

Maternal Time, Child Care and Child Cognitive Development: The Case of Single Mothers

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Abstract

This paper evaluates the effects of maternal time inputs and alternative providers' time inputs on children's cognitive development using the sample of single mothers in the National Longitudinal Survey of Youth (NLSY). In order to deal with the selection problem that arises when trying to assess the impact of mothers' employment and child care choices on children's development, we take advantage of the exogenous variation in employment and child care choices generated by the differences in welfare regulations across states and over time introduced by the Welfare Reform (1996) and prior to that by Section 1115 Welfare Waivers. In particular, we construct a comprehensive set of welfare policy variables at the individual and State level and use them as instrumental variables in order to identify the effects of maternal employment, child care and labor income on children's cognitive development. The results indicate that the effect of maternal employment on children's achievement is positive but insignificant. The effect of child care use is negative, significant and rather sizeable. In particular, one additional quarter of child use is associated with a reduction of 0.50% in test scores. In addition, the effect of income is significant and positive and in most cases large enough to offset the negative effect of child care. Finally, the negative effect of child care seems to be related to a significant negative effect of child care used after the first year after childbirth and mostly from the use of informal child care.

1. Introduction

The effect of parental time inputs and child care (and child care quality) on children's development has been widely analyzed, especially in the psychology and sociology literature. Economists have also realized the importance of this question. For many years we have been trying to understand the determinants of individuals' labor market performance, in particular, wages. In spite of the vast research in this area, there is still a large component of wages that we have not been able to explain. Furthermore, recent studies¹ have concluded that once people reach certain age, around 16-18 years old, most of what determines their later labor market performance has been already determined. In other words, a set of unobserved (to the researcher) characteristics that determine a significant portion of wages, educational attainment or other career outcomes are already present by age 16. These unobserved characteristics have often been called the individual's "cognitive ability" or "skill endowment". But their determinants remain largely a black box.

Extensive research has shown that children's early achievements are strong predictors of a variety of outcomes later in life: the high achievers are more likely to have higher educational attainment and higher earnings; and less likely to have out-of-wedlock births, be on welfare or participate in crime. However, the question of what determines children's cognitive achievement remains unresolved². For this reason, the issue of what determines ability of individuals at early stages of life is a very relevant question and is critical for the design of public policy aimed at improving labor market outcomes.

A major challenge to estimating the determinants of achievement is that the data available are often deficient. For example, data on inherited ability is often unavailable, which creates problems of endogeneity and self-selection that are difficult to address. In fact, the main reason for the diversity of results in previous literature may well be the common limitation of failing to control for potential biases that may arise as a result of one or both of the following facts: (1) Women that work/use child care may be systematically different from women that do not work/do not use child care; (2) The child's cognitive ability itself may influence the mother's decisions of whether to work or not and/or place the child in daycare.

Women are heterogeneous in both the constraints they face and their tastes. Likewise, children are heterogeneous in their cognitive ability endowments. Some of these characteristics are unobserved by the researcher. Mothers' decisions of whether or not to work and whether or not to use child care will depend on these unobserved characteristics of both mothers and children.

To make this selection bias problem clear, we lay out an example in each of the two cases. In the

¹ See Keane and Wolpin (1997) and Cameron and Heckman (1998).

² In Section 2 we discuss in detail the fact that results from previous literature are inconclusive at best.

case of (1), for example, a woman with higher skills is more likely to have a child with high cognitive ability and also more likely to work. Then, a statistical analysis would attribute the effect of this woman's higher skills to employment, and the estimated effects of maternal employment on child's cognitive outcomes would be upwardly biased. In the case of (2), mothers of low ability endowment children may choose to compensate them by spending more time with them, in which case mothers are more likely to work if they have high ability children. Again, the estimated effect of maternal employment on child's cognitive outcomes would be upwardly biased. Clearly, these sample selection issues make evaluation of the effects of women's decisions on child outcomes very difficult.

In this paper, we estimate a child's cognitive ability production function for single mothers in the NLSY. We focus on single mothers because recent important changes in welfare rules, generated by welfare waivers and the Temporary Aid to Needy Families (TANF) program, along with increased day care subsidy spending, have led to dramatic and plausibly exogenous variation in work incentives and child care prices and availability which, in turn, may have generated exogenous variation in maternal employment and child care choices. Thus, we can construct an extensive set of State and individual-specific welfare rules variables which we then use as instrumental variables in the estimation of the cognitive ability production function. Most of the leverage for identification comes from comparing behavior and child outcomes of women who had children between 1990 and 2000, so they were impacted by welfare waivers and TANF, with women whose children were born earlier, since these two groups are subject to very different welfare rules.

Between 1993 and 1996, 43 States were granted "Section 1115" Welfare Waivers which introduced innovative approaches to welfare reform. Many of the policies and concepts included in state waivers were later incorporated into "The Personal Responsibility and Work Opportunity Reconciliation Act" (PRWORA) of 1996. PRWORA changed the welfare system into one requiring work in exchange for time-limited assistance. It created the Temporary Assistance for Needy Families (TANF) program, which replaced the Aid to Families with Dependent Children (AFDC), and created the Child Care and Development Fund (CCDF). Under TANF and the CCDF, States operate their own programs, so a great deal of heterogeneity in work incentives and day care subsidy programs across states has emerged.

The main changes in the welfare system under both Section 1115 Waivers and TANF that are relevant for our exercise could be classified into the following categories: termination and work requirement time limits, earnings disregard, child care assistance and child support enforcement. By setting time limits on benefit receipt, conditioning receipt on work requirements, changing the amount of earned income that is disregarded in calculating benefits, providing child care subsidies or

changing the way in which child support collections were allocated, these changes in welfare rules generated substantial and plausibly exogenous variation in work incentives, child care prices and child care availability facing single mothers across the 50 U.S. States. We take advantage of this variation in order to identify the effects of maternal employment and child care use on children's cognitive development.

The study of the case of single mothers is motivated by two main reasons. First, Bernal (2003) estimated the effects of maternal employment and child care on children of married women in the NLSY. A key motivation of this work is to see whether her results on the importance of maternal time inputs generalize from married to single mothers. Second, the study of single mothers is of special interest, given the huge welfare policy changes that have substantially altered their work decisions in recent years.

The main results indicate that the effect of maternal employment on children's achievement is positive but insignificant in most specifications estimated. The effect of child care use on children's achievement is negative, significant and rather sizeable. In particular, one additional quarter of child use is associated with a reduction of approximately 0.50% in test scores (depending on the specification of the cognitive ability production function). In addition, the effect of income is significant and positive and in most cases large enough to offset the negative effect of child care.

Finally, the negative effect of child care seems to be related to a significant negative effect of child care used after the first year after childbirth while the effect of child care used in the first year seems to have a negative effect as well but is insignificant. In addition, the negative effect seems to be associated to the use of informal child care rather than formal child care which turns out to be insignificant in explaining child's achievement. In particular, an additional quarter of informal child care use is associated with 0.77% lower test scores.

This paper is organized as follows. In section 2 we present a brief review of the relevant literature. In Section 3 we discuss our identification strategy, and in particular, the way in which welfare rules are expected to affect employment and child care choices of mothers. In addition we discuss specifically how we constructed the welfare variables used in the analysis. In Section 4 we present the theoretical framework. In Section 5 we talk about the data and the sample used in this paper. Section 6 presents the estimation results and finally Section 7 concludes.

2. Literature Review

We now briefly summarize the main results of studies examining the impact of early maternal employment and child care on child outcomes in the U.S. using data from the National Longitudinal Survey of Youth (NLSY). For most part, these studies present simple correlations between inputs and child outcomes, or use a limited set of measures of family and child characteristics. In most cases, no correction for self-selection of children into child care arrangements or the group of working mothers was implemented³.

2.1. Effect of Maternal Employment on Child Outcomes

A number of prior studies have found negative effects of maternal employment on child outcomes. Desai et al. (1989) used 503 four year olds from the NLSY in 1986 to investigate the impact of maternal employment on children's intellectual ability. Results from multivariate regression analysis show a statistically significant adverse effect of maternal employment on children's intellectual ability but only for boys in higher income families. Baydar and Brooks-Gunn (1991) analyzed 572 white 3-4 year olds (in 1986) and concluded that the effects of maternal employment differ, depending on the timing of the employment. The authors found that maternal employment during the first year of life has negative effects on Peabody Picture Vocabulary Test (PPVT) scores, while there is no effect of working in the second or third year. Mott (1991) analyzed 2387 one to four year olds in 1986. He found maternal employment over 20 hours per week during the second quarter of the child's life to be negatively correlated with PPVT scores.

Harvey (1999) used children from 3 to 12 years old in 1986, 1988, 1990, 1992 and 1994. She found a negative effect of maternal work hours on PPVT and PIAT scores for young children and a weaker or null effect at higher ages. Given the fact that the sample of children varied from year to year it is difficult to conclude whether the effects of maternal employment attenuate over time or are simply different for different groups of children. Waldfogel et al. (2000) analyzed 1872 children followed longitudinally from birth to age 7 or 8. They found small and persistent negative effects of maternal employment during the first year on children's cognitive outcomes for white children but not for African-American children. Han et al. (2001) used a cohort of 462 children followed from birth to age 7 or 8. They found that maternal employment in the first year has a negative but small effect on cognitive outcomes for white children, which persisted to ages 7 and 8.

³ There are several papers, such as Todd and Wolpin (2001), Rosenzweig and Wolpin (1994), Rosenzweig and Schultz (1983), on the general topic of the specification/estimation of cognitive ability production functions. We summarize here only studies related in particular to the parental time and child care inputs.

On the other hand, some prior studies have found positive effects. Vandell and Ramanan (1992) studied 189 low income non-Hispanic second graders (in 1986) and found positive effects of maternal employment on children's cognitive development. In particular, employment in the first three years is found to be correlated with higher Picture Individual Achievement Test (PIAT) - math scores and recent employment associated with higher PIAT - reading and PPVT scores. [For a detailed description of these tests see section D.1.2.]. Parcel and Menaghan (1994) used 768 3-6 year olds whose mothers were employed in 1986. They found positive effects from mothers' employment during the first year or first three years on PPVT scores.

And yet another group of studies finds inconclusive or insignificant results. Greenstein (1995) analyzed 2040 4-6 year olds during 1986, 1988 and 1990. He performed different analyses by race and gender. He found an insignificant relationship between maternal employment and PPVT scores. Moore and Driscoll (1997) analyzed 1154 five to fourteen year olds (in 1992) whose mothers were on AFDC during 1986-1990. The authors found that maternal employment is associated with higher PIAT - Reading and Math scores, although most of the effects are eliminated after controlling for maternal and household characteristics.

The main reason for the diversity of these results may well be the common limitation of failing to control for potential biases that may arise due to the endogeneity of employment and child care choices. A few recent studies have tried to overcome this problem by either using a more extensive set of explanatory variables or using instrumental variables. Blau and Grossberg (1992) used 874 3-4 year olds in 1986. To correct for potential heterogeneity bias, they estimated their basic equation using instrumental variables for maternal labor supply. However, the instruments, such as region of residence and maternal and child health, may be debatable since they may affect child outcomes directly. They concluded that maternal employment in the first year after birth is associated with lower PPVT scores, while the contrary is true for the second and third years of employment. Ruhm (2000) used a larger and more representative sample from the NLSY in an attempt to control for as many characteristics as possible which might otherwise bias the estimated effect of maternal employment on child outcomes. His results from multivariate regressions indicate that maternal labor supply during the first three years of the child's life is predicted to have a small negative effect on the verbal ability of 3 and 4 year olds and a significant negative effect on the reading and math achievement of 5 and 6 year olds. James-Burdumy (1998) used 2,119 three to four year olds to estimate a household fixed-effect model using instrumental variables to control for unobserved heterogeneity in cognitive ability. She concluded that there is no effect of maternal labor supply in

years 1, 2 or 3 on child test scores. However, it is plausible that mothers make time compensations for children depending on their ability type. In this case, using a household fixed effect model would not be appropriate, since maternal employment is correlated with the sibling specific part of the cognitive ability endowment. One last possible approach to tackle the selection problem is to estimate individual fixed effects. In this case, however, identification of the production function parameters would require that the effect of each input is independent of the age at which it was applied and the effect of the ability endowment is independent of the achievement age. Both seem like implausible assumptions. Chase-Lansdale et al. (2003) analyzed 2402 low-income families during the recent era of welfare reform. Their results from child fixed effects models suggest that mothers' transitions off welfare and into employment are not associated with negative outcomes for preschoolers or young⁴.

Finally, Bernal (2003) develops a model of work and child care choices of women after birth. Estimation of the child's cognitive ability production function, which includes mother's time and child care use as inputs, jointly with the mother's work and child care decision rules enables her to implement a selection correction, in the sense that she can adjust for the fact that certain types of children are more likely to be put in child care and/or to have working mothers. Her results suggest that the effects of maternal employment and child care use on children's cognitive ability are rather sizeable. In particular, an additional year of working experience and child care use is associated with a reduction of approximately 2% in cognitive ability test scores of children ages 3 through 7. Bernal restricted the sample to women that did not have an additional child for at least five years after birth. This enabled her to avoid modeling fertility decisions and mothers' time allocation among multiple preschool aged children. However, her results may not generalize to larger families. In our reduced form framework we let the effects of maternal work and day care depend on the number of children. Additionally, she relies on a set of exclusion restrictions to identify the structural parameters of the child ability production function, and these may be debatable. Her basic identification assumption is that short run movements in mothers' and husbands' wage rates enter the mother's working and child care decision rules, but do not directly affect child's ability (for example, movement along the mother's and father's age-wage profile generates exogenous variation in their wage rates, which in turn affects the mother's work and child care decisions but does not directly affect child outcomes). We believe that additional (and stronger) instruments are available for single mothers. In this paper, we propose to use the variation in welfare rules to achieve a stronger basis for identification.

⁴ These authors do not attempt to use the changes in welfare rules as instruments for maternal employment as we do.

Effect of Child Care Quality on Child Outcomes

There are about 30 studies, primarily in the Developmental Psychology literature, that try to assess the effect of child care inputs on child development or child behavior. Recent reviews of this literature can be found in Love, Schochet and Meckstroth (1996), Doherty-Derkowki (1995) and Blau (1999). Less than half of these studies provide results that are interpretable in terms of effects of specific inputs.⁵ Of the remaining studies, approximately half report that either small groups, more staff per group, or better trained teachers have positive and statistically significant effects on child development and behavior. The remaining studies find either no statistically significant effects of inputs or statistically significant effects with unexpected sign. Most of these studies present simple correlations between inputs and child outcomes and do not include additional controls for family characteristics and/or child characteristics. Furthermore, some of these studies use small samples, often nonrandomly selected. In most cases, no control for self-selection of children into child care arrangements was implemented.⁶ Sample-selection issues are likely to be important in this context. First, high ability women will be more likely to have higher wages and hence more likely to use higher quality daycare. In this case, a statistical analysis would attribute the effect of the woman's higher skills to child care quality, and the estimated effects of daycare quality on child's cognitive outcomes would be upwardly biased. Similarly, it might be the case that parents tend to place a certain type of children, say the ones who develop more slowly, in higher quality daycare in order to compensate. In this case, the direction of the bias would go in the opposite direction, i.e., the effect of daycare quality on children's development would be underestimated.

Very few studies have attempted to address these sample selection issues. The National Day Care Study (NDCS, Ruopp et al. (1979)) monitored a sample of 64 day care centers and 1,600 of the attending children for a period of approximately 9 months. The children were given developmental assessments at the beginning and end of the 9-month period, during which inputs were closely monitored. The study randomly assigned children to different classrooms (within a center), with different staff-child ratios and teachers with different levels of training. The results indicate that preschool age (3-5 year old) children assigned to classrooms with smaller groups and/or where teachers had special training made greater gains on both language receptivity tests and general

⁵ Some studies show associations between clusters of child care arrangements and children's development instead of assessing the impact of each input (Broberg et al. (1997), Howes and Rubenstein (1985), Peterson and Peterson (1986), Studer (1992)). In some other cases, coefficient estimates or signs of the estimated effects are not provided by authors (Howes et al. (1998), Smith and Connolly (1986), Howes and Rubenstein (1981)).

⁶ See for example, Burchinal et al. (1996), Clarke-Stewart and Gruber (1984), Dunn (1993b), Holloway and Reichart-Erickson (1988), Howes et al. (1988), Parcel and Menaghan (1990), Ruopp et al. (1979), and Smith et al. (1989).

knowledge tests. Doubling class size was estimated to reduce gains on the PPVT by 23%. As Blau (1999) notes, however, a problem with this study is that, while children were randomly assigned to classrooms with different class sizes and where teachers had different types of training, other aspects of the environment were not controlled (and these other factors may vary systematically with class size and teacher attributes). Therefore, the effect estimates in the study are hard to interpret.

The NICHD Study for Early Child Care has followed a sample of 1,300 children from birth, closely monitoring their home and child care environments and their development. Results from several studies based on the NICHD Study for Early Child Care (Phase I and II)⁷ suggest that the overall effect of child care depends on the quality of that care. High quality childcare offers an advantage to children and low quality care a disadvantage to children in terms of their cognitive and language development compared to care from the average mother. Similarly, results from the Cost, Quality, and Outcomes follow-up study⁸ which followed 418 children from pre-school to second grade suggest that children who attended higher quality pre-schools had better outcomes in second grade than those who attended lower-quality pre-schools, with particularly strong results for the children of less-educated mothers.

Some studies have used NLSY data to assess the effects of child care on child development. However, most of these studies have used measures of the type of child care (e.g. day care center, relatives at home, nonrelatives, etc.), rather than measures of child care quality.⁹ Parcel and Menaghan (1990) and Studer (1992) did include actual child care inputs in their studies. Parcel and Menaghan report that the staff-child ratio had a negative but insignificant effect on PPVT scores. Studer constructed an “index of quality” by combining group size and staff. She found the quality index to have a positive but insignificant effect on PPVT in a sample of 95 children. Blau (1999) analyzed the relationship between child care inputs and child development outcomes. By using a larger more representative sample that contains more comprehensive measures of the home environment, and repeated measures of child development, he controls for some aspects of selection bias. He runs OLS regressions and mother fixed effects models, and concludes that child care characteristics have little association with child development on average. But, as we noted early, the use of mother fixed effects does not control for the type of selection bias that arises if mothers make child care quality decisions based on child specific characteristics. Attempting to deal with this type

⁷ NICHD Early Child Care Research Network, 1996, 1997, 1998, 1999, 2000.

⁸ Peisner-Feinber et al. 1999, “Executive Summary of the Cost, Quality, and Outcomes Study”.

⁹ Baydar and Brooks-Gunn (1991), Blau and Grossberg (1992), Desai, et al. (1989), Korenman, Miller and Sjastaad (1995), Mott (1991).

of bias is a key aspect of our proposal.

In conclusion, several studies have found evidence that child's attachment, child-mother interactions and cognitive and behavioral outcomes depend critically on the characteristics of child care. As a consequence, interest has shifted from the question of whether early child care or maternal employment harms children to the question of what types of early child care can be most helpful for what types of children.

3. Welfare Rules and Considerations about their Effects on Work and Child Care Decisions of Mothers

We collected detailed information about States policies from many sources, including the State Policy Documentation Project (SPDP), GAO (1997), the Administration for Children & Families (DHHS) TANF Annual Reports to Congress (1997 to 2001), Center for Law and Social Policy (1995), Gallagher et al (1998), Hotz and Scholz (2002), Office of Family Assistance (1999), Department of Agriculture (USDA), Urban Institute, Center on Budget and Policy Priorities (CBPP), Green Book (various years), Internal Revenue Services (IRS) and various State TANF policy handbooks.

Using the collected welfare policy variables together with detailed individual demographic variables we constructed two types of variables. The first one contains individual level policy variables. These are constructed from the individual's demographic variables in conjunction with relevant policy variables. For example, we calculate the maximum *potential* real monthly AFDC/TANF benefit amount (assuming zero earnings), constructed using the State payment standard for the corresponding family size of the single mother. We call this variable BEN_{ist} . Since we have individual level data, we exploited every opportunity to tailor policy variables to the individuals based on the demographics. The second group of variables are State level policy variables. They include all variables that vary across States and time, but do not vary across individuals in the same State and year.

In this section we outline the main aspects of the 1996 Welfare Reform and Section 1115 Welfare Waivers which are relevant to this work, in the sense that they generated plausible exogenous variation in work incentives, child care prices and availability. We discuss both, the way in which we expect these rules to have an effect on work and child care decisions of single mothers and the way in which the policy variables were constructed and coded.

3.1. Time Limits

Under AFDC, single mothers with children under 18 were entitled to receive benefits, as long as they met the income and asset eligibility requirements. But under the Section 1115 Waivers, and under TANF, the states could set time limits on benefit receipt. It is useful to think of time limits as falling into three broad categories. The “termination” time limits result in a total loss of AFDC benefits for families who have used up their time. “Work requirement” time limits impose mandatory work requirements on families that reach the time limit, but do not cut off aid so long as participants comply with the work requirements. Finally, “reduction” time limits reduce the amount of assistance that a family can receive after they have been on welfare for a certain period of time, either by a percentage, or by removing the adults’ needs from the grant.

While PWRORA forbids the use of federal funds to provide benefits to adults beyond a 60-month lifetime time limit (except that 20 percent of a State’s caseload can be exempted), it allows states to set shorter time limits. States may use their own funds to aid families that have reached the federal time limit. Thus, for instance, New York and Michigan do not impose termination time limits¹⁰, California imposes a 5-year time limit but at that point only the adult share of benefits is cut, and Texas and Florida impose termination time limits in the 2-3 year range. This is a key source of variation in the data that helps identify the effects of time limits on work decisions.

We can think of the potential impact of time limits as falling in one of two types: anticipatory and direct effects. The latter are simply related to the fact that a welfare recipient who reaches the time limit becomes immediately ineligible for benefits (so long as the limit is being enforced). The former, is associated with the more subtle idea that if an individual is forward-looking and is faced with a welfare time limit then she will try to “save” or “bank” months of eligibility, in order to use them when it is truly necessary.

In a dynamic setting, a single mother should make welfare participation decisions by comparing the value of current period welfare benefits to the value of current period potential earnings plus the “option value” of conserving a month of benefit eligibility. Grogger and Michalopoulos (1999) point out that this option value is, *ceteris paribus*, an increasing function of the time horizon over which benefits may be used (the number of months/years until the woman’s youngest child reaches 18) and a decreasing function of the stock of remaining months of eligibility¹¹. Various features of state

¹⁰ This means, that these States have chosen to use State funds to provide benefits to families beyond the 60-month Federal limit.

¹¹ The option value of preserving a month of eligibility is greater when the woman has only one month left than when she has 60.

welfare plans make the presumption that the anticipatory effect of time limits played a major role in single mothers' work decisions, rather implausible. For example, the fact that a few states stopped the time limit clock if the participant worked complemented by generous earnings disregards for employed TANF participants, or partial (instead of full) benefit reductions once the time limit was reached. These features reduced the "option value" of banking months of eligibility and hence reduced the potential anticipatory effect of time limits on work decisions.

For example, the TANF benefit for a family of three with no income in Illinois is \$377, and the benefit reduction rate is 33% of earnings (for every dollar earned, the TANF benefit is decreased by 33 cents). If a woman works 130 hours per month at a \$6.00 per hour wage rate she will be taxed \$257, which leaves a total TANF benefit amount of \$120. She might choose to pass up the \$120 in order to "save" or "bank" the full \$377 for some future month, if she thinks she will be likely to face a future unemployment spell. However, in Illinois, a month in which a woman works does not count toward the time limit clock, hence the woman in our example will not have such an incentive.

In sum, time limits may make the option of working and/or staying off welfare more attractive than participation by adding the option value of preserving a future month of welfare eligibility to the value of working. However, given the fact that some State TANF plans stipulate generous earnings disregards, stop the clock if the recipient works during a given month and/or reduces (rather than eliminates) benefits when the limit is reached, we expect that the anticipatory effects to have been small.

In this paper, we have constructed several variables to capture the impact of time limits. These will incorporate both, time limits created under TANF and earlier under AFDC waivers. A set of variables will capture variations at the state level while others are individual-specific in the sense that they capture whether a specific woman in the sample could potentially be subject to a given rule. These variables are summarized in Table 1. Each variable has up to three subscripts: i for individual, s for State and t for period (quarter in our case).

First, we include a dummy for whether the residence State of a single mother had imposed a time limit (TLI_{st}) in time t , as well as a dummy for whether the time limit could be binding for that particular woman (TL_HIT_{ist}). The latter is individual specific since it accounts for the age of this woman's children. In other words, a single mother whose oldest child is A^o years old cannot have received welfare for more than A^o years. This means, that the time limit cannot bind for this woman unless A^o exceeds the limit, regardless how many years ago her State implemented time limits.

Note that TLI_{st} captures an anticipatory effect of time limits, while TL_HIT_{ist} captures a direct

effect. Some additional variables that capture anticipatory and direct effects of time limits on work decisions were constructed. First, a variable that we call “months elapsed since the implementation of time limits” (*ELAPSED_TL_{st}*). Second, a variable called “months elapsed since the time limits could first potentially bind” for a given woman (*ELAPSED_TL_HIT_{ist}*). Third, we constructed a variable that measures the length of the time horizon over which a woman will be categorically eligible for benefits, which can be thought of as increasing the option value of “banking” welfare eligibility. This is equal to the remaining time until her youngest child reaches age 18 (*REMAIN_ELIG_{ist}*). Finally, as we mentioned before, the option value of “banking” welfare eligibility is decreasing in the stock of eligible months that a woman currently possesses. This measure, is constructed by calculating the maximum number of months that a woman could have received welfare since her State started her clock and subtracting this from the State time limit. We call this variable *REMAIN_TL_ELIG_{ist}*.

It is worth noting that we are assuming that the woman’s demographics and the welfare policy rules she faces are exogenous. In order for these policy variables to be valid instruments we require that they are a function of these demographic and policy variables. For example, we do not want to use a woman’s actual welfare participation history to construct the remaining months on her time limit clock, because actual participation decisions are endogenous. Similarly, in constructing *REMAIN_ELIG_{ist}*, we ignore the fact that a woman can always extend her months of categorical eligibility by having another child.

3.2. Work Requirements and Exemptions

Under PRWORA, with few exceptions, recipients must participate in “work activities” as soon as job ready, or no later than two years after coming on assistance¹². In FY 1997, each State had to ensure that 25 percent of all families in the state were engaged in work activities. This percentage increased to 50 percent in fiscal year 2002. Many States have chosen to adopt shorter work requirement time limit clocks. Under the first wave of TANF plans (adopted approximately from October 1996 to January 1998), 20 States required welfare recipients to start participating in work activities immediately. Under the second wave of revised TANF plans (roughly two years after the first wave), 25 States required immediate work participation. Of the remaining States, most adopted

¹² “Work activities” include: 1) unsubsidized employment, 2) subsidized private sector employment, 3) subsidized public sector employment, 4) work experience, 5) on-the-job training, 6) job search and job readiness assistance, 7) community service programs, 8) vocational educational training, and 9) the provision of child care services to an individual who is participating in a community service program.

the 24-month maximum allowed under the federal law. Note that the requirement that one participate in work activities in order to receive benefits may increase the disutility of welfare program participation, leading to reductions in participation and increased work among single mothers.

Under PRWORA, States have the option to exempt single parents with children up to 1 year of age from work requirements and have the flexibility to provide exemptions to other families. A few states only exempt single mothers with children under 3 or 6 months (e.g., California), while others chose to grant longer exemptions.

Thus, there are two key sources of identification of the effects of work requirement time limits. First, due to variation in when States implemented their TANF plans, and in the length of their work requirement time clocks, there is substantial variation across States in how early single mothers could have been subject to binding work requirements. For example, work requirements adopted under AFDC waivers could have hit as early as mid-1994 in Iowa, October 1995 in Michigan, and mid-1996 in Wisconsin. Later TANF work requirements could have bind as early as the Fall of 1996 in Alabama, Connecticut, Florida, Oregon and Utah among a few other States. However, work requirements were not binding until December 1998 in New York or February 1999 in New Jersey.

Second, given that mothers can be exempt of work requirements depending on the youngest child's age, we can exploit individual level variation based on children's ages. For instance, take two similar women who have each been on TANF for long enough that they have used up their State's work requirement time limit clock. Suppose each has a youngest child who is 9-months old. If they live in two States with similar policies, except one State exempts women with children under 12 months old and the other exempts women with children 6 months old, then only the woman who lives in the former State is exempt. Thus, the difference in welfare participation and work behavior between these two similar women provides additional evidence on the effects of work requirements.

In order to capture these effects, we constructed two variables. We called the first one "age of youngest child exemption from work requirements" (AGE_EXEM_{st}). The second one is an indicator for whether the woman could have been subject to work requirements (WR_HIT_{ist}) and is calculated by using the previous variable in conjunction with the State specific work requirement time limit and the age of the woman's youngest child.

Besides the age of youngest child exemption, many States allow a few other exemptions from work requirements under TANF. These include exemptions for single parents with children under age 6 who are unable to obtain child care, and for recipients who are disabled or have a disabled household member. We constructed an additional variable called "total number of work

requirements exemptions” ($EXEMP_{st}$). Additionally, states also differ in the type of sanction imposed in case the recipient does not satisfy the work requirement. A “partial” sanction generally means that only the adult portion of benefits is taken away while the children’s portion is not. In 1996, 9 States had imposed a full sanction. By 1997, the number of States with a full sanction increased to 23 and to 30 by 1998. This dummy variable is coded as $WR_ULT_SANC_{st}$. Both these variables, can be thought of as measures of strictness with which States enforced work requirement time limits. These are then interacted with work requirement variables.

Finally, we include a dummy for whether a State has a work requirement time limit in effect (DWR_{st}). This indicator captures the fact that, in principle, work requirements can also have anticipatory effects. If a State adopts a work requirement with a 24-month work time limit clock, this can create an incentive to avoid welfare participation even before the 24 months are used up. This could be done to preserve time on the clock, or just because the value of human capital investment today is increased given that expected future welfare participation is reduced.

3.3. Earnings Disregards and Benefit Reduction Rates

Under AFDC, a benefit reduction rate (BRR) on earnings was always imposed. This tax was applied after allowance for deductions for work and child care expenses. Both, these amounts and the benefit reduction rate have changed several times over the history of the AFDC program. In 1967, the BRR was decreased from 100% (a recipient’s grant amount was reduced by one dollar for every dollar that she earned above the amount set aside to cover her work and child care expenses) to 67%. In 1982, it was increased back up to 100%. Since 1982, the work expense deduction was set at \$90 per month, and there was an additional child care expense deduction.

In addition, the AFDC program incorporated “earnings disregards” in an effort to encourage work among participants. This means that if an AFDC recipient started working, then for a period of time, a fraction of her earnings (on top of the amounts set aside for work and child care expenses) would not be subject to the BRR. Generally, this disregard would consist of a “flat” component (e.g., the first \$30 of monthly earnings) and a “percentage” part (e.g., one-third of earnings beyond the flat part). Both would be eliminated after a certain number of months of work.

Many states obtained waivers to increase the income disregard and hence, encourage work starting in late 1992. Under PRWORA states are not required to adopt any particular earned income disregards, so a great deal of state heterogeneity has emerged in the generosity of earnings disregards. A few states expanded disregards and allowed them to apply indefinitely. For example,

in the State plan implemented in 1998, California set a “flat” disregard of \$225 of month earnings and a “percentage” disregard of 50% of additional monthly earnings, with no phase-out of either over time. Given that the percentage disregard is not phased out, this works exactly as a 50% BRR which is exactly the way we code it. Flat disregards varied from \$0 to \$252 across states, while percentage disregards were anywhere between 0% to 100%.

Clearly, earnings disregards and the BRR affect a woman’s incentive to work and use child care directly, by shifting her budget constraint, in particular, her after-tax wage rate. A lower effective tax rate makes welfare participation more attractive. Also, as discussed previously, in the presence of time limits, the effective tax rate increases or reduces the incentive to forego participating in welfare in a month when a woman can work.

3.4. Child Support Enforcement and Child Support Income

Child support is an important source of income for single women with dependent children, despite the widespread non-payment by non-custodial fathers¹³. Under AFDC, recipients were required to assign all child support collections, up to the amount of benefits they receive, to the welfare agency. States were required to pass-through the first \$50 of current month child support payments to the family for which they were collected. The amount of this pass-through was disregarded, so families received this amount as additional income. It did not count against the recipients’ income in determining their family’s AFDC eligibility or the assistance grant amount. The remainder of the child support collected was shared between the state and the federal government to reimburse the cost of providing AFDC assistance. Between January 1993 and August 1996 states requested and received waivers of a number of provisions related to child support enforcement. The most common types of waivers included changes in the pass-through amount, or allowing single mothers to keep child support payments. In case of the latter, they would be subject to certain disregards just like earned income.

Under TANF, recipients are still required to assign child support collections to the welfare agency. However, the \$50 pass-through has been eliminated. States may still opt to pass-through some of the funds collected to the custodial family. States establish their own policy in terms of whether or not to disregard the pass-through. Clearly, by shifting a single mother’s budget constraint, the way in which child support income is treated has an effect on the woman’s incentives to work and/or use child care. At the same time, enhance pass-throughs or disregards may also

¹³ In 2002, child support accounted for approximately 6.5% of single mother’s real incomes (March CPS).

increase the incentive to participate in welfare. To account for these effects we include measures of the flat and percentage disregards in the state of residence of a woman ($FLAT_DIS_{st}$ and $PERC_DIS_{st}$) under both AFDC waivers and TANF.

Aside from these AFDC or TANF rules, child support income collection has also been affected by the Child Support Enforcement (CSE) program. This program was enacted in 1975 to address the problem of non-payment of child support by non-custodial parents. For instance, CSE has implemented programs to locate absent parents and establish paternity. CSE expenditures have significantly increased from \$2.9 billion in 1996 to \$5.1 billion in 2002 (76% increase). These expenditures are an important indication of how likely is a single women of collecting child support. We include a measure of State level CSE activity by taking the State CSE expenditure and dividing it by the State population of single mothers ($ENFORCE_{st}$). Variation across States and over time in CSE spending, provides two key sources of variation that identify the effects of child support enforcement expenditures on welfare participation and work.

3.5. Child Care Subsidies and the Child Care and Development Fund (CCDF)

In the late 1980s, several programs were created that expanded Federal support for child care. The Family Support Act (FSA) of 1988 created two programs, AFDC Child Care and Transitional Child Care (TCC). The first program funds child care services of AFDC families who are working or participating in an approved work, education, or training program. The second program funds care for families for up to 1 year after they leave AFDC to start working. In both cases, AFDC participation determined eligibility. The Omnibus Budget Reconciliation Act (OBRA) of 1990 created the At-Risk Child Care Program and the Child Care and Development Grant (CCDBG). The former funds care for working families who are “at risk” of becoming eligible for AFDC if they are not given child care assistance. The latter program provides subsidies to low-income working families generally. Unlike AFDC Child Care and TCC, these benefits were not an entitlement. Under PRWORA these four pre-existing programs were consolidated into the Child Care and Development Fund (CCDF). The CCDF is a block grant to states to provide subsidized child care programs for low-income families, including those who are not current or former cash assistance recipients. Under the CCDF, states have autonomy to design child care assistance programs for low-income families and a great deal of heterogeneity has emerged across States in the design of their child care subsidy programs. In particular, income eligibility criteria, reimbursement rate ceilings and parent co-payments (States may require a contribution from the family to the cost of child care) vary significantly across states. Additionally states differ in terms

of whether they give priority to low-income families who are on TANF or just transitioning off TANF.

As an additional policy instrument, we use the State CCDF expenditure per single mother ($CHILDCARE_{st}$). This variable measures the availability and generosity of child care subsidies in a State. An alternative to measure the generosity of a State's child care program would be to use detailed program parameters, such as, monthly income eligibility criteria, reimbursement rate ceilings or the co-payment rates, which are State specific and have also varied over time. We opt not to use these measures due to problems associated with rationing. For example, a State with a seemingly generous program (e.g., high income eligibility threshold and low co-payment) will tend to have a longer waiting list. Hence, program generosity can be more accurately measured by the States' actual per-case expenditure.

3.6. Other Contemporaneous Policy Changes: The Earned Income Tax Credit

The Earned Income Tax Credit (EITC), enacted in 1975, is a refundable Federal income tax credit that supplements wages for low-income working families. Major expansions of the federal EITC occurred in 1986, 1991, 1994 and 1996. Because of these expansions, the number of families receiving EITC increased from 6.2 million in 1975 to 19.5 million in 2000 (U.S. House of Representatives Green Book 2000, pg 813).

The EITC rules specify four parameters, a "phase-in" and "phase-out" rate, and a "phase-in" and "phase-out" income range. These parameters depend on family size. After the expansions in the mid-1990s, the EITC became a sizable wage subsidy to low and moderate-income families. Thus, it may provide an important work incentive. For example, in 2003, the phase-in and phase-out rates for a family with one child are 34% and 15.98%, respectively. As of 2003, 17 States have enacted State earned income tax credits that supplement the federal credit.¹⁴ To account for this effect we construct the EITC phase-in rate ($EITC_{ist}$) using Federal and State level EITC rules together with the mother's family composition.

4. The Child's Cognitive Ability Production Function

The child's cognitive ability production function that we present in this section is consistent with theoretical notions that child development is a cumulative process that depends upon the interaction between the history of family and child care/school inputs and the genetic endowments. Let A_{it} be the child's i cognitive ability in period t . A standard production function framework, first

¹⁴ We collect this information from Fang and Keane (2004).

modeled by Ben Porath (1967) in the case of an individual who chooses the level of resources to devote to human capital investments, conceives the process of knowledge acquisition as a production process in which current and past inputs interact with an individual’s genetic ability endowment to produce a cognitive outcome. Leibowitz (1974) adapted the original human capital production framework to assess whether home investments in children add to preschool stocks of human capital. In this context, the process of acquiring preschool human capital is analogous to the acquisition of human capital through schooling or on-the-job training. At preschool ages, genetic endowments interact with human capital inputs in early childhood to determine “ability”, A_{it} .

This yields a cognitive ability production function of the form:

$$\ln A_{it} = A(X_{it}, \omega_i) \quad (1)$$

where X_{it} is a vector of inputs accumulated since birth (e.g. parental time) and ω_i is the child’s ability endowment. Furthermore, our specification of the production function allows for interactions between X_{it} and observed characteristics of the parent (such as education) in order to capture the notion that the effect of home inputs on child’s cognitive ability might vary depending on the type of mother.

It is easy to see from equation (1) that the difficulty in estimating a production function of this type has to do with the fact that the child’s ability endowment ω_i is not observed and the possibility that inputs contained in X_{it} are endogenous to the unobserved child’s ability type. For example, mothers might engage in compensating behaviors by which they spend more time with low ability children. If this were the case then mothers are more likely to work if they have high ability children. In this case, the estimated effect of maternal employment on child’s cognitive ability would be upwardly biased.

The production function that we estimate in this paper takes the following form:

$$\ln A_{it} = \alpha_0 + \alpha_1 E_{it} + \alpha_2 C_{it} + \alpha_3 I_{it} + \underline{\alpha}_4 Z_i + \omega_i \quad (2)$$

where E_{it} is accumulated maternal work experience since birth (measured in number of quarters), C_{it} is accumulated child care use (in number of quarters) and I_{it} average annual total household income¹⁵. $\underline{\alpha}_4$ is a vector of parameters associated with characteristics Z_i of the mother and the child.

A detailed description of the variables included in vector Z_i can be found in Table 2.

Note that (2) can be derived from a production function with maternal time as an input.

¹⁵ For detailed definitions of these variables see Section 5.

Suppose each mother has a stock of time to spend with the child, and work or day care reduces that contact time. Then one can obtain an equation like (2) by substituting an equation for maternal contact time as a function of work and day care use into the production function. Additionally, we include average labor income as an input so that the specification allows for goods and services that can be purchased with labor income to enhance child's ability. In other words, the time that the mother spends away from the child might reduce achievement but income earned during that time might be beneficial for the child through purchased goods and services such as books, educational activities, availability of health care, etc. Strictly speaking, income should not be a direct input into the production of child's achievement if one could control for all inputs (including goods and services purchased with the purpose of increasing child's ability). However, given that data on these goods and services is not available excluding income would be problematic in the sense that the specification would not be capturing the tradeoff facing the mother between reduction in maternal contact time with the child and what the income that she brings home can buy for the child.

Note that the econometrician does not observe actual cognitive ability of children, but instead has available a set of (age adjusted) cognitive ability test scores from which it is possible to infer the child's cognitive ability. Let S_t be the (age adjusted) test scores observed in period t and let measurement error be specified as:

$$\ln S_{it} = \ln A_{it} + \eta_1 d_{i1t} + \eta_2 d_{i2t} + \varepsilon_{it} \quad (3)$$

where d_{1t} and d_{2t} are cognitive ability test dummies¹⁶ which capture the fact that the means on the different tests differ, and ε_{it} is measurement error.

By replacing (2) into (3) we obtain the equation that is finally estimated:

$$\ln S_{it} = \alpha_0 + \alpha_1 E_{it} + \alpha_2 C_{it} + \alpha_3 I_{it} + \alpha_4 Z_i + \eta_1 d_{i1t} + \eta_2 d_{i2t} + v_{it} \quad (4)$$

where $v_{it} = \omega_i + \varepsilon_{it}$. Note that since the child's ability endowment ω_i is moved into the error term, estimation of equation (4) by OLS would yield biased estimates of the relevant effects (α_1 to α_3). There are basically two reasons for why this is the case. The first one is that mothers that work (mothers that use child care) might be systematically different from mothers that do not work (do not use child care). For example, high ability women are more likely to work more because they demand higher wages but also more likely to have high ability children, i.e., high ω_i . If this is the case, the

¹⁶ In particular, $d_{1t}=1$ if S_t corresponds to the Peabody Picture Vocabulary Test, 0 otherwise and $d_{2t}=1$ if S_t corresponds to the Peabody Individual Achievement Test- Math Section.

estimated effect of maternal employment on child's achievement would be upwardly biased. The second reason is that maternal choices might directly depend on the child's ability endowment. For example it is plausible to think that mothers of low ability children will try to compensate by spending more time with them. In this case, the estimated effect of maternal employment on child's ability would also be upwardly biased since it is likely to observe in the data that working women are mothers of high ability children.

For this reason, in this paper we estimate equation (4) by using a set of State and time specific welfare and child care subsidies rules as instrumental variables for home inputs. These variables were described in detail in Section 3. The basic intuition is that these rules capture changes in incentives to work and/or use child care because they change child care prices and child care availability, the mother's budget constraint, the choice set available to the mother at a given period of time and/or incentives associated with mothers' forward-looking behavior.

In particular, we use welfare rules associated with termination and work requirement time limits, earnings disregard, child care assistance and child support enforcement. By setting time limits on benefit receipt, conditioning receipt on work requirements, changing the amount of earned income that is disregarded in calculating benefits, providing child care subsidies or changing the way in which child support collections were allocated, these changes in welfare rules plausibly generated substantial and plausibly exogenous variation in work incentives, child care prices and child care availability facing single mothers across the 50 U.S. States. We take advantage of this variation in order to identify the effects of maternal employment, child care use and income on children's cognitive development.

5. Data

We use data from the National Longitudinal Survey of Youth. The NLSY (1979 youth cohort) consists of 12,686 individuals, approximately half of them women, who were 14-21 years of age as of January 1, 1979. The sample consists of a core random sample and an oversample of blacks, Hispanics, poor whites and the military. Interviews were first conducted in 1979 and have been conducted annually to the present. On a regular basis, the NLSY79 has collected pre- and postnatal care information from the sample of women as they became mothers. Using data from the NLSY 79 Workhistory File, it is possible to construct a detailed employment history for each mother in the sample for the period surrounding the birth of her child, i.e., up to four quarters before birth and each

quarter interval since the child's birth for a period of five years. In regards to child care, retrospective data were gathered during 1986, 1988, 1992, and 1994-2000 that allows us to construct complete child care histories during each of the first three years of the child's life. In particular, if the mother reported having used at least 10 hours per week of some kind of child care during the quarter, she is assumed to have used child care during the corresponding period. In addition, data on whether the mother used child care or not during the 4 weeks prior to the interview date are available for the 1982-86, 1988, 1992 and 1994-2000 survey years. This information allows us to construct at least partial histories of child care for the fourth and fifth years after birth.

In 1986 a separate survey of all children born to NLSY79 female respondents began. The child survey includes assessments of each child as well as additional demographic and development information collected from either the mother or the child. A battery of child cognitive, socio-emotional, and psychological well-being questions have been administered biennially for children of appropriate age.

Finally we use the geocode data that allows us to identify the residence state of each individual in order to be able to model the effect of state-specific welfare benefits and rules. Different rules imply different budget constraints and choice sets which the individual will face when deciding on work and child care.

5.1. Home Inputs and Child Assessments

Maternal employment is measured in the following way. Women reporting between 75 and 375 hours of work per quarter are assumed to be working part-time, women reporting more than 375 hours of work per quarter are assumed to be working full-time and women reporting less than 75 hours per quarter are assumed to be staying at home during the period. We define the following indicator functions: if a mother worked full-time in period t then $f_t=1$ (0 otherwise), if she worked part-time then $p_t=1$ (0 otherwise) and if the mother stayed at home in period t then $f_t=0$ and $p_t=0$. Then accumulated work experience in period t , E_t , is given by:

$$E_t = \sum_{\tau=1}^t \left(f_{\tau} + \frac{p_{\tau}}{2} \right)$$

Similarly, if a woman reported having used at least 10 hours per week of some kind of child care¹⁷ then she is assumed to have used child care during the corresponding period. We define the following indicator function: $I_t^C=1$ if the mother used child care in period t (0 otherwise).

¹⁷ Types of child care include care by a relative or non-relative, day care center, nursery/preschool or regular school.

Accumulated child care use, C_t , is then given by:

$$C_t = \sum_{\tau=1}^t I_{\tau}^C$$

It is important to mention that complete child care histories are only available for the first three years after childbirth. Hence we have to construct child care choices for years 4 and 5 based on the observed child care history. First, we let $I_t^C=1$ for mothers who report to have been working in a given period t after the third year. If the mother is working she has to have used child care that period. In the case of a married woman, the alternative to child care would be to leave the child with her spouse or partner. However, a single mother must have used child care since she does not have that option. Second, for mothers who do not work in a given period t we impute the child care choice based on the predicted probability of using child care based on the estimated parameters of a probit model for child care use.

In particular, we estimate a probit model for the probability of having used child care (given that the mother does not work) during the last period t by the end of the third year after childbirth based on a set of characteristics that include: an indicator for whether the mother worked prior to childbirth, this indicator interacted with average hourly wage prior to childbirth, total work experience accumulated prior to childbirth, the child's race and gender, mother's education and age at birth, the mother's marital status, urban/rural residence, total work experience since childbirth, total child care use since childbirth and whether child care was used during the immediately preceding period. The results of this estimation are shown in Table 3.

As can be observed, whether the mother worked prior to childbirth and this indicator interacted with the average hourly wage prior to childbirth are significant predictors of child care use by the end of the third year after childbirth. In addition, mother's education, total work experience since childbirth, total child care use since childbirth and whether child care was used during the immediately preceding period also turn out to be significant predictors of the probability of using child care. Based on the results of this probit model we assign $I_t^C=1$ to a mother that did not work in period t at the beginning of year 4 after childbirth and whose predicted probability is greater or equal than 0.65.¹⁸

Finally, total household income refers to reported income from all sources including wages,

¹⁸ This threshold is chosen to obtain choice distributions after year 3 that are consistent with the trends observed from childbirth to year 3.

public assistance, unemployment benefits, interest or dividends, pension, rentals, alimony, child support and/or transfers from family or relatives.

We use as measures of the child's cognitive ability the scores on the Peabody Picture Vocabulary Test (PPVT) and the Peabody Individual Achievement Test Reading Recognition subtest (PIAT-R) and Mathematics subtest (PIAT-M). Both assessments are among the most widely used for preschool and early school-aged children. The PPVT is a vocabulary test for standard American English and provides a quick estimate of verbal ability and scholastic aptitude. The PIAT-M measures attainment in mathematics. It consists of eighty-four multiple-choice items of increasing difficulty. It begins with such early skills as numeral recognition and progresses to measuring advanced concepts in geometry and trigonometry. Finally the PIAT-R measures word recognition and pronunciation ability.

5.2. The Sample

We use the sample of single mothers in the NLSY to estimate the child's ability production function. In particular, we require that women in our sample are single (or do not cohabitate with a male co-resident) during five years following the birth of the child and that we observe at least one test score for the child. We allow for women with multiple children. In fact we interact inputs (E_t , C_t and I_t) with the number of children to account for the issue that day care use, maternal employment and income would be expected to affect child outcomes differently depending on the number of children. Also, note that number of children may itself be endogenous in such an equation (e.g., there is a quality/quantity tradeoff). Welfare rule parameters are again used as instruments here.

There are 1,519 mothers in the NLSY who were single (with no co-resident male) during the first five years after the birth of the child and at least one test score observation was available for the child. Of these women, 251 had children between 1990 and 2000, so they are impacted by welfare waivers and TANF. Much of our leverage for identification will come from comparing behavior and outcomes of these 251 women with those for the 1,268 women whose children were born earlier, since these two groups are subject to very different welfare rules.

In Table 4 we show mean characteristics of the women in this sample compared with characteristics of all women in the NLSY. Mothers in the sample are younger than the average mother in the NLSY by more than a year and are also less educated but only by approximately 9.6 months. A considerable percentage of mothers in the sample (83%) is Hispanic or black while this proportion is 47% in the NLSY. Approximately 39% of women in the sample worked at some point during the first year after giving birth compared to 47% in the NLSY sample. The hourly wage

before childbirth (for women who worked before childbirth) was lower for women in the sample and equal to \$4.39 (constant dollars of 1983). Finally, women in the sample had significantly more children on average than the average woman in the NLSY (3.12 vs. 2.83).

Figure 1 displays employment and child care choices after birth of women in our sample. During the first quarter after birth, about 73% of single mothers stayed at home and did not use child care, 10% returned to work full time and 4.7% part-time while using child care. Around 11.5% stayed at home and used child care. By the end of the period (5th year after childbirth), 29% of women were working full-time (and used child care) and 38% continued to stay at home and did not use child care and 17% stayed at home while using child care.

6. Estimation Results

Equation (4) is first estimated by OLS. Then the estimated effects are compared with IV estimates where the instruments are the welfare and child care subsidies rules described in Table 1 and discussed in Section 3. Table 5 examines the correlation of the instruments with the regressors (home inputs and number of children). For each regressor, the instruments are jointly significant ($p\text{-value} < 0.001$).

In Table 6 we present estimation results of different specifications of the cognitive ability production function. In particular, the first two columns include just inputs and additional controls, the third and fourth column include in addition interactions between inputs and mother's education. The idea is to understand whether the effects of inputs on children's achievement vary with the "type" of mother. Finally, columns five and six present estimates for a specification that includes both, interaction of inputs with mother's education and interaction of inputs with the number of children. Again, we would expect that day care use, maternal employment and income would affect child outcomes differently depending on the number of children. Also, note that number of children may itself be endogenous in such an equation (e.g., there is a quality/quantity tradeoff). Welfare rule parameters are again used as instruments here.

These results indicate that child care has a negative and significant effect on children's cognitive ability regardless of the specification. In particular, the effect of child care ranges from -0.35% to -0.75% per quarter (depending on the specification). For example, if a mother used child care during all first five years after childbirth then his/her test scores would be approximately 11% lower than test scores of a child whose mother did not use child care at all, other things equal. This difference is quite significant and is approximately equal to 0.57 standard deviations. Maternal

employment turns out to have a positive sign but is not significant in most specifications. The effect ranges from 0.17% to 0.54% per quarter but is only significant in the full-fledged specification that includes interactions of inputs with mother's education and number of children.

Finally, total household income turns out to be positive and significant. In particular, the effect of income ranges from 0.6% to 1.5% per quarter and it is significant. In most cases, this positive effect is large enough to offset the negative effect of child care use.

Table 7 presents estimations of the cognitive ability production function in which we differentiate inputs by age. In particular, we include work experience and child care in year 1 and work experience and child care accumulated since year 1 as two separate inputs. Results indicate that while maternal employment during the first year seems to have a negative effect on child's achievement, this effect is not statistically significant even after estimating the production function by IV. In addition, we find that cumulative child care in the first year has a positive and insignificant effect, while child care used after year 1 has a negative and significant effect on children's cognitive development.

In an effort to understand the effect of child care on children's achievement we estimated an alternative specification in which child care is split into different types. In particular, we differentiate between informal and formal child care. On one hand, informal child care refers to care provided by a relative (like grandparents) or a non-relative at the child's home. On the other hand, formal child care refers to care provided by a daycare, nursery, pre-K or other kind of formal arrangement.

The results of this estimation are presented in Table 8. It is clear that the negative effect of cumulative child care use is mostly due to the use of informal child care. Formal child care use also has a negative effect on child's achievement but it is not significant. In particular, an additional quarter of informal child care use is associated with 0.77% lower test scores.

7. Conclusions

This paper evaluates the effects of maternal time inputs and alternative providers' time inputs on children's cognitive development using the sample of single mothers in the National Longitudinal Survey of Youth (NLSY). In order to deal with the selection problem that arises when trying to assess the impact of mothers' employment and child care choices on children's development, we take advantage of the exogenous variation in employment and child care choices generated by the differences in welfare regulations across states and over time introduced by the Welfare Reform (1996) and prior to that by Section 1115 Welfare Waivers.

In particular, we construct a comprehensive set of welfare policy variables at the individual and State level and use them as instrumental variables in order to identify the effects of maternal employment, child care and labor income on children's cognitive development.

The main changes in the welfare system under both Section 1115 Waivers and TANF that are relevant for our exercise could be classified into the following categories: termination and work requirement time limits, earnings disregard, child care assistance and child support enforcement. By setting time limits on benefit receipt, conditioning receipt on work requirements, changing the amount of earned income that is disregarded in calculating benefits, providing child care subsidies or changing the way in which child support collections were allocated, these changes in welfare rules generated substantial and plausibly exogenous variation in work incentives, child care prices and child care availability facing single mothers across the 50 U.S. States. We take advantage of this variation in order to identify the effects of maternal employment and child care use on children's cognitive development.

The study of the case of single mothers is motivated by two main reasons. First, Bernal (2003) estimated the effects of maternal employment and child care on children of married women in the NLSY. A key motivation of this work is to see whether her results on the importance of maternal time inputs generalize from married to single mothers. Second, the study of single mothers is of special interest, given the huge welfare policy changes that have substantially altered their work decisions in recent years.

The results indicate that the effect of maternal employment on children's achievement is positive but insignificant in most specifications estimated. The effect of child care use on children's achievement is negative, significant and rather sizeable. In particular, one additional quarter of child use is associated with a reduction of approximately 0.50% in test scores (depending on the specification of the cognitive ability production function). In addition, the effect of income is significant and positive and in most cases large enough to offset the negative effect of child care.

Finally, the negative effect of child care seems to be related to a significant negative effect of child care used after the first year after childbirth while the effect of child care used in the first year seems to have a negative effect as well but is insignificant. In addition, the negative effect seems to be associated to the use of informal child care rather than formal child care which turns out to be insignificant in explaining child's achievement. In particular, an additional quarter of informal child care use is associated with 0.77% lower test scores.

References

- Baydar, N. and J. Brooks-Gunn, 1991, "Effects of Maternal Employment and Child Care Arrangements on Preschoolers' cognitive and Behavioral Outcomes: Evidence from Children of the National Longitudinal Survey of Youth", *Developmental Psychology* 27(6), 932-945.
- Becker, G.S. and L. Thomes, 1986, "Human Capital and the Rise and Fall of Families", *Journal of Labor Economics* 4:S1-S139.
- Belskey, J. and D. Eggenbeen, 1991, "Early and Extensive Maternal Employment and Young Children's Socioemotional Development: Children of the National Longitudinal Survey of Youth", *Journal of Marriage and the Family*, 53 (November): 1083:1110.
- Belsky, J. and M. Rovine, 1988, "Nonmaternal care in the first year of life and infant-parent attachment security", *Child Development* 59:157-176.
- Ben-Porath, Y., 1967, "The production of human capital and the life-cycle of earnings", *Journal of Political Economy*, vol. 75, no. 4, part I, August, 352-265.
- Bernal, R., 2003, "Employment and Child Care Decisions of Mothers and the Well-being of their Children", manuscript, New York University, May.
- Blau, D, 1999, "The Effects of Child Care Characteristics on Child Development", *The Journal of Human Resources*, XXXIV, 4.
- Blau, D., 1997, "The Production of Quality in Child Care Centers", *The Journal of Human Resources* 32(Spring):354-387.222
- Blau, D., D. Guilkey and B. Popkin, 1996, "Infant Health and the Labor Supply of Mothers", *The Journal of Human Resources*, 31(1):90-139.
- Blau, D. and A. Hagy, 1998, "The Demand for Quality in child Care", *Journal of Political Economy* 106(1): 104-146.
- Blau, F. and A. Grossberg, 1992, "Maternal Labor Supply and Children's Cognitive Development", *The Review of Economics and Statistics* 74(3), 474-481.
- Bradley, R.H., B.M. Caldwell and S.L. Rock, 1988, "Home Environment and School Performance: A Ten Year Follow-up and Eximation of Three Models of Environmental Action", *Child Development* 59:852-867.
- Broberg, A.G., C.P. Hwang and S. Chace, 1993, "Effects of day care on elementary school performance and adjustment", Paper presented at the 60th Anniversary Meeting of the Society for Research and Child Development, New Orleans, Louisiana.
- Burchinal, M., S. Ramey, M. Reid and J. Jaccard, 1995, "Early Child Care Experiences and their Association with Family and Child Characeristics during Middle Childhood", *Early Childhood Research Quarterly*, 10, 33-61.
- Burchinal, M.R., J. Roberts, L. Nabors and D. Bryant, 1996, "Quality of Center Child Care and Infant Cognitive and Language Development", *Child Development*, 67: 606-620.
- Cameron, S.V. and J.J. Heckman, 1998, "Life Cycle Schooling and Dynamic Selection Bias: Models and Evidence for Five Cohorts of American Males", *Journal of Political Economy*, Vol, 106, No.2.

- Campbell, F.A. and C. Ramey, 1994, "Effects of Early Intervention on Intellectual and Academic Achievement: A follow-up Study of Children from Low-income Families", *Child Development* 65:684-698.
- Chase-Lansdale, P.L., R. Moffitt, B. Lohman, A. Cherlin, R. Coley, L. Pittman, J. Roff, E. Votruba, 2003, "Mothers' Transitions from Welfare to Work and the Well-Being of Preschoolers and Adolescents", *Science*, 299(March):1548-1552.
- Clarke-Stewart, K. and C. Gruber, 1984, "Day Care Forms and Features" In R.C. Ainslie (Ed.), *The Child and the Day Care Setting* (pg. 35-62). New York: Praeger.
- Conger, R.D., K.J. Conger, G. Elder, F. Lorenz, R. Simons and L. Whitbeck, 1992, "A Family Process Model of Economic Hardship and Adjustment of Early Adolescent Boys", *Child Development*, 63: 526-541.
- Conger, R.D., K.J. Conger, G. Elder, F. Lorenz, R. Simons and L. Whitbeck, 1993, "Family Economics Stress and Adjustment of Early Adolescent Girls", *Developmental Psychology*, 29:206-219.
- Conger, R.D. and G. Elder, 1994, *Families in Troubled Times: Adapting to Change in Rural America*. New York: Aldine de Gruyter.
- Conger, R.D., G. Patterson, and X. Ge, 1995, "It Takes Two to Replicate: a Mediational Model for the Impact of Parents' Stress on Adolescent Adjustment", *Child Development*, 65: 541-561.
- Conger, R.D., M. Rueter and G. Elder, 1999, "Couple Resilience to Economic Pressure", *Journal of Personality and Social Psychology*, 76: 54-71.
- Council of Economic Advisers. "Explaining the Decline in Welfare Receipt, 1993-1996", May 9, 1997.
- Currie, J. and T. Duncan, 1999, "Early test scores, socioeconomic status and future outcomes", NBER working paper #6943.
- Desai, S., L. Chase-Lansdale and M. Robert, 1989, "Mother or Market? Effects of Maternal Employment on the Intellectual Ability of 4-year Old Children", *Demography*, Vol. 26, No. 4.
- Doherty-Derkowski, Gillian, 1995, *Quality Matters: Excellence in Early Childhood Programs*. Don Mills, Ontario: Addison-Wesley Publishers Limited.
- Elder, G. and A. Caspi, 1988, "Economic Distress in Lives: Developmental Perspectives", *Journal of Social Issues*, 44: 25-45.
- Elrod, Terry and Michael P. Keane, 1995, "A Factor-Analytic Probit Model for Representing the Market Structure in Panel Data," *Journal of Marketing Research*, 32, pp. 1-16.
- Ermish, J. and M. Francesconi, 2000, "The Effect of Parents' Employment on Children's Educational Attainment", IZA Discussion Paper No. 215.
- Geronimus, A., Korenman, S. and M. Hillemeier, 1994, "Does Young Maternal Age Adversely Affect Child Development? Evidence from Cousin Comparisons in the United States", *Population and Development Review* 20, pp. 585-609.
- Geweke, J., M. Keane and D. Runkle, 1994, "Alternative Computational Approaches to Inference in the Multinomial Probit Model", *The Review of Economics and Statistics*, Volume 76, Issue 4,

November.

Greenstein, T., 1995, "Are the 'Most Disadvantaged' Children Truly Disadvantaged by Early Maternal Employment?", *Journal of Family Issues* 16(2), Mar: 149-169.

Grogger, J. and C. Michalopoulos, 2003, "Welfare Dynamic under Time Limits", *Journal of Political Economy*, 530-554.

Han, W., Waldfogel, J., and J. Brooks-Gunn, 2001, "The Effects of Early Maternal Employment on Later Cognitive and Behavioral Outcomes". *Journal of Marriage and the Family*, 63(2): 336-354.

Harvey, E., 1999, "Short-term and Long-term Effects of Early Parental Employment on Children of the National Longitudinal Survey of Youth", *Developmental Psychology* 35(2), 445-459.

Harvey, R. and B. Wolfe, 1995, "The Determinants of Children's Attainments: A Review of Methods and Findings", *Journal of Economic Literature*, Volume 33, Issue 4, Dec: 1829-1878.

Haskins, R., 1985, "Public School Aggression among Children with Varying Day Care Experience", *Child Development* 56:689-703.

Haveman, R. and B. Wolfe, 1994, *Succeeding Generations: On the Effects of Investments in Children*. New York: Russell Sage Foundation.

Heckman, J. and B. Singer, 1984, "A Method For Minimizing the Impact of Distributional Assumptions in Econometric Models for Duration Data", *Econometrica*, Vol. 52, No. 2, pp. 271-320.

Heckman, J. and J. Walker, 1990, "The Relationship between Wages and Income and the Timing and Spacing of Births: Evidence from Swedish Longitudinal Data", *Econometrica*, Vol. 58, No. 6, pp. 1411-1441.

Holloway, S. and M. Reichhart-Erikson, 1988, "The Relationship of Day Care Quality of Children's Free-play Behavior and Social Problem-solving Skills", *Early Childhood Research Quarterly*, 3, 39-53.

Howes, C. and J. Rubenstein, 1981, "Toddler Peer Behavior in Two Types of Day Care", *Infant Behavior and Development* 4:387-393.

_____. 1985, "Determinants of Toddlers' Experiences in Day Care: Age of Entry and Quality of Setting", *Child Care Quarterly*, 14: 140-151.

Howes, C. C. Rodning, D. Galluzzo and L. Myers, 1988, "Attachment and Child Care: Relationships with Mother and Caregiver", *Early Childhood Research Quarterly*, 3, 403-416.

Hutchinson, D., H. Prosser and P. Wedge, 1979, "The prediction of educational failure", *Educational Studies*, 5, #1.

James-Burdumy, S., 1998, "The Effect of Maternal Labor Force Participation on Child Educational Attainment", manuscript, John Hopkins University, October.

Keane, M., 1994, "A Computationally Practical Simulation Estimator for Panel Data", *Econometrica*, Vol. 62, No. 1, pp. 95-116.

Keane, M. and R. Moffitt, 1998, "A Structural Model of Multiple Welfare Program Participation and Labor Supply", *International Economic Review*, Vol. 39, No. 3, pp. 553-589

Keane, M. and K. Wolpin, 1994, "The Solution and Estimation of Discrete Choice Dynamic

- Programming Models by Simulation and Interpolation: Monte Carlo Evidence”, *The Review of Economics and Statistics*, Vol. 76, No. 4, pp. 648-672.
- Keane, M. and K. Wolpin, 1997, "The Career Decisions of Young Men", *Journal of Political Economy*, Vol. 105, No. 3.
- Keane, M. and K. Wolpin, 2001, “The Effect of Parental Transfers and Borrowing Constraints on Education Attainment”, *International Economic Review* 42(4), pp. 1051-1103.
- Keane, M. and K. Wolpin, 2002a, “Estimating Welfare Effects Consistent with Forward-Looking Behavior. Part I: Lessons from a Simulation Exercise”, *Journal of Human Resources* 37(3):570-599.
- Keane, M. and K. Wolpin, 2002b, “Estimating Welfare Effects Consistent with Forward-Looking Behavior. Part I: Empirical Results”, *Journal of Human Resources* 37(3):600-622.
- Keane, M. and K. Wolpin, 2003, “Public Welfare and the Life-Cycle Decisions of Young Women, Working Paper, University of Pennsylvania.
- Keane, M. and R. Sauer, 2003, “Computationally Practical Simulation Estimator for Dynamic Panel Data Models with Missing Endogenous State Variables”, Working Paper, University of Tel-Aviv.
- Korenman, S., J. Miller, and J. Sjaastad, 1995, “Long-term Poverty and Child Development in the United States: Results from the NLSY”, *Child and Youth Services Review* 17(12):127-155.
- Lamb, M.E.,1998, “Nonparental Child Care: Context, Quality, Correlates”, In: *Handbook of Child Psychology, Volume 4: Child Psychology in Practice*, 5th ed. W. Damon, I.E. Sigel and K.A. Renninger, eds. New York, John Wiley & Sons, Inc
- Lazar, I. and R. Darlington, 1982, “Lasting Effects of Early Education”, *Monographs of the Society for Research in Child Development* (Serial No. 195) 47(2/3):1-151.
- Leibowitz, A., 1974, “Home investments in children”, *Journal of Political Economy*, vol. 82, no. 2, Part I, March, 111-131.
- Leibowitz, A., 1977, “Parental Inputs and Children's Achievement”, *Journal of Human Resources*, 12(2) 242-251.
- Leibowitz, A. J. Kerman and L. Waite, 1992, “Employment of New Mothers and Child Care Choice”, *Journal of Human Resources* 27:112-133.
- Linver, M., J. Brooks-Gunn and D. Kohen, 2002, “Family Processes as Pathways from Income to Young Children’s Development”, *Developmental Psychology*, 38(5): 719-734.
- Lohman, B., L. Pittman, R. Levine, P.L. Chase-Lansdale, 2004, “Welfare History, Sanctions, and Developmental Outcomes among Low-Income Children and Youth”, *Social Service Review*, March: 41-72.
- Lopez, R., 2003, “Are Children of Young Mothers Disadvantaged because of Their Mother’s Age or Family Background?”, *Child Development* 74, pp. 465-474.
- Love, J.M., P. Schochet and A. Meckstroth, 1996, "Are They in Real Danger? What Research Does - And Does not- Tell Us About Child Care Quality and Children's Well-being", Plainsboro NJ: Mathematica Policy Research (ERIC Document Reproduction Service No. ED145 030).
- MaCurdy, T., 1981, “An Empirical Model of Labor Supply in a Life-Cycle Setting”, *The Journal of Political Economy*, Vol. 89, No. 6, pp. 1059-1085

- Martin, Joyce A; Melissa M. Park; and Paul D. Sutton (2002). "Births: Preliminary Data for 2001," National Vital Statistics Report, Vol. 50, No. 10, June 6.
- Mayer, S.E., 1997, *What Money Can't Buy: Family Income and Children's Life Chances*. Cambridge, MA: Harvard University Press.
- McLoyd, V.C., 1989, "Socialization and Development in a Changing Economy: The effects of Parental Job and Income Loss on Children", *American Psychologist*, 44: 293-302.
- Melhuish, E.C., A. Mooney, E. Hennesy, and S. Martin, 1992, "Characteristics of Child Care in Early Childhood and Child Development in Middle Childhood". Paper presented at the European Conference on Developmental Psychology in Seville, Spain, Sept. 1992.
- Moffitt, R., 1983, "An Economic Model of Welfare Stigma", *The American Economic Review*, Vol. 73, No. 5, pp. 1023-1035.
- Moffitt, R., 1992, "Incentive Effects of the U.S. Welfare System: A Review", *Journal of Economic Literature*, 30(1), pp. 1-61.
- Moore, K. and A. Driscoll, 1997, "Low-wage Maternal Employment and Outcomes for Children: A Study", *The Future of Children* 7(1), Spring, 122-127.
- Mott, F., 1991, "Developmental Effects of Infant Care: The Mediating Role of Gender and Health", *Journal of Social Issues* 47(2):139-158.
- Murnane, R. J., J. Willet and F. Levy, 1995, "The growing importance of cognitive skills in wage determination", *Review of Economics and Statistics*, LXXVII, pp. 251-266.
- National Academy of Sciences, Shonkoff, J. and D. Phillips (Eds.), 2000, *Neurons to Neighborhoods: The Science of Early Childhood Development*, Committee on Integrating the Science of Early Childhood Development, National Research Council and Institute of Medicine, Washington, DC.
- Neal, D. and W. Johnson, 1996, "The role of pre-market factors in black-white wage differences", *Journal of Political Economy*, vol. 104, no.5, pp. 869-895.
- NICHD Early Child Care Research Network, 2001, "Overview of Early Child Care Effects at 4 5 years". Paper presented at the Biennial Meeting of the Society for Research in Child Development, Minneapolis.
- NICHD Early Child Care Research Network, 2000, "Characteristics and Quality of Child Care for Toddlers and Preschoolers", *Journal of Applied Developmental Science*, 4(3):116-135.
- NICHD Early Child Care Research Network, 1999, "Child Outcomes When Child Care Center Classes Meet Recommended Standards and Quality", *American Journal of Public Health*, 89: 1072-1077.
- NICHD Early Child Care Research Network, 1997a, "Poverty and Patterns of Child Care", In Brooks-Gunn, J. and G. Duncan (Eds.), *Consequences of Growing up Poor*. New York, NY: Russell-Sage.
- NICHD Early Child Care Research Network, 1997b, "Familial Factors Associated with the Characteristics of Nonmaternal Care for Infants", *Journal of Marriage and the Family*, 59(2):3899-408.

- NICHD Early Child Care Research Network, 1997c, "Results of NICHD Study of Early Child Care Reported at Society for Research in Child Development Meeting", NIH News Alert.
- NICHD Early Child Care Research Network, 1996, "Characteristics of Infant Child Care: Factors Contributing to Positive Caregiving", *Early childhood Research Quarterly*, 11(3):269-306.
- Norberg, K., "The effects of daycare reconsidered", NBER Working Paper No. 6769.
- Parcel, T. and E. Menaghan, 1990, "Maternal Working Conditions and Children's Verbal Facility: Studying the Intergenerational Transmission of Inequality from Mothers to Young Children", *Social Psychology Quarterly* 53: 132-147.
- Parcel, T. and E. Menaghan, 1994, "Early Parental Work, Family Social Capital, and Early Childhood Outcomes", *American Journal of Sociology* 99(4), 972-1009.
- Peterson, C. and R. Peterson, 1986, "Parent-child Interaction and Day Care: Does Quality of Day Care Matter?", *Journal of Applied Developmental Psychology*, 7, 1-15.
- Robertson, D. and J. Symons, 1990, "The occupation choice of British children", *Economic Journal*, 100, pp. 828-841.
- Ribar, D., 1995, "A Structural Model of child Care and Labor Supply of Married Women", *Journal of Labor Economics* 13(3):558-597.
- Rosenzweig, M. and P. Schultz, 1983, "Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs, and Their Effects on Birth Weight", *The Journal of Political Economy*, Vol. 91, Issue 5.
- Rosenzweig, M. and K. Wolpin, 1994, "Are There Increasing Returns to the Intergenerational Production of Human Capital? Maternal Schooling and Child Intellectual Achievement", *The Journal of Human Resources*, Vol. 29, Issue 2.
- Rubenstein, J. and C. Howes, 1983, "Adaptation to Toddler Day Care", In S. Kilmer (ed.), *Advances in Early Education and Day Care*, Greenwich, CT: JAI Press.
- Ruopp, R., J. Travers, F. Glantz and C. Coelen, 1979, *Children at the Center: Final Results of the National Day Care Study*. Cambridge, MA: Abt Books.
- Ruhm, C., 2000, "Parental Employment and Child Cognitive Development", NBER Working Paper No. 7666.
- Sayer, L.C., S.M. Bianchi and J.P. Robinson, 2004, "Are Parents Investing Less in Children? Trends in Mothers' and Fathers' Time with Children", *American Journal of Sociology* (Forthcoming).
- Smith, S., 1998, "The Past Decade's Research on Child Care Quality and Children's Development: What we are Learning, Direction for the Future", paper prepared for a meeting on Child Care in the New Policy Context, U.S., Department of Health and Human Services, April, 1998
- Smith, P. and K. Connolly, 1986, "Experimental Studies of the Preschool Environment: The Sheffield Project", In S. Kilmer (ed.), *Advances in Early Education and Day Care* Volume IV (pg. 27-67), JAI Press.
- Smith, A., B. McMillan, S. Kennedy and B. Ratcliffe, 1989, "The Effect of Improving Preschool Teacher/Child Ratios: An 'Experiment in Nature'", *Early Child Development and Care* 41:123-38.
- Studer, M., 1992, "Quality of Center Care and Preschool Cognitive Outcomes: Differences by

Family Income", *Sociological Studies of Child Development*, Vol. 5, P. Adler and P. Adler, eds.

Todd, P. and K. Wolpin, 2001, "Towards a Unified Approach for Modeling the Production Function for Cognitive Achievement", forthcoming in *Economic Journal*.

Vandell, D. and M. Corasaniti, 1990, "Child Care and the Family: Complex Contributors to Child Development", In K. McCartney (ed.), *Child Care and Maternal Employment: A Social Ecology Approach*. San Francisco: Jossey-Bass.

Vandell, D. and J. Ramanan, 1992, "Effects of Early and Recent Maternal Employment on Children from Low-income Families", *Child Development* 63(4), 938-949.

Ventura, Stephanie J. and Christine A. Bachrach (2000). "Nonmarital Childbearing in the United States, 1940-99," *National Vital Statistics Reports*, Vol. 48, No. 16 (Revised), October 18

Waldfogel, J., W. Han and J. Brooks-Gunn, 2000, "Early Maternal Employment and Child Outcomes: A Longitudinal Analysis of Children from the NLSY", forthcoming in *Demography*.

Figure 1

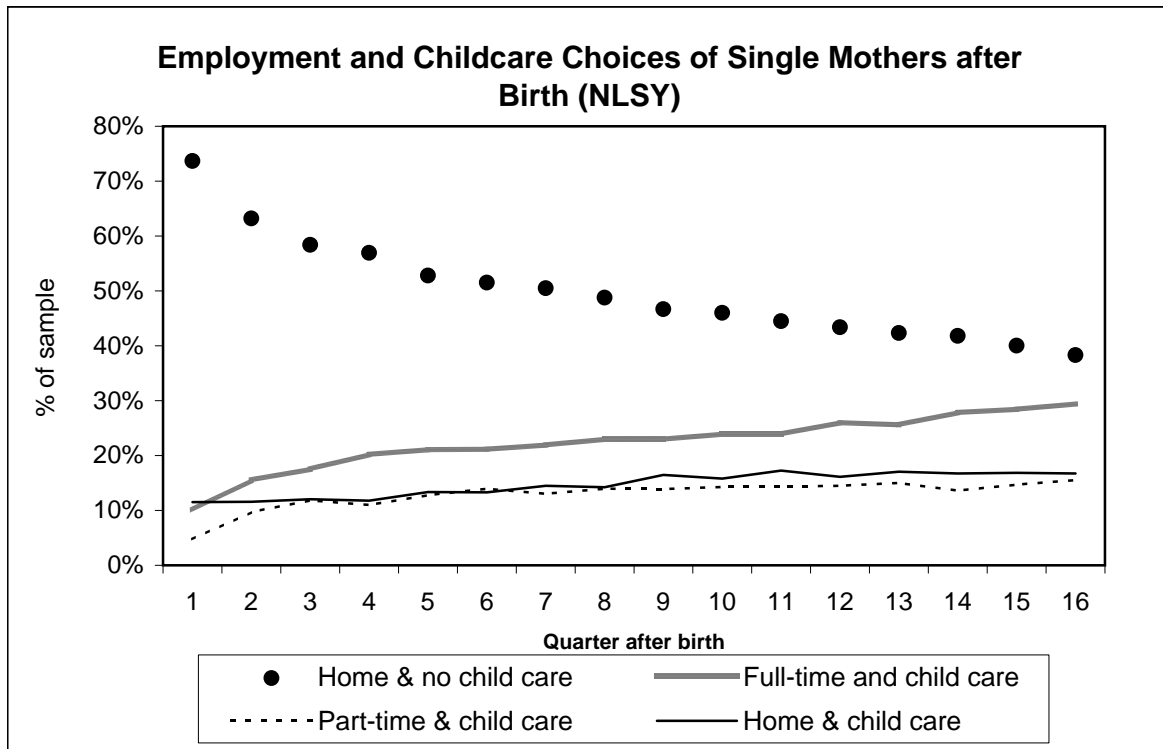


Table 1

List of Instruments (Welfare Policy Variables)

Variable	Description
Individual Level Policy Variables	
BEN_{ist}	Real AFDC/TANF maximum benefits, calculated using the state level benefit rule and the mother's family composition.
$EITC_{ist}$	EITC phase in rate constructed from both the federal and state level EITC rules, together with mother's family composition.
TL_HIT_{ist}	Dummy variable indicating whether a woman would have hit time limit
$ELAPSED_TL_HIT_{ist}$	Time elapsed since woman i may potentially be subject to time limit
$REMAIN_TL_HIT_{ist}$	Maximum potential remaining length of a woman's time limit, constructed: $TL_LENGTH_{st} - \min\{AGE_OLDEST_CHILD_{ist}, ELAPSED_TL_{st}\}$
$REMAIN_ELIG_{ist}$	Remaining length of time to be categorically eligible for welfare benefits: $18 - AGE_YOUNGEST_CHILD_{ist}$
WR_HIT_{ist}	Indicator for whether a woman could be subject to a work requirement: $= 1$ if [$WR_LENGTH_{st} \leq \min\{AGE_OLDEST_CHILD_{ist}, ELAPSED_WR_{st}\}$ & $AGE_YOUNGEST_CHILD_{ist} \geq AGE_CHILD_EXEM_{st}$]
$ELAPSED_WR_HIT_{ist}$	Time elapsed since woman i may be potentially subject to work requirement
State Level Policy Variables	
TLI_{st}	Dummy for whether state s has time limit in place in period t .
TL_LENGTH_{st}	Length of time limit in state s in period t .
$ELAPSED_TL_{st}$	Time (in months) elapsed since the implementation of time limit in state s .
$DCHILDBEN_{st}$	Dummy variable indicating whether the child portion of the welfare benefit continues after time limit exhaustion
DWR_{st}	Dummy for whether state s has work requirement in place in period t .
WR_LENGTH_{st}	Length (in months) of work requirement limit in state s in period t .
$ELAPSED_WR_{st}$	Time (in months) elapsed since the implementation of work requirement in state s .
$CHILD_EXEM_{st}$	Dummy for whether state s has age of youngest child exemption in place at t
$AGE_CHILD_EXEM_{st}$	Age of youngest child below which the mother will be exempted from work requirement in state s at time t .
$WR_ULT_SANC_{st}$	Dummy for whether state s has a full sanction for non-compliance of work requirement in state s at time t .
$EXEMP_{st}$	Number of work requirement exemptions in state s
$FLAT_DISREGARD_{st}$	Flat amount of earnings disregarded in calculating the benefit amount.
$PERC_DISREGARD_{st}$	Benefit reduction rate (Does not include phase-out)
$CHILDCARE_{st}$	CCDF expenditure per single mother in state s at time t .
$ENFORCE_{st}$	Child support enforcement expenditure in state s at year t per single mother.

Table 2

Control Variables in the Cognitive Ability Production Function	
AGE_i	Mother's age at childbirth
$EDUC_i$	Mother's educational attainment at childbirth
$I[WORK_BEF]_i$	Dummy for whether mother worked prior to childbirth
$I[WORK_BEF]_i \times HWAGE_{oi}$	Work dummy interacted with the average hourly wage* of the mother prior to childbirth
$EXPBEF_i$	Mother's total work experience (in number of years) prior to childbirth
$MARAFT_i$	Mother's marital status at time of child's test
$URBAN_i$	Urban/Rural residence at time of child's test
$NUMCHILD_i$	Number of children
$RACE_i$	Child's race (1 if black/hispanic, 0 otherwise)
$GENDER_i$	Child's gender (1 if male, 0 if female)
BW_i	Child's birthweight
$dPPVT_i$	Dummy for whether the corresponding test is PPVT
$dMATH_i$	Dummy for whether the corresponding test is PIAT-MATH

* Average hourly wage for the 18-month period prior to childbirth

Table 3**Child Care Probit**Dependent Variable-> Pr(using child care in t)

Whether worked before giving birth	0.59202 (0.2078) **
(Whether worked before) x (Avg. wage before)	-0.06419 (0.0398) *
Total work experience (prior to giving birth)	-0.00599 (0.0194)
Child's race	-0.08744 (0.1702)
Child's gender	0.04967 (0.1196)
Mother's education	0.08213 (0.0384) **
Total work experience since child birth	-0.39835 (0.0698) **
Total child care use since child birth	0.22263 (0.0527) **
Whether used child care or not in $t-1$	1.78009 (0.1639) **

Estimation	Probit
Number of observations	867
Pseudo-R ²	0.4585

Additional controls: Marital status at child birth (never married, separated, divorced, widowed), urban/rural residence and mother's age at birth.

Table 4**Mean Characteristics of Mothers in the Sample**

Description	NLSY	Our Sample	ttest
Worked within 4 quarters after birth	0.47 (0.004)	0.39 (0.015)	**
Mother's age in years at birth	24.8 (0.053)	23.13 (0.054)	**
Mother's education in years at birth year	12.0 (0.024)	11.2 (0.054)	**
Hispanic or Black	0.47 (0.004)	0.83 (0.013)	**
Hourly wage before birth	6.71 (0.22)	4.39 (0.06)	**
	Obs		
	5728	977	
Total number of children of mother	2.83 (0.012)	3.12 (0.043)	**
Father present at birth	0.55 (0.004)	-	
Observations	4814	1519	

Table 5**Table 5. R-squared Values for First Stage Regressions of Inputs on Instruments Set**

Input	R-squared	p-value from joint test of significance
Accumulated Work Experience up to t	0.1830	0.0000
Accumulated Work Experience 1st year	0.1167	0.0000
Accumulated Work Experience after 1st year	0.1862	0.0000
Accumulated Child Care Use	0.1650	0.0000
Accumulated Non-formal Child Care	0.0928	0.0000
Accumulated Formal Child Care	0.0641	0.0000
Accumulated Child Care Use 1st year	0.0984	0.0000
Accumulated Child Care Use after 1st year	0.1718	0.0000
Number of Children	0.3839	0.0000

Table 6

Effect of maternal employment and child care use on children's cognitive development

Dependent Variable-> Log(Test Score)	(1)	(2)	(3)	(4)	(5)	(6)
Experience	0.00042 (0.0008)	0.00171 (0.0045)	0.00426 (0.0049)	0.05673 (0.0392)	0.00461 (0.0050)	0.08087 (0.0450) *
Child Care Use	0.00103 (0.0006)	-0.00746 (0.0041) *	0.00288 (0.0035)	-0.05515 (0.0271) *	0.005052 (0.0036)	-0.08429 (0.0338) **
Log(Cumulative Labor Income)	0.00296 (0.0033)	0.02013 (0.0129)	0.02169 (0.0215)	0.21146 (0.1149) *	0.013708 (0.0223)	0.32839 (0.1474) *
(Experience)*(Mother's Education)			-0.00029 (0.0004)	-0.00465 (0.0031)	-0.00035 (0.0004)	-0.00561 (0.0036)
(Child Care Use)*(Mother's Education)			-0.00019 (0.0003)	0.00389 (0.0023) *	-0.00024 (0.0003)	0.00542 (0.0027) *
Log(Income)*(Mother's Education)			-0.00173 (0.0019)	-0.01753 (0.0103) *	-0.00129 (0.0020)	-0.02511 (0.0133) *
(Experience)*(Number of children)					-0.00006 (0.0006)	-0.00409 (0.0035)
(Child Care Use)*(Number of children)					-0.0092 (0.0004) *	0.00644 (0.0032) *
Log(Income)*(Number of children)					0.00192 (0.0026)	-0.01301 (0.0105)
Estimation	OLS	IV	OLS	IV	OLS	IV
Number of observations	3787	3787	3787	3787	3787	3787
R ²	0.3675	0.3237	0.3682	0.2743	0.3698	0.131

Additional controls: Mother's age, education, total work experience prior to giving birth, whether she worked prior to birth or not, whether she worked prior to birth or not interacted with prior wage, marital status after giving birth, urban/rural, child's race, gender, birthweight, number of children in the household and test dummies.

Table 7**Specific-age effects of maternal employment and child care use on children's cognitive development**

Dependent Variable-> Log(Test Score)	(1)	(2)
Accumulated Experience in year 1	0.00458 (0.0042)	-0.01926 (0.0257)
Accumulated Experience after year 1	-0.00028 (0.0010)	0.00479 (0.0059)
Child Care Use in year 1	0.00025 (0.0030)	0.02534 (0.0193)
Child Care Use after year 1	0.0012 (0.0008)	-0.0136 (0.0053) **
Log(Total Income)	0.00302 (0.0033)	0.02771 (0.0138) *
Estimation	OLS	IV
Number of observations	3787	3787
R ²	0.3667	0.3016

Additional controls: Mother's age, education, total work experience prior to giving birth, whether she worked prior to birth or not, whether she worked prior to birth or not interacted with prior wage, marital status after giving birth, urban/rural, child's race, gender, birthweight, number of children in the household and test dummies.

Table 8**Effects of Different Types of Child Care Use on Children's Cognitive Development**

Dependent Variable-> Log(Test Score)	(1)	(2)
Accumulated Work Experience	0.00055 (0.0008)	0.00092 (0.0041)
Formal Child Care Use	0.00168 (0.0006) **	-0.00197 (0.0040)
Informal Child Care Use	0.00046 (0.0007)	-0.00775 (0.0038) *
Log(Total Income)	0.00298 (0.0033)	0.01526 (0.0060) **
Estimation	OLS	IV
Number of observations	3787	3787
R ²	0.3684	0.3283

Additional controls: Mother's age, education, total work experience prior to giving birth, whether she worked prior to birth or not, whether she worked prior to birth or not interacted with prior wage, marital status after giving birth, urban/rural, child's race, gender, birthweight, number of children in the household and test dummies.