on the capital embodied in parents (see Becker, Murphy, & Tamura, 1990, for a related argument in the analysis of macropatterns in economic growth and fertility). For these conditions to predict low modern fertility, the sum of age-specific investments in offspring must constitute a greater proportion of adult income in modern contexts than in high fertility regimes. To predict the lack of a positive association between income and fertility, age-specific parental investments must increase proportionally with wealth. Our theory is that skills-based competitive labor markets produce just such conditions. In response to those conditions, the evolved proximate mechanisms governing fertility and parental investment produce a fertility much lower than the fitness-maximizing output. The psychological processes regulating desired investment per child and other expenditures produce a budget that does not permit more than two to three children. There is a conflict between the fertility schedule that our physiological response system would produce and consciously desired fertility. This has stimulated the demand for effective birth control technology. The interaction of those processes with current socioeconomic conditions is discussed following the analysis of investment in embodied capital in competitive labor markets.

Investment in Embodied Capital in Skills-Based, Competitive Labor Markets

There are qualitative differences between subsistence production and modern competitive labor markets in the relationship between investments in human capital and productivity. In subsistence-based economies, the relationship between skills and productivity depends on the activity. For example, successful agricultural production requires knowledge of weather, soil, and pests in differing degrees depending on the local ecology. Some function with eventually diminishing returns will likely characterize the relationship between productivity and human capital. In those economies, optimal levels of investment will be determined by the diminishing impacts of further investments on productivity. However, competitive labor markets will tend to produce wage structures that equalize the present value of costs of investments with the earnings (see Becker, 1975, for a detailed presentation of this argument).

This section begins with a basic summary of some of the principal results from the economic analysis of labor markets. It then applies those results to parental investment in the embodied capital of offspring. It also models the case in which parents with higher levels of skill are able to produce embodied capital in offspring at a higher rate per unit of investment. This model is designed to specify the conditions that would have to be met in order for the models of fitness-maximizing investments in offspring number and offspring quality to predict the empirical pattern of results found in modern society.

This analysis is a form of reverse optimality. We already know much about the basic empirical patterning of modern fertility and parental investment behavior. The goal here is to develop an optimality framework for analyzing optimal fertility and parental investment behavior in the context of a labor market economy, and then to determine the assumptions that would have to be met for the model to predict the observed behavior. Once those conditions are specified, empirical research can be conducted to determine if they hold in modern society.

The economic analysis of labor markets examines wage structures in terms of the supply and demand for labor. Firms are expected to hire labor and combine it with physical capital in an optimal mix to produce goods at the lowest cost. The firm's demand for labor is depicted as a function of the wages paid per unit of labor. The demand curve slopes downward, because as wages decrease, profit-maximizing firms will wish to hire more workers (see, for example, Varian, 1992). The basic assumption underlying the downward sloping demand curve is that, if all other inputs into the production process are held constant, each extra unit of labor will have a diminishing marginal product. Thus, if there are 1,000 laborers employed in the labor market, the 1,001th worker will increase total production (and hence sales revenues) less than the 1,000th worker. A profit maximizing firm will wish to employ units of labor as long as the revenues derived from adding the next worker are greater than the wages that must be paid (i.e., until a quantity is reached such that the marginal revenue derived from a unit of labor is equal to the cost). Thus, the demand curve represents the marginal revenue of a worker as a function of the total quantity employed.

Fitness-maximizing or, in economic usage, utility-maximizing individuals will attempt to get the highest possible return for their labor. The supply curve represents the amount of labor that workers would be willing to supply as a function of wages. In general, supply curves are upward sloping because higher wages will entice more workers to join the labor force. The market is cleared at the point of intersection between the demand and supply curves, and the wage level defined by this intersection is the equilibrium wage paid to workers. One important result obtained from the analysis of wage structures is that at equilibrium, the difference in wages paid for jobs requiring differing levels of human capital will exactly compensate for the increased costs of acquiring the capital (Becker, 1975).

This result can be extended to parental investment in offspring embodied capital. According to the model in Fig. 5.1, fitness-maximizing parents will be willing to pay those costs if the increase in the adult income of their offspring would offset the loss in fertility. Define the total parental investment in the traditional and unskilled labor sectors at equilibrium as p^* with an associated fertility rate,

$$b^* \left(= \frac{I_0}{p^*}\right).$$

The fertility of parents producing skilled offspring, b', would be

$$b' = \frac{I_0}{p^* + c} = b^* \frac{p^*}{p^* + c}.$$

Fitness-maximizing parents would be indifferent to raising skilled workers if

$$b^* I_0 = b' I', \text{ or } I' = \frac{p^* + c}{p^*} I_0$$

where I' is the income of skilled workers. This leads to the prediction that forces of supply and demand will automatically generate an equilibrium in which parents are indifferent to alternative levels of fertility and offspring income. Fitness gains from increased income per child will exactly equal the fitness costs of lost fertility.

In addition, variation in fertility will also reflect changes in other investments due to increased investment in skill. The initial model of investment trade-offs among fertility, survival, and income of children implies that increased investment in one component of offspring reproductive value leads to increases in other components (Kaplan, 1996b). Thus, anyone investing in more skilled children will also invest more in their health and survival. This would engender even greater fertility differences among parents investing in differing skill levels for their children. In fact, one might argue the increased investment in public health at the end of the 19th century was as much a consequence of fertility reduction as a cause.

This simple analysis is potentially capable of explaining several aspects of the empirical pattern just discussed. It explains why competitive labor markets with skill-differentials linearize the relationship between parental investment and offspring income for a large part of the observed range. It also predicts variation in fertility levels within income classes, because parents will be indifferent to alternative choices of fertility and income. In addition, the children of higher investing parents will earn more, but will not necessarily have more children than the children of lesser investing parents. Because optimal investment in this model does not depend on income, skilled workers will be indifferent to producing skilled or unskilled offspring. If they produce unskilled offspring, they will have more children than unskilled workers. If they produce skilled offspring, they will have the same fertility as unskilled workers who produce unskilled offspring. If both skilled and unskilled workers invest in skilled offspring, then skilled workers will again have higher fertility due to their higher income. It also predicts investments in health will reflect investments in income-producing skills, both historically and across skill levels.

Still, several major problems remain unresolved. First the model, as it stands, predicts that there will be a mean difference in the fertility of skilled and unskilled workers. Although both types of workers will be indifferent to raising skilled and unskilled children, skilled workers, on average, should be more fertile due to their higher income. Second, the model can not account for sustained fertility reduction because initial decreases in fertility in one generation will be matched by increases in some future generation. Third, the model does not predict an intergenerational correlation in income (i.e., wealthier parents producing wealthier children), as is found empirically.

To explain the equality of fertility across income classes and the intergenerational correlation in fertility, higher-earning parents must invest more in children than lesser-earning parents. Here we follow Becker et al.'s (1990) suggestion that the production of human capital is human-capital intensive. If the qualities that increase productive output are knowledge, reading, writing, logic, and mathematical skills, the production of those qualities are likely to require inputs of a similar nature. The value of many inputs, in terms of the embodied capital produced, should depend on the capital embodied in those inputs. First, consider inputs of parents' time. There is significant evidence that the nature of parent–child interaction varies with the educational level of parents (Hart & Risley, 1995; Hoff-Ginsberg & Tardif, 1995). This probably means the skills and behavior patterns that result from parental time inputs are associated with the capital embodied in parents. By the time children enter the public education system, there are clear differences among them in school-related skills, and those differences are related to socioeconomic status. Second, the rate at which a child learns may depend on the knowledge and skills she already possesses. Much of the education offered in schools is based on the premise that knowledge is cumulative (Cromer, 1993). Basic skills are acquired first, and those skills are used as a foundation for the acquisition of the next set of skills. This would imply that the impact of the child's time inputs would depend on skills already in place.

This would mean that the net increase in embodied capital at each age would be functions of both the quality of inputs, and the capital acquired at younger ages. Define E_x as the total amount of embodied capital at age x, and e_x as the net increase in embodied capital at age x. We can think of E_x as a stock and e_x as a flow where

$$E_x = \sum_{y=0}^{x-1} e_y.$$

Next define for a given age of the child, $t_{c,x}$ as the child's time, $t_{p,x}$ as parent's time, $t_{o,x}$ as other's time (such as teachers'), $E_{c,x}$ as the child's existing stock of capital, $E_{p,x}$ as the embodied capital of parents, $E_{o,x}$ as the embodied capital of the others giving time to the child, and i_x as resources spent on all other inputs. Then e can be written as a funciton of inputs:

$$e(x) = e(t_{c,x}, t_{p,x}, t_{o,x}; E_{c,x}, E_{p,x}, E_{o,x}, i_x, x, t),$$

where

$$\frac{\partial^2 e_x}{\partial t_{c,x}\,\partial E_{c,x}}, \frac{\partial^2 e_x}{\partial t_{p,x}\,\partial E_{c,x}}, \frac{\partial^2 e_x}{\partial t_{o,x}\,\partial E_{c,x}}, \frac{\partial^2 e_x}{\partial i_x\,\partial E_{c,x}}, \frac{\partial^2 e_x}{\partial t_{p,x}\,\partial E_{p,x}}, \text{ and } \frac{\partial^2 e_x}{\partial t_{o,x}\,\partial E_{o,x}} >> 0.$$

The first four cross-derivatives or interaction terms are written to indicate that the effect of each input will be greater as the recipient's (i.e., the child's) stock of embodied capital increases. This is important because it means that at each age, optimum investment in the child will be a positive function of the skills the child already possesses and that variance in investment will increase with age. The last two terms indicate the expectations, that the value of parents' and other's time inputs will also be an increasing function of their own stock of embodied capital. This means that more skilled parents should invest more and that parents should also invest more in children who are receiving inputs from higher quality schools. The rate of capital embodiment is also a function of time, t. This is meant to indicate that the overall level of technology and knowledge in the society will impact the rate of capital acquisition and optimal levels of investment.

If this is true, it has important implications for the supply and demand for embodied capital in the labor force. Now, the optimal level of investment in children may vary with income. It is easy to imagine a positive covariance between income of parents and the child's stock of human capital in early childhood, due to the positive covariance between income and the value of parental time inputs to children's development. Even if there are diminishing returns to parental time inputs, parents with more embodied capital may actually spend more time with children if the impact of their time is greater at each level than that of the time parents with less capital have to spend.

If the value of later inputs, such as resources and time dedicated to education, is an increasing function of the child's stock of embodied capital, then the stock of capital in children will become increasingly divergent with age. This will also mean that the total costs of embodying a given amount of capital will be a decreasing function of the parents' stock of capital. Although the cost of the time parents invest in children will be greater as parental income increases, the increased efficiency of later inputs will compensate for the greater expense of time by higher earning parents.

Total investment in embodied capital at the optimum will therefore be positively related, both directly and indirectly, to the stock of capital embodied in parents.

The significant implication of this reasoning is that the population distribution of fertility, parental investment, and incomes in competitive labor markets will be determined by both demand and supply functions. The demand curves will reflect technologies of production and the attendant demands for workers with varying levels of skill. The shape of the supply curves will reflect population variance in rates of return to investment in embodied capital. The values of the cross-derivatives just discussed are critical for determining whether the model predicts a positive association between parental stocks of embodied capital and parental investments in children's stocks, and a corresponding association between children's incomes and parents' incomes. The lack of income differences in fertility requires that optimal investments increase linearly with income. If we denote optimal parental investment for the ith and jth parents as $\bar{p}_i^0$ and $\bar{p}_j^0$, respectively, then equal numbers of children for all income levels requires that

$$\frac{\bar{p}_i^0}{\bar{p}_j^0} = \frac{I_i^0}{I_j^0} = \frac{I_i^1}{I_j^1}$$

with superscripts 0 and 1 representing the parental and offspring generations. However, if embodied capital decreases, the costs of embodying capital in offspring increases as well, the increased income necessary to motivate people to invest in higher levels of skills for offspring need not be as great as the fitness costs of obtaining those skills.

This within-population heterogeneity in the costs of embodying capital in children means that diminishing returns to parental investment are not determined by the environment as they would be in primary production economies, but rather by the population distribution of embodied-capital production functions. First, consider the highest skilled jobs in the economy. Those jobs would be filled by individuals with the lowest costs of skill acquisition in decreasing rank order until the point is reached when the next cheapest worker is more expensive than the product he or she produces. His or her parents would therefore invest less in him or her than would be necessary to obtain the highest skilled jobs, and he or she would find employment in the next tier of skill. That tier would then be occupied by individuals in decreasing rank order until the next cheapest worker would not be paid enough to compensate for skill embodiment. This process would continue through the lowest skilled jobs in the economy.

Next, consider the related proposition that technological change in production will be positively related to the stock of embodied capital at the population level (Becker et al., 1990). If higher levels of general education of the population are associated with more rapid technical progress, the demand for more skilled workers will increase as more investment is made in education. Through time then, the demand for new levels of skill will grow. For the simple model, this would imply that skilled parents would not only have the option of producing children of equal or lesser skill, but will have the opportunity to reinvest the dividend from their own educational investments in even higher levels of skill for their children. As long as technology is constantly growing and generating demand for new levels of skill, sustained fertility reduction over many generations is possible.

Although the continual intergenerational reinvestment of dividends from investments in embodied capital seems hard to sustain indefinitely, it does seem consistent with the last century of technological growth and increasing investment in education (see, e.g., Denison, 1985, Lesthaeghe & Wilson, 1986; and Lindert, 1986). In fact, there may be some excess return to education, especially at high levels, if there is a significant lag between increases in demand for skilled labor and corresponding increases in supply (see Fig. 5.3). Because the embodiment of skills takes time, some lags between demand and supply are likely. This would lead to higher rates of return to investments than would be expected at equilibrium. Such excess returns could drive fertility to a minimum level.

So far, we considered only fertility reduction and not the quantitative level of fertility. We also neglected the integer constraints on fertility and have treated fertility as if it were continuous. However, we know that minimum fertility greater than zero is one. If there were excess returns to investments in embodied capital, one might expect most people to have one child. Yet evidence suggests most people consider an only child to be undesirable and have a target fertility of two or three children (see Fig. 5.2). There is also evidence, however, that only children do not differ in education and achievement from children raised in two-child families (Blake, 1989). Yet, families with more than two children do show reductions in educational and income achievement (e.g., Blake, 1989; Kaplan et al., 1995). This suggests that decreases in family size below two children does not increase the total capital embodied by children.

This lack of effect may be due to several factors. Some of the costs of investment in embodied capital may be fixed (see Becker, 1991, for an analytical treatment of fixed and variable costs). The choice of a neighborhood to live in and the taxes paid for social services, including public education, are obvious examples of fixed costs. Thus the non-impact of a reduction from two children to one child may reflect diminishing marginal returns to variable costs, as they represent an increasing proportion of total costs. This would be true if the two types of costs were not perfectly substitutable. Also, men in focus-group discussions in Albuquerque expressed the opinion that interactions with siblings were an important contribution to development, and that mutual assistance among siblings was helpful in attaining life goals. Regardless of the reasons for this lack of impact, there seems little positive incentive to reduce fertility below two children. Moreover, because the number of children is not continuous, a reduction of fertility below two children requires a 50% change in fertility. This fact, coupled with the risk associated with the possible loss of an only child, creates a large disincentive. Increasing returns to scale for increases in embodied capital, combined with a lack of increase in embodied capital with a reduction to one child, may be sufficient to account for the two-child family.

Empirical Predictions Derived from the Skills-Based, Competitive Labor Market Model

To summarize, we propose that two characteristics of modern economies might be sufficient to account for a period of sustained fertility reduction and for a corresponding lack of income variation in fertility. The first characteristic is the direct link between costs of investment and wage rates due to the forces of supply and demand for labor in competitive economies. The second is the increasing emphasis on cumulative knowledge, skills, and technologies in the production of resources. These two characteristics may together produce the historically novel conditions that (a) investments in offspring income have nondecreasing (i.e., constant or increasing) returns to scale at the population level, and (b) embodied capital of parents is positively associated with returns to investment in embodied capital of children with diminishing returns at the individual level set by the within-population distribution of costs of skill embodiment.

These propositions generate a series of predictions with respect to fertility, parental investment, and child outcomes. Patterns of fertility should reflect investments in embodied capital and efficiency in the production of embodied capital. First, the observed relationship between income and fertility (i.e., no effect; see Fig. 5.4) should be the result of two opposing causal processes. Increased resources should be associated with higher fertility, but increased efficiency in the production of human capital should decrease fertility. However, because education and training affect both income and efficiency in the production of human capital in the same direction, the two opposing effects cancel each other out. Second, two kinds of fertility effects of embodied capital should be discernible. One effect is due to investments in own embodied capital. Men who invest more in training and education are expected to delay fertility. Another effect is due to increased investment in offspring embodied capital. Holding income constant, more educated men are expected to stop reproducing at

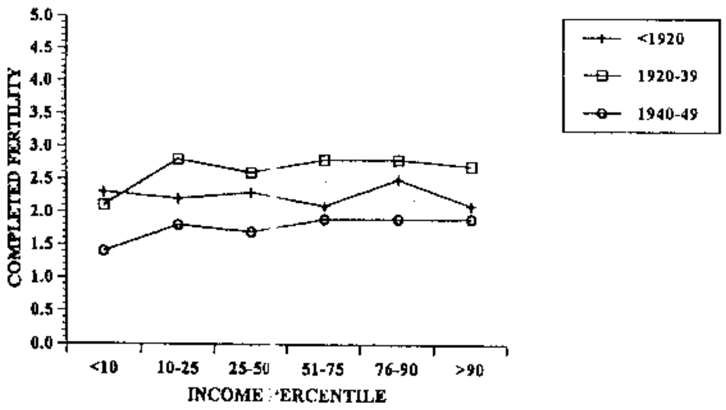

FIG. 5.4a. Anglo completed fertility by income and birth period.

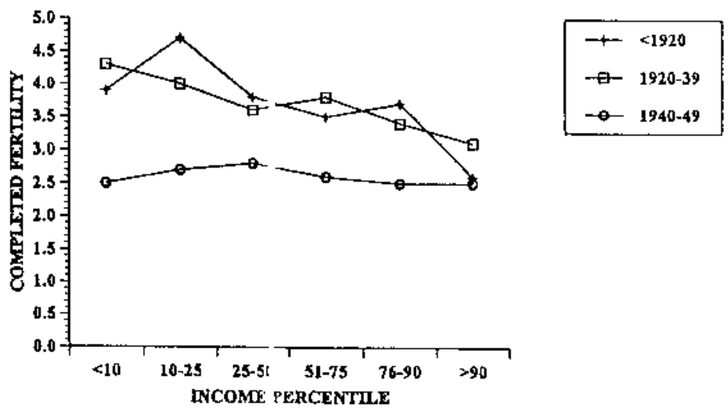

FIG. 5.4b. Hispanic completed fertility by income and birth period.

lower parities. Third, education has become increasingly important in determining economic outcomes during the course of this century (Burck, 1976; Herrnstein & Murray, 1994; Newcomer, 1955; Vinovskis, 1994), so that we should find a pattern of increasing importance of education in determining fertility.

A similar series of predictions are generated with respect to parental investment. First, within economic strata, more educated parents should invest more time and resources in each child as well as having lower fertility. This should be especially true of investments in the child's education. Second, parental education should be negatively related to the probability of ceasing to live with an offspring, because the negative effect of lowered parental investment will be greater for children of more educated parents.

Third, more academically able children should receive higher levels of investment (especially, school-related investment) than less able children, even within families, because there are higher returns to investment in their human capital (see Becker & Tomes, 1976, for a similar argument). Fourth, levels of investment at different stages of the child's development should be positively correlated with one another, contingent on the child's progress. The quantity and quality of early investments should positively affect early educational performance, which should, in turn, positively affect later investments. The loss of parental investment due to marital or relationship dissolution should also negatively impact child outcomes.

METHODS

The specific aims of the project were to test alternative theories of fertility, mating and parenting among men, using a representative sample from Albuquerque, New Mexico. The research design for the Albuquerque men sample consisted of two complementary interviews, a short interview administered to a large representative sample and a longer interview administered to a subset of the men in the short interview sample. Approximately 7,100 short interviews and 1,250 long interviews were conducted.

Potential respondents for the short interview were contacted at the Bernalillo County Motor Vehicle Division (MVD) as they received their driver's license photograph. The Bernalillo County MVD serves all of Albuquerque. All men who appeared to be over 18 years of age were considered eligible for initial contact. If they agreed to the short interview, which took about 7 minutes to administer, the interview was conducted in a private area at that time. On the basis of the answers to the short interview questions, eligibility for inclusion in the long interview sample was determined. The criteria for eligibility were (a) being age 25 or over and (b) having come to the MVD for the purpose of license origination, renewal, or for a photo ID. The purposes of the study were then explained to eligible men in more detail and they were offered the opportunity to participate in the long interview, for which they received a $30 payment. An appointment was then made to conduct the long interview in either a mobile office vehicle, an office at the University of New Mexico, or at their homes.

Albuquerque is the largest city in New Mexico with a population of 455,000; approximately 35% of the state's population lives in greater Albuquerque. More than 95% of all New Mexican males over 20 years of age have a current driver's license (U.S. Department of Transportation, 1993), compared to an estimated 92% telephone availability (of which 30% are unlisted numbers) for the Albuquerque area (U.S. Department of Commerce, 1992). Individuals who do not drive use the MVD to obtain valid photo IDs, and drivers' licenses and photo IDs must each be renewed every 4 years. By law in New Mexico, drivers' licenses and IDs cannot be renewed by mail or by phone. Thus, sampling licensed drivers and individuals obtaining photo ID's at the MVD provided a highly representative sample of the male population.

This approach has several advantages over standard sampling techniques, such as random digit telephone numbers, city directory listings, or housing units. The long interview requests sensitive information about illegitimate children, sexual affairs during marriage, family violence, homosexual experiences, and variation in male parental investment in children of different wives or of different sexes. Our ability to guarantee privacy, confidentiality, and anonymity was essential to the gathering of such intimate data from a large sample of men.

Evaluation of Sample Bias

We compared the demographic characteristics of our sample with data from other sources such as the census. We examined the age and ethnic distributions of our sample compared to licensed drivers and to census population data for males. There were no significant differences in any of these comparisons. In fact, the ethnic breakdown of the MVD sample is almost identical to the one obtained from the 1990 Census.

The Short Interview

This instrument was designed to obtain information on place and year of birth of the respondent and his parents, years in Albuquerque, ethnic, educational, religious, and economic background of the respondent and his parents, number of years he lived with each parent, number of half- and full-siblings, the fertility and age of siblings, number and age of biological children, years lived with biological children, number of spouses and women with whom the respondent had children, number of nonbiological offspring (step and foster) that the respondent parented, and income of the respondent and his current partner.

The Long Interview

The long interview collected information on the life history of the respondent, including his family history, rearing background, the parental investment he and his siblings received, employment history, major sexual and marital relationships, investment in children, and child outcomes. The form began by establishing the composition of the respondent's current household and then asked about the respondent's childhood and about the people who raised him. It focused on parental and extraparental investment the respondent received, and the stability of caretaking relationships. This information provided us with a socioeconomic and educational context for the respondent's upbringing, as well as a measure of the stability of his parents' major sexual relationships. The next section of the interview focused on resources in the life course such as the financial investment made in the respondent by the previous generation or by his caretakers, and at what age he established financial independence. It recorded the respondent's employment history with occupation, industry, and income data collected in a life-history format. The subsequent section gathered data on each of the respondent's full and half-siblings. This section was designed to provide data on each of the respondent's siblings, which was comparable to data regarding the respondent himself. This allowed us to extend our data set by one generation. The next section concerned reproductive relationships. It elicited data regarding the interviewee's sexual unions, marital relationships, and any relationship that produced a pregnancy. Data in this section was also collected to follow a life-history format for integration with employment, reproductive and parenting data. The following section covered parental investment, reproductive decision making, and parenting behavior. The initial portion was a history of all pregnancies and outcomes, which the respondent believed or suspected he fathered or someone claimed he fathered. The next part collected data regarding parenting of children, both biological and nonbiological. If the man did not live with the child until age 18, a special series of questions were asked as to why they were separated and what investment the man made in the child. Questions were also asked about financial investment in all children after the age of 18 that parallel the questions in the sibship portion of the interview. The last section of the interview focused on life-course strategies. We asked about reproductive or family composition preferences, reasons for not having more children, reasons for not reproducing at all, and financial strategies during the life course such as changes in being a borrower, saver, and spender, and current financial status. The interview concluded with a brief self-report questionnaire that allowed us to ask some personal questions, such as attitudes about women, relationships and commitment, engagement in behaviors used to get women to have sex with them, total numbers of sexual partners during stages of the life course, and risk-taking behaviors that affect morbidity and mortality.

RESULTS

Fertility

Figures 5.4a and 5.4b show the effects of year of birth, ethnicity, and income on the completed fertility of men. Parallel to national statistics on the fertility of women, the results show that Anglo men(non-Hispanic

Whites) men born prior to 1920 and after 1940 have lower completed fertility than men born between 1920 and 1939, who accomplished most of their reproduction during the Baby Boom years.[3] New Mexican Hispanics evidence higher fertility than Anglos in each cohort. However, there is no indication of a baby boom; instead there is a trend toward lower fertility through time, approaching Anglo norms. There is no net effect of current income on completed fertility among Anglos, and a slight negative effect among the earlier cohorts of Hispanics.

Although the lifetime data show no net effects of income on completed fertility, the relationship between fertility and income is, in fact, complex and bidirectional. Education is a major pathway to higher income, and education clearly depresses fertility at young ages. Table 5.1 summarizes the results of a set of logistic regression analyses, designed to determine the impacts of education on the probability of having a child during a year at risk, using data from the short interview sample. All years from age of 15 to 49 are in the risk set. One regression analysis was conducted for each age class and ethnicity. Income was controlled for in each analysis. The column labeled N is the sample size in risk years. The education parameter is the maximum likelihood estimator of the impact of an additional year of education on the log-odds of a birth occurring. The odds-ratio can be interpreted as approximating the relative risk due to a unit change in the independent variable when event probabilities are close to zero. The partial p is the standard probability that the education parameter is actually zero for the population as a whole, given the estimated value of the sample statistic.

The results show that for both Anglos and Hispanics, education has a very strong negative effect on reproduction during the late teens and even through the 20s. It gets gradually weaker with age, and in fact, is mildly positive among Anglos in the age classes of 35 to 39 and 45 to 49, suggesting differential scheduling of births. In these analyses, income at the time of the interview either has a small positive effect on fertility or no effect on fertility, after education is controlled for (results not shown—see analyses based on year-by-year income data from the following long interview).

The data presented in Fig. 5.5 clearly demonstrate, however, that for most men, there is a long delay between the completion of education and first reproduction, suggesting that the inhibitory effects of early reproduction on subsequent education are not great. Panels A and B of the figure show the hazard of first reproduction for Anglos and Hispanics, respec-

[3] Men born after 1945 are omitted from this analysis because many of them had not completed their fertility by the time of the interview. Results published previously (Kaplan et al., 1995) show that most men complete their reproduction by age 45, and including years past the age of 45 does not alter results appreciably.

TABLE 5.1
Effect of Each Additional Year of Education on Male Fertility by Age-Class and Ethnicity

	Anglo				*Hispanic*				*All*			
Age Class	N	*Education Parameter*	*Education Odds-Ratio*	*Partial* p	N	*Education Parameter*	*Education Odds-Ratio*	*Partial* p	N	*Education Parameter*	*Education Odds-Ratio*	*Partial* p
15–19	17378	−0.24	0.79	0.0001	12495	−0.17	0.85	0.0001	29873	−0.19	0.83	0.0001
20–24	17373	−0.15	0.86	0.0001	12495	−0.10	0.90	0.0001	29868	−0.12	0.89	0.0001
25–29	17347	−0.03	0.97	0.0003	12465	−0.06	0.94	0.0001	29812	−0.05	0.96	0.0001
30–34	15960	0.01	1.01	0.2228	10744	−0.02	0.98	0.0489	26704	−0.00	1.00	0.5120
35–39	13435	0.05	1.06	0.0001	8192	0.00	1.00	0.8054	21627	0.03	1.03	0.0014
40–44	10602	0.03	1.03	0.1902	5872	−0.03	0.98	0.2155	16474	−0.01	0.99	0.6947
45–49	8028	0.08	1.08	0.0289	4000	−0.00	1.00	0.9366	12028	0.03	1.03	0.2792

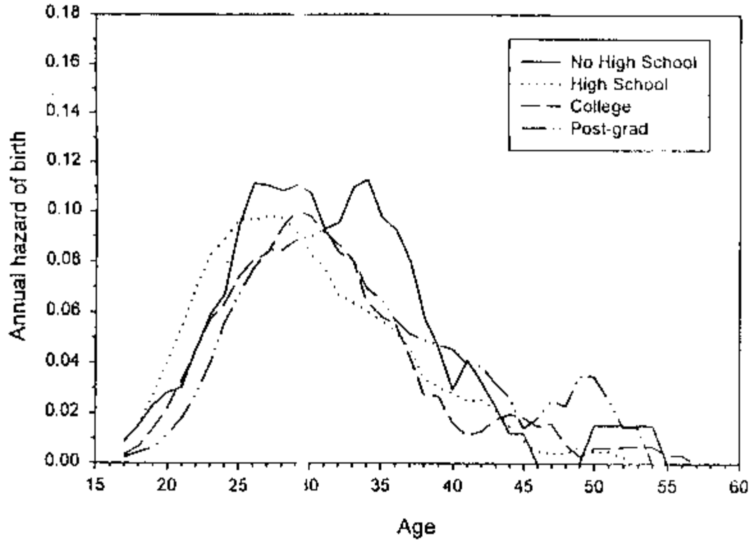

FIG. 5.5a. Hazards curves (5-year running average) for first birth of Anglo men by education level.

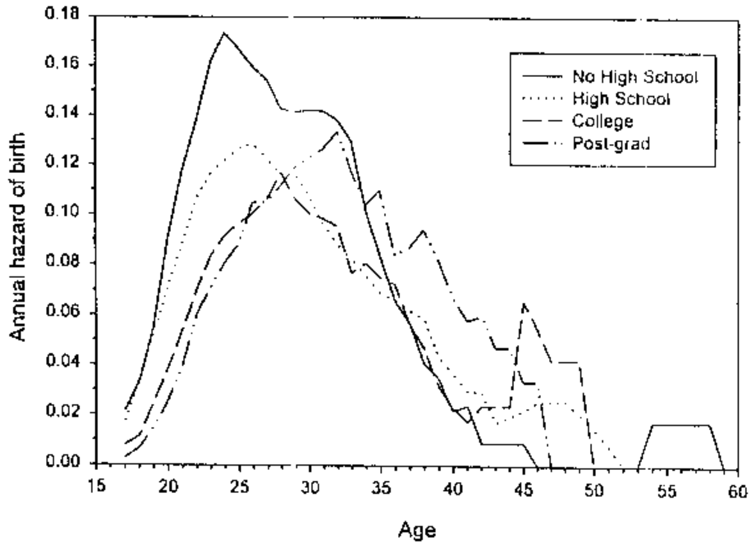

FIG. 5.5b. Hazards curves (5-year running average) for first birth of Hispanic men by education level.

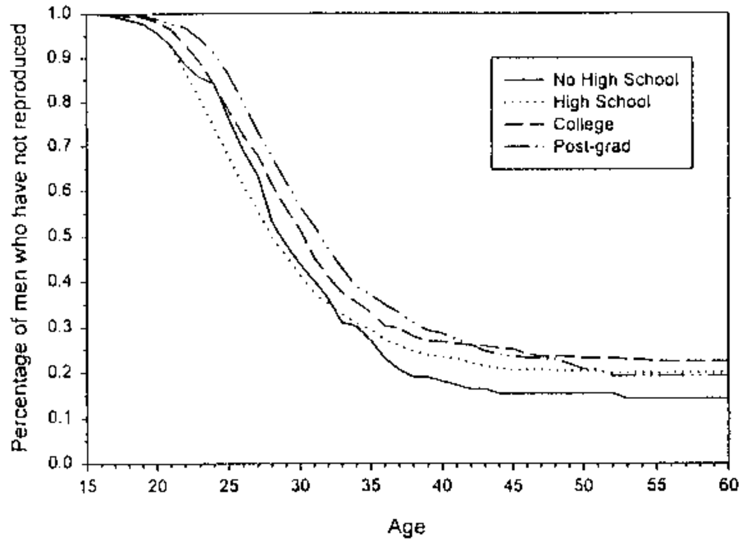

FIG. 5.5c. Survival curves for first birth of Anglo men.

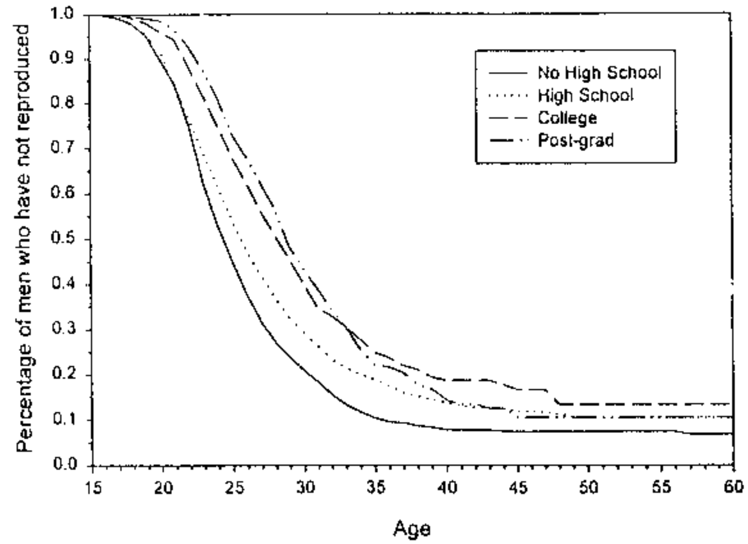

FIG. 5.5d. Survival curves for first birth of Hispanic men.

tively; panels C and D show the corresponding survival curves (the figures were generated using the life-table method with the Lifetest procedure in Statistical Analysis Software). The hazard of first reproduction is very low for all education levels prior to the age of 20. Even for those who did not complete high school, the peak hazard of first reproduction does not occur until about ages 25 and 22 for Anglos and Hispanics, respectively. In fact, for Anglos, the hazard of first birth is actually higher among those who completed high school than among dropouts during the late teens and early 20s. For college graduates and those with postgraduate degrees, the peak hazards of first birth do not occur until 29 and 31, respectively, among Anglos and 28 and 32, respectively, among Hispanics. The survival curves that correspond to these hazards distributions reflect these trends, and also show that almost twice as many Anglos fail to reproduce as do Hispanics.

The impact of education on reproduction has increased through time. Table 5.2 presents the result of logistic models in which the log-odds of a birth occurring in a year at risk prior to the age of 30 are regressed on education by decade of birth and ethnicity. For both Anglos and Hispanics, the negative effect of education increases dramatically for men born after 1940.

There are also period-parity interactions in fertility. Table 5.3 shows the results of logistic models in which the probability of a birth is regressed on period by parity. The baseline period is all years of risk prior to 1946 (i.e., prior to the Baby Boom period). The Boom period denotes the years between 1946 and 1962, and the post-Boom period denotes the years after 1962. For both Anglos and Hispanics, the probability of first reproduction (i.e., at parity zero) is about twice as high during the Boom period (see the odds-ratio column) and about 75% higher during the post Boom period than it is prior to the Baby Boom. This reflects the much later ages at first reproduction during the depression and war years (cf. Table 5.5). The progression from one child to two children also occurs more rapidly during the Boom period for both Anglos and Hispanics, but is not significantly different between the pre- and post-Boom periods. The higher parity progressions show a very different trend. There is no significant difference between the Boom and pre-Boom periods in the progressions from two or more children to the next higher parity; however, after the Baby Boom, men are less than half as likely to progress from two or more children to the next higher parity.

Table 5.4 examines the period-parity-education interactions. For Anglos, education has a strong negative effect on first reproduction for all periods. However, during the Baby Boom period, it increases the rate for all parity progressions after the first child. During the pre- and post-Boom periods, education has no significant effect on higher parity progressions. For His-

TABLE 5.2

Effect of Each Additional Year of Education on Fertility for Men Under 30, by Decade of Birth

	Anglo				*Hispanic*				*All*			
Decade of Birth	*N*	*Education Parameter*	*Education Odds-Ratio*	*Partial p*	*N*	*Education Parameter*	*Education Odds-Ratio*	*Partial p*	*N*	*Education Parameter*	*Education Odds-Ratio*	*Partial p*
< 1920	6585	−0.05	0.95	0.0148	1500	−0.02	0.98	0.5796	8085	−0.10	0.95	0.0033
1920–1929	5100	−0.02	0.98	0.1828	2310	−0.03	0.97	0.1782	7410	−0.03	0.97	0.0244
1930–1939	7350	−0.05	0.95	0.0001	4560	−0.05	0.95	0.0003	11910	−0.05	0.95	0.0106
1940–1949	14400	−0.11	0.90	0.0001	10275	−0.09	0.91	0.0001	24675	−0.10	0.91	0.0001
1950–1959	15960	−0.14	0.87	0.0001	14805	−0.10	0.91	0.0001	30765	−0.12	0.89	0.0001
1960+	2700	−0.15	0.86	0.0005	4005	−0.09	0.92	0.0001	6705	−0.10	0.90	0.0001

TABLE 5.3
Effect of Period on Male Fertility, by Previous Parity

	Anglo					Hispanic					All				
Parity	*N*	*Period*	*Period Parameter*	*Odds-Ratio*	*Partial p*	*N*	*Period*	*Period Parameter*	*Odds-Ratio*	*Partial p*	*N*	*Period*	*Period Parameter*	*Odds-Ratio*	*Partial p*
0	56652	Boom	0.73	2.08	0.0001	31662	Boom	0.95	2.60	0.0001	88314	Boom	0.75	2.12	0.0001
	56652	Post	0.56	1.76	0.0001	31662	Post	1.08	2.96	0.0001	88314	Post	0.71	2.04	0.0001
1	13565	Boom	0.43	1.54	0.0001	9476	Boom	0.47	1.60	0.0167	23014	Boom	0.44	1.55	0.0001
	13565	Post	−0.11	0.90	0.2861	9476	Post	0.00	1.00	0.9912	23014	Post	−0.08	0.93	0.3682
2	15995	Boom	0.10	1.11	0.5671	10809	Boom	−0.01	0.99	0.9696	26804	Boom	0.07	1.07	0.6263
	15995	Post	−0.67	0.51	0.0002	10809	Post	−1.00	0.37	0.0001	26804	Post	−0.79	0.45	0.0001
3	8277	Boom	0.06	1.07	0.8544	7248	Boom	−0.56	0.57	0.0820	15525	Boom	−0.24	0.79	0.2915
	8277	Post	−1.00	0.37	0.0034	7248	Post	−1.79	0.17	0.0001	15525	Post	−1.39	0.25	0.0001
4 or more	5634	Boom	−0.04	0.97	0.9597	7068	Boom	−0.00	1.00	0.9981	12702	Boom	−0.08	0.93	0.7916
	5634	Post	−0.85	0.43	0.2631	7068	Post	−1.15	0.32	0.0003	12702	Post	−1.11	0.33	0.0001

TABLE 5.4
Effect of Each Additional Year of Education on Male Fertility, by Previous Parity. Results Shown by Period of the 20th Century (i.e., Pre-Baby Boom, Baby Boom, Post-Baby Boom, and Overall) and by Ethnicity

	Anglo					Hispanic					All				
Parity	*N*	*Period*	*Education Parameter*	*Odds-Ratio*	*Partial p*	*N*	*Period*	*Education Parameter*	*Odds-Ratio*	*Partial p*	*N*	*Period*	*Education Parameter*	*Odds-Ratio*	*Partial p*
	8665	Pre	−0.05	0.95	0.0088	2207	Pre	−0.03	0.97	0.4341	10872	Pre	−0.05	0.95	0.0034
0	12412	Boom	−0.07	0.93	0.0001	6472	Boom	−0.08	0.93	0.0001	18884	Boom	−0.07	0.93	0.0001
	35575	Post	−0.07	0.93	0.0001	22983	Post	−0.07	0.94	0.0001	58558	Post	−0.07	0.93	0.0001
	56652	All	−0.06	0.94	0.0001	3[illegible]	All	−0.07	0.93	0.0001	88314	All	−0.07	0.94	0.0001
	993	Pre	0.02	1.02	0.4946	203	Pre	0.04	1.04	0.3713	1196	Pre	0.02	1.03	0.3245
1	3099	Boom	0.08	1.08	0.0001	1185	Boom	0.04	1.04	0.0516	4284	Boom	0.07	1.07	0.0001
	9473	Post	0.01	1.01	0.3637	8088	Post	−0.03	0.97	0.0070	17561	Post	−0.01	0.99	0.2218
	13565	All	0.04	1.04	0.0001	9476	All	−0.01	0.99	0.2431	23014	All	0.02	1.02	0.0119
	419	Pre	0.00	1.00	0.9535	119	Pre	−0.03	0.97	0.6810	538	Pre	−0.02	0.98	0.6720
2	3621	Boom	0.04	1.04	0.0350	978	Boom	0.02	1.02	0.4925	4599	Boom	0.02	1.02	0.1183
	11955	Post	−0.03	0.98	0.1276	9712	Post	−0.06	0.94	0.0001	21667	Post	−0.05	0.95	0.0001
	15995	All	0.00	1.00	0.8628	10809	All	-0.04	0.96	0.0005	26804	All	−0.03	0.98	0.0032
	112	Pre	0.03	1.03	0.7826	54	Pre	0.20	1.22	0.0643	166	Pre	0.09	1.09	0.2012
3	1698	Boom	0.06	1.06	0.0281	707	Boom	0.03	1.03	0.2475	2405	Boom	0.05	1.05	0.0143
	6467	Post	0.01	1.01	0.6864	6487	Post	−0.03	0.97	0.0837	12954	Post	−0.02	0.98	0.1862
	8277	All	0.03	1.03	0.0640	7248	All	−0.01	0.99	0.6325	15525	All	0.01	1.01	0.5976
	23	Pre	—	—	—	64	Pre	0.02	1.02	0.8022	87	Pre	0.01	1.01	0.8711
4 or	998	Boom	0.11	1.12	0.0029	872	Boom	−0.04	0.96	0.1359	1870	Boom	0.02	1.02	0.4667
more	4613	Post	−0.02	0.98	0.4076	6132	Post	−0.07	0.93	0.0003	10745	Post	−0.06	0.94	0.0001
	5634	All	0.02	1.02	0.3066	7068	All	−0.06	0.94	0.0002	12702	All	−0.04	0.97	0.0044

TABLE 5.5
Median Age at First Reproduction by
Birth Cohort, Ethnicity, and Education

	Cohort	*No High School*		*High School*		*College*		*Post-Graduate*	
		Age	*N*	*Age*	*N*	*Age*	*N*	*Age*	*N*
	< 1920	30	54	30	264	31	115	33	80
	1920–1929	29	24	27	148	29	114	27	89
Anglo	1930–1939	26	21	25	221	26	137	27	139
	1940–1949	30	13	26	374	28	303	31	323
	1950–1959	28	21	30	531	33	306	34	265
	< 1920	27	56	28	39	34	8	29	113
	1920–1929	25	62	26	90	27	22	27	9
Hispanic	1930–1939	24	80	25	181	26	44	26	32
	1940–1949	23	97	24	473	26	102	27	75
	1950–1959	24	127	25	738	30	137	31	66

panics, there is no effect of education during the pre-Boom period. During the Boom period, there is a negative effect on first reproduction, a small positive effect on the progression from one to two children and no effect on higher progressions. During the post-Boom period, education has a negative effect on all parity progressions.

Table 5.5 examines the ethnicity-education-cohort interactions for first birth in greater detail. It shows the median age at first birth for men by decade of their birth, educational attainment and ethnicity. For Anglos, two effects are readily apparent. First, median age of first reproduction is high for the oldest men, decreases steadily to a minimum age for the men born between 1930 and 1939, and then increases steadily for men born later in the century. The effect of education changes through time. There is a small positive effect for men prior to 1920, no effect for men born between 1920 and 1939, and a very large positive effect on age at first reproduction for the 1950 to 1959 cohort. For the 1940to 1949 cohort, there is a positive effect for men who have at least completed high school, but high-school dropouts have a high median age at first reproduction. For Hispanics, there is little effect until the 1940 to 1949 cohort. The positive effect of education on age at first reproduction is also greatest for men born in the 1950 to 1959 cohort.

Table 5.6 examines marital and cohabiting fertility with the smaller, but more detailed, long interview sample. It displays the results of a logistic model of the predictors of the probability of a first birth. With respect to ethnicity, it shows that overall Anglos are only 93% as likely to reproduce in a given year as are Hispanics. The period effects on marital/cohabiting

TABLE 5.6
Logistic Regression Model for the Probability of Birth for Married and Cohabiting Couples*

Variable	*DF*	*Parameter Estimate*	*Standard Error*	*Wald* χ^2	*Partial* p	*Standardized Parameter Estimate*	*Odds-Ratio*
Intercept	1	–4.65	0.81	33.24	0.0001	—	0.01
Anglo	1	–0.08	0.02	12.70	0.0004	–0.07	0.93
During Boom	1	0.49	0.17	7.68	0.0056	0.10	1.62
Post-Boom	1	–0.59	0.17	12.48	0.0004	–0.13	0.55
Parity of 1	1	1.08	0.09	130.41	0.0001	0.24	2.94
Parity of 2	1	0.23	0.12	3.75	0.0528	0.05	1.25
Parity of 3	1	0.20	0.17	1.49	0.2224	0.04	1.22
Parity of 4	1	0.95	0.19	25.57	0.0001	0.14	2.59
Presence of youngest child age 1–2	1	–5.45	0.71	58.64	0.0001	–0.87	0.00
Presence of youngest child age 2–3	1	–4.51	0.59	59.97	0.0001	–0.63	0.01
Her education (years)	1	–0.05	0.02	11.44	0.0007	–0.08	0.95
His education (years)	1	0.01	0.01	0.40	0.5277	0.02	1.01
Number of her kids from previous relationships	1	–0.17	0.08	4.94	0.0262	–0.08	0.84
Number of his kids from previous relationships	1	–0.07	0.08	0.93	0.3343	–0.03	0.93
Income (in thousands of 1990 dollars)	1	0.00	0.00	7.15	0.0075	0.06	1.00
Her age	1	0.43	0.06	54.25	0.0001	1.87	1.54
Her age (squared)	1	–0.01	0.00	96.63	0.0001	–2.93	0.99

*N = 10,210 χ^2 = 1661.1, $p < 0.0001$.

fertility reveal the different causal processes at work in determining total fertility for the different periods. The pre-Boom period is the baseline. The probability of a birth is about 62% higher during the Boom period, and only half as high during the post-Boom period relative to the pre-Boom baseline. Although for Anglos, total fertility rates are almost the same for cohorts reproducing prior to the Baby Boom as for those reproducing after the Baby Boom (Fig. 4.4a), marital fertility is much higher prior to the Baby Boom. This shows that the low completed fertility prior to the Baby Boom is due primarily to delay in marriage, whereas the low completed fertility after the Baby Boom is due to decreased marital fertility. To examine the parity effects, a parity of zero is used as the baseline. Because all years from the age of 15 to 49 define the risk set, the lowest probability of reproduction occurs before the first birth. After the first birth, men are more than 3 times as likely to have a second child in a given year. The progressions to higher parities, although higher than the probability of first birth, are much lower than the progression probability from first to second birth. Birth spacing effects are evident as well. The baseline is no child under the age of 3. Not surprisingly, if there is a child of 1 year or less of age, the probability of the next birth is only 5% as likely. If the child is between 1 and 2 years of age, a birth is 10% as likely. The data also show that the characteristics of a man's mate are highly determinate of fertility rates. The effects of a man's education on fertility appear to operate solely through his mate's education (the Pearson correlation between the two is .6). When both a man and his mate's education are in the regression model, the woman's education has a strong negative effect on fertility (the odds-ratio is .95 for each additional year of education), but the man's education is not significant. In addition, if his mate has children from a previous marriage, they are also less likely to reproduce (see below). If a man has children from a previous relationship, on the other hand, there is no significant decrease in the likelihood of having a child. Because the long interview sample contains data on income earned during each year of a man's life, we can also assess the impact of income on fertility. A man's income in a given year is positively associated with the probability of having a child. This reduces the negative effect of education on fertility.

Investment

Parental investment in children is multidimensional and difficult to measure. Men can spend time with their children, take an active interest in their development, spend money on them directly, and attempt to influence their well-being through the choice of a partner, residential location, and school system. To begin the analysis, we examine physical co-presence,

and the likelihood of ceasing to live with a child before he or she reaches given ages. We then proceed to time investments and monetary expenditures.

Table 5.7 presents the results of a logistic model in which the log-odds of divorce/relationship dissolution for each year of the relationship are regressed on a vector of predictor variables using the long interview sample of Hispanic and Anglo men. Ethnicity has no apparent effect on relationship dissolution. As found in other samples, there is a distinctive time trend in divorce. Years at risk after 1980 are the baseline for the analysis. During the 1940s and 1950s, the hazard of dissolution was much lower. The hazard increases significantly in the 1960s, but it is still lower than in the years after 1980. The 1970s are not statistically different from the period after 1980. The log-odds of divorce decreases linearly with time in the relationship (a second-order polynomial term is not significant—not shown in the table). Marriages are much less likely to end than are cohabiting relationships (note the odds-ratio of 0.16). As found in other studies, the woman's age at the beginning of the relationship is a strong predictor of dissolution, with the likelihood of dissolution decreasing with age. The conditional probability of dissolution increases with each successive relationship (i.e., with each prior dissolution).

The effect of children's presence depends on their biological relationship to the men. Children who are the genetic offspring of men inhibit dissolution. The log-odds of dissolution increase almost linearly with each additional biological child (the linearity of this effect can be seen when number of children is treated as a vector of indicator or dummy variables—not shown here). The presence of a child under the age of 4 also has an additional negative effect on the likelihood of dissolution. The presence of a child from a previous union of the woman (i.e., her child, but not his) increases the likelihood of divorce, whereas if the man has children from a previous relationship, there is no discernible effect.

As in the case of fertility, the effect of education on dissolution operates through the woman. Although in an uncontrolled analysis, male education is negatively associated with the likelihood of dissolution, it has no effect once the negative effect of the woman's education is controlled for. Male income has no effect on dissolution, but the proportion of total family income contributed by the man is positively associated with the likelihood of divorce.

Figure 5.6 examines separation from children per se. Using the data from the short interview sample, Fig. 5.6a shows the changing likelihood of ceasing to live with a child under the age of 6 as a function of the child's year of birth and the man's education. A very small percentage of children (about 5%) born before 1960 cease to live with their father before the age of 6, regardless of parental education. However, as separation

TABLE 5.7
Logistic Regression Model of the Annual Probability of Divorce/Relationship Dissolution for Married and Cohabiting Couples.*

Variable	*DF*	*Parameter Estimate*	*Standard Error*	*Wald* χ^2	*Partial* p	*Standardized Parameter Estimate*	*Odds-Ratio*
Intercept	1	1.62	0.44	13.77	0.0002	—	5.04
Anglos	1	0.02	0.03	0.51	0.4775	0.02	1.02
During 1940s	1	−1.13	0.40	7.84	0.0051	−0.13	0.32
During 1950s	1	−1.42	0.37	14.48	0.0001	−0.22	0.24
During 1960s	1	−0.51	0.19	7.08	0.0078	−0.10	0.60
During 1970s	1	−0.04	0.12	0.08	0.7755	−0.01	0.97
Duration of the relationship so far	1	−0.03	0.01	13.18	0.0003	−0.19	0.97
Married	1	−1.81	0.13	187.50	0.0001	−0.24	0.16
Her age when the relationship began	1	−0.08	0.01	47.37	0.0001	−0.27	0.93
His number of previous relationships	1	0.21	0.06	10.93	0.0009	0.08	1.23
Number of children they have together	1	−0.23	0.06	13.55	0.0002	−0.21	0.79
Presence of youngest child under age 4	1	−0.83	0.17	23.16	0.0001	−0.20	0.44
Number of her kids from previous relationships	1	0.14	0.06	5.20	0.0226	0.07	1.15
Number of his kids from previous relationships	1	−0.08	0.07	1.15	0.2846	−0.03	0.92
Her education (years)	1	−0.09	0.02	17.87	0.0001	−0.14	0.92
Income (in thousands of 1990 dollars)	1	−0.00	0.00	0.56	0.4553	−0.03	1.00
Percentage of family income he provides	1	0.49	0.22	5.11	0.0238	0.07	1.63

*N = 12,191, χ^2 = 654.4, p < 0.0001.

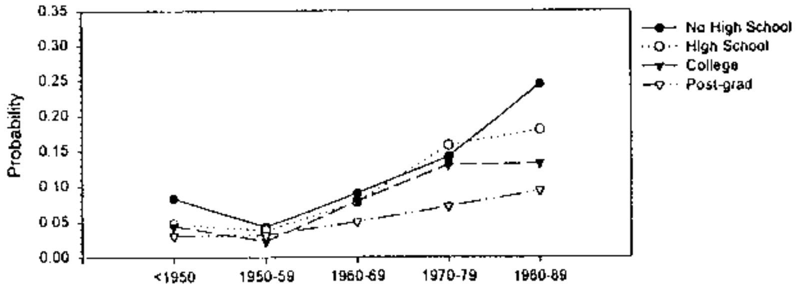

FIG. 5.6a. Effects of father's education on the probability of ceasing to live with a child before the age of 6.

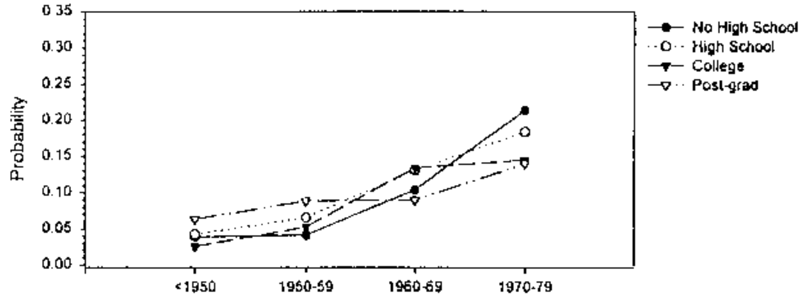

FIG. 5.6b. Effects of father's education on the probability of ceasing to live with a child between the ages of 6 and 15.

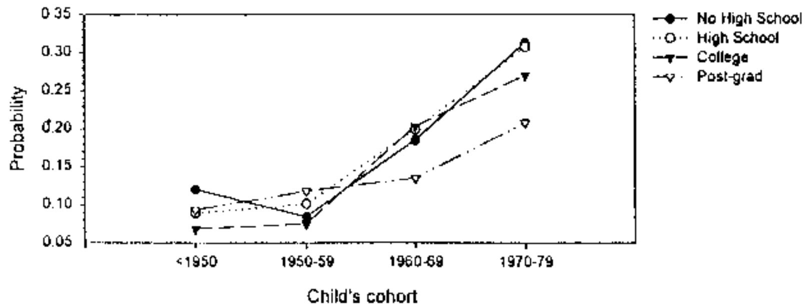

FIG. 5.6c. Effects of father's education on the probability of ceasing to live with a child before the age of 15.

becomes increasingly likely through time, the effects of education become readily apparent. For the cohort born in the 1980s, the probability of separating from the father before the age of 6 increases to about 25% for children whose father has less than a high school diploma, 18% for those whose father has only a high school diploma, 12% for children of men with a Bachelor's degree, and only 8% for children of men with a post-graduate degrees (this graphical presentation is supported by regression analyses, not shown). A similar, but less dramatic, pattern of effects can be seen for the probabilities of ceasing to live with the father between the ages of 6 and 15 (Fig. 5.6b) and for all children prior to age 15 (Fig. 5.6c).

Table 5.8 presents the analysis of men's time investments in children during their elementary school years. The dependent variable is an index of time involvement, dèrived from summing time spent alone with the child between the ages of 5 and 12 (in 5 levels, for ranges of average number of hours per week) and involvement in the child's education (low = 1, mid = 3, and high = 5). Hispanic men report higher time involvement with children than Anglos. Neither sex nor income appear to have any effect, although there is a nonsignificant trend toward slightly more involvement with both. Men report much lower time involvement with children who are not their biological offspring. Similarly, the number of siblings within 2 years of the focal child is negatively associated with time involvement. Men's time involvement has increased through time, as the child's year of birth is positively associated with it. Both the respondent's education and assessment of the child's scholastic intelligence are positively related to time involvement. Only 11.5% of the variance in the dependent variable, however, is accounted for by the independent variables in the model.

Analyses of monetary expenditures on children during the year prior to the interview are reported in Tables 5.9a and 5.9b. They cover all monetary expenditures on children (the sum of expenditures on the child including food and housing, education, clothing, lessons and hobbies, pocket money, medical expenses, room and board [if away], and gifts). A tobit model was run to account for the truncation in the distribution associated with reports of zero expenditures, especially for children between 18 and 23 years of age. It is possible that some children actually contributed to their parents, and that some men would have taken money from children they parented if they could. In any case, the results of the tobit analyses were very similar to the Ordinary Least Squares (OLS) regressions, which we omit for the sake of brevity.

For children under the age of 18 (Table 5.9a), total expenditures do not vary by sex. The respondent's year of birth and ethnicity affect expenditures, indicating a trend toward increased expenditure with age and lower expenditures by Anglos, respectively. Expenditures increase with age

TABLE 5.8
Least Squares Regression Model of Men's Time Investment in Elementary School-Aged Children*

Variable	*DF*	*Parameter Estimate*	*Standard Error*	*T*	*Partial p*
Intercept	1	−30.55	9.97	−3.06	0.0022
Anglo	1	−0.70	0.14	−4.96	0.0001
Child's sex	1	−0.18	0.12	−1.55	0.1219
Income when child was 5	1	0.00	0.00	−0.60	0.5469
Unrelated child	1	−0.58	0.16	−3.69	0.0002
Number of siblings 2 years older or younger	1	−0.39	0.09	−4.60	0.0001
Child's year of birth	1	0.02	0.01	3.63	0.0003
His education (years)	1	0.07	0.02	3.53	0.0004
His assessment of child's intelligence	1	0.46	0.07	6.33	0.0001

*$N = 1173$, $F = 18.91$, $p < 0.0001$, $R^2 = 0.115$.

of the child. Not surprisingly, both the respondent's and his mate's income (measured in thousands of dollars) are strong positive predictors of expenditures. However, years of education of both the respondent and his mate have independent positive effects. The parameter estimate for number of children in the family is negative, but the standard error of the estimate is so high that it is not significantly different from zero. The effects of genetic relatedness and cohabitation with the child's mother are interesting. Children are divided into four groups. Children who are the

TABLE 5.9a
Tobit Maximum Likelihood Regression Model of Men's Monetary Expenditures on Offspring Ages 0 Through 17*

Variable	*Parameter Estimate*	*Standard Error*	*Z*	*Partial p*
Intercept	9925.60	2286.60	4.34	0.0000
Offspring's sex	−210.27	226.34	−0.93	0.3529
Man's year of Birth	−48.50	21.15	−2.29	0.0219
Anglo	−574.95	254.69	−2.26	0.0240
Offspring's year of birth	−107.10	26.76	−4.00	0.0001
Man's income (in thousands of dollars)	8.33	2.31	3.60	0.0003
Wife's income (in thousands of dollars)	14.69	6.42	2.29	0.0222
Man's education (years)	114.11	52.90	2.16	0.0310
Mother's education (years)	157.43	60.90	2.59	0.0097
Total number of offspring	−89.21	90.40	−0.99	0.3237
Unrelated child living with him	−478.34	468.73	−1.02	0.3075
Genetic offspring not living with him	−1008.90	272.27	−3.71	0.0002
Unrelated child not living with him	−1910.40	471.17	−4.06	0.0001

*$N = 500$, log likelihood = −4308.07, $p < 0.0001$.

TABLE 5.9b
Tobit Maximum Likelihood Regression Model of Men's Monetary Expenditures on Offspring Ages 18 Through 23*

Variable	*Parameter Estimate*	*Standard Error*	*Z*	*Partial p*
Intercept	−1917.80	11089.00	−0.17	0.8627
Sex	−405.67	543.58	−0.75	0.4555
Offspring's year of birth	39.52	160.31	0.25	0.8053
Anglo	−766.65	662.40	−1.16	0.2471
Total number of siblings	−169.96	209.05	−0.81	0.4162
Man's year of birth	−95.81	46.56	−2.06	0.0396
Man's income (in thousands of dollars)	54.79	8.58	6.39	0.0000
Wife's income (in thousands of dollars)	12.22	13.27	0.92	0.3572
Man's education (years)	39.61	118.05	0.34	0.7372
Mother's education (years)	394.34	122.93	3.21	0.0013
Unrelated child, man living with the mother	−2686.10	912.54	−2.94	0.0033
Genetic offspring, man not living with the mother	−2362.50	699.11	−3.38	0.0007
Unrelated child, man not living with the mother	−4600.80	920.10	−5.00	0.0000

*$N = 195$, log likelihood = −162[illegible].76, $p < 0.0001$.

genetic offspring of the respondent and who are still living with the respondent are the baseline. They receive the most monetary investment. The next highest level of investment is given to nongenetic offspring (i.e., usually the mate's child) who are living with the respondent (in fact, those children do not differ significantly from genetic offspring). Genetic offspring who are not living with the respondent receive less investment, approximately $1,000 less. Children who are not the genetic offspring of the respondent and who no longer live with respondent receive the very least investment, $1,900 less.

Expenditures during the college years (ages 18 to 23; Table 5.9b) do not vary by the child's sex, age, ethnicity or number of siblings. Father's gross income is the strongest predictor of expenditures, whereas mother's income is nonsignificant. Mother's years of education has a strong positive effect (again, father's education has a positive effect when mother's education is omitted from the model, suggesting that father's education may operate through mother's education). In this case, genetic relatedness and the respondent's relationship to the child's mother both have large effects. Children who are the genetic offspring of the respondent and whose mother is still living with the respondent are the baseline; they receive the most monetary investment.[4] The next highest level of investment is given to genetic offspring whose mothers are separated from the respondent

[4]Because many children over the age of 18 reside away from their parents and we are particularly interested in the effects of marital dissolution on children, we use the respondent's coresidence with the child's mother as the baseline.

and to unrelated children whose mothers are living with the respondent; they receive $2,000 less investment. The very least investment is given to children who are not the genetic offspring of the respondent and whose mothers no longer live with the respondent, a decrease of $4,600.

Finally, Table 5.10 examines financial support for higher education by the respondent. The cause and effect relationship between educational attainment and support for education is difficult to disentangle. If a child decides not to attend college, it is not possible to provide support for college; however, it is also possible that a lack of support is the cause of nonattendance. For this reason, we restrict our analysis to only those children of the respondent who attended college, about 50% of whom received some support. A logistic regression analysis was conducted. Hispanics are less likely to provide support. Number of siblings is negatively associated with support, and the effect is strong. The respondent's income is also associated with the probability of support, although his mate's is not. The education of both mother and father are significant with small effect sizes, as is the father's prior time involvement with the child (i.e., when he or she was in elementary school—see previous definition). Again, we find strong effects of biological paternity and the respondent's relationship to the child's mother. Support is reduced when the father does not live with the child's mother and is not the child's biological parent. Children who are not the respondent's biological offspring and whose mother is no longer living with him do not receive support from him.

Outcomes

In a previous paper (Kaplan et al., 1995), we reported that both the respondent's education and income were negatively associated with number of siblings, positively associated with father's income and number years prior to the respondent's 18th birthday that he lived with his father. Those analyses were based on the short interview data set. Here, we examine outcomes for the respondents' children using the long interview data set. An OLS regression analysis of the child's years of education is presented in Table 5.11. Only individuals older than 22 years of age are included in the analysis. The child's sex, year of birth, and number of siblings apparently have no effect, once the other predictors are controlled for (even though in uncontrolled analyses, individuals with more siblings have lower educational attainment). Anglos have about .6 years more education on average. The respondent's income when the child was 18 is positively associated with educational attainment, although his mate's income is not. Both the respondent's and the child's mother's years of education are positively associated with the child's education, although mother's effect is greater. The respondent's time involvement has an additional positive

TABLE 5.10
Logistic Regression Model of the Probability of a Man Providing Financial Support for an Offspring's Higher Education*

Variable	*Parameter Estimate*	*Standard Error*	Z	*Partial* p	*Odds-Ratio*
Intercept	−5.09	1.45	−3.50	0.0005	0.01
Offspring's year of birth	0.05	0.03	1.87	0.0615	1.05
Man's year of birth	−0.03	0.02	−1.36	0.1739	0.97
Sex	0.18	0.25	0.73	0.4648	1.20
Anglo	0.62	0.33	1.86	0.0628	1.85
Total number of siblings when offspring was 18	−0.33	0.07	−4.39	0.0000	0.72
Man's income (in thousands of 1990 dollars) when offspring was 18	0.01	0.00	2.88	0.0039	1.01
Wife's income (in thousands of 1990 dollars) when offspring was 18	−0.01	0.01	−1.39	0.1638	0.99
Man's education (years)	0.10	0.05	2.03	0.0426	1.10
Mother's education	0.11	0.06	1.80	0.0714	1.11
Man's time involvement with offspring when offspring was young	0.15	0.07	2.13	0.0333	1.16
Unrelated offspring, man lived with the mother when child was 18	−0.99	0.50	−1.97	0.0492	0.37
Genetic offspring, man not living with the mother when child was 18	−1.35	0.40	−3.36	0.0008	0.26
Unrelated offspring, man not living with the mother when child was 18	−3.34	0.94	−3.56	0.0004	0.04

*$N = 387$, $\chi^2 = 84.2$, $p < 0.0001$.

TABLE 5.11
Least Square Regression Model of the Number of Years of Education Obtained by Respondents' Children Age 23 and Older*

Variable	*Parameter Estimate*	*Standard Error*	Z	*Partial* p
Constant	11.46	1.06	10.86	0.0000
Sex	0.01	0.19	0.04	0.9721
Offspring's year of birth	−0.01	0.02	−0.28	0.7765
Man's year of birth	−0.02	0.02	−1.27	0.2041
Total number of siblings when offspring was 18	−0.05	0.05	−0.99	0.3214
Anglo	0.64	0.26	2.50	0.0126
Man's income (in thousands of 1990 dollars) when offspring was 18	0.01	0.00	2.62	0.0087
Wife's income (in thousands of 1990 dollars) when offspring was 18	0.00	0.01	−0.26	0.7958
Man's education (years)	0.07	0.03	2.12	0.0338
Mother's education (years)	0.21	0.04	5.42	0.0000
Man's time involvement with offspring when offspring was young	0.11	0.05	2.05	0.0403
Unrelated offspring, man lived with the mother when child was 18	−0.74	0.36	−2.07	0.0383
Genetic offspring, man not living with the mother when child was 18	−1.28	0.30	−4.33	0.0000
Unrelated offspring, man not living with the mother when child was 18	−2.65	0.59	−4.52	0.0000

*$N = 559$, $F = 16.30$, $p < 0.0001$, adjusted $R^2 = 0.263$.

effect (a separate analysis, not discussed here, indicates that this effect of time involvement operates through the child's school years, during elementary and secondary school). Children who are not biologically related to the respondent but whose mothers were living with him when they were 18 years of age achieve about .7 years less education than biological offspring whose mothers were living with him when they were 18 years of age. Biological offspring whose mothers ceased to live with the respondent before the child turned 18 achieve about 1.3 years less education, whereas children who are not biological offspring and whose mothers ceased to live with the respondent before the child turned 18 achieved 2.6 years less education.

DISCUSSION OF THE RESULTS

The data on male fertility indicate that both the onset of reproduction and parity progressions have changed through the course of the century. Age at first reproduction is high for men born early in the century, decreases for men born during 1920 to 1939, and then increases for men born after 1940. The effect of investment in human capital, as measured by years of education, on fertility is greatest before the age of 30. This reflects its greater impact on the onset of fertility than on parity progressions after the first child. However, the impact of investment in own human capital on the onset of fertility appears to have changed through time. For men born during the early part of the century, years of education have little effect on age at first reproduction. The delaying effect of education on fertility has increased through time.

One interpretation of these results is that the Great Depression of the 1930s and World Wars I and II delayed fertility for all men. During the postwar Baby Boom, low-cost loans for affordable housing and the GI bill allowed men to reproduce at earlier ages, even though investment in education was increasing. Following the Baby Boom, the onset of fertility is again delayed for everybody, but especially for men investing more in human capital. This may reflect increasing costs of education, as well as increasing importance of education in the determination of wages (Burck, 1976; Herrnstein & Murray, 1994; Newcomer, 1955; Vinovskis, 1994).

The onset of reproduction is probably determined by many factors. In addition to investment in human capital, men must obtain a partner and acquire the resources necessary for reproduction. This is probably why there is a significant delay (as much as 10 years, on average) between completion of schooling and first reproduction. Examination of fertility onset among men without high school education suggests that those other factors were more important during the early part of this century. Perhaps the earlier onset of reproduction among less-educated men in recent cohorts is due to the fact that acquiring the resources for reproduction is less of a constraint now that there are social welfare supports for poor families. It is also possible that now more educated men are also engaging in more postgraduate, on-the-job training. In both national samples (U.S. Bureau of the Census, 1985) and the Albuquerque sample, men with higher education exhibit greater increases in wages with increasing employment experience than do men with fewer years of education. This may also account for an increasing delay in the onset of fertility with education.

There has also been major historical change in the higher parity progressions. For Anglos, the hazard of progressing from one parity to the next is greater at all parities during the Baby Boom than either prior to or after the Boom. There appear to be different causal processes underlying the low completed fertility prior to, and after the Baby Boom. The principal cause of low fertility prior to the Boom is the low hazard of progression from zero children to the first child. Following the Boom, the low fertility is due to the low hazard of progressing from two to more children. Perhaps, this change reflects an increasing trend toward investing in the human capital of children and increasing costs of educating them. Men today are much more likely to stop reproducing at the second or third child. Focus groups' discussions with men in Albuquerque suggest that men are consciously deciding to stop reproducing at low parities so that they can invest more time in their children and provide them with funding for education.

The analysis of the long interview data on marital fertility suggests that once a union is established, it is the man's partner's level of education, rather than his education, that significantly lowers marital fertility. One way men may opt into a parental investment strategy is through the selection of a partner. Men who choose educated women may be selecting a low-fertility, high-investment strategy. It is also interesting that after controlling for partner's education, male income positively affects fertility. This result runs counter to conventional wisdom.

The predictions of the competitive labor market model just discussed were supported by the analysis of the data on investment in children and on child outcomes. Consistent with the idea that human capital of parents is positively associated with rates of return to investment in offspring human capital, men's education is associated with higher levels of investment in children, including time involvement, monetary investments, and the probability of living with the child throughout the period of parental investment. Also, as predicted by the model, men's time involvement with children is positively associated with their assessment of the child's scholastic intelligence, although the direction of causality may be unclear. A third prediction of the model is that investments in children be positively correlated over the child's life course. This prediction is supported by the fact that financial support for college is positively correlated with the man's earlier time involvement with the child during elementary school years.

The impact of fertility on parental investment appears to be greater for time involvement than for monetary investments. The number of siblings within 2 years of the focal child is negatively correlated with time involvement, but we find no effects on expenditures. The effect of income is just the opposite. There is no effect of income on time involvement, but it is by far the strongest predictor of monetary expenditures.

The data on outcomes suggest that those investments do increase the educational achievement of children. It is interesting to note that even after the effects of investments are taken into account, there is still a residual effect of both mother's and father's education on children's educational achievement. This result is consistent with the idea that the rate of return to investments in human capital of offspring increases with the level of parental human capital. However, it is also possible that the effect is due to genetically mediated parent–offspring correlations in academic ability or motivation. Another possibility is that more educated parents instill more positive attitudes toward education and greater expectations of educational achievement in their children.

Taken together, these results provide substantial indirect support for the embodied capital approach to fertility and parental investment, and for the specific model of investment in embodied capital in skills-based labor markets. However, the support is based largely on qualitative predictions, each of which is potentially consistent with some other theoretical model. An adequate assessment of the model will require more rigorous tests of quantitative predictions.

Two major difficulties must be overcome. First, the model's theoretical constructs are very difficult to measure. Years of education is only a proxy for embodied capital. Measuring the embodied capital of both parents and children is especially challenging, given that it is multidimensional and heterogeneous. Similarly, parental investment is only poorly approximated by our recall-based measures of expenditures of time and money. The effect sizes we obtained are probably smaller than the true effect sizes as a result of measurement error. In order to determine the quantitative relationship between parental embodied capital and the rate of return on investments in children's embodied capital, a prospective study that overcomes those measurement problems will be necessary.

Second, selection bias produces another difficulty. Educational achievement, fertility, parental investment, and mate selection are endogenous choices. This means that men are not randomly assigned to educational achievement levels, parities, and so on. As a result, it is difficult to assess the impacts of those characteristics on child outcomes. For example, the association between parental education and the child's education could be due partially to unobserved characteristics that affected the parents choices about how many years of education to pursue as well as to the effect of education, per se. Because the theory presented here implies an intricate causal pathway relates endogenous choices to one another and ultimately, to child outcomes, the problem of selection bias must be solved so that an accurate quantitative assessment of those relationships can be obtained.

As a final point, there is clear evidence that biological paternity is relevant to male parental investment. Men invest less in children from previous unions of their mate. Although expenditures on young children are not affected by biological paternity, both time investment and support during the college years is greater for genetic offspring than for a mate's child. In addition, the investment in a mate's child is contingent on a continuing relationship with that partner. Men cease to invest in a child after they stop living with the child's mother, unless the child is also the biological offspring of the man, and even then support is reduced significantly (see Weiss & Willis, 1985, for a theoretical treatment of this effect). The effect of those reduced investments is also seen in child outcomes, with children who are raised by men other than their biological father or who are not fully raised by their father achieving lower educational outcomes (even after parental income and education are controlled for).

SUMMARY

The fundamental features of the human life course, clearly exhibited by all extant hunter-gatherers and in contrast to other nonhuman primates and mammals, are prolonged postweaning juvenile dependence on parents, the simultaneous support and provisioning of multiple, dependent young of different ages, marriage, and the involvement of men in the care and provisioning of children, and a long life span with older, nonreproductive individuals supporting their offspring's reproduction (Kaplan, 1996a; Lancaster & Lancaster, 1987). In other words, the critical human life-history adaptations are all features that focus on the investment in offspring by parents over much of the life course, particularly after infancy, and not simply on greater numbers of children produced.

Selection must have acted on the coordinated outcome of mechanisms that both regulate parental investment and fertility. Investment may be regulated by psychological mechanisms that direct attention to fundamental relationships between investments and outcomes, and that detect diminishing returns to investment. Actual decisions will be the product of those mechanisms and some reliance on cultural norms that benefit from accumulated experience. The regulation of fertility, on the other hand, may involve little or no direct cognition, and be wholly regulated by physiological mechanisms responsive to breastfeeding regimes and net energy flow. This makes sense in the context of the theoretical model insofar as fertility is the passive result of optimal parental investment and an income budget for reproduction. If, after allocating investments to existing children, there is enough time and energy to support the next offspring, it should be produced.

This complex set of mechanisms that regulated parental investment and fertility in time past, one that appreciates relationships between investments and outcomes and diminishing returns to effort, is now expressed in the context of modern economies and is associated with major reductions in fertility and increases in parental investment. We proposed that two characteristics of modern economies might be sufficient to account for a period of sustained fertility reduction and to a corresponding lack of income variation in fertility. The first characteristic is the direct link between costs of investment and wage rates due to the forces of supply and demand for labor in competitive economies. The second is the increasing emphasis on cumulative knowledge, skills, and technologies in the production of resources. These two characteristics may together produce the historically novel conditions that (a) investments in offspring income have nondecreasing (i.e., constant or increasing) returns to scale at the population level; and (b) embodied capital of parents is positively associated with returns to investment in embodied capital of children with diminishing returns at the individual level set by the within-population distribution of costs of skill embodiment.

The apparently non-adaptive nature of modern fertility decisions (as measured by the number of descendants produced) rests on the evolved rule of thumb that fixed number of children not in terms of birth-spacing, but by the optimal allocation of parental investment. In the past, investment in growth and skill acquisition reached diminishing returns at a much lower level of investment. In the evolutionarily novel conditions of today, people in developed countries with skills-based, competitive labor markets make decisions to minimize their fertility to two or three children using the same psychological mechanisms that, in the past, produced much larger families. Now, people employ birth control and subvert the lactation-energy system that for millions of years used to translate parental investment into fertility.

We presented tests of a model of human fertility and the timing of reproduction in the life course using interviews with men living in Albuquerque, New Mexico, about their reproductive careers. The model assumes that men's decisions regarding fertility and investment in children are directly related to investments they received from their parents and to their investments in own education-related human capital. Specifically, it predicts that men who have higher levels of human capital will invest more in their children's human capital and exhibit lower fertility as a result. This prediction is derived from considering two principal trade-offs in modern societies with skills-based labor markets. The first trade-off is between investments in own human capital and the onset of reproduction. The second trade-off is between investments in children's human capital and total fertility. Alternative life histories result from a positive correlation between men's stock of human capital and rates of return from investments in own and in children's human capital. Male reproductive strategies, directed either toward more less-educated children or towards fewer more-educated children, impact on family formation strategies in terms of the timing of reproduction in the life course, number of mates, total fertility, likelihood of desertion, and the production of second families.

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REFERENCES

Barkow, J. (1989). *Darwin, sex, and status.* Toronto: Toronto University Press.
Becker, G. S. (1975). *Human capital* (2nd ed.). New York: Columbia University Press.

Becker, G. S. (1991). *A treatise on the family* (2nd ed.). Cambridge, MA: Harvard University Press.

Becker, G. S., & Barro, R. J. (1988). A reformulation of the economic theory of fertility. *Quarterly Journal of Economics, 103,* 1–25.

Becker, G. S., & Lewis, H. G. (1973). Interaction between quantity and quality of children. In T. W. Schultz (Ed.), *Economics of the family: Marriage, children, and human capital* (pp. 81–90). Chicago: University of Chicago Press.

Becker, G. S., Murphy, K. M., & Tamura, R. (1990). Human capital, fertility and economic growth. *Journal of Political Economy, 98,* s12–s37.

Becker, G. S., & Tomes, N. (1976). Child endowments and the quantity and quality of children. *Journal of Political Economy, 84,* s143–s163.

Becker, G. S., & Tomes, N. (1986). Human capital and the rise and fall of families. *Journal of Labor Economics, 4,* s1–s39.

Ben-Porath, Y. (1967). The production of human capital and the life cycle of earnings. *Journal of Political Economy, 75,* 352–365.

Betzig, L. L. (1986). *Despotism and differential reproduction: A Darwinian view of history.* Hawthorne, NY: Aldine.

Blake, J. (1989). *Family size and achievement.* Los Angeles, CA: University of California Press.

Blurton Jones, N. G. (1986). Bushman birth spacing: A test for optimal interbirth intervals. *Ethology and Sociobiology, 7,* 91–105.

Blurton Jones, N. G. (1987). Bushman birth spacing: A direct test of simple predictions. *Ethology and Sociobiology, 8,* 183–203.

Blurton Jones, N. G., Hawkes, K., & Draper, P. (1994a). Foraging returns of !Kung adults and children: Why didn't !Kung children forage? *Journal of Anthropological Research, 50*(3), 217–248.

Blurton Jones, N. G., Hawkes, K., & Draper, P. (1994b). Differences between Hadza and !Kung children's work: Affluence or practical reason? In E. S. Burch, Jr., & L. J. Ellanna (Eds.), *Key issues in hunter-gatherer research* (pp. 189–215). Oxford, England: Berg Publishers.

Blurton Jones, N. G., Hawkes, K., & O'Connell, J. F. (1989). Modeling and measuring the costs of children in two foraging societies. In V. Standen & R. Foley (Eds.), *Comparative socioecology: The behavioral ecology of humans and other mammals* (pp. 367–390). Oxford: Blackwell.

Blurton Jones, N. G., & Sibly, R. M. (1978). Testing adaptiveness of culturally determined behavior. Do bushman women maximize their reproductive success by spacing births widely and foraging seldom? In N. G. Blurton Jones & V. Reynolds (Eds.), *Human behavior and adaptation* (pp. 135–157). London: Taylor & Francis.

Bock, J. (1995). *The determinants of variation in children's activities in a southern African community.* Unpublished PhD dissertation, University of New Mexico.

Boone, J. (1986). Parental investment and elite family structure in preindustrial states: A case study of late medieval–early modern Portuguese genealogies. *American Anthropologist, 88,* 859–878.

Borgerhoff Mulder, M. (1987). On cultural and reproductive success: Kipsigis evidence. *American Anthropologist, 89,* 617–634.

Borgerhoff Mulder, M. (1988). Reproductive consequences of sex-biased inheritance for the Kipsigis. In V. Standen & R. Foley (Eds.), *Comparative socioecology of mammals and man* (pp. 405–427). London: Blackwell.

Borgerhoff Mulder, M. (1992). Reproductive decisions. In E. A. Smith & B. Winterhalder (Eds.), *Evolutionary ecology and human behavior* (pp. 339–374). Hawthorne, NY: Aldine de Gruyter.

Burck, C. G. (1976, May). A group profile of the Fortune 500 chief executives. *Fortune,* 173–177.

Chagnon, N. (1988). Life histories, blood revenge, and warfare in a tribal population. *Science, 239,* 985–992.

Charlesworth, B. (1980). *Evolution in age structured populations.* Cambridge: Cambridge University Press.

Charnov, E. L. (1993). *Life history invariants: Some explorations of symmetry in evolutionary ecology.* New York: Oxford University Press.

Cromer, A. (1993). *Uncommon sense: The heretical nature of science.* New York: Oxford.

Cronk, L. (1991a). Human behavioral ecology. *Annual Reviews in Anthropology, 20,* 25–53.

Cronk, L. (1991b). Wealth, status and reproductive success among the Mukogodo. *American Anthropologist, 93,* 345–360.

Denison, E. F. (1985). *Trends in American growth, 1929–1982.* Washington: Brookings Institute.

de Tray, D. N. (1973). Child quality and the demand for children. *Journal of Political Economy, 81,* S70–S95.

Downey, D. B. (1995). When bigger is not better: Family size, parental resources, and children's educational performance. *American Sociological Review, 60,* 746–761.

Draper, P., & Harpending, H. (1987). Parental investment and the child's environment. In J. Lancaster, J. Altmann, A. Rossi, & L. Sherrod (Eds.), *Parenting across the lifespan: Biosocial dimensions* (pp. 207–235). New York: Aldine de Gruyter.

Flinn, M. (1986). Correlates of reproductive success in a Caribbean village. *Ethology and Sociobiology, 9,* 1–29.

Hanson, L. A. (1982). The mammary gland as an immunological organ. *Immunology Today, 3,* 168–172.

Harpending, H. C., Draper, P., & Pennington, R. (1990). Cultural evolution, parental care, and mortality. In A. Swedlund & G. Armelegos (Eds.), *Health and disease in traditional societies* (pp. 241–255). South Hadley, MA: Bergin and Garvey.

Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experience of young American children.* Baltimore: Brookes.

Hawkes, K., O'Connell, J. F., & Blurton Jones, N. (1995). Hadza children's foraging: Juvenile dependency, social arrangements and mobility among hunter-gatherers. *Current Anthropology, 6*(4), 688–700.

Herrnstein, R. J., & Murray, C. (1994). *The bell curve: Intelligence and class structure in American life.* New York: Free Press.

Hill, K. (1993). Life history theory and evolutionary anthropology. *Evolutionary Anthropology, 2,* 78–88.

Hill, K., & Hurtado, A. M. (1996). *Ache life history: The ecology and demography of a foraging people.* Hawthorne, NY: Aldine de Gruyter Press.

Hoff-Ginsberg, E., & Tardif, T. (1995). Socioeconomic status and parenting. In M. Bornstein (Ed.), *The handbook of parenting* (Vol. 2, pp. 161–188). Hillsdale, NJ: Lawrence Erlbaum Associates.

Howie, P. W., Forsyth, J. S. Ogston, S. A., Clark, A., & du Florey, C. V. (1990). Protective effect of breast feeding against infection. *British Medical Journal, 300,* 11–16.

Hughes, A. (1986). Reproductive success and occupational class in eighteenth-century Lancashire, England. *Social Biology, 33,* 109–115.

Irons, W. (1979). Cultural and biological success. In N. Chagnon and W. Irons, (Eds.), *Evolutionary biology and human social behavior* (pp. 257–272). North Scituate, MA: Duxbury.

Irons, W. (1983). Human female reproductive strategies. In S. K. Wasser (Ed.), *Social behavior of female vertebrates* (pp. 169–213). New York: Academic Press.

Irons, W. (1990). Let's make our perspectives broader rather than narrower: A comment on Turke's "Which humans behave adaptively, and why does it matter?" and on the so-called DA-DP Debate. *Ethology and Sociobiology, 11,* 361–375.

Irons, W. (1993). Monogamy, contraception, and the cultural and reproductive success hypothesis. *Behavior and Brain Sciences, 16,* 295–296.

Irons, W. (1995). *Cultural and reproductive success in traditional societies.* Unpublished manuscript, Northwestern University.

Kaplan, H. (1996a). *The evolution of the human life course.* Unpublished manuscript, University of New Mexico.

Kaplan, H. (1996b). The competitive labor market theory of the demographic transition and the evolutionary economics of human fertility and parental investment. Unpublished manuscript, University of New Mexico.

Kaplan, H., & Hill, K. (1985). Hunting ability and reproductive success among male Ache foragers. *Current Anthropology, 26,* 131–133.

Kaplan, H., Lancaster, J. B., Bock, J., & Johnson, S. (1995). Does observed fertility maximize fitness among New Mexican men? A test of an optimality model and a new theory of parental investment in the embodied capital of offspring. *Human Nature, 6,* 325–360.

Kozlowski, J. (1992). Optimal allocation to growth and reproduction: Implications for age and size at maturity. *Trends Ecology and Evolution, 7,* 15–19.

Kozlowski, J., & Wiegert, R. G. (1986). Optimal allocation of energy to growth and reproduction. *Theoretical Population Biology, 29,* 16–37.

Kozlowski, J., & Wiegert, R. G. (1987). Optimal age and size at maturity in annuals and perennials with determinate growth. *Evolutionary Ecology, 1,* 231–244.

Lack, D. (1954). *The natural regulation of animal numbers.* Oxford: Oxford University Press.

Lack, D. (1968). *Ecological adaptations for breeding in birds.* London: Methuen & Co.

Lam, D. (1986). The dynamics of population growth, differential fertility, and inequality. *American Economic Review, 76,* 1103–1116.

Lancaster, J. B., & Kaplan, H. (1992). Human mating and family formation strategies: The effects of variability among males in quality and the allocation of male effort and parental investment. In A. Ehara, T. Kimura, O. Takenaka, & M. Iwamoto (Eds.), *Primatology today* (pp. 21–33). Amsterdam: Elsevier.

Lancaster, J. B., & Lancaster, C. S. (1987). The watershed: Change in parental-investment and family-formation strategies in the course of human evolution. In J. B. Lancaster, J. Altmann, A. S. Rossi, & L. R. Sherrod (Eds.), *Parenting across the life span: Biosocial dimensions* (pp. 187–205). Hawthorne, NY: de Gruyter.

Lee, P. C., Majluf, P., & Gordon, I. J. (1991). Growth, weaning and maternal investment from a comparative perspective. *Journal of Zoology, London, 225,* 99–114.

Lessells, C. M. (1991). The evolution of life histories. In J. R. Krebs & N. B. Davies (Eds.), *Behavioral ecology: An evolutionary approach* (3rd ed., pp. 32–68). Oxford: Blackwell Scientific.

Lesthaeghe, R., & Wilson, C. (1986). Modes of production, secularization, and the pace of fertility decline in western Europe, 1870–1930. In A. J. Coale & S. C. Watkins (Eds.), *The decline of fertility in Europe* (pp. 261–292). Princeton, NJ: Princeton University Press.

Lindert, P. H. (1986). Unequal English wealth since 1670. *Journal of Political Economy, 94,* 1127–1162.

Lloyd, D. G. (1987). Selection of offspring size at independence and other size-versus-number strategies. *American Naturalist, 129,* 800–817.

Low, B. (1990). Occupational status, landownership, and reproductive behavior in 19th-century Sweden: Tuna Parish. *American Anthropologist, 92,* 457–468.

McGinley, M. A., & Charnov, E. L. (1988). Multiple resources and the optimal balance between size and number of offspring. *Evolutionary Ecology, 2,* 77–84.

Mealey, L. (1985). The relationship between social status and biological success: A case study of the Mormon religious hierarchy. *Ethology and Sociobiology, 11,* 83–95.

Mincer, J. (1974). *Schooling, experience and earnings.* Chicago: National Bureau of Economic Research.

Newcomer, M. (1955). *The big business executive: The factors that made him. 1900–1950.* New York: Columbia University Press.

Oftedal, O. T. (184). Milk composition, milk yield and energy output at peak lactation: A comparative review. *Symposium Zoological Society of London, 5,* 33–85.

Pennington, R., & Harpending, H. (1988). Fitness and fertility among the Kalahari !Kung. *American Journal of Physical Anthropology, 77,* 303–319.

Perusse, D. (1993). Cultural and reproductive success in industrial societies: Testing the relationship at the proximate and ultimate levels (with comments). *Brain and Behavioral Sciences, 16,* 267–323.

Retherford, R. D. (1993). *Demographic transition and the evolution of intelligence: Theory and evidence.* Unpublished manuscript, Program on Population, East-West Center, Honolulu, Hawaii.

Roff, D. A. (1992). *The evolution of life histories: Theory and analysis.* New York: Chapman Hall.

Rogers, A. R. (1993). Why menopause? *Evolutionary Ecology, 7,* 406–420.

Rogers, A. R. (1994). Evolution of time preference by natural selection. *American Economic Review, 84,* 460–481.

Rogers, A. R., & Blurton Jones, N. G. (1992). *Allocation of parental care.* Unpublished manuscript, University of Utah, Salt Lake City.

Sheard, N. F., & Walker, W. A. (1988). The role of breast milk in the development of the gastrointestinal tract. *Nutrition Reviews, 46,* 1–8.

Simons, J. L. (1974). *The effects of income on fertility.* Chapel Hill, NC: Carolina Populations Center.

Smith, C. C., & Fretwell, S. D. (1974). The optimal balance between size and number of offspring. *American Naturalist, 108,* 499–506.

Stearns, S. C. (1992). *The evolution of life histories.* New York: Oxford University Press.

Stearns, S. C., & Koella, J. (1986). The evolution of phenotypic plasticity in life history traits: Predictions for norms of reaction for age- and size-at-maturity. *Evolution, 40,* 893–913.

Turke, P., & Betzig, L. (1985). Those who can do: Wealth, status and reproductive success on Ifaluk. *Ethology and Sociobiology, 6,* 79–87.

U.S. Bureau of the Census. (1985). *Current population reports, P-60,* No. 156, Table 35.

U.S. Department of Commerce. (1992). *U.S. census of population: General population characteristics: New Mexico.* Washington, DC: Bureau of Census.

U.S. Department of Transportation, Federal Highway Administration. (1993). *Highway statistics 1987.* TD2.22.991. Washington, DC: U.S. Government Printing Office.

Varian, H. R. (1992). *Microeconomic analysis* (3rd ed.). New York: Norton.

Vining, D. R., Jr. (1986). Social versus reproductive success: The central theoretical problem of human sociobiology. *The Behavioral and Brain Sciences, 9,* 167–216.

Vinovskis, M. A. (1994). Education and the economic transformation of nineteenth-century America. In M. W. Riley, R. L. Kahn, & A. Foner (Eds.), *Age and structural lag: Society's failure to provide meaningful opportunities in work, family, and leisure* (pp. 171–196). New York: Wiley.

Vitzthum, V. (1994). Comparative study of breastfeeding structure and its relation to human reproductive ecology. *Yearbook of Physical Anthropology, 37,* 307–349.

Voland, E. (1990). Differential reproductive success with the Krummerhorn population (Germany, 18th and 19th centuries). *Behavioral Ecology and Sociobiology, 26,* 65–72.

Weiss, Y., & Willis, R. (1985). Children as collective goods and divorce settlements. *Journal of Labor Economics, 3,* 268–292.

Whitehead, R. G., & Paul, A. (1981). Infant growth and human milk requirements: A first approach. *Lancet, 2,* 161–163.

Willis, R. J. (1973). A new approach to the economic theory of fertility behavior. *Journal of Political Economy, 81,* S14–S64.