Welfare Reform and Children's Early Cognitive Development

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Abstract

In this paper, we use a dynamic structural model to measure the effects of (i) single mothers' work and welfare use decisions and (ii) welfare reform initiatives on the early cognitive development of the children of the NLSY79 mothers. We use PIAT-Math scores as a measure of attainment and show that both the mothers' work and welfare use benefit children on average. Our simulation of a policy that combines a time limit with work requirement reduces the use of welfare and increases employment significantly. These changes in turn significantly increase children's cognitive attainment. This implies that the welfare reform was not only successful in achieving its stated goals, but was also beneficial to welfare children's outcomes. In another policy simulation, we show that increasing work incentives for welfare population by exempting labor income from welfare tax can be a very successful policy with some additional benefits for children's outcomes. Finally, a counterfactual with an extended maternal leave policy significantly reduces employment and has negative, though economically insignificant, impact on cognitive outcomes.

Keywords: Welfare reform, childhood cognitive development, female work, dynamic choice model, maximum likelihood
JEL codes: I38, J22, J18

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1 Introduction

In 1996, the Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) ended Aid for Families with Dependent Children (AFDC), replacing it with the new Temporary Assistance for Needy Families (TANF) program. TANF differs from AFDC by ending the "entitlement" period of welfare via introduction of a time limit on welfare benefits and work requirement for participants. In this paper, we analyze the impact of this welfare reform on the early cognitive development of welfare program 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 single mothers and their children from the National Longitudinal Survey of Youth 1979 (NLSY79) Cohort. 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 as a result, children's cognitive development.

Early cognitive development has been found to be a strong predictor of long-term achievement and other outcomes such as educational attainment, crime involvement, salaries and out-of-wedlock pregnancy (see reviews by Duncan and Brooks-Gunn, 1997; Haveman and Wolfe, 1995; and Currie and Thomas, 1995). Thus, it is crucial to understand whether, and by how much welfare program participation affects children's cognitive outcomes. Moreover, any public policy initiative, such as PRWORA, that affects parents' incentives to work or participate in the welfare program by altering the opportunity costs of parental time and financial inputs should be carefully evaluated. There is an abundance of studies on the effects of welfare reform on mothers' behaviors. However, implications of welfare reform on children's outcomes have not been studied by many. To our knowledge, other than this paper, there is only one other study, Miller and Zhang (2009), that analyzes the indirect effects of welfare reform on children's cognitive outcomes.

Earlier studies generally find significantly negative relationships between welfare receipt and various types of child attainment measures. However, these negative relationships may not be causal due to improper comparison groups or the unobserved heterogeneity issue that is not addressed (Currie, 1998; Duncan, Magnuson and Ludwig, 2004; and Dahl and Lochner, 2012). Chyi and Ozturk (2012) show that welfare program participation is not detrimental to early development of the children when the analysis is constrained to families who are most disadvantaged (and thus likely to be eligible for welfare benefits) and when unobserved heterogeneity is properly controlled for. We follow their lead and focus only on the attainment of children born to single mothers with twelve or fewer years of schooling. We model unobserved heterogeneity and use exogenous variations in welfare benefits across states and local labor market conditions to alleviate concerns of endogeneity. Moreover, we incorporate the dynamic nature of welfare program participation and employment decisions into our econometric setup. We estimate structural parameters of our model which enable us to run policy simulations with counterfactuals that imitate the changes brought upon by PRWORA. Thus, we not only provide insight on how welfare and employment affect the children's cognitive development, but also document behavioral responses to the welfare reform and resulting impact on children's outcomes.

Our estimates show that on average mother's work and welfare use both are beneficial for children's cognitive development. In our model, their effects are allowed to vary by children's ability endowment and they do; we find that benefits are highest for children with low endowment. Moreover, we allow the effects to vary by mother's attitudes towards welfare receipt and work and by her ability to utilize resources in child-rearing. We model unobserved heterogeneity in these dimensions and identify two types of mothers: mothers who are not likely to use welfare but are very efficient at using welfare resources if they do (Type I) and mothers who are very likely to use welfare but are not efficient at utilizing welfare resources (Type II). Both an additional year of employment and an additional year of welfare use each increase the test scores by about 1% if the child has median level of ability endowment without controlling for mother's type. For children with Type I mothers, the welfare participation benefit is higher (1.61% per year for the median ability) and positive regardless of their cognitive ability endowment. For the ones with Type II mothers, on the other hand, effect of welfare participation is not only lower but it becomes negative if they have higher than median cognitive endowment. Effect of mother's employment is positive for all children even though it becomes economically insignificant as the ability endowment gets higher.

In our simulations, we find that policy changes that reduce welfare use and/or increase employment are generally beneficial to early cognitive development. Specifically, a policy that combines a work requirement and a two-year welfare time limit significantly increases the test score of a child with median ability endowment by 3.55%. Miller and Zhang (2009) also find positive welfare reform effects for children's cognitive outcomes. They show that welfare reform narrows the gap in the math test scores of high- and low-income children among 4th to 8th graders. Our findings of positive association between welfare reform and children's early cognitive outcomes complement Miller and Zhang's by providing estimates of the effects at an earlier age, prior to schooling.

Following an initiative that is adopted by many state waiver programs, we also simulate a policy that exempts labor income from "welfare tax". Employment increases sharply in this simulation without much change in welfare participation. Consequently, the simulated test score for a median child increases by 0.46%. We also analyze counterfactual of an extended maternity leave policy that has not been implemented but may be of interest to policy makers. Simulation suggests that this policy reduces employment by about 10 percentage points but does not change welfare use significantly. This policy eventually decreases log test scores by 0.31% on average.

Overall, we see that the most successful policies are the ones that encourage more work through tax incentives and time limits. Welfare reform resulted in big reductions in welfare rolls which potentially increased resources for other uses such as child care subsidies and afterschool programs. Our results indicate that access to these resources boosts cognitive outcomes.

The structure of the paper is as follows. In the next section we construct our economic model and discuss how it works in capturing the patterns in the data. We give an overview of our data in Section **??**. In Section **??** we not only report the parameter estimates, but also analyze our policy simulations in a subsection, Section **??**. Section **??** will conclude our paper with a discussion of our results.

2 Model

Our dynamic structural model is motivated by Bernal (2008). We assume that a child's early attainment is determined by the cumulative welfare use and employment of the mother during the first five years after childbirth. A mother cares about how much leisure and the composite consumption good she has, and the ability of her child. In this dynamic setup, every period she chooses how much to work and whether to use welfare to maximize her expected utility. Below we discuss the economic rationale of our model. The solution and the estimation of the model is discussed in detail in the Appendix **??**.

2.1 Child's Cognitive Attainment

We assume each child is born with a fixed level of cognitive ability endowment (A_0). A mother is assumed to know this but we, as econometricians, do not. We approximate this endowment using time-invariant characteristics such as birth weight (BW), race (Black=1), and gender (girl=1) of the child, as well as Armed Forces Qualification Test (AFQT) percentile score and years of education (edu) of the mother.[1] We also consider two age related dummy variables: one if the mother is younger than 18 $(ageless18)$ and another if she is older than 33 $(agemore33)$. These dummy variables capture the increased possibility of health problems for children born to young mothers and possible complications of geriatric pregnancy that may lead to lower cognitive ability.[2] Corre-

[1]This setup is also used in Bernal (2008), Bernal and Keane (2010; 2011) and Chyi and Ozturk (2012).

[2]When mother's age is included directly, its effect is not significant.We suspect that the effect may have been absorbed by other maternal characteristics such as years of education or pre-birth work experience and welfare use.

lations between these variables and cognitive ability endowment is modeled linearly as follows:

$$\ln A_0 = \gamma_6 BW + \gamma_7 gender + \gamma_8 race + \gamma_9 ageless18 + \gamma_{10} agemore33 + \gamma_{11} edu + \gamma_{12} AFQT. \tag{1}$$

A mother "produces" her child's current cognitive achievement (A_t) by using monetary and non-monetary resources. Even though we do not observe the amount directly spent on the child, we have the amount of labor income, welfare income and other income received by the household in our data. Moreover, we do not observe measures of non-monetary inputs, including time spent with the child or non-cash welfare benefits such as housing and health care. We use work and welfare use decisions as proxy variables to capture the availability and the amount of these monetary and non-monetary inputs. A child's cognitive ability is correlated with these factors and the cognitive ability endowment as follows:

$$\ln A_t = \ln A_0 + \gamma_1 \ln \frac{Y_t}{N_t} + \gamma_2 E_t + \gamma_3 W_t + \gamma_4 \ln A_0 W_t + \gamma_5 \ln A_0 E_t. \tag{2}$$

In this expression, Y_t is the income accumulated since childbirth and N_t is the number of children in the household.[3] Cumulative work experience is defined as $E_t = \sum_{k=1}^{t} h_k$ where h_k=0, 1, or 2 if the mother is not employed, employed part-time or full-time in year k, respectively. Similarly, cumulative welfare experience is $W_t = \sum_{k=1}^{t} \omega_k$, where ω_k=0 if the mother is not on welfare at year k, 1 otherwise.[4] By adding interactions between the

[3] Y_t is the sum of labor earnings, welfare benefits (B) and other income (M), that is $Y_t = \sum_{s=1}^{t} (h_s w_s + \omega_s B_s + M_s)$. We approximate the average income spent on each child by dividing Y_t by the number of children in the household (N) at year t. We treat children born to the same mother as independent observations. Bernal (2008) and Bernal and Keane (2010; 2011) use a similar treatment.

Initially, we allowed income to interact with $\ln A_0$ to capture the potential differential effects of income by cognitive ability endowment. The coefficient for this interaction was insignificant, thus we dropped it for simplicity.

[4] We assume that only the cumulative inputs matter. Bernal (2008) and Bernal and Keane (2010; 2011)

mothers' decisions and the observed cognitive ability endowment, we allow for possible differential effects of the mothers' decisions. In other words, a child's cognitive ability endowment can affect the returns to inputs in the production of current cognitive ability.

All children in the NLSY79 have taken several cognitive achievement tests biannually once they turn six. We use the child's first PIAT-Math test score (O_t) as a proxy for the ability as follows:[5]

$$\ln O_t = \ln A_t + \gamma_{13} testage + \mu_0 + \nu_t, \tag{3}$$

where $testage$ is the child's age in months, μ_0 is the mean test score and ν_t is the random disturbance drawn from a normal distribution with mean of zero, and a variance of σ_ν^2.[6]

In our model, welfare use can affect the cognitive development of a child in three ways. First, welfare program provides income, effect of which is captured by the coefficient of $\frac{Y_t}{N_t}$ in Equation (**??**). Second, a mother may choose to substitute welfare for work so that she can spend more time with her child. This effect will be captured by a decrease in maternal employment, E_t. Finally, many means-tested transfer programs are linked with AFDC (and now with TANF), such as the early childhood education program, Head Start, housing subsidies and the Medicaid health insurance program. As we do not separately control for participation in different programs that are linked with AFDC,[7] the

have a similar setup. A different modeling strategy is based on the timing of investment (Brooks-Gunn, Han and Waldfogel, 2002 and Todd and Wolpin, 2003). In such a model, inputs made by the mother at each age may have differential effects on the child's potential achievement. The empirical results of such a model estimated with our sample (not presented but available upon request) indicate that we cannot reject that all of the age-specific coefficients are the same. We believe, instead of proving that the effects are not sensitive to timing, this just reflects the lack of variation in the data that is needed to identify such age-specific effects.

[5] We choose mathematical attainment because it has shown to be mostly closely related to a child's later cognitive achievement (Claessens, Duncan and Engel, 2009).

[6] Although the PIAT-Math tests are given to each child biannually from age five onwards, some of the first observed test scores are from later ages. Also, PIAT test scores are known to have a potential "cohort effect." Namely, latter cohorts have higher mean test scores than previous cohorts. We deal with this issue by adding the cohort mean, μ_0, to the outcome, Equation (**??**).

[7] It is almost impossible to separately identify the effects of various programs. For example, before the expansion of Medicaid in 1986, applying for AFDC was the primary means of obtaining health insurance for poor children. Before 1992, a mechanical correlation implies that anyone who participated in the AFDC was automatically eligible for Medicaid, food stamps, school lunch, Head Start,...,etc. See Citro and Michael (1995) for a complete list of all means-tested programs of which the eligibility hinges directly on the AFDC.

benefits on a child's attainment from these programs are captured by the coefficient of the welfare use history, W_t.

Mothers' employment decisions can affect ability through two channels: income and time. Income related effects will be captured by the coefficient of cumulative income variable. Thus, the work coefficient itself picks up the time related effects only. By working, mothers forgo time to educate or care for their children and as a result employment may be detrimental to children's attainment (Morrill, 2009; Baker, et.al., 2008; Curie and Hotz, 2004; and Blau and Grossberg, 1992). On the other hand, children's attainment can improve when, for instance, working mothers provide a positive role model. Both sociology and psychology literature commonly argue the role model effect is strong. Also, according to Cascio (2009), compared to the general population of mothers, low-income single mothers are more likely to put their children in kindergarten, perhaps because kindergarten is 100% subsidized day care. Children from disadvantaged families who are placed in kindergarten may have access to educational tools in the classroom that are not available in the home environment. This may result in a positive relationship between a child's attainment and the mother's employment. Our outcome measures take place before children go to elementary school. So low-income mothers' employment can capture the benefits obtained from subsidized child care.[8] Unless we are willing to make more structural assumptions on how a mother takes care of her child, these opposing time related effects will be all captured by the coefficient of E_t in Equation (2). Empirical results will show which effect dominates. In Appendix **??** we give a detailed discussion of the identification of these channels in our data.

[8]As Cascio and Schanzenbach (2007) and Bedard and Dhuey (2006) point out, this could lower the age at school entry for disadvantaged children, which might be detrimental because younger children tend to perform worse than older children in most school cohorts.

2.2 Mother's Utility Function

We assume a mother's current period utility is determined by her consumption of leisure and a composite good and by her child's current level of cognitive ability. She chooses how much to work and whether to use welfare or not. She has six possible combinations of work and welfare use as her alternatives: $j = \{(h_t, \omega_t) : \; h_t = 0, 1, 2; \; \omega_t = 0, 1\}$.[9] The mother's current-period utility of choosing alternative j is given by:

$$\begin{aligned} U(j, \epsilon_{jt}) = \alpha_1 \frac{c_{jt}^{\lambda_1}}{\lambda_1} + \alpha_2 h_t + \alpha_3 (\frac{A_t^{\lambda_2} - 1}{\lambda_2}) + \alpha_4 \omega_t + \alpha_5 I(W_t = 0) \\ + \alpha_6 I(E_t = 0) + \alpha_7 h_1 + \epsilon_{jt}. \end{aligned} \tag{4}$$

The utility function has constant relative risk aversion (CRRA) both in terms of composite consumption and the child's cognitive ability, captured by the parameters λ_1 and λ_2. If $\lambda_2 < 1$, by CRRA a mother receive diminishing returns to her child's cognitive achievements and thus have incentive to compensate for low cognitive ability endowment with more resources. Both α_1 and α_3 should be positive since both composite good consumption and the child's current ability should increase the mother's utility. To capture the well-known fact that many low-income mothers do not use welfare (even though they are eligible), and that a lot of them do not work, we have parameters α_2 and α_4, distastes for work and welfare, respectively. We further add α_5 and α_6, the additional disutility incurred when applying for welfare for the first time and the cost of initiating work, respectively. α_7 is added to capture the extra costs of work during the first year after giving birth.[10] As our population focuses on poor families with little to save, we choose not to model saving decisions. As a result, the composite consumption good is determined by

[9] For example, if $j = 1$ we have $(h_t, I_t^w) = (0, 0)$, meaning that a mother chooses (no work, no welfare) in period t; $j = 2$ corresponds to $(h_t, I_t^w) = (1, 0)$ (part-time, no welfare); $j = 3$ represents $(h_t, I_t^w) = (2, 0)$ (full-time, no welfare),...,etc. $d_j = 1$ indicates that alternative j is chosen.

[10] This parameter captures the psychological cost of separation from the child when the child is very young. In practice, labor force participation in the first year will be slightly overestimated if we do not include α_7 in the estimate. Table **??** shows the big drop in employment in the first year following child birth.

the current-period income:

$$c_{jt} = w_t h_t + B_{st}\omega_t + M_t,$$

in which w_t is the offered wage, B_{st} is the annual welfare income and M_t is the non-labor and non-welfare income. Welfare benefits vary by the state of residence, by the number of children (noC is the number of children, $noCSq$ is the squared number of children) and the amount of labor and other income one has, as follows:

$$\begin{aligned} B_{st} = b_0 + (b_2 + \sum_s b_{3s} D_{st}) \cdot noC_t + (b_4 + \sum_s b_{5s} D_{st}) \cdot noCSq_t \\ + (b_6 + \sum_s b_{7s} D_{st}) M_t + (b_8 + \sum_s b_{9s} D_{st})(w_t h_t), \end{aligned} \tag{5}$$

where D_{st} is the indicator for the state of residence at time t (in state s, D_{st}=1).

Wage offer, w_t, is determined as a function of labor market experience and other human capital attributes, as well as local labor market characteristics. Specifically, we have:

$$\begin{aligned} \ln w_t =& \phi_1 age + \phi_2 age^2 + \phi_3 race + \phi_4 edu + \phi_5 AFQT + \phi_6 \\ & - \delta t + \phi_7 E_t + \phi_8 (E_t \times edu) + \phi_9 p_{t-1} + \phi_{10} f_{t-1} + L'_{ct}\varphi + \xi_t, \end{aligned} \tag{6}$$

where δ is the depreciation rate, $E_t = \sum_{-2}^{t-1} h_\tau$ is the mother's cumulative work experience in two years prior to giving birth, and f_{t-1} and p_{t-1} indicate whether a mother has worked full-time or part-time immediately before giving birth. L_{ct} is a vector of county-level labor market quality measures, including the county unemployment rate, employment share in services sector and average wage level, where c is the county in which the mother and her child reside at time t. Finally, ξ_t is the random shock that is assumed to be i.i.d. normal. Even though this assumption is not crucial in estimations, it simplifies the estimation and the simulations.

2.2.1 Unobserved Heterogeneity

In our setup, mothers are heterogeneous in terms of their tastes for work and welfare use. Specifically, α_2 and α_4 are determined at the time of childbirth as follows:

$$\begin{aligned} \alpha_2 &= \alpha_{21} edu + \alpha_{22} race + \overline{\alpha}_2 \\ \alpha_{4k} &= \alpha_{41} edu + \alpha_{42} race + \overline{\alpha}_{4k},\ k = L, H, \end{aligned} \tag{7}$$

where $\overline{\alpha}_{4k}$, which we will call welfare stigma, is the unobserved component of taste for welfare use. We assume that there are two unobserved types: mothers with low welfare stigma, $\overline{\alpha}_{4L}$, and mother's with high welfare stigma, $\overline{\alpha}_{4H}$.

Furthermore, we assume that mothers also differ in how efficiently they can use the resources (to which they gain access through the welfare program, such as health care and child care) in rearing their children. In particular, we link γ_3, the production function parameter regarding welfare use in Equation (**??**), to the welfare stigma types: γ_{3H} for a high stigma mother (Type I) mother and γ_{3L} for a low stigma (Type II) mother.[11] Associated type proportions are denoted by π_H and π_L, which are parameters to be estimated.[12]

Note that the marginal effect of a mother's welfare use on her child's attainment is:

$$\frac{\partial \ln O_t}{\partial W_t} = \gamma_3 + \gamma_4 \ln A_0.$$

By adding unobserved variation to γ_3, we allow for the intercept of the marginal effect of welfare use to be different. However, we assume this effect does not vary by the endowed ability of the child.[13]

[11]Although γ_3 is linked with α_4, we allow the data to tell us whether $\gamma_{3H} > \gamma_{3L}$. That is, we do not impose a mother who has lower welfare stigma (α_{4L}) to be less efficient at using welfare-related non-cash benefits for her child.

[12]We choose not to link $\ln A_0$ with α_4. In other words, we assume mothers of different tastes in welfare use can give birth to children with the same observed ability, so long as their observed covariates are identical.

[13]The unreported result indicates that the empirical difference in the slope terms for the two types of

3 Data and Sample

We construct our mother-child pair sample using following criteria: (i) the child's mother must have always been single for the entirety of the first five years after childbirth,[14] (ii) the child's mother must have recoverable information on work and welfare use for the first five years of the child's life, and (iii) the child must have at least one valid PIAT-Math test score. Given that we do not model initiatives of welfare reform at this point, we exclude children who reside in states that implemented any state waiver programs prior to the welfare reform and children who directly experienced the welfare reform.

We have 2,820 observations from 564 children who were born to 392 mothers. Table **??** reports the mean values for the variables we use. Welfare participation rate in our sample is 79.4%. 12.8% of the mothers worked part-time, whereas 18.6% of them worked full-time. The sample of children consists of a nearly equal share of males and females, and is predominantly Black (74%). The average for PIAT-Math scores is 93.1, which is significantly lower than the population mean (100).[15] This is indicative of the disadvantages of growing up poor. Average age is 25.5 at child birth which is younger than the NLSY79 average of 27. Sample mothers, on average, have 10.9 years of education and two children. Those who have worked receive a mean annual labor income of $10,737.[16] Table **??** indicates that our average mother is at the 14th percentile of the AFQT distribution. Our sample mothers tend to live in counties with higher unemployment rates (the sample average is 7.9% while the national average is 6.8%), higher shares of service

mothers is economically and statistically insignificant. Thus, we do not link γ_4 to welfare types for simplicity.

[14]Single motherhood is measured by not having a spouse or a cohabiting partner. It is well known that marriage is a common way for single mothers to gain economic support. For example, O'Neill, Bassi, and Wolf (1987) found that about one-third of single mothers who left the welfare program from the late 1970s to the mid-1980s did so via marriage. Conversely, dissolution of marriage can lead to economic hardship. Since we do not model marriage decisions and the potentially complicated joint household labor supply decisions, we use only mothers who have always been single during our study period.

[15]PIAT standardized test scores range from 65 to 135 with a mean of 100 and a standard deviation of 15 based on the 1968 national norm sample of children.

[16]All monetary variables are adjusted to year 2000 dollars by the Personal Consumption Expenditure Deflator for nondurable goods (PCED-nondurable).

industry (16.5% versus 15.8%), and lower median income ($23,967 versus $27,019).

Table **??** looks at the distribution of individual characteristics and distribution of test scores. Such correlations between these variables and the outcomes indicate variations that helped us identify the corresponding model parameters. First, we see that more than 75% of the sample children score below the population mean (100), as the mean test score of the third quartile is only 93.3. We next report the quartiles of the variables, and for each of these quartiles we report the mean test score observed. For example, the second quartile mean of real hourly wages is $2.60. For children whose mothers' wages fall into this quartile, the mean test score is 92.4.[17] We see that both a mothers' AFQT scores and education are positively correlated with the children's test scores and children of older mothers tend to have lower scores. Furthermore, we see that Black and Hispanic children have lower test scores than their non-Black, non-Hispanic counterparts and girls perform better than boys. There is a negative correlation between a child's PIAT-Math test score and the number of siblings, capturing the effect of defused resources as the household gets larger. Finally, test-taking age and the county labor market characteristics do not exhibit clear patterns of correlation with test scores without further controls.

4 Results

In this section, we first discuss the implications of mothers' decisions on their children's attainments derived from our estimates. We then perform policy simulations and discuss their implications.

[17]To get a measure of general financial wellbeing while children grow up, we take an average of the wage and income measures over the study period.

4.1 Parameter Estimates

Our model fits the data very well, we predict more than 90% of the work behavior and more than 95% of the welfare use behavior correctly. Appendix **??** gives further details on the model fit.

Table **??** reports the estimates of the log-wage function, Equation (**??**). Both part-time work and full-time work and the interaction of each with education are associated with higher wages. A higher local unemployment rate is associated with lower wages. A higher county service employment ratio and median income, on the other hand, are associated with higher wages. According to the estimates, an extra year of work increases wage by only 0.7% for our sample mothers. This effect is smaller than the ones estimated by Bernal (2008) (2.8%), Moffitt (1984) (4%), and Blau and Kahn (2004) (4%) using general samples of female workers. The depreciation rate is 0.0107, which means the wage offer in the next period will be 1% lower if a mother doesn't work in the current period. This is larger than what is estimated in Bernal (2008) for mothers who are married and on average more educated. Our estimate of the discount rate is about 0.9.

Table **??** reports the parameter estimates of utility function, Equation (**??**). The utility from the composite consumption, α_1, is 0.7112. As λ_1 is 0.7275, marginal utility from consumption is decreasing. A mother receives a significantly positive utility from her child's cognitive ability (a highly positive α_3). We also find that λ_2 is 0.52, which indicates that a mother has an incentive to invest more in a child with lower cognitive ability. A mother's taste for work (α_2) is captured by a constant term ($\overline{\alpha_2}$), years of education, and ethnicity. The estimates suggest that mothers generally value leisure ($\overline{\alpha_2}$ is negative). Mothers who have more years of education tend to dislike work more. Black mothers, on the other hand, receive slightly higher utility from work, everything else constant.[18] Other

[18] Bernal (2008) finds that compared to mothers of other racial or ethnic backgrounds, Black mothers receive a larger negative utility from work. However, Bernal also finds that Black mothers receive a higher positive utility from using child care. The combined effect of the two decisions is that Black mothers receive a positive utility from working and using child care simultaneously. Since we do not model child care use decisions, our work decision may have captured the average utility effects from both employment and child care use decisions.

things equal, mothers who are better educated and Black are more likely to use welfare. There are two very distinct types in terms of welfare stigma ($\overline{\alpha_{4H}}$ and $\overline{\alpha_{4L}}$); high stigma types have utility cost of -1.0028 as opposed to -0.2188 for low stigma types. We discuss the implications of welfare types in detail in Appendix Section **??**.

We see that mothers have a cost of initiating welfare (negative α_5) that is even higher than the disutility of receiving welfare (α_4 for both high stigma and low stigma types). This captures the observation that many eligible single mothers choose not to participate in the welfare program. Moreover, both utility parameters for finding a new job after childbirth and working in the first year (α_6 and α_7) are negative. This reflects the fact that many mothers chose not to work in the first year after their children's birth.

Table **??** reports the parameters of the log ability production function, Equation (**??**). First, we see that the estimates of the observed cognitive ability endowment, Equation (**??**), are comparable to estimates from the literature (Bernal (2008) and Bernal and Keane (2010 and 2011)). On average, girls perform better than boys. A higher birthweight, a higher maternal education, and a higher AFQT score all imply a higher cognitive ability endowment. Having a mother who is younger than 18 or older than 33, on the other hand, both lead to a lower cognitive ability endowment. Estimated log cognitive ability endowment ranges between 0.1092 to 0.4180. Figure 1 draws the marginal effects of work and welfare use against the distribution of $\ln A_0$.[19] We see that a mother's work improves her child's math test score, but the effect declines with the child's cognitive ability endowment. The marginal change in attainment resulting from a one-year increase in work ranges from 9.23% at the lowest cognitive ability endowment to 2.20% at the highest, with the median effect (marked by middle dashed line) at 3.13%. The highest, lowest and median marginal effects translate to 1.01, 0.919 and 0.962 points increases in the the standardized test scores, respectively.[20] Estimates in Table **??** shows that 60% of

[19]The effect of employment on a child's log test score is: $\frac{\partial \ln O}{\partial E} = 0.0104 - 0.0029 * \ln A_0$. Welfare effects are: $\frac{\partial \ln O}{\partial W_H} = 0.0607 - 0.1465 * \ln A_0$ for a child of a Type I mother and, $\frac{\partial \ln O}{\partial W_L} = 0.0452 - 0.1465 * \ln A_0$, for a child of a Type II mother.

[20]These positive employment effect estimates, however small in magnitude, are significantly different from Bernal (2008) and Bernal and Keane (2010; 2011), who find that a mother's employment is detrimen-

our sample mothers are Type I. For a Type I mother, the net marginal effect of welfare use on her child ranges from 4.47% to -0.0005%, with a median of 1.61%. This effect is quite substantial, as it translates to a 1.50 points increase in the mean PIAT-Math test score. That is, despite higher disutility for the mother, children of Type I mothers can potentially benefit greatly from welfare use, except for those children with the highest cognitive ability endowment. On the contrary, for about half of the children with Type II mothers, the net effect of welfare use on the child's cognitive achievement is negative. The net effect of welfare use for the children of Type II mothers ranges from 2.92% to -1.60% per year, with an economically insignificant effect on the median child (0.00062%, which is 0.00057 points increase in the standardized test score). Recall that the coefficients of welfare capture the benefits from in-kind transfer programs such as Medicaid and Head Start. We would expect Medicaid to have universal benefits for all participants. However, programs such as Head Start may benefit children with high cognitive ability endowment less compared to low ability children. Having a negative role model, on the other hand, may hurt the children with high cognitive ability more.

Chyi and Ozturk (2012) estimate a similar but a reduced form attainment production function using a correction function approach. In that study, they find that the marginal effects of an additional year of employment and welfare use for a child with median level of cognitive ability endowment are at 1.44% (1.34 points) and 0.649% (0.604 points), respectively. Our estimates are comparable to theirs in direction and magnitude.[21]

tal to a child's cognitive achievement. Our sample and model differ in certain ways that may explain the differences in findings. First, Bernal (2008) focuses on a population of married mothers, who may have different child rearing technology and children of much higher ability endowments. Second, Bernal and Keane (2010; 2011) study the effect of child care focusing on a group of single mothers that also includes potentially better-educated mothers. Finally, since NLSY79 does not provide detailed child care information, they use employment as a proxy. We find that about 20% of our sample reported using child care in the first three years but no employment. However, such cases are defined as having worked in Bernal and Keane (2010; 2011). We find that such variations in the definition of employment explains a significant part of the variation between our results. Detailed explanation and comparisons of estimates by different samples is available upon request.

[21] Though they have the same sign, these effects are smaller than ours. Modeling and sampling differences may explain the difference in magnitudes. Our dynamic model with unobserved heterogeneity is likely capturing more of the variation. Moreover, Chyi and Ozturk (2012) use "sometimes single mothers" in

4.2 Policy Analysis

Using the estimated parameters, we simulate the effects of three policy changes. These policy changes gauge mothers' behavioral responses facing (i) a welfare time limit and work requirement, (ii) a relief of welfare tax on labor income and (iii) a policy that is similar to maternity leave. In each policy exercise, we look at the changes in work and welfare participation and analyze how achievement measures differ for children of women with different work and welfare choices.

4.2.1 Imposing Time Limit on Welfare and Work Requirement

According to the new TANF rules, the longest time one can be on welfare without working is two years, and the cumulative welfare use cannot exceed five years. We simulate this policy by setting benefits to zero if cumulative welfare use exceeds two years and no work is chosen.[22] Figure **??** part (a) and (b) document the behavioral responses for an average mother whose observed covariates are at the sample mean. We can see that welfare choice decreases by about 4 percentage points in the first two periods. After that, welfare participation decreases gradually by about 9 percentage points. Meanwhile, the increase in work participation is also significant. The employment rate goes up by about 12 percentage points in the first two periods. In the last three periods, this increase reaches more than 30 percentage points.

These results indicate that the combination of a welfare time limit and work requirement has a sizable effect on mothers' behaviors. According to the new welfare rule, a typical mother who currently gets all of her income from welfare will no longer be able to receive a welfare benefit after the first two years. Thus, she will choose to work to

addition to "always single mothers." Robustness checks indicate children of always single mothers are more responsive to to their mother's employment and welfare use. Chyi and Ozturk (2012) also include children born after welfare reform in addition to pre-reform sample to utilize policy variations as IVs. NLSY79 mothers who gave birth after welfare reform were much older, and thus they have more work experience and possibly higher wages.

[22]Since we only model the first five years of a child's live, it is not possible for us to impose the five-year time limit.

make up for the lost income, which explains the sharp increase in employment rate after two periods. Note that in our model, one can find employment so long as one wants to. Since we do not model the job matching difficulty and a mother's searching intensity, the insurance aspect of welfare use is not factored into our model. As a result, welfare use does not decline by as much as what we observe in the data.

Our results are in line with other studies on the effects of welfare reform on mothers' behaviors. Fang and Keane (2004) focus on single mothers and find that work requirements and welfare time limit explains most of the decrease in the welfare participation rate and the increase in the work participation rate, even after controlling for other factors such as the 1993 EITC expansion and the economic expansion of 1990s. Furthermore, Grogger and Michalopoulos (2003) argue that the effects of welfare time limits may be largest on mothers who have younger children, since they value the insurance purpose of the welfare program more.

Finally, this policy increases the mean of simulated test scores by 3.55% (or a 3.90 points increase in test score. See Figure **??** part (c)). Even though our model is naive in the sense that we have not taken into account the difficulty of finding a job, we find that at least at the mean level for cognitive ability, positive impact of increased work outweighs the negative impact of decreased welfare use.

4.2.2 Eliminating Welfare Tax on Labor Income

In this experiment, we relax the relationship between the decisions for welfare use and employment. We simulate this policy by assuming that work income would not reduce the benefit from welfare use (in other words, we set $b_8 + \sum_s b_{9s} D_s = 0$). The resulting increase in work is about 3.54 percentage points in the first year. In the next three years employment increases even more (by about 9 percentage points), but not as much in the fifth year (only by 1.77 percentage points). However, this policy change only has a slightly positive effect on welfare use (see Figures **??** part (a) and (b)). The increase of mean log achievement is only about 0.46% (or 0.42 points in standardized test scores. See Figure

?? part (c)), which is far smaller than the effect of a combination of a welfare time limit and work requirements as proposed in the previous experiment.

As a result, if the policy goal is to promote work, reducing welfare tax on labor income can be a valid alternative since it sharply increases employment. Furthermore, it does increase the attainment of children whose mothers are on welfare.

4.2.3 Maternity Leave Policy

In this experiment, we analyze the impact of a maternity leave policy by setting the wage depreciation rate of the first year after childbirth to zero.[23] This policy change would have no effect on those mothers who have not worked before giving birth. Thus, we focus on the proportion of the sample who worked before giving birth (only 42% of the whole sample). Because the maternity leave policy decreases the wage depreciation cost of leaving a job, we expect fewer mothers to work in the first period after giving birth. This reduction may continue for the remaining periods because fewer benefits are received from the working experience. At the same time, we expect these mothers to choose welfare to make up for the loss of labor income. With this policy change, our simulations show that the employment rate decreases by about 10 percentage points in the first year and 6 percentage points in the second year. The effect is insignificant for the later years. The increase in the welfare use is minuscule in all periods (See Figures **??** part (a) and (b)). However, even though the effect on welfare is very small and effect on work is insignificant in most periods, this policy reform decreases of mean log achievement is about 0.31% (or 0.34 points in standardized test scores. See Figure **??** part (c)).

Our finding of a decrease in labor force participation is in line with the findings of Baker and Milligan (2008), who find that when Canada changed its maternity leave policy, the percentage of mothers who went back to work within the first nine months declined

[23] In the second year wage equation ($\ln w_2$ in Equation (**??**)), we also set the work premium terms for the second year after child-birth (corresponding to ϕ_9 and ϕ_{10}) equal to the first year estimates.

Currently, there is a four week unpaid maternal leave in the U.S. However, there was none before 1993.

significantly, from 53% to about 33%. Furthermore, Han, et.al. (2009) find that within nine months of leaving work after child birth, about 60% of all women go back to work. This is especially high among Black new mothers who are the majority of our welfare users. They further indicate that non-college-graduate, young and single mothers are the ones who are most likely to go back to work within two months of giving birth. On the other hand, older, married, and at-least-college-graduate mothers are the least likely to go back to work quickly, because they are likely to have savings to draw upon and have access to maternity leave. Since this policy experiment only applies to about 40% of our sample mothers who have been working before childbirth, the average effect on the whole population should be smaller.

5 Conclusion

Our results reveal significant policy effects for a sample of children who are in disadvantaged households with low-income single mothers. We find that in this sample a mother's employment is beneficial for cognitive development of the child, especially if the child has a low cognitive ability endowment. This result is significantly different from the literature which documents negative cognitive achievement responses to a mother's employment. This positive impact may be due to a positive role model effect. Alternatively, it may be capturing the benefits from subsidized child care instead.

In our model the welfare program participation variable captures the effect of benefits from non-monetary programs that are somewhat linked to the AFDC, such as subsidized housing, Medicaid, and Head Start. Our results show that a mother's welfare use contributes positively to cognitive ability accumulation of her child as well, especially if she is a high-stigma user, who rarely uses welfare but when she does, she fully utilizes the benefits to nurture her child. However, for high ability children the effects are low, even negative, if the mother is a high frequency user who does not utilize welfare resources well.

In our counterfactual simulations, we find that policy changes that reduce welfare use/increase employment are generally beneficial to early cognitive development. Specifically, a policy that combines a work requirement and a two-year welfare time limit increases the test score of a child with median ability endowment by 3.55%, a result that is both statistically and economically significant. This implies that welfare reform was not only successful in achieving its stated goals, but was also beneficial to welfare children's outcomes. Ours is the first paper to assess the effects of welfare reform on early cognitive development at national level with observational data. However, there are some experimental studies that provide evidence for positive changes on early outcomes (primary school children) in response to local welfare reform initiatives (Duncan and Chase-Lansdale, 2001; Morris, Duncan and Clark-Kauffman, 2005). Our results serve to validate this evidence at the national level with a representative dataset. Moreover, we complement the only other study that is directly comparable to ours, Miller and Zhang (2009) by estimating the effects on pre-school outcomes. Their positive welfare reform effects for low-income 4th to 8th graders suggests the early positive effects we find persist in the long run and translate into better scores at school as well.

In another policy simulation, we show that increasing work incentives for the welfare population by exempting labor income from "welfare tax" can be a very successful policy with some additional benefits for children's outcomes. However, we find that a counterfactual with an extended maternal leave policy does not provide positive changes to cognitive outcomes. This policy, moreover, significantly reduces maternal employment with no significant change in welfare use.

We conclude that if the goal is to reduce welfare dependency, policies that increase incentives to work such as EITC work better than mandates alone. These policy changes, along with improvements in accessibility and quality of non-cash welfare programs, can significantly improve the cognitive outcomes of children with disadvantaged backgrounds. This is promising in breaking the intergenerational cycle of welfare dependency.

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6 Tables and Graphs

Table 1: Sample Descriptives - Means

Mother's Decisions		Mother's Characteristics	
Welfare participation	0.794	Age at Birth	25.5
	(0.404)		(4.4)
Annual Employment		Years of Education	10.9
Part-Time	.128		(1.6)
(500-1499 hours)	(0.335)	Number of Children	2.4
Full-Time	0.186		(1.3)
(>= 1500 hours)	(0.389)	Annual Labor	10,737.2
Hours of Work	1605	Income*	(9,070.4)
(Conditional on work)	(626)	Annual Other	6,063.0
		Income*	(33,938.9)
Child's Characteristics		AFQT	14.2
Female/Male	0.48/0.52		(14.0)
Black/Others	0.74/0.26	County Characteristics	
Birth Weight(Ounces)	110.7	Unemployment Rate	7.8
	(22.9)		(3.2)
Age Taking Test (Quarters)	25.3	Service Industry	0.16
	(4.8)		(0.04)
PIAT-Math Score	93.1	Medium Income	23,967.1
	(13.4)		(6,228.3)
Child-Years	2,820		
Children	564		
Mothers	392		

- Standard errors are in parentheses.
- Population weighted to reflect the 1979 national population of low-skilled single mothers.
* In 2000 dollars deflated by PCED-nondurable.

Table 2: Detailed Descriptive Statistics of Test Scores by Quartiles of Demographic Characteristics

	Quartile				
	1st	2nd	3rd	4th	
PIAT-Math Score	75.60	89.40	98.40	111.02	
	(5.56)	(2.67)	(2.75)	(6.43)	
Mother's Characteristics					
Real Hourly Wages†	1.1	2.6	4.8	10.6	
Mean Standard Test Scores	94.8	92.4	95.8	96.7	
(Standard Deviation of Scores)	(13.7)	(14.8)	(12.5)	(12.7)	
Average Labor Income†	181.6	1010.9	3598.1	11,823.2	
	94.8	97.3	93.2	96.2	
	(13.4)	(13.6)	(13.2)	(12.2)	
Average Other Income	479.0	1919.4	4126.5	19,805.8	
	94.0	93.5	93.6	94.8	
	(14.50)	(13.90)	(12.90)	(12.70)	
AFQT Score	3.0	7.8	14.0	34.9	
	90.2	92.3	94.1	96.7	
	(13.2)	(12.8)	(12.5)	(14.3)	
Education	< 12	$= 12$			
	91.4	94.7			
	(13.60)	(13.30)			
Age at Birth	21.1	25.0	28.4	33.7	
	93.9	93.5	92.6	92.0	
	(13.20)	(13.40)	(13.20)	(14.00)	
Child's Characteristics					
Race	Black	Hispanic	Other		
	73.8	12.9	13.3		
	93.6	92.2	97.8		
	(11.89)	(13.59)	(13.24)		
Gender	Male	Female			
	92.6	93.6			
	(13.80)	(13.03)			
Number of Siblings	1	2	3	4	
	0	1	2	3	> 3
	95.7	95.3	93.0	90.7	90.2
	(13.62)	(13.73)	(12.53)	(13.00)	(14.10)
Age Taking Test (Quarters)	21.2	24.1	26.4	32.1	
	91.6	94.6	93.3	92.5	
	(14.70)	(12.70)	(12.50)	(13.50)	
County Characteristics					
Unemployment Rate	4.7	6.5	8.3	12.3	
	93.5	93.2	93.0	92.7	
	(14.0)	(13.6)	(12.8)	(13.4)	
Service Industry	0.09	0.14	0.18	0.22	
	93.9	92.4	92.2	94.0	
	(13.7)	(13.0)	(12.5)	(14.4)	
Medium Income	15,433.50	21,000.50	25,317.30	31,582.70	
	92.4	94.1	92.3	93.7	
	(13.4)	(14.0)	(13.1)	(13.1)	

- Standard errors are in parentheses.

† Conditional on work.

Table 3: Log-wage Estimates

Variables	Coefficient
Time-Invariant	
Age (ϕ_1)	0.0625
	(0.0013)
Age Squared (ϕ_2)	-0.0010
	(0.0000)
Race (ϕ_3)	-0.0041
	(0.0025)
Education (ϕ_4)	0.0052
	(0.0020)
AFQT (ϕ_5)	0.0014
	(0.0003)
Constant (ϕ_6)	0.6124
	(0.0232)
Depreciation Rate (δ)	0.0107
	(0.0033)
Experience-Related	
Work Experience (ϕ_7)	0.0065
	(0.0013)
Education*Experience (ϕ_8)	0.0006
	(0.0001)
Part-Time Premium (ϕ_9)	0.1013
	(0.0096)
Full-Time Premium (ϕ_{10})	0.1713
	(0.0060)
County Characteristics (φ)	
Unemployment Rate (φ_1)	-0.0270
	(0.0070)
Services Industry (φ_2)	0.0003
	(0.0026)
Medium Income (φ_3)	0.0026
	(0.0005)

- Standard errors are in parentheses.

Table 4: Utility Parameters

Variables	Coefficient
λ_1	0.7275
	(0.0085)
Consumption (α_1)	0.7112
	(0.0204)
Taste for Work (α_2)	
Disutility from Work $(\overline{\alpha_2})$	-3.8780
	(0.1164)
Mother's Education on Taste for Work (α_{21})	-0.0632
	(0.0436)
Mother's Race on Taste for Work (α_{22})	0.0042
	(0.0178)
Ability of the Child (α_3)	4.7047
	(0.0333)
λ_2	0.4120
	(0.0036)
Taste for Welfare (α_4)	
Disutility from Welfare Type I $(\overline{\alpha_{4H}})$	-1.0028
	(0.0149)
Disutility from Welfare Type II $(\overline{\alpha_{4L}})$	-0.2188
	(0.0766)
Mother's Education on Taste for Welfare (α_{41})	0.1574
	(0.0428)
Mother's Race on Taste for Welfare (α_{42})	-0.6537
	(0.0544)
First Year Using Welfare after Birth (α_5)	-4.7570
	(0.0758)
First Job after Birth (α_6)	-0.2926
	(0.0590)
Work in First Year after Birth (α_7)	-0.9359
	(0.1001)
Discount Factor (β)	0.9041
	(0.1001)

- Standard errors are in parentheses.

Table 5: Initial and Current Ability Parameters

Variables	Coefficient
Initial Ability Parameters	
Birth Weight (γ_6)	0.0428
	(0.0003)
Gender (γ_7)	0.0110
	(0.0039)
Race (γ_8)	-0.0177
	(0.0010)
Mother Too Young Dummy (γ_9)	-0.0424
	(0.0084)
Mother Too Old Dummy (γ_{10})	-0.0202
	(0.0096)
Education of Mother (γ_{11})	0.0234
	(0.0012)
AFQT (γ_{12})	0.0011
	(0.0003)
Current Ability Parameters	
Cumulative Income (γ_1)	-0.0043
	(0.0011)
Cumulative Work Experience (γ_2)	0.0104
	(0.0011)
Cumulative Years on Welfare of Type I (γ_{3h})	0.0607
	(0.0015)
Cumulative Years on Welfare of Type II (γ_{3l})	0.0452
	(0.0006)
Cumulative Years on Welfare*Initial Ability (γ_4)	-0.1465
	(0.0041)
Cumulative Work Experience*Initial Ability (γ_5)	-0.0029
	(0.0006)
Outcome	
Age (γ_{13})	0.1491
	(0.0029)
Mean Test Score (μ_0)	3.4185
	(0.0147)

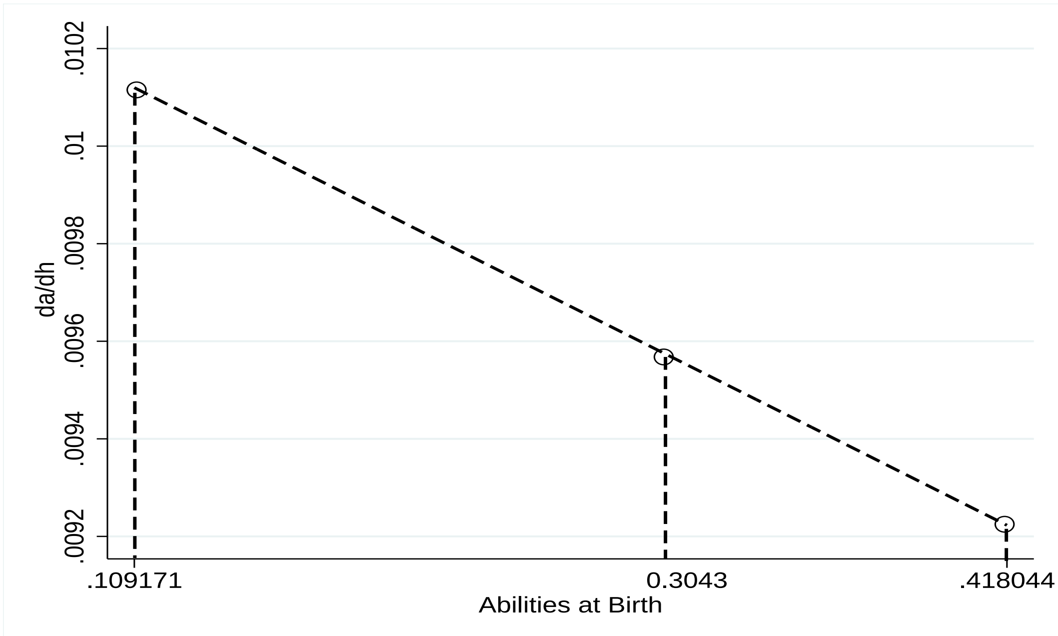
- Standard errors are in parentheses.

Table 6: Type-Related Parameters

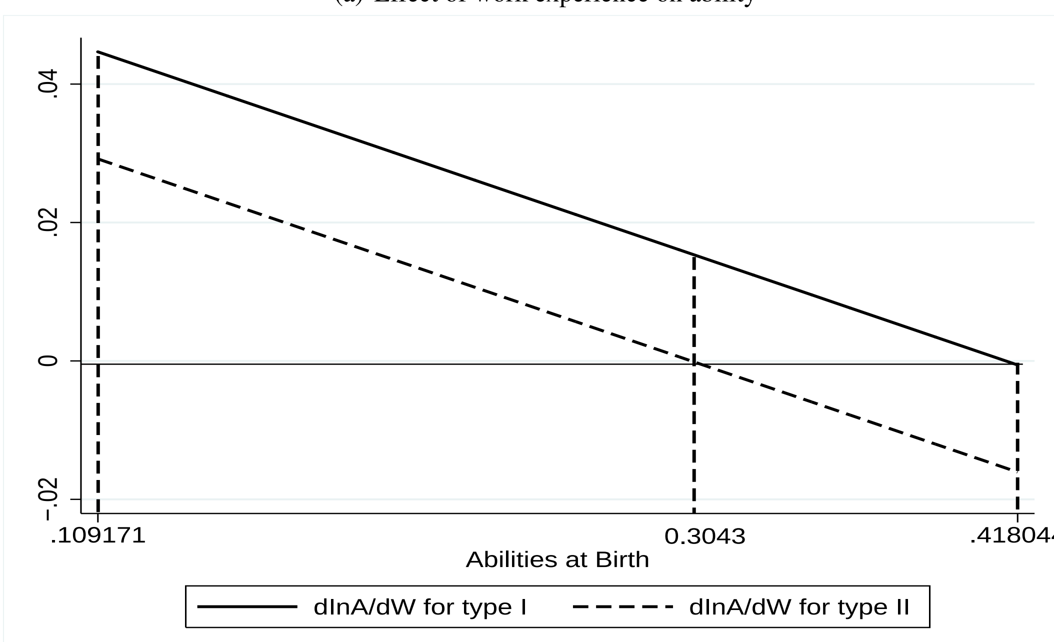
Variables	Coefficient
Type Proportions	
Type I Stigma from Benefit Use (π_h)	0.5989
	(0.1097)
Type II Stigma from Benefit Use (π_l)	0.4011
	(...)
Welfare Stigma	
Disutility from Welfare Type I ($\overline{\alpha_{4H}}$)	-1.0028
	(0.0149)
Disutility from Welfare Type II ($\overline{\alpha_{4L}}$)	0.2188
	(0.0766)
Rearing Technology	
Cumulative Years on Welfare of Type I (γ_{3h})	0.0607
	(0.0015)
Cumulative Years on Welfare of Type II (γ_{3l})	0.0452
	(0.0006)

- Standard errors are in parentheses.

Figure 1: Effects of Mothers' Decisions on Ability Given Cognitive Ability Endowment

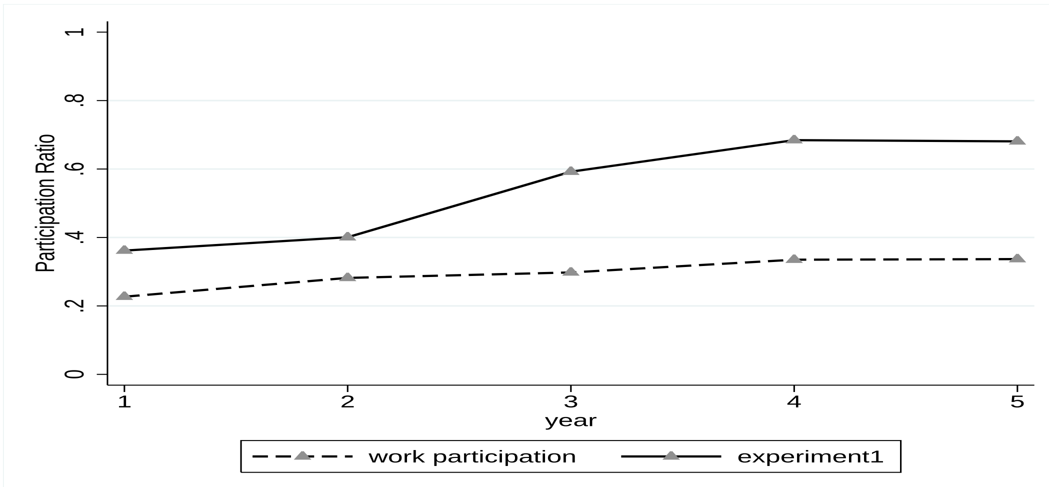


(a) Effect of work experience on ability

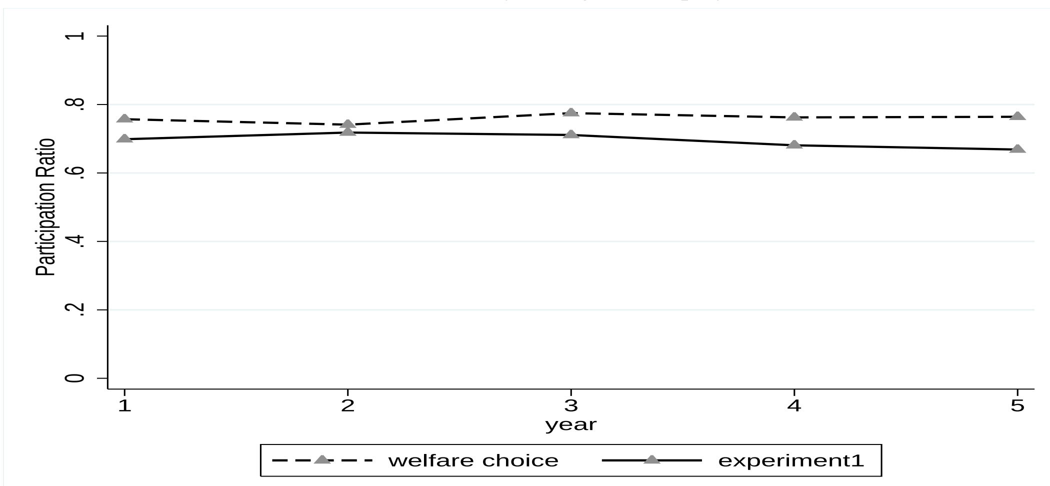


(b) Effect of welfare experience on ability

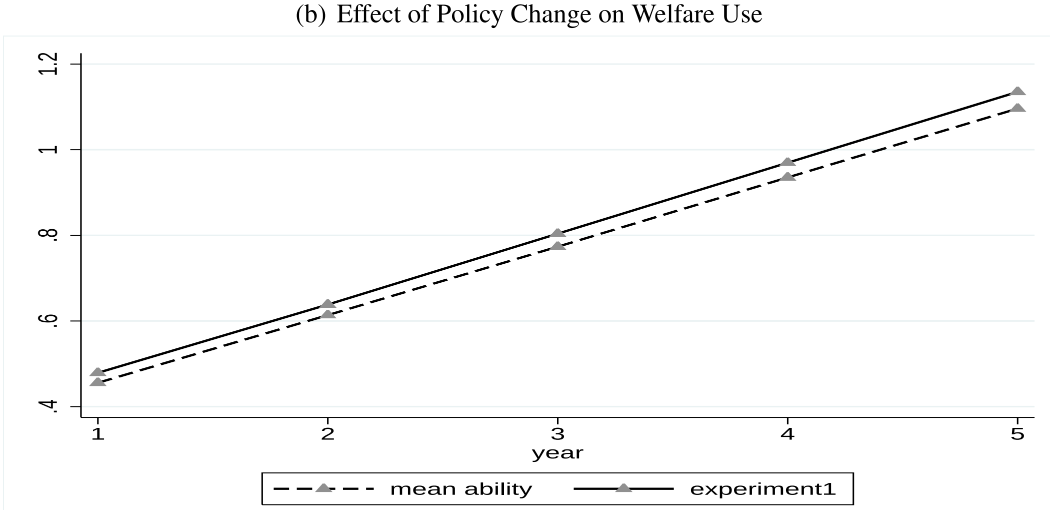
Figure 2: Effect of Time Limit and Work Requirement



(a) Effect of Policy Change on Employment

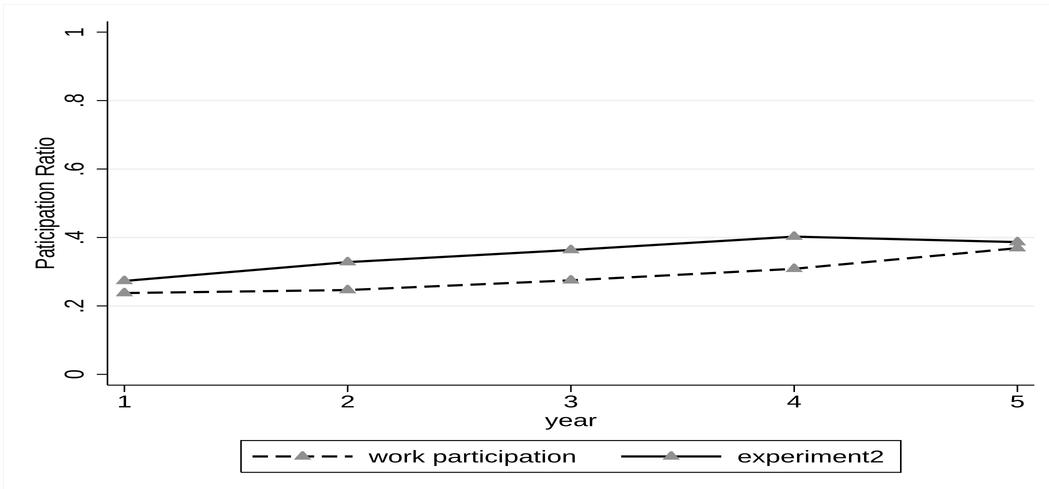


(b) Effect of Policy Change on Welfare Use

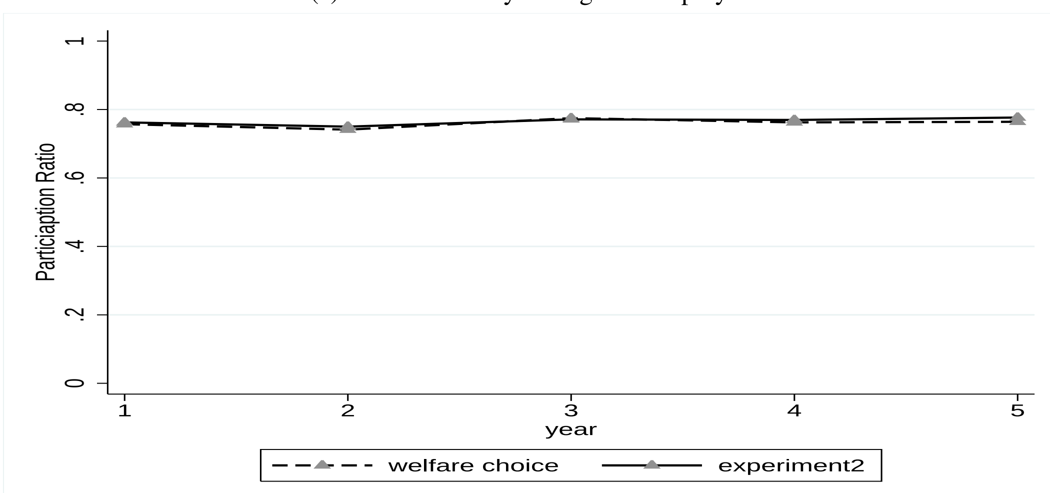


(c) Effect of Policy Change on Children's Current Ability

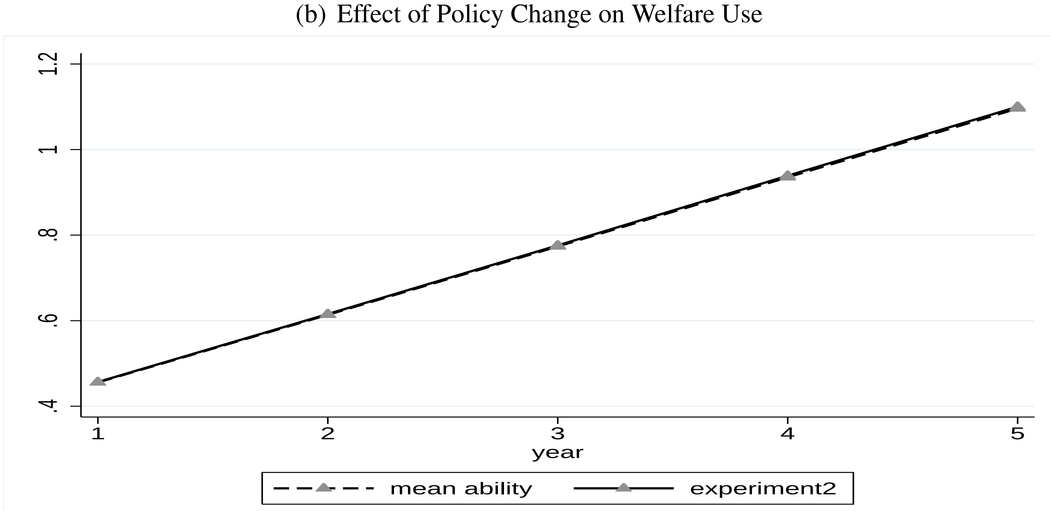
Figure 3: Effect of Eliminating Welfare Tax



(a) Effect of Policy Change on Employment

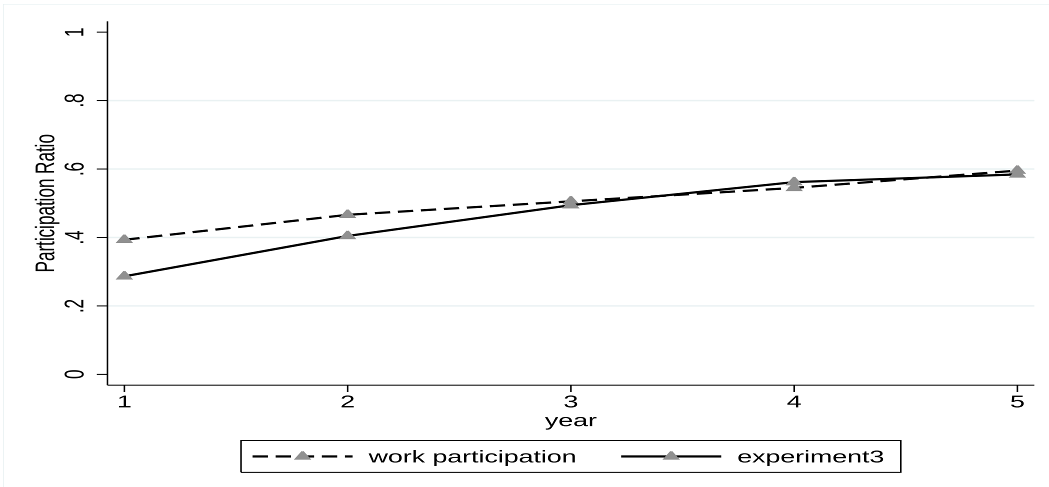


(b) Effect of Policy Change on Welfare Use

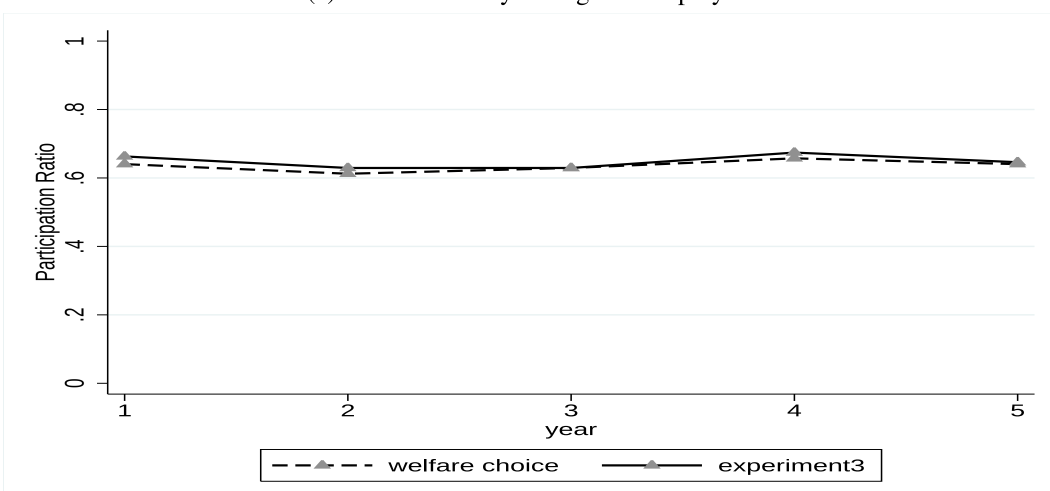


(c) Effect of Policy Change on Children's Current Ability

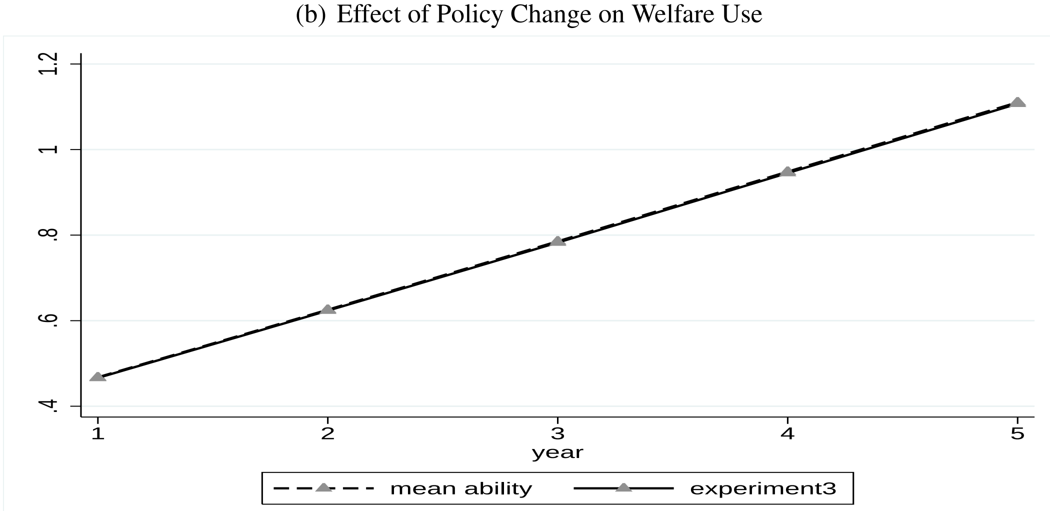
Figure 4: Effect of Extended Maternity Leave Policy



(a) Effect of Policy Change on Employment



(b) Effect of Policy Change on Welfare Use



(c) Effect of Policy Change on Children's Current Ability

Appendix

A.1 Solution to the Mother's Optimization Problem and the Likelihood Function

At the beginning of period t, a mother faces the state vector S_t, determined by her choices up to t. S_t includes work experience E_t and cumulative welfare usage W_t up to the current year beginning from two years prior to child-birth and evolves as follows:[A-1]

$$\begin{aligned} E_1 =& h_{-1} + h_{-2} \\ E_t =& E_{t-1} + h_{t-1} \\ W_1 =& \omega_{-1} + \omega_{-2} \\ W_t =& W_{t-1} + \omega_{t-1}, \end{aligned} \tag{A.8}$$

where h_{t-1} and ω_{t-1} are the work and welfare choices in the previous period, respectively. Given this state, a mother chooses h_t and ω_t that maximize the expected utility for the remaining periods, which we will call V_t. V_t is the sum of period-specific utilities from the remaining periods, beginning with period t. Defining current-period alternative-specific utility, $u(S_t, j, \epsilon_{jt})$, as the sum of a deterministic part U_t^j and an alternative-specific shock ϵ_{jt} , we have:

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

where d_{jt} is the indicator that alternative j is chosen, and 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

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

[A-1] Notice that initial conditions E_1 and W_1 are predetermined because they depend only on information before a child's birth, which is taken as given.

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

$$V^j(S_t, j) = U_t^j + \beta \sum_{S'} \Pr(S' \mid S, j) EV(S', \epsilon').^{\text{A-2}}$$

This optimization problem is solved recursively using backward induction. In order to make a choice at $T-1$, a mother calculates the expected value of 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 sets d_{jT-1}=1 by calculating

$$V(S_{T-1}, \epsilon_{T-1}) = \max_j \{U_{T-1}^j + d_{jT-1}\epsilon_{jT-1} + \beta E_\epsilon V(S_T, \epsilon_T | S_{t-1}, d_{jt-1})\}.$$

In order to do this, first the mother must calculate

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

Now, returning to period $T-2$, before she can decide what to do in $T-2$ she needs to know the alternative-specific value functions for every feasible S_{T-2}^j, and so forth, until she comes back at the current period t.

The individual likelihood function for individual i at time t with type k can be written as

$$L_{itk} = \{\sum_k^{I,II} \pi_k [\sum_{j=1}^{J} d_j \ \Pr(d_j = 1 \mid S_t, k) g(O_t \mid k)^{I[O_t \text{ available}]}]\} f(w_t \mid S_t)^{I[h_t > 0]}$$

where $f(w_t \mid S_t)^{I(h_t > 0)}$ is the probability of receiving a wage offer at w_t if the mother is working, conditional on the work experience and other state variables. $g(O_t \mid k)^{I[O_t\ available]}$ is the probability of observing the test score O_t when a test is taken by a child with a type

[A-2]Note that in our setup of transition of state variables, Equation (**??**), $\Pr(S' \mid S, j)$ is deterministic.

k mother at time t. The product of L_{itk} across years gives us the individual likelihood function. The natural logarithm of the product of individual likelihoods gives the log likelihood function.

We estimate our model using the maximum likelihood method. We write V_t^j as the value function of choice j in period t, and we need to solve it before we can compute $\Pr(d_j = 1 \mid S_t, k; \theta)$. Given state variable S_t and the alternative-specific error term ϵ_t^j , we know that

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

We assume that the preference shocks ϵ are drawn i.i.d. from the Type I extreme value distribution with a location parameter of 0 and a scale parameter of 1. This enables us to write the probability of choosing d_j, given state S_t, as $\Pr(d_j = 1 \mid S_t, k) = \frac{\exp(V^j(S_t,k,d_j))}{\sum_k \exp(V^k(S_t,k,d_j))}$.

A.2 Identification

An importance source of identification of differences in mothers' work and welfare behaviors is the exogenous variation in the AFDC benefits across states and local labor market market conditions.

The benefit rule for the AFDC program of each state is a nonlinear function of a mother's income, work decisions, and the number of children she has. Keane and Wolpin (2002) find that empirical results vary widely in the literature mostly due to the adoption of different benefit-rule parameters. They argue that the benefit level of a specific year fails to capture the long-term changes in state AFDC rules, which are more likely to affect mothers' decisions in a dynamic setting. Instead of using randomly drawn, real benefit levels, they suggest that researchers should estimate the long-term state-benefit rules and use the estimated parameters as instruments.

Following the strategy of Keane and Wolpin (2002), we estimate the AFDC benefit rules for each U.S. state by pooling all single-mother welfare receipts in the Panel Study of Income Dynamics (PSID) from 1968 to 1992 and using dummy variables to identify state benefit parameters. The AFDC benefit for a mother i who lives in state s is given by the equation:

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

where D_s is the indicator of the residence of individual i. $D_s = 1$ if mother i lives in state s. noC_i is the number of children in the household and $noCSq_i$ is the square of this number. M_i is the unearned income and $w_i h_i$ is the labor income of the individual.

The fact that we have a panel of five years with information on mothers' work and welfare use enables us compare not only the attainment of children who have experienced one decision and those who have experienced none, but also those who have been exposed to varying combinations of welfare and work. We incorporate effective welfare tax on earned income to separate the effects of welfare use and work in the children's attainment function. The rationale is that the higher the effective tax on earned income, the less likely a mother who has already been on welfare would have chosen to work. However, it is important to note that the separation of the effects of welfare use and work on children's attainment does not simply hinge on the effective welfare tax.

In our model, identification of the parameters relies on at least three assumptions. First, the structure of the model is correct. Second, the distributional assumptions required for the estimation (i.e., the likelihood function) are correct. Third, there are some exclusion conditions that affect only mothers' decisions but not children's outcomes. For example, both Bernal (2008) and our study rely on the county labor market conditions to separate mothers' decisions and children's attainment. For this to be correct, we need to further assume that the county labor market conditions only affect the demand for low-income single mothers. That is, these conditions are not correlated with mothers' taste for work and welfare use. Additionally, we need to assume that the welfare benefit rules are not correlated with uncontrolled factors in children's cognitive attainment productive function. For example, we need to assume that states with more generous welfare benefits do not have better subsidized child care. Or, even if they do, the effects will not fundamentally change our results.

Although these assumptions are not directly testable, we estimate several alternative models to evaluate the appropriateness of them. As parameter estimates are not directly interpretable, we will focus on discussing the changes in the marginal effects of mothers' decisions on children's attainment in Equation (3). Table **??** collects these marginal effects of an additional year of each decision against children whose cognitive ability endowment is at 1st, 25th, 50th, 75th and 99th percentiles, as well as the mean effects.

Specification 1 gives the marginal effects of our baseline model. These are the data we use to draw Figure 1. Specifications 2 estimates Equation (3) using the OLS. In this specification mothers' employment is negatively associated with outcomes for at least half of the sample children. Even though the median effect is positive (and small in magnitude), the mean effect is negative. Welfare use appears to be negatively associated with children's test scores, regardless of the endowed ability. Comparing Specifications 1 and 2, it is easy to see that without controlling for the unobserved heterogeneity and the excluded exogenous variation, estimates are significantly biased downwards.

Specification 3 is the IV estimation of Equation (3). Comparing Specification 3 to Specification 2 we see that the marginal effect of mothers' employment is now positive for all children except the ones with highest endowed ability. Both median and mean effects are also positive. However, they are both about 50% smaller than the structural model estimates in Specification 1. IV estimates overestimate the effects of mothers' employment on children with endowed abilities on both the high and low ends of the distribution. In other words, the IV method seems to overestimate γ_5 in Equation (3).

Specifications 4 to 7 further study the effects of different channels through which mothers' decisions affect their children's attainment as discussed in Section **??**.

Specification 4 excludes accumulated family income in the attainment production function. As a result, the income effect is going to be absorbed by the variables that are correlated with it. For example, the coefficient of work now also captures the effects from an increase in labor earnings. On the other hand, an increase in income through any welfare program is absorbed by the coefficients of welfare. The marginal effects do not change much when income is excluded from the model. In fact, Bernal and Keane (2011) also find that even after instrumenting for it, the effect of family income on children's outcome is small and insignificant. One explanation for this, as pointed out by Keane and Wolpin (2001), is that once variables such as mothers' education and AFDC are taken into account, we essentially control for the permanent part of the income and remaining variations in transitory income (even when it is cumulative) do not matter much in the behaviors of a forward-looking agent.

Specification 5 excludes controls for mothers' employment. Note that work is negatively correlated with welfare use in the data. When work is excluded in the attainment production function (but family financial resources are controlled for), an increase in welfare use hence incorporates not only the effect of nonpecuniary means-tested transfer programs but also time-use related effects(such as subsidized child care) and role model effects. As a result, the marginal effects of welfare use in Specification 5 are sizably reduced. Specification 6 excludes welfare use. Similarly, we see that the negative correlation between welfare use and employment in the data indicates that the effect of either decision is reduced once we drop the other decision in the model.

Finally, Specification 7 combines the effects of all three channels of mothers' decisions into a single employment variable by dropping both income and welfare use variables in the model. The last column shows that the marginal effect is even lower than it is with Specification 6. Comparing Specifications 6 and 7 to Specification 1, it illustrates the importance of separately controlling for the effects of mothers' decisions from different economic channels.

A.3 Model Fit

Figure **??** provides support for how well the model fits the data. Overall, we fit the participation rates for welfare and work nicely (Figure **??**). We predict more than 90% of mothers' full-time and part-time work choices successfully. Meanwhile, we also predict more than 95% of mothers' welfare behavior. However, our estimation of part-time work suffer a slight underestimation in the second period and a slight overestimation in the fourth period. At the same time, our prediction of full-time work is mildly overstated, especially in the last two periods.

A.4 Understanding Unobserved Heterogeneity

Table **??** reports estimates of all parameters that are related to "types" in the model. Figure **??** draws the annual means of welfare use and work patterns for mothers of different types. As can be expected, they have noticeable differences in terms of welfare use, as mothers with higher welfare stigma (Type I mothers) use slightly less welfare following childbirth. On the other hand, there is no significant difference in employment patterns between mothers who have different levels of welfare stigma. As discussed before, we assume the distaste of work in the utility function to be the same for both types of mothers. The difference in work patterns is hence initially generated only through variation in income resulting from differences in welfare use. In later periods, variation in wages coming through the differences in work experience play a role as well.

The difference in children's annual attainment ($\ln A_t$) for the two types of mothers is large, as can be seen in Figure **??**. With high γ_5, Type I mothers are better at utilizing resources from welfare programs to nurture their children and as a result each year of welfare and work contribute more to the cognitive development.

The fact that we have more Type I mothers is encouraging. First, since the effects of employment is mostly positive, policies that are pro-employment will be beneficial to most children's attainment. On the other hand, policies that curb welfare use will not affect children born to Type I mothers ex-post, as their mothers do not use welfare much to begin with. As for children born to Type II mothers, reducing welfare use actually is beneficial for at least half of them, given that the marginal effect of welfare use is negative for children with more than the median level of observed cognitive ability endowment.

Overall, allowing mothers to have varying levels of welfare stigma and efficiency utilizing welfare resources adds greatly to our model's ability to capture the effects of work and welfare on children's attainment. Having types also enhances our understanding of the potential channels welfare reform initiatives contribute to these effects.

Table A-1: Mother's Employment and Welfare Use by Child's Age

Child's Age	Welfare Use	Part-Time (500-1499 Hours)	Full-Time ($\geq$ 1500 Hours)	Hours of Work[†]
-2	0.54	0.16	0.18	1510
	(0.50)	(0.36)	(0.39)	(628)
-1	0.67	0.15	0.17	1519
	(0.47)	(0.36)	(0.37)	(657)
1	0.81	0.11	0.12	1463
	(0.39)	(0.31)	(0.32)	(538)
2	0.79	0.13	0.17	1532
	(0.41)	(0.34)	(0.38)	(600)
3	0.81	0.12	0.19	1625
	(0.39)	(0.32)	(0.39)	(633)
4	0.80	0.13	0.22	1692
	(0.40)	(0.34)	(0.42)	(684)
5	0.76	0.15	0.22	1651
	(0.43)	(0.35)	(0.42)	(618)

- Standard errors are in parentheses.

† Conditional on work.

Table A-2: Marginal Effects of Alternative Models

Specification	1 Baseline	2 OLS	3 IV	4 No Income	5 No Work No income	6 No Welfare	7 No Welfare No income
Marginal Effects of Employment							
1%	0.0100	0.0115	0.0158	0.0101		0.0043	0.0041
25%	0.0097	0.0018	0.0070	0.0097		0.0040	0.0039
50%	0.0096	0.0004	0.0052	0.0096		0.0039	0.0038
75%	0.0095	-0.0026	0.0030	0.0096		0.0038	0.0037
99%	0.0093	-0.0076	-0.0030	0.0094		0.0035	0.0035
Mean	0.0096	-0.0002	0.0049	0.0096		0.0039	0.0038
Marginal Effects of Type I Welfare Use*							
1%	0.0383	-0.0135	0.0124	0.0381	0.0314		
25%	0.0212	-0.0006	0.0009	0.0210	0.0142		
50%	0.0161	-0.0031	-0.0010	0.0158	0.0094		
75%	0.0124	-0.0057	-0.0032	0.0122	0.0058		
99%	0.0035	-0.0119	-0.0084	0.0029	-0.0023		
Mean	0.0172	-0.0028	-0.0008	0.0169	0.0104		
Marginal Effects of Type II Welfare Use							
1%	0.0228			0.0227	0.0163		
25%	0.0057			0.0055	-0.0009		
50%	0.0006			0.0004	-0.0057		
75%	-0.0031			-0.0033	-0.0093		
99%	-0.0120			-0.0125	-0.0174		
Mean	0.0017			0.0017	-0.0046		

*Note that there are no types in OLS and the IV models. Welfare results under Type I heading are just the overall results

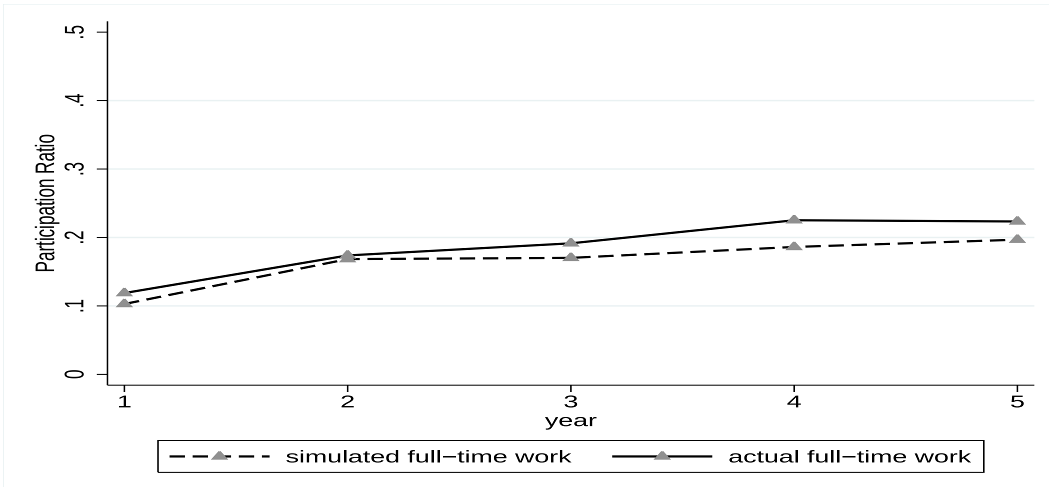
Table A-3: Marginal Effects Calculated (Based on Table ??)

Specification	1 B&K's Work, Regressors and Sample	2 Our Work and B&K's Regressors and Sample	3 B&K's Work and Regressors, Our Sample	4 No Prior Work, B&K's Work and Sample
Marginal Effects of Employment $= \gamma_e + \sum_i \gamma_{aei} V_{1i}$				
1%	0.283***	0.641***	0.474***	0.845***
	(0.059)	(0.041)	(0.041)	(0.056)
25%	-0.015	0.269***	0.097***	0.508***
	(0.039)	(0.031)	(0.031)	(0.035)
50%	-0.127***	0.078***	-0.025	0.388***
	(0.038)	(0.028)	(0.028)	(0.034)
75%	-0.284***	-0.115***	-0.120***	0.240***
	(0.037)	(0.026)	(0.027)	(0.034)
99%	-0.774***	-0.664***	-0.456***	-0.177***
	(0.045)	(0.023)	(0.039)	(0.038)
Mean	-0.164***	0.067*	-0.010	0.367***
	(0.039)	(0.028)	(0.028)	(0.033)

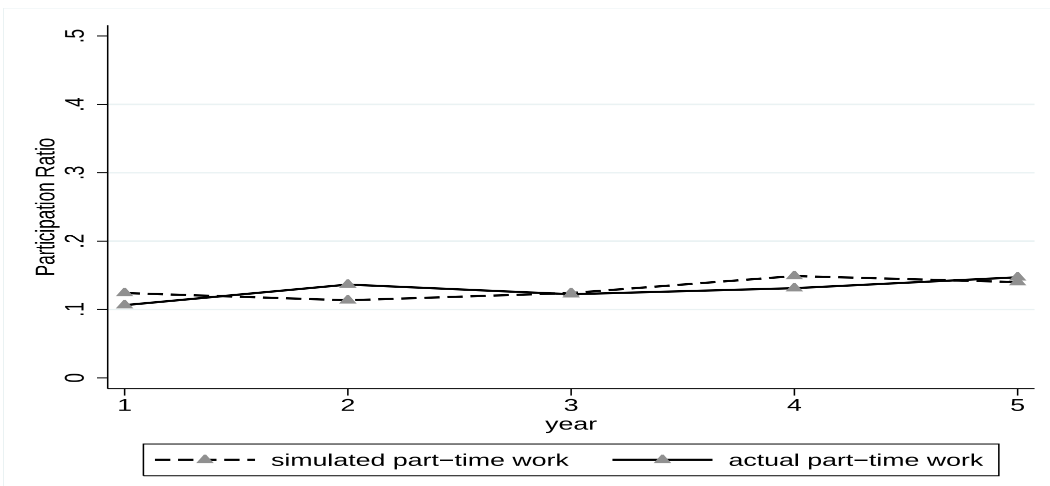
· All specifications also include state and cohort fixed effects.

*** : significant at 1% significance level. **: significant at 5% significance level. *: significant at 10% significance level.

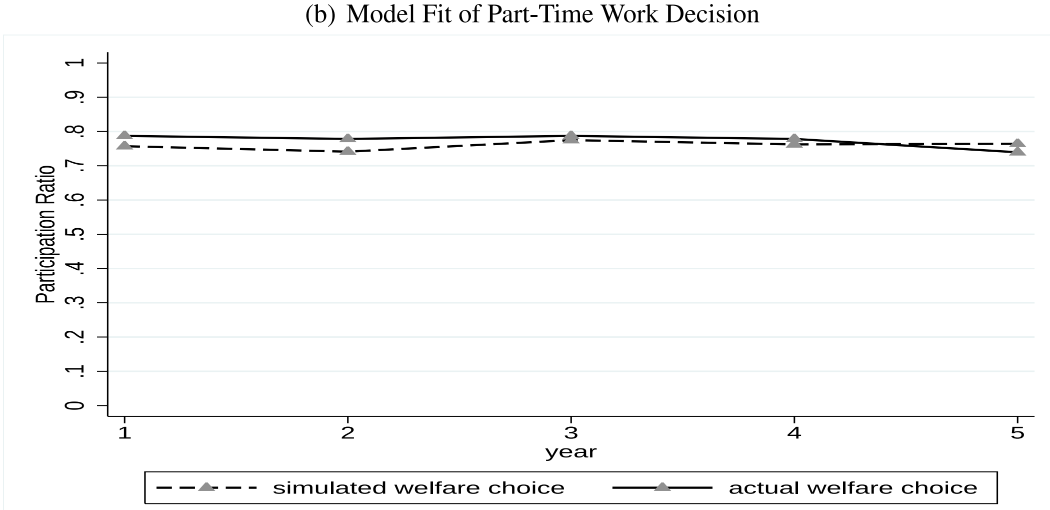
Figure A-1: Model Fit of Mothers' Decisions



(a) Model Fit of Full-Time Work Decision

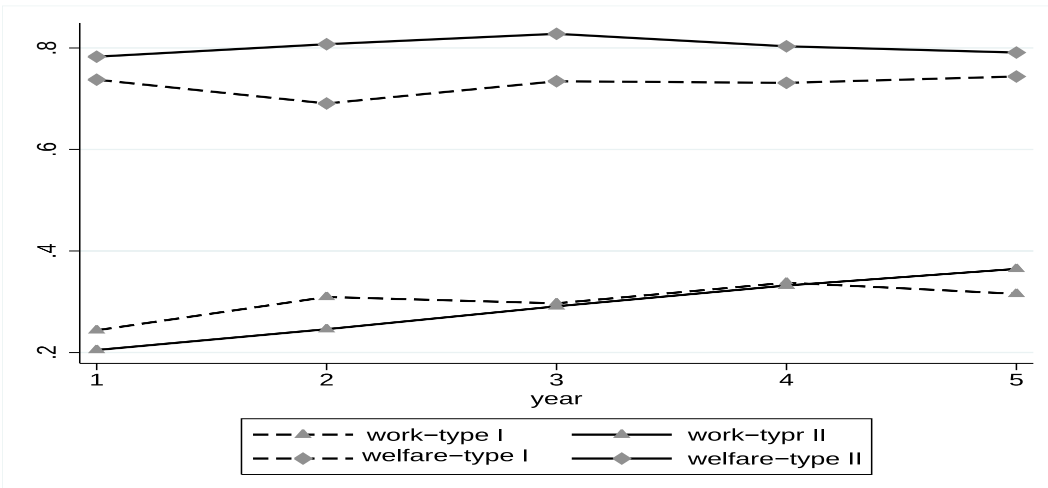


(b) Model Fit of Part-Time Work Decision

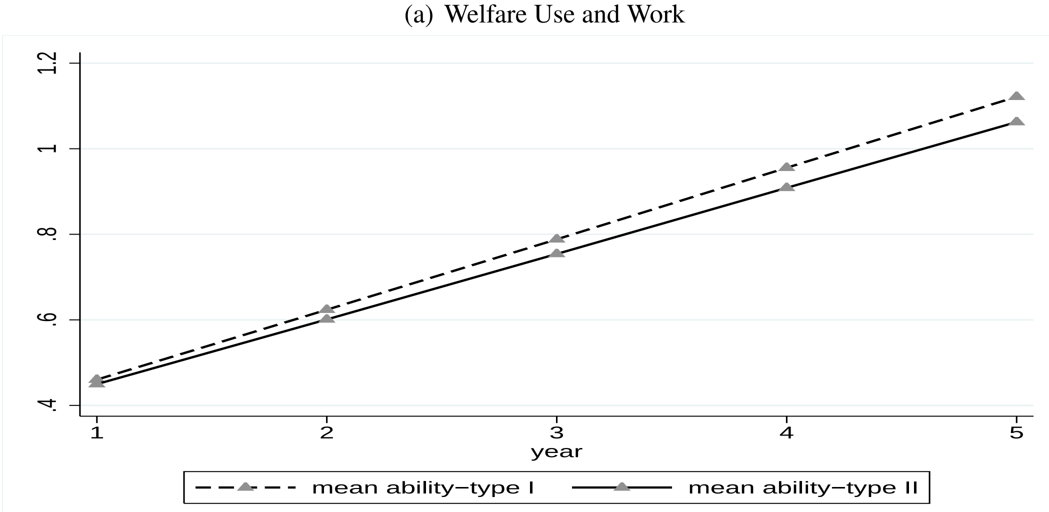


(c) Model Fit of Welfare Decision

Figure A-2: Participation and Attainment of Different Types



(a) Welfare Use and Work



(b) Children's Ability