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Chyi, Hau and Ozturk, Orgul

Wise Xiamen University, University of South Carolina

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Welfare Reform and Children's Short-Run Attainments – A Structural Approach

Hau Chyi* Orgul Demet Ozturk†

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Abstract

In this paper, we develop a dynamic structural model of single mothers' work and welfare participation decisions while their children are young. This model is used to measure the effects of mothers' decisions on short run attainments of the children of NLSY 79. Using PIAT Math test score as a measure of attainment, we find that both single mothers' work and welfare use in the first five years of their children's lives have a positive effect on children's outcomes, but this effect declines with initial ability. The higher the initial ability of a child, the lower the positive impact work and welfare have. In fact, in the case of welfare the effect is negative if a child has more than median initial ability. Furthermore, we find that the work requirement reduces a single mother's use of welfare. However, the net effect of the work requirement on a child's test score depends on whether the mother's work brings in enough labor income to compensate for the loss of welfare benefits. We also look at the implications of the welfare eligibility time limit and maternal leave policies on children's outcomes.
Keywords: Welfare reform, childhood cognitive ability, female work, dynamic choice model, maximum likelihood
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*WISE, Xiamen University

†University of South Carolina, Economics Department, Moore School of Business, Columbia SC, 29208. e-mail: odozturk@moore.sc.edu. The authors would like to thank all participants at the European Society for Population Economics 2007 and Southern Economic Association 2007 conferences and seminars at Academia Sinica, Taiwan; CCER, Beijing University, China; University of South Carolina; Tsinghua University and WISE, Xiamen University, China. We would like to give special thanks to Jay Zagorsky who generously provides us the child custom weight program for children of the NLSY79 mothers.

1 Introduction

Aid to Families with Dependent Children (AFDC) program (and after 1996, Temporary Aid to Needy Families (TANF) program) has long been one of the most important means for the U.S. government to fight for poverty. Besides a monthly cash benefit, the eligibility of the AFDC has been linked to other important means-tested transfer programs, including among others, Medicaid, Food Stamps, School Lunch, and Head Start.[1] Theses welfare programs through various channels, have helped welfare participants (now mostly low-skilled single mothers) to better educate their children during childhoods.

In 1996, the Personal Responsibility and Work Opportunity Reconciliation Act of 1996 (PROWORA) ended AFDC, replacing it with the new TANF program. TANF differs from AFDC in the sense that it ends the "entitlement" of eligible welfare families by mainly introducing a parent's five-year time limit on welfare benefits and requiring participants to work. Despite plentiful studies on the effects of welfare reform on mothers' behavioral responses, it is not clear whether, or how, the cognitive developments of children lived in poor families will be affected by the welfare reform. Our research intends to shed some light on this issue.

In this paper, we analyze the impact of the welfare reform on the short-run cognitive development of welfare participants' children using a multi-period structural model. We first estimate the effects of mothers' work and welfare use on children's ability formation using a sample of low-skilled single mothers and their children from the National Longitudinal Survey of Youth 1979 Cohort (Children of NLSY79). With the estimated parameters, we then simulate different policy initiatives of the welfare reform to evaluate how each particular change impacts work and welfare participation behaviors of the mothers, and in turn, children's cognitive developments.

We assume a low-skilled single mother makes quarterly work and welfare use de-

[1] See Table D-1, Citro and Michael (1995). Note that Housing subsidy and Head Start are block grant programs. That means not all eligible children will be admitted.

cisions in her child's early childhood, which is defined as from the child'd birth to the age of five. In our model, a child's ability production function is comprised by: (1) initial ability that a child is born with; (2) a mothers' cumulated financial investments during childhood; (3) the child's childhood welfare and work experiences. Participating in the welfare program during childhood has various implications on a child's cognitive development that will be incorporated by the above three channels.

First, quarterly welfare cash benefit (if applied) increases a mother's available financial resources that can be used to invest on her child's cognitive ability. Since share of cumulative income is already included in the child ability production function, it is isolated from the effect of welfare experience. Second, participating in the welfare program allows a mother to spend more time on children (through not work). Given that we have also controlled cumulative work experience in the production function, the effect from saved time through welfare will be captured as a reduction in the work experience. In our model, what we do not control in either budget constraint or work experience, hence are captured by the welfare experience, are benefits through non-monetary means-tested transfer programs, among them, most notably, Medicaid.[2]

Add correlation between medicaid and AFDC in the data

One important econometric issue is to control the unobserved characteristics. For example, certain issues faced by a single mother (for example, parental depression due to poverty, stress from work, and marital status); though they are unobserved by econometricians, surely affect a mother's work and welfare participation decisions, as well as her children's attainments. Also, each child may have specific needs that could affect the mother's decisions during his or her childhood. If a child was born less healthy than his siblings, his mother may need to take more time off from work, or may need to apply for AFDC for Medicaid coverage.The child may also have a lower attainment because of this situation. Without taking into account for these unobserved factors that simultaneously affect mothers' decisions

[2]Before the expansion of Medicaid in 1986, applying for AFDC is the only way for poor families to be eligible for Medicaid. After 1996, more children are eligible for Medicaid than for AFDC.

and children's attainments, our estimates of the effects of work and welfare are very likely to be biased. This may explain why previous studies exhibit negative relationships between welfare participation and children's outcomes.

HOW DO WE CONTROL THESE TWO FACTORS IN OUR MODEL?

Results to be added here.

The structure of the paper is as follows. In Section 2, we provide a review of previous studies of the effects of welfare on children's attainments. In Section 3, we propose a dynamic structural model of a mother's welfare and work decisions during her child's childhood and Section 4 discusses the empirical specification. Section 5 describe the sample we are using for the empirical analysis. Section 6 and 7 report estimation results and policy analysis, respectively. Section 8 concludes with a discussion of results and future extensions.

2 Literature Review

The literature on children's development is well developed (see reviews by Haveman and Wolfe (1995), Currie (1998), and Morris, Duncan, and Rodrigues (2004) for a more recent survey). Most studies use reduced-form estimation, and focus their attention on children growing up in two-parent, financially stable families using OLS. These studies generally use survey data on all children and utilize dummy variables, such as observed welfare status, poverty status, and marital status to identify children that were raised in environments that are different 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 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 status and men's early adulthood labor income. Using children in PSID families, Haveman et al. (1999) 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 program, 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 participation during a child's childhood have no effect on his or her short-run test score. 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 score 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.

Todd and Wolpin (2003) reviews (1) effects of whatt mothers' decisions?

Bernal (2007) 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. She reports that a 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. Our study complements hers in the sense that, first, she focuses on children from married women, while our sample contains disadvantaged families with single mother as heads of the household. 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.

3 Model

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. A mother's past cumulative decisions concerning work and welfare participation contribute to her current period utility. In particular, the mother's decision to work has four effects in this model. First, it directly decreases the mother's current period utility. Second, it increases 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.

In this model, mothers are heterogenous in terms of their innate ability. A mother's innate ability together with her other characteristics like education and age at birth determines her child's initial ability. The current cognitive ability of a child is then produced as a function of this initial cognitive ability, mother's cumulative work and welfare participation decisions, and her cumulative income up to the current year. To simplify the matter, we assume the functional form of cognitive ability formation is known to the mother (but not observed by the econometrician). We can only observe 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.

The attainment measures 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.

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.

3.1 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)[4]. Welfare choice is defined as a binary variable and work choice has three possibilities: working full-time (2000 hours a year or 40 hours a week for 50 weeks), working part-time (1000 hours a year or 20 hours a week for 50 weeks) and not working. 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_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

[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.

[4] Subscript to indicate individuals, i, is suppressed for simplicity. j is the subscript for choice, and t is the script for period.

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 and $d_j = 1$ means alternative j is chosen. According to this setup, we are estimating the *joint* probability distribution of the 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:

$$\begin{aligned} &E_1 = 0 \\ &E_t = E_{t-1} + h_{t-1} \\ &W_1 = 0 \\ &W_t = W_{t-1} + I_{t-1}^W, \end{aligned}$$

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. she 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 of 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 $u(S_t, j, \epsilon_{jt})$ as the sum of a non-random part U_{jt} and an alternative-specific shock ϵ_{jt}. We have

$$u(S_t, j, \epsilon_{jt}) = u(S_t, j) + d_{jt}\epsilon_{jt} = U_t^j + d_{jt}\epsilon_{jt}, \tag{1}$$

where the ϵ_{jt} is assumed to be i.i.d. across time.

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

$$V(S_t, \epsilon_{jt}) = \max_{d_{jt}}\{V^j(S_t, j) + d_{jt}\epsilon_{jt}\}, \tag{2}$$

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

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

3.2 Solution to Mother's Optimization Problem

A mother's optimization problem is 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 j. That is, at the beginning of period $T-1$, the mother is choosing $d_{j,T-1}$ by calculating:

$$V(S_{T-1}, \epsilon_{T-1}) = \max_{j}\{U_{T-1}^{j} + d_{j,T-1}\epsilon_{j,T-1} + \beta EV(S_T, \epsilon_T)\}.$$

In order to do this, first, the mother must calculate:

$$\begin{aligned} E_\epsilon V(S_T, \epsilon_T) &= \max_{d_{j,T}} E_\epsilon(V_T^1, V_T^2, V_T^3, V_T^4, V_T^5, V_T^6 | S_{T-1}, d_{T-1}) \\ &= \sum_k \Pr(S_T, d_T^k = 1)\ U_T^K. \end{aligned}$$

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_{T-2}^{j},....etc, until she reaches back to the current period t.

4 Empirical Implementation

4.1 Mother's Current Period Utility Function

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

$$U_{jt} = \frac{1}{\alpha_1} c_{jt}^{\alpha_1} + \alpha_2 h_t + \alpha_3(\frac{A_t^\lambda - 1}{\lambda}) + \alpha_4 I_t^W + \alpha_5 I\left(W_T = 0\right) + \alpha_6 I\left(E_T = 0\right) + \epsilon_{jt} \quad (4)$$

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 disutility incurred when applying for welfare for the first time and α_6 is the search cost of finding a new job if the woman has not worked after giving birth. Consumption is given by the budget constraint

$$c_{jt} = w_t h_t + M_t + I_t^W * WI_{jt} - KI_{jt} \tag{5}$$

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_{jt}, in the budget constraint, is the money invested in the child's ability. KI is assumed to be a constant percent of yearly income, that is $KI_{jt} = \kappa(w_t h_t + M_t + I_t^W * WI_{jt})$ 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.

4.2 Wage Equation

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

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

where 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. We can 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:

$$\ln w_t = \ln \overline{w_0} - \delta t + \phi_1 E_t + \phi_2 (E_t * ed) + \phi_3 L_{st} + \xi_t, \tag{8}$$

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. Even though this assumption is not crucial in estimations, it simplifies the simulations.

4.3 Child's Cognitive Ability

Each child is 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 the childbirth. This last factor is characterized by two 0-1 dummies which are equal to 1 either when mother is younger than 18 ($ageless18$) or when she is older than 33 ($agemore33$)

$$\ln A_0 = \gamma_7 AFQT + \gamma_8 gender + \gamma_9 race + \gamma_{10} ageless18 + \gamma_{11} agemore33 + \gamma_{12} educ,$$

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

$$\ln A_t = \ln A_0 + \gamma_1 \ln \kappa Y + \gamma_2 E_t + \gamma_3 W_t + \gamma_4 \ln A_0 W_t + \gamma_5 \ln A_0 E_t + \gamma_6 t, \tag{9}$$

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 current income, κ is the share of this income spent on child's ability production. In the ability function, t indexes the age of child, here from 1 to 5.[5]

We do not observe the child's ability but we can use his eventual test score 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:

$$\ln O_t = \ln A_t + \varkappa + \nu_t \tag{10}$$

where $\varkappa$ is the mean test score and ν_T is the random disturbance, distributed as normal with zero mean and σ_ν. We can write equation (9) as follows

$$\ln O_t = \ln A_0 + \gamma_1 \ln \kappa Y + \gamma_2 E_t + \gamma_3 W_t + \gamma_4 \ln A_0 W_t + \gamma_5 \ln A_0 E_t + \gamma_6 t + \varkappa + \nu_t$$

or

$$\begin{aligned}
\ln O_t \;=\; & \gamma_1 \ln \kappa Y + \gamma_2 E_t + \gamma_3 W_t \\
& +\gamma_4(\gamma_7 AFQT + \gamma_8 gender + \gamma_9 race \\
& \quad +\gamma_{10} ageless18 + \gamma_{11} agemore33 + \gamma_{12} educ) E_t \\
& +\gamma_5(\gamma_7 AFQT + \gamma_8 gender + \gamma_9 race \\
& \quad +\gamma_{10} ageless18 + \gamma_{11} agemore33 + \gamma_{12} educ) W_t + \gamma_6 t \\
& +\gamma_7 AFQT + \gamma_8 gender + \gamma_9 race \\
& \quad +\gamma_{10} ageless18 + \gamma_{11} agemore33 + \gamma_{12} educ + \varkappa + \nu_t
\end{aligned}$$

[5]The marginal contribution of mother's decision (for example, E_t) is derived as:

$$\frac{\partial A_t}{\partial E_t} = A_t \times \frac{\partial \ln A_t}{\partial E_t} = (\gamma_2 + \gamma_5 \ln A_0) A_t > 0 \text{ if } (\gamma_2 + \gamma_5 \ln A_0) > 0,$$

and

$$\frac{\partial^2 A_t}{\partial {E_t}^2} = (\gamma_2 + \gamma_5 \ln A_0) \frac{\partial A_t}{\partial E_t} = (\gamma_2 + \gamma_5 \ln A_0)^2 A_t > 0$$

This implies that given any initial ability level ($\ln A_0$, child's ability exhibits increasing marginal return in a mother's decision. However, lnA_t is decreasing return to scale in $(Y_t,\ E_t,\ W_t)$ due to the constant term $\ln A_0 + \gamma_6 t$

This equation tells us, for example, the difference between mean test score of males and females, everything else equal, can be captured by $\gamma_8 + \gamma_4\gamma_8 E_t + \gamma_5\gamma_8 W_t$. Also note that the information regarding cumulative income of past is carried in this expression by the work and welfare experience. This may mean that we need further specifications in order to identify direct impact of work and welfare choices, like time spent with the child, from income effects.

4.4 The Likelihood Function

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

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

where $f(w_t|S_t)^{I(h_t>0)}$ is the probability of wage, w_t, if the mother is working given the state variables, and $g(O_t)^{I[O_t \ \ available]}$ is the probability of observing the test score O_t when a 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.

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 $\Pr(d_j = 1|S_t;\theta)$. 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 i.i.d. from the Type I extreme value distribution with location parameter 0 and scale parameter 1. This enables us to write the probability of choosing d_j given state S_t as:[6]

$$\Pr(d_j = 1|S_t) = \frac{\exp\{V^j(S_t, d_j)\}}{\sum_k \exp\{V^k(S_t, d_k)\}}. \tag{12}$$

4.5 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:

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

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

[6] See Rust (1987, 2000).

5 Data and Sample

The population of focus is children who were born to low-skilled single mothers. Since most children start school at either age five or six, childhood is defined as from ages one to five. The unit of sample period is a quarter. As a result, a mother is making decisions for twenty quarters in our research. To measure attainment we make use of the math standardized 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. PIAT standardized test score ranges from 65 to 135 with a mean of 100 and a standard deviation of 15 based on the 1968 national norm sample of children.[7]

The NLSY mother-child pair sample is constructed on the basis of the following criteria: (i) a child's mother must have always been single 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. Given that we do not model initiatives of welfare reform at this point, we exclude children whose resident U.S. states have implemented any state waiver programs or welfare reform during their childhoods. Appendix A.1 discusses potential sample selection issues due to our sampling strategy.

5.1 Sample Description

Table 1 reports mean values of the variables used in this research. We have $15,640$ sample quarters from 782 children who were born to 525 single mothers. The first panel lists the mean patterns of mothers' decisions during the twenty quarters of

[7]We note that there is an issue of so-called "cohort effect" in using the PIAT standardized scores as outcome measures. Namely, the latter cohorts have higher mean test scores than those of the previous ones. We deal with this by adding a cohort mean $\varkappa$ in the outcome equation (10).

their children's ages one to five. Defined as having reported positive welfare income for more than one months in a quarter, childhood welfare participation rate of this group of children is at 68%. 32% of this group of low-skilled single mothers have worked part-time during their children's childhoods, while 24% of them have worked full-time. In other words, labor force participation rate is roughly at about 56%. The sample of children is comprised by an equal percentage between male and female. Among them, 63% are black. The average PIAT standardized math score is at 94.6, which is (significantly) lower than the mean test score of the 1968 norm population. This mainly indicates that disadvantage of growing up poor. In terms of mothers' characteristics, the mean age at birth is 23.7 years old. This is younger than the average age (27) that NLSY mothers gave birth to their children. The mean sample mother receives 10.8 years of education and has 2 children. Also, those who have worked received a mean annual labor income of $9,092 (in 2000 dollars).

Table 2 further distinguishes a mother's welfare use and work decisions according to her child's age. Since pre-birth decisions are incorporated as the initial state variables, the table begins from those of a child's two years before birth. Comparing pre- and after-birth welfare use, we note that single mothers have increased welfare use by a minimum of 10 percentage points due to giving birth to a new child. In terms of labor force participation, only that of the first two years seem to have been affected by childbearing. In fact, mothers' mean hours of work (conditional on work) have increased significantly after a child turns one year old.

Table 3 tabulates means and standard deviations of PIAT math standardized score in different quartiles of variables used in the estimation. First, the quartiles of PIAT math score itself indicate that more that 75% of the children who were raised by low-skilled single mothers have their test scores below the population mean (100), as the mean test score of the third quartile is at only 99.3. In terms of mothers' characteristics, the first set of variables are monetary variables which include hourly wage rate, labor income, and other income. To measure the general financial wellbeing while the children grew up, these are average values over twenty quarters.[8] As we can see from Table 3, mean value of the second quartile of labor income is \$5.4 in the sample. The same values for average labor (conditional on work) and average non-labor, non-welfare income during five years are at \$2,884 and \$1,283, respectively. In general, we do not see a close connection between children's childhood financial wellbeing and their test scores.

The next set of mothers' characteristics include her AFQT score, education level (at child's birth), and her age at the time of child's birth. Given our sampling strategy, all mothers in our sample received no more than twelve years of schooling. We group them into no more than twelve, and exactly twelve and summarized the test score of the children of the mothers in these groups. One can see that there is a significant positive correlation between mother's AFQT scores as well as education level and child's test score. In terms of age at birth, it seems to suggest that children with older mothers tend to have lower scores. However as it will be seen later in the table, this correlation might be explained by the fact that older mothers also tend to have more children, and it reduces average resources to be invested on each of her child.

The next category is children's characteristics, including gender, race and number of siblings. On average, girls perform better than boys. Also, even all grew up in disadvantaged backgrounds, Black and Hispanic children have lower test scores than their counterpart of non-Black, non-Hispanic children. Finally, 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 mean test score of 98, but the mean score for a child with more than three siblings is just 91.5. Finally, we include the county unemployment rate, county ratio of service industry, county medium income level, and county crime rate as controls for local socioeconomic status in the current wage function (Equation 8). As might be expected, there do not exhibit a clear pattern between these county characteristics

[8] We use the Personal Consumption Expenditure Deflator for non-durable goods (PCED Non-Durable) to convert nominal monetary terms into 2000 dollars. Other income is defined as annual family income subtracts labor and welfare (AFDC plus food stamp) income.

and resident children's test scores.

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 is significantly lower.

6 Results

Table 7 gives the estimates for the wage parameters with given initial wage estimates reported in Table 5 and unestimated parameters of the model fixed at the values given in table 6. 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. According to the estimates, one extra year of work implies 5% increase in wages, which is quite similar to the estimates from the literature.

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 the utility cost of welfare use.

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). According to our estimation results a one log standardized test point increase in a mother's AFQT score increases the child's ability by about one log point, or about three points. The initial ability of a female offspring is about 0.20 log points, that is 1.2 points 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 points, or 1.03 points, lower. Given the standard deviation is 15 these differences are not significant. Furthermore, based on our estimates, being born to a mother who was very young or very old when giving birth increases the child's initial ability. Finally, a one dollar increase in the income of the mother increases the child's current ability level by 0.004 log points or by 1.004 points. Our estimates tell us that mothers spent about 8 percent of of their income directly on child's ability production.

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:

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

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. Plausible test scores (non standard) range from 65 to 130. The log mean test score is set equal to the mean test score from the sample which is 4.29 or 72.96. Our estimates imply initial log-ability ranges from 0.007 to 1.790.

We see from Figure 1 and 2 that the effects of a mother's work and welfare decisions on her child's test score are different. A mother's work is good for her child's math test score. However, the effect declines with the initial ability. Given this the contribution of the change in work experience to the change in ability ranges from 0.25 to 0.5. This makes sense since the returns time with child should be higher if the child is high ability. Mother's welfare use, on the contrary, has positive effect on child's ability if the child has low initial ability. However, for children with higher initial ability levels one extra year on welfare reduces the mean test score at age 5. The effect of one extra year on welfare ranges from 0.10 to -0.11 log points, or 1.1 to -1.11 points. Note that the income figure we have in the ability function is current income. Experience and welfare participation history carries information about the mother's lifetime earnings. Thus, the above coefficients may be not sufficiently identified/distinguished from cumulative income effect. This can be solved by the inclusion of more information into the decision function.

Table 10 provides a simple support for model fit. We fit the participation rates for welfare and work nicely. We predict 74% 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 the data we see that women participate less in both market work and welfare, our estimates have this pattern, especially in work behavior. These estimates fail to catch the nonparticipants in the very first period. This should improve by introduction of pre-birth history of work and welfare to data. The data for two years prior to the birth are available but have not been used, in order to keep the number of periods low in this analysis.

We were also successful at replicating the mean test score estimates by welfare and work status as reported in Table 11.

7 Policy Analysis

We consider the impact of two policies on women's work and welfare participation decisions and children's average math test score. Using the estimated parameters we simulate the several policy changes. In each policy exercise we look at the changes in work and welfare participation, and analyze how ability measures differ for children of women with different work and welfare choices. We are particularly interested in the changes in the test scores of the children of welfare participants.

7.1 Time Limit on Welfare and Work Requirement

We imposed a time limit of 2 years on welfare without work. This corresponds to two of the policy changes brought by TANF. According to the new rules, the longest time someone can be on welfare without working is 2 years, and cumulative welfare use cannot exceed 5 years. We implement this policy by setting benefits to zero if the number of cumulative welfare years exceeds 2 years and no work is chosen. With the data available at the time being (we only have 5 years and no history), it is not possible to analyze implications of the general time limit policy implied by the welfare reform. However, the policy change we are looking at in this section should imitate the effects of cumulative time limit for the first two periods with a smaller magnitude. For later years, when limit kicks in it may be imitating the effects of the consecutive use limit or the total use limit. We do not distinguish between these two possible effects for the time being. Data on mother work before birth can be added for a better implementation of the policy. For the time being, we limit ourselves to the above policy change.

In the data simulated with this policy the welfare participation rate decreases by about one percentage points. However, we do not observe any increase in work participation. In the data, we observe a sharper decline in the welfare participation rates after the reform. If we do more detailed analysis of the work and welfare participation in subgroups of AFQT score, education, and age we may be able to understand how and why our data differ from the general population of welfare participants. Moreover, we suspect the inclusion of additional data and a policy simulation that is more closely related to the actual policy change will give us a closer approximation to observed changes.

With this policy change, simulated mean log initial increases by less than 0.1, or by 1.1 points. This change is not very significant economically. One would expect women who are not participating in welfare to start working to make up for the lost income. Since we do not observe any change in work participation this does not seem to be the case. One concern we have is the effect of this policy on participation in other welfare programs, like assisted housing. We do not model this possibility, and our data does not clearly differentiate the source of welfare and other income. We can also compare the test results simulations to what we observe in the data; kids who are born after 1996 spent all their lives under the new policy and they have already given their first couple tests. This is a natural extension to the counterfactual analysis and a good test for the strength and accuracy of the simulations.

7.2 Maternity Leave Policy

In this experiment we analyze the impact of a maternity leave policy according to which there is 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 after a period of inactivity (α_6) to 0. The aim of the policy is to understand how women respond in terms of work and welfare choices if they do not get any penalty in terms of wages and can get back to their jobs costlessly after birth.

With this policy change participation rate decreases by 2 percentage points the very first period, but no significant change after the first period. The lack of significant effect on later years, we suggest, follows from the fact that we fail to catch non-participants in the first period, so for periods 2 to 5 employment decisions are already made as if the penalty is zero. Moreover, the depreciation rate is set to be too low at 0.003. We will repeat the analysis with a higher depreciation rate of 1.2 %.

This policy reduces the mean simulated ability by about 0.1 log points. This shows that the non-employment wage penalty reduction (implied by zero depreciation rate) is dominated by the positive impact of work on ability. A logical addition to analysis will be addition of detailed description of changes in simulated test outcomes by initial ability levels, since the effect of work experience changes with the level of innate ability.

8 Conclusion

Even though our data and model are restricted for simplicity, our results imply significant and interesting policy effects. The next step in this research is to extend the data. We have access to information on mothers up to two years before the birth of their first child. This can give us a better handle on the work and welfare history of mothers' and better estimate their initial wages. Moreover, children in the data are given tests biannually in some cases until they are fourteen-years-old. Using multiple test results will help us better identify the determinants of children's ability, and make it possible to have a say about children's "medium-run" achievements. We can take it even further by using the future wage information of the kids in our data. However, this will restrict our current sample a lot, leaving us with no more than 700 kids since most of the children in our data are still quite young (oldest kids we can have is younger than 30 born in 1978).

Another change we are considering is the inclusion of sibling information. From data analysis we see that everything else constant ability of the child decreases with the size of the household. By reorienting our data we can identify the source of this reduction or use this information to better identify the effects of work and welfare. This will require mothers to be the unit of analysis. This also calls for modelling fertility decisions of the mother.

In this paper we ignore the household structure as a factor in decisions. However, single mothers are very likely to be living with their parents or in close proximity to their parents. This can change the dynamics in the model and determination of ability as a function of mother's work. We are assuming that when mother is working she is leaving the kid with child care etc. Even though we may argue mother's care is better than child care for child's ability development, we cannot make such strong argument against grandmother's care. This information can be added to the data for future analysis..

In order to have more meaningful measures of job search and welfare initiation costs and a better setup to implement work requirements by the welfare reform we will be adding the previous years work and welfare choice as states to our analysis. This increases the state space significantly and will be computationally quite demanding. However, adding this dimension will be a significant addition to our research and to the welfare literature in general if it can improve our structural model.

Following the above improvements to data and the model, we would like to look at a couple more counterfactuals: Five-year limit on total welfare use and earnings disregard in determination of welfare payments. These two policy changes are part of the AFDC to TANF transformation. We can implement the first policy change as we add more years to our data, specifically two years prior to the birth and ages 6 and 7. With current setting of our model this policy should replicate - with higher magnitude - the effects of two year welfare limit policy we analyzed above. We also need to add previous year's work and welfare choices as states to distinguish between consecutive usage and total usage of welfare. Policy regarding the earnings disregard can be implemented by setting the income tax in benefits function to zero. Even though this assumes no other change to the benefits, the results should nevertheless be interesting to see.

9 Reference

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10 Tables and Graphs

Table 1: Sample Descriptives - Means

Mother's Decisions		Mother's Characteristics	
Welfare participation	.68	Age at Birth	23.7
	(.47)		(4.6)
Quarterly Work Participation		Years of Education	10.8
Part-Time	.32		(1.5)
(125-375 hours)	(.47)	Number of children	2.0
Full-Time	.24		(1.2)
(>= 375 hours)	(.43)	Annual Labor	9,092.3
Hours	421	Income**†	(8,766.2)
of Work†	(199)	Annual Other	9,115.0
		Income**	(54,989.0)
Children's Characteristics		AFQT	17.5
Female	.50		(17.6)
Male	.50	County Characteristics	
Black	.63	Crime Rate	.06
Other Race	.37		(.03)
Birth Weight	111.4	Medium Income	23,802.6
	(21.8)		(6,958.1)
PIAT Standardized Math Score	94.6	Unemployment Rate	8.0
	(12.8)		(3.1)
Age Taking Test (Months)	76.9	Service Industry	13.4
	(14.7)		(8.1)
Children-Years	15,640		
Children	782		
Mothers	525		

* Population weighted to reflect 1979 national population of low-skilled single mothers

** In 2000 dollars deflated by PCED nondurables

† Conditional on work

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

Child's Age	Welfare Use	Part-Time (125-375 Hours)	Full-Time ($>= 375 Hours$)	Hours of Work†
-2	.49	.44	.36	404
	(.50)	(.50)	(.48)	(199)
-1	.55	.34	.26	398
	(.50)	(.47)	(.44)	(210)
1	.67	.25	.17	388
	(.47)	(.43)	(.38)	(197)
2	.69	.31	.23	409
	(.46)	(.46)	(.42)	(187)
3	.70	.33	.25	416
	(.47)	(.47)	(.43)	(208)
4	.68	.34	.27	440
	(.47)	(.48)	(.44)	(211)
5	.65	.36	.28	441
	(.48)	(.48)	(.45)	(183)

† Conditional on work

Table 3: Detailed Descriptive Statistics

quartile	1st	2nd	3rd	4th
Mother Characteristics				
Real Hourly Wages†	4.0	5.4	6.6	16.3
Mean Standard Scores	97.3	94.3	96.5	93.1
(Standard Deviation)	(14.3)	(12.5)	(10.5)	(16.3)
Average Labor Income†	875.2	2,884.0	7,477.6	17,305.4
	95.9	95.2	95.2	93.8
	(12.2)	(13.3)	(12.5)	(12.9)
Average Other Income	-287.9	1,891.1	6,097.2	32,334.3
	94.0	94.4	95.0	95.4
	(11.7)	(13.4)	(12.8)	(13.0)
AFQT Score	3.0	8.3	16.7	44.2
	90.8	93.4	95.1	99.8
	(11.1)	(12.2)	(12.2)	(13.8)
Eduction	< 12	$= 12$		
	92.9	96.5		
	(11.9)	(13.3)		
Age at Birth	20.7	23.9	26.9	32.5
	95.5	95.0	93.3	94.4
	(11.7)	(12.5)	(12.7)	(14.3)
Children Characteristics				
Race	Black	Hispanic	Other	
	63.5	8.6	27.9	

Continue to next page

Continue from last page

quartile	1st	2nd	3rd	4th	
	92.8	93.3	100.1		
	(12.2)	(11.7)	(13.0)		
Gender	Male	Female			
	93.1	96.2			
	(12.1)	(13.1)			
Number of Siblings	1	2	3	4	
	0	1	2	3	> 3
	98.0	98.6	94.1	92.4	91.5
	(10.8)	(12.8)	(11.8)	(12.9)	(13.1)
PIAT Math Test Score	78.2	91.0	99.3	110.9	
	(5.7)	(2.6)	(2.4)	(6.8)	
Age Taking Test	63.4	72.1	78.7	96.9	
(months)	92.5	95.8	94.7	95.8	
	(14.5)	(12.6)	(11.9)	(11.5)	
County Characteristics					
County Unemployment Rate	4.7	6.6	8.5	12.4	
	95.2	94.2	93.9	95.6	
	(13.0)	(12.9)	(12.4)	(12.9)	
Service Industry	.01	.14	.18	.22	
	95.1	93.8	95.1	94.3	
	(11.4)	(12.4)	(13.6)	(13.6)	
Medium Income	15,151.7	21,236.5	26,055.6	32,817.4	
	94.1	94.6	94.9	95.2	
	(12.4)	(12.8)	(12.7)	(13.2)	
Crime Rate	.02	.05	.07	.10	
	94.1	95.0	95.3	94.4	
	(14.1)	(12.1)	(12.6)	(12.3)	

† Conditional on work.

Table 4: Detailed Descriptive Statistics - Mother's Decisions

Units	Half Years of Welfare	Half Years of Work	Percentile	Half Years of Welfare	Half Years of Work
0	99.7 (14.4)	92.4 (12.6)	25%	1.5	0
1	97.4 (13.8)	94.7 (11.7)	50%	6.7	1
2	94.5 (10.2)	94.0 (13.3)	75%	9.8	3.6
3	97.3 (13.3)	95.2 (12.3)	99%	10.0	8.8
4	94.6 (11.2)	96.5 (11.5)			
5	95.9 (9.8)	94.6 (13.2)			
6	93.6 (11.4)	97.8 (11.2)			
7	96.3 (12.2)	94.3 (12.2)			
8	96.3 (11.4)	97.0 (13.6)			
9	94.8 (10.1)	96.0 (10.3)			
10	92.4 (13.2)	102.6 (14.1)			

Appendix

A.1 Appendix- Data Construction

Our population concerns the group of single mothers with no more than twelve years of schooling. To construct our sample, we impose following additional constraints. First, mothers need to be always single. Second, children need to have observed outcomes. Also, all children were raised completely in the AFDC era. In other words, we exclude children whose resident U.S. States implemented state waiver/welfare reform initiatives during their childhoods. Finally, the mother cannot be in school during her child's childhood.

Using PIAT math standard test score, Table A-1 lists observations of children lost due to the above criterion. There are 7,642 children born to low-skilled mothers from NLSY 79. Of them, 3,966 children were born to mothers who were always married during their ages one to five. 2,642 children have their mothers been sometimes single during the same age span. Only 1,034 children have their mothers always been single during their childhoods. Of them, 32 children were lost due to their mothers being in school during their childhoods, and 145 were further lost due to being born in a U.S. State with implementation of either a state waiver program or welfare reform. Finally, of the remaining 857 children, 78 were lost because we do not have their PIAT Math Standardized test scores. In the end, our sampling strategy gives us 782 sample children born to 525 mothers.

To check if excluding different groups of children may have created any sample selection issues, we investigate the followings: (i) availabilities and means of children's test scores; and (ii) patterns of mothers' decisions of included sample and different excluded groups of children. The purpose is to see if the dependent variable and explanatory variables in interest of this research were affected due to different sampling criteria.

Judging by the availabilities of test scores reported in Table A-1, been born to a single mother does not seem to imply that children will have no observed outcomes. For example, more than 90% of the 1,034 children whose mothers were always single during their childhoods have observed standardized PIAT math test scores. This is higher than those of children who were born to either mothers who had been single (78%) or were always single (75%). Among children whose mothers were always single and were born before state-waiver/reform era, 92% of them gave observed outcomes.

In terms of mean test scores, not surprisingly, children born to mothers who were always single have much lower mean scores (94.7) than those who were always married (100.9) and sometimes single (98). However, state waiver programs and welfare reform do not seem to be correlated with the mean scores of children. Mean test scores for children who were born before and after state-waiver/reform are at

94.7 and 94.6, respectively. Finally, mean test score for children whose mothers have been in school during there childhoods is at 96.7. Given that there are only 30 (out of 1,032) of them, the mean may not be reliable.

We choose to focus only on single mothers who have always been single so that we do not have to model marriage decisions. It will be made clear that mothers who were always single and those who had a spouse at some point during their children's childhoods have very different welfare use and labor force participation patterns. Figure A-1 shows the trends of welfare use and work decisions of single mothers based on (i) always married, (ii) married sometimes, and further separate the always single group into (iii) born before reform (the included sample), (iv) born after reform, and finally, (v) born before reform but without valid test scores. Figure legend is listed on Figure 1(b).

As can be seen from Figure 1(a), regardless of the availability of test scores, mothers who were always single before waiver/reform were equally less likely to be working during their children's early childhoods than those who were at least sometimes married. However, the former group of mothers appears to have similar labor force pattern to their married counterparts after their resident U.S. States implemented waiver/reform. Furthermore, conditional on work, Figure 1(b) shows that the hours of work patterns do not differ based on mothers' marital status. Despite some outliers from the (No Reform, No Test) group, mothers who were always single after welfare were among groups with the most hours of work during their children's childhoods. Finally, mothers who have ever been single are significantly more likely to use welfare than those who have never been single (Figure 1(c)). Among them, mothers who were always single are 20% and 40% more likely to use welfare than those who have been single and those who have never been single, respectively. Again, those who have experienced welfare reform use much less welfare than their pre-reform counterpart.

Given the very different patterns in the decisions based on marital status and pre/post-reform, it seems likely to us that using a sample with some mothers who remarried without modeling the marriage decision might induce bias due to unobserved characteristics. Also, welfare reform significantly changed single mothers' behaviors. As a result, we also exclude mother who have experienced welfare reform from our sample.[A-1]

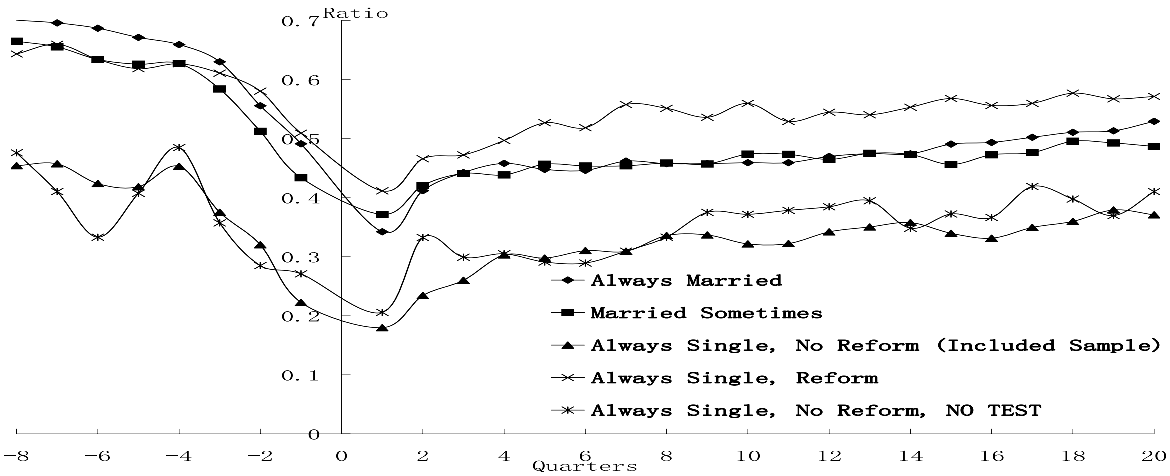
Table A-1: Effects of Different Sample Selection Criteria - by Observing Children's Test Scores

	Observe Test Scores?			
Marital Status	No	Yes	Mean Scores	Number of Obs.
Always Married	25(%)	75	100.9 (12.8)	3,966
Sometimes Single	22	78	98.0 (13.5)	2,642
Always Single	9	91	94.7 (12.9)	1,034
Number of Obs.	1,657	5,985	97.0 (13.3)	7,642
Among Always Single (Population = 1,034)				
in School	4	96	96.7 (13.3)	32
Not in School	8	92	94.7 (12.9)	1,002
Among Always Single and Not in School (Population = 1,002)				
Experienced Reform	10	90	94.6 (13.9)	145
Reform	8	92*	94.7 (12.8)	857

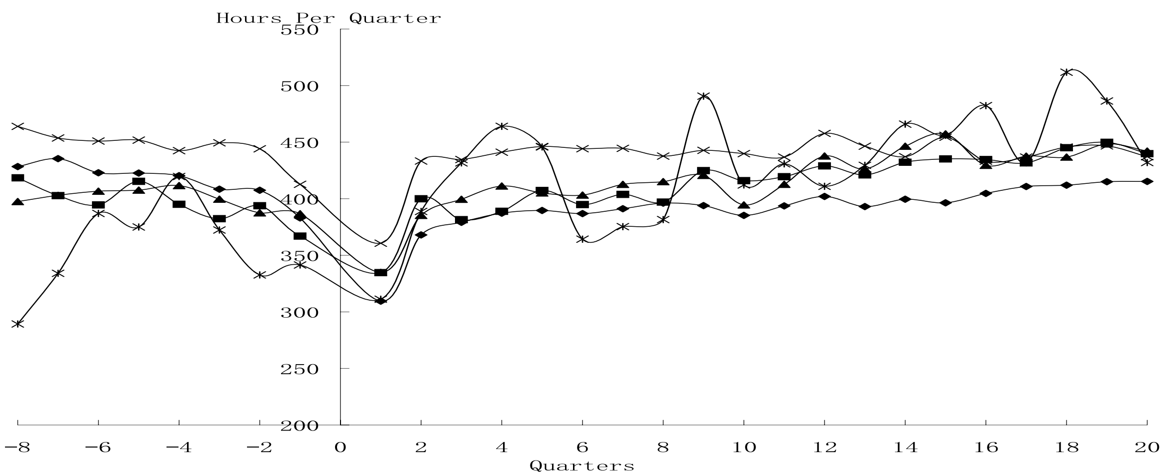
* This category is our included sample of children. There are 782 children in total.

[A-1] In NLSY79, they also have much older ages at birth than those that gave birth before reform.

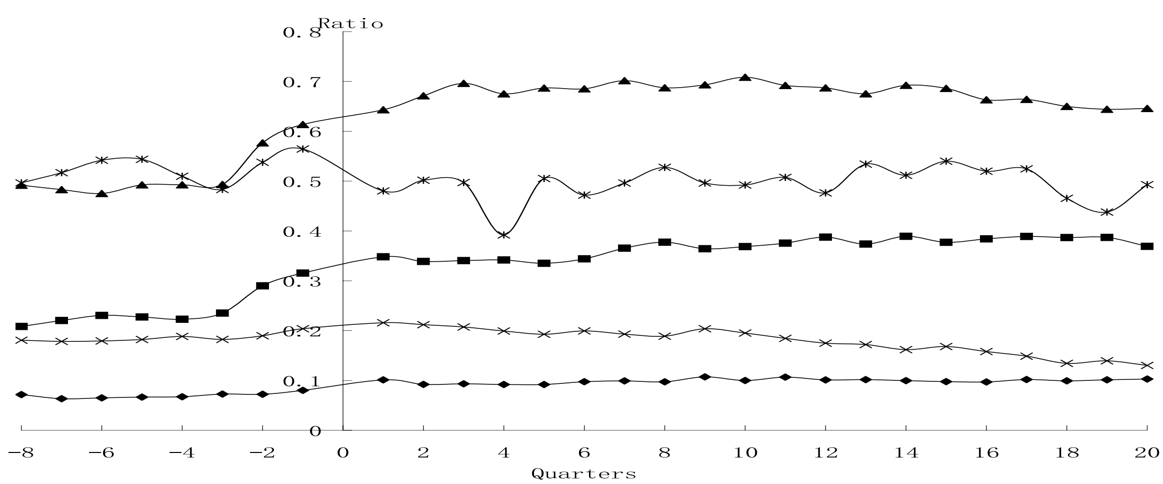
Figure A-1: Welfare and Work Decisions of Low-Skilled Single Mothers of NLSY 79 Given Marriage Status



(a) Labor Force Participation



(b) Hours of Work (if Work)



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