A Benefit Cost Analysis

of the

Abecedarian Early Childhood Intervention

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Introduction

A commonly proposed approach to improving the educational success of children in poverty is the provision of early childhood education programs. These interventions, most notably Head Start, typically begin at age three or four and operate on a school calendar. Such programs seem able to boost cognitive scores and school success, though some evidence suggests that at least some of the effects fade out as children proceed in school (Barnett 1998). A less common approach is the provision of full-day, year round, child care and preschool services starting soon after birth. These programs can be considered more preventative in the sense that services begin before any marked educational deficit can occur.

The Carolina Abecedarian Study is an experiment in the provision of intensive pre-school services to children in low-income families from infancy to five years of age. The program began in 1972, and research on program effects found that experimental group children experienced durable gains in IQ, and achievement in mathematics and reading (Campbell and Ramey 1995). Comparison of the findings for the Abecedarian preschool project to other interventions suggests that effects may be more persistent if a program is preventative, intensive, and starts very early in life (Ramey and Ramey 1998).

The increment to academic achievement and cognitive development experienced by the Abecedarian children has been fairly well documented. A question that remains, however, is whether or not expenditures on programs based on the Abecedarian preschool model represent sound social investments. Simply put, are the benefits worth the costs when viewed in the light of the many alternative uses of scarce public and private funds? This paper presents the findings of a benefit-cost analysis of the Abecedarian preschool program. The primary data sources are follow-up surveys and official school records through age 21.

Methods

Subjects

The program followed an experimental design and originally involved 112 children, mostly of African American descent, who were born between 1972 and 1977 and whose family situations were believed to put the children at risk of retarded intellectual and social development. A "High-Risk Index" was used to determine risk for retarded cognitive development. The index was constructed based on factors such as household income, parental education, school histories of family members, welfare payments, parental intelligence, and parental occupations (Ramey and Campbell 1984). Selected background characteristics at program entry were: maternal education of approximately 10 years, maternal IQ of 85, 25 percent of households with both parents, and 55 percent of households on Aid to Families with Dependent Children - AFDC (Ramey and Campbell 1984; Campbell et al. 1998). Between 6 and 12 weeks of age children were randomly assigned to either a preschool program or a

control group. By 1978, 104 participants remained in the study and the follow-up at age 21 involved all 104 of these participants.

Treatment

The preschool program was center-based with teacher/child ratios that ranged from 1:3 for infants/toddlers to 1:6 for older children. The center was operated from 7:30 a.m. to 5:30 p.m., five days per week, and fifty weeks out of the year, with free transportation available. The curriculum is called "Partners in Learning" and is discussed in Ramey and Ramey (1998). The curriculum emphasized language development, but addressed the needs of children in all developmental domains. Children at the center also received medical and nutritional services. In order to avoid the confounding effects of these factors on intellectual development, the same medical and nutritional services were provided to the children in the preschool control group.

Outcome Measures

The educational results of the program are summarized in Table 8.1. Early assessments indicated substantial gains in intellectual development. Children in the preschool group consistently outscored children in the control group on standard measures of intelligence (Ramey and Campbell 1984). At age 8 participants were assessed and it was found that children in the preschool group had IQ scores that were significantly higher than the scores of the control group. Further, at 8 years of age children who had received the preschool intervention also scored significantly higher on a set of achievement tests in mathematics and reading (Campbell and Ramey 1995).

An additional assessment was conducted at age 12 and the results were similar to those discussed above, indicating durable gains in intelligence and achievement (Campbell and Ramey 1994). An assessment at age 15 indicated that the effect on IQ tended to "fade" but that the effects on reading and mathematics scores remained positive and significant (Campbell and Ramey 1995). The most recent assessment at age 21 indicated similar effects with respect to measures of intelligence and achievement. Importantly, the age 21 data demonstrated that the experimental group children were much more likely to have attended a four year college than the control group children (P=36%, C=13%, p=.01)[1]. In general, the results from all the assessments supported the claim that the preschool intervention was effective in improving measures of intelligence and achievement over the long term.

Comparisons of the two groups revealed benefits of the program beyond those discussed above. Campbell and Ramey (1995) reported that preschool participants experienced lower levels of grade retention and placements in special education classes. Clearly, these cost-savings to school districts and families represent real economic benefits of the Abecedarian program. Following the example set by the Perry Preschool Program, researchers examined the relationship between program participation and the incidence of youth crime to an average age of 21 and found no statistically significant differences between the groups (Clarke and Campbell 1998). The differences in the nature of community life experienced by the Perry families and the Abecedarian families could account for the differing results. Although further examination of the relationship between preschool participation and crime is possible, it does not appear likely that

[1] All tests of significance are two-tailed.

crime reduction and cost-savings to victims will represent significant benefits in the Abecedarian case.

Researchers also investigated the impact of preschool availability on the lives of the subsample of teenage mothers (under 18 years of age) who participated in the study (Campbell et al. 1986). When children were approximately 54 months of age, it was found that teenage mothers of preschool children were more likely to have graduated high school, to have received post-secondary training, to be self-supporting, and less likely to have borne subsequent children. It was also reported that mothers with children in the preschool group were generally more likely to be employed and to obtain jobs with a classification of "skilled or semi-skilled" (Ramey et al. 1983). To the extent that additional training, job experience, and education was realized in increased earnings and/or decreased future reliance on social assistance, the above effects on mothers represent a direct and quantifiable benefit of the program.

Economic Measures and Analysis

This study presents a benefit-cost analysis of the Carolina Abecedarian Preschool Program. As informed by economic theory, our perspective is that education is both a consumption good that confers immediate benefits and an investment good that confers personal and social benefits well into the future (Becker 1964; Haveman and Wolfe 1984). Benefit-cost analysis involves estimating the monetary values of streams of cost and benefits in order to measure the program's net value as a social investment.

The benefit-cost analysis of the Abecedarian Project will follow the standard procedures set forth by Thompson (1980) and Levin and McEwan (2001), and followed by Barnett in the

analysis of the Perry Preschool Program (Barnett 1996). The two core parts of a benefit-cost analysis are a detailed estimation of program costs and the identification and estimation of program benefits or effects. In this case, records provided by the program sponsor (Frank Porter Graham Child Development Center - FPG) are the primary data sources used for estimation of program costs and effects.

In this benefit-cost analysis, program costs are estimated for three different resource "settings" in which the program might be offered. Program benefits are generated for 6 categories for which it was possible to obtain monetary estimates: 1) earnings and fringe benefits of participants, 2) earnings and fringe benefits of future generations, 3) maternal employment and earnings, 3) elementary and secondary education cost-savings, 4) improved health, 5) higher education costs, and 6) welfare use. The effects of the program on crime and delinquency appear to be negligible given earlier research in this area (Clarke and Campbell 1998).

As the analysis involves streams of cost and benefits over time, estimated benefits and costs are converted into constant dollars (deflated) and discounted to the present using appropriate rates of discount. The rate of discount reflects the opportunity cost of public resources. A range of discount rates from zero to seven percent is employed in this analysis. The analysis estimates the present value of benefits minus costs for each alternative rate of discount. Additionally, estimates of the internal rate of return, the rate at which the project benefits are equal to its costs, can be generated.

Results

Table 8.2 presents estimates of the present value of program costs and benefits at various rates of discount. Some of the benefits and costs accrue to the program participants and some to the general public. The distribution of benefits and costs is important to the political viability of an instrument of public policy. A relevant question is whether or not society realizes returns in excess of public funds and resources that are dedicated to the program. As we will point out below, the Abecedarian program does "pay for itself" at healthy rates of discount when all benefits and costs are included in the analysis. However, Masse (2002) estimates that taxpayers benefits alone (excluding benefits to participants) fall short of program costs at a discount rate of 3 percent.[2] This may be considered a relatively low price for an effective targeted intervention that is consistent with social or governmental goals concerning access to education, learning, and economic opportunity.

Program Cost

Resources employed for a representative sample of program years were identified by the Frank Porter Graham Development Center (FPG). The resources, or program ingredients, were broadly classified according to function (Levin and McEwan 2001). Categories included labor resources (paid staff and volunteer workers), and non-labor resources (equipment, supplies, facilities, etc.). The cost of reproducing the Abecedarian program according to its resource requirements is clearly relevant for policy purposes. Resources are therefore valued at the prices typically paid by two institutions that might provide such programs on a large scale:

[2] Unless otherwise stated, all values are in 2002 dollars.

public schools and child care centers. This is in addition to estimating cost based on the actual prices paid by FPG during the program's operation.

Total Costs

Table 8.3 presents the yearly costs of providing the Abecedarian treatment by program year in the three different cost settings. Average enrollment in the nursery was about 12 infants and the staff/child ratio was 1:3. Average age at entry was 4.4 months. In program years 2 and 3 the average unit of instruction/care was 7 children for both age groups and the staff/child ratio was 1:3.5. In program years 4 and 5 the average unit of instruction/care was 12 children for both age groups and the staff/child ratio was 1:6.

The undiscounted total resource costs for the FPG and public school settings are clearly greater than the costs for the child care setting. A few comments are in order. First, it is not surprising that the cost of executing the program in the FPG and public school settings are similar. FPG paid workers what they considered to be competitive public school salaries. The difference in the two estimates is due, in part, to the lower cost of living and level of salaries in North Carolina relative to the national average. Second, the relatively low cost of executing the program in a child care setting is presented mostly as a benchmark. It is unlikely that the input quality necessary to execute a high-quality program could be maintained at the prices and wages paid in this setting. The extent to which cost savings, represented by a movement along the resource continuum from the public preschool setting to the child care setting, can be discovered while preserving benefits is important even if the program is found to lead to substantial net benefits in the highest cost setting. Although movement away from a successful setting involves

risk of lost benefits, this would have to weighed against the probable cost-savings. A full treatment of this issue is beyond the scope of the current work and is suggestive of an area for future research.

Cost of Care - Control Children

The cost of the program, properly considered, is the additional cost of the Abecedarian treatment over the cost of child care arrangements experienced by the control group. Both sets of experiences involve a stream of costs and a stream of benefits. The measurement of benefits is necessarily marginal (i.e. the difference between groups consists of benefits beyond the benefits received by the control group) and the appropriate comparison is with the marginal cost of the Abecedarian treatment.

Data on the child care experiences of the control children are somewhat limited. Data were collected on the use of center-based child-care by age. The percentage rates of participation are 18, 29, 67, 78 and 73 for the first five years of life. Compared to national and regional data, these rates seem high, especially for years 3 to 5. Possibly, families that volunteered for the study were exceptionally predisposed to use center- based care. There is indication, however, that the community in which the experiment took place was one that was unusually supportive of the care and education of young children (Burchinal, Lee and Ramey 1989). To the extent that higher quality center-based care was available to the control group, this analysis may underestimate net marginal benefits if the Abecedarian program were provided nationally.

Meaningful cost estimates for the child care received by the control children require estimates of participation rates and hours of care by type of care. Since the analysis seeks to inform current public policy, the estimation procedure considers the nature of care as it currently exists. Using data from the National Household Education Survey of 1995, estimates of the number of hours a child was in center-based care, relative care, and non-relative care for each of the five program years or age groups are obtained. One of the advantages of using the NHES data is that it permits the estimation of the use of relative and non-relative care arrangements for the control group children. These data are not available from FPG but are clearly important to the calculations of the cost of care for non-treatment children.

The cost estimate for the care of the control children is based on the actual participation rates of the control group children in center-based child care. In addition, the NHES data is used to obtain estimates of participation rates and hours of care in non-center-based care arrangements. The weekly cost of care for each program year is calculated by multiplying the average number of hours of care by a weighted average (based on participation rates) of the cost of care. Yearly costs are generated for the non-parental care arrangements of the control group children. These estimates are used to calculate the marginal cost of the program.

Parental Care

The benefit cost analysis seeks to weigh the marginal benefits that accrue due to program participation against the marginal costs that are incurred. The marginal cost of the program is the difference between the cost of the intervention and the cost of the care experienced by the control group children. The program provided an average of 40 hours of care per week. The

control group children also experienced care for the same 40 hours but a portion of the care was parental. Since it is the difference in the quality and composition of the care during these 40 hours that leads to program benefits, then it is consistent to obtain a cost for the full 40 hours of care experienced by the control group children. In order to accomplish this it is necessary to obtain estimates for the parental component of care and to combine these with the estimates for non-parental care.

In order to estimate the cost of parental care a price needs to be assigned to an hour of parental-provided care. Information is available on the prices paid to individuals for the care of young children. The prices of non-relative and relative care are estimated at $2.12 and $1.34, respectively (Hofferth et al. 1991). The price of relative care may be conservatively low, and not reflect market prices, for a number of reasons. Individuals may provide care at a subsidized rate for children of relatives either because of reciprocity agreements between family members (exchange of services) or merely due to a sense of family responsibility. A relative may also receive a lower than market wage to reflect the fact that he/she may receive a benefit from participating in the care of a child to which there is some attachment. For these reasons, an hour of parental provided care is valued at the price for non-relative care.

Marginal Costs

The cost of care for the control group children is subtracted from the cost of care for the program group children to estimate a yearly net cost for the program at each age or program year. The average marginal yearly costs for the program are $7565 at FPG, $8849 in a public preschool setting and $2818 in a child care setting. Table 8.4 presents the present value of the

marginal costs under various rates of discount. As detailed above, the cost of implementing the Abecedarian program in a public preschool is far more expensive than implementation in a child care setting. Both options are presented as suitable endpoints for the analysis. Benefit-cost analysis is an important component of a full program evaluation but it cannot provide answers to all relevant policy questions. Measures that are cost-saving and quality-preserving are clearly relevant as policy makers consider movement away from the public preschool model and to the child care model. The benefit cost analysis, at the minimum, should provide information on the magnitude of the required movement.

Comparative Costs

The average annual total cost of the Abecedarian Program is approximately $13,900. By comparison, the annual amounts for Head Start and the Perry Preschool Program are approximately $7000 and $9200, respectively (Barnett 1996; USDHHS 2000). The Abecedarian treatment is clearly more intensive than the other two and this is reflected in its higher costs. This analysis is partially aimed at determining whether or not the higher costs of the Abecedarian Program are associated with sufficient benefits to justify the intervention on purely economic grounds.

At the federal level, the United States in 2001 spent approximately 16 billion dollars on the early care and education of young children (Barnett and Masse in press). State and local governments spent an additional 9 billion dollars and direct expenditures by families (not accounting for parental-provided care) is estimated at 30 billion dollars (Barnett and Masse in press). What would be the effect on funding levels of providing the Abecedarian program to all

poor children? How much additional funds would have to be allocated by government to early care and education?

According to the United States Census Bureau (2002), there are approximately 19 million children less than 5 years of age in the United States. Assuming that 20% of these children are poor, then the target population for the Abecedarian program totals 3.8 million children. The total annual cost of providing the Abecedarian program to poor children in the United States is therefore approximately 53 billion dollars. This is greater than two times the level of current federal and state expenditures for early childhood education and about equal to the level of total current expenditures (including federal, state and household expenditures).

The costs of the program may seem prohibitively high for replication on a large scale. Governments and policy makers may experience "sticker shock" at first but must bear in mind that costs alone offer little guidance. The costs of a program must be compared against the benefits that the program generates. Benefit-cost ratios that are greater than one for acceptable rates of discount indicate that a program is worthy of consideration regardless of the absolute level of program costs.

Participant Earnings

Earnings are forecasted on the basis of educational attainment based on the standard method first presented in Miller and Hornseth (1967). Using cross-sectional data from the Bureau of the Census, earnings estimates are obtained by age, race, and gender for various categories of educational attainment (United States Bureau of the Census 1998). Each category corresponds to an estimated stream of lifetime income. An individual's estimated lifetime

income depends on educational attainment at age 21 and the probability of higher educational attainment later in life.

FPG provided data on the educational levels of the Abecedarian control and program group participants at age 21. The schooling levels of the participant fell into 8 categories (less than 9 years, 9 to 11 years, GED enrollee, GED graduate, high school graduate with no college credits, some college but no degree, enrolled in an AA program, and enrolled in a BA program). In order to estimate future earnings it was assumed that educational status at age 21 did not necessarily represent an individual's final educational status. It was therefore necessary to calculate the expected value of an individual's future stream of income. In order to accomplish this, it was necessary to assign probabilities to each level of future educational attainment (9 census categories) for each level of current educational status (8 study categories). The conditional probabilities were based on the results of United States Department of Education longitudinal studies that follow the educational advances of specific age cohorts (Adelman 1999; Boesal et al. 1998; McCormick et al. 1999) and cross sectional data on high school dropout and graduation rates (USDOE 1998). For each level of current education, the expected value of future income is the sum of the products of the probability of obtaining each level of higher education and the present value of the income stream associated with each educational level.

The procedure for estimating lifetime earnings therefore involved several steps. First, earnings for ages 22-65 were estimated using cross-sectional data for the nine levels of future educational attainment. Second, these earnings were multiplied by the probability that a participant would survive to each age. Survival rates were estimated from data from the

National Center for Health Statistics (1998). Discounted lifetime earnings were then calculated for each level of future educational attainment. The estimated probabilities for future educational attainment were then employed to calculate the expected value of discounted lifetime earnings given the level of educational attainment at age 21.

The simple use of cross-sectional data assumes that there is no productivity-induced growth in real income over the lifetimes of participants. Government data show that the output per hour of all persons employed grew at an average annual rate of 2.3 percent over the period from 1948-1997. More recently, the average annual rate in gross domestic product per worker hour was 1.2 percent over the period from 1979-1990 and was 1.3 percent over the period from 1990-1997 (Bureau of Labor Statistics 2000). In this analysis, therefore, earnings are adjusted assuming a 1.0 percent growth in real income.

The estimates for the program effects on lifetime compensation beyond age 21 are presented in Table 8.5. Compensation includes base salary and fringe and employer-provided benefits that are valued at 20% of base salary. In this benefit-cost analysis results are not presented by gender. It is noted however that gender differences in program effects on academic achievement and attainment seem to have translated into effects with respect to earnings. The mechanism through which females participants are more likely than male participants to realize a marginal effect on higher educational attainment and earnings is an area of research that warrants further attention.

The program effect on lifetime compensation beyond age 21 is approximately $37,500 at a discount rate of 3 percent. Overall, lifetime compensation beyond age 21 is somewhat conservatively estimated. The use of cross sectional data assumes that age-earnings profiles are

relatively stable over time. In particular, it assumes that the labor force participation rates of men and women that gave rise to the current cross-sectional earnings data will prevail over the working lives of our sample. However, the labor force participation rates of women have shown a significant upward trend over the past 50 years for women of all ages (Fullerton 1999). Using 1998 cross-sectional data, the labor force participation rates for women aged 35-44 is estimated at 77 percent. However, Fullerton (1999) estimates that in 2015 this rate will had increased to 82 percent. For women aged 45-54, the 1998 and 2025 estimates are 76 percent and 82 percent, respectively. Similarly, Fullerton's estimate of 59 percent for the LFP in 2025 of women aged 55-64 can be used as an estimate for the LFP of Abecedarian women when they reach this age interval (approximately 2035). The estimate employed for this age group using cross sectional data is 51 percent.

In 1998, 2015, 2025, and 2035, the Abecedarian participants (were) will be approximately 23, 40, 50 and 60 years of age. The use of 1998 cross-sectional data, therefore, seems to underestimate the labor force participation of program participants by approximately 5-6 percent at ages 40 and 50 and 8 percent at age 60. Therefore, projecting female earnings based on cross-sectional data is conservative and leads to estimates that are below the actual earnings that will be realized by program participants.

Earnings of Future Generations

In this section, the magnitude of benefits that accrue to the descendants of the Abecedarian participants is explored. There are a number of clear mechanisms through which benefits from the preschool program may be transmitted across generations. In theory, most

benefits that accrue to program participants are sources of benefits for the children of participants. These include effects on academic achievement, educational attainment, earnings, criminal behavior, welfare use, educational cost-savings, job-satisfaction and status, self-esteem, pro-social behavior, household management, fertility and birth weight. As is the case with the effects for the program participants, some of these effects are difficult to monetize and will remain unmeasured. The overall ratio of program benefits to costs is conservatively estimated for this reason.

There is a significant amount of evidence that supports the positive relationship between parental education and income and the educational attainment and income of children (Birdsall and Cochrane 1982; Wolfe and Behrman 1985; Singh 1992; Glewwe and Jacoby 1994; Leigh 1998). Measures of household income and family background are standard variables used in estimating wage and earnings functions (Cohn and Geske 1990). Using cross sectional data, Peters (1992) presents the conditional probabilities of a child's income attainment given the income attainment of the father or male head-of-household. In general, the probability that a child's income attainment is greater than or equal to that of the parent is greater than .50. Peters (1992) also estimates an earnings function and finds that the elasticity of child income with respect to the income of the father is approximately .26. Estimates from other studies range from .07 to .44 (Atkinson 1981; Behrman and Taubman 1985; Solon 1992).

In order to estimate the program's effect on the earnings of future generations, elasticities estimates presented in Altonji and Dunn (1990) are employed. Using data from the National Longitudinal Surveys of Labor Market Experience, Altonji and Dunn derive estimates of the elasticity of child income with respect to the income of parent. In particular, they find that the

elasticity of the income of a son (daughter) with respect to the income of the father is equal to .210 (.335). The elasticity of the income of a son (daughter) with respect to the income of the mother is equal to .148 (.348).

In order to use these elasticities to estimate the earnings of future generations, it is first assumed that they can be applied to undiscounted lifetime earnings. It is also assumed that the program effect on generation one (G1) parental income can be considered an increment to income relative to the base level achieved by the control group. Using the program effects by gender, the percentage change in G1 income associated with each effect is calculated. Employing the elasticities given above, the corresponding change in generation two income (G2) associated with the calculated change in parental income is calculated. Once the program effect in G2 income is calculated, the process can be repeated and effects calculated for future generations in an iterative manner. For the purpose of this analysis, estimates for the combined program effects on generations two through four are provided.

In Table 8.5 the discounted values for combined incomes of future generations are presented. It is assumed, conservatively, that each participant (parent) has one child at age 25 and that the children will have earned income from age 22 to age 65. The overall effects are the weighted average of the individual effects for males and females. We can see from Table 8.5 that the program effects on the earnings of future generations are not economically insignificant. At an interest rate of 3%, these effects equal $5722 per participant, an amount equal to approximately 16 percent of the per child marginal cost in the FPG setting.

Elementary and Secondary Education

The effects of the program on the elementary and secondary education costs of participants were estimated. School histories were constructed for 99 of the study participants based on data that was originally gathered from official school record data by FPG. For each participant, a school placement was assigned to every year that a child was in school. The major distinction was between special education placements and regular educational placements, with the former being more resource intensive and, hence, more costly.

Costs were mapped onto the schooling histories in the following manner. A school year that involved at least one special education category was assigned the yearly estimate for special education. All other school years were assigned the cost estimate for regular education. The estimates for the costs of regular education and special education are adjusted from data presented in Parrish, O'Rielly, Duenas and Wolman (1997), which are based on data from the national cost study conducted by Moore and colleagues (1988). According to Parrish and colleagues, the average annual real rate of growth in per pupil special education costs over the period from 1968 to 1986 was 4.1 percent. The corresponding rate for regular education was 2.1 percent (Parrish, et al 1997). Assuming that education costs grew at these rates over the period from 1986 to 1999, revised national estimates for the costs of regular education and special education are $7931 and $18341, respectively.

In Table 8.5 the program effects on educational costs are presented. At a discount rate of 3% the cost reduction was equal to $8836, an amount equal to approximately 25 percent of the per child marginal cost in the FPG setting. It was expected, however, that the savings from reduced rates of grade retention and special education would be somewhat larger. Campbell

and Ramey (1995) reported that the rates of placement in special education by the end of grade 9 were 25% and 48% for the program group and control group, respectively (n=92). These rates represent the percentage of children that had ever received special education services by the end of grade 9. The current reexamination of the schooling data results in comparable estimates of 31% and 49% for the program and control groups (n=99, p=.0672). The difference between the two estimates is likely due to the change in the sample size over the years as more complete schooling data became available.

In addition to the above measure, the percentage of total school years in special education was calculated for the program and control groups. The program effect using this measure was not nearly as pronounced. The estimates for the program and control groups were found to be 12% and 18%, respectively (p=.0082). Since years in special education are more directly related to cost than the former measure, the expected program effect is somewhat reduced.

Smoking and Health

Schooling is related to an individual's ability to obtain and process information related to matters of health (Grossman 1972; Grossman and Kaestner 1997). Higher-schooled individuals can make more informed and better decisions regarding their personal health (ex. they may have a healthier diet, visit the doctor more regularly, and be able to provide a higher standard of personal health care than someone who is less informed). There may be a number of mechanisms through which schooling increases the opportunity for an individual to lead a

healthier life. Education increases the ability to be an effective consumer of health care services and producer of personal health. Education also increases earning power, the ability to command wages, fringe benefits, vacation time, and the ability to avoid working conditions that may be detrimental to personal health. Education also increases income that allows one to purchase higher quality and quantity of health services and to establish living conditions that are conducive to good health.

Another proposed mediating factor in the relationship between schooling and general health is the degree to which an individual has concern and regard for the future. Someone who is willing to invest in human capital demonstrates that he/she is willing to trade off a certain degree of current consumption for returns that will mainly accrue in the future (Fuchs 1982, 1996). Such an individual may also, therefore, be more willing to engage in behaviors that reflect a concern for future health. In this view, it is willingness to consider future events in present decisions that is responsible for the investments in both education and personal health (Becker and Mulligan 1994). Further, some have argued that schooling, concern for the future (time preference), and cognitive ability, all independently affect the probability that an individual will engage in healthy behavior (Sander 1998).

Sorting out the independent contributions of schooling, achievement, income, and time preference on health-related behaviors is important but beyond the scope of this study. The above information indicates that there are possible health-related benefits to an early childhood intervention that had positive effects on the schooling, achievement, and income levels of participants. Although the independent effects of all three are of some interest, it is much more important in this case to realize that the program effects on these variables are likely responsible

for whatever differences are observed in the health-related behaviors of the program and control groups. Isolating, measuring, and valuing possible health effects of the program contributes to a more complete analysis of program benefits and costs.

The measurement of possible health effects in the current study is limited to effects related to smoking. Data collected by FPG indicate that there are differences in the rates of smoking between the program and control group children, although the rates seem high relative to national average data. However, any program or policy that can reduce smoking rates has the clear potential to generate significant economic benefits. The benefits include, but are not limited to, improvements in health and longevity, and reductions in the cost of health care.

Sander (1998) found that cognitive ability, educational attainment, and time preference all affected the probability that an individual smoked. Grossman and Kaestner (1997) found a negative relationship between achievement scores in high school and the likelihood of smoking. National data indicate that there are a number of strong associations between smoking and certain demographic characteristics (USDHHS 1997). First, individuals with less than a high school degree currently smoke at a rate of 47%, which is nearly four times the rate of 12% for college graduates. Second, smoking is negatively associated with the level of income. At household income levels that are less than 150 percent of the poverty level, the rate of adult smoking is 38 percent. At household income levels that are 300 percent of the poverty level, the corresponding rate is 25 percent. The national data also suggest that individuals that live in households that do not include both biological parents are more likely to be smoking as adults. It can be argued that these data indicate that situations that involve certain forms of stress raise the possibility that an individual will smoke, in part, as a reaction to his/her situation in life

(USDHHS 1998). In this view, policies aimed at reducing stress from these sources for any reason should consider as a benefit the possible effect of the policy or program on the rate of smoking for the target group.

Data on smoking by Abecedarian participants come from a 1993 youth risk behavior survey conducted by FPG. The rates of smoking for the control group and program group were estimated at 55% and 39%, respectively (p=.106). The results are clearly suggestive, if not strictly significant from a statistical point of view. In order to estimate the economic value of the program's effect on the rate of smoking, it is necessary to translate these rates into monetary returns. For the purposes of this analysis, the effects on morbidity (illness) prior to death are ignored and the focus is only on the value of differences in expected mortality between the two groups. Ignoring the effect of smoking on illness prior to death simplifies the estimation procedure at the cost of underestimating potential benefits by potentially significant amounts. However, the effect on mortality may still contribute significantly to program benefits and this suggests a future area for research. In any case, data on smoking behavior should be collected in follow-ups of early intervention programs.

Cutler and associates use national data to estimate the life expectancy of individuals who either are or had been a regular smoker by age 20 (Cutler et al. 2000). Being a non-smoker at age 20 increases longevity by approximately 6.5 years. In order to value these additional years of life, an economic estimate of the value of an additional year of life is needed. It is assumed that additional years gained occur after the average age for life expectancy by gender. The value of a life (L) is associated with the years from 70-76 for male non-smokers and for the years 77-82 for female non-smokers. The estimates for L are then discounted to program

entry and the discounted values are multiplied by the average difference in smoking rates between the two groups in order to obtain estimates of program effects.

In order to execute the above simple procedure the non-simple task of attaching a value (L) to a year of life is necessary. There is a vast literature in the area of health economics that corresponds to the economic value of an increase in mortality and/or a decrease in morbidity (Oster, Colditz and Kelly 1984; Moore and Viscusi 1988; Manning et al. 1989; Miller, Calhoun and Arthur 1990; Tolley, Kenkel and Fabien 1994; Adams and Young 1999). For example, values are associated with decreases in government expenditures on Medicaid, an individual's willingness to pay for reductions in health risks, income loss due to premature death, and property loss or damage due to fire. Following the example of Cutler and associates (2000) and Gruber and Zinman (2000), in their respective works for the National Bureau of Economic Research, the range for the value of a year of life that emerges from this literature is between $100,000 and $200,000 (1999 dollars).

Table 8.6 presents the estimates for the program effects on smoking and the economic value of increased longevity assuming that a year of life has a value of $161,000 ($150,000 in 1999 dollars). The discounted values of increased longevity between males and females were not significantly different and, therefore, average values were used to calculate program effects. It is clear from Table 8.6 that the benefits from a reduction in the rate of smoking are not insignificant. It is also clear from the estimates that the assumption that benefits accrue in the last years of life results in a large reduction in benefits at higher rates of discount. At a discount rate of 3 percent, the program effect on smoking is equal to approximately 50 percent of the per child marginal cost in the FPG setting. At a discount rate of 7 percent, the program effect on

smoking is reduced to approximately 3 percent of the per child marginal cost. Although not explicitly measured here, there are benefits from reductions in the consumption of cigarettes that occur in the present. General health is improved and individuals can lead more active and productive lives. There is also arguably a benefit in the reduction of the number of individuals captive to a physical addiction that exceeds whatever benefits individuals may experience due to the act of smoking. However, even ignoring these benefits and the substantial benefits from reduction in the pain and suffering associated with illness, program effects on the rate of smoking result in benefits that are not economically insignificant at lower rates of discount.

In some sense the effect on smoking is an unexpected result. The program had its main goal of improving the cognitive ability of young children and increasing the probability of school and workplace success later in life. However, a relative increase in cognitive ability, coupled with significant differences in achievement and school-related experiences, can arguably result in the program group children making relatively more productive choices about personal health. The general nature of this finding may be limited by the fact that the smoking rates were much higher for the Abecedarian participants relative to the national population. Measured benefits for a different population of children will likely be less than those presented here. However, given the great concern over youth smoking, and the strong relationship between youth and adult smoking, the results here are particularly encouraging.

Maternal Productivity and Earnings

Benasich and colleagues (1992) reviewed the literature on early intervention and maternal outcomes and summarized the results of a variety of programs that are child-centered

and/or parent-centered and reported outcomes for mothers. The review was restricted to experimental and quasi-experimental studies on interventions that began before age 3, lasted for at least 6 months, and were targeted at educationally disadvantaged families. Positive outcomes for mothers are generally reported in four areas: education and employment, fertility, parent-child interaction, and in the quality of the home environment.

Seven studies of child-centered preschool programs meet the criteria established by Benasich and colleagues: the Abecedarian Project , the Birmingham Parent-Child Development Center , the Infant Health and Development Project , the Milwaukee Project, the Perry Preschool Project, the Teenage Parenting Project, and the Teenage Pregnancy Intervention Program. The majority of these programs were center-based and provided care and education on a full-time basis for a number of years.

The Abecedarian project reported that, relative to a control group, experimental group mothers had higher levels of educational attainment and held higher-paying jobs when their children were age 5 (Campbell and Ramey 1994). The current study reports that program group mothers held an earnings advantage over the control group mothers at various times since program entry. Pungello and colleagues (2000) report that program group mothers were more likely to have a skilled versus unskilled job when the program child was 21 years of age. The Birmingham Parent-Child Development Center project reports that program group mothers were more likely to return to paid employment (Andrews et al. 1982). The Infant Health and Development Project reports that program group mothers held at an employment advantage over control group mothers when the target child was age 3 (Brooks-Gunn et al. 1994). The Milwaukee Project reports that program mothers experienced more stable employment and

higher weekly earnings (Garber 1988). The Teenage Parenting Project and the Teenage Pregnancy Intervention Program report that participating mothers were more likely to complete high school (Field et al. 1982; Roosa and Vaughan 1983). The Perry Preschool Project measured maternal outcomes on employment and education and found no significant effects (Schweinhart et al. 1993). This is not surprising given that the Perry program operated on a part-time, part-year basis. More so than the other programs mentioned, the Perry Preschool Project did not have a major child care component and therefore did not substantially reduce the necessary quantity of maternal-provided care.

Despite the fact that econometric studies on child care and maternal employment have produced mixed results (Kimmell 1998), there is some experimental and quasi-experimental evidence to support the position that quality child care results in benefits for mothers in disadvantaged households. It is not clear that pure custodial care, with less attention to the educational experiences of children, would result in similar benefits. The stability and general quality of child care arrangements may be related to the ability of mothers to focus or concentrate more consistently on matters related to work or employment (Vandell and Wolfe 2002). Mothers, feeling that their children are safe and well cared for, may be more willing and able to participate effectively in the labor force and to reallocate time to employment activities (Meyers 1993; Ross and Paulsell 1998; Vandell and Wolfe 2002). Furthermore, this reallocation may not come fully at the expense of time spent caring for children. Bianchi (2000) argues that working mothers trade off time spent working in the home, volunteering, sleeping, and engaging in general leisure activities in an attempt to preserve time spent caring for children. Overall, the use of quality and stable care arrangements may not significantly decrease the

amount of maternal-provided care a child receives and also permits mothers and employers to establish relationships that are continuous, reliable, and productive.

In the current study, it appears that the provision of 5 years of high-quality, full-time care and education increased the opportunities of mothers to obtain employment, training, and other productivity-enhancing activities. These opportunities resulted in increased earnings for the program group mothers relative to the earnings of the mothers in the control group. Self-reported income data were available on maternal earnings at participant ages of 12, 15 and 21. Corresponding maternal ages were approximately 32, 35 and 41. Based on these data, a yearly program effect on maternal earnings of $3750 per child is estimated.

Table 8.7 presents the program effect on maternal earnings for various rates of discount. The program effects through age 41 are estimated based on the actual earnings. The program effects from ages 42 to 60 are extrapolations based on the effects through age 41 and assume, conservatively, that there is no increase in the earnings differential between the two groups. Due to a lack of earlier data on maternal earnings, the estimates are also conservative in that they assume that the earnings differential does not occur until maternal age 26. Despite these assumptions, the program effect on maternal earnings is quite substantial and is greater than the per child marginal cost of the intervention in the FPG setting at a discount rate of 7 percent.

This analysis indicates that an important benefit of the program is the effect of fully subsidized preschool on the labor market success of mothers. This issue, by itself, is important to the child care debate because program effects on the household go beyond those that involve the children receiving care. Maternal employment is clearly related to labor market experience, training, and earnings, all of which promote self-sufficiency and an improved quality of life for all

members of the household. Society benefits as well from improvements in the productive capacity of female workers and from a decrease in the need for social assistance. The results of this analysis with respect to maternal employment, therefore, are encouraging and warrant further attention.

Cost of Higher Education

The program group participants have higher levels of educational attainment at age 21 than the control group participants. The higher levels of educational attainment reflect, among other things, higher levels of academic achievement and are assumed to result in higher productivity and individual earnings. However, the cost of attending institutions of higher education must be taken into account. In this section the program effects on the costs of higher education are estimated. Since the program group has a higher rate of attendance in higher education by age 21, it is expected that the program effect due to cost of higher education will be negative.

The estimated program effects for the costs of higher education are included in Table 8.2. The effects are fairly significant in size due to the large differences in the educational attainment of the program and control groups. The increase in cost due to higher education is approximately $8128 at a 3% rate of discount. The effects due to the cost of higher education decrease overall program effects and are therefore negative in value.

The cost of adult education, particularly the cost of a GED program is not employed in this study for a number of reasons. First, the rates of participation at age 21 for the program group and the control group are 11% and 15%, respectively, and the difference is not

statistically significant. Second, because of the higher rate of GED attendance for the control group, the inclusion of a cost estimate for GED education would tend to increase overall program effects. Lastly, the adult education cost estimate employed by Barnett (1996) in the benefit-cost analysis of the Perry Preschool Program is $1710 per class in 1992 dollars (Varden 1982). Using this figure, the undiscounted program effect of the cost of adult education is calculated to be $93 per person for the Abecedarian Preschool Program. Given the relatively small nature of this effect, and the reasons detailed above, the adult education program effects are not included in the final analysis of benefits and costs.

Income-tested Programs at age 21

A reduction in welfare payments to program participants represents a transfer of money to the general taxpayer and does not change total social benefits associated with the program. The program effect is therefore the reduction in the cost of administration for a lower number of AFDC-related cases. At age 21 the use of Aid to Families with Dependent Children (AFDC) in both the program and control groups was restricted to females. The rates of AFDC use for the program and control groups were 8% and 16%, respectively (p=.2340). Neither a two tailed test of significance (p=.2340) or a one-tailed test (p=.1170) indicated a significant difference between the two groups. Restricting attention to females only, the corresponding rates were 17% and 32%. Again, neither a two-tailed test (p=.2224) or a one tailed test (p=.1112) indicated a significant difference between the two groups.

Although the rates are not statistically different at age 21, the relative differences are quite substantial. The rate of AFDC use for control group is approximately twice the rate for

the program group. The small sample size, especially when the attention is directed at females only, limits the statistical power of the findings. In this section, estimates are therefore generated for the cost-savings from the reduction in the rate of AFDC use that is associated with program participation. As stated above, the magnitude of the effect is expected to be small relative to the major benefits and costs of the program.

The Committee on Ways and Means (1998) reports the average value of income-tested programs for a household that participated in the AFDC program in 1995. In particular, the average value of AFDC was $3935 per participating household. Given that a household participated in AFDC, the probability that the household participated in the Food Stamp program was .83 and the average value received was $2306. Similarly, the probability that an AFDC household received a housing subsidy was .29 and the average value of that subsidy was $2650. The probability that an AFDC household received Supplemental Security Income (SSI) was .15 and the average value was $5380. The probability that an AFDC household received Medicaid benefits was .98 and the amount of these benefits was $2057. The expected value, therefore, of all income-tested programs is calculated to be $9441 per household in 1995 dollars. Converting to 2002 dollars the estimate becomes $10,715 per AFDC household.

In order to estimate program effects due to AFDC use, a number of assumptions are employed. First, effects are estimated assuming that the average value of total assistance per AFDC household is $10,715. Consistent with current welfare law that limits the term of AFDC assistance but permits states to extend benefits for 20% of participating households because of economic hardship, AFDC use is assumed to be for five years with a 20% probability of

continuation thereafter and no future reentry into the program (Committee on Ways and Means 1998). These assumptions likely underestimate the use of AFDC and income-tested programs over the lives of the participants. The assumptions ignore households who could enter the program for the first time after age 21. It also does not permit reentry of households after age 26 who are receiving AFDC at age 21. However, given the higher rate of entry into AFDC by the control group at age 21, these assumptions will provide conservative estimates of program effects.

In Table 8.2 the effects of program participation on the use of AFDC and other income-tested programs are presented.. The overall program effect at a discount rate of 3% is estimated to be $196 per participant. Again, the program effect is related to the savings in administrative costs that are associated with a relatively lower number of AFDC cases. It is clear from Table 8.2 that reductions in the use of AFDC and other income-tested programs due to program participation results in a relatively minor benefit when measured in dollar terms. It is noted, however, that unmeasured benefits include additional psychological or personal benefits that may accrue to participants and their families resulting from a decreased reliance on social assistance.

Discussion

The last two lines of Table 8.2 present the net present values of benefits and costs at three different rates of discount for program replication in the FPG and public school settings. In both cases the net present value is greater than zero for discount rates up to 7 percent. The same is clearly true for replication in the lower cost child care setting. If we include all measured

benefits, then the internal rate of return for the Abecedarian intervention appears to be slightly greater than 7 percent. The positive results are not highly sensitive to the presence or exclusion of any one benefit. Excluding maternal earnings from ages 42-60 yields an internal rate of return of between 5 and 7 percent in the FPG and the public school resource settings. Excluding forecasted participant earnings and the earnings of future generations also results in an internal rate of return between 5 and 7 percent. Excluding the estimates for smoking and health still results in an internal rate of return greater than 7 percent. If we confine attention to the benefits that accrue mainly to the children (participant earnings and smoking/health), then the rate of return to the program is between 3 and 5 percent. Overall, the rate of return to the Abecedarian project is no less than 3 percent and is likely higher than 7 percent.

The Abecedarian program results in healthy returns for the investment of public resources targeted at a disadvantaged group. This occurs even when viewed in the light of significant unmeasured benefits from improved education, such as the personal consumption value of learning and educational experiences, increases in civic and pro-social behavior, increases in the overall quality of life, and improvements in personal decision-making and household management (Haveman and Wolfe 1984). In addition, Donohue (1999) argues that lower rates of discount or estimated internal rates of return may actually be appropriate if government programs help future generations avoid some irreversible damage. Market rates of return, and hence market rates of discount, may not lead to appropriate decisions if markets alone cannot bring about the desired program effects. If the goal is to increase the income and prospects of a disadvantaged group, and there exists no other clear mechanism for doing so, it may make sense to apply a lower rate of discount to projects that accomplish this goal. An alternative is to

recognize that a dollar of program benefit to a target group has more value than a dollar of program cost to others. Favoring the disadvantaged group may help improve distributional equity at the expense of efficiency in resource allocation. In this case, the effects of program participation on the educational attainment, productivity, and earnings of at-risk children result in an improvement in overall social equity. Change in equity remains, therefore, a potentially large unmeasured benefit of the Abecedarian program.

It is unlikely that the results of the Abecedarian program can be replicated perfectly in all settings and for all populations. The benefits that accrued to the participants were due to the marginal differences in the quality of the care received by the program group children and the quality of the care received by the control group children in the first five years of life. In the cases where the care currently being received is of a higher quality, then the marginal effects will not be as great. However, if attention is limited to the 20% of our nation's children that are estimated to be living in poverty, then the results of the study are more directly applicable.

Replication in other settings will also affect the magnitude of specific benefits. It is possible that the effects on the smoking behavior of participants may not be as great outside of North Carolina and the southern region of the United States. However, this is relatively minor measured benefit. More importantly, it is also very possible that the effects of the intervention on criminal behavior may be more pronounced in higher-crime areas. We would, therefore, not be surprised if the Abecedarian intervention resulted in greater program effects and returns than estimated above if replicated on a large scale for at-risk children in areas where the quality of care currently being received was relatively low.

The issue of the *optimal* form and intensity of a preschool program cannot be settled with the encouraging results of the Abecedarian project. How many years of full-time quality preschool and child care are needed to produce the results outlined above? As a matter of research, more information is needed on the long-term results of programs that vary the amount and form of care before this issue can be settled. As a matter of principle, all children should receive quality care in the first five years of life. A concern for the lives of the children considered to be most "at-risk" can, by itself, direct public resources to an intervention that will provide quality experiences to children and, over the long run, result in benefits that exceed costs.

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Table 8.1: Preschool Program Effects Related to Economic Benefits.

Outcome Variable	Program Group Measure	Program Group N	No-Program Group Measure	No-Program Group N
	Education Effects (children)			
IQ (Stanford Binet), age 3*	101	50	84	48
IQ (McCarthey GCI), age 4.5*	101	49	91	46
IQ (WISC-R), age 15	95	48	90	44
Reading Achievement (WJ), age 15*	94	48	88	44
Math Achievement (WJ), age 15*	93	48	82	44
Ever retained in grade by age 15*	31%	48	55%	44
Special Services by grade 9*	25%	48	48%	44
High School Graduation by age 19	67%	54	51%	51
Ever enrolled in a 4-yr college by age 21*	36%	53	13%	51
Employment Effects at participant's age of 54 months (teenage parents)				
Teenage Mothers and post-secondary training	46%	13	13%	15
Teenage Mothers and self-supporting	70%	13	58%	15
Teenage mothers and additional births	23%	13	40%	13

Notes: * Differences are significant at the .05 level of confidence. WISC-R is the abbreviation for the Wechsler Intelligence Scale for Children Revised (Wechsler 1974). WJ is the abbreviation for the Woodcock-Johnson Psycho-Educational Battery, Part 2: Tests of Academic Achievement (Woodcock and Johnson 1977). McCarthy GCI is abbreviation for the McCarthy General Cognitive Index. Data on education effects are from Campbell and Ramey (1995), Ramey and Campbell (1984), Clarke and Campbell (1998), and Campbell et al. (2002). Data on employment effects for teenage mothers are from Campbell et al. (1986). A mother was considered to be self-supporting if welfare funds were not used except in the cases where the mother was a student and had made 4 years of educational progress in the 4.5 years since the birth of her child.

Table 8.2: Present Value of Per Child Benefits and Costs of the Abecedarian Early Intervention. Data are in 2002 dollars.

	Discount rate		
	3%	5%	7%
Program Cost FPG Setting[a]	$35,864	$34,599	$33,421
Program Cost PS Setting[b]	$41,916	$40,427	$39,041
Program Benefits			
Part. Earnings	37,531	16,460	6,376
Earnings of Future Generations	5,722	1,586	449
Maternal Earnings			
Ages 26-41[c]	43,030	34,378	27,786
Ages 42-60[d]	30,578	17,561	10,299
Subtotal	73,608	51,939	38,085
K-12 Education	8,836	7,375	6,205
Smoking / Health	17,781	4,166	1,008
Higher Education Costs	-8,128	-5,621	-3,920
AFDC	196	129	85
Total Benefits	$135,546	$76,035	$48,317
Net Present Value FPG Setting	$99,682	$41,436	$14,896
Net Present Value PS Setting	$93,630	$35,608	$9,276

[a]Program cost is for the Frank Porter Graham Child Development Center.
[b]Program cost is for replication in a public school setting.
[c]Maternal earnings through age 41 are estimated using actual data on maternal earnings at ages 32, 35, and 41.
[d]Maternal earnings from age 42 to age 60 are extrapolated based on estimates through age 41 and assumes no increase in program effects.

Table 8.3: Estimated yearly costs of the Abecedarian Program in three different settings. Data are undiscounted and in 2002 dollars.

Year	Abecedarian (Actual)	Public School	Child Care
Year 1	10,799	11,710	6,847
Year 2	16,222	17,793	10,189
Year 3	16,222	17,793	10,189
Year 4	11,991	13,175	8,133
Year 5	11,991	13,175	8,133
Totals	67,225	73,646	43,491

Table 8.4. Present Value of Marginal Costs of the Abecedarian Program in three Cost Settings. Data are in 2002 dollars.

Discount Rate	Abec/FPG	Public School	Child Care
0%	$37,826	$44,246	$14,092
3%	35,864	41,916	13,410
5%	34,599	40,427	12,923
7%	33,421	39,041	12,469
10%	31,799	37,135	11,843

Table 8.5. Estimated Program Effects on Participant Compensation, Earnings of Future Generations, and Schooling Costs. Data are in 2002 dollars.

Discount Rate	Compensation	Future Generations	Schooling
0%	$144,998	$48,542	$11,605
3%	37,531	5,722	8,836
5%	16,460	1,586	7,375
7%	6,376	479	6,205

Table 8.6. Program Effects on the Value of Life due to Decreased Rates of Smoking and Increased Longevity. Data are in 2002 dollars.

Discount Rate	Program Effect
0%	$167,076
3%	17,781
5%	4,166
7%	1,008
10%	127

Table 8.7. Program Effects due to Increased Maternal Earnings. Data are in 2002 dollars.

	Discount Rate	Program Effect
Ages 26-41	0%	$61,690
	3%	43,030
	5%	34,378
	7%	27,786
Ages 42-60	0%	73,256
	3%	30,578
	5%	17,561
	7%	10,299
Total	0%	$134,946
	3%	73,608
	5%	51,939
	7%	38,085