Long Term Effects of Preschool Investment on school Performance and Labor Market Outcome[1]

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Abstract:

Using the NLSY data set, this paper formulates and then empirically estimates the production processes for social, motivational and cognitive skills during early childhood development and the long-term effects of these skills on learning and life-time earnings of an individual. Using these estimated relationships, the paper provides a calibrated intergenerational altruistic model of parental investment in children's preschool. This dynamic model is then used to estimate the effects of publicly provided preschool to the children of poor socioeconomic status (SES) on college mobility and intergenerational social mobility and to estimate the tax burden of such a social contract.

Keywords: Preschool Investment, Early Childhood Development, Intergenerational Social Mobility, College Mobility

JEL Classification Nos.: J24, J62, O15, I21

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1. Introduction

Many are highly skeptical about a positive answer to the basic question: "Can we conquer poverty through school?" There are many reasons for this skepticism. In the US, education up to high school level is virtually free. Yet many children of poor SES do not complete high school and many of them perform poorly in schools. This naturally beckons to the possibility that the poor quality of the public schools that the children of poor SES attend is the reason for such failings. Improving school quality will improve school performance of these children only marginally. Many empirical studies find that better school quality in terms of lower class size, higher public expenditures per pupil, improved curriculum, and higher desegregation have only marginal effects on school performance of the children of poor SES. See Hanushek [1986] for a survey of studies along this line.

A growing consensus reached among educators, among media writers (see for instance, Taub [2002], among researchers in economics (see for instance, Heckman [1999] and Currie [2001]) and among researchers in sociology, psychology and education (see for in stance, Barnett [1995], Entwisle [1995], McCormick [1989], Schweinhart et al. [1993]) is that the children of poor SES are not prepared for college because they were not prepared for school to begin with. The most effective intervention for the children of poor SES should be directed at the preschool stage so that these children are prepared for school and college. The question is then does preschool investment have long-term positive effects on school performance and labor market success? This is the main issue I address in this paper.

Most of the studies along this line use data on Head Start preschool program which is funded by the Federal government. The program is available only to children whose parents earn incomes below poverty line. Not all eligible children are covered by the program, however. The quality of the program is very poor compared to the pilot programs and most of the private preschool programs. Some studies find that the Head Start Preschool Program has no long-term effect on children's cognitive achievements and school performance especially for black children. Currie and Thomas [1995] carried out a careful econometric investigation and concluded that the benefits disappear for black children because most of the Head Start black children attend low quality public schools. After controlling for the school quality, however, they found significant positive effects of Head Start Preschool Program. See Barnett [1995] for a survey of other studies on the long-term educational effects of early childhood programs in the US.

The above studies are not based on nationally representative samples of children, and most studies examine only the effect on school performance such as grade retention and high school and college graduation rates, and do not model parental choice of children's preschool investment. In this paper, I formulate a model of parental investment in preschool that is guided by economic incentives. I empirically show that preschool investment benefits children to acquire socialization and motivational skills, especially for the children of poor SES who live in poor HOME environments, that the motivational skills significantly improve school performance, and that the socialization and motivational skills improve the life-time earnings of children. These significant positive effects are found after controlling for their education level, innate ability, and family background. I formulate an intergenerational altruistic model of parental preschool investment. I use a mixed reduced form econometric estimation method and a calibration method to numerically specify the parameters of the model, and then use this model to examine the long-term intergenerational economic effects of publicly providing preschool to children of poor SES.

The rest of the paper is organized as follows: Section 2 provides the basic decision making framework, section 3 provides empirical estimates, and section 4 provides the economic benefits of social program of providing preschool to children of poor SES. .

2. The Basic Framework

In this section I formulate a simple model of preschool investment decision of an altruistic parent. The preschool investment decision of a parent depends on several other decisions made at later stages by the parent and the child. In this section, I describe each of these decision stages. In a subsection later I discuss the estimation issues. I report the empirical estimates in the next section. For expositional ease I assume that each family has one parent and one child, and address them using male gender.

I assume that an individual's life comprises of several discrete periods during which important life-cycle events relevant to leaning and earning occur. I aggregate the whole life-cycle into four periods as follows: [0-4], [5-16], [17-25], [26–]. In each of these periods some educational and labor market decisions are made and outcomes are observed. During age [0-5] a parent invests in his child's preschool activities which develop the child's school readiness, and cognitive, social and motivational skills. Let h be the level of parental preschool investment. I assume that h is annualized over the working years of the parent[2]. At the end of this period, the child acquires a level of innate ability or cognitive skill τ, social skill σ and motivational skill μ. The level of each type of skills that the child acquires depends on other factors as well. For instance, it depends on child-rearing practices at home, the nature of neighborhood in which the child grows-up, and the level of schooling, cognitive, socialization and motivational skills of the

[2] We are assuming that parents are not liquidity constrained for investing in their children's preschool. This is a strong assumption given that parents are at their early years of working age when they have children and might not have built up enough assets to be able to borrow from the market at the market interest rate.

parent. In the next section I describe and empirically estimate the role of parental preschool investment in the production of these skills in details.

During age [5-16], the child goes to school. The school performance at this stage depends on the levels of τ, σ and μ that the child acquired during the previous stage, on the quality of the school that he attends, and also on the type of neighborhood kids whom the child mingles with. It also depends on the parental home inputs such as how many hours the parent spend time with the child to do his homework, how many hours the child watches TV, and how stable and stimulating the relationships among the family members are. Many of these are choice variables for the parent. Since not much information about these is available in the data set, I assume that the levels of τ, σ and μ from the previous period remain constant at the end of second stage.

During [17-25] the child makes his schooling decisions. Two important ingredients to this decision are the costs and benefits of attaining a given level of schooling. There are many dimensions to the cost of schooling, but I will make many simplifying assumptions. I assume that he does not work during this schooling period. During [26-] he works, forms a family with a child and decides how much to invest in his preschool, elementary school and high school. At the beginning of the schooling period [17-25], the child decides how many years of college to have and what type of college to attend. An important determinant of this decision is the financial rewards or earnings in the labor market over the whole life time that an individual will command from various levels of schooling. Another non-financial benefit of higher schooling of an individual is that it provides better family background for his child from which his child benefits. The structure of schooling costs is generally very complicated. The type of college that he likes to attend depends on how much college fund he can raise from the market and how much college money he can get from his parent. I assume that each individual borrows the whole college fund from the market. The interest rate *r* for borrowing the college fund may depend on his parent's

wealth position and if there is government educational loans available at a low rate. Let $c(s,r)$ be the cost of s years of college annualized over the working years of the individual. There are many important life cycle events that also influence the schooling decision of an adult child. For instance, bad influence and financial responsibilities towards other family members because of bad health shocks, or loss of employment of the parent may cause a child choose less education. I represent these factors by an aggregative random variable ε_s.

I take the rewards or benefits from schooling to be the yearly permanent income, which depends on his number of years of schooling s, his innate ability τ, his level of socialization skills, σ, his level of motivational skills, μ, and also on his life-cycle experience of random shock ε_p such as market luck, family connection and network. Let the yearly permanent income of the child over the working years[3] be denoted as $w\left(s;\tau,\sigma,\mu,\varepsilon_p\right)$. His financial rewards net of schooling cost is then given by $\hat{w}\left(s;\tau,\sigma,\mu,\varepsilon_p\right) = w\left(s;\tau,\sigma,\mu,\varepsilon_p\right) - c(s,r)$.

Let the state variables of our system be denoted by the vector $z = \left(s,\tau,\sigma,\mu,\varepsilon_s,\varepsilon_p\right)$. For any variable x, I adopt the convention of using x if it refers to parent and x' if it refers to his child. Denote the optimal schooling level of the child by $s^*\left(\tau,\sigma,\mu,h,\varepsilon_s\right)$. The parent takes this optimal schooling decision of his child as given[4] and decides the level of optimal preschool investment level by solving the following Bellman equation of the associated dynamic programming problem:

[3] Since the traditionally earnings function does not incorporate skills such as σ and μ which can be produced by spending resources, we refer to our yearly permanent income incorporating σ and μ as an augmented Mincer earnings function.

[4] I take this optimal schooling decisions as given and estimate this optimal reaction function using the NLSY data set. The determination of this optimal solution is not specified in this paper. It can be determined as solution to a subgame perfect equilibrium (see Raut [2000]) on this).

(1) $$V(z) = \max_{0 \le h \le w(z)} u\left(\tilde{w}(z) - h\right) + \gamma \int V(z') Q_h(z, dz'),$$

where V(.) is the value function, *u(.)* is the felicity index of yearly permanent consumption $\tilde{w}\left(\tilde{z}, \varepsilon_p\right) - h$ of the parent, γ measures the degree of parental altruism towards the child, and $Q_h(z, z')$ is the transition probability of the child moving to state z' given the state variable of the parent z. This transition probability depends on the production processes for talent, socialization, motivational skills and how the random shocks are generated. In the next section, I explain the specifications and estimation of these relationships. Assuming that $0 \le \gamma < 1$ but close to 1, and that the optimal schooling decision, $s' = s^*\left(\tau', \sigma', \mu', \varepsilon_s', h\right)$ is a well-behaved function, there exists a value function $V(z)$, and optimal decision rule $h^*(z)$ under quite general conditions on the primitives, $u(.)$, $Q_h(z, z')$, γ and $\tilde{w}(z)$ (see Stokey and Lucas [1989] for instance).

The NLSY dataset does not have data on the amount spent on preschool. It has data only on a binary variable of whether the respondent had preschool or not. Given this data limitation, I treat parental preschool investment decision variable as a binary variable. Another serious limitation of the NLSY dataset is that it does not have data on all the state variables of the parents of the respondents, e.g., on τ, σ and μ. While it has information on τ, σ and μ for the respondents, it does not have information on the preschool of their own children. Thus I cannot follow the synthetic cohort approach of using respondents' data to estimate the counterfactual optimal preschool decision rule h^* of their parents. Given these data limitations, I do not follow the strategy of imposing strong restrictions on the functional forms to identify and estimate the structural model. Instead, I follow a mixed calibration and reduced form estimation procedure as

follows: I drop ε_p in our model, i.e., I assume that the permanent yearly income is independent of ε_p, and thus it does not enter the optimal preschool choice rule. I estimate $Q_h(z, z')$, $w(\tilde{z})$, $s^*(\tau', \sigma', \mu', \varepsilon_s', h)$ directly using the NLSY data and specify numerically the felicity index $u(.)$ and the parental altruism parameter γ. I then solve the fully specified dynamic programming problem numerically. I use these estimates and the optimal solution to examine the economic effects of providing preschool resources to children of poor SES.

3. Empirical Findings

3.1 The NLSY79 Dataset

A lot has been written about the NLSY79 data set, so I will not describe the data set in details. The NLSY79 dataset contains life-cycle information on a nationally representative sample of 12,686 young men and women who were 14-22 years old when they were first surveyed in 1979. From 1979 to 1994, these individuals were surveyed annually. Currently they are interviewed on a biennial basis. Since their first interview 1979, many of the respondents have made transitions from school to work, and formed their own family instead of living with their parents. This dataset provides a large sample of American men and women that were born in the 1950s and 1960s and living in the United States in 1979.

This dataset contains richer information on school and labor market experiences of a nationally representative sample of individuals. This dataset, however, contains limited information on early childhood inputs of the sampled individuals. Although there is a recent dataset that collects panel data on the children of the NLSY respondents, we

have to wait several years to obtain data on labor market outcomes of these children. From all these considerations, the NLSY dataset stands out as the best choice for our analysis.

3.2 Production of social and motivational skills

In this section I consider the production process of the socialization and motivational skills. In the next two subsections I empirically show that motivational and socialization skills are important determinants of earning and learning.

The literature in sociology, psychology, early childhood development and physiology suggest that early childhood investment is the most crucial input for development of cognitive, social and motivational skills. The studies in these literatures link school success to home environment, child rearing practices, neighborhood type in which the kid is raised. For instance, the Coleman report [1966] and subsequent studies find that the family capital, which captures family tradition and values towards economic success and education, and the social capital, which captures the benefits of social bonds, social norms, social networks, the social bonds between adults and children and among children in a neighborhood are of immense value during a child's growing up. These factors affect parental choices of preschool investment and child rearing methods which in turn determine a child's cognitive abilities and social abilities such as motivation and sociability that affect their learning and earning. Physiology literature produces ample evidence that the human brain develops extremely rapidly during age [2-4], and the type of stimulations regarding health and learning that the child experiences during this period is a critical determinant of a child's cognitive, social and motor developments. Child psychology literature also points out that a structured preschool stimulation boosts a child's self-confidence, school preparedness, parents' and teachers' assessment of the child's ability. These in turn create

a conducive learning environment for the child over many more years of schooling beginning with the elementary school. See Entwisle [1995], and Barnett [1995] for more on these issues.

I construct the variables of this study as follows:

Early childhood inputs and home environment: I take father's and mother's education levels to measure family background. The NLSY dataset has poor measures of respondent's early childhood inputs. It has only a binary variable containing information on whether the respondent had preschool (does not include Head Start) experience or not. I treated individuals with Head Start experience as no preschool. Notice that this will lead to underestimation of the effect of preschool investment. I use the revised AFQT score to measure innate ability.

Socialization skill (σ): Each respondent were asked how social he/she felt towards others at age 6. This was expressed in the scale of 1 to 4. The highest number represented most social. I create a binary sociability variable by assigning value 1 if a respondent reported an answer 3 or 4 to this question and assigning 0 otherwise.

Motivational skill (μ): I use three measures of motivation. (i) Job aspiration (μ_1) which I construct as a binary variable taking value 1 if during the first interview in 1979 the respondent aspired for professional jobs, otherwise taking value 0. (ii) The educational goal (μ_2) is the grade that the respondent in 1979 expected to achieve. (iii) The Rotter's scale of self control and self-confidence (μ_3) which I reconstructed from the scores of original four questions in the data set. My measure takes values 0 to 4, a higher value representing more confident and self-control.

I estimated a Probit model for σ and μ_1 and OLS models for μ_2 and μ_3. The parameter estimates are reported in table 1.

Table 1: Determinants of Sociability and Motivations

Variables	Sociability (σ)	Job Aspiration (μ_1)	Education Goal (μ_2)	Self-Control (Rotter) (μ_3)
Intercept	-0.6467 (8.11)	-0.6102 (7.24)	11.8089 (98.13)	1.9911 (31.903)
Revised AFQT Score	0.0013 (1.91)	0.0131 (17.80)	0.0311 (31.30)	0.0094 (18.16)
Mother's grade	0.0115 (1.63)	-0.0064 (0.86)	0.0471 (4.45)	0.0100 (1.82)
Father's Grade	0.0199 (3.43)	0.0207 (3.35)	0.0421 (4.82)	0.0083 (1.84)
Preschool	0.0884 (2.12)	0.1553 (3.33)	0.6100 (9.58)	0.0399 (1.21)
Gender	-0.0462 (1.41)	0.2884 (8.17)	0.1484 (2.99)	-0.0322 (1.25)
N	6072	6072	5961	6041
Log-likelihood/R^2	-4010.09	-3389.02	0.2541	0.0861

Note: First two columns show parameter estimates from Probit model, and the last two columns show parameter estimates of ordinary least squares estimates. The absolute t-value of an parameter estimate is shown in parentheses below the parameter estimate.

From table 1 it is clear that after controlling for parents' grades, preschool experience has a significantly positive effect on socialization skill and on all measures of motivational skills except the Rotter's scale of self control. The estimates in the table also show that innate ability has strong positive effect on all measures of motivational skills but has no significant effect on socialization skills. Socialization skills are created in the family using the preschool and neighborhood inputs.

It will be interesting to see if preschool has stronger positive effect on socialization and motivational skills of children of poorer SES. If so, then the preschool could be used to compensate for the better HOME environment that the well-to-do counterpart of these children have. That is, through intervention like preschool, we can achieve a higher equality of

opportunities by equalizing the differences in the starting social, motivational, and cognitive skills of the children.

3.3 An Augmented Earnings Function - Role of socialization and motivational skills

In this section I examine the effect of social and motivational skills together with the effect of innate ability and grades on earnings. The previous studies, however, included only innate ability, schooling level and school quality as the main determinants of earnings. While preschool investment is an important determinant of these skills, I also included preschool binary variable as one of the regressors in the earnings function to see if it has an independent effect. In my specification, I also included a dummy variable for College (taking value 1 if a respondent graduated from college). This dummy variable after controlling for the grade variable captures any earnings premiums that a worker earners by graduating from college. Since I included AFQT score which is a reasonably good measure of one's innate ability, the parameter estimates do not have the ability bias problem.

The column 1 of Table 1 shows the parameter estimates of this augmented earnings function. It is clear from the estimates that after controlling for innate ability, family background and the schooling level, the measures of socialization and motivational skills have significant positive effects on earnings. Preschool has no independent positive effect on earnings. It is also interesting to note that completing college provides a positive premium on yearly earnings.

Table 2: Estimated Parameters of the Augmented Mincer Earnings Function and the Optimal Schooling Function

Variables	Log of Yearly Wages	Completed Grade Level
Intercept	0.4456 (3.32)	3.7194 (21.64)
Revised AFQT Scores	0.0047 (22.09)	0.0312 (30.00)
Grade	0.0407 (14.61)	
Dummy Variable for College	0.0688 (4.94)	
Age	0.5284 (52.54)	
Square of Age	-0.0079 (41.80)	
Mother's Grade	0.0095 (5.18)	0.0620 (6.61)
Father's Grade	0.0058 (3.94)	0.0318 (4.25)
Dummy Variable for Preschool	0.0117 (1.10)	0.2551 (4.69)
Sociobility (σ)	0.0157 (1.89)	0.0718 (1.66)
Motivation- Job Aspiration ($\mu 1$)	0.0425 (4.55)	0.1697 (3.46)
Motivation- Education Goal ($\mu 2$)	0.0108 (4.32)	0.4440 (38.00)
Motivation -Rotter Scale ($\mu 3$)	0.0335 (8.31)	0.0673 (3.21)
Dummy Variable for Female Gender	-0.5036 (61.97)	0.1595 (3.78)
Dummy Variable for Race Hispanic	0.0481 (3.83)	0.1698 (2.60)
Dummay Variable for Race Black	-0.2056 (17.15)	0.3147 (5.15)
R^2	0.32	0.56
Number of observations	60,490	5,926

Note: Absolute value of t-statistics are in parentheses

3.4 Estimation of optimal schooling level

I consider two specifications of the optimal schooling function $s^*\left(\tau', \sigma', \mu', \varepsilon_s', h\right)$ in this paper. In the first specification, I assume that the schooling level is a continuous variable and specify the optimal reaction function $s^*\left(\tau', \sigma', \mu', \varepsilon_s', h\right)$ as a linear function. I assume that the random variable ε_s' constitutes the error term and satisfies all the assumptions of the OLS model[5]. The parameter estimates from this model are shown in the second column of table 1. I included the socialization and motivational skills together with innate ability and family background measured by parents' education levels.

It is clear from the estimates that the main determinant of grade is the innate ability measured by AFQT score. After controlling for family background, I also find that motivation measures have significant positive effect on schooling level. Out of the three measures of motivation, the measure μ_2 based on the expected grade that the respondent desired to attain while very young turns out to be the most important one. The sociability skill has, however, no effect on the schooling level. After controlling for all other variables, preschool has still an independent positive effect on the completed grade. This may be because the preschool creates other skills that are important for school success but are not captured in the included determinants in our specification of optimal schooling function.

Notice that even after controlling for innate ability, the family backgrounds measured by mother's grade and father's grade have significant positive effects on the completed grade. Given everything else same, a Black or a Hispanic child attains a higher grade than a White child. The observed low grade achievements of the Black and Hispanic children are then due to their poor family background.

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[5] More generally we could assume that $E\left(\varepsilon_s' \mid \tau', \sigma', \mu', h\right) = 0$, and use GLS method to correct for heteroskedasticity.

In the second specification, I consider two levels of schooling: college or higher ($s=1$), and no college ($s=0$). This simplified specification is for the purpose of calibrating the dynamic programming problem in (1). Again I assume that $s^*\left(\tau',\sigma',\mu',\varepsilon_s',h\right)$ is linear, and that ε_s' constitutes the error term and it is normally distributed. This gives us a Probit model of college enrollment. The parameter estimates are reported in table 3. Here again the innate ability, motivation, preschool and the college status of parents (which takes 1 if at least one parent had some college, and 0 otherwise) turn out to have significant positive effects on the probability of college enrollment.

3.5 Optimal Parental Preschool Investment

To numerically solve the dynamic programming problem in (1), one has a few choices. One could assume the state variables s, τ, and ε to be continuous and the rest to be binary, and then use the parametric path method of Judd [1999] or a suitable value-iterations or policy iterations methods developed in the numerical dynamic programming literature, see Rust [1995] for a survey of these methods. Because we have many state variables, our problem is subject to the well-known "curse of dimensionality" problem of numerical dynamic programming methods. I impose the following restrictions to keep the numerical computation manageable.

I assume that the state variables s,τ,σ,μ are binary, the random variable ε_s is continuous which is observed by the decision maker but not by the econometrician, the random variable ε_p is absent, and the preschool investment decision h is a binary variable, taking value 1 when parents decide to invest in preschool and 0 otherwise. For most children, we have two parents but in the model I have assumed one parent. I have used both parents' information in computation as follows: I construct parent's binary schooling variable s by assigning s = 1 if the average grades of two parents is more than 12, otherwise s = 0. I assume that τ is biologically

inherited and it is not influenced by preschool investment. I create the binary variable τ assigning it the value 1 (interpreted as an individual is highly talented) if the AFQT score of the individual is 70 or higher, and assigning it the value 0 otherwise. I do not have information on AFQT of parents. The literature on intelligence recommends that the correlation between parent's IQ and the child's IQ is anywhere between 0.3 and 0.7. I assume it to be 0.3 in our numerical exercise. To measure motivation, I use the binary job aspiration variable μ_1. The specifications and the estimates of the Probit models of s^*, σ and μ are shown in table 3. I use these estimates to calculate the transition matrix Q_h.

Schweinhart et al. took average yearly preschool cost to be $6178 per year. Consistent with their study, I take the preschool cost per child to be $18000 for three years and annualize it over the working years of an individual. I further assume that the felicity index is linear and measured in dollars. I numerically specify the parental altruism parameter to be $\gamma = 0.65$.

After calibrating the model as above, I use the linear programming approach to solve (1) numerically. The optimal preschool investment decision and the value function are shown respectively in column 3 and 4 of table 4.

Notice from table 4 that parents with income below a cut-off point do not invest in their children's preschool. I refer to these parents as parents of poor SES.

Table 3: Estimated forms of earnings function and Probit models of college completion, socialization and motivation

Variables	w(s,τ,σ,μ)	Probability of College	Probability of being sociable	Probability of being motivated
Intercept	8330.0784 (15.62)	-1.4313 (48.85)	0.4763 (28.32)	-0.3034 (18.17)
Schooling (= 1 If College, 0 otherwise	6653.9343 (7.50)			
Innate ability (τ)	6109.6419 (7.04)	1.3779 (33.84)		
Sociability (σ)	1293.8865 (1.94)			
Motivation: Job aspiration (μ1)	2731.5873 (4.10)	0.1344 (3.54)		
Preschool (h = 1) H=0 no preschool	2126.5631 (2.55)	0.3431 (7.51)	0.1457 (3.63)	0.0728 (1.89)
Parent's schooling (= 1 If college, 0 otherwise)		0.9480 (13.34)	0.2005 (2.99)	0.2925 (4.78)
Average value of the Dependent variable		0.2069	0.6964	0.3933

Table 4: Solutions of the Subgame Perfect Equilibrium

State (s,τ,β,μ)	w(s,τ,β,μ)	opt.h*	V*(s) (without)	invariant distribution		V*'(s) (with)
				p* (without)	p* (with)	
(0, 0, 0, 0)	8718.235854	0	32951.71	0.0614	0.0409	33471.62
(0, 0, 1, 0)	10122.63317	0	34356.11	0.1370	0.1147	34876.02
(0, 0, 0, 1)	10144.64353	0	34378.12	0.1310	0.1094	34898.03
(0, 0, 1, 1)	11549.04085	0	35782.52	0.3200	0.3289	36302.43
(0, 1, 0, 0)	14975.44989	1	41575.34	0.0082	0.0049	41575.34
(1, 0, 0, 0)	15463.36815	1	41740.68	0.0028	0.0036	41740.68
(0, 1, 1, 0)	16379.8472	1	42979.74	0.0189	0.0139	42979.74
(0, 1, 0, 1)	16401.85757	1	43001.75	0.0123	0.0086	43001.75
(1, 0, 1, 0)	16867.76546	1	43145.07	0.0073	0.0108	43145.07
(1, 0, 0, 1)	16889.77583	1	43167.08	0.0338	0.0438	43167.08
(0, 1, 1, 1)	17806.25488	1	44406.14	0.0303	0.0256	44406.14
(1, 0, 1, 1)	18294.17314	1	44571.48	0.1066	0.1480	44571.48
(1, 1, 0, 0)	21720.58218	1	50395.88	0.0046	0.0043	50395.88
(1, 1, 1, 0)	23124.9795	1	51800.28	0.0118	0.0128	51800.28
(1, 1, 0, 1)	23146.98986	1	51822.29	0.0279	0.0298	51822.29
(1, 1, 1, 1)	24551.38718	1	53226.69	0.0859	0.1001	53226.69

4. Economic benefits from public provision of preschool

I have shown that investment in preschool enhances certain skills that are important for learning and earning. The optimal solution revealed that the parents of poor SES do not invest in their children's preschool. If preschool is publicly provided for the children of poor SES, it will have many economic benefits: It will increase social mobility, it will reduce income inequality, it will improve college enrollment rate, it will improve the community or criminal behavior, and it will also bring higher tax revenues because more workers will be earning higher wages. It is important to note that the magnitude of the effects of publicly provided preschool depends on whether the social protection is available to all future generations or it is just a one time deal.

While examining the estimated economic benefits below, it is important to keep in mind that the reported effects are underestimated for many reasons: First, I have treated the Head Start children in the same footing as the children without preschool. Second, the preschool programs that the respondents went into were the ones that existed during the sixties. The quality of preschool programs ever since has improved significantly and thus the effects of current preschool programs will be much higher than the estimates that we have.

Note that since ε does not affect earnings, the optimal h^* depends only on the observable component of the parent's state variables. In the absence of a social contract, suppose the parents follow the optimum preschool investment plan h^* as shown in table 4. The invariant distribution of the corresponding transition matrix Q_{h^*} is also shown in table 4 under the heading $p^*(\text{without})$. The interpretation of this invariant distribution is as follows: If $p^*(\text{without})$ is the distribution of population over the observable states of generation *t*, and the parents of generation *t* follow the optimal preschool investment plan h^*, then the distribution of population of the next generation will also be $p^*(\text{without})$.

4.1 Social Mobility

Given any transition matrix Q_{h^*} over the observable states, there exists a number of mobility measures in the literature. Sommers and Conlisk [1979] argue that out of the existing measures, $1-\lambda_{\max}$ is the most appropriate measure of social mobility, where $\lambda_{\max}$ is the second highest positive eigenvalue of the transition probability matrix Q_{h^*} (the highest positive eigenvalue of a transition matrix is always 1). I use this measure of social mobility to examine how the introduction of a social contract would improve social mobility. The estimate of this measure of social mobility without a social contract is 0.6163. After the introduction of a social contract, it improves to 0.6770. The estimate of 0.6163 for the measure is very close to the estimates found in other studies of social mobility in the US.

4.2 College Mobility

Denote by $Q^s = \left[q_{ij} \right], i, j = 1, 2$ the intergenerational college mobility matrix in which state 1 represents no college and state 2 represents college and higher. The element q_{ij} represents the probability that a child of a parent of college education status *j* will move to college education status *i*. I report below the estimates of college mobility matrices, the corresponding invariant distributions, and the estimates of the mobility measure before and after the introduction of the social contract. These estimates indicate that the introduction of the social contract will increase college enrollment from 0.24 to 0.28 for a child of non-college parent. And the percentage of college enrolled population will increase in the long-run from the current low rate of 21% to a much higher rate of 41% with the introduction of the social contract, and to a rate of 38% without the social contract. That is, there will be a 3% increase in college enrollments in the long-run.

College mobility statistics before introduction of social contract:

$$Q^s = \begin{bmatrix} 0.758 & 0.400 \\ 0.242 & 0.600 \end{bmatrix} \quad p^s = \begin{bmatrix} 0.623 & 0.377 \end{bmatrix} \; 1 - \lambda^s_{\max} = 0.642$$

College mobility statistics after introduction of social contract:

$$Q^s = \begin{bmatrix} 0.720 & 0.400 \\ 0.280 & 0.600 \end{bmatrix} \quad p^s = \begin{bmatrix} 0.588 & 0.412 \end{bmatrix} \; 1 - \lambda^s_{\max} = 0.680$$

4.3 Income Inequality

Preschool experience will increase the income of the children of poor SES and thus it will reduce the income gap between the rich and the poor. In the long-run, the income distribution that one observes is the invariant distribution. Taking the Gini-coefficient as our measure the income inequality, the estimated coefficients of income inequality are respectively 0.1809 without the social contract, and 0.1484 with the social contract. The estimated Gini-coefficient of 0.1809 turns out to be very close to the estimates found in other studies on the US. We note that the social contract of publicly providing preschool to children of poor SES leads to a significant reduction in income inequality.

4.4 Tax Burden of the Social Contract

Suppose the government provides preschool to the children of poor SES perpetually. We know that the size of the population of poor SES will become smaller and smaller over time. Thus the resource needs of the program will become smaller, and the tax revenues will become higher over time. One can look at the stream of these costs and benefits to the society and then compute the average per period costs and benefits to calculate the tax-burdens of the social

contract. Applying the Ergodic theorem, however, this boils down to computing the costs and benefits of the invariant distribution that will result after the introduction of the social contract.

Assuming a flat average income tax rate of 15% for all income groups, I computed that each dollar spent to provide free preschool to children of poor SES, the tax payers get back $1.16. This estimate is, however, based on using the cost data of a very high cost program whose benefits are much higher than the estimated benefits of this model, and also this benefit calculation does not take into account other public savings such as savings from welfare assistance and savings to the criminal justice system and potential victims of crimes. If these effects were incorporated, the returns would be much higher. Using data from the High/Scope Perry Preschool Program Schweinhart et al. estimated a total benefit from all these sources to be $7.16 for each dollar spent on the preschool program.

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