WELFARE AND WORK PARTICIPATION OF SINGLE MOTHERS AND CHILDREN'S COGNITIVE DEVELOPMENT

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ASTRACT

The effects of single mothers' welfare participation and work decisions on children's outcomes are important. First, theories and empirical studies regarding the effects of mothers' work on children's attainments yield ambiguous findings. Second, participating in AFDC also exhibits a negative statistical relationship with the participating children's possible outcomes of all sorts in the data. We develop a dynamic structural model of a single mother's work and welfare participation decisions while their children are young. This model is used to measure the effects of mothers' decisions on children's attainments in the short run. Using NLSY79 children's PIAT Math test scores as a measure of attainment, we find that single mother's work and welfare use in the first five years of her child's life both have positive effect on her child's outcome, but this effect declines by the initial ability. The higher the potential ability of child, the lower the positive impact work and welfare have. In fact, in case of welfare the effect is negative if child has more than about median initial ability.. Furthermore, we find that work requirement reduces a single mother's use of welfare. However, the net effect of work requirement on a child's test score depends on whether mother's work brings in enough labor income to compensate for the loss of welfare benefits. We also look at the implications of welfare eligibility time limit, child bonus, and maternal leave, on child's outcome. (JEL CODES: I38, J22, J18)

SECTION I: INTRODUCTION

Poor families, many of them headed by single mothers, are eligible for various government mean-tested transfer programs designed to improve the well-being of family members. Among all such transfer programs, Aid to Families with Dependent Children (AFDC) was one of the largest. In fact, AFDC was often referred to simply as "welfare" in the U.S. In addition to offering cash benefits, participating in the welfare program often assures participants' eligibility for other programs such as food stamps and Medicaid.[1] In 1996, the Personal Responsibility and Work Opportunity Reconciliation Act of 1996 (PROWORA) ended AFDC, replacing it with the new, Temporary Aid for Needy Families (TANF) program. TANF differs from AFDC in the sense that it ends the "entitlement" of eligible welfare families by introducing a time limit on welfare benefits and requiring participants to work, as well as giving U.S. states more flexibility in developing their own programs.

Although studies on the relationship between welfare participation and single mothers' behaviors abound, it is not clear whether, or how, children living in poor families will be affected by their parents' decisions regarding welfare participation. Several important questions warrant investigation. First, previous studies find that childhood AFDC participation exhibits a negative statistical relationship with all sorts of children's outcomes in the data. These relationships seem counterintuitive, since the provision of both cash and in-kind benefits from government programs presumably should have helped participating families to better educate their offspring.

Second, AFDC benefits declined in labor income, possibly creating a disincentive to work. It is therefore important to distinguish the effect of participating in welfare from that of mother's work decision on children's attainments. Throughout the years, the effective welfare tax on labor earnings is generally at about 30%.[2] When losing the eligibility of other linked welfare programs is considered, the implicit tax rate of AFDC at the margin is well above 100% (Keane and Moffitt, 1996). As a result, welfare participants are often also associated

[1] Keane and Moffitt (1998) state that, in 1984, 89% of AFDC recipients also received Food Stamps and Medicaid benefits, and another 42% also had a fourth benefit, mostly housing subsidies.

[2] See Fraker, Moffitt, and Wolf (1985) and McKinnish, Sanders, and Smith (1999) for estimates of effective welfare tax rates using AFDC administrative data.

with unemployment, or with working only enough to fulfil the minimum requirement. It is exactly due to this reason that TANF eventually requires welfare participants to work.

Theories on the effect of mothers' work decisions on children's attainments yield ambiguous predictions. On the one hand, the mother's work experience represents the forgone time she could have spent with her child. In this aspect, more work experience may hinder her child's development. However, a mother can also be a role model for her child to follow by working more. The effect of the work requirement of TANF on children's attainments is thus not immediately clear.

Welfare reform imposes two drastic changes, namely, a five-year time limit and a work requirement. Previous studies suggest that childhood welfare experience has a time-varying effect on children's attainments. That is, the marginal effect of each additional year on welfare may depend on a participant's past welfare experience. Empirical research using reduced-form estimation suggests that having a parent who participates in welfare for less than three years before the child begins formal schooling is correlated with a gain as high as five percentage points in Picture Individual Achievement Test (PIAT) percentile scores. If such a nonlinear effect exists in determining a child's attainments, it is important to know the implication of the new five-year time limit on participating children's attainments.

To answer the above questions, we propose a dynamic structural model of a mother's work and welfare participation decisions while raising children. We model a single-decision maker (mother) during multiple-periods (the offspring's childhood, in particular, the period from ages one to five years old). In each period, the mother's current period utility function depends on three "goods": leisure, consumption, and her child's cognitive ability, and one "bad" : welfare participation, as well as a preference shock. The mother's current period income is determined by her work and welfare decisions, her individual-specific wage function, welfare benefit, and her other income. The mother's current wage depends on her past work experience, individual characteristics (including age), and a (normal) random shock.

The child's current cognitive ability is a function of his or her own initial cognitive ability, his mother's current time input, cumulative work and welfare participation decisions, and his mother's cumulative income up to the current year. As discussed in previous sections,

the mother's two decisions have conflicting effects on her child's ability. The mother's work experience represents the forgone time she could have spent with her child. In this aspect, more work experience may hinder her child's development. However, a mother can also be a role model for her child to follow by working more. The empirical study is hence to identify which effect, if any, would dominate in determining a child's cognitive ability. Of course, though it may make for bad role models, welfare does provide a cash benefit.

To simplify the matter, we assume the functional form of cognitive ability formation is known to the mother (but not observed by economists). What economists can observe is the results of the test children are given as a part of the survey from which child's ability is inferred. We will not model the mother's saving decision in this model, which means that a family consumes all it has in each period (this is reasonable, considering that poor families are more likely to face binding borrowing constraints).

In this model, a mother's past cumulative decisions concerning work and welfare participation would contribute to her current period utility, and hence build up the links between periods. In particular, the mother's decision to work has four effects in this model. First, they directly decrease the mother's current period utility. Second, they increase family income (and future wage). Third, it reduces the time available to spend with the child, and last, they will affect her child's cognitive ability. The last three will indirectly increase the mother's current and future utilities. Finally, in this model, the heterogeneity of mothers will result from their different levels of initial human capital at birth.

The childhood of an individual will be defined as the period of ages one through five. The attainments we adopt come from the National Longitudinal Survey of Youth (NLSY), including the standardized Picture Individual Achievement Test (PIAT), which involves math (PIAT-Math) and reading Recognition (PIAT-Read) scores[3]. To better control for the heterogeneity in the data, we only focus on mothers who have been single for at least a year.

The structure of the paper is as follows. In the next section, we provide a review of previous studies of the effects of welfare on children's attainments. In section three, we

[3]NLSY uses the 1968 national norm sample to standardize test scores. The standardized score ranges from 65 to 135, with a mean of 100 and a standard deviation of 15.

propose a dynamic structural model of a mother's welfare and work decisions during her child's childhood. Sections four and five describe the sample we are using for the empirical analysis. Section six reports estimation results. Section seven concludes with a discussion of results and a future extensions.

SECTION II: LITERATURE REVIEW

In this section, we review previous studies on the determinants of children's attainments. Facing the concerns of mothers' observed and unobserved heterogeneities, we put particular emphasis on the following: the sample composition of research, the scholars' investigating methodologies, which parental decisions they investigate, and the resulting effects of the decisions on children's various attainments.

The literature on children's development is abundant (see reviews by Haveman and Wolfe (1995), Currie (1998), and Morris, Duncan, and Rodrigues (2004) for a more recent survey). Most of studies use reduced-form estimation, and focus their attention on children growing up in two-parent, financially stable families using OLS. Below is a short-review of this type of research.

In exploring the determinants of attainment of a child raised in a "standard" family, studies generally include all observed children from data surveys, and dummy variables, such as observed welfare recipience, poverty status, and marital status are used to identify children that were raised in environments that differed from those of standard families. As these dummy variables generally indicate the differences in the disadvantages in the socioeconomic status that may not be captured by econometricians, the estimator of an OLS estimator will be biased. For example, Corcoran *et al.* (1992), using all male children observed in PSID and OLS method, find that there is a significant negative relationship between childhood welfare recipiency and men's early adulthood labor income. Using children in PSID families, Haveman *et al.* (1991) also find a significant negative relationship for the high school graduation rate. Duncan (1994), using PSID children who lived in urban areas during 1968 to 1991, also found a significant negative coefficient for years of schooling.

Even though we focus only on the group of people that are eligible for the welfare pro-

gram, a second issue is that, despite its entitlement feature, only about 60% of all the eligible single mothers actually participate in the program. If this decision is based on some unobserved matter (such as a stigma, as suggested by Moffitt (1983)), which also correlates with children's attainments, the estimates based simply upon a comparison between participants and eligible non-participants would be biased. As a result, the negative coefficients may simply capture the negative relationship between the unobservables and children's attainments (see Duncan, G. *et al.* (2004) for a discussion on the endogeneity problem in developmental studies).

Several econometric methods have been proposed by researchers to solve the unobserved heterogeneity issue. Hill and O'Neill (1994) and Currie (1995) use an instrumental variables (IV) approach, where the IVs are probabilities of work and welfare and the guarantee benefit for a single mother with two children and no income, respectively. They find that welfare recipience during a child's childhood have no effect on his or her short-run test scores. On the other hand, Currie and Thomas (1995) and Garces *et al.* (2002) use sibling comparisons to investigate the effect of Head Start. Currie and Thomas (1995) find that Head Start has different effects (from insignificant to positive) on test scores based on a child's ethnic background, and Garces *et al.* (2002) find that it has a positive effect on a child's long-run outcome measures, such as crime rate.

Chyi (2006) combines both sibling comparisons and IV approach. Exploiting the longitudinal nature of PSID and NLSY79, he tracks the effects of welfare experiences in the first five years since a child's birth on his test scores at age six, number of years of schooling at age twenty-five, and early adulthood labor income from ages twenty-five to, at most, thirty-five. Due to sample size restrictions, he models sibling comparison using a random-effect framework. The instrument he adopts are the expected years of welfare and work in the first five years since a child's birth. The identification comes from the exogenous variation in a mother's economic incentives to work and to participate in the welfare program due to different levels of generosity in each U.S. state's benefit program. He finds that the effects of mothers' decisions are significant and nonlinear. Participating in the welfare program for no more than three years during a child's formative years provides as high as a five percentage

point gain in a child's Picture Individual Achievement Test (PIAT) test scores but has no effects on number of years of schooling nor on labor income. Work, on the contrary, has no effect on test scores, but mothers who work for four years or less can expect their children to have as high as $7,000 more in labor income than those who were not on welfare during their children's childhoods.

However, Chyi (2006) uses a sample of children whose childhoods ended before the welfare of 1996. As a result, it is hard to extend his finding to predict the possible changes in children's attainments under the new welfare program. Furthermore, due to the dynamic nature of mothers' decisions as well as children's attainments formulation, more studies have turned their focus on the estimation of the parameters from a dynamic structural model (for example, Keane and Moffitt (1998) and Bernal (2006)).

Bernal develops and estimates a dynamic model of employment and child care decisions of mothers within 5 years of birth. She uses the model to analyze the effects of these decisions on a child's cognitive development. She recovers structural utility, productivity and ability parameters. By developing a structural model, she overcomes issues such as selection and the endogeneity of the decisions and outcomes in the data. She reports that mother's employment and the use of outside child care significantly reduces a child's ability accumulation. Her results also indicate that children with higher ability are more sensitive to mothers' decisions. She provides evidence that the return to time investment is higher for high ability children. However, mothers still have an incentive to invest in their low ability children, since the mothers' marginal utility of child's ability is diminishing.

This study motivates our structural work. Our study compliments hers in the sense that, first, she focuses on children from married women, while our sample contains disadvantaged families with single mother heads. Second, we will analyze the welfare participation and work decisions, and study the implication of welfare reform (most notably, work requirements, earning disregard, and time-limits) on children's attainments.

SECTION III: MODEL

In this section, we will present a dynamic model of a single mother's work and welfare

participation decisions and the effects of these decisions on her child's cognitive development. In this model, the mother is the sole decision maker, maximizing her utility by choosing the amount of the composite good and leisure she wants to consume every period from her child's birth until the child goes to primary school at age five. Her decision in each period affects three things: how much ability her child gains that period, the worth of her labor in the subsequent periods, and her child's test scores in the final period.

A dynamic model of decision making in this context allows us to overcome the limitations of most previous studies on the relationships between a mothers' decisions and her children's attainments by formally modeling the unobserved heterogeneities that bias reduced-form estimations. Women who are working or participating in welfare may be systematically different from those women who are not. Also, reduced-form estimations assume that work and welfare decisions of the mother determine her child's cognitive ability. However, the ability of a child will also affect the mother's decision to work and participate in welfare. Moreover, the structural model allows us to evaluate counterfactual policy experiments. Even though a structural model requires strong distributional assumptions and hence implies a higher risk of model misspecification, such counterfactual analysis could not be done with a reduced form estimation of production functions.

In our model, women are heterogenous in their market productivity. Children are homogenous in their initial ability endowments. For simplicity, we assume a mother has the full knowledge of her child's ability (even though it is not observed by econometrician). However, a child's final-period test score is determined by the cumulative ability as well as a random disturbance, which is unobserved by neither econometrician nor the mother.

In the following sections we explain the mother's dynamic optimization problem in detail and provide the solution for the problem. The econometric model and the estimation follows.

A. Mother's Optimization Problem

In each period, a mother makes two decisions, whether to participate in welfare (I^W) and how much to work (h). Welfare choice is defined as a binary variable and work choice has three possibilities, including work full-time (2000 hours a year or 40 hours a week for 50

weeks), part-time (1000 hours a year or 20 hours a week for 50 weeks) and no work. As a result, there are 6 possible outcomes which can be formally written as:

$$J = \{(h_t, I_t^w) : h_t = 0, 1, 2 \; and \; I_t^w = 0, 1\}$$

We use indicator functions d_t^j to represent the alternatives that are chosen, where $j = 1, .., 6$. To clarify, $j = 1$ corresponds to $(h_t, I_t^w) = (0, 0)$, and means that a mother chooses (no work, no welfare) in period t. $j = 2$ represents $(h_t, I_t^w) = (1, 0)$, (part-time, no welfare), and $j = 3$ represents (full-time, no welfare), ... etc. According to this setup, we are estimating the *joint* probability distribution of mother's work and welfare participation decisions.

In each period, the state vector S_t includes previous work experience E_t, and cumulative welfare usage W_t, which evolve in the following manner:

$$\begin{aligned} E_0 &= 0 \\ E_t &= E_{t-1} + h_{t-1} \\ W_0 &= 0 \\ W_t &= W_{t-1} + I_{t-1}^W, \end{aligned}$$

where h_{t-1}, and I_{t-1}^W are previous-period work and welfare choices, respectively.

Facing a given state vector S_τ at the beginning of a specific period τ, a mother makes choices for periods from τ on, i.e. chooses d_t^j for $t = \tau, \tau + 1, ..., 5\}$ to maximize her expected utility of the remaining periods, V_τ. V_τ can be thought as the sum of a mother's current-period utility and discounted future utilities that depends on the alternative j she chooses for the current period that maximizes V_τ.

Define a current-period, alternative-specific utility $u(S_t, j, \epsilon_t)$ as the sum of a non-random part U^j and an alternative-specific shock ϵ^j. We have

$$u(S_t, j, \epsilon_t) = u(S_t, j) + d_t^j \epsilon^j = U_t^j + d_t^j \epsilon^j, \tag{1}$$

where the ϵ^j is assumed to be i.i.d. across time.

With S_t, j, and discount rate β, we can write V_t as:

$$V(S_t, \epsilon_t) = \max_{d_t^j} \{V^j(S_t, j) + d_t^j \epsilon_t^j\}, \tag{2}$$

where $V^j(S,j)$ is given by the recursive form:

$$V^j(S,j) = U^j + \beta \sum_{S'} \Pr(S'|S,j) EV(S',\epsilon'). \tag{3}$$

B. Solution to Mother's Optimization Problem

A mother's optimization problem will be solved recursively from the final period T. The rationale is as follows: in order to make a choice at $T-1$, a mother needs to know her choice at period T, given that her choice at $T-1$ is d^j_{T-1}. In other words, before making the decision of d^j_{T-1}, we need to know the decision of $d^j_T|_{d^j_{T-1}}$.

That is, at the beginning of period $T-1$, the mother is choosing d^j_{T-1} by calculating:

$$V(S_{T-1},\epsilon_{T-1}) = \max_j \{U^j_{T-1} + d^j_{T-1}\epsilon^j_{T-1} + \beta EV(S_T,\epsilon_T)\}.$$

To solve this, first, the mother must calculate:

$$\begin{aligned} E_\epsilon V(S_T,\epsilon_T) &= \max_{d^j_T} E_\epsilon(V^1_T, V^2_T, V^3_T, V^4_T, V^5_T, V^6_T | S_{T-1}, d^j_{T-1}) \\ &= \sum_k \Pr(S_T, d^k_T = 1)\ U^K_T. \end{aligned}$$

Now, move back to period $T-2$. Before she can make the decision of d_{T-2}, she needs to know the alternative-specific value functions for every feasible S^j_{T-2},....etc, until she reaches back to the current period t.

SECTION IV: EMPIRICAL IMPLEMENTATION

A. Mother's Current Period Utility Function

The mother's current period utility of choosing alternative $j \in J$ is given by

$$U^j_t = \frac{1}{\alpha_1} c_t^{\alpha_1} + \alpha_2 h_t + \alpha_3 (\frac{A^\lambda_t - 1}{\lambda}) + \alpha_4 I^W_t + \alpha_5 I\left(\sum_{T=1}^{t-1} I^W_T < 0\right) + \alpha_6 I\left(\sum_{T=1}^{t-1} h_T < 0\right) + \epsilon^j_t \tag{4}$$

where c_t is consumption, h_t is the work, and A_t is the ability of the child. α_2 and α_4 are distaste for work and welfare. α_5 captures the additional cost incurred when applying for welfare for the first time and α_6 is the search cost of job if the woman has not worked after giving birth. Consumption is given by the budget constraint

$$c_t = w_t h_t + M_t + I_t^W * WI_t - KI \tag{5}$$

in which M_t is non-labor and non-welfare income, and WI_{jt} is the dollar amount of welfare transfer for that year, I_t^W is an indicator for welfare participation. KI, in the budget constraint, is the money invested in the kid's ability. KI is assumed to be a constant percent of yearly income, that is $KI = \kappa(w_t h_t + M_t + I_t^W * WI_t)$ where κ is a parameter to be estimated. The utility function is of the constant relative risk averse (CRRA) variety both in consumption and child's ability. By CRRA, $\lambda < 1$ means the mother gets diminishing returns to child's ability and thus has a higher incentive to invest in ability production when her child's ability is relatively low.

The parameters α_2 and α_4 are tastes for leisure and welfare, respectively.

B. Wage Equation

The mother's log initial wage, $\ln w_0$, is determined as

$$\ln w_0 = \mu_0 + X_0\theta + \xi_0, \tag{6}$$

where μ_0 is the unobserved heterogeneity, and X_0 is the mother's demographic characteristics, including race, age at childbirth, education and AFQT score. ξ_0 is the measurement error and is assumed to be i.i.d. Rewrite the log initial wage as

$$\ln w_0 = \ln \overline{w_0} + \xi_0, \tag{7}$$

where $\ln \overline{w_0}$ represents the persistent part of a mother's initial productivity endowment. Her future wages are determined by this persistent initial wage component with depreciation, as well as other factors:

$$\ln w_t = \ln \overline{w_0} - \delta t + \phi_1 E_t + \phi_2 (E_t * ed) + \phi_3 L_{st} + \xi_t,$$

where δ is the depreciation rate. $E_t = \sum_0^{t-1} h_\tau$ is the mother's cumulative work experiences, ed is mother's education in number of years. L_{st} is the labor market quality measure, in our case, unemployment rate in U.S. state s where the mother and child reside at time t. Finally, ξ_t is the random shock which is assumed to be i.i.d normal.

C. Child's Cognitive Ability

Each child was born with an initial ability level A_0, which is a function of the child's own characteristics such as gender and race, the mother's characteristics, here measured by AFQT score, the mother's education, and her age at childbirth.

Once the initial ability is given, the mother can "produce" the current-period cognitive ability (A_t) using the following production function:

$$\ln A_t = \ln A_0 + \gamma_1 \ln \kappa Y + \gamma_2 E_t + \gamma_3 W_t + \gamma_4 \ln A_0 W_t + \gamma_5 \ln A_0 E_t + \gamma_6 t), \tag{8}$$

where E_t is work experience at time t, W_t is the number of periods between 1 and $t-1$ spent on welfare, Y_t is mother's cumulative income (assuming that a mother spends a constant proportion of her income, κ, on child's ability accumulation). t indexes the age of child, here from 1 to 5. We do not observe the child's ability but we can use his eventual test scores as a proxy. In the data, all children take ability tests biannually starting from age 5. Thus, whenever there is a test score observed, O_T, outcome/score of the child can be written as:

$$\ln O_t = \ln A_t + \varkappa + \nu_t \tag{9}$$

where $\varkappa$ is the mean test score and ν_T is the random disturbance, distributed as normal with zero mean and σ_ν.

D. The Likelihood Function

The individual likelihood function for individual i for time t can be written as

$$L_{it} = \{\sum_{j=1}^{J} d_t^j \ \Pr(d_t^j = 1|S_t)\} \phi(w_t|S_t)^{I[h_t>0]} \phi(O_t)^{I[O_t \ \ available]} \tag{10}$$

where $\phi(w_t|S_t)^{I(h_t>0)}$ is the probability of observing wage (w_t) if the mother is working and $\phi(O_t)^{I[O_t \ \ available]}$ is the probability of observing a test score (O_t) if the test is given at time t. The product of L_{it} for all t gives us the individual likelihood. The natural logarithm of the product of individual likelihoods is the log likelihood function, i.e the objective function we are maximizing.

E. Estimation Issues

We will estimate the full model using maximum likelihood. There are three issues regarding the estimation of θ using the maximum likelihood method. First, V_t^j is a dynamic programming problem, and we need to solve it before we can compute $\Pr(d_t^j = 1, S_t; \theta)$. We know, given state variable S_t, and the alternative-specific error term ϵ_t^j, that

$$V^j(S_t, \epsilon_t^j, \theta) = u_t^j + \beta \int_{\epsilon'} \max(V^1, V^2, ..., V^J) dF(\epsilon').$$

The problem can then be solved by backward induction, as discussed in the previous section.

We assume that the preference shocks ϵ are drawn iid from the Type I extreme value distributions with unit variance. This enables to write the probability of choosing j given state S_t as

$$\Pr(S_t, j) = \frac{\exp\{V^j(S_t, j)\}}{\sum_k \exp\{V_k(S_t, j)\}}. \tag{12}$$

(see Rust (1987, 2000)).

Identification

The variation of AFDC benefits across states is often used to identify the utility parameters in research on the effects of AFDC on single mothers' decisions (see a complete review in Moffitt (2002)). However, the benefit rules for the AFDC program are a non-linear function of a mother's income, work decision, and number of children. Keane and Wolpin (2002) find that empirical results vary widely among studies adopting different benefit rule parameters. They argue that this is because simply using the benefit level of a specific year would fail to capture the long-run changes of state AFDC rules, which are more likely to affect mothers' decisions in a dynamic setting. Instead of using random real benefit levels, they suggest

one should estimate the long-run state benefit rules and use the estimated parameters as instruments.

Following Keane and Wolpin's strategy, we estimate the AFDC benefit rules for each of the U.S. states by pooling all single mothers' welfare receipts in PSID from 1968 to 1992 using dummy variables to identify the benefit parameters of each state. The AFDC benefit for a mother i who lives in state s is given by:

$$\begin{aligned} WI_{is} = b_0 + (b_2 + \sum_s b_{3s} D_s) \cdot noC_i + (b_4 + \sum_k b_{5k} D_k) \cdot noCSq_i \\ + (b_6 + \sum_s b_{7s} D_s) M_i + (b_8 + \sum_k b_{9k} D_s)(w_i h_i), \end{aligned} \tag{13}$$

where D_s is the indicator of the residence of individual i. $D_s = 1$ if i lives in state s.

SECTION V: DATA AND SAMPLE

A. Sample Construction

We focus on children whose mothers have been single for at least one year during their children's life up to age 5.[4] The reason for avoiding use of all single mothers who are financially eligible for welfare is that financial eligibility is, to some extent, the result of a mother's decisions (i.e. choosing not to work). Focusing on the children of these mothers can create a more serious sample selection problem.

The unit sample period in this research is a year. Since most children start school at age five or six, here childhood is defined as from ages one to five. In the NLSY 79 Children survey, a mother's profile from one year before giving birth to when her child is 5 is readily constructed. Each child's profile includes his mother's time-invariant characteristics, as well as her quarterly work history and detailed information on her various sources of income. A family's monthly AFDC receipts can be found in a mother's main NLSY 79 profile. We transform all information into annual measures and also use the Personal Consumption Expenditure Deflator (PCED) to convert nominal monetary terms into 1996 dollars.

[4] An alternative way to construct the sample is to require mothers to have always been single during this period. The estimation results are similar, but this requirement significantly reduces the sample size (by about 60%) and the significance of the estimation.

To measure attainment we make use of the math percentile scores of the Picture Individual Achievement Test (PIAT) from the Children of the National Longitudinal Survey of Youth 1979 Cohort Survey (NLSY 79 Children). Since 1986, PIAT has been assessed biannually and given repeatedly to children starting at the age of 5. We use a child's first observed test scores as his short-run attainments.[5]

Each PIAT assessment begins with five age appropriate simple questions (also know as basal), and progresses to more advanced concepts. NLSY reports three different scores, including raw, percentile, and standardized scores. We use standardized scores as the measure of children's attainments. These are derived from the percentile score, based on the national sample in 1968, with mean 100 and a standard deviation of 15. We note that standardized scores are known for their increasing cohort effect, i.e., mean standardized scores are increasing over cohorts. For example, the sample of disadvantaged children used in this research has a mean math standardized score of 102, which is higher than the mean score of the 1968 national sample.

The NLSY mother-child pair sample is constructed on the basis of the following criteria: (i), the child's mother must have been single at least at some point during the child's ages one to five; (ii), the mother must have recoverable information for the first five years of the child's life; and (iii), the child must have at least one valid PIAT test score.

B. Sample Description

Table 1 summarizes variables used in this research. Sample means are weighted to represent the national population in the year of 1996. We have $11,430$ sample years from $2,286$ children and $1,554$ single mothers.

In terms of mothers' work and welfare participation decisions, these mothers work on average 1742 hours a year (hence work full-time by our definition) during the five-year period. Moreover, about 12% of the mother-child pairs are on welfare. Table 2 further distinguishes these two decisions by the age of the child. As we can see, a mother works more and

[5] Since 1994, only children under the age of 14 have been given the test. The latest cohort available for this research is year 2000, but all the sample children had their first tests taken before 2000.

participates in welfare program less as her child grows. An average mother receives 13 years of education, gives birth to her child at 26 years old, and has about 1.5 children.

The gender and race composition of our sample is as follows: 49% of the sample children are female 54% are black, 27% Hispanic, and 19% non-black, non-Hispanic. The average age adjusted PIAT math standardized score of these children is 102. Note that we use the first-observed valid test score as a child's attainment. On average, the age when they took the first test is at 72 months.

Table 3 shows the correlation between the outcome variable, the PIAT math standardized score, and the variables used in the structural estimation. For continuous variables, we summarized the outcome variable by each variable's $0th-25th$, $25th-50th$, $50th-75th$, and $75th-99th$ percentile ranges in order to see the association of different levels of a particular variable and the outcome variable. As for categorical variables, we list the mean of outcome by each variable's different categories. For each variable, the first row lists the value of the upper percentile in the range. The second and the third row are the mean and standard deviation of outcome. We divide these variables into three categories. They are monetary, mother's, and child's characteristics, respectively. We will discuss them accordingly.

Monetary variables include the hourly wage rate, labor income, and other income. All of them are averaging over five years and measured in 2000 dollars. As we can see from the table, median hourly wage rate is at 10.2 dollars in the sample. For labor and unearned income, the median is at $\$9,000$ and \$0 dollars respectively. Furthermore, the PIAT math score shows a positive correlation with the hourly wage rate. For the two income measures, however, the positive correlation do not seem to be obvious. For example, the mean test score of the $50-75\%$ and $75-99\%$ ranges for real labor income are lower than the $25-50\%$ range. Also, although children who grew up in the upper 25% other income families have significant more money from unearned sources, their test scores are not significantly better.

The next category, the mother's characteristics, includes the mother's age at the time of her child's birth, her education level (at child's age five) and her AFQT score. There seems to be a positive correlation between the mother's age at giving birth and her child's test score. This trend is particularly obvious with older mothers. For education level, we

separate four different categories, including no more than twelve, exactly twelve, twelve to sixteen and more than sixteen, and calculate the group mean accordingly. It exhibits a significant positive correlation between mother's education level and child's test score. For a mother's AFQT scores, the sample exhibits a large variation. As in the case of mother's education level, her AFQT score also exhibits a strong positive correlation with her child's PIAT test score.

The last category is the child's characteristics, including the child's race, gender, number of siblings. On average, black children's test scores are lower than their white and non-white, non-black counterparts. Also, the sample has about an equal percentage of boys and girls, and girls seem to perform better than boys. We separate the number of siblings into zero, one, two, three and more than three. The sample exhibits a negative correlation between PIAT math test score and number of siblings a child has. For example, a child who has no sibling is associated with a 100.3 mean test score, but the mean score for a child with more than three siblings is at just 98.

Finally, we include the county unemployment rate as a control for the local economic situation in the current wage function. The sample seems to suggest that, the higher the unemployment rate in the county where the child grew up, the lower the child's test score is.

Next, Table 4 continues with the simple correlation analysis between PIAT math score and a child's welfare participation and work experiences. For welfare experience, the measure unit is one year. As for work experience, it is every half-year. We also list the percentiles for welfare and work experiences in the last three columns of the table. As seen from the second column, welfare experience exhibits a strong, negative correlation with the outcome. The difference in the mean test scores between children who have never been on welfare and those who have always been on welfare is 8.3 points (the standardized score has a standard deviation of 15). A mother's work experience exhibits a similar correlation, too. When a mother works more during her child's childhood, the child's test score seems to decrease.

Above was a detailed description of the data that we are aim to fit with our model. The next section reports the results of our estimations.

SECTION VI: RESULTS

Table 7 gives the estimates for the wage parameters with given initial wage estimates. The coefficient all have the expected signs: work experience and the interaction of experience and education increases the hourly wages while unemployment level in the county decreases the wage a woman earns.

Table 8 reports estimates for utility function parameters. We find that λ is less than one. This indicates that a mother has an incentive to invest more in her low ability child, which is supported by the data. As for other parameters of the utility function, we see that welfare participation brings in negative utility for a mother, and the initial cost to participate in the welfare is even higher than the disutility from welfare use. This explains why most of the eligible single mothers choose to not participate in the welfare program. The cost of finding the first job, on the contrary, is much smaller than that of the welfare use. This explains why most single mother works in our sample.

The main set of parameters we were interested in is the ability function parameters, which are reported in *Table* 9. Note that the coefficients here refer to the child's log ability (log- standardized test score). As a result, the effects on the standardized test score are the logarithm of the reported coefficients. According to our estimations a one log standardized test point increase in a mother's AFQT score increases the child's ability by about one exponential point. The initial ability of a female offspring is about 0.20 point higher than a male one. Also, if the child is born to a Black or Hispanic mother, its test score is expected to be almost 0.03 log point lower. Furthermore, based on our estimates, born to a mother who were very young or very old when giving birth increases the child's initial ability. Finally, a one thousand dollar increase in the cumulative income of the family increases the child's current ability level by 0.40 log standardized test points.

The marginal effects of a mother's work experience (E) or welfare use (W) on her child's last-period log-outcome can be written as:

$$\begin{aligned} \frac{\triangle \ln A}{\triangle E} &= \gamma_2 + \gamma_5 \ln A_0 \\ \frac{\triangle \ln A}{\triangle W} &= \gamma_3 + \gamma_4 \ln A_0 \end{aligned}$$

Since they depend also on her child's initial log-ability level, $\ln A_0$, we draw Figure 1 and Figure 2 based on different levels of $\ln A_0$ for the effects of work and welfare, respectively. Note that the plausible outcome ranges from 65 to 130. Please note that log mean test score is set to be 4.29. Our estimates imply initial log-ability ranges from 0.007 to 1.790. Given this the contribution of work experience to ability

We see that the effects of a mother's work and welfare decisions on her child's test scores are different. A mother's work is detrimental to her child's math test score. Her welfare use, on the contrary, is beneficial to her child's math score. For a child who has the lowest possible initial ability (4.17), an additional year of mother's work can expect to decrease his test score by about 0.4 log point. Furthermore, the higher a child's initial ability is, the worse the effects of the mother's work decision to its test score. For example, the test score of a child with the highest possible initial log-ability (4.9) will be decreased by 0.52 log point if a mother works for an additional year, as opposed to 0.4 log point when a child has the lowest initial ability.

The effect of the child's childhood welfare experience on his test score is positive. The marginal effect of an additional year of welfare use is at about 0.45 log point. Also, the marginal effect is relatively constant regardless of the level of a child's initial ability. This fact can be seen by the fact that the interaction term of welfare use and initial ability is at just 0.005, as opposed to the main effect of an additional year of welfare use, which is at 0.43. This suggests that welfare program provides a uniform benefit to a child's outcome, regardless of the child's initial ability.

Compare this results to that estimated by Chyi (2006), who uses a statistical correlation model using a similar sample of disadvantaged children from Children of NLSY 79. Controlling for the unobserved heterogeneity in mothers' background by a random-effect

instrumental-variable (REIV) approach, he suggests that an additional year of welfare can provide as high as five percentage points gain on PIAT math and reading recognition scores average. As a result, our structural model practise validates the usefulness of a statistical correlation approach.

Table provides a simple support for model fit. We fit the participation rates for welfare and work quite nicely. We predict 79% of the work behavior correctly. We are a little more successful with welfare; we can predict 87% of the welfare behavior correctly. We also replicate the pattern of change in participation rates with child's age. In data we see that women participate less in both market work and welfare, our estimates have this pattern, especially in work behavior. Our estimates only fail to catch the nonparticipants in the very first period. This should be improved by introduction of pre-birth history of work and welfare to data and. The data for 2 years prior to the birth is available but have not been used to reduce the data points in our analyis.

SECTION VII: POLICY ANALYSIS

We consider the impact of three policies on women's work and welfare participation decisions and children's average math test score..

A. Child Bonus

We estimated that women spend 8% of their annual income directly on kids ability production. On average this corresponds to about 720 dollars for median level of income. In this policy experiment, we transfer this amount to the mother.

B. Maternity Leave Policy

In this experiment we analyse the impact of a maternity leave policy according to which there us no wage penalty for time out of the labor market after giving birth. This policy change is brought upon by setting both the wage depreciation rate (δ) and the cost of initiating market activity (α_{24}) to 0. The aim of the policy is to understand how women respond in terms of work and welfare chocies if they do not get any penalty in terms of wages and can get back to their jobs costlessly after birth.

C. Time Limit on Welfare

We imposed a time limit of 2 years on welfare without work. This corresponds to the policy change brought upon by TANF. We implement this policy by setting benefits to zero if the cumulative welfare years exceed 2 years and no work is chosen.

SECTION VIII: CONCLUSIONS AND FUTURE EXTENSIONS

(Will be updated)

TABLES

Table 1: Sample Descriptives - Means

Mother's Decisions	
Hours of work	1,730
	(579)
Welfare participation rate	0.12
	(0.33)
Work participation rate	
>=500 hours	0.97
	(0.18)
>=1000 hours	0.87
	(0.33)
Mother's characteristics	
Age at birth	26.32
	(4.55)
Years of education	12.99
	(2.18)
Number of children	1.96
	(0.96)
Labor income	19.03
	(17.10)
Other Income	13.08
	(81.18)
AFQT	42.60
	(26.54)
Children's Characterisctics	
Female	0.50
Male	0.50
Black	0.53
Other race	0.47
PIAT standardized math score	101.24
	(13.31)
Age taking test (in months)	73.74
	(10.95)
Other	
Unemployment rate	8.06
	(3.43)
Children-years	12,720
Children	2,286
Mothers	1,653

*population weighted to reflect 1996 national population

**In 2000 dollars

Table 2: Mother's Employment and Welfare Participation by Child's Age

Child's age	Welfare	Work (=500)	work(>=1000)	Hours of work
1	0.16	0.97	0.88	1,733
	(0.37)	(0.16)	(0.32)	(570)
2	0.13	0.97	0.87	1,732
	(0.34)	(0.18)	(0.33)	(582)
3	0.12	0.96	0.87	1,740
	(0.33)	(0.18)	(0.33)	(580)
4	0.11	0.94	0.87	1,727
	(0.31)	(0.18)	(0.34)	(583)
5	0.10	0.97	0.87	1,721
	(0.30)	(0.18)	(0.33)	(580)

Table 3: Detailed Descriptive Statistics

Percentile	**25%**	**50%**	**75%**	**99%**	
Real Hourly Wages	7.6	10.2	14.6	56.2	
Mean Standard Scores	98.0	99.8	101.2	106	
(Standard Deviation)	(13.1)	(13.3)	(12.5)	(13.0)	
Age at Birth	20	23	26	36	
	99.7	101.1	102/9	104.6	
	(12.9)	(12.8)	(14.1)	(13.4)	
Real Other Income($1000)	0	0	5.0	114.6	
	99.2	103.2	102.1	102.0	
	(13.4)	(13.1)	(13.1)	(13.1)	
Real Labor Income($1000)	3.2	9.0	16.0	69.2	
	100.0	99.7	100.1	104.5	
	(13.4)	(13.2)	(13.0)	(13.0)	
Country Unemployment Rate	4.3	5.6	7.3	19.4	
	102.1	101.7	101.3	99.8	
	(12.8)	(13.7)	(13.2)	(13.3)	
Mother's AFQT Score	21	38	64	98	
	95.8	99.5	103.3	106.9	
	(13.2)	(12.4)	(12.5)	(12.4)	
Race	**Black**	**NonBlack**			
	.53%	.47%			
	97.8	104.3			
	(13.1)	(12.8)			
Gender	**Male**	**Female**			
	50%	50%			
	100.3	102.1			
	(14.1)	(12.3)			
Mother's Eduction	**1**	**2**	**3**	**4**	
	<12	**12**	**13-16**	**>16**	
	96.7	99.8	103.0	109.9	
	(12.3)	(13.0)	(13.3)	(14.4)	
Number of Siblings	**1**	**2**	**3**	**4**	
	0	**1**	**2**	**3**	**>3**
	100.3	102.2	101.7	99.3	98.0
	(13.7)	(13.1)	(13.3)	(13.3)	(13.6)
	Mean: 51.9		Std: 26.6		

Table 4: Detailed Descriptive Statistics - Mother's Decisions

Units	Years of Welfare	Work Experince (Half year)	Percentile	Years of Welfare	Work Experince(Half year)
0	102.5	111.5	25%	0	6
	(13.2)	(14.6)			
1	99.2	101.8	50%	0	9
	(13.4)	(11.4)			
2	97.1	106.3	75%	1	10
	(12.1)	(12.8)			
3	93.7	103.5	99%	5	10
	(13.0)	(14.8)			
4	98.6	105.1			
	(11.8)	(12.1)			
5	94.8	103.6			
	(13.2)	(12.4)			
6		102.2			
		(13.2)			
7		99.3			
		(13.6)			
8		100.8			
		(13.2)			
9		100.1			
		(13.1)			
10		100.9			
		(13.5)			

Table 5: Initial Log-wage Estimates

Variables	Coefficient
Years of Schooling	-0.02
	(0.02)
Years of Schooling Squared	0.004*
	(0.001)
Age	-0.01
	(0.01)
Age Squared	0.0002**
	(0.0001)
Black	-0.14*
	(0.02)
Hispanic	-0.05*
	(0.02)
Constant	1.82*
	(0.18)

*: significant at %1 , **: 5% , ***: 10% level

Table 6: Fixed Parameter Values	
Mean test score(x)	4.29
Beta (β)	0.9
Delta (δ)	0.003

Table 7: Wage Parameters	
work experience	0.052
	(0.004)
full time premium	-0.009
	(0.02)
education*experience	0.001
	(0.006)
county unemployment rate	-0.025
	(0.02)

Table 8: Utility Parameters	
consumption	1.64
	(0.003)
ability of the child	3.22
	(0.021)
work participation	-2.04
	(0.002)
welfare participation	-3.39
	(0.01)
first job after birth	-1.63
	(0.002)
first year on welfare after birth	-2.91
	(0.01)
share of income not consumed	0.08
	(0.003)
lambda	0.28
	(0.001)

Table 9: Initial and Current Ability Parameters	
AFQT	0.004
	(0.001)
gender	0.54
	(0.001)
race	0.05
	(0.000)
education of mother	0.0004
	(0.000)
age less than 18	0.5881
	(0.05)
age more than 33	0.785
	(0.05)
cumulative work experience	0.246
	(0.000)
years on welfare	0.1022
	(0.05)
cumulative income	0.004
	(0.05)
years on welfare*initial ability	-0.1175
	(0.05)
cumulative work experience*initial ability	-0.109
	(0.007)
age	-0.01
	(0.2)

Table 10: Model Fit		
	actual	**predicted**
Welfare Participation Rate	12.45	13.24
Work Participation Rate	86.75	86.15

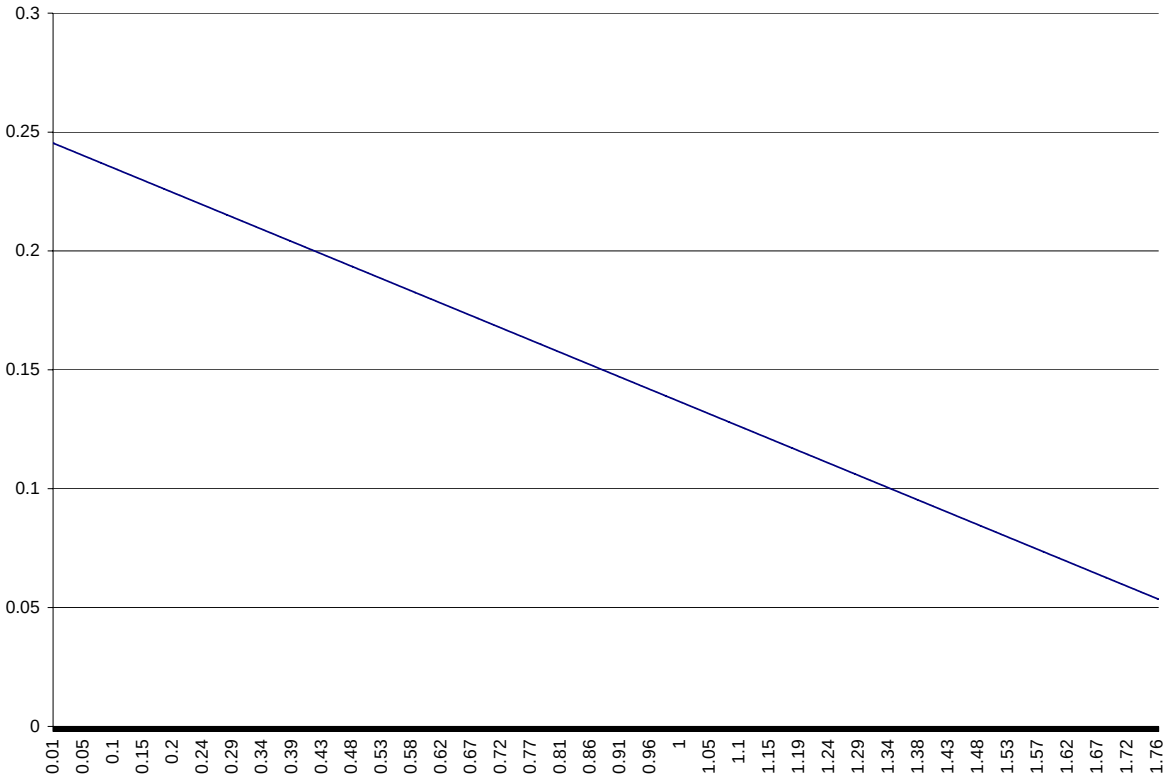

Figure 1: Effect of work experience on ability for a given initial ability

Figure 2: Effect of welfare experience on ability for a given initial ability