PRELIMINARY DRAFT
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Is Mothers' Labor Market Participation Related to Childhood Weight Changes in the United States?: Evidence from Early Childhood Longitudinal Study, Kindergarten Cohorts (ECLS-K)

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Abstract

Maternal employment has been pointed out as one of the several possible causes of increase in child obesity in recent decades. The sharp increase (from 47.4% to 71.2%) in labor force participation rate of mothers with children under age 18 between 1974 and 2008 is well aligned with the 3 to 4 fold increase in child obesity during the same time period. Also, family economic production theory elaborates this possible causation arguing that maternal work is predicted to change the allocation of the time and money resources in child supervision and food preparation at home and thus, adversely affects children's weight related health outcomes. Using Early Childhood Longitudinal Study-Kindergarten Class of 1998-1999 (ELCS-K), we examine the effect of maternal work on children's health outcome across different developmental stages, i.e. 1^{st} - 3^{rd} grade and 3^{rd} - 5^{th} grade. We use the fixed effect model addressing potential endogeneity problem driven by the individual heterogeneity. Our findings suggest that though maternal work increases child BMI z-score, it does not increase the risk of being obese, overweight, or underweight. Among married mothers living with husband and unmarried mothers cohabiting with partners, except for families under poverty line, most children are not negatively affected by maternal work. For single mother families, maternal work positively affects children's health by reducing the risk of being overweight and underweight. For this group of mothers, it seems that maternal work results in more resources to improve children's physical development.

Introduction

The skyrocketed prevalence of childhood obesity is one of the most serious health concerns in the U.S. Recent statistics from the National Health and Nutrition Examination Survey (NHANES) of 2007-2008 indicate that 19.6% of children aged 6-11 are obese, i.e. at or above the 95^{th} percentile of Body Mass Index (BMI; in kg/m^2) and 35.5% of them are overweight, i.e. at or above the 85^{th} percentile of BMI of the Centers for Disease Control and Prevention (CDC) 2000 growth charts (Ogden et al., 2010a). Strikingly, the proportion of obese and overweight children tripled since the 1970s (Ogden et al., 2010b).

Research findings by health professionals emphasize the adverse outcomes of childhood obesity. Well established previous research shows that pediatric obesity is associated not only with increased risk for physiological problems such as metabolic disorders (Must & Strauss, 1999), multiple cardiovascular diseases (Freedman et al.,1999), and pulmonary, gastrointestinal, and skeletal abnormalities (Daniels, 2006), but also with increased risk of psychological problems such as negative self-image and lower self-esteem concomitant with psychosocial discrimination and negative stereotyping (Dietz, 1998). Children with higher BMI are more likely to be obese adults that are susceptible to chronic illness and decreased life expectancy (Daniels, 2006; Fontaine et al., 2003; Guo et al., 2002; Must & Strauss, 1999). The increased potential risks of comorbidities due to childhood obesity may result in significant increases in health care utilization and expenditure (Trasande & Chatterjee, 2009), as well as indirect costs such as lost school days and poor academic performance (Datar et al., 2004).

Despite clear evidence about the adverse effects of childhood obesity, important question on what lead to the dramatic increase of childhood obesity is still a subject of long-lasting debate. At the simplest level, obesity is thought of as a state of positive balance between energy intake

and energy expenditure. Any manipulation of either side of energy equation produces storage of excess weight (Hill, 2006). A tremendous amount of attention from research communities across different disciplines devoted to exploring the determinants of phenomenal energy imbalance. Cawley (2010) argues that environmental influences such as decreased real price of food, a technological innovation in mass preparation and preservation of food, and farm subsidy and higher income (though controversial) provide people with incentives to consume energy in excess of daily need. Increased consumption of energy-dense food concomitant with rapid expansion of fast food outlets and an upsurge in advertisement of prepared meal and sugar-sweetened beverages is a frequently cited causal factor in the development of obesity (St-Onge et al., 2003; Thompson et al., 2004). Other explanations to the rise in obesity include low physical exercise (Troiano et al., 2008), increase in sedentary behavior associated with increase in television and computer use time, nutritionally unbalanced snacking and exposure to high calorie food advertisements as independent predicative factors impeding the energy balance equation (Eisenmann et al., 2002; Gortmaker et al., 1996; Lowry et al., 2002).

Though environmental changes may be a necessary condition, they are not a sufficient condition for rise in obesity epidemic since choices on diet and level of physical activity are made by parents and children themselves. It is certain that a variety of environmental changes may encourage overeating and discourage physical activity, ceteris paribus. But what if parents who are responsible for rearing children have no choice but to change their lifestyle to engage in unhealthy diet and less exercise? In that sense, family factors, as well as social and environmental factors, must be considered to explain childhood obesity phenomenon (Patrick and Nicklas, 2005). Among a variety of family factors, recent studies pay more attention to coincidently rising mother's work (Anderson et al., 2003; Chia, 2008; Fertig et al., 2009; Liu et

al., 2009; Miller, 2011; Morrissey et al., 2011; Ruhm, 2008). In fact, the labor force participation rate of mothers with children under age 18 rose from 47.4% to 71.2% between 1974 and 2008, according to recent data from Bureau of Labor Statistics. During the same period, the obesity rate (defined as 95^{th} percentile or above of BMI) increased from 4.0% to 19.6% among children aged 6-11 and from 6.1% to 18.1% among those aged 12-19 (Odgen et al., 2010a).

[Figure 1 here]

Intrigued by the coincident upsurge both in mothers' labor force participation rate and in childhood obesity rate, recent empirical research has explored the causal relationship and potential mechanisms, if any, between childhood obesity and mother's labor force participation. Commonly cited pathway is that maternal work is predicted to alter the allocation of the time and money between child rearing and work and hence is positively correlated with children's weight outcome (Anderson et al., 2003; Bauer et al., 2012; Chia, 2008; Fertig et al., 2009; Gennetian et al., 2010; Liu et al., 2009; Miller, 2011; Morrissey et al., 2011; Ruhm, 2008).

More specifically, maternal work may contribute to childhood obesity through several mediators. First, under the assumption that mothers allocate their time and budget to maximize their utility, working mothers have less time with their children, including time in preparing meals, time spent on family meals, and time in engaging children in outdoor activities (Anderson et al., 2003; Bauer et al., 2012; Cawley & Liu, 2007; Fertig et al., 2009). Reduction in parental time also translates into decreased parental attentiveness and supervision, disrupting family routines (Anderson, 2012; Gennetian et al., 2010).

Second, working mothers have no choice but to leave their kids in non-parental care during work. Non-parental caregivers' behavior including nutritional intake may differ from that of parents (Cesur et al., 2010; Maher et al., 2008; Story et al., 2006). Strikingly, it is observed

that the nutritional quality of foods and the level of physical activity in non-parental child care arrangement do not meet the recommended guidelines (Cesur et al., 2010; Padget & Briley, 2005; Story et al., 2006).

Third, mothers' labor market participation results in additional household income. The effect of additional income on childhood weight related health outcomes, however, is not clearly identified. Higher income allows mothers to purchase healthier foods and more structured after-school exercise as well as higher standard housing and better medical care with insurance, which are expected to produce positive health outcomes. On the other hand, subsequent work-life stress may render mothers to skip or delay meals, to purchase additional calories at home, or to substitute calorie-dense restaurant food, which are expected to produce negative health outcomes (Bauer et al., 2012; Gennetian et al., 2010; Fertig et al., 2009; Miller, 2011).

Previous Studies on Maternal Employment and Childhood Obesity

On the basis of potential pathway discussed above, previous research studies confirm that children with working mothers are more likely to be obese, especially among the advantaged. Anderson et al. (2003) found a positive correlation between maternal work intensity and children's likelihood of being obese, only among children in high income family, with a well-educated or white mother, using matched mother-child data from the National Longitudinal Study of Youth (NLSY). Similarly, using NLSY data, Ruhm (2008) reported that maternal employment three years after child birth has a deleterious effect on child's weight only among advantaged groups,. The study also suggests a plausible reverse direction that mother's labor market participation decision may be a consequence, not a cause, of children's poor health outcomes. Fertig et al. (2009) provide further empirical evidence that the adverse effect of maternal work on children's weight is salient only among children with higher educated mothers.

Analyzing time diaries from the Child Development Supplement of the Panel Study of Income Dynamics (PSID), they also demonstrate that more educated mothers' additional work hours contributes to children's weight gain (measured by both BMI percentile and binary outcome of being obese) through fewer meal consumption, sedentary activities, and TV watching, whereas less educated mothers' additional work hours decreases children's BMI through the mechanism of school attendance.

Recent studies report new lines of evidence of the influence of mothers' work on children weight problem. First, it is observed that the impact of mothers' work on children's obesity outcome is contingent on the developmental stage of the child. Miller (2011) found that while mother's current work increases children's likelihood of being overweight among children aged 9-11 and 12-14, mother's past and current work decreases children's likelihood of being obese among children aged 9-11. Furthermore, in contrast to previous research, the maternal work effect is found to be more prominent among low income and single mother families. Second, father's work hours are associated with an even greater increase in child's BMI, and hence studies without considering father's contributions may suffer from omitted variable bias. Benson & Mokhtari (2011) found that additional father's work crowds out shared parent-child activities, leading to an increased risk of childhood obesity. Specifically, a 1percent increase in father's work hours is associated with a 7 percent increase in child's (aged 10-19) BMI percentile, while a 1percent increase of mother's work hour leads to a 3percent increase in child's BMI percentile. They argue that a more harmful consequence of father's additional work comes from the fact that a small proportion of child rearing activities are performed by fathers. Bauer et al. (2012) also find the more negative effect of father's work hours than of mother's work hours by showing that full-time employed fathers spend 2.7 hours less on family food preparation per week than fathers

who are not employed. Morrissey (2012), analyzing employment status of both parents, indicates that an additional work period of parental full-time employment regardless of when they worked is associated with a two-fifth standard deviation increase in BMI among preschool children (aged 2-5), but not among children of school-attending age and adolescents.

Reviewing recent studies in describing the relationship between maternal work and children's weight problem, we find some important discussions in the existing literature that should be addressed carefully. First, as Miller (2011) points out, previous studies examine the impact of mother's average weekly work hours on children's health and obesity/overweight outcomes either across childhood or at a single age. Miller (2011) suggests that 'timing' effect of mother's work on children's different developmental stages should be considered. We agree with his argument in principle, and we further suggest that research need to account for 'adiposity rebound' (i.e.; the onset of the second period of rapid growth in body fat) in childhood development. For example, study results targeting children aged 4-5 may be different from study results targeting children aged 6-7 because BMI of children aged 4-5 tends to decrease and to rebound after reaching a lowest point at around age 6 (Whitaker et al., 1998). Thus, inclusion of preschoolers may confound the true impact of maternal work. Furthermore, adolescents in puberty (on average after 7^{th} grade) tend to be independent from their parents and influenced by peer behavior (Morrissey, 2012; Thompson et al., 2004), confounding the pure effect of maternal work.

Second, while previous works using binomial outcome of being obese/overweight as dependent variable offer the maternal work effect on becoming obese/overweight, these works do not provide clear answer on whether maternal work changes children's health even remaining in the same weight-related health outcome status categories. For example, Anderson et al. (2003)

found that 10 additional hours of mother's work increases the likelihood of children being obese by 1.2 percentage point. This finding, however, cannot tell us whether children with working mothers are being closer to cut-point (e.g. 95^{th} percentile), even not crossing the cut-point. In order to fully understand the maternal work effect on children weight problem, research must take into consideration the BMI z-score distribution as well as cut-points including obesity, overweight, normal weight, and underweight into account.

Third, studies interested in the effect of mother's *current* employment or of *only* mothers' work hours may be limited in their scope for explaining obesity outcomes, since body weight remains quite stable over long period of time (Hill, 2006) and since mother's work decision is closely related with father's employment and work hours (Benson & Mokhtari, 2011). Hence, previous and/or current parental work hours may be related with children's current health status. In this regard, two recent studies have some notable findings. Morrissey (2012) studies duration (i.e. sum of the number of periods) and intensity (i.e. sum of weekly work hours) of parental employment in her model, while Miller (2011) studies both average weekly hours of previous developmental stage (or stages) and current developmental stage in his model. Adding to their studies, we suggest that research should calculate the duration of parental work based on the same time intervals and analyze the lagged effect and contemporaneous effect of parental work at the same time, reflecting substantial and increasing role of fathers in domestic and childrearing activities. Inclusion of paternal work also increases the necessity of subgroup analysis differentiating married mothers with spouse and single mothers without spouse, reflecting a significance increase of one parent family.

Finally, while several studies find that adverse effect of maternal work on children's obesity is only confined to family with high income and well-educated mothers (Anderson et al.,

2003; Fertig et al., 2009; Ruhm, 2008), other studies find that the deleterious effect of mothers' work is salient among low income family (Chia, 2008; Miller, 2011; Morrissey et al., 2011; Scholder, 2008). This inconsistency may be attributed to different definitions of low income family. For example, while Anderson et al. (2003) and Miller (2011) use first quartile of average family income , Ruhm (2008) uses lower half of his own SES index definition as low income families while Morrissey et al. (2011) defines low income family as a family whose income is less than twice the federal poverty threshold. Though there is standard definition for low income families, it is certain that necessary living cost of family depends on family size and structure and needs to be adjusted over time.

To address these concerns, our study adds to the existing literatures exploring the relationship between maternal work and children's weight problem in several ways. First, we employ a relatively recent, nationally representative panel survey data, Early Childhood Longitudinal Study-Kindergarten Class of 1998-1999 (ELCS-K), to assess the impact of maternal work on children's health outcomes. We narrow down our focus to elementary school children (1^{st} grade – 5^{th} grade), excluding preschoolers who tend to be in decline of BMI and adolescents who tend to be in puberty. Second, we examine effect of maternal work on children's health outcome across different developmental stages, i.e. 1^{st} - 3^{rd} grade and 3^{rd} - 5^{th} grade, using fixed effect (FE) model and instrumental variable (IV) model addressing potential endogeneity problem driven by the individual heterogeneity. Third, in contrast to previous empirical studies, we investigate maternal work on both children's weight change and their likelihood of having a weight problem, using BMI z-score and binary indicators of being obese, overweight, normal, and underweight. Fourth, we took both the contemporaneous and lagged effect of parental work intensity into account to reflect increasing role of fathers in child rearing

and family activities. We conduct three subgroup analyses – married mothers living with husbands, mothers living with partners (spouse or cohabitants), and single mothers without cohabitants. Finally, we attempt to resolve discrepancy over definition of low income family by studying maternal work effect on children weight problem using federal poverty thresholds (adjusted for family size and age of members) each year by Census Bureau.

Data

Overview

Data for this study is gathered from the Early Childhood Longitudinal Study-Kindergarten Class of 1998-1999 (ECLS-K), a nationally representative cohort of Kindergarteners in the U.S., sponsored by U.S. Department of Education, Institute of Education Sciences, and National Center for Education Statistics. The ECLS-K data contains detailed information on children and parent, teacher, and school characteristics to analyze children's cognitive skills and knowledge, physical health and growth, and socio-emotional development.

ECLS-K study selected 21,260 children (from 1,280 schools) who entered kindergarten in the fall of 1998 using a multi-stage cluster sampling and followed them through the eighth grade, with in-depth interviews with children, parents, and teachers conducted in the fall of kindergarten (wave 1), the spring of kindergarten (wave 2), the fall of first grade (wave 3)[1], the spring of first grade (wave 4), the spring of third grade (wave 5), the spring of fifth grade (wave 6), and the spring of eighth grade (wave 7). Our study employed data from waves 4, 5, and 6, eliminating children in adiposity rebound and adolescents in puberty.

From the initial sample of children that participated in the fall kindergarten interview, about 15%, 22%, and 46.3% dropped out of the study due to non-eligibility or moving without follow-up in the spring first grade, the spring of third grade, and the spring fifth grade,

[1] The fall first grade wave surveyed only 30% of baseline sample.

respectively. We do not count newly added children each period for the panel analysis. While response rate of children assessment among remaining sample is pretty high in each period due to one-to-one assessment (95%, 91%, and 98% respectively), the response rate of parental interview is lower (on average around 80%) due to computer-assisted interview by telephone in most cases. Observations missing BMI information and other key independent and control variables are excluded from the sample. In our study sample, we have 13,270 observations from spring of first grade, 10,130 observations from spring of third grade, 8,530 observations from spring of fifth grade, making for an unbalanced panel data structure.[2]

[Table 1 here]

Variables Defined for Weight related Health Outcomes

ECLS-K study recorded children's height (in inches) using Shoor Board vertical stadiometer and weight (in pounds) using Seca digital scale in all waves. Further, to minimize measurement error, height and weight were measured twice and were averaged across the two measurements. Using SAS program provided by CDC, we transformed the children's height and weight data into BMI, BMI-for-age percentiles, and BMI z scores. Following CDC guidelines and Nader et al. (2006), around 0.6% of observations with biologically implausible BMI z-score (BMI z < -4 and BMI z > 4) were eliminated.

To address our research questions, we used continuous BMI z-score and dichotomous indicators of being obese, overweight, and underweight as the dependent variable in each regression. While dichotomous weight indicators enable us to grasp children weight variation across categories, BMI z-score enables us to catch within-child variation over time while children remaining in the same categories of health status. We do not employ raw BMI and BMI

[2] Please note that missing data due to non-eligibility and nonresponse are not random. They are more likely to come from families with large family size, single parent, less educated mothers, and lower income.

percentile as the dependent variable. While raw BMI is a good indicator for the levels of body fat, it does not take into account children's age and sex. BMI percentile is another good indicator for identifying children weight problem, but it is bounded between 0 and 100. In other words, it is sensitive to changes among normal weight children at base year, whereas it is relatively insensitive to changes among obesity or underweight children at base year (Cole et al., 2005). Though BMI z-score is not ideal, it helps us explore whether maternal work shifts general mean and BMI distribution over time (Scholder, 2008; Thompson et al., 2004).

Besides BMI z-score, we also employ three health outcome indicators as the dependent variable in each regression. Each indicator represents whether the child is obese (BMI above or at 95th percentile), overweight (BMI above or at 85th percentile), or underweight (BMI below 25th percentile), respectively. This helps us to examine the effect of maternal employment on the cut-off point of having a weight problem. The cut-off points based on 2000 CDC age- and gender-specific growth charts are widely used for children over the age of 2 following the Institute of Medicine report (IOM, 2005; Krebs et al., 2007). However, there is no clear cut-off point for underweight children. For example, CDC defines underweight as children whose BMI-for-age is less than 5th percentile, but WIC Nutrition Risk Criteria defines underweight as children whose BMI-for-age is less than 10th percentile. Recent experimental study (Koleilat, 2012) uses BMI below 25th percentile as underweight, which we use in our main analysis.[3]

Variables Defined for Mothers' Work

Our key independent variable of interest is mothers' work intensity, which is measured by mothers' average work hours per week. As Fertig et al., (2009) and Miller (2011) point out, children's weight outcome may be cumulative result of behavioral change over time. Thus,

[3] We also conduct additional analyses on 5th percentile cut-off and 10th percentile cut-off. The results are not significantly different.

considering the possibility that children's current health outcome may be the outcome of mother's previous work and/or current work, we also control for lagged mother's work hour.

We also consider mothers' decision to work to be contingent on father's work decision and work hours, and that fathers' responsibility in raising children at home is significantly increasing over recent years (Benson & Mokhtari, 2011; Bauer et al., 2012), though Cawley & Liu (2007) suggest that the decrease in time spent on food preparation due to maternal work is only partly offset by fathers' help. Ignoring fathers' input in child health production, however, may lead to biased results (Fertig et al., 2009). Thus, we include fathers' work intensity, i.e., previous work hours as well as current work hours, in our regression model. Fathers indicate husband for married mothers with spouse, cohabitants for mothers with partners, and none for single mothers.

We utilize question on ECLS-K study, "about how many hours per week do you usually work for pay?"[4] We use work hours divided by 10; hence a 1 unit change in both current and lagged maternal and paternal work variables correspond to a 10-hour per week increase in work hours.

Demographic Characteristics

We control for a number of other variables that might confound the linkage between maternal work and child weight problem. Those include children's gender, race (White/Black/Hispanic/Asian/Others), poverty indicators[5], mother's education indicators (lessHS/HS/Bachelor(or less)/ Grad(or more)), marital status indicators, birth weight indicators (low/normal/high), whether family lives with older adults (age $\geq$ 65), and number of siblings.

[4] Unfortunately, this question does not identify duration of work. Further, it is worth noting that responses were top-coded, making range of 0 and 80 hours.
[5] We use either family income category dummies or poverty dummies for cross-sectional Ordinary Least Square regression.

Table 1 provides descriptive statistics and further details about all the variables and year dummies. In contrast to previous studies which control only for current period characteristics, we employ previous as well as current period characteristics as control variables, in accordance with our independent variables. For example, rather than using current poverty status dummy, we coded 1 if the family was below federal poverty line ever from Kindergarten to each period and 0 if the family was above or at poverty level ever. Similarly, we coded 1 if the mother was married ever from Kindergarten to each period and 0 if she was single for the whole period.

Although we include a group of exogenous control variables to reduce heterogeneity, we suspect the validity of results with the inclusion of family-routine variables (e.g. eating, TV watching, or sleeping, etc.), following recent work of Anderson (2012). Unlike conventional speculation of the role of behavioral change or lifestyle modification mediating maternal work and child obesity, Anderson (2012) found that family routines does not play a key role in exploring the mechanism of adverse effect on child obesity. Furthermore, since those behavioral variables work as intermediate links between maternal work hours and child obesity, controlling for those variables does not yield the full impact of maternal work hours on child obesity. For these reasons, we avoid including behavioral variables in our model (Wooldridge, 2009).

Analytical Strategy

The main purpose of this paper is to examine whether maternal work intensity (along with paternal work intensity) affects child weight-related health outcomes. We investigate three groups of mothers. The first group includes married mothers living with their husbands, the second group consists of mothers cohabiting with partners, and the third group consists of single

mother families.[6] We investigate these three groups separately because we are interested in examining how maternal employment affects child health with regards to weight related health outcomes in families with and without a father figure. Within each group, we look at families under the poverty line and those that at or above the poverty line to investigate whether the total family income mediates against or for the effect of maternal work. In order to examine whether timing of maternal work is important, we also separately examine two different periods of children's development such as a period from 1st to 3rd grade and a period from 3rd to 5th grade. We use the lagged and present maternal weekly work hours as treatment variables of maternal work to examine the long term and short term effects of maternal work, respectively.

We also examine the impact of maternal work on children's weight related health outcomes using various dependent variables related to weight related health outcomes. We not only use BMI z score but also use different variables indicating children's weight related health outcomes such as whether they are obese (95th percentile in BMI or more), whether they are overweight (85th percentile in BMI or more), and whether they are underweight (25th percentile in BMI or less).

When estimating the maternal work effect on children weight problem, a widely acknowledged concern is that researchers cannot fully control for unobservable heterogeneity and that regressing child weight problem on maternal work using Ordinary Least Squares may be biased if mothers' unobserved characteristics are correlated with the labor market participation decision (Anderson et al., 2003; Miller, 2011; Morrissey et al., 2011; Wooldridge, 2009). To address unobservable heterogeneity and to yield unbiased impacts of maternal work on child

[6] Mother with partners includes married mothers with husbands and unmarried mothers with partners. We do not investigate unmarried mothers with partners separately because mothers' marital status changed over time and it is difficult to define this group in our panel data.

weight related health outcomes, we adopt 1) Fixed Effect (FE) model to difference out time-invariant characteristics over time, and 2) Instrument Variable (IV) model.

In order to control for factors in a domestic production process within a family, we include husband's weekly work hours and other family characteristics. Other control variables include year dummy (respectively), child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of High-school, Bachelor or less, Graduate school or above), child's birth weight (dummies of low birth weight (<2500g) and high birth weight (>4000g)), living with older adults (dummy of living with adults age >= 65), and number of siblings. For regressions for all mothers, we also control for poverty status.

Results

1) Fixed Effect (FE) model

First, we ran a pooled OLS regression[7] for the 1st and 3rd graders and for the 3rd and 5th graders respectively and found that maternal work is positively related with BMI z-score increase, especially for a family above or at poverty line. For a family with married parents, additional 10 hours of mothers' lagged work significantly increases BMI z-score by 0.019 standard deviations (SD) for 1st to the 3rd grade children and by 0.023 SD for children in 3rd to the 5th grade respectively. For the same family, additional 10 hours of mothers' current work significantly increase BMI z-score by 0.019 SD from the 1st to the 3rd grade and by 0.031 SD from the 3rd to the 5th grade respectively. Similarly, additional 10 hours of mothers' lagged and current work significantly increases their children's likelihood of being obese or overweight by around 0.5 to 1 percentage point. Both lagged and current maternal work does not significantly change BMI z-score and binary health outcomes for a family below poverty line and a family

[7] Detailed results are available in Tables 1 to 4 in Appendix.

with single mother without cohabitants, which is aligned with the previous findings (Anderson et al., 2003).

Fixed effect model to deal with unobservable heterogeneity confirms maternal work effect on BMI z-score.[8] As shown in panel (a) of Figure 2, for a family above or at poverty line living with married parents, additional 10 hours of the lagged maternal work significantly increases BMI z-score by 0.017 standard deviations (SD) from the 1st to the 3rd grade while additional 10 hours of the current maternal work significantly increases BMI z-score by 0.010 SD from the 3rd to the 5th grade. Interestingly, mother's current work from the 1st and 3rd grade and lagged work from the 3rd to the 5th grade lose statistical power. For a family below poverty line and/or a family with single mother, noticeable impacts are not detected. These results imply that negative impact of maternal work on child obesity mainly occurs for families above or at poverty line, which is aligned with the findings in previous studies including Anderson et al. (2003).

[Figure 2 here]

However, when we change our dependent variable from BMI z-score to the other weight-related binary variables, our FE model suggests a somewhat different story. In panel (b) of Figure 2, we find that for families above or at poverty line living with married parents, additional 10 hours of the lagged maternal work decreases probability of being obese by 0.6 percentage points from 3rd to 5th grade, while for families below poverty line living with married parents, additional 10 hours of the lagged and current maternal work increases probability of being obese by 2.2 percentage points and 3.4 percentage points respectively from 3rd to 5th grade. In panel (d) of Figure 2, we also find that for families above or at poverty line, additional 10 hours of the lagged maternal work decreases probability of being underweight by 0.8 percentage points. We

[8] Detailed results are available in Tables 5 to 8 in Appendix.

find no other noticeable estimates in Figure 2. Thus, for married mothers living with husband, risk of being obese of children in families below poverty line is increased by lagged and current maternal work from the 3rd to 5th grade, while most of children are not negatively affected by maternal work. The results for the group of mothers cohabiting with partners are similar to the group of married mothers with husbands.[9]

Finally, we study single mother families without cohabitants.[10] We do not find any statistically significant effect of maternal work on BMI z-score and being obesity. As shown in panel (c) of Figure 3, however, for a family above or at poverty line, additional 10 hours of the current maternal work significantly decrease being overweight by 3.4 percentage points from the 1st to the 3rd grade. Also, as shown in panel (d) of Figure 3, for families below poverty line, additional 10 hours of lagged and present maternal work reduce probability of being underweight by 2.9 percentage points from 1st and 3rd grade and 3.2 percentage points from 3rd to 5th grade respectively. Maternal work positively affects children's health by reducing probability of being overweight and underweight even though it depends on the poverty status and the children's grade.

[Figure 3 here]

In summary, empirical findings using Fixed Effect model suggest that maternal work increases BMI z-score of children[11] but does not increase the risk of being obese, overweight, and underweight of most of children. In particular, our findings suggest that for single mother families, additional income or resources from maternal work may improve children's physical development while lost time and supervision due to maternal work does not negatively affect

[9] Detailed results are available in Tables 5 to 8 in Appendix.
[10] Detailed results are available in Tables 5 to 8 in Appendix.
[11] Readers should be cautious in that using BMI z-score is a limited aggregate measure of child weight related health outcomes because an increase or decrease in BMI z-score of children is not converted into an increase or decrease of weight related health outcomes as a group.

children's health outcomes. Overall, we do not find any deleterious effect of maternal work on children health outcome, except for the 3rd and 5th grade children who live below poverty line with married parents.

2) Instrumental Variable (IV) Model

To correct endogeneity issue, we search for a valid instrumental variable, which is highly correlated with maternal work but not with the error term. We pay attention to several variables which exogenously induce or discourage mother's labor market participation or more work hours without affecting children's health outcome. Table 2 summarizes the potential instrumental variables.

[Table 2 here]

First, we adopt states' lagged and current annual average unemployment rate as IV assuming lower unemployment rate offers mothers more opportunity to participate in labor market. In the first stage regression, mothers' work decision and the number of working hours are significantly correlated with states' unemployment rate.[12] However, we face under-identification problem since unemployment rate affects father's work decision as well as mother's work decision. In addition, even without controlling father's lagged and current work, unemployment rate is not statistically powerful.

As shown in the previous studies that childcare cost is an imperative factor for whether mothers decide to work more or less hours (Ahn, 2012; Forry & Hofferth, 2011), we take state-funded prekindergarten initiative, State Child and Dependent Care Tax Credit (SCADC), and Childcare and Development Block Grant (CCDBG) into consideration. State-funded prekindergarten initiatives are designed not only to provide children at risk with quality early education experience to promote their successful development, but also to meet childcare needs

[12] Detailed results are available in Tables 10 to 11 in Appendix.

of low-income working parents. As of 1998, a total of 42 states invest in state prekindergarten initiatives but, the scope of support (targeting age and hours of operation), per capita funding, and funding per pupil served by the initiative differ from state to state (CDF, 1999). We expect that states with more beneficial programs may induce mother to enter into work or to work more hours before children enter kindergarten. Unlike our expectation, maternal work experience between child birth and children enter kindergarten is not significantly or reversely related with state prekindergarten program, as shown in the first stage regression.[13] This might be due to data limitation (e.g. work experience not employment history), to the insufficient program implementation, or to the substitution effect exceeding the income effect.

We also take state childcare cost subsidy programs such as State Child and Dependent Care Tax Credit (SCADC), and Childcare and Development Fund (CCDF) into account. SCADC program is designed to take some burden off families in paying for employment-related child care and to lessen barriers to labor market participation (Donahue & Campbell, 2002). Like federal Child and Dependent Care Tax Credit (CADC) which provides taxpayers with a tax credit to compensate employment-related childcare expense, several states established SCADC to reduce the amount of state tax owed through credit or deduction (Donahue & Campbell, 2002). As of 2002, 27 states (including District of Columbia) have SCADC income tax provisions but, there are numerous variations among states in terms of benefit types (credit vs. deductions), refundability, and maximum benefit limit.

Similarly, the federal Childcare and Development Fund (CCDF) is used by states to subsidize childcare cost to parents that are entering the labor force or in job training and education programs. While federal law establishes requirements that states must meet to receive CCDF, each state has broad discretion in terms of how the fund will be spent (HHS, 2003). For

[13] Detailed results are available in Table 9 in Appendix.

example, while federal CCDF regulation stipulates that families whose income does not exceed 85 percent of the state median income are eligible for CCDF subsidies, each state has flexibility to set income criteria that restrict eligibility. Further, CCDF requires each state to establish a sliding fee scale that provides for cost sharing by subsidy recipients. We expect that these state variations exogenously affect mother's working decision, as shown in the previous findings that receiving childcare cost subsidy and maternal employment status are closely related with, especially for low-income family (Ahn, 2012; Forry & Hofferth, 2011).

Different from our expectation, the first stage regression results do not show the clear association between subsidy programs and maternal work decision or working hours, leading the second stage regression coefficients to be badly biased. This week IV bias might be due to insufficient program effect. We are suspicious that the benefits of childcare subsidy program were not enough to induce maternal work, that the programs were not fully informed, especially to low-income families, or that the subsidy programs were not totally exogenous. Further study must be followed to explore the true relationship between maternal work and child health outcome.

Discussion and Conclusion

Skyrocketing increase in childhood obesity in the US, over the last few decades, has drawn a lot of attention from researchers and policy makers due to the well-established findings that childhood obesity not only increases the risk of physiological, psychological, and psychosocial problems, but also induces significant amount of rising health care utilization and expenditure. In other words, child obesity is understood as negative human capital that limits children's wellbeing during childhood and consequent adulthood.

One of the several possible causes for the increase in child obesity is maternal employment. The sharp increase (from 47.4% to 71.2%) in labor force participation rate of mothers with children under age 18 between 1974 and 2008 is well aligned with the 3 to 4 fold increase in child obesity during the same time period. Also, family economic production theory elaborates this possible causation arguing that maternal work is predicted to change the allocation of the time and money resources in child supervision and food preparation at home and thus, negatively affects children's weight related health outcomes.

Based on this nicely aligned macro trend and plausible theory, previous studies investigate whether maternal work increases the probability of child obesity and propose possible causal mechanisms to explain this association using micro data that capture information on mothers' work, children's BMI, and other individual/family/household demographic characteristics. They find a positive correlation between maternal work intensity and children's likelihood of being obese only among children in high income families, with a well-educated or white mother. They suggest that children with working mothers have more readymade meals and more sedentary activities including TV watching, and less playing with parents. Recent studies move their focus on how the timing (age of children) and intensity (part time and full time) of maternal work affect childhood obesity.

Assimilating all major arguments from previous studies, our study contributes to the existing literature in several ways. First, the study employs a relatively recent, nationally representative panel survey data, Early Childhood Longitudinal Study-Kindergarten Class of 1998-1999 (ELCS-K), to assess the impact of maternal work on children's health outcomes. We narrow down our focus to elementary school children (1^{st} grade – 5^{th} grade), excluding preschoolers who tend to be in BMI decline and adolescents who tend to be in puberty. Second,

we examine effect of maternal work on children's health outcome across different developmental stages, i.e. 1st - 3rd grade and 3rd - 5th grade, using fixed effect model addressing potential endogeneity problem driven by the individual heterogeneity. Third, in contrast to previous empirical studies, we investigate maternal work on both children's weight change and their likelihood of having a weight problem, using BMI z-score and binary indicators of being obese, overweight, normal, and underweight. Fourth, we took both the contemporaneous and lagged effect of parental work intensity into account to reflect the increasing role of fathers in child rearing and family activities. We conduct three subgroup analyses - mothers living with partners (spouse or cohabitants), married mothers living with husbands, and single mothers without cohabitants. Finally, we attempt to resolve discrepancy over definition of low income family by studying maternal work effect on children weight problem using federal poverty thresholds (adjusted for family size and age of members) each year by census bureau.

Our findings suggest that though maternal work increases child BMI z-score, it does not increase the risk of being obese, overweight, or underweight. Among married mothers living with husband and unmarried mothers cohabiting with partners, except for families under poverty line, most children are not negatively affected by maternal work. For single mother families, maternal work positively affects children's health by reducing the risk of being overweight and underweight. For this group of mothers, it seems that maternal work results in more income and resources to improve children's physical development.

Our findings are not free from several limitations. First, though we use maternal employment status in past four weeks as an indicator of maternal current work, we are not able to fully track maternal work schedule and working history. Second, despite our findings, we are not able to account for why maternal work results in increasing child BMI z-score and for to what

extent increasing BMI z-score might be a bad signal for children health. Further, as a previous study (Burkhauser & Cawley, 2007) points out, BMI measure may not fully explain body fatness. Finally to deal with individual heterogeneity, we use both Fixed Effect model and Instrumental Variable models. Unfortunately, our instrumental variables are marginally correlated with maternal work, exacerbating probable bias. Finding valid instrumental variables to resolve endogeneity issue is one of the prior requirements for the further study.

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Figure 1. Mothers' Labor Force Participation Rate and Obesity Rate 1971-2008

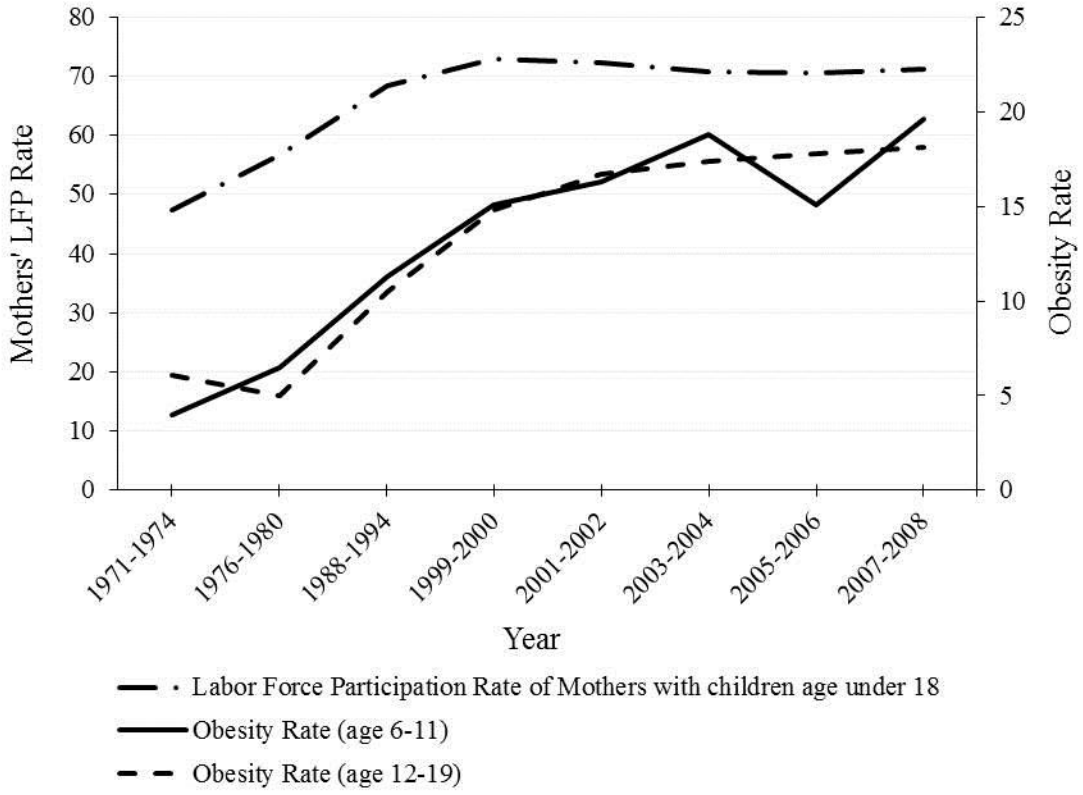
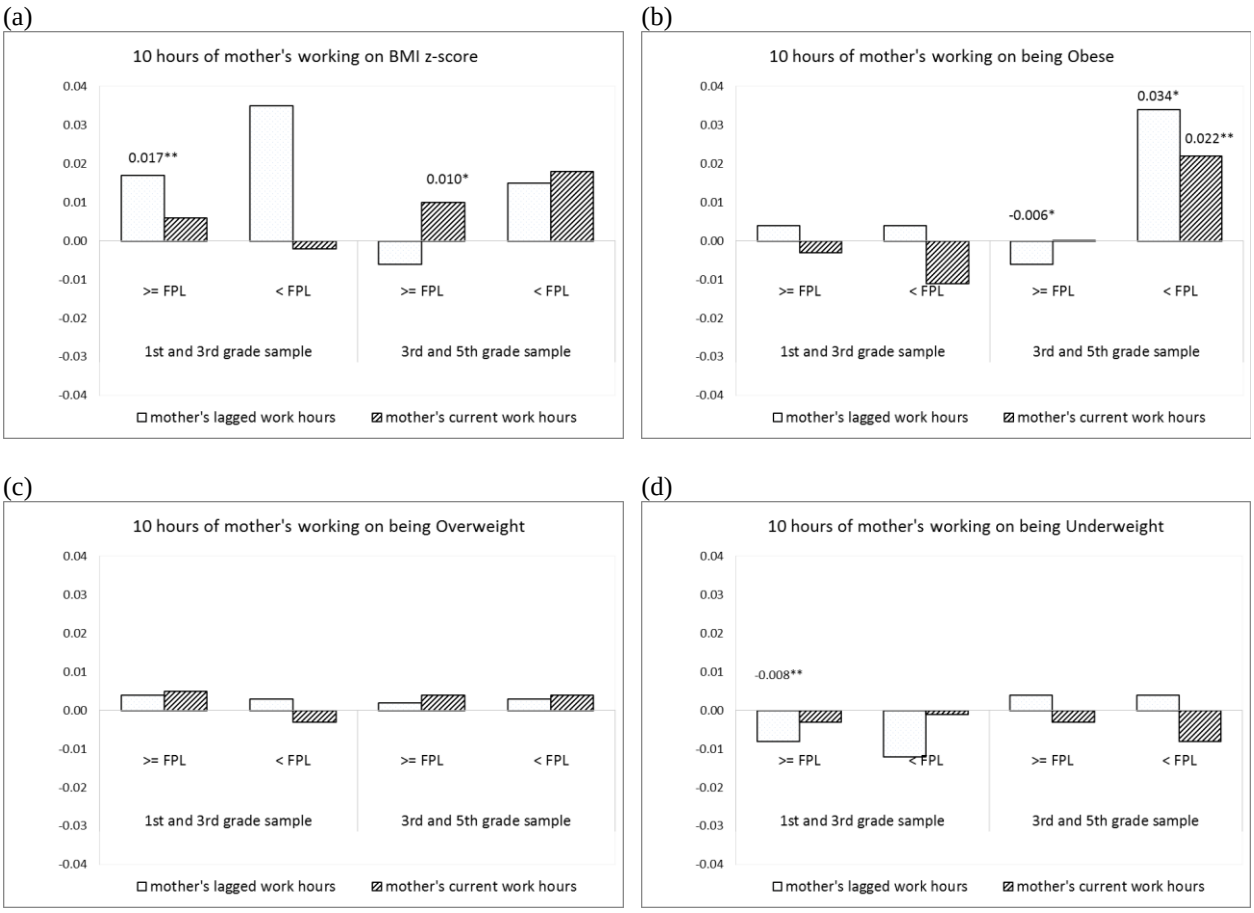


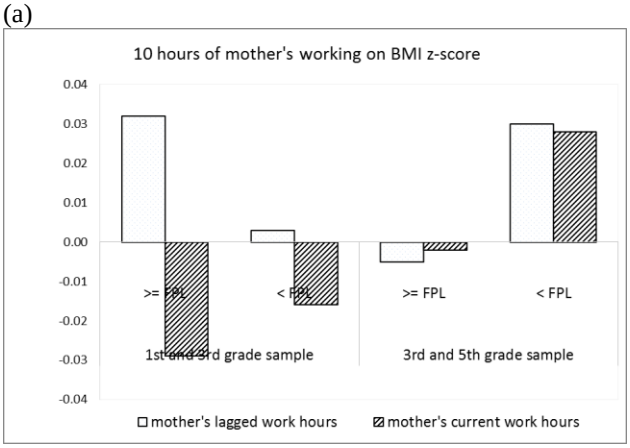
Figure 2. Estimated Impact of Mothers' Work on Children's Weight Problems among married mothers living with husband



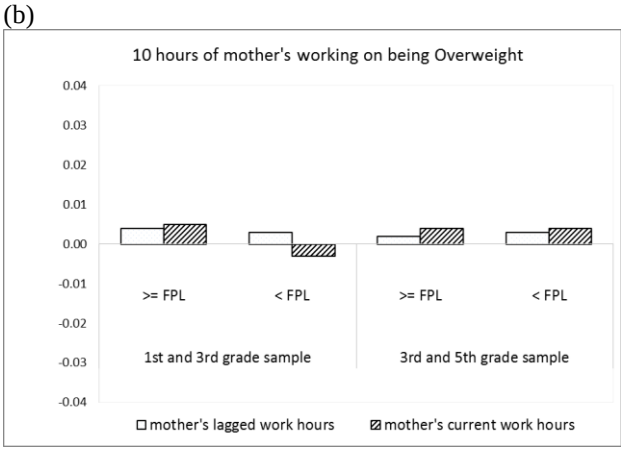
Note) Y-axis in panel (a) indicates the standard deviation of BMI z-score and y-axis in panels (b), (c), and (d) indicates the probability of being obese, overweight, or underweight, respectively.

Figure 3. Estimated Impact of Mothers' Work on Children's Weight Problems among single mothers without cohabitant

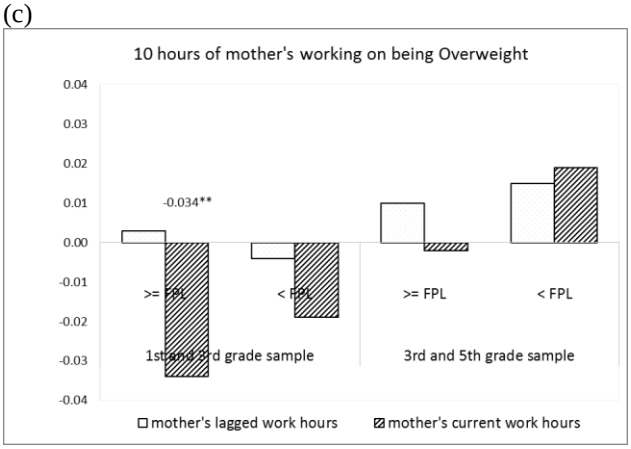
(a)



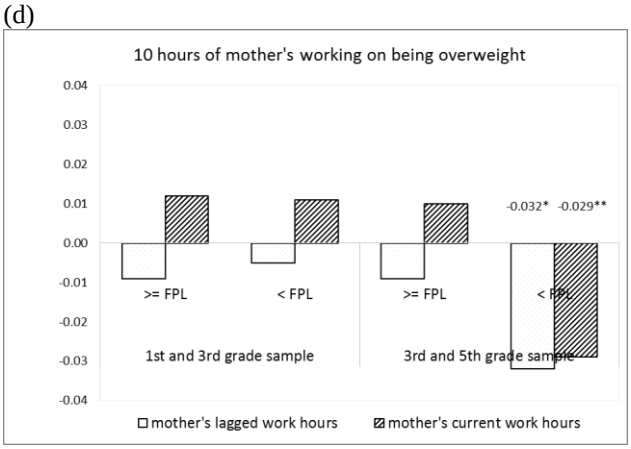
(b)



(c)



(d)



Note) Y-axis in panel (a) indicates the standard deviation of BMI z-score and y-axis in panels (b), (c), and (d) indicates the probability of being obese, overweight, or underweight, respectively.

Table 1. Sample Description

	Full Sample (72-144 mo.)	First Grade (72-96 mo.)	Third Grade (96-120 mo.)	Fifth Grade (120-144 mo.)
Dependent Variable				
Body Mass Index	18.58	16.86	18.57	20.49
BMI z score	0.54	0.39	0.56	0.67
Weight Indicator				
Obese (BMI percentile ≥95th)	17.87%	13.02%	18.54%	22.56%
Overweight (85th ≤BMI percentile <95th)	15.94%	13.50%	16.24%	18.33%
Normal Weight (25th ≤BMI percentile <85th)	52.98%	58.78%	52.38%	47.18%
Underweight (BMI percentile < 25th)	13.21%	14.71%	12.84%	11.93%
Independent Variables				
Mother's Average Work Hours per week (in 10hrs)	2.61	2.49	2.61	2.73
Father's Average Work Hours per week (in 10hrs)	4.41	4.45	4.35	4.42
Control Variables				
Gender				
Male	50.84%	51.05%	51.44%	50.04%
Female	49.16%	48.95%	48.56%	49.96%
Race/Ethnicity				
White	61.73%	61.46%	63.38%	61.46%
Black	13.26%	14.05%	12.29%	13.33%
Hispanic	17.81%	17.60%	17.64%	18.21%
Asian	2.30%	2.38%	2.18%	2.33%
Others	4.56%	4.51%	4.51%	4.67%
Poverty Indicators				
Above or at Poverty Line	80.60%	80.35%	80.94%	80.55%
Below Poverty Line	19.40%	19.65%	19.06%	19.45%
Education Indicators				
Less than High School	11.84%	13.93%	11.70%	9.68%
High School or Equivalent	26.52%	29.69%	25.26%	24.26%
Bachelor's Degree or lesser	52.55%	48.83%	53.49%	55.73%
Graduate School or higher	9.08%	7.54%	9.56%	10.33%
Marital Status Indicators				
Married	72.44%	71.32%	74.63%	71.56%
Single (Separated/Divorced/Widowed/Never Married)	27.56%	28.68%	25.37%	28.44%
Birth Weight (in grams)	3,348	3,347	3,350	3,348
Birth Weight Indicators				
Low Birth Weight (≤ 2500g)	7.91%	7.83%	7.74%	8.17%
Normal Birth Weight (2500g < Weight ≤ 4000g)	80.68%	80.72%	80.82%	80.49%
High Birth Weight (> 4000g)	11.41%	11.45%	11.44%	11.34%
Living with Older Adults (age ≥ 65)	4.35%	3.25%	4.75%	5.19%
Number of Siblings (age < 18)	1.55	1.52	1.57	1.57
Number of Observations	31,930	13,270	10,130	8,530

Notes) Sample weights are applied

Table 2. Potential Instrumental Variable

	Motivation	Instrumented Variable	Potential Instrument Variable (State Variation)
State funded Prekindergarten Initiatives	State investment in (preK aged) childcare	Mother's work experience from child's birth to before Kindergarten	1) Availability (existence of the program) 2) Targeting child age (3-4 yrs. vs. 4 yrs.) 3) Hours of operation (part day vs. full day) 4) State fund per capita in $ 5) State fund per pupil in $ 6) Universal program (existence of universal program)
State Child and Dependent Care Tax Credit (SCADC)	SCADC addresses family's employment-related care needs	Mother's decision on current labor market participation or current working hours	1) Availability (existence of the program) 2) Refundability of SCADC credit 3) Maximum credit in $ for families with two or more children
Child Care and Development Fund (CCDF)	Federal-state cooperated CCDF subsidize childcare service to working or job training parents	Mother's decision on current labor market participation or current working hours	1) Income eligibility (income cutoff as percentage of poverty) 2) Face waiting list (whether a state has a waiting list or frozen intake) 3) Copayment rate for a family of three with income at 100% of poverty (as a percentage of income)

Appendix

Table 1. Child BMI z Score Predicted by Mother's and Father's Work (Pooled OLS regression)

	1st and 3rd grade sample			3rd and 5th grade sample		
	All	Above or At Poverty Line	Below Poverty Line	All	Above or At Poverty Line	Below Poverty Line
Pooled OLS Regression Analysis 1: Mothers Living with Partners [a]						
mother's current work hours per week in 10 hrs	0.021***	0.020***	0.017	0.024***	0.028***	-0.033
	(0.007)	(0.007)	(0.024)	(0.008)	(0.008)	(0.028)
mother's lagged work hours per week in 10 hrs	0.016**	0.018***	-0.007	0.023***	0.023***	0.006
	(0.007)	(0.007)	(0.024)	(0.008)	(0.008)	(0.031)
father's current work hours per week in 10 hrs	-0.002	-0.001	-0.014	-0.005	-0.005	-0.004
	(0.008)	(0.008)	(0.023)	(0.008)	(0.009)	(0.030)
father's lagged work hours per week in 10 hrs	0.009	0.010	0.003	0.001	0.003	-0.012
	(0.008)	(0.009)	(0.023)	(0.009)	(0.009)	(0.030)
Number of observations	14260	13470	790	11400	10900	500
R^2	0.035	0.034	0.055	0.041	0.039	0.092
Adjusted R^2	0.033	0.032	0.032	0.039	0.037	0.056
Pooled OLS Regression Analysis 2: Married Mothers Living with Husbands						
mother's current work hours per week in 10 hrs	0.019***	0.019***	0.012	0.028***	0.031***	-0.012
	(0.007)	(0.007)	(0.026)	(0.008)	(0.008)	(0.035)
mother's lagged work hours per week in 10 hrs	0.019***	0.019***	0.017	0.024***	0.023***	0.035
	(0.007)	(0.007)	(0.026)	(0.008)	(0.008)	(0.036)
father's current work hours per week in 10 hrs	-0.000	0.000	-0.011	-0.005	-0.005	0.003
	(0.008)	(0.008)	(0.026)	(0.009)	(0.009)	(0.034)
father's lagged work hours per week in 10 hrs	0.007	0.007	0.004	0.002	0.002	0.003
	(0.008)	(0.009)	(0.026)	(0.009)	(0.010)	(0.038)
Number of observations	13730	13050	680	10770	10390	380
R^2	0.034	0.033	0.055	0.041	0.038	0.092
Adjusted R^2	0.033	0.032	0.032	0.039	0.036	0.056
Pooled OLS Regression Analysis 3:						

Single Mothers without Partners

mother's current work hours per week in 10 hrs	0.014	0.004	0.018	0.003	-0.001	0.008
	(0.016)	(0.024)	(0.020)	(0.023)	(0.033)	(0.031)
mother's lagged work hours per week in 10 hrs	0.032**	0.056**	0.017	0.034	0.048	0.034
	(0.016)	(0.025)	(0.021)	(0.023)	(0.033)	(0.031)
Number of observations	2260	1350	920	1260	790	470
R^2	0.022	0.029	0.037	0.021	0.039	0.067
Adjusted R^2	0.014	0.017	0.019	0.007	0.018	0.031

a. Married and unmarried mothers with partners

Note) *** p<.01, ** p<.05, * p<.1

Note) Control variables include child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of high school, bachelor's degree or less, graduate degree or above), child's birth weight (dummies of low birth weight (<2.5kg) and high birth weight (>4.0kg)), living with older adults (dummy for living with adults age>=65), and number of siblings age under 3yrs, 3-7yrs, 7yrs or more.

Table 2. Child Obesity Predicted by Mother's and Father's Work (Pooled OLS regression)

	1st and 3rd grade sample			3rd and 5th grade sample		
	All	Above or At Poverty Line	Below Poverty Line	All	Above or At Poverty Line	Below Poverty Line
Pooled OLS Regression Analysis 1: Mothers Living with Partners						
mother's current work hours per week in 10 hrs	0.004*	0.004*	0.001	0.002	0.002	-0.013
	(0.002)	(0.002)	(0.008)	(0.003)	(0.003)	(0.011)
mother's lagged work hours per week in 10 hrs	0.004*	0.005**	-0.008	0.010***	0.009***	0.011
	(0.002)	(0.002)	(0.008)	(0.003)	(0.003)	(0.012)
father's current work hours per week in 10 hrs	-0.001	-0.001	-0.001	-0.001	0.000	-0.012
	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.012)
father's lagged work hours per week in 10 hrs	0.000	0.001	-0.006	-0.005	-0.004	-0.012
	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.012)
Number of observations	14260	13470	790	11400	10900	500
R^2	0.019	0.019	0.053	0.024	0.023	0.071
Adjusted R^2	0.018	0.018	0.029	0.022	0.021	0.034
Pooled OLS Regression Analysis 2: Married Mothers Living with Husbands						
mother's current work hours per week in 10 hrs	0.004*	0.003	0.001	0.003	0.003	-0.001
	(0.002)	(0.002)	(0.009)	(0.003)	(0.003)	(0.013)
mother's lagged work hours per week in 10 hrs	0.004**	0.005**	-0.007	0.010***	0.010***	0.013
	(0.002)	(0.002)	(0.009)	(0.003)	(0.003)	(0.014)
father's current work hours per week in 10 hrs	-0.001	-0.001	0.002	-0.000	0.000	-0.009
	(0.003)	(0.003)	(0.009)	(0.003)	(0.003)	(0.013)
father's lagged work hours per week in 10 hrs	0.001	0.001	-0.003	-0.005	-0.005	-0.006
	(0.003)	(0.003)	(0.009)	(0.003)	(0.003)	(0.014)
Number of observations	13730	13050	680	10770	10390	380
R^2	0.018	0.018	0.053	0.022	0.021	0.071
Adjusted R^2	0.017	0.017	0.029	0.020	0.019	0.034
Pooled OLS Regression Analysis 3: Single Mothers without Partners						
mother's current work hours per week in 10 hrs	0.001	-0.004	0.004	0.008	0.016	-0.002

	(0.006)	(0.009)	(0.007)	(0.009)	(0.012)	(0.012)
mother's lagged work hours per week in 10 hrs	0.007	0.009	0.006	0.006	0.006	0.012
	(0.006)	(0.009)	(0.007)	(0.009)	(0.012)	(0.012)
Number of observations	2260	1350	920	1260	790	470
R^2	0.014	0.026	0.019	0.020	0.033	0.061
Adjusted R^2	0.006	0.014	0.000	0.006	0.012	0.025

Note) *** p<.01, ** p<.05, * p<.1

Note) Control variables include child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of high school, bachelor's degree or less, graduate degree or above), child's birth weight (dummies of low birth weight (<2.5kg) and high birth weight (>4.0kg)), living with older adults (dummy for living with adults age>=65), and number of siblings age under 3yrs, 3-7yrs, 7yrs or more.

Table 3. Child Risk Obesity Predicted by Mother's and Father's Work (Pooled OLS regression)

	1st and 3rd grade sample			3rd and 5th grade sample		
	All	Above or At Poverty Line	Below Poverty Line	All	Above or At Poverty Line	Below Poverty Line
Pooled OLS Regression Analysis 1: Mothers Living with Partners						
mother's current work hours per week in 10 hrs	0.007**	0.006**	0.010	0.008**	0.009**	-0.008
	(0.003)	(0.003)	(0.011)	(0.003)	(0.004)	(0.014)
mother's lagged work hours per week in 10 hrs	0.005*	0.007**	-0.016	0.009***	0.010***	-0.009
	(0.003)	(0.003)	(0.011)	(0.003)	(0.003)	(0.014)
father's current work hours per week in 10 hrs	-0.001	-0.001	-0.001	-0.002	-0.001	-0.007
	(0.003)	(0.003)	(0.010)	(0.004)	(0.004)	(0.013)
father's lagged work hours per week in 10 hrs	0.001	0.001	-0.005	-0.004	-0.004	-0.012
	(0.003)	(0.004)	(0.010)	(0.004)	(0.004)	(0.013)
Number of observations	14260	13470	790	11400	10900	497
R^2	0.023	0.023	0.039	0.029	0.028	0.065
Adjusted R^2	0.022	0.022	0.016	0.027	0.026	0.028
Pooled OLS Regression Analysis 2: Married Mothers Living with Husbands						
mother's current work hours per week in 10 hrs	0.007**	0.006*	0.010	0.009***	0.010***	-0.001
	(0.003)	(0.003)	(0.012)	(0.004)	(0.004)	(0.016)
mother's lagged work hours per week in 10 hrs	0.006**	0.007**	-0.011	0.010***	0.010***	-0.003
	(0.003)	(0.003)	(0.012)	(0.004)	(0.004)	(0.016)
father's current work hours per week in 10 hrs	-0.000	-0.000	0.001	-0.002	-0.002	-0.002
	(0.003)	(0.003)	(0.011)	(0.004)	(0.004)	(0.015)
father's lagged work hours per week in 10 hrs	0.000	0.000	-0.005	-0.003	-0.002	-0.013
	(0.003)	(0.004)	(0.011)	(0.004)	(0.004)	(0.015)
Number of observations	13730	13050	680	10770	10390	380
R^2	0.022	0.022	0.039	0.028	0.026	0.065
Adjusted R^2	0.021	0.021	0.016	0.026	0.024	0.028
Pooled OLS Regression Analysis 3: Single Mothers without Partners						
mother's current work hours per week in 10 hrs	0.003	-0.008	0.008	0.001	-0.006	0.008

	(0.007)	(0.011)	(0.009)	(0.006)	(0.016)	(0.014)
mother's lagged work hours per week in 10 hrs	0.016**	0.021**	0.013	0.007	0.024	0.016
	(0.007)	(0.011)	(0.009)	(0.006)	(0.015)	(0.014)
Number of observations	2260	1350	920	2260	790	470
R^2	0.019	0.030	0.026	0.014	0.035	0.078
Adjusted R^2	0.011	0.017	0.008	0.006	0.013	0.043

Note) *** p<.01, ** p<.05, * p<.1

Note) Control variables include child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of high school, bachelor's degree or less, graduate degree or above), child's birth weight (dummies of low birth weight (<2.5kg) and high birth weight (>4.0kg)), living with older adults (dummy for living with adults age>=65), and number of siblings age under 3yrs, 3-7yrs, 7yrs or more.

Table 4. Child Underweight Predicted by Mother's and Father's Work (Pooled OLS regression)

	1st and 3rd grade sample			3rd and 5th grade sample		
	All	Above or At Poverty Line	Below Poverty Line	All	Above or At Poverty Line	Below Poverty Line
Pooled OLS Regression Analysis 1: Mothers Living with Partners						
mother's current work hours per week in 10 hrs	-0.004*	-0.004*	-0.003	-0.008***	-0.009***	0.010
	(0.002)	(0.002)	(0.007)	(0.002)	(0.003)	(0.009)
mother's lagged work hours per week in 10 hrs	-0.003	-0.002	-0.004	-0.003	-0.002	-0.009
	(0.002)	(0.002)	(0.008)	(0.002)	(0.002)	(0.009)
father's current work hours per week in 10 hrs	-0.000	0.000	0.002	0.002	0.003	-0.010
	(0.003)	(0.003)	(0.007)	(0.003)	(0.003)	(0.009)
father's lagged work hours per week in 10 hrs	-0.004	-0.004	0.003	-0.005*	-0.005*	-0.002
	(0.003)	(0.003)	(0.006)	(0.003)	(0.003)	(0.009)
Number of observations	14260	13470	790	11400	10900	500
R^2	0.014	0.014	0.047	0.016	0.015	0.090
Adjusted R^2	0.013	0.012	0.023	0.014	0.014	0.053
Pooled OLS Regression Analysis 2: Married Mothers Living with Husbands						
mother's current work hours per week in 10 hrs	-0.003	-0.004	-0.001	-0.008***	-0.009***	-0.002
	(0.002)	(0.002)	(0.008)	(0.003)	(0.003)	(0.011)
mother's lagged work hours per week in 10 hrs	-0.003	-0.002	-0.011	-0.003	-0.002	-0.016
	(0.002)	(0.002)	(0.008)	(0.002)	(0.003)	(0.011)
father's current work hours per week in 10 hrs	-0.000	-0.000	-0.000	-0.002	-0.003	-0.012
	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.010)
father's lagged work hours per week in 10 hrs	-0.003	-0.004	-0.005	-0.005*	-0.005	-0.008
	(0.003)	(0.003)	(0.007)	(0.003)	(0.003)	(0.010)
Number of observations	13730	13050	680	10770	10390	380
R^2	0.014	0.014	0.047	0.018	0.016	0.090
Adjusted R^2	0.013	0.012	0.023	0.016	0.014	0.053
Pooled OLS Regression Analysis 3: Single Mothers without Partners						
mother's current work hours per week in 10 hrs	-0.005	-0.008	-0.002	-0.006	-0.004	-0.007

	(0.005)	(0.007)	(0.006)	(0.007)	(0.009)	(0.010)
mother's lagged work hours per week in 10 hrs	-0.005	-0.011	-0.001	-0.012*	-0.012	-0.013
	(0.005)	(0.007)	(0.007)	(0.007)	(0.010)	(0.010)
Number of observations	2260	1350	920	1260	790	470
R^2	0.019	0.022	0.032	0.016	0.026	0.023
Adjusted R^2	0.011	0.010	0.013	0.002	0.005	-0.014

Note) *** p<.01, ** p<.05, * p<.1

Note) Control variables include child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of high school, bachelor's degree or less, graduate degree or above), child's birth weight (dummies of low birth weight (<2.5kg) and high birth weight (>4.0kg)), living with older adults (dummy for living with adults age>=65), and number of siblings age under 3yrs, 3-7yrs, 7yrs or more.

Table 5. Child BMI z Score Predicted by Mother's and Father's Work (Fixed Effect Model)

	1st and 3rd grade sample			3rd and 5th grade sample		
	All	Above or At Poverty Line	Below Poverty Line	All	Above or At Poverty Line	Below Poverty Line
FE model Regression Analysis 1: Mothers Living with Partners[a]						
mother's current work hours per week in 10 hrs	0.006	0.005	0.004	0.010*	0.011*	0.011
	(0.006)	(0.006)	(0.021)	(0.005)	(0.006)	(0.021)
mother's lagged work hours per week in 10 hrs	0.014**	0.016**	0.004	-0.004	-0.005	0.010
	(0.007)	(0.007)	(0.037)	(0.006)	(0.006)	(0.021)
father's current work hours per week in 10 hrs	0.000	-0.001	0.009	0.001	-0.001	0.044
	(0.007)	(0.007)	(0.028)	(0.006)	(0.006)	(0.028)
father's lagged work hours per week in 10 hrs	0.007	0.009	-0.013	0.010	0.008	0.031*
	(0.007)	(0.008)	(0.022)	(0.006)	(0.007)	(0.018)
Number of observations	14260	13470	790	11400	10900	790
Number of groups	8550	8010	540	6710	6370	540
R^2 (within)	0.057	0.057	0.085	0.011	0.009	0.125
Adjusted R^2 (within)	0.056	0.056	0.069	0.009	0.008	0.103
FE model Regression Analysis 2: Married Mothers Living with Husbands						
mother's current work hours per week in 10 hrs	0.005	0.006	-0.002	0.009*	0.010*	0.018
	(0.006)	(0.006)	(0.023)	(0.006)	(0.006)	(0.025)
mother's lagged work hours per week in 10 hrs	0.017**	0.017**	0.035	-0.005	-0.006	0.015
	(0.007)	(0.007)	(0.037)	(0.006)	(0.006)	(0.023)
father's current work hours per week in 10 hrs	-0.002	-0.002	-0.004	0.001	-0.001	0.046
	(0.007)	(0.007)	(0.026)	(0.007)	(0.007)	(0.032)
father's lagged work hours per week in 10 hrs	0.006	0.008	-0.014	0.009	0.007	0.043*
	(0.007)	(0.008)	(0.021)	(0.007)	(0.007)	(0.026)
Number of observations	13730	13050	680	10770	10390	380
Number of groups	8170	7700	470	6280	6030	250
R^2 (within)	0.057	0.056	0.105	0.010	0.009	0.134
Adjusted R^2 (within)	0.056	0.055	0.087	0.009	0.007	0.108
FE model Regression Analysis 3:						

Single Mothers without Partners

mother's current work hours per week in 10 hrs	-0.020	-0.029	-0.016	0.006	-0.002	0.028
	(0.016)	(0.021)	(0.024)	(0.017)	(0.018)	(0.032)
mother's lagged work hours per week in 10 hrs	0.015	0.032	0.003	0.016	-0.005	0.030
	(0.016)	(0.025)	(0.020)	(0.026)	(0.023)	(0.042)
Number of observations	2260	1350	920	1260	790	470
Number of groups	1610	940	670	850	520	320
R^2 (within)	0.079	0.095	0.070	0.071	0.050	0.181
Adjusted R^2 (within)	0.074	0.087	0.060	0.063	0.036	0.163

Note) *** p<.01, ** p<.05, * p<.1

Note) Control variables include child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of high school, bachelor's degree or less, graduate degree or above), child's birth weight (dummies of low birth weight (<2.5kg) and high birth weight (>4.0kg)), living with older adults (dummy for living with adults age>=65), and number of siblings age under 3yrs, 3-7yrs, 7yrs or more.

Table 6. Child Obesity Predicted by Mother's and Father's Work (Fixed Effect Model)

	1st and 3rd grade sample			3rd and 5th grade sample		
	All	Above or At Poverty Line	Below Poverty Line	All	Above or At Poverty Line	Below Poverty Line
FE model Regression Analysis 1: Mothers Living with Partners						
mother's current work hours per week in 10 hrs	-0.003	-0.002	-0.011	-0.001	-0.001	0.025**
	(0.003)	(0.003)	(0.010)	(0.003)	(0.003)	(0.011)
mother's lagged work hours per week in 10 hrs	0.003	0.003	-0.004	-0.005	-0.007**	0.044**
	(0.003)	(0.003)	(0.007)	(0.003)	(0.003)	(0.017)
father's current work hours per week in 10 hrs	0.002	0.003	-0.019**	-0.004	-0.003	-0.004
	(0.003)	(0.003)	(0.010)	(0.003)	(0.003)	(0.010)
father's lagged work hours per week in 10 hrs	0.003	0.008**	-0.040***	0.001	0.001	0.001
	(0.004)	(0.004)	(0.012)	(0.003)	(0.003)	(0.010)
Number of observations	14260	13470	790	11400	10900	790
Number of groups	8550	8010	540	6710	6370	540
R^2 (within)	0.035	0.036	0.126	0.011	0.011	0.114
Adjusted R^2 (within)	0.034	0.035	0.111	0.010	0.010	0.092
FE model Regression Analysis 2: Married Mothers Living with Husbands						
mother's current work hours per week in 10 hrs	-0.003	-0.003	-0.011	0.000	-0.000	0.022**
	(0.003)	(0.003)	(0.011)	(0.003)	(0.003)	(0.011)
mother's lagged work hours per week in 10 hrs	0.003	0.004	0.004	-0.004	-0.006*	0.034*
	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.018)
father's current work hours per week in 10 hrs	0.002	0.004	-0.023**	-0.003	-0.002	-0.007
	(0.003)	(0.003)	(0.011)	(0.003)	(0.003)	(0.010)
father's lagged work hours per week in 10 hrs	0.004	0.008**	-0.042***	-0.000	0.000	-0.006
	(0.004)	(0.004)	(0.014)	(0.003)	(0.004)	(0.007)
Number of observations	13730	13050	680	10770	10390	380
Number of groups	8170	7700	470	6280	6030	250
R^2 (within)	0.035	0.036	0.134	0.009	0.009	0.093
Adjusted R^2 (within)	0.034	0.035	0.117	0.008	0.008	0.066
FE model Regression Analysis 3: Single Mothers without Partners						

mother's current work hours per week in 10 hrs	-0.016*	-0.010	-0.019	-0.004	0.000	-0.010
	(0.008)	(0.010)	(0.012)	(0.006)	(0.004)	(0.014)
mother's lagged work hours per week in 10 hrs	0.008	0.019	0.001	-0.001	-0.003	-0.005
	(0.011)	(0.016)	(0.015)	(0.012)	(0.011)	(0.019)
Number of observations	2260	1350	920	1260	790	470
Number of groups	1610	940	670	850	520	320
R^2 (within)	0.061	0.075	0.061	0.040	0.055	0.142
Adjusted R^2 (within)	0.056	0.067	0.050	0.032	0.042	0.124

Note) *** p<.01, ** p<.05, * p<.1

Note) Control variables include child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of high school, bachelor's degree or less, graduate degree or above), child's birth weight (dummies of low birth weight (<2.5kg) and high birth weight (>4.0kg)), living with older adults (dummy for living with adults age>=65), and number of siblings age under 3yrs, 3-7yrs, 7yrs or more.

Table 7. Child Risk Obesity Predicted by Mother's and Father's Work (Fixed Effect Model)

	1st and 3rd grade sample			3rd and 5th grade sample		
	All	Above or At Poverty Line	Below Poverty Line	All	Above or At Poverty Line	Below Poverty Line
FE Model Regression Analysis 1: Mothers Living with Partners						
mother's current work hours per week in 10 hrs	0.005	0.005	0.003	0.002	0.003	-0.001
	(0.003)	(0.003)	(0.011)	(0.004)	(0.004)	(0.012)
mother's lagged work hours per week in 10 hrs	0.004	0.004	0.007	0.001	0.001	-0.003
	(0.003)	(0.004)	(0.016)	(0.004)	(0.004)	(0.011)
father's current work hours per week in 10 hrs	0.003	0.003	-0.001	-0.008**	-0.009**	0.004
	(0.004)	(0.004)	(0.013)	(0.004)	(0.004)	(0.015)
father's lagged work hours per week in 10 hrs	0.001	0.001	-0.003	-0.010**	-0.011***	0.003
	(0.004)	(0.004)	(0.014)	(0.004)	(0.004)	(0.012)
Number of observations	14260	13470	790	11400	10900	790
Number of groups	8550	8010	540	6710	6370	540
R^2 (within)	0.047	0.047	0.084	0.019	0.018	0.085
Adjusted R^2 (within)	0.046	0.046	0.069	0.017	0.017	0.062
FE Model Regression Analysis 2: Married Mothers Living with Husbands						
mother's current work hours per week in 10 hrs	0.004	0.005	-0.003	0.004	0.004	0.004
	(0.003)	(0.003)	(0.013)	(0.004)	(0.004)	(0.014)
mother's lagged work hours per week in 10 hrs	0.003	0.004	0.003	0.002	0.002	0.003
	(0.004)	(0.004)	(0.019)	(0.004)	(0.004)	(0.013)
father's current work hours per week in 10 hrs	0.002	0.002	0.009	-0.008**	-0.009**	0.002
	(0.004)	(0.004)	(0.015)	(0.004)	(0.004)	(0.020)
father's lagged work hours per week in 10 hrs	0.000	0.000	0.005	-0.008**	-0.009**	0.009
	(0.004)	(0.005)	(0.015)	(0.004)	(0.004)	(0.017)
Number of observations	13730	13050	680	10770	10390	380
Number of groups	8170	7700	470	6280	6030	250
R^2 (within)	0.047	0.047	0.095	0.019	0.018	0.097
Adjusted R^2 (within)	0.046	0.046	0.077	0.017	0.016	0.070
FE Model Regression Analysis 3: Single Mothers without Partners						

mother's current work hours per week in 10 hrs	-0.024**	-0.034**	-0.019	-0.016*	-0.002	0.019
	(0.010)	(0.014)	(0.016)	(0.008)	(0.018)	(0.016)
mother's lagged work hours per week in 10 hrs	-0.001	0.003	-0.004	0.008	0.010	0.015
	(0.009)	(0.014)	(0.013)	(0.011)	(0.019)	(0.019)
Number of observations	2260	1350	920	1260	790	470
Number of groups	1610	940	670	850	520	320
R^2 (within)	0.075	0.096	0.076	0.061	0.023	0.085
Adjusted R^2 (within)	0.070	0.089	0.065	0.056	0.010	0.065

Note) *** p<.01, ** p<.05, * p<.1

Note) Control variables include child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of high school, bachelor's degree or less, graduate degree or above), child's birth weight (dummies of low birth weight (<2.5kg) and high birth weight (>4.0kg)), living with older adults (dummy for living with adults age>=65), and number of siblings age under 3yrs, 3-7yrs, 7yrs or more.

Table 8. Child Underweight Predicted by Mother's and Father's Work (Fixed Effect Model)

	1st and 3rd grade sample			3rd and 5th grade sample		
	All	Above or At Poverty Line	Below Poverty Line	All	Above or At Poverty Line	Below Poverty Line
FE Model Regression Analysis 1: Mothers Living with Partners						
mother's current work hours per week in 10 hrs	-0.004	-0.004	-0.002	-0.002	-0.002	-0.011
	(0.003)	(0.003)	(0.011)	(0.003)	(0.003)	(0.010)
mother's lagged work hours per week in 10 hrs	-0.008**	-0.008**	-0.002	-0.004	-0.004	-0.006
	(0.003)	(0.003)	(0.014)	(0.003)	(0.003)	(0.007)
father's current work hours per week in 10 hrs	-0.004	-0.006	-0.009	-0.001	-0.002	-0.011
	(0.004)	(0.004)	(0.012)	(0.003)	(0.003)	(0.009)
father's lagged work hours per week in 10 hrs	-0.001	-0.001	-0.001	-0.006*	-0.006	-0.009
	0.004	0.004	0.002	(0.004)	(0.004)	(0.015)
Number of observations	14260	13470	790	11400	10900	790
Number of groups	8550	8010	540	6710	6370	540
R^2 (within)	0.006	0.006	0.060	0.003	0.003	0.017
Adjusted R^2 (within)	0.005	0.005	0.044	0.002	0.002	-0.007
FE Model Regression Analysis 2: Married Mothers Living with Husbands						
mother's current work hours per week in 10 hrs	-0.003	-0.003	-0.001	-0.003	-0.003	-0.008
	(0.003)	(0.003)	(0.012)	(0.003)	(0.003)	(0.012)
mother's lagged work hours per week in 10 hrs	-0.008**	-0.008**	-0.012	0.004	0.004	0.004
	(0.003)	(0.004)	(0.012)	(0.003)	(0.004)	(0.007)
father's current work hours per week in 10 hrs	-0.004	-0.005	-0.008	0.002	0.002	-0.003
	(0.004)	(0.004)	(0.012)	(0.003)	(0.003)	(0.010)
father's lagged work hours per week in 10 hrs	-0.001	-0.001	-0.004	-0.004	-0.005	-0.008
	(0.004)	(0.004)	(0.011)	(0.004)	(0.004)	(0.017)
Number of observations	13730	13050	680	10770	10390	380
Number of groups	8170	7700	470	6280	6030	250
R^2 (within)	0.006	0.006	0.040	0.003	0.004	0.015
Adjusted R^2 (within)	0.005	0.005	0.022	0.002	0.002	-0.014
FE Model Regression Analysis 3: Single Mothers without Partners						

mother's current work hours per week in 10 hrs	0.010	0.012	0.011	-0.006	0.010	-0.029*
	(0.009)	(0.011)	(0.013)	(0.008)	(0.010)	(0.015)
mother's lagged work hours per week in 10 hrs	0.000	-0.009	-0.005	-0.014	-0.009	-0.032**
	(0.007)	(0.012)	(0.009)	(0.011)	(0.016)	(0.016)
Number of observations	2260	1350	920	1260	790	470
Number of groups	1610	940	670	850	520	320
R^2 (within)	0.016	0.036	0.019	0.029	0.042	0.111
Adjusted R^2 (within)	0.012	0.028	0.009	0.020	0.028	0.091

Note) *** p<.01, ** p<.05, * p<.1

Note) Control variables include child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of high school, bachelor's degree or less, graduate degree or above), child's birth weight (dummies of low birth weight (<2.5kg) and high birth weight (>4.0kg)), living with older adults (dummy for living with adults age>=65), and number of siblings age under 3yrs, 3-7yrs, 7yrs or more.

Table 9. Potential Instrument Variable for mothers' work experience before Kindergarten and first stage regression result

			Model for mothers' work experience (before Kindergarten)						
			Model1	Model2	Model3	Model 4	Model 5	Model 6	Model 7
State funded Prekindergarten initiative	Availability	Availability	-0.012 (0.019)						
	Hours of operation	Part Day		-0.018 (0.019)					
		Full Day		0.013 (0.023)					
	Targeting child age	4yrs only			-0.014 (0.021)				
		3~4yrs			-0.009 (0.021)				
	Policy combination	Part Day 4yrs only				-0.020 (0.021)			
		Part Day 3-4yrs				-0.014 (0.022)			
		Full Day 4yrs only				0.020 (0.027)			
		Full Day 3~4yrs				0.006 (0.027)			
	Fund per capita	$0 ~ $20					-0.063***		
							(0.021)		
		$20 ~ $100					-0.013		
							(0.015)		
		≥ $100					-0.033		
							(0.020)		
	Fund per pupil	< $3000						-0.042**	
								(0.018)	
		≥ $3000						-0.023	
								(0.015)	
	Universal program	Availability							0.023
									(0.025)

Note) *** p<.01, ** p<.05, * p<.1

Note) Control variables include child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of high school, bachelor's degree or less, graduate degree or above), child's birth weight (dummies of low birth weight (<2.5kg) and high birth weight (>4.0kg)), living with older adults (dummy for living with adults age>=65), and number of siblings age under 3yrs, 3-7yrs, 7yrs or more.

Table 10. Potential Instrument Variable for mothers' current work decision and first stage regression result

		Mothers' work decision								
		Model1 (2000)	Model 2 (2002)	Model 3 (2004)	Model 4 (2000)	Model 5 (2002)	Model 6 (2004)	Model 7 (2000)	Model 8 (2002)	Model 9 (2004)
Unemployment Rate	Unemployment Rate	-0.026**	-0.024**	-0.001***						
		(0.011)	(0.010)	(0.000)						
State Child and Dependent Care Tax Credit (SCADC)	Availability	-0.026	-0.033	0.018						
		(0.023)	(0.025)	(0.030)						
	Refundable				-0.009	0.011	-0.037			
					(0.028)	(0.026)	(0.035)			
	Max credit							NA	-0.000	0.000
								NA	(0.000)	(0.000)
Childcare and Development Fund (CCDF)	Income eligibility	0.008	0.002	0.056						
		(0.023)	(0.027)	(0.042)						
	Waiting list (dummy)				0.012	0.030	-0.026			
					(0.019)	(0.022)	(0.028)			
	Yearly copayment rate							NA	0.240	0.639
								NA	(0.305)	(0.461)

Note) *** p<.01, ** p<.05, * p<.1

Note) Control variables include child's gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others), mother's education (dummies of high school, bachelor's degree or less, graduate degree or above), child's birth weight (dummies of low birth weight (<2.5kg) and high birth weight (>4.0kg)), living with older adults (dummy for living with adults age>=65), and number of siblings age under 3yrs, 3-7yrs, 7yrs or more.

Table 11. Potential Instrument Variable for mothers' current work hours and first stage regression result

		Mothers' current work hour in 10hrs								
		Model1 (2000)	Model 2 (2002)	Model 3 (2004)	Model 4 (2000)	Model 5 (2002)	Model 6 (2004)	Model 7 (2000)	Model 8 (2002)	Model 9 (2004)
Unemployment Rate	Unemployment Rate	-0.104	-0.143***	-0.008***						
		(0.066)	(0.043)	(0.002)						
State Child and Dependent Care Tax Credit (SCADC)	Availability	-0.134	-0.135	0.069						
		(0.100)	(0.097)	(0.119)						
	Refundable				-0.032	0.059	-0.012			
					(0.103)	(0.098)	(0.141)			
	Max credit							NA	-0.000	0.000
								NA	(0.000)	(0.000)
Childcare and Development Fund (CCDF)	Income eligibility	0.119	0.058	0.162						
		(0.132)	(0.111)	(0.163)						
	Waiting list (dummy)				-0.026	0.111	-0.233**			
					(0.101)	(0.083)	(0.111)			
	Yearly copayment rate							NA	-0.006	4.732**
								NA	(1.358)	(1.852)

note: *** p<.01, ** p<.05, * p<.1

note: Control variables include children gender, race/ethnicity (dummies of Black, Hispanic, Asian, and Others),birthweight (dummies of low birthweight (<2.5kg) and high birthweight (>4.0kg)), mother's education (dummies of Highschool, some college or more), marital status dummy, poverty indicator dummy, whether living with old adults (dummy of living with adults age >= 65), and number of siblings age under 3yrs, 3-7 yrs, 7yrs or more.