THREE ESSAYS IN HEALTH ECONOMICS AND LABOR ECONOMICS

by

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A Dissertation

Submitted to the University at Albany, State University of New York

in Partial Fulfillment of

the Requirements for the Degree of

Doctor of Philosophy

College of Arts & Sciences

Department of Economics

2013

Acknowledgements

My dissertation is dedicated to my parents, Yulan Li and Tianfa Li, and my beautiful wife, Linsey Li. Without your love and support, I wouldn't have been able to finish this journey. All of you make my life so much more meaningful and enjoyable.

I thank my advisor, Professor Pinka Chatterji, for her guidance and help through ups and downs. I thank Professor Gerald Marschke for his guidance and support, especially during my difficult times. I thank Professor Baris Yoruk for his comments and help. And finally, I thank Professor Michael Jerison for his comments and support. I am grateful to have all of them as my professors and the first three of them as my committee.

I thank National Science Foundation (NSF) to allow me to use the Survey of Doctorate Recipients (SDR) data, and National Institute of Child Health and Human Development (NICHD) to allow me to use Study of Early Child Care (SECC) data.

Abstract

There are three essays in this dissertation. The first two explore the effect of maternal employment on family well being. The third essay explores the effect of academic department quality on publication productivity.

The purpose of Essay One is to explore the effect of the timing of maternal employment on childhood and adolescence overweight and obesity, and examine the possible mechanisms, such as diet, physical activity, and TV viewing, using longitudinal data from the NICHD Study on Early Child Care (SECC). The baseline LPM results show that maternal employment during elementary school increases the probability of childhood and adolescent obesity by 12-15%. After controlling for unobserved heterogeneity, however, the magnitude of the adverse effect of maternal employment on children's obesity decreases. Physical activity and TV viewing appear to be mechanisms through which maternal employment affects children's bodyweight.

Essay Two uses longitudinal data from the NICHD Study on Early Child Care (SECC) to examine the effects of maternal employment on family well-being, measured by maternal mental and overall health, parenting stress, and parenting quality. We use dynamic panel data models to examine the effects of maternal employment on family outcomes during the first 4.5 years of children's lives. We find that maternal work hours are associated with maternal health, and no evidence that maternal employment is associated with parenting stress and quality.

In Essay Three, I used SDR data to establish the existence of the increasing inequality in publication productivity, examined the effect of the quality of the academic department

on publication productivity, and found that that effect decreases over time and therefore does not contribute to the increasing inequality. Furthermore, one characteristic of the academic department marginally significantly affects the publication productivity, the Gini coefficient for publications, which suggests that the faculty who works in an academic department with lower inequality of publication publishes more than a faculty in other academic departments.

Essay One

Maternal employment and childhood obesity

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1. Introduction

The prevalence of obese children and adolescents has increased dramatically over the past two decades in the United States. Classen and Hokayem (2005) pointed out that the prevalence of obesity among children and adolescents remained stable between the mid 1960's and 1980. From 1980 to 2006, the rate of obesity among children aged 2-5 and 6–11 more than doubled, from 5.0% to 12%, and from 7% to 17% respectively; among adolescents aged 12–19, it more than tripled, from 5% to 18% (CDC, 2006).

At the same time, during this time period, there was also a dramatic change in maternal employment in the US. According to the Department of Labor, between 1975 and 2007, the labor force participation rate of mothers with children under eighteen increased from 47.4 to 70.6 percent; among mothers with children under six, participation rates increased from 39 to 63.5 percent, and, among mothers with children under three, rates increased from 34.3 to 60.1. Recent literature has established that there is positive correlation between maternal employment and childhood obesity (Anderson et al., 2003; Rhum, 2004; Liu et al., 2009; Scholder, 2008). But few analyses have examined the effect of the timing of maternal employment, and the mechanism through which maternal employment affects childhood/adolescence obesity is not established yet, which is critical for any policy making aiming at childhood/adolescence obesity prevention.

This study uses longitudinal data from the NICHD Study on Early Child Care (SECC) to first explore the effect of maternal employment at different stages on childhood/adolescence obesity, and second explore potential mechanisms. The findings suggest that maternal employment during elementary school increases the probability of adolescence obesity at age 15 by 12 percentage points, accounting for other factors, and increases the probability of obesity at 6^{th} grade by 16 percentage points for children with part-time working mothers and 12 percentage points for children with full-time working mothers. Maternal employment in most other stages of childhood is not associated with childhood obesity.

These baseline estimates, however, may be confounded by unmeasured factors correlated with both maternal employment and childhood obesity, such as unobserved components of socioeconomic status. After implementing "Mundlak"-like specifications using the overall average and before birth maternal employment, and fixed effect models to control the effect of unobserved heterogeneity, maternal employment during elementary school is still a statistically significant predictor of childhood obesity. The coefficient on maternal employment in the fixed effect model is smaller than that in the linear probability model, suggesting that unobserved maternal heterogeneity increases the adverse effect of maternal employment on childhood/adolescence obesity, which is a self-selection bias.

Analysis of potential mechanisms shows that maternal employment increases TV viewing and reduces physical activity. Further study on physical activity shows that unobserved maternal heterogeneity increases the reduction on vigorous physical activity caused by maternal employment, and therefore confirmed the previous finding of self-selection bias that unobserved maternal heterogeneity increases the adverse effect of maternal employment on childhood/adolescence obesity by reducing vigorous physical activity more than maternal employment alone.

2. Previous research on effects of maternal employment on child outcomes

The research interest in maternal employment and families was started by Nye and Hoffman's publication "The Employed Mother in America" in 1963. Harvey (1999) and Goldberg et al. (2008) did comprehensive reviews of the maternal employment and child outcomes research literature. Overall, past research has produced mixed results, with most studies focusing on the effects of maternal employment on academic outcomes of children.

Early research before 1980 showed mixed results. Burchinal and Rossman (1961) and Leibowitz (1977) found no association between maternal employment and children's achievement including formal tests of achievement and intellectual functioning, grades and teacher ratings of cognitive competence. Hunter (1972) found that children with mothers not working or working part time had higher achievement scores than children with mothers working full time. Cherry and Eaton (1977) found mixed results. Children with working mothers scored lower on the Stanford-Binet than children with mothers not working, but scored higher in spelling and on a formal set of achievement. Recent studies also produced mixed results with some finding positive association between maternal employment and children achievement (Blau and Grossberg, 1992), some finding no association (Desai, Chase-Lansdale, and Michael , 1989), and others finding negative association (Baum, 2003; Farel, 1980; Brooks-Gunn, Han and Waldfogel, 2002; Ruhm, 2004). Baum (2003) found that the negative effect of maternal employment on cognitive outcomes was partially mitigated by maternal income. Harvey (1999) reviewed six studies which used the same National Longitudinal Survey of Youth 1979 but have different findings, and found no significant main effect of early maternal employment on

Peabody Picture Vocabulary Test (PPVT-R) scores, Peabody Individual Achievement Test (PIAT) scores, Behavior Problem Index (BPI) scores, and Self-Perception Profile for Children (SPPC) scores. Vandell and Ramanan (1992), Parcel and Menaghan (1994), and Greenstein (1995) found no adverse effects of early maternal employment on PPVT-R or behavior problems. Vandell and Ramanan (1992) found some positive effects on children's PIAT scores. Desai, Chase-Lansdale, and Michael (1989) found negative effects on PPVT-R scores only for boys from high-income families. Baydar and Brooks-Gunn (1991) found negative effects on PPVT-R and behavior problems for white families only. Belsky and Eggebeen (1991) found adverse effects on a variable created based on both BPI scores and temperament variables, and no significant effects on BPI scores alone.

Past research also found mixed results about the effect of maternal employment on social outcomes for adolescents (Trzcinski and Brandell, 2002). Aughinbaugh and Gittleman (2003) found no evidence that maternal employment during a child's first three years or during adolescence affects the likelihood of participation in risky behaviors: smoking cigarettes, drinking alcohol, using marijuana and other drugs, engaging in sex and committing crimes. Gennetian et al. (2010) found a modest adverse effect of maternal employment on the health status of low-income, elementary-school-aged children using instrumental variable method and fixed effect model. Morrill (2011) found maternal employment adversely affects the health of children ages 7 to 17.

There are two main challenges for empirically identifying the effect of maternal employment on children's health or outcomes. First of all, a mother's decision to work is endogenous. Some studies showed that maternal employment is affected by children's health (Poweres, 2003; Gould, 2004; Corman et al., 2005; Norberg, 1998), a reverse causality, which cofounds the effect of maternal employment on the child's well-being. Second of all, a mother's decision to work may reflect her unobserved preference or ability, which may correlate with her ability of raising children, and therefore confound the effect of maternal employment on children's health (Morrill 2011).

Childhood obesity has become an epidemic and a major concern for the whole society. Thus, there is recent interest in the relationship between maternal employment and child bodyweight. As discussed below, previous studies consistently show that maternal employment is positively associated with children's bodyweight, which is different from the mixed results of the effect of maternal employment on other child outcomes. But mechanisms are not well established, and it is difficult to disentangle an association between maternal employment and obesity from a causal relationship.

Using data from the National Longitudinal Survey of Youth 1979 (NLSY79), Anderson, Butcher and Levine in 2002 examined the relationship between maternal employment and child bodyweight and used four techniques to address unobservable heterogeneity. They first took the difference between the first and the last observation of weight status for each child to difference out the child fixed effect. Then, they took the sibling difference at the same time point and at the same age to difference out the family fixed effect. And finally they used instrumental variable method using the variation between states and over time in the unemployment rate, child care regulations, wage of child care workers, welfare benefit levels and the status of welfare reform in the states. They found that a child is more likely to be overweight if his/her mother worked more intensively over the child's life. The effect is particularly evident for children of white mothers, children of mothers with more education, and children of mothers with a high income level.

Ruhm (2004) used the NLSY data and studied the effect of maternal employment measured as average weekly work hours on adolescent development, including cognitive development, obesity and risky behaviors such as smoking or drinking, when the children who were born between 1979 and 1988 were 10 or 11 years old. Ruhm (2004) found that the negative effect of maternal employment on obesity among high socioeconomic status children is largely restricted to maternal labor supply after the first three years. He included post-assessment maternal employment in the regression to test model misspecification, and he compared the results of basic ordinary linear regressions to those when including maternal fixed-effects and to average treatment effects using propensity score techniques to reduce potential bias. He found that even limited amounts of maternal labor supply for advantaged adolescents have negative effect on children's weight status.

Liu, Hsiao, Matsumoto and Chou (2009) also use matched mother-child data from the wave 2000 of the NLSY79 data to estimate the effect of full-time maternal employment on children's body mass index (BMI) and the likelihood of obesity. They employed parametric, semi-parametric and non-parametric methods to correct the selection bias on both observable and unobservable factors. The parametric and semi-parametric methods are basically Tobit models. The difference is that the parametric method requires specification of the probability distributions of the unobservables, but the semi-parametric method does not. They used an employment decision function to correct for the potential selection bias. The variables for the employment decision function include whether receiving income or property from estates, trust or inheritances, highest grade completed, the location of residence (urban versus rural), race and ethnicity dummies, whether a child's father lives in the same household, age of the youngest child, and the local unemployment rate. The non-parametric method used the propensity score techniques to match the probability conditional on observables that a mother works full time between mothers working full-time and others, and then estimate the average treatment effect, i.e., the effect of full-time maternal employment, but it does not take into account the unobservables. They found that full-time maternal employment raises a child's BMI by 0.58, and the likelihood of obesity by 12.3%.

These studies described above are limited by the lack of information on physical activity, TV viewing and food intake. Even though Anderson, Butcher and Levine supplement it with NHANES and CSFII on food intake and TV viewing information, both are cross-sectional data sets with only contemporaneous measures of maternal employment, which is far from ideal. As described below, with SECC data, we have a rich set of measures of maternal employment from before the child's birth to 15 years of age, detailed information on physical activity both reported and measured by motion detectors, and information about food intake and TV viewing. Improvement on this topic can be made by utilizing all the information mentioned above.

Another limitation on the studies mentioned above is that they used average maternal employment throughout the study periods. But theoretically maternal employment at different stages could have different effect on childhood/adolescence obesity. Scholder (2007) studied the effect of maternal employment at different times on children's weight status using a British data set. She used fixed effect model to control unobserved heterogeneity and proxied it with the average maternal employment status. Her results showed a significant positive correlation between maternal employment at age 7 and the probability of overweight at age 16. Additionally she finds it is full-time as opposed to part-time employment that increases the child's weight.

Some studies showed that overweight or obese children are more likely to become overweight or obese adults. Nader et al (2006) used the same SECC data and found that children with BMIs>85th percentile are more likely to reach overweight status by adolescence. Whitaker et al (1997) found that, obese 1-or-2-year-olds has 8% chance to be obese adults (21 to 29), but obese 10-to-14-year-olds are more likely to be obese adults. Field et al (2005) found that children with a BMI between 75TH and 84th percentile were up to 20 times more likely to become overweight young adults, compared with children with a BMI<50th percentile. Mamun et al (2008) found that being overweight at 5 years of age substantively increases BMI at 21 years.

Since maternal employment increases the possibility of childhood/adolescence obesity, which in turn increases adulthood obesity, it is critical to understand the mechanism through which maternal employment affects childhood/adolescence obesity in order to prevent childhood/adolescence obesity and adulthood obesity. Only a few papers tried to explore the mechanism through which maternal employment affects children's weight status.

Cawley and Liu (2007) used data from the American Time Use Survey and found that employed women spend significantly less time cooking, eating with children, and playing with their children, and are more likely to purchase prepared foods, which offers plausible mechanisms for the association of maternal employment with childhood obesity. But the data doesn't have children's height and weight, and therefore the direct association between mother's allocation of time and children's weight status is not established. Fertig, Glomm, and Tchernis (2009) used the Child Development Supplement of the Panel Study of Income Dynamics and showed that employment of mothers with more education increases TV viewing and in turn increases children's BMI, but employment of mothers with little education increases time spent in school and in turn decreases children's BMI. Brown, Broom, Nicholson and Bittman (2010) used two waves of data from Longitudinal Study of Australian Children at ages 4-5 years and 6-7 years and found that children with mothers working part-time watch less television and are less likely to be overweight than children with mothers not working or working full-time.

This study addresses some problems presented by previous studies. First of all, the effect of maternal employment at different stages on adolescence obesity is explored in the context of the U.S., utilizing the only national longitudinal data set available with detailed information about maternal employment, children's physical activity, TV viewing, food intake and beverage consumption. Second of all, two different models are used to control unobserved heterogeneity, and therefore reduce the source of potential bias. And finally the mechanism through which maternal employment affects adolescence obesity is established thanks to the rich and accurate measurements of physical activity.

3. Description of the data

The NICHD Study of Early Child Care (SECC) is a longitudinal study initiated by The National Institute of Child Health and Human Development (NICHD) in 1989. In

1991, 1,364 healthy newborns were enrolled in the study from 10 sites across the country and followed from birth to age 15. The number of participants dropped to 913 at the end of the study.

Table 13 shows the attrition from 1 month to age 15. 147 observations were deleted due to missing data, and 766 were kept in the sample. Among the 147 observations, 80 were deleted due to missing weight status at age 15, 11 due to missing variable “being prematurely born”, 42 due to missing variable “mother smoked during pregnancy”, and 51 due to missing variable “STDSCM36”. The numbers of missing data add up more than 147 because some observations have more than one missing variable.

Table 14 shows the comparison between the sample and the deleted. For most variables, there are no significant difference between the two groups, including being white, having a low birth weight, being prematurely born, being first born, mother smoked during pregnancy, mother’s age, mother having a health problem during pregnancy, STDSCM36, birth weight, planned pregnancy, household size, number of adults, public assistance, total income-to-needs ratio, Abidin parenting stress index, maternal feeling about pregnancy, baby’s health at one month, mother’s health at one month, mother’s feeling about baby, and any care more than 30 hours per week. A few variables show some difference. The sample has marginally significantly higher percentage of female than the deleted, significantly higher percentage of households with husband/partner living with mother, lower percentage of mothers with education less than high school, and higher percentage of mothers with education more than high school. So mothers without husband/partner or less than high school education are more likely to have missing information. The sampling frame included mothers who planned to work either full-time or part-time, and mothers who planned to stay home with the child. Maternal employment information was collected before birth in person, at 1, 6, 15, 24, 36 and 54 months at home, at 3, 9, 12, 42, 46, 50, 60 months and kindergarten by telephone, and every year after 1st grade by telephone. To estimate the effect of maternal employment in different periods, I take the average of maternal employment weekly hours from 15 months to 36 months (because a lot of mothers were still on maternal leave after birth, and to be on the safe side, I chose 15 months as a cutoff point), from 42 months to kindergarten, from grade one to grade five, and from grade six to age 15, and then divided them into three categories, not working (0 hours), part-time (larger than 0 hours and less than 35 hours), and full-time (no less than 35 hours).

There is no universal way to define categories of maternal employment using SECC data. Burchinal and Clarke-Stewart (2007) who used SECC data to study the relationship between maternal employment and child cognitive outcomes took a different approach, defining no employment as not-working, more than 0 hour and no more than 29 hours per week as part-time, and 30 or more hours per week as full-time, following the approach of Brooks-Gunn et al. (2002). Gordon, Kaestner and Korenman(2007) used SECC data to estimate the effects of maternal employment on child injuries and infectious disease. They divided working mothers into three groups, 1-10 hours per week, 11-29 hours per week, and 30 or more hours per week. Chatterji, Markowitz and Brooks-Gunn (2011) used SECC data to examine the effects of maternal employment on family well-being. They divided working mothers into three groups, 1-20 hours per week, 21-39 hours per week, and 40 or more hours per week. To be consistent with Anderson, Butcher and Levin's approach, I followed their way of categorization of maternal employment.

In addition, I examined hours worked as a continuous variable. The advantage of taking the average of employment hours in periods is that, first, one or two missing responses won't reduce the number of observations, and second, it allows the effect of maternal employment in different periods to vary. Table 15 shows the number of mothers switching among the three categories of employment. More mothers switched from part-time and full-time before birth to not working at three years than from not working to working. 68 remained not working, 128 remained part-time, and 224 remained full-time. The switch from three years to age six is almost symmetrical, with 59 remaining not working, 256 remaining part-time, and 197 remaining full-time. More mothers switched from not-working to part-time and from part-time to full-time than the other way around from age six to elementary school, with 37 remaining not working, 254 remaining part-time, and 218 remaining full-time. The switch from elementary school to high school showed a similar pattern, with 47 remaining not working, 221 remaining part-time, and 268 remaining full-time. The overall trend is that more mothers switch from part-time or full-time to not working or part-time after the child is born, and more mothers switch from not-working or part-time to part-time or full-time as the child gets older.

Height and weight were measured at 24, 36, and 54 months, 1st, 3rd, 5th, 6th, 7th, and 8th grade, and reported at age 15. Body mass index (BMI) percentile, BMI z-score were calculated by NICHD using a SAS program based on the 2000 CDC Growth Charts (http://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm). BMI is calculated as weight in kilograms divided by height in meters squared. BMI percentile is calculated by comparing the age and gender specific BMI to the standard population which is created by CDC based on five cross-sectional, nationally representative surveys. All biologically implausible values (BIV) were coded as missing. The child is considered overweight if the BMI percentile is above the 85th centile, and obese if above 95th centile. Table 16 showed the number of children changing their obesity status from 1st grade to 6th grade. 42 kids became obese from non-obese and 9 became non-obese from obese, 559 remained non-obese, and 62 remained obese from 1st grade to 6th grade. Table 17 showed the obesity status change from 6th grade to age 15. 21 became non-obese from obese, 51 became obese from non-obese, 558 remained non-obese, and 52 remained obese from 6th grade to age 15.

At third, fifth, and sixth grade, and age 15, children's physical activity was monitored directly for a week by a physical activity monitor (accelerometer). The thresholds for moderate, vigorous and very vigorous physical activity are 3, 6 and 9 METs (metabolic equivalent of task). Metabolic equivalent of task, known as MET or metabolic equivalent, is a concept frequently used to indicate the amount of oxygen or energy the body uses during physical activity. It is conventionally agreed that 1 MET is the equivalent of the energy or oxygen the body uses while at rest. One MET is considered the resting metabolic rate, or the metabolic rate at which the body consumes 3.5 milliliters of oxygen per kilogram of body weight per minute. In mathematical terms, 1 MET = 50 kcal/hour/m2 body surface area (http://www.wisegeek.com/what-is-a-metabolic-equivalent.htm). According to Nader (2008), the accelerometer recorded minute-by-minute movement counts which were used to estimate the energy expended in moderate (3.0-5.9 METs), vigorous (6.0-8.9 METs), and very vigorous (>9.0 METs) activity, based on the age-specific equation of Freedson et al (2005):

METs=[2.757 + (0.0015* count)− (0.08957*age in years) − (0.000038*count* age in years)].

The obesity rate for the SECC data at grade 6 and age 15 is 15%, close to, but a little bit lower than the national average 18%.

STDSCM36 is mothers' scores on a standardized vocabulary test named Peabody Picture Vocabulary Test-Revised. Female is 1 if the child is female and 0 if male. White is 1 if the child is white and 0 if not. Having a low birth weight (defined as less than 2,500 grams, or 5 pounds, 8 ounces), being firstborn, being prematurely born, mother smoked during pregnancy, and mother having a health problem during pregnancy are all dummy variables with 1 as yes and 0 as no.

Table 1 presents the two key variables, weight status (obesity and overweight) and maternal employment in the three survey waves, 1^{st} grade, 6^{th} grade and age 15. Both obesity and overweight percentages are significantly higher at 6^{th} grade and age 15 than at 1^{st} grade, but there is no significant difference between 6^{th} grade and age 15. The percentage of mothers not working is significantly higher at 1^{st} grade than at 6^{th} grade and age 15, so is the percentage of mothers working part-time. And the percentage of mothers working full-time is significantly lower at 1^{st} grade than at 6^{th} grade and age 15.

Table 2 presents some descriptive statistics by mother's employment status during elementary school, including being female, being white, birth weight (kilogram), having a low birth weight, being prematurely born, being firstborn, mother smoked during pregnancy, mother's age, mother's education, mother having a health problem during pregnancy, STDSCM36, planned pregnancy, household size (adults and kids) ,number of adults, public assistance, total income-to-needs ratio, husband/partner lives with mother, Abidin parenting stress index, maternal feeling about pregnancy, income before birth, baby's health at one month, health of mother at one month, mother's feeling about the baby (1 means good, 0 means not), and any care more than 30 hours per week, which are risk factors controlled by Anderson et al (2002), Chia (2008), Rhum(2004), and Lohman et al (2009). These variables are likely to affect maternal employment, or children's weight status, or both. For example, Anderson et al. argued that if minority mothers (black or Hispanic) have fewer employment opportunities that white mothers, and minority children are more likely to be obese, excluding race/ethnicity in the regression would bias the effect of maternal employment.

The same argument applies to other variables too. Birth weight, being prematurely born, having a low birth weight, and baby's health at one month control the child's health endowment. Income before birth, public assistance, and total income-to-needs ratio control socioeconomic status. Mother smoked during pregnancy, mother's age, mother's education, mother having a health problem during pregnancy, STDSCM36, planned pregnancy, Abidin parenting stress index, maternal feeling about pregnancy, health of mother at one month, mother's feeling about the baby control observable characteristics of mothers. Household size, number of adults, and husband/partner lives with mother control family structure. Variables about socioeconomic status such as family income and ratio of income to needs have more missing observations than other demographic variables. Therefore, those missing observations are replaced with sample means and a dummy variable is included indicating whether it is missing.

We can see the big difference in the proportion of obese children at age 15 between the category of “not working”, which is 6%, and “full-time”, which is 17%, and a small difference between “full-time” and “part-time”. The difference between “not working” and “full-time” or “part-time” is even bigger at 6th grade, but much smaller at 1st grade. Most other variables show very small difference among the three categories, such as having low birth weight, being first born, mother smoking during pregnancy, mother’s age, mother having health problem during pregnancy. There is marginally significant difference in the proportion of female children among the three categories of maternal employment, with mothers not working having a slightly higher proportion of female children than part-time and full-time working mothers. Lower percent of full-time working mothers are white than mothers not working. Both part-time and full-time working mothers have marginally significant higher proportion of prematurely born children than mothers not working. Family income before birth of not working mothers is significantly higher than that of full-time working mothers, and marginally significantly higher than that of part-time working mothers. Not working mothers’ feeling about the baby is higher than both part-time and full-time working mothers. Both part-time and full-time working mothers have their kids cared by others more than 30 hours per week more often than not working mothers. There are no significant differences among mothers with education less than or higher than high school in terms of employment, but there is a difference among mothers with high school education in terms of employment, with the highest percentage in full-time working and the lowest in not working.

4. Theoretical and Econometric Model

4.1 Theoretical model

The following economic model is proposed by Ruhm (2004). Households aim to maximize the utility by allocating the limited resources. In this paper, the household's utility at time t, U_t is a function leisure time of the parents (L_{mt} and L_{ft}) and household's consumption of goods and services (G_t). And the child's health at time t, H_t is one argument in the utility function.

$$U_t(H_t, \theta_t) = U(L_{mt}, L_{ft}, G_t) \quad (1)$$

Θ_t is a vector of all other arguments included in the household utility function.

In this paper, the health of the child is the weight status, which can be affected by the child's health in the previous period H_{t-1}, leisure time of parents (L_{mt} and L_{ft}), the purchased goods and services G_t, the unobserved child specific health endowments ζ and unobserved parental characteristics τ.

$$H_t = f(H_{t-1}, L_{mt}, L_{ft}, G_t, \zeta, \tau) \quad (2)$$

Now let's see how these arguments affect the child health at time t. First, H_t depends heavily on H_{t-1}. Because the weight status rarely changes quickly, so H_{t-1} is a good predictor of H_t. Second, the leisure time of the parents benefits the child by increasing time investment, reducing stress, raising energy level and so on. So the partial derivative of the parental leisure time is positive. Third, the purchased goods and services can affect the child's weight status in two directions. On one hand, the increased income could be spent on inputs that increase the weight, such as restaurant and fast food meals. On the other hand, the increased income could be spent on inputs that reduce the weight, such as quality child care, healthy food and so on.

The above production function has a time and income budget constraint. The parents' time constraint is:

$$L_{pt} + E_{pt} = T \qquad \text{p=m,f} \tag{3}$$

E_{pt} is the employment time of the parents.

Assuming the hourly wage rate is w_{pt}, non-labor income is V_{pt}, then the income at time t, Y_t is the budget constraint:

$$Y_t = w_{pt}E_{pt} + V_{pt} \tag{4}$$

Solving (3) for E and recursively substituting in for lagged values of H, equation (2) will be rewritten as follows:

$$H_t = f(\mathrm{E}_{,}\mathrm{G}, \zeta, \tau) \tag{5}$$

E and G are vectors of current and lagged values, $E=(E_t, E_{t-1}, \ldots, E_0)$, $G=(G_t, G_{t-1}, \ldots, G_0)$ Since the consumption of goods and services is not observed, the empirical analysis will estimate the reduced form demand function of child weight instead of equation (5).

$$H_t = f(E, X, \varepsilon) \tag{6}$$

X is a vector of child and parental characteristics and ε is a disturbance term. The employment coefficient in equation (6) represents the net effect of employment, combing effects of the increased income and decreased parental leisure time.

The equation above is referred to as a "hybrid equation" by Rosenzweig and Schultz (1983), where the unobserved inputs G are dealt with by including their determinants, such as income and education level. In a hybrid model, the coefficients generally embody both the technological properties of the production function and the characteristics of unobserved household preferences or tastes. A fully specified model would have to control for the endogeneity of the household preferences. But, since these preferences are not observed, the employment coefficient might be biased.

4.2 Econometric Model

In empirical analysis, equation (6) could be specified as below:

$$H_{it} = \alpha + \sum_{j=0}^{t} \beta_j E_{it-j} + \gamma X_{it} + \zeta_i + \tau_i + u_{it}, j = 0,..., t \quad (7)$$

where H_{it} is a binary variable indicating whether the child is obese at time t, E_{it-j} is a variable indicating the mother's work status, at time t-j, X_{it} is a vector of child and family variables, ζ_i is time-invariant unobserved child-specific health endowment, τ_i is unobserved parental characteristics, and μ_{it} is an i.i.d. error term. In this analysis, the family and child unobserved effect cannot be separated, because there is only one child in each family in this data set. Therefore, η_i can be used to indicate the combined unobserved time-invariant effect ζ_{i+} τ_i. Then we can combine all unobserved variables, $\eta_i + \mu_{it} = \varepsilon_{it}$. Equation (7) will become:

$$H_{it} = \alpha + \sum_{j=0}^{t} \beta_j E_{it-j} + \gamma X_{it} + \varepsilon_{it}, j = 0,..., t \quad (8)$$

The coefficients of E_{it-j} are unbiased if $Cov(E_{it-j}, \varepsilon_{it}) = 0$. If after controlling all observable variables X_{it}, there are still unobservable factors in ε_{it} that are correlated with E_{it-j}, then the estimated β_j will be biased.

Equation (8) will be used to explore the effect of maternal employment at different times. This analysis will tell us whether it is the early or late maternal employment that affects the child's weight status at age 15. This exploits the longitudinal structure of the

SECC data set. Suppose it's the maternal employment at time t-j that is significant, then equation (8) can be simplified as:

$$H_i = \alpha + \beta E_{it-j} + \gamma X_i + \varepsilon_i \qquad (9)$$

E_{it-j} could be correlated with τ_i, meaning the maternal employment is correlated with the unobserved maternal characteristics, which in turn can be correlated with the child's weight. For example, if working mothers generally are less interested in their children or less skillful in nurturing them than non-working mothers, then it means $Cov(E_{t-j}, \tau_i) < 0$. Furthermore, if assuming that the mother's ability in rearing children is inversely correlated with the probability of the child being obese, then the estimated β_j will be biased upwards. Conversely, if working mothers are more interested in their children or more skillful in rearing them than non-working mothers, i.e. market productivity is positively correlated with home productivity, and still assuming that mothers' ability is inversely correlated with the probability of child obesity, then β_j will be underestimated.

E_{it-j} could be correlated with child-specific health endowment ζ_i . For example, if the child's health endowment is inversely correlated with the mother's decision to work, in another word, if the child is not obese, then the mother would like to work, i.e. $Cov(E_{it-j}, \zeta_i) > 0$. Assuming that the child's health endowment is negatively correlated with the probability of being obese, then β_j will be overestimated. On the other hand, if the child's health endowment is positively correlated with the mother's decision to work, and still assuming that health endowment is negatively correlated with the probability of being obese, then then β_j will be underestimated.

Given all the possibilities of biased estimates of β_j, two methods will be employed to take care of the unobserved variables, i.e.“Mundlak”-like specification and fixed effect model.

4.2.1 “Mundlak”-like specification

The following is closely modeled after Scholder (2007). To avoid biased estimates of the effect of maternal employment caused by unobserved individual heterogeneity, the first attempt is to specify it as a function of some variables that proxy the unobserved variables. Since working mothers might be systematically different from non-working mothers, the unobserved heterogeneity η_i may be approximated by the overall average of maternal employment status:

$$\eta_i = f(E_{it}) = \frac{1}{T}\sum_{t=0}^{T} E_{it} + v_i = \bar{E}_i + v_i \tag{10}$$

The right hand side of equation (10) then replaces η_i in equation (8):

$$H_i = \alpha + \sum_{j=0}^{t} \beta_j E_{t-j} + \gamma X_i + \lambda \bar{E}_i + e_i \tag{11}$$

where $e_i = v_i + u_i$.

The alternative way is to proxy the unobserved heterogeneity by maternal employment status before the birth of the child. Because one might argue that maternal employment may be interactive with the weight status of the child. If the child is obese, the mother might quit working to take care of the child. Then the overall average is not a good proxy of the unobserved effect. In this case, the maternal employment status before the birth of the child, E_{bi} is a better proxy:

$$H_i = \alpha + \sum_{j=0}^{t} \beta_j E_{t-j} + \gamma X_i + \lambda E_{bi} + e_i \quad (12)$$

After checking the frequency of the three categories of overall average maternal employment, I only found 16 in the category of "not working", which results in very unreliable estimates. Therefore, the overall average employment is not a good proxy for the unobserved characteristics in our study. Using maternal employment before birth gives a more reliable and reasonable estimates.

4.2.2 Fixed effects

The fixed effect model will be used to control the unobserved heterogeneity. Instead of finding a proxy for the heterogeneity, a linear probability fixed effect model allows us to remove the time-invariant unobserved child and family characteristics η_i thanks to the longitudinal structure of the SECC data set. The model can be specified as:

$$\begin{aligned} H_{i,2} &= \beta_1 E_{i,1} + \beta_2 E_{i,2} + \gamma X_i + \eta_i + u_{i,2} \\ H_{i,3} &= \beta_1 E_{i,1} + \beta_2 E_{i,2} + \beta_3 E_{i,3} + \gamma X_i + \eta_i + u_{i,3} \\ H_{i,4} &= \beta_1 E_{i,1} + \beta_2 E_{i,2} + \beta_3 E_{i,3} + \beta_4 E_{i,4} + \gamma X_i + \eta_i + u_{i,4} \end{aligned} \quad (13)$$

where the first equation refers to pre-school period, the second to elementary school, and the third to high school. $E_{i,1}$ is the maternal employment status before age three, $E_{i,2}$ is during pre-school, $E_{i,3}$ is during elementary school, and $E_{i,4}$ is during high school. The child's weight status can only be affected by the current and previous maternal employment.

Taking difference between equation 2 and 1, and 3 and 1, would result in the following equations:

$$H_{i,3} - H_{i,2} = \beta_3 E_{i,3} + (u_{i,3} - u_{i,2})$$
$$H_{i,4} - H_{i,2} = \beta_3 E_{i,3} + \beta_4 E_{i,4} + (u_{i,4} - u_{i,2}) \qquad (14)$$

Thus, the child/family fixed effect η_i is removed.

But the shortcoming of this model is that not all coefficients of maternal employment are identified, such as β_1 *and* β_2 .Only β_3 and β_4 are identified. And the fixed effect model can't control unobserved time varying characteristics that affect both maternal employment and childhood obesity.

The conventional fixed effect model was run with time varying variables including obesity, maternal employment, partner/husband living at home, and total household size, where the coefficient for maternal employment is not significant, suggesting a timing effect model. Please see table 25.

5. Results

5.1 The effect of maternal employment at different times

There are three tables with obesity at age 15, at 6th grade and 1st grade as dependent variables. For the first table at age 15, the first column is the probit regression including maternal employment in all four periods, and other covariates, the second column is the linear probability regression including the same variables, the rest columns are probit regressions including maternal employment in one period at a time. Only employment during elementary school is significant in all specifications. It makes sense because elementary school is a pivotal period in eating, playing, TV watching and other habits, and body developing, all related to obesity developing. This also shows that the effect of maternal employment on children's obesity developing takes a long time to show up.

Both probit and linear regressions show that there is significant difference between not-working and part-time working, and not-working and full-time working. Children with working (both part-time and full-time) mothers are about 13 percentage points more likely to become obese than children with not-working mothers based on linear probability regressions. Since probit and linear probability model gave similar results, linear probability model will be used in order to utilize the fixed effect model.

For the second table at 6th grade, the effect of maternal employment during elementary school is significant with p-value less than .01 and even bigger than that at age 15. For the third table at 1st grade, the effect of maternal employment is not significant.

Maternal employment before birth is a good proxy for unobserved maternal heterogeneity, because it is not influenced by the weight status of the child. Adding maternal employment before birth didn't change the results.

The fixed effect model requires within-individual variation to estimate the coefficients, and can't be used if children's obesity status and maternal employment status don't change over time. Fortunately, the SECC sample provided enough variation in both main variables. Table 16 and 17 showed the changes of obesity status from 1st grade to 6th grade and age 15. 42 kids became obese from 1st grade to 6th grade, 9 became non-obese, 62 stayed obese, and 559 stayed non-obese. 51 kids became obese from 1st grade to age 15, 21 became non-obese, 52 stayed obese, and 558 stayed non-obese. Table 15 showed the changes of maternal employment status over time. Most changes are between not-working and part-time, and part-time and full-time. Very few mothers switch between not-working and full-time. In the fixed effect model, maternal employment during elementary school significantly increases the possibility of obesity at 6th grade and age 15 by 5 percentage points for children with part-time working mothers, and 7 percentage points for children with full-time working mothers, both of which are smaller than those effects in LPM, indicating that the results in the LPM are biased upward. The possible explanation is that working mothers have comparative advantage in working, and staying-home mothers have comparative advantage in rearing children and housekeeping. If all mothers have the same unobserved abilities, then children with working mothers are more likely to be obese, or if all mothers either stay home (or work), children with these working mothers are more likely to be obese. Therefore the actual effect of maternal employment in the LPM includes both the pure effect of maternal employment in the fixed effect model and the effect of unobserved characteristic. Controlling more time varying characteristics including partner/spouse living at home and household size doesn't change the results (table 26). Additionally, obese children at 1st grade are very likely to continue to be obese at 6th grade and at age 15. Both part-time and full-time maternal employment in high school reduces the possibility of obesity at age 15, but they are not significant. It might indicate that the benefit of working starts to outweigh the cost during high school. It makes sense, because children in high school are in general less dependent on mothers but can benefit more from extra income than younger children.

6. Mechanisms

The next step is to explore the channel through which maternal employment affects childhood obesity. There is rich information about many factors in this data set, such as self-reported TV viewing time, sedentary time, physical activity time in different period times, and physical activity intensity recorded by motion detector.

First, I replaced maternal employment with one of the variables above which theoretically affect weight status in the regression of obesity at age 15 and obesity at 6th grade at a time. The reason is that the effect of maternal employment on childhood/adolescence obesity is materialized through mechanisms, and therefore excluding maternal employment would enable mechanisms to capture that effect. Results show that a lot of variables are significant, such as moderately vigorous physical activity, vigorous physical activity, very vigorous physical activity, TV viewing, and sedentary time. In general, longer physical activity reduces chances of obesity; longer TV viewing and sedentary time increases the possibility of obesity. Other factors, such as food intake, drink, were only collected at age 15, and therefore it's not surprising that most of them are not significant. Because there should be time lags between obesity and factors. Only bread consumed at morning is marginally significant. The possible reason could be that bread consumption at morning may be a consistent habit. But more detailed data are needed to verify this hypothesis.

Second, I ran the linear regressions of those variables on maternal employment and other demographic variables in three models, without employment before birth, with employment before birth, and fixed effect model (which takes difference between two regressions at different time points and therefore get rid of unobserved heterogeneity) respectively. The results show that usually only concurrent maternal employment significantly affects physical activity in both 3rd and 6th grade, but at age 15, maternal employment becomes non-significant. Both full-time and part-time maternal employments reduce physical activity time when they are significant in 3rd and 6th grade. Table 6a shows that vigorous physical activity at 6th grade has a bigger (0.006) and significant effect on obesity at 15, while moderate physical activity at 6th grade has a much smaller (0.0007) and marginally significant effect on obesity at 15. This is also true for obesity at 6th grade in table 6b. This confirms the previous hypothesis that it is the unobserved heterogeneity that causes the difference in vigorous physical activity and therefore the difference in obesity in addition to the effect of maternal employment. The proxy for heterogeneity, employment before birth, significantly and negatively affects some measures of physical activity in table 7 and 8, which also confirms the inference above. Maternal employment significantly increases TV viewing time at 5th grade, but is non-significant in regression of other variables, such as sedentary time at 6th grade, TV viewing at 4th grade, video time at 6th grade, self-reported light physical activity at 6th grade, and bread consumption at morning at age 15. Table 9 and 10 showed that by age 15 the effect of maternal employment on physical activity disappeared, but was still marginally significant on TV viewing. To further investigate the mechanism of maternal employment, I included both maternal employment and mechanism variables at different stages (see table 27 and 28). First, for obesity at age 15, maternal employment in all stages, minutes of vigorous physical activity in 3rd grade, 6th grade and age 15, and other mechanism variables (number of times watching TV, snacking in 4th and 5th grade, and minutes of sedentary minutes in 6th grade) are included in three regressions with only one vigorous physical activity variable at a time. The coefficients of maternal employment in elementary school are insignificant when minutes of vigorous physical activity in 3rd grade is included (table 27a), only the coefficient of part-time is significant when minutes of vigorous physical activity in 6th grade is included (table 27b), and the coefficients of part-time and full-time are significant when minutes of vigorous physical activity at age 15 is included (table 27c). This suggests that the effect of maternal employment on obesity at age 15 is mainly materialized through vigorous physical activity in 3rd grade, and through other uncontrolled mechanisms at age 15. For obesity at 6th grade, only the coefficient of part-time is significant when vigorous physical activity in 3rd grade is included, and the coefficients of both part-time and full-time are insignificant when vigorous physical activity in 6th grade is included. Table 29 shows the mean of mechanism variables by maternal employment status. There is a clear pattern between not working and full time. Children with mothers not working tend to engage in physical activity longer and watch TV or videos less often than children with mothers working full time. Children with mothers not working tend to engage in physical activity shorter in 3rd grade but longer in 6th grade, and watch TV or videos less often than children with mothers working part time.

Dummy variables were created based on the physical activity guidance for children and adolescents aged 6 to 17 from the department of health and human services. The key guideline is that children and adolescents should do 60 minutes or more of physical activity daily. They are not significant (see table 6a and 6b).

Because SECC data have both self-reported and objective measures of physical activity, comparisons of the two measurements can test the reliability of the self-reported measurements. Table 12 shows that self-reported light activity minutes in 6th grade is not correlated with either moderate or moderate and vigorous physical activity measured by physical activity monitors. Even though self-reported heavy activity minutes in 6th grade is significantly correlated with both moderate and vigorous physical activity except on weekends, vigorous physical activity, and very vigorous physical activity except on weekends, measured by physical activity monitors, the highest correlation coefficient is 0.22, which is far from ideal. The correlation coefficient between self-reported heavy activity minutes and sum of vigorous and very vigorous physical activity is even smaller. This shows that self-reported measurements of physical activity is correlated with objective measurements, but not very reliable, which is confirmed in table 5b, where vigorous physical activity in 6th grade is significant, but self-reported heavy activity minutes are not, and moderate physical activity and self-reported light activity minutes have the opposite signs.

7. **Different specification**

Different ways of measuring the maternal employment and children's weight status are used to check the results above. First, the three categories of maternal employment are replaced with continuous hours worked in the LPMs, where the maternal employment hours during elementary school are significant for obesity at age 15 (see table 19). Second, the obesity dummy variable is replaced with a continuous BMI percentile (see table 20a and 20b) and overweight (including obesity) dummy (table 21 and 22) in the LPMs, where full-time and part-time mothers are significantly different from not-working mothers for BMI percentile at 6th grade and age 15; and part-time working mothers significantly increase the chance of overweight at 6th grade and age 15 compared to not-working mothers. Finally both categorical variables are replaced with continuous variables at the same time (see table 23), where maternal employment hours are no longer significant.

In addition, quantile regression is run not only to check the findings, but to capture a more complete picture of the relationship between childhood weight status and maternal employment. Linear regression estimates the mean value of the dependent variable for given levels of independent variables. Quantile regression models the relationship between a set of independent variables and specific quantiles of the dependent variable, such as 50th, 85th, and 95th quantile. The logic is that the relationship between child weight status and maternal employment varies with the child weight status. Quantile regression was first introduced by Koenker and Bassett in 1978. Let Y be a random variable with distribution function $F_Y(y) = P(Y \leq y)$. Define the loss function as $\rho_\tau(y) = y(\tau - I(y < 0))$. A specific quantile can be found by minimizing the expected loss of $Y - u$ with respect to u:

$$\min_u E(\rho_\tau(Y-u)) = \min_u (\tau - 1)\int_{-\infty}^{u}(y-u)dF_Y(y) + \tau\int_{u}^{\infty}(y-u)dF_Y(y).$$

The results show that for children with weight status above 85th quantile, both part-time and full-time working mothers are significantly different than not working mothers.

Finally, because maternal employment at different periods is highly correlated, therefore a single measure of maternal employment is used in place of multiple measures (see table 24). The results show that maternal employment is significant for BMI over 85th and 95th quantile at 6th grade, and significant for BMI above 95th at age 15. Overall, different specifications and methods supported our results.

8. **Conclusion**

The baseline LPM results show that maternal employment during elementary school increases the probability of childhood and adolescent obesity by 12-15%. After controlling for unobserved heterogeneity, however, the magnitude of the adverse effect of maternal employment on children's obesity decreases. Physical activity and TV viewing appear to be mechanisms through which maternal employment affects children's bodyweight.

9. Future study

SECC data gives a lot of detailed information which yields a certain advantage over other data sets. Yet, there are rooms for improvement. For example, Children at age 15 are still developing in terms of body and related habits such as TV viewing, physical activity and eating. So if the study could follow up and collect the weight status at adulthood, it'll give us more stable estimates, and insight about the relationship between maternal employment and adulthood obesity. Thanks to rich data on physical activity collected through accelerometer, the effect of maternal employment on childhood obesity through physical activity is established. Maternal employment increases childhood obesity by reducing vigorous physical activity time, and employed mothers' unobserved heterogeneity increases that reduction, and therefore increases the adverse effect of maternal employment on childhood obesity. Also a lot of other important variables were collected only once, such as eating habit, drink, diet and video time. That limits further study on other mechanisms. It would be ideal that those mechanism variables are reported in each survey wave, therefore providing detailed data on studying other mechanisms.

And finally, if the study had collected data on multiple children per family, the difference between unobserved child health endowment and unobserved maternal heterogeneity could be separated.

References:

1. Anderson, P. M., Butcher, K. F., & Levine, P. B. (2003). Maternal employment and overweight children. Journal of Health Economics, 22(3), 477–504.
2. Aughinbaugh, A., & Gittleman, M. (2004). Maternal employment and adolescent risky behavior. *Journal of Health Economics*, 23(4), 815-838.
3. Baum, C. L. (2003). Does early maternal employment harm child development? An analysis of the potential benefits of leave taking. *Journal of Labor Economics, 21,* 409–448.
4. Baydar, N., & Brooks-Gunn, J. (1991). Effects of maternal employment and child-care arrangements on preschoolers' cognitive and behavioral outcomes: Evidence from the children of the National Longitudinal Survey of Youth. *Developmental Psychology, 27,* 932–945.
5. Belsky, J., & Eggebeen, D. (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,* 1083-1110
6. Blau, F. D., & Grossberg, A. J. (1992). Maternal labor supply and children's cognitive development. *Review of Economics and Statistics,74,* 474–481.
7. Brooks-Gunn, J., Han, W.-J., & Waldfogel, J. (2002). Maternal employment and child cognitive outcomes in the first three years of life: The NICHD Study of Early Child Care. *Child Development, 73,* 1052–1072.
8. Brown, J. E., Broom, D. H., Nicholson, J. M., & Bittman, M. (2010). Do working mothers raise couch potato kids? Maternal employment and children' s lifestyle behaviours and weight in early childhood. *Social Science and Medicine, 70*(11), 1816-1824.
9. Burchinal, L. G., & Rossman, J. E. (1961). Relations among maternal employment indices and developmental characteristics of children. *Marriage& Family Living, 23,* 334–340.
10. Burchinal, Margaret R.; Clarke-Stewart, K. Alison (2007). Maternal employment and child cognitive outcomes: The importance of analytic approach. *Developmental Psychology, Vol 43(5)*:1140-1155.
11. Cawley, J. and Liu, F. (2007). Maternal employment and childhood obesity: A search for mechanisms in time use data. *NBER Working Paper Series, Paper no.13600*.
12. Chatterji, P., Markowitz, S., and Brooks-Gunn, J. (2011). Early maternal employment and family wellbeing. Working paper.
13. Cherry, F. F., & Eaton, E. L. (1977). Physical and cognitive development in children of low-income mothers working in the child's early years. *Child Development, 48,* 158–166.
14. Chia, Y. F. (2008). Maternal labor supply and childhood obesity in Canada: Evidence from the NLSCY. *Canadian Journal of Economics, 41,* 217–242.
15. Classen, T., & Hokayem, C. (2005). Childhood influences on youth obesity. *Economics and Human Biology, 3,* 165–187.
16. Corman, Hope, Nancy Reichman, and Kelly Noonan (2005), "Mother's Labor Supply in Fragile Families: The Role of Child Health." *National Poverty Center Working Paper Series,* Working Paper #04-6.

17. Desai, S., Chase-Lansdale, P. L., & Michael, R. T. (1989). Mother or market? Effects of maternal employment on the intellectual ability of 4-year-old children. *Demography, 26,* 545–561.
18. Farel, A. M. (1980). Effects of preferred maternal roles, maternal employment, and sociodemographic status on school adjustment and competence. *Child Development, 51,* 1179–1186.
19. Fertig, A., Glomm, G., & Tchernis, R. (2009). The connection between maternal employment and childhood obesity: Inspecting the mechanisms. *Review of Economics of the Household*, 7(3), 227-255.
20. Field, A. E., Cook, N. R., and Gillman, M. W (2005). Weight Status in childhood as a predictor of becoming overweight of hypertensive in early adulthood. *Obesity research 2005; vol 13*:163-169
21. Freedson, P.S., Pober, D. and Janz, K.F. (2005) Calibration of accelerometer output for children. *Medicine and Science in Sports and Exercise 37,* S523-S530.
22. Gennetian, L. A., Hill, H. D., London, A. S., & Lopoo, L. M. (2010). Maternal employment and the health of low-income young children. *Journal of Health Economics*, 29(3), 353-363.
23. Gordon, Rachel A., Robert Kaestner, and Sanders Korenman (2007). "Effects of Maternal Employment on Child Injuries and Infectious Disease." *Demography*, 44(2): 207-333.
24. Gould, Elise(2004). "Decomposing the effects of children's health on mother's labor supply: is it time or money?" *Health Economics, 13*, 525-541.
25. Greenstein, T. N. (1995). Are the "most advantaged" children truly disadvantaged by early maternal employment? *Journal of Family Issues, 16,* 149–169.
26. 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,* 445–459.
27. Hutner, F. C. (1972). Mother's education and working: Effect on the school child. *Journal of Psychology, 82,* 27–37.
28. Leibowitz, A. (1977). Parental inputs and children's achievement. *Journal of Human Resources, 12,* 242–251.
29. Liu, E., C. Hsiao, T. Matsumoto and S.-Y. Chou (2009). .Maternal Full-Time Employment and Overweight Children: Parametric, Semi-Parametric, and Non-Parametric Assessment. *Journal of Econometrics 152(1)*: 61-69.
30. Lohman, B. J., Stewart, S., Gundersen, C., Garasky, S., & Eisenmann, J. C. (2009). Adolescent overweight and obesity: links to food insecurity and individual, maternal, and family stressors. *Journal of Adolescent Health, 45(3)*, 230-237.
31. Mamun AA, McDermott BM, O'Callaghan MJ, Najman JM, et al. (2008). Predictors of maternal misclassifications of their offspring's weight status: A longitudinal study. *International Journal of Obesity 32*(1):48-54.
32. Morrill, M. (2011). The effects of maternal employment on the health of school-age children. *Journal of Health Economics*, 30(2), 240-257.

33. Nader PR, O'Brien M, Houts R, et al. Identifying Risk for Obesity in Early Childhood. *PEDIATRICS 2006;118*:e594–e601.
34. Norberg, Karen (1998). "The Effects of Daycare Reconsidered" *NBER Working Paper* No. W6769
35. Nye, F. I., & Hoffman, L. W. (1963). *The employed mother in America.* Chicago: Rand McNally.
36. Parcel, T.L., & Menaghan, E. G. (1994). Early parental work, family social capital, and early childhood outcomes. *American Journal of Sociology,* 99, 972-1009
37. Powers, Elizabeth T., "Children's Health and Maternal Work Activity: Estimates under Alternative Disability Definitions." *The Journal of Human Resources*, Vol. 38, No. 3 (Summer, 2003), 522-556.
38. Ruhm, C.J. (2004). Parental Employment and Child Cognitive Development. *Journal of Human Resources*, 39, 155-92.
39. Ruhm, C.J. (2008) Maternal employment and adolescent development. *Labour Economics*, 15, 958-983.
40. Scholder, S.V. H.K. (2008) Maternal Employment and Overweight Children: Does Timing Matter? *Health Economics* 17 (8), 889-906
41. Trzcinski, Eileen and Jerry Brandell. 2002. "Adolescent Outcomes, Poverty Status and Welfare Reform: An Analysis Based on the Survey of Program Dynamics." *Joint Center for Poverty Research Working Paper* No. 269, January.
42. Vandell, D., & Ramanan, J. (1992), Effects of early and recent maternal employment on children from low-income families. *Child Development,* 63, 938-949
43. Whitaker, R. et al. 1998. "Early adiposity rebound and the risk of adult obesity." *Pediatrics* 101(3):e5.

Table 1-1 Descriptive statistics by survey waves

Survey waves		1st grade	6th grade***	Age 15***
Obese	Yes	10.7%	15.5%	15%
Overweight	Yes	22.9%	31%	29.4%
Maternal employment	Not working	12.3%	10.3%	11%
	Part-time	52.7%	46.1%	40.7%
	Full-time	35%	43.6%	48.3%

Notes: *p<0.10, **p<0.05 ***p<0.01. Obesity, overweight and maternal employment at 6th grade and age 15 are different than at 1st grade with p<.001. Maternal employment for each wave is the maternal employment before that point of time, i.e., 1st grade maternal employment is during pre-school, 6th grade is during elementary school, and age 15 is during high school.

Table 1-2 Descriptive statistics by maternal employment status in elementary school

	Not working n=79	Part-time n=353	Full-time n=334	p-value		
	Mean	Mean	Mean	ANOVA	not working vs. part-time	not working vs. full-time
Child is obese at age 15	0.06	0.15	0.17	.06	.008	.003
Child is obese 6th grade	0.03	0.17	0.17	.01	<.001	<.001
Child is obese at 1st grade	0.05	0.12	0.11	.26	.03	.08
Child is overweight at age 15	0.18	0.31	0.31	.06	.01	.02
Child is overweight at 6th grade	0.17	0.32	0.33	.03	.005	.003
Child is overweight at 1st grade	0.18	0.24	0.22	.49	.25	.43
BMI at age 15	21.42 (3.80)	23.02 (5.25)	23.13 (4.90)	.02	.002	.001
BMI at 6th grade	18.95 (3.06)	20.55 (4.68)	20.70 (4.62)	.01	.001	<.001
BMI at 1st grade	16.11 (1.80)	16.76 (2.51)	16.70 (2.31)	.11	.01	.02
Female	0.61	0.5	0.5	.22	.10	.09
White	0.86	0.81	0.73	.001	.27	.005
Birth weight (kilogram)	3.5 (0.47)	3.5 (0.51)	3.48 (0.51)	.83	.96	.69
Having a low birth weight	0.01	0.02	0.03	.42	.63	.21
Being prematurely born	0.01	0.04	0.04	.41	.07	.06
Being firstborn	0.51	0.45	0.45	.60	.34	.34
Mother smoked during pregnancy	0.2	0.22	0.22	.92	.68	.76
Mother's age	29.19 (5.39)	28.79 (5.38)	28.61 (5.63)	.69	.55	.41
Mother having a health problem during pregnancy	0.29	0.33	0.3	.56	.49	.93
STDSCM36	100.67 (16.84)	101.1 (19.32)	98.26 (18.27)	.12	.85	.29
Planned pregnancy	0.33	0.29	0.41	.002	.45	.17
Household size(adults and kids)	3.84 (1.01)	4.06 (1.35)	4.01 (1.18)	.34	.09	.22
Number of adults	2.11 (0.62)	2.14 (0.71)	2.12 (0.60)	.91	.75	.91
Public assistance	0.10	0.16	0.16	.37	.11	.15
Total income-to-needs ratio	3.77 (2.63)	3.10 (2.33)	2.72 (2.36)	.001	.02	.001
Husband/partner lives with mother	0.90	0.88	0.88	.87	.66	.60

Abidin parenting stress index	55.04 (10.58)	54.02 (10.63)	52.24 (10.30)	.03	.44	.03
Maternal feeling about pregnancy	0.81	0.71	0.65	.01	.07	.002
Income before birth	58893 (40596)	51543 (35331)	47593 (32859)	.03	.10	.02
Baby's health at one month	0.96	0.97	0.98	.78	.59	.55
Health of mother at one month	0.94	0.95	0.96	.79	.66	.54
Mother's feeling about the baby	1.00	0.97	0.96	.18	.002	<.001
Any care more than 30 hours per week	0.48	0.68	0.90	<.001	.001	<.001
Mother's education less than high school	0.09	0.07	0.06	.54	.59	.36
Mother's education equal to high school	0.11	0.19	0.23	.06	.07	.009
Mother's education more than high school	0.80	0.74	0.72	.32	.28	.14

Notes: Table 2 shows the average of main variables for the three categories of maternal employment in elementary school, not working (work hours=0), part-time (0<work hours<35) and full-time (work hours>=35), and ANOVA test and pair-wise t-test of the difference among the three categories.

Table 1-3a Effect of maternal employment in different periods on obesity at age 15

	Probit		LPM		Probit		Probit		Probit		Probit	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.	β	S.E.	β	S.E.
3 years part-time	0.036	0.192	0.008	0.040	0.036	0.181						
3 years full-time	0.403	0.243	0.082	0.051	0.386*	0.210						
Pre-school part-time	-0.273	0.215	-0.063	0.046			-0.161	0.197				
Pre-school full-time	-0.250	0.278	-0.058	0.060			0.073	0.222				
Elementary school part-time	0.653** [0.135]	0.288	0.127**	0.052					0.465*	0.252		
Elementary school full-time	0.675** [0.144]	0.323	0.131**	0.062					0.531**	0.259		
High school part-time	-0.244	0.238	-0.047	0.050							-0.014	0.206
High school full-time	-0.331	0.254	-0.073	0.054							0.016	0.206
Intercept	-0.873	1.400	0.293	0.294								
marry	-0.295**	0.138	-0.072**	0.031								
Mother graduated from high school	-0.458*	0.252	-0.146**	0.062								
Mother attended college	-0.506*	0.261	-0.152**	0.064								
White	-0.034	0.167	-0.002	0.037								
Birth weight (kilogram)	0.465***	0.134	0.097***	0.029								
Having a low birth weight	0.458	0.431	0.081	0.090								
Being prematurely born	0.056	0.355	0.034	0.069								
Being firstborn	0.057	0.169	0.013	0.036								
Mother smoked during pregnancy	0.110	0.148	0.024	0.033								
Mother's age	-0.023	0.015	-0.004	0.003								
Mother having a health problem during pregnancy	0.089	0.131	0.020	0.028								
STDSCM36	0.002	0.004	0.000	0.001								
Planned pregnancy	0.036	0.150	0.002	0.033								
Household size(adults and kids)	0.030	0.072	0.009	0.017								
Number of adults	-0.019	0.116	-0.007	0.028								
Public assistance	0.076	0.197	0.027	0.047								
Husband/partner lives with mother	0.345	0.225	0.090	0.051								
Abidin parenting stress index	-0.002	0.006	0.000	0.001								
Maternal feeling about pregnancy	0.012	0.158	0.003	0.034								
Log of income before birth	-0.244**	0.105	-0.049**	0.023								
Baby's health at one month	1.049*	0.579	0.149*	0.082								
Health of mother at one month	-0.011	0.268	0.003	0.063								
Mother's feeling about the baby	0.258	0.410	0.050	0.077								
Any care more than 30 hours per week	-0.200	0.176	-0.033	0.036								
Dummy for missing income-to needs ratio	0.223	0.298	0.065	0.072								
Dummy for missing log of income before birth	0.442	0.304	0.083	0.073								
R^2			0.06									
N	766		766		766		766		766		766	

Notes: *p<0.10, **p<0.05 ***p<0.01. Table 3a shows the Probit and LPM regression results for obesity at age 15. The first two columns include maternal employment in all four stages. The last four columns include maternal employment one stage at a time. All regressions include the basic set of variables shown in table 2 except obesity, female and BMI, but only the first two regressions are shown with the coefficients for those covariates. In the brackets in the first probit column for elementary part-time and full-time are the marginal effects.

Table 1-3b Effect of maternal employment in different periods on obesity at 6th grade

	Probit		LPM		Probit		Probit		Probit	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.	β	S.E.
3 years part-time	-0.318	0.199	-0.057	0.043	-0.246	0.184				
3 years full-time	-0.093	0.250	-0.004	0.054	0.096	0.211				
Pre-school part-time	-0.232	0.229	-0.050	0.049			-0.158	0.205		
Pre-school full-time	0.078	0.290	0.020	0.063			0.222	0.230		
Elementary school part-time	1.048***	0.346	0.152***	0.050					0.969***	0.338
Elementary school full-time	0.905**	0.365	0.116*	0.056					0.994***	0.344
Other covariates	x		x		x		x		x	
R^2			0.06							
N	766		766		766		766		766	

Notes: *p<0.10, **p<0.05 ***p<0.01. Table 3b shows the Probit and LPM regression results for obesity in 6th grade. The first two columns include maternal employment in the first three stages. The last three columns include maternal employment one stage at a time. All regressions include the basic set of variables shown in table 2 except obesity, female and BMI.

Table 1-3c Effect of maternal employment in different periods on obesity at 1st grade

	Probit		LPM		Probit		Probit	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.
3 years part-time	-0.187	0.215	-0.029	0.038	-0.265	0.204		
3 years full-time	0.156	0.269	0.034	0.048	0.060	0.230		
Pre-school part-time	-0.342	0.227	-0.059	0.042			-0.351	0.216
Pre-school full-time	-0.310	0.283	-0.056	0.051			-0.163	0.242
Other covariates	x		x		x		x	
R^2			0.01					
N	766		766		766		766	

Notes: *p<0.10, **p<0.05 ***p<0.01. Table 3c shows the Probit and LPM regression results for obesity in 1st grade. The first two columns include maternal employment in the first two stages. The last two columns include maternal employment one stage at a time. All regressions include the basic set of variables shown in table 2 except obesity, BMI and female.

Table 1-4a Mundlak specification for obesity at age 15

	Probit		LPM		Probit		Probit		Probit		Probit	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.	β	S.E.	β	S.E.
3 years part-time	0.018	0.195	0.003	0.041	0.039	0.186						
3 years full-time	0.311	0.247	0.063	0.052	0.316	0.217						
Pre-school part-time	-0.290	0.219	-0.065	0.047			-0.171	0.203				
Pre-school full-time	-0.266	0.281	-0.060	0.060			0.016	0.229				
Elementary school part-time	0.709**	0.296	0.131**	0.052					0.512**	0.257		
Elementary school full-time	0.734**	0.331	0.136**	0.062					0.544**	0.263		
High school part-time	-0.230	0.241	-0.043	0.050							0.025	0.209
High school full-time	-0.338	0.257	-0.074	0.054							0.013	0.208
Before-birth part-time	0.141	0.247	0.026	0.050	0.032	0.236	0.093	0.236	0.088	0.233	0.063	0.229
Before-birth full-time	0.448	0.246	0.086	0.050	0.341	0.235	0.428*	0.232	0.460*	0.232	0.432*	0.227
Other covariates	x		x		x		x		x		x	
R^2			0.06									
N	766		766		766		766		766		766	

Notes: *p<0.10, **p<0.05 ***p<0.01. Table 4a shows the Probit and LPM regression results for obesity at age 15. The first two columns include maternal employment in all four stages after birth plus maternal employment before birth. The last four columns include maternal employment one stage at a time. All regressions include maternal employment before birth and the basic set of variables shown in table 2 except obesity and female.

Table 1-4b Mundlak specification for obesity at 6th grade

	Probit		LPM		Probit		Probit		Probit	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.	β	S.E.
3 years part-time	-0.331	0.202	-0.062	0.044	-0.241	0.190				
3 years full-time	-0.160	0.254	-0.019	0.055	0.052	0.219				
Pre-school part-time	-0.253	0.236	-0.053	0.050			-0.139	0.213		
Pre-school full-time	0.057	0.293	0.017	0.064			0.212	0.238		
Elementary school part-time	1.080***	0.349	0.157***	0.050					0.989***	0.338
Elementary school full-time	0.937**	0.367	0.119**	0.056					0.994***	0.344
Before-birth part-time	0.127	0.258	0.025	0.054	-0.021	0.241	-0.036	0.242	-0.027	0.240
Before-birth full-time	0.352	0.257	0.069	0.053	0.219	0.241	0.222	0.238	0.286	0.240
Other covariates	x		x		x		x		x	
R^2			0.06							
N	766		766		766		766		766	

Notes: *p<0.10, **p<0.05 ***p<0.01. Table 4b shows the Probit and LPM regression results for obesity in 6th grade. The first two columns include maternal employment in the first three stages after birth plus maternal employment before birth. The last three columns include maternal employment one stage at a time. All regressions include maternal employment before birth and the basic set of variables shown in table 2 except obesity and female.

Table 1-4c Mundlak specification for obesity at 1st grade

	Probit		LPM		Probit		Probit	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.
3 years part-time	-0.210	0.219	-0.032	0.039	-0.268	0.212	-0.359	0.225
3 years full-time	0.093	0.275	0.024	0.049	0.016	0.240	-0.195	0.251
Pre-school part-time	-0.352	0.233	-0.060	0.043				
Pre-school full-time	-0.316	0.288	-0.057	0.052				
Before-birth part-time	0.098	0.284	0.015	0.048	-0.001	0.274	0.056	0.275
Before-birth full-time	0.277	0.278	0.041	0.048	0.208	0.273	0.283	0.267
Other covariates	x		x		x		x	
R^2			0.01					
N	766		766		766		766	

Notes: *p<0.10, **p<0.05 ***p<0.01. Table 4c shows the Probit and LPM regression results for obesity in 1st grade. The first two columns include maternal employment in the first two stages after birth plus maternal employment before birth. The last three columns include maternal employment one stage at a time. All regressions include maternal employment before birth and the basic set of variables shown in table 2 except obesity and female.

Table 1-5 Fixed effect model

	Equation 14-1		Equation 14-2	
	β	S.E.	β	S.E.
Elementary school part-time	0.05*	0.03	0.05*	0.03
Elementary school full-time	0.07**	0.03	0.07**	0.03
High school part-time	-	-	-0.06	.04
High school full-time	-	-	-0.06	.04
N	672			

Notes: *p<0.10, **p<0.05 ***p<0.01.

Table 1-6a Obesity at age 15 regressed on demographic variable and mechanism variables (one at a time) without maternal employment.

Mechanism Variable	β	S.E.	p-value
minutes of moderate and vigorous physical activity in 3rd grade	-0.0005	0.0003	0.084
minutes of moderate and vigorous physical activity on weekends in 3rd grade	-0.0004	0.0002	0.038
minutes of vigorous physical activity in 3rd grade	-0.0048	0.0012	<.0001
minutes of vigorous physical activity on weekdays in 3rd grade	-0.0046	0.0012	0.000
minutes of vigorous physical activity on weekends in 3rd grade	-0.0027	0.0009	0.003
minutes of very vigorous physical activity in 3rd grade	-0.0062	0.0020	0.002
minutes of very vigorous physical activity on weekdays in 3rd grade	-0.0064	0.0019	0.001
minutes of moderate and vigorous physical activity in 6th grade	-0.0008	0.0004	0.067
minutes of moderate and vigorous physical activity on weekdays in 6th grade	-0.0007	0.0004	0.099
minutes of vigorous physical activity in 6th grade	-0.0060	0.0020	0.003
minutes of vigorous physical activity on weekdays in 6th grade	-0.0050	0.0019	0.009
minutes of vigorous physical activity on weekends in 6th grade	-0.0027	0.0014	0.058
minutes of vigorous physical activity at age 15	-0.0085	0.0030	0.005
minutes of vigorous physical activity on weekdays at age 15	-0.0080	0.0029	0.006
minutes of very vigorous physical activity at age 15	-0.0117	0.0055	0.035
minutes of very vigorous physical activity on weekdays at age 15	-0.0111	0.0053	0.038
number of times watching TV or videos/day in 4th grade	0.0181	0.0067	0.007
number of times watching TV or videos/day in 5th grade	0.0110	0.0053	0.037
minutes watching TV or videos/day in 5th grade	0.0005	0.0002	0.010
minutes of reported light activity/day in 5th grade	0.0008	0.0003	0.014
number of times watching TV or videos/day on weekdays in 5th grade	0.0095	0.0026	0.000
minutes of reported light activity/day in 6th grade	0.0008	0.0004	0.036
minutes of reported sedentary activity/day in 6th grade	0.0003	0.0001	0.022
minutes of video or computer time/day in 6th grade	0.0006	0.0003	0.035
number of times watching TV or videos/day on weekdays at age 15	0.0060	0.0019	0.002
bread consumption in the morning	0.4266	0.2421	0.079

Mechanism Variable	β	S.E.	p-value
60 minutes or more of moderate and vigorous physical activity in 3rd grade (without maternal employment)	0.198	0.253	.43
60 minutes or more of moderate and vigorous physical activity in 6th grade	0.004	0.04	.93
60 minutes or more of moderate and vigorous physical activity at age 15	-0.03	0.04	.36
60 minutes or more of moderate and vigorous physical activity in 3rd grade (with maternal employment)	0.22	0.25	.39
60 minutes or more of moderate and vigorous physical activity in 6th grade	0.006	0.04	.89
60 minutes or more of moderate and vigorous physical activity at age 15	-0.04	0.04	.33

Table 1-6b Obesity at 6th grade regressed on demographic variable and mechanism variables (one at a time) without maternal employment.

Mechanism Variable	β	S.E.	p-value
minutes of moderate physical activity in 3rd grade	-0.0008	0.0004	0.045
minutes of moderate physical activity on weekends in 3rd grade	-0.0006	0.0003	0.039
minutes of moderate and vigorous physical activity in 3rd grade	-0.0010	0.0003	0.002
minutes of moderate and vigorous physical activity on weekdays in 3rd grade	-0.0009	0.0003	0.004
minutes of moderate and vigorous physical activity on weekends in 3rd grade	-0.0006	0.0002	0.009
minutes of vigorous physical activity in 3rd grade	-0.0055	0.0013	<.0001
minutes of vigorous physical activity on weekdays in 3rd grade	-0.0057	0.0013	<.0001
minutes of vigorous physical activity on weekends in 3rd grade	-0.0029	0.0010	0.003
minutes of very vigorous physical activity in 3rd grade	-0.0075	0.0021	0.000
minutes of very vigorous physical activity on weekdays in 3rd grade	-0.0077	0.0020	<.0001
minutes of very vigorous physical activity on weekends in 3rd grade	-0.0031	0.0017	0.071
minutes of moderate physical activity in 6th grade	-0.0012	0.0006	0.043
minutes of moderate and vigorous physical activity in 6th grade	-0.0011	0.0004	0.011
minutes of moderate and vigorous physical activity on weekdays in 6th grade	-0.0008	0.0004	0.049
minutes of moderate and vigorous physical activity on weekends in 6th grade	-0.0006	0.0003	0.054
minutes of vigorous physical activity in 6th grade	-0.0065	0.0021	0.002
minutes of vigorous physical activity on weekdays in 6th grade	-0.0052	0.0020	0.009
minutes of vigorous physical activity on weekends in 6th grade	-0.0024	0.0014	0.093
number of times watching TV or videos/day in 4th grade	0.0245	0.0071	0.001
number of times watching TV or videos/day in 5th grade	0.0118	0.0056	0.037
minutes watching TV or videos/day in 5th grade	0.0004	0.0002	0.061
minutes of reported heavy activity/day in 5th grade	-0.0002	0.0003	0.484
minutes of reported light activity/day in 5th grade	0.0003	0.0003	0.315
number of times watching TV or videos/day on weekdays in 5th grade	0.0102	0.0028	0.000
minutes of reported heavy activity/day in 6th grade	0.0002	0.0003	0.495
minutes of reported light activity/day in 6th grade	0.0007	0.0004	0.086
60 minutes or more of moderate and vigorous physical activity in 3rd grade (without maternal employment)	0.193	0.26	.45

Mechanism Variable	β	S.E.	p-value
60 minutes or more of moderate and vigorous physical activity in 6th grade	-0.005	0.04	.91
60 minutes or more of moderate and vigorous physical activity in 3rd grade (with maternal employment)	0.17	0.26	.51
60 minutes or more of moderate and vigorous physical activity in 6th grade	0.002	0.04	.96

Table 1-7 Measures of physical activity (by accelerometer) at 3rd grade regressed on demographic variables and maternal employment after birth with and without maternal employment before birth.

Physical activity in 3rd grade	Maternal employment	β	p-value	β	p-value
Moderate and vigorous					
	3 month part-time	4.38751	0.4856	3.23545	0.5939
	3 month full-time	-0.89526	0.9082	-1.17454	0.8740
	Pre-school part-time	-12.29549	0.1016	-13.50516	0.0680
	Pre-school full-time	-14.19717	0.1257	-15.21668	0.0979
	1st to 3rd grade part-time	0.50252	0.9383	0.70941	0.9126
	1st to 3rd grade full-time	-4.00060	0.5752	-3.84882	0.5896
	Before birth part-time	-7.00816	0.3662		
	Before birth full-time	-1.50254	0.8415		
Moderate and vigorous on weekends					
	3 month part-time	9.91443	0.2582	5.19745	0.5398
	3 month full-time	2.64169	0.8083	-1.65546	0.8737
	Pre-school part-time	-18.72540	0.0714	-22.56279	0.0281
	Pre-school full-time	-18.74731	0.1472	-22.16853	0.0851
	1st to 3rd grade part-time	6.93093	0.4430	8.44567	0.3492
	1st to 3rd grade full-time	-9.03355	0.3634	-8.53730	0.3914
	Before birth part-time	-23.52092	0.0291		
	Before birth full-time	-14.97196	0.1496		
Vigorous					
	3 month part-time	0.65896	0.6682	0.15600	0.9163
	3 month full-time	-0.53928	0.7763	-0.89812	0.6200
	Pre-school part-time	-0.71748	0.6955	-1.17350	0.5163
	Pre-school full-time	-1.41252	0.5327	-1.81702	0.4186
	1st to 3rd grade part-time	-1.28808	0.4172	-1.15925	0.4636

Physical activity in 3rd grade	Maternal employment	β	p-value	β	p-value
	1st to 3rd grade full-time	-2.32819	0.1824	-2.26565	0.1944
	Before birth part-time	-2.70584	0.1536		
	Before birth full-time	-1.32716	0.4699		
Vigorous on weekdays					
	3 month part-time	0.39854	0.7972	0.11763	0.9373
	3 month full-time	-0.51238	0.7889	-0.69228	0.7043
	Pre-school part-time	-0.58806	0.7505	-0.84900	0.6410
	Pre-school full-time	-1.76056	0.4408	-1.99000	0.3792
	1st to 3rd grade part-time	-1.57548	0.3252	-1.50686	0.3443
	1st to 3rd grade full-time	-1.95496	0.2668	-1.91971	0.2749
	Before birth part-time	-1.54188	0.4199		
	Before birth full-time	-0.68313	0.7123		
Vigorous on weekends					
	3 month part-time	1.49515	0.4775	0.37604	0.8535
	3 month full-time	-0.44065	0.8661	-1.32315	0.5968
	Pre-school part-time	-2.02557	0.4162	-2.96944	0.2283
	Pre-school full-time	-0.79141	0.7987	-1.61994	0.6001
	1st to 3rd grade part-time	0.39566	0.8553	0.74069	0.7325
	1st to 3rd grade full-time	-2.88005	0.2277	-2.76541	0.2480
	Before birth part-time	-5.76276	0.0260		
	Before birth full-time	-3.17532	0.2030		
Very vigorous					
	3 month part-time	-0.76217	0.4234	-0.96882	0.2912
	3 month full-time	-0.79083	0.5010	-1.06964	0.3396
	Pre-school part-time	2.14179	0.0596	1.99439	0.0747
	Pre-school full-time	1.89339	0.1771	1.74970	0.2079
	1st to 3rd grade part-time	-1.58759	0.1066	-1.51330	0.1220

Physical activity in 3rd grade	Maternal employment	β	p-value	β	p-value
	1st to 3rd grade full-time	-1.92349	0.0754	-1.89986	0.0786
	Before birth part-time	-0.91556	0.4353		
	Before birth full-time	-0.91747	0.4198		
Very vigorous on weekdays					
	3 month part-time	-1.08861	0.2831	-1.09324	0.2633
	3 month full-time	-0.88493	0.4796	-1.00560	0.3991
	Pre-school part-time	1.81906	0.1328	1.85057	0.1202
	Pre-school full-time	1.73125	0.2464	1.74763	0.2374
	1st to 3rd grade part-time	-1.91395	0.0678	-1.89368	0.0692
	1st to 3rd grade full-time	-2.13016	0.0645	-2.13143	0.0639
	Before birth part-time	0.15032	0.9042		
	Before birth full-time	-0.34472	0.7759		
Number of times watching TV or videos/day in 4th grade					
	3 month part-time	0.03583	0.8791	0.06471	0.7785
	3 month full-time	0.05605	0.8453	0.08141	0.7683
	Pre-school part-time	0.15111	0.5859	0.18533	0.4963
	Pre-school full-time	-0.00053575	0.9988	0.03470	0.9192
	1st to 3rd grade part-time	-0.09711	0.6811	-0.10217	0.6641
	1st to 3rd grade full-time	0.22529	0.3892	0.22319	0.3931
	Before birth part-time	0.19611	0.5017		
	Before birth full-time	0.13779	0.6309		

Table 1-8 Measures of physical activity (by accelerometer) at 6rd grade regressed on demographic variables and maternal employment after birth with and without maternal employment before birth, and in fixed effect model.

Physical activity in 6th grade	Maternal employment	β	p-value	β	p-value	β	p-value
Moderate and vigorous							
	3 month part-time	8.66055	0.0945	6.16823	0.2243		
	3 month full-time	5.36731	0.4002	1.90338	0.7564		
	Pre-school part-time	-3.00485	0.6218	-4.94809	0.4121		
	Pre-school full-time	-1.84458	0.8118	-3.84205	0.6180		
	1st to 3rd grade part-time	4.42963	0.4293	5.04555	0.3684		
	1st to 3rd grade full-time	0.07938	0.9906	0.13079	0.9846		
	4th to 6th grade part-time	-7.69739	0.1796	-6.82799	0.2340	-6.55370	0.3648
	4th to 6th grade full-time	-10.14753	0.1234	-9.62105	0.1443	-10.80513	0.1241
	Before birth part-time	-13.82813	0.0318				
	Before birth full-time	-13.56614	0.0301				
Moderate and vigorous on weekdays							
	3 month part-time	10.39018	0.0530	7.11905	0.1775		
	3 month full-time	5.06541	0.4435	0.54530	0.9318		
	Pre-school part-time	-1.67554	0.7905	-4.24669	0.4981		
	Pre-school full-time	-4.13974	0.6061	-6.79944	0.3961		
	1st to 3rd grade part-time	1.09657	0.8501	1.89547	0.7449		
	1st to 3rd grade full-time	1.45919	0.8352	1.54657	0.8265		
	4th to 6th grade part-time	-4.87684	0.4115	-3.72003	0.5325	-5.57521	0.4678
	4th to 6th grade full-time	-6.58947	0.3342	-5.89821	0.3892	-13.53427	0.0697
	Before birth part-time	-18.27597	0.0063				
	Before birth full-time	-17.79237	0.0061				
Vigorous							
	3 month part-time	1.57967	0.1426	1.22865	0.2437		
	3 month full-time	0.63826	0.6306	-0.01533	0.9904		
	Pre-school part-time	0.53222	0.6745	0.33901	0.7866		
	Pre-school full-time	1.59621	0.3222	1.40004	0.3816		
	1st to 3rd grade part-time	-0.56327	0.6290	-0.42783	0.7132		
	1st to 3rd grade full-time	-1.56968	0.2642	-1.53185	0.2762		
	4th to 6th grade part-time	-1.68631	0.1577	-1.59409	0.1809	-2.59579	0.1108
	4th to 6th grade full-time	-1.46842	0.2837	-1.46371	0.2845	-2.52421	0.1103
	Before birth part-time	-1.57719	0.2385				
	Before birth full-time	-2.22883	0.0866				
Vigorous on weekdays							
	3 month part-time	2.08289	0.0628	1.61989	0.1397		
	3 month full-time	0.70023	0.6113	-0.15831	0.9049		
	Pre-school part-time	0.21195	0.8720	-0.04421	0.9729		
	Pre-school full-time	0.93410	0.5768	0.67480	0.6851		
	1st to 3rd grade part-time	-1.32775	0.2728	-1.15006	0.3422		
	1st to 3rd grade full-time	-2.12256	0.1470	-2.07461	0.1574		
	4th to 6th grade part-time	-0.48082	0.6977	-0.35910	0.7717	-1.25366	0.4516
	4th to 6th grade full-time	0.25478	0.8578	0.26305	0.8533	-1.49838	0.3538
	Before birth part-time	-2.08473	0.1336				
	Before birth full-time	-2.93110	0.0300				
Vigorous on weekends							

Physical activity in 6th grade	Maternal employment	β	p-value	β	p-value	β	p-value
	3 month part-time	-0.65419	0.6931	-0.57853	0.7199		
	3 month full-time	-0.18227	0.9299	-0.07097	0.9715		
	Pre-school part-time	1.35816	0.4788	1.39975	0.4591		
	Pre-school full-time	2.31888	0.3457	2.37361	0.3287		
	1st to 3rd grade part-time	2.31225	0.1946	2.29568	0.1961		
	1st to 3rd grade full-time	1.95784	0.3643	1.95002	0.3651		
	4th to 6th grade part-time	-4.84121	0.0078	-4.86492	0.0072	-1.25366	0.4516
	4th to 6th grade full-time	-6.80030	0.0013	-6.80947	0.0012	-1.49838	0.3538
	Before birth part-time	0.37320	0.8567				
	Before birth full-time	0.41845	0.8363				

Table 1-9 Measures of physical activity (by accelerometer) at age 15 regressed on demographic variables and maternal employment after birth with and without maternal employment before birth, and in fixed effect model.

Physical activity at age 15	Maternal employment	β	p-value	β	p-value	β	p-value
Vigorous							
	3 month part-time	0.08986	0.9090	0.01828	0.9810		
	3 month full-time	-0.64238	0.5027	-0.68901	0.4565		
	Pre-school part-time	0.80277	0.3936	0.72750	0.4325		
	Pre-school full-time	0.27967	0.8079	0.20624	0.8561		
	1st to 3rd grade part-time	-1.22848	0.1686	-1.24224	0.1620		
	1st to 3rd grade full-time	-1.81541	0.0807	-1.85214	0.0734		
	4th to 6th grade part-time	0.80057	0.4325	0.82256	0.4186	-1.70787	0.4386
	4th to 6th grade full-time	0.58247	0.6266	0.63389	0.5944	1.65496	0.4988
	7th grade to age 15 part-time	0.56770	0.5604	0.55103	0.5710	-1.33163	0.5512
	7th grade to age 15 full-time	1.34304	0.2163	1.32878	0.2201	-3.55822	0.1453
	Before birth part-time	-0.49270	0.6252				
	Before birth full-time	-0.31258	0.7498				
Vigorous on weekdays							
	3 month part-time	0.01419	0.9864	-0.04317	0.9575		
	3 month full-time	-0.66848	0.5097	-0.69945	0.4748		
	Pre-school part-time	0.77750	0.4348	0.71468	0.4661		
	Pre-school full-time	0.43445	0.7211	0.37405	0.7560		
	1st to 3rd grade part-time	-1.09891	0.2442	-1.11280	0.2362		
	1st to 3rd grade full-time	-1.82878	0.0962	-1.86104	0.0889		
	4th to 6th grade part-time	0.68779	0.5238	0.70646	0.5114	-1.31809	0.5584
	4th to 6th grade full-time	0.58011	0.6470	0.62461	0.6199	0.91297	0.7149
	7th grade to age 15 part-time	0.49481	0.6314	0.48054	0.6404	-0.83106	0.7157
	7th grade to age 15 full-time	1.17135	0.3079	1.15924	0.3118	-2.17377	0.3834
	Before birth part-time	-0.40790	0.7023				
	Before birth full-time	-0.23619	0.8199				
Very vigorous							
	3 month part-time	-0.19846	0.6451	-0.27018	0.5206		
	3 month full-time	-0.24212	0.6448	-0.30824	0.5435		
	Pre-school part-time	0.55382	0.2830	0.48597	0.3391		
	Pre-school full-time	0.18142	0.7735	0.11252	0.8569		
	1st to 3rd grade part-time	-0.35516	0.4674	-0.36028	0.4592		
	1st to 3rd grade full-time	-0.47190	0.4068	-0.50016	0.3773		
	4th to 6th grade part-time	0.55242	0.3232	0.57126	0.3058	-1.07375	0.4650
	4th to 6th grade full-time	0.74256	0.2582	0.78414	0.2301	0.73727	0.6511
	7th grade to age 15 part-time	0.52650	0.3247	0.51259	0.3367	0.20505	0.8904
	7th grade to age 15 full-time	0.09969	0.8669	0.08745	0.8829	-1.91516	0.2393
	Before birth part-time	-0.45423	0.4114				
	Before birth full-time	-0.35657	0.5071				
Very vigorous on weekdays							
	3 month part-time	-0.41320	0.3553	-0.47943	0.2717		
	3 month full-time	-0.59434	0.2754	-0.66111	0.2091		
	Pre-school part-time	0.87857	0.1008	0.81813	0.1209		
	Pre-school full-time	0.65035	0.3201	0.58810	0.3634		

Physical activity at age 15	Maternal employment	β	p-value	β	p-value	β	p-value
	1st to 3rd grade part-time	-0.19358	0.7024	-0.19576	0.6980		
	1st to 3rd grade full-time	-0.49379	0.4026	-0.51738	0.3784		
	4th to 6th grade part-time	0.32314	0.5772	0.33961	0.5569	-0.92020	0.5441
	4th to 6th grade full-time	0.65057	0.3393	0.68605	0.3110	0.78711	0.6401
	7th grade to age 15 part-time	0.48826	0.3784	0.47623	0.3892	0.20186	0.8955
	7th grade to age 15 full-time	0.00950	0.9877	-0.00119	0.9985	-1.96505	0.2422
	Before birth part-time	-0.40789	0.4768				
	Before birth full-time	-0.34206	0.5394				
Number of times watching TV or videos/day on weekdays at age 15							
	3 month part-time	0.40880	0.6103	0.34586	0.6576		
	3 month full-time	-0.42185	0.6678	-0.34908	0.7119		
	Pre-school part-time	-0.20504	0.8289	-0.30886	0.7404		
	Pre-school full-time	1.07146	0.3687	0.96819	0.4108		
	1st to 3rd grade part-time	0.27226	0.7647	0.21035	0.8165		
	1st to 3rd grade full-time	0.26194	0.8062	0.20769	0.8455		
	4th to 6th grade part-time	1.65008	0.1012	1.69867	0.0911		
	4th to 6th grade full-time	1.98177	0.0980	2.07431	0.0825		
	7th grade to age 15 part-time	-0.31727	0.7385	-0.32539	0.7316		
	7th grade to age 15 full-time	-0.47798	0.6556	-0.48631	0.6497		
	Before birth part-time	-0.66689	0.5043				
	Before birth full-time	0.02900	0.9764				

Notes: By age 15 the effect of maternal employment on physical activity disappeared. But the effect on watching TV or videos was still marginally significant.

Table 1-10 Measures of TV viewing, physical activity (self-report) at 5rd grade regressed on demographic variables and maternal employment after birth with and without maternal employment before birth.

Mechanism variable	Maternal employment	β	p-value	β	p-value
Number of times watching TV or videos/day in 5th grade					
	3 month part-time	0.43448	0.1655	0.48816	0.1104
	3 month full-time	0.66753	0.0819	0.75920	0.0400
	Pre-school part-time	-0.64631	0.0784	-0.59728	0.0964
	Pre-school full-time	-0.74338	0.1079	-0.68930	0.1301
	1st to 5th grade part-time	0.31843	0.3758	0.29714	0.4067
	1st to 5th grade full-time	0.31034	0.4468	0.29879	0.4630
	Before birth part-time	0.24291	0.5281		
	Before birth full-time	0.33671	0.3742		
Minutes watching TV or videos/day in 5th grade					
	3 month part-time	-2.74895	0.7495	-0.29723	0.9716
	3 month full-time	-3.93197	0.7094	-0.38942	0.9693
	Pre-school part-time	-5.24619	0.6015	-3.07087	0.7547
	Pre-school full-time	-8.37887	0.5022	-6.03992	0.6235
	1st to 5th grade part-time	23.74890	0.0168	22.53365	0.0224
	1st to 5th grade full-time	29.74818	0.0075	28.89381	0.0092
	Before birth part-time	11.30605	0.2870		
	Before birth full-time	12.78601	0.2171		
Minutes of light activity in 5th grade					
	3 month part-time	12.24987	0.0234	12.24765	0.0195
	3 month full-time	9.34594	0.1576	8.16721	0.1977
	Pre-school part-time	0.66501	0.9158	1.03510	0.8664
	Pre-school full-time	-4.40878	0.5729	-4.18316	0.5872
	1st to 5th grade part-time	-3.55911	0.5663	-3.62109	0.5571
	1st to 5th grade full-time	5.47691	0.4304	5.39441	0.4360
	Before birth part-time	1.82927	0.7832		
	Before birth full-time	-2.81318	0.6644		

Mechanism variable	Maternal employment	β	p-value	β	p-value
Number of times watching TV or videos/day on weekdays in 5th grade					
	3 month part-time	-0.68695	0.2487	-0.54807	0.3467
	3 month full-time	-0.96543	0.1835	-0.63711	0.3630
	Pre-school part-time	-0.44601	0.5195	-0.33535	0.6215
	Pre-school full-time	0.33016	0.7030	0.47304	0.5798
	1st to 5th grade part-time	1.85111	0.0069	1.79131	0.0087
	1st to 5th grade full-time	2.27355	0.0032	2.23831	0.0037
	Before birth part-time	0.53816	0.4642		
	Before birth full-time	1.11967	0.1198		

Table 1-11 Measures of TV viewing, physical activity (self-report) at 6[rd] grade regressed on demographic variables, maternal employment after and before birth.

Mechanism variable	Maternal employment	β	p-value	β	p-value
Minutes of light activity in 6th grade					
	3 month part-time	0.27778	0.9506	2.93900	0.5008
	3 month full-time	-3.10878	0.5801	-0.25950	0.9615
	Pre-school part-time	-0.00437	0.9993	2.41915	0.6463
	Pre-school full-time	-1.03179	0.8764	1.38450	0.8336
	1st to 5th grade part-time	-0.78036	0.8967	-2.11614	0.7248
	1st to 5th grade full-time	3.64986	0.6019	2.57039	0.7136
	6th grade part-time	-4.33517	0.3554	-3.93338	0.4031
	6th grade full-time	-6.66517	0.1455	-6.41770	0.1616
	Before birth part-time	14.34362	0.0105		
	Before birth full-time	11.59545	0.0351		
Minutes of sedentary activity in 6th grade					
	3 month part-time	9.24499	0.4247	7.32092	0.5142
	3 month full-time	22.50486	0.1210	22.39062	0.1057
	Pre-school part-time	-14.95354	0.2781	-17.80778	0.1892
	Pre-school full-time	-25.63283	0.1348	-28.21182	0.0963
	1st to 5th grade part-time	-6.04736	0.6968	-4.93507	0.7495
	1st to 5th grade full-time	18.26360	0.3120	18.81963	0.2962
	6th grade part-time	19.18709	0.1132	18.87429	0.1189
	6th grade full-time	10.86832	0.3575	11.21860	0.3411
	Before birth part-time	-14.89109	0.3021		
	Before birth full-time	-4.99226	0.7248		
Minutes of video or computer time/day in 6th grade					
	3 month part-time	8.54348	0.1792	8.88145	0.1494
	3 month full-time	22.92772	0.0041	22.48746	0.0031
	Pre-school part-time	-1.99547	0.7919	-1.22992	0.8686
	Pre-school full-time	-12.92158	0.1695	-12.26233	0.1873
	1st to 5th grade part-time	1.85996	0.8271	1.62426	0.8480
	1st to 5th grade full-time	-5.07482	0.6087	-5.10963	0.6050
	6th grade part-time	4.06988	0.5402	4.13531	0.5330
	6th grade full-time	8.75025	0.1778	8.54634	0.1867
	Before birth part-time	3.73080	0.6377		
	Before birth full-time	0.09499	0.9903		

Table 1-12 Correlations between self-reported and objective measures of physical activity.

		Moderate in 6th grade	Moderate on weekdays in 6th grade	Moderate on weekends in 6th grade	Moderate and vigorous in 6th grade	Moderate and vigorous on weekdays in 6th grade	Moderate and vigorous on weekends in 6th grade
Self-reported light activity in 6th grade	Correlation coefficient R	-0.021	-0.009	-0.024	-0.024	-0.019	-0.019
	p-value	.63	.82	.59	.58	.65	.67
	n	503	502	470	503	502	470

		Moderate and vigorous in 6th grade	Moderate and vigorous on weekdays in 6th grade	Moderate and vigorous on weekends in 6th grade	Vigorous in 6th grade
Self-reported heavy activity in 6th grade	R	0.150	0.186	0.037	0.187
	p-value	<.001	<.001	.41	<.001
	n	503	502	470	503

		Vigorous on weekdays in 6th grade	Vigorous on weekends in 6th grade	Very vigorous in 6th grade	Very vigorous on weekdays in 6th grade	Very vigorous on weekends in 6th grade
Self-reported heavy activity in 6th grade	R	0.216	0.073	0.082	0.095	0.050
	p-value	<.001	.11	.06	.03	.27
	n	502	470	503	502	470

Table 1-13 Sample attrition

Assesment time point	Frequency
1 moth	1364
15 moths	1164
24 moths	1108
36 moths	1128
54 moths	1045
Grade 1	1002
Grade 3	950
Grade 5	931
Grade 6	918
Grade 7	801
Grade 8	741
15 years	913

Table 1-14 Comparison of sample with deleted observations

	Deleted			Sample			
Variable	N	Mean	Std. Dev.	N	Mean	Std. Dev	p-value
Female	147	0.44	0.5	766	0.51	0.5	0.08
White	147	0.72	0.45	766	0.78	0.41	0.12
Having a low birth weight	147	0.02	0.14	766	0.02	0.16	0.75
Being prematurely born	136	0.04	0.21	766	0.04	0.2	0.84
Being firstborn	147	0.46	0.5	766	0.45	0.5	0.95
Mother smoked during pregnancy	105	0.26	0.44	766	0.22	0.41	0.38
Mother's age	147	27.97	5.97	766	28.75	5.49	0.12
Mother having a health problem during pregnancy	147	0.37	0.49	766	0.31	0.46	0.14
Mother's education less than high school	147	0.14	0.35	766	0.07	0.25	0.01
Mother's education equal to high school	147	0.20	0.40	766	0.20	0.40	0.97
Mother's education more than high school	147	0.66	0.48	766	0.73	0.44	0.06
STDSCM36	96	98.98	17.65	766	99.82	18.65	0.68
Birth weight (kilogram)	147	3.54	0.52	766	3.49	0.51	0.31
Planned pregnancy	147	0.38	0.49	766	0.35	0.48	0.42
Household size(adults and kids)	147	4.01	1.22	766	4.02	1.24	0.98
Number of adults	147	2.12	0.83	766	2.13	0.66	0.91
Public assistance	147	0.2	0.4	766	0.16	0.36	0.14
Total income-to-needs ratio	147	2.64	2.78	766	2.85	2.49	0.37
Husband/partner lives with mother	147	0.79	0.41	766	0.88	0.32	0.01
Abidin parenting stress index	147	53.41	12.41	766	53.35	10.52	0.95
Maternal feeling about pregnancy	147	0.64	0.48	766	0.69	0.46	0.19
Baby's health at one month	147	0.97	0.16	766	0.97	0.16	0.94
Health of mother at one month	147	0.95	0.21	766	0.95	0.22	0.92
Mother's feeling about the baby	147	0.98	0.14	766	0.97	0.17	0.47
Any care more than 30 hours per week	147	0.73	0.45	766	0.75	0.43	0.54

Table 1-15a Switching of maternal employment status from period to period

Maternal employment before birth	Maternal employment at three years			
	Not working	Part-time	Full-time	Total
Not working	62	43	3	108
Part-time	29	128	40	197
Full-time	50	187	224	461
Total	141	358	267	766

Table 1-15b Switching of maternal employment status from period to period

Maternal employment at three years	Maternal employment at pre-school			
	Not working	Part-time	Full-time	Total
Not working	59	79	3	141
Part-time	34	256	68	358
Full-time	1	69	197	267
Total	94	404	268	766

Table 1-15c Switching of maternal employment status from period to period

Maternal employment at pre-school	Maternal employment during elementary school			
	Not working	Part-time	Full-time	Total
Not working	37	50	7	94
Part-time	41	254	109	404
Full-time	1	49	218	268
Total	79	353	334	766

Table 1-15d Switching of maternal employment status from period to period

Maternal employment during elementary school	Maternal employment during elementary school			
	Not working	Part-time	Full-time	Total
Not working	47	30	2	79
Part-time	32	221	100	353
Full-time	5	61	268	334
Total	84	312	370	766

Table 1-16 Switching of obesity status from 1st grade to 6th grade

	Not obese at 6th grade	Obese at 6th grade	Total
Not obese at 1st grade	559	42	601
Obese at 1st grade	9	62	71
Total	568	104	672

Frequency Missing = 94

Table 1-17 Switching of obesity status from 1st grade to age 15

	Not obese at age 15	Obese at age 15	Total
Not obese 1st grade	558	51	609
Obese at 1st grade	21	52	73
Total	579	103	682

Frequency Missing = 84

Table 1-18a Overweight at 1st grade by maternal employment during elementary school

Overweight at 1st grade		Maternal employment during elementary school			
		Not working	Part-time	Full-time	Total
No	n	51	241	234	526
	%	82%	76%	78%	
Yes	n	11	78	67	156
	%	18%	24%	22%	
Total		62	319	301	682

Frequency Missing = 84

Table 1-18b Overweight at 6th grade by maternal employment during elementary school

Overweight at 6th grade		Maternal employment during elementary school			
		Not working	Part-time	Full-time	Total
No	n	58	220	207	485
	%	83%	68%	67%	
Yes	n	12	104	102	218
	%	17%	32%	33%	
Total		70	324	309	703

Frequency Missing = 63

Table 1-18c Overweight at age 15 by maternal employment during elementary school

Overweight at age 15		Maternal employment during elementary school			
		Not working	Part-time	Full-time	Total
No	n	65	244	232	541
	%	82%	69%	69%	
Yes	n	14	109	102	225
	%	18%	31%	31%	
Total		79	353	334	766

Table 1-19 Categorical maternal employment replaced with continuous work hours (with obesity at 15 years as dependent variable)

Continuous work hours	β	S.E.	p-value
3 years	0.002	0.001	0.045
Pre-school	0.000	0.001	0.902
Elementary school	0.003	0.001	0.013
High school	-0.003	0.001	0.015
Other covariates	x	x	x
R^2	0.06		
Elementary school	0.002	0.001	0.026
Other covariates	x	x	x
R^2	0.05		

Table 1-20a BMI percentile replaces obesity dummy

BMI percentile at grade 6	β	S.E.	p-value
3 years part-time	-5.69	3.49	0.10
3 years full-time	-4.21	4.35	0.33
Pre-school part-time	-4.47	3.97	0.26
Pre-school full-time	0.20	5.11	0.97
Elementary school part-time	9.32	4.04	0.02
Elementary school full-time	8.71	4.55	0.06
Other covariates	x	x	x
R^2	0.06		
Elementary school part-time	7.48	3.86	0.05
Elementary school full-time	8.78	4.03	0.03
Other covariates	x	x	x
R^2	0.06		
Elementary school part-time	7.50	3.87	0.05
Elementary school full-time	8.82	4.04	0.03
Before-birth part-time	-1.26	4.11	0.76
Before-birth full-time	-0.40	4.14	0.92
Other covariates	x	x	x
R^2	0.05		

Table 1-20b BMI percentile replaces obesity dummy

BMI percentile at age 15	β	S.E.	p-value
3 years part-time	-5.41	3.00	0.07
3 years full-time	-2.06	3.78	0.59
Pre-school part-time	-3.90	3.43	0.26
Pre-school full-time	-0.92	4.45	0.84
Elementary school part-time	9.68	3.89	0.01
Elementary school full-time	9.10	4.59	0.05
High school part-time	-2.24	3.68	0.54
High school full-time	-2.27	4.04	0.57
Other covariates	x	x	x
R^2	0.08		
Elementary school part-time	6.65	3.30	0.04
Elementary school full-time	7.76	3.46	0.03
Other covariates	x	x	x
R^2	0.08		
Elementary school part-time	6.78	3.30	0.04
Elementary school full-time	7.58	3.47	0.03
Before-birth part-time	3.17	3.52	0.37
Before-birth full-time	4.31	3.55	0.22
Other covariates	x	x	x
R^2	0.08		

Table 1-21 Overweight (including obesity) replaces obesity dummy at age 15

Overweight at age 15	β	S.E.	p-value
3 years part-time	-0.04	0.05	0.48
3 years full-time	0.04	0.06	0.58
Pre-school part-time	-0.06	0.06	0.34
Pre-school full-time	0.00	0.08	0.97
Elementary school part-time	0.16	0.07	0.02
Elementary school full-time	0.10	0.08	0.19
High school part-time	-0.07	0.06	0.28
High school full-time	-0.07	0.07	0.31
Other covariates	x	x	x
R^2	0.07		
Elementary school part-time	0.10	0.06	0.06
Elementary school full-time	0.08	0.06	0.15
Other covariates	x	x	x
R^2	0.07		
Elementary school part-time	0.11	0.06	0.05
Elementary school full-time	0.08	0.06	0.18
Before-birth part-time	0.06	0.06	0.31
Before-birth full-time	0.14	0.06	0.02
Other covariates	x	x	x
R^2	0.07		

Table 1-22 Overweight (including obesity) replaces obesity dummy at grade 6

Overweight at grade 6	β	S.E.	p-value
3 years part-time	-0.06	0.06	0.32
3 years full-time	-0.04	0.07	0.54
Pre-school part-time	-0.03	0.06	0.63
Pre-school full-time	0.07	0.08	0.38
Elementary school part-time	0.14	0.06	0.04
Elementary school full-time	0.10	0.07	0.17
Other covariates	x	x	x
R^2	0.04		
Elementary school part-time	0.13	0.06	0.04
Elementary school full-time	0.14	0.06	0.04
Other covariates	x	x	x
R^2	0.04		
Elementary school part-time	0.13	0.06	0.03
Elementary school full-time	0.13	0.06	0.04
Before-birth part-time	-0.05	0.07	0.49
Before-birth full-time	0.05	0.07	0.41
Other covariates	x	x	x
R^2	0.05		

Table 1-23 BMI percentile as dependent variable and continuous hours as independent variable

BMI percentile at age 15	β	S.E.	p-value
3 years	0.00	0.09	0.97
Pre-school	0.06	0.10	0.52
Elementary school	0.11	0.10	0.27
High school	-0.03	0.08	0.70
Other covariates	x	x	x
R^2	0.07		
Elementary school	0.12	0.06	0.07
Other covariates	x	x	x
R^2	0.07		

BMI percentile at grade 6	β	S.E.	p-value
3 years	-0.09	0.10	0.40
Pre-school	0.10	0.11	0.38
Elementary school	0.11	0.09	0.21
Other covariates	x	x	x
R^2	0.05		
Elementary school	0.14	0.07	0.07
Other covariates	x	x	x
R^2	0.06		

Table 1-24 Quantile regression of BMI percentiles (50, 85 and 95) at grade 6 and age 15 on continuous maternal employment hours

	BMI percentile	β	S.E.	p-value
6th grade				
	50th	0.09	0.18	0.59
	85th	0.20	0.08	0.01
	95th	0.09	0.05	0.04
Age 15				
	50th	0.19	0.16	0.23
	85th	0.02	0.09	0.83
	95th	0.08	0.05	0.08

Table 1-25 Conventional fixed effect model

	β	S.E.	p-value
Part-time	-0.02	0.02	0.50
Full-time	-0.03	0.03	0.27
Total household size	0.03	0.01	0.01
Partner/husband living at home	-0.05	0.03	0.08

Table 1-26 Fixed effect model with time varying variables

	Equation 14-1		Equation 14-2	
	β	S.E.	β	S.E.
Elementary school part-time	0.05*	0.03	0.05*	0.03
Elementary school full-time	0.06**	0.03	0.06**	0.03
High school part-time	-	-	-0.05	.04
High school full-time	-	-	-0.05	.04
Partner living at home in 3rd grade	0.01	0.04	0.01	0.04
Partner living at home in 4th grade	-0.01	0.04	-0.01	0.04
Partner living at home in 5th grade	-0.04	0.04	-0.04	0.04
Partner living at home in 6th grade	-0.09**	0.04	-0.09**	0.04
Partner living at home in 7th grade	-	-	0.11	0.06
Partner living at home at age 14	-	-	0.03	0.06
Partner living at home at age 15	-	-	-0.12**	0.05
Household size in 3rd grade	-0.006	0.02	-0.006	0.02
Household size in 4th grade	0.02	0.02	0.02	0.02
Household size in 5th grade	-0.007	0.02	-0.007	0.02
Household size in 6th grade	0.003	0.02	0.003	0.02
Household size in 7th grade	-	-	-0.004	0.02
Household size at age 14	-	-	-0.02	0.03
Household size at age 15	-	-	0.03	0.02
N	672			

Notes: *p<0.10, **p<0.05 ***p<0.01.

Table 1-27a Controlling the effect of both mechanism variables and maternal employment for obesity at age 15

	β	S.E.	t value	p value
Intercept	0.35	0.38	0.92	0.36
3 years part-time	-0.02	0.05	-0.37	0.71
3 years full-time	0.03	0.06	0.42	0.67
Pre-school part-time	-0.04	0.06	-0.67	0.51
Pre-school full-time	-0.03	0.08	-0.37	0.71
Elementary school part-time	0.1	0.07	1.45	0.15
Elementary school full-time	0.1	0.08	1.28	0.2
High school part-time	-0.07	0.06	-1.05	0.29
High school full-time	-0.1	0.07	-1.38	0.17
Married	-0.09	0.04	-2.47	0.01
Mother graduated from high school	-0.13	0.08	-1.52	0.13
Mother attended college	-0.1	0.08	-1.18	0.24
White	-0.01	0.05	-0.11	0.91
Birth weight (kilogram)	0.09	0.03	2.69	0.01
Having a low birth weight	0.13	0.1	1.22	0.22
Being prematurely born	0.04	0.08	0.47	0.64
Being firstborn	0	0.04	-0.07	0.95
Mother smoked during pregnancy	0.04	0.04	0.93	0.35
Mother’s age	-0.01	0	-2.4	0.02
Mother having a health problem during pregnancy	0.01	0.03	0.32	0.75
STDSCM36	0	0	1.59	0.11
Planned pregnancy	0	0.04	-0.04	0.97
Household size(adults and kids)	0.01	0.02	0.33	0.74
Number of adults	-0.01	0.03	-0.29	0.77
Public assistance	0.1	0.06	1.56	0.12
Husband/partner lives with mother	0.17	0.07	2.51	0.01
Abidin parenting stress index	0	0	-0.14	0.89
Maternal feeling about pregnancy	-0.03	0.04	-0.64	0.52
Log of income before birth	-0.05	0.03	-1.67	0.1
Baby’s health at one month	0.13	0.12	1.03	0.3
Health of mother at one month	0.07	0.08	0.92	0.36
Mother’s feeling about the baby	-0.03	0.1	-0.3	0.76
Any care more than 30 hours per week	-0.04	0.04	-0.9	0.37
Dummy for missing income-to needs ratio	-0.06	0.1	-0.62	0.53

Dummy for missing log of income before birth	0.05	0.1	0.55	0.58
Number of times watching TV or videos/day in 4th grade	0.02	0.01	2	0.05
Number of times snacking/day in 4th grade	0	0.02	-0.04	0.97
Number of times watching TV or videos/day on weekdays in 5th grade	0	0.01	0.69	0.49
Number of times snacking/day in 5th grade	0	0.02	0.3	0.76
Minutes of reported sedentary activity/day in 6th grade	0	0	1.02	0.31
Minutes of vigorous physical activity in 3rd grade	-0.004	0.001	-3.16	0.002

Table 1-27b Controlling the effect of both mechanism variables and maternal employment for obesity at age 15

	β	S.E.	t value	p value
Intercept	0.3	0.4	0.76	0.45
3 years part-time	-0.02	0.05	-0.3	0.76
3 years full-time	0.03	0.07	0.49	0.63
Pre-school part-time	0.02	0.06	0.26	0.8
Pre-school full-time	0.1	0.08	1.23	0.22
Elementary school part-time	0.12	0.07	1.84	0.07
Elementary school full-time	0.06	0.08	0.77	0.44
High school part-time	-0.13	0.06	-2.01	0.05
High school full-time	-0.17	0.07	-2.37	0.02
Married	-0.08	0.04	-1.81	0.07
Mother graduated from high school	-0.17	0.08	-2.05	0.04
Mother attended college	-0.14	0.08	-1.64	0.1
White	0.03	0.05	0.57	0.57
Birth weight (kilogram)	0.08	0.04	2.2	0.03
Having a low birth weight	0.11	0.12	0.91	0.37
Being prematurely born	0.03	0.09	0.29	0.78
Being firstborn	-0.03	0.05	-0.56	0.58
Mother smoked during pregnancy	0.02	0.04	0.54	0.59
Mother's age	-0.01	0	-1.66	0.1
Mother having a health problem during pregnancy	0	0.04	0.02	0.98
STDSCM36	0	0	0.22	0.82
Planned pregnancy	0.01	0.04	0.33	0.74
Household size(adults and kids)	0	0.02	0.13	0.9
Number of adults	-0.03	0.03	-0.78	0.44
Public assistance	0.12	0.06	1.83	0.07
Husband/partner lives with mother	0.12	0.07	1.76	0.08
Abidin parenting stress index	0	0	0.79	0.43
Maternal feeling about pregnancy	0	0.04	0.09	0.93
Log of income before birth	-0.03	0.03	-1.13	0.26
Baby's health at one month	0.19	0.12	1.55	0.12
Health of mother at one month	-0.05	0.08	-0.58	0.56
Mother's feeling about the baby	-0.03	0.1	-0.3	0.77
Any care more than 30 hours per week	-0.03	0.05	-0.62	0.53
Dummy for missing income-to needs ratio	-0.06	0.1	-0.64	0.52

Dummy for missing log of income before birth	0.09	0.1	0.94	0.35
Number of times watching TV or videos/day in 4th grade	0.02	0.01	2.16	0.03
Number of times snacking/day in 4th grade	-0.02	0.03	-0.7	0.49
Number of times watching TV or videos/day on weekdays in 5th grade	0	0.01	-0.33	0.74
Number of times snacking/day in 5th grade	0	0.02	0.27	0.78
Minutes of reported sedentary activity/day in 6th grade	0	0	1.65	0.1
Minutes of vigorous physical activity in 6th grade	-0.004	0.002	-2.09	0.04

Table 1-27c Controlling the effect of both mechanism variables and maternal employment for obesity at age 15

	β	S.E.	t value	p value
Intercept	0.25	0.43	0.59	0.56
3 years part-time	0	0.06	0.04	0.97
3 years full-time	0.03	0.08	0.4	0.69
Pre-school part-time	-0.07	0.07	-0.97	0.33
Pre-school full-time	-0.05	0.09	-0.55	0.58
Elementary school part-time	0.21	0.08	2.52	0.01
Elementary school full-time	0.23	0.1	2.4	0.02
High school part-time	-0.13	0.08	-1.77	0.08
High school full-time	-0.19	0.08	-2.31	0.02
Married	-0.14	0.05	-2.88	0
Mother graduated from high school	-0.21	0.09	-2.25	0.03
Mother attended college	-0.23	0.1	-2.43	0.02
White	0	0.05	0.07	0.95
Birth weight (kilogram)	0.11	0.04	2.73	0.01
Having a low birth weight	0.17	0.13	1.28	0.2
Being prematurely born	-0.01	0.1	-0.12	0.9
Being firstborn	-0.04	0.05	-0.83	0.41
Mother smoked during pregnancy	0.05	0.05	1.12	0.26
Mother's age	-0.01	0	-1.32	0.19
Mother having a health problem during pregnancy	0.02	0.04	0.57	0.57
STDSCM36	0	0	1.4	0.16
Planned pregnancy	0	0.05	-0.09	0.93
Household size(adults and kids)	-0.01	0.02	-0.22	0.83
Number of adults	-0.01	0.04	-0.35	0.73
Public assistance	-0.01	0.07	-0.1	0.92
Husband/partner lives with mother	0.08	0.08	0.99	0.32
Abidin parenting stress index	0	0	-0.38	0.71
Maternal feeling about pregnancy	-0.05	0.05	-1	0.32
Log of income before birth	-0.03	0.03	-0.89	0.37
Baby's health at one month	0.19	0.14	1.4	0.16
Health of mother at one month	0.01	0.09	0.13	0.9
Mother's feeling about the baby	-0.02	0.12	-0.19	0.85
Any care more than 30 hours per week	-0.03	0.05	-0.59	0.56
Dummy for missing income-to needs ratio	-0.08	0.11	-0.77	0.44

Dummy for missing log of income before birth	0.23	0.11	2.01	0.05
Number of times watching TV or videos/day in 4th grade	0.02	0.01	1.51	0.13
Number of times snacking/day in 4th grade	0.02	0.03	0.53	0.6
Number of times watching TV or videos/day on weekdays in 5th grade	0.01	0.01	0.9	0.37
Number of times snacking/day in 5th grade	-0.01	0.02	-0.44	0.66
Minutes of reported sedentary activity/day in 6th grade	0	0	0.36	0.72
Minutes of vigorous physical activity at age 15	-0.01	0	-2.37	0.02

Table 1-28a Controlling the effect of both mechanism variables and maternal employment for obesity at 6th grade

	β	S.E.	t value	p value
Intercept	0.04	0.4	0.1	0.92
3 years part-time	-0.02	0.05	-0.42	0.67
3 years full-time	-0.03	0.07	-0.47	0.64
Pre-school part-time	-0.03	0.06	-0.44	0.66
Pre-school full-time	0.07	0.08	0.84	0.4
Elementary school part-time	0.13	0.07	2.05	0.04
Elementary school full-time	0.09	0.07	1.28	0.2
Married	-0.11	0.04	-2.92	0
Mother graduated from high school	0.05	0.09	0.61	0.54
Mother attended college	0.1	0.09	1.09	0.28
White	0.01	0.05	0.12	0.91
Birth weight (kilogram)	0.1	0.03	2.74	0.01
Having a low birth weight	0.25	0.11	2.3	0.02
Being prematurely born	-0.05	0.08	-0.65	0.52
Being firstborn	-0.01	0.04	-0.15	0.88
Mother smoked during pregnancy	0.04	0.04	0.84	0.4
Mother's age	-0.01	0	-2.04	0.04
Mother having a health problem during pregnancy	0.01	0.04	0.2	0.84
STDSCM36	0	0	1.14	0.26
Planned pregnancy	-0.01	0.04	-0.13	0.9
Household size(adults and kids)	-0.01	0.02	-0.51	0.61
Number of adults	0	0.03	0.13	0.9
Public assistance	0.09	0.06	1.42	0.16
Husband/partner lives with mother	0.14	0.07	2.05	0.04
Abidin parenting stress index	0	0	-0.36	0.72
Maternal feeling about pregnancy	-0.05	0.04	-1.26	0.21
Log of income before birth	-0.03	0.03	-0.91	0.36
Baby's health at one month	0.12	0.13	0.96	0.34
Health of mother at one month	-0.09	0.08	-1.13	0.26
Mother's feeling about the baby	0.08	0.1	0.82	0.41
Any care more than 30 hours per week	-0.06	0.04	-1.3	0.19
Dummy for missing income-to needs ratio	-0.05	0.1	-0.54	0.59
Dummy for missing log of income before birth	0.03	0.1	0.34	0.74
Number of times watching TV or videos/day in 4th	0.02	0.01	2.62	0.01

grade				
Number of times snacking/day in 4th grade	-0.02	0.02	-0.74	0.46
Number of times watching TV or videos/day on weekdays in 5th grade	0.01	0.01	1.3	0.2
Number of times snacking/day in 5th grade	0.03	0.02	1.84	0.07
Minutes of reported sedentary activity/day in 6th grade	0	0	-0.42	0.68
Minutes of vigorous physical activity in 3rd grade	-0.005	0	-3.66	0.0003

Table 1-28b Controlling the effect of both mechanism variables and maternal employment for obesity at 6th grade

	β	S.E.	t value	p value
Intercept	0.19	0.40	0.49	0.63
3 years part-time	-0.06	0.05	-1.11	0.27
3 years full-time	-0.04	0.07	-0.62	0.54
Pre-school part-time	0.06	0.07	0.89	0.37
Pre-school full-time	0.16	0.08	1.90	0.06
Elementary school part-time	0.07	0.06	1.05	0.29
Elementary school full-time	0.00	0.07	-0.07	0.95
Married	-0.12	0.04	-2.91	0.00
Mother graduated from high school	-0.01	0.08	-0.07	0.95
Mother attended college	0.09	0.09	1.10	0.27
White	-0.01	0.05	-0.29	0.77
Birth weight (kilogram)	0.09	0.04	2.32	0.02
Having a low birth weight	0.19	0.12	1.62	0.11
Being prematurely born	0.02	0.09	0.22	0.82
Being firstborn	-0.07	0.05	-1.59	0.11
Mother smoked during pregnancy	0.06	0.05	1.38	0.17
Mother's age	-0.01	0.00	-2.01	0.04
Mother having a health problem during pregnancy	0.02	0.04	0.52	0.60
STDSCM36	0.00	0.00	0.24	0.81
Planned pregnancy	-0.03	0.04	-0.60	0.55
Household size(adults and kids)	-0.01	0.02	-0.71	0.48
Number of adults	0.00	0.03	-0.14	0.89
Public assistance	0.09	0.06	1.50	0.13
Husband/partner lives with mother	0.14	0.07	2.03	0.04
Abidin parenting stress index	0.00	0.00	-0.18	0.86
Maternal feeling about pregnancy	-0.07	0.04	-1.48	0.14
Log of income before birth	-0.03	0.03	-0.93	0.35
Baby's health at one month	0.19	0.12	1.63	0.10
Health of mother at one month	-0.09	0.09	-0.96	0.34
Mother's feeling about the baby	0.00	0.10	0.04	0.97
Any care more than 30 hours per week	-0.01	0.05	-0.30	0.77
Dummy for missing income-to needs ratio	-0.06	0.10	-0.58	0.56
Dummy for missing log of income before birth	0.07	0.11	0.65	0.51
Number of times watching TV or videos/day in 4th	0.02	0.01	2.07	0.04

grade				
Number of times snacking/day in 4th grade	-0.02	0.03	-0.84	0.40
Number of times watching TV or videos/day on weekdays in 5th grade	0.01	0.01	1.30	0.20
Number of times snacking/day in 5th grade	0.03	0.02	1.92	0.06
Minutes of reported sedentary activity/day in 6th grade	0.00	0.00	0.77	0.44
Minutes of vigorous physical activity in 3rd grade	-0.01	0.00	-2.52	0.01

Table 1-29 Means of mechanism variables by maternal employment status

Mechanism variables	Not working		Part-time		Full-time	
	n	mean	n	mean	n	mean
minutes of moderate physical activity in 3rd grade	57	151.9	299	155.6	278	149.9
minutes of moderate physical activity on weekends in 3rd grade	57	155	294	160.9	268	145.4
minutes of moderate and vigorous physical activity in 3rd grade	57	179.1	299	184.3	278	176
minutes of moderate and vigorous physical activity on weekdays in 3rd grade	57	179.4	299	182.8	278	178.9
minutes of moderate and vigorous physical activity on weekends in 3rd grade	57	178.6	294	187.7	268	168.7
minutes of vigorous physical activity in 3rd grade	57	20.5	299	21.3	278	19.4
minutes of vigorous physical activity on weekdays in 3rd grade	57	21.3	299	21.7	278	20.2
minutes of vigorous physical activity on weekends in 3rd grade	57	18.4	294	20	268	17.5
minutes of very vigorous physical activity in 3rd grade	57	6.6	299	7.4	278	6.8
minutes of very vigorous physical activity on weekdays in 3rd grade	57	7.1	299	7.6	278	7.2
minutes of very vigorous physical activity on weekends in 3rd grade	57	5.2	294	6.7	268	5.8
minutes of moderate physical activity in 6th grade	64	82.8	241	83.1	242	79.3
minutes of moderate and vigorous physical activity in 6th grade	64	98.4	241	97.9	242	92.4
minutes of moderate and vigorous physical activity on weekdays in 6th grade	64	101.1	241	100.2	241	95.6
minutes of moderate and vigorous physical activity on weekends in 6th grade	58	90.3	226	91.7	222	84
minutes of vigorous physical activity in 6th grade	64	11.2	241	10.2	242	9.5
minutes of vigorous physical activity on weekdays in 6th grade	64	11.5	241	10.5	241	10
minutes of vigorous physical activity on weekends in 6th grade	58	10.1	226	9.3	222	8
number of times watching TV or videos/day in 4th grade	77	1.6	340	2	326	2.1
Number of times snacking/day in 4th grade	77	0.8	340	0.7	326	0.7
number of times watching TV or videos/day in 5th grade	71	1.7	332	2	304	2.1
Number of times snacking/day in 5th grade	71	0.7	332	0.7	304	0.6

Essay Two

Early maternal employment and family well being

- A longitudinal study

Lei Li

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1. Introduction

Maternal employment has been the norm in the US since the 1980's. As of 2008, 71 percent of mothers of children under age 18 participated in the labor force (US BLS, 2009). For mothers of young children and infants – 64 percent of mothers with children under 6 years old, and 56 percent of mothers of infants participated in the labor force in 2008 (US BLS, 2009). Child-rearing and market work are both time-intensive activities. Thus, there has been concern that maternal employment harms children by reducing the quantity and quality of time mothers spend with their families (Baum 2003; Ruhm, 2004; Cawley & Liu, 2007). When mothers reallocate their time from home to market work, however, this shift potentially affects not just the health and wellbeing of children but also the health and well-being of the parents and the family as a whole (Bianchi, 2000; Riggio, 2006).

The primary contributions of this paper is: we draw on longitudinal data to gauge whether effects of maternal employment on family well-being persist over early childhood, and we use empirical methods that address the potential endogeneity of maternal work hours, as well as the dynamic nature of the relationship between maternal employment and family outcomes.

2. Literature review

There is an extensive theoretical and empirical literature outside of economics that highlights the importance of the family environment, parenting, and maternal health in shaping children's health and developmental trajectories (National Research Council and Institute of Medicine, 2000; Belsky, 1988; Coleman,1988; Bornstein, 2002).

Parenting behaviors, such as nurturance, discipline, and teaching, as well as the home environment have powerful influence on children's wellbeing and development (Brooks-Gunn & Markman, 2005). Parenting and the home environment have been linked to cognitive and behavioral outcomes such as children's academic achievement, social functioning, and health (Bornstein, 2002; Collins et al., 2000; Steinberg, 2001; Steinberg & Sheffield-Morris, 2001). Specifically, parental hostility, low nurturance, parenting stress, physical discipline and other harsh parenting practices are associated with aggression, low self-control, higher levels of externalizing behavior problems, and other mental health problems in children (Feldman et al., 2000; Qi & Kaiser, 2003; Barry et al., 2005; Ispa et al. forthcoming).

Poor parental health reduces the quality of time mothers spend with their children and is associated with adverse outcomes. Numerous studies show that clinical depression in mothers as well as self-reported depressive symptoms, anxiety, and psychological distress, are important risk factors for adverse emotional and cognitive outcomes in their children, particularly during the first few years of life (Gray et al. 2004; NICHD Early Child Care Research Network, 1999; Petterson & Albers, 2001). Depressed mothers of infants are less interactive with and less responsive to their children (Campbell et al. 1995), and are less likely to seek appropriate health care for their children (Minkovitz et al., 2005). Compared to infants of healthy mothers, infants of depressed mothers are more negative and less playful (Cohn et al., 1986; Field, 1984), have more behavior problems during childhood (Field 1984; Barry et al., 2005; Essex et al., 2001; Lyons-Ruth et al., 1997; Hay et al., 2003), and they are more likely to eventually develop psychopathology during childhood and adulthood (Downey & Coyne, 1990; Kim-Cohen et al., 2005).

Despite the importance of maternal health and parenting outcomes, there has been little attention in the economics literature to the effects of maternal employment on outcomes of family members other than children. Most research focuses on the effects of maternal employment on children's academic and behavioral outcomes. Recent research indicates that early maternal employment increases the frequency of child behavior problems, and detracts from school readiness, verbal ability, and test scores (Berger et al., 2008; Berger et al., 2005; Brooks-Gunn et al., 2002; Hill et al., 2005; Waldfogel et al., 2002; Waldfogel, 2002; Ruhm, 2004; Ruhm 2008; Baum, 2003; James-Burdumy, 2005; Gregg et al., 2005). Full-time employment during the first eighteen months is particularly harmful for children's cognitive and behavioral outcomes (Gregg et al., 2005; Baum, 2003; Brooks-Gunn et al., 2002).

A few recent studies focus on the effect of one aspect of maternal employment – the length of maternity leave – on maternal health, which is one of the measures of family wellbeing we consider in the present study. These studies offer mixed evidence that maternity leave is associated with maternal health. Based on Canadian data, Baker and Milligan (2008) evaluate a mandated increase in the number of weeks of maternity leave granted to new parents. They find that increasing paid leave benefits from a maximum of 25 weeks to 50 weeks has no influence on maternal health measured by self-reported health status, a depression scale, an indicator of post-partum depression and a count of post-partum physical problems. In the US context, Chatterji & Markowitz (2005, 2008) use data from the 1988 National Maternal and Infant Health Survey (NMIHS) and the Early Childhood Longitudinal Study – Birth Cohort (ECLS-B) to examine the association between maternity leave length and maternal health. The findings from these two papers suggest that longer maternity leave (paid and un-paid) is associated with lower levels of maternal depressive symptoms, a lower likelihood of the mother having frequent outpatient visits during the first six months after childbirth, and better self-reported overall health among mothers.

To our knowledge, only one recent study in economics has focused on the effects of maternal employment on the wellbeing of the family. Baker, Gruber & Milligan (2008) take advantage of a natural experiment in which one Canadian province (Quebec) introduced a comprehensive, highly subsidized child care system. This policy change led to a rise in child care usage, an increase in maternal employment, and an increase in children's adverse health and developmental outcomes in Quebec relative to the rest of Canada. These negative effects on children are consistent with the US-based literature on the effects of maternal employment on child outcomes. Baker, Gruber & Milligan, however, also examine family outcomes which have not been studied in the US context. These authors find that the policy change was associated with less effective parenting, less satisfaction with marital relationships, increases in maternal depressive symptoms, and decline in the overall self-assessed health of fathers (but not mothers).

3. The data

The NICHD Study of Early Child Care (SECC) is a longitudinal study initiated by The National Institute of Child Health and Human Development (NICHD) in 1989. In 1991 1,364 healthy newborns were enrolled in the study from 10 sites across the country and followed from birth to age 15. Maternal employment information was collected before birth in person, at 1, 6, 15, 24, 36 and 54 months at home, at 3, 9, 12, 42, 46, 50, 60 months by telephone. Information about maternal mental health and parenting stress was collected between home visits at 3, 9, 12, 18, 21, 27, 30, 33, 42, 46 and 50 months, and some health measures were updated every 3 to 4 months through the telephone contacts.

All basic variables at one month are summarized in tables 1 to 4. There are four tables because the four dependent variables, mother's depressive symptoms, overall health, parenting stress and maternal sensitivity, have different numbers of observations. Despite the different number of observations, there is no or very little difference among the four tables for the same variable.

About 10% of families don't have father at home, the average household size is four person, the average age of mothers is 29, the average mother's education is 15 years, 50% of the sample is female, the average family income before birth is $56,200, the average ppvt-r standard score for the mother is 101, about 21% of mothers smoked during pregnancy, about 4% of children were born prematurely, 2% of children were born with low birth weight. 3% of children are Hispanic, 9% are black, 6% are other race, 31% of mothers had problems during pregnancy, 64% of mothers were employed, the average hours worked are 21, 36% of children were born second, 14% were born third, 5% were born fourth or plus, 7% of mothers have poor/fair health, the average overall health score is 3.4, 17% of mothers were depressed at 1 month, the average of log CES-D is 1.7, the average abidin parenting stress index is 50, and the average maternal sensitivity is 9.5.

We use a pooled sample which includes repeated observations on children and mothers. When analyzing effects of maternal employment on maternal overall health, we pool data from all telephone and home interviews from 1 month until 54 months, yielding potentially 16 assessment time points for each mother (we are not able to use the 1 month assessment as a time point since we use this interview for lagged values of the dependent variable for the 3 month interview, as described below). In these models, maternal overall health and maternal employment are measured about every 3 months. We run analyses with a balanced panel of 13,328 observations which includes observations with available data on maternal health, employment, and time-varying characteristics.

When analyzing maternal depression and parenting quality, we pool data from the 6, 15, 24, 36 and 54 month interviews. For the depression outcomes, we run analyses on a sample limited to 4,375 observations with available data; for parenting quality, the sample size is 3,532. When analyzing parenting stress, we pool data from the 6, 15, 24 and 36 month interviews, since parenting stress is not assessed at the 54 month interview – the sample size for these analyses is 3,912.

a. Family Outcomes

<u>Depressive symptoms</u>: We measure maternal depression using the 20-item Center for Epidemiologic Studies Depression Scale (CES-D), which is used to measure depressive symptoms in the past week in non-clinical populations. Mothers completed CES-D instruments during the 1, 6, 15, 24, 36, and 54 month home interviews. The CES-D is one of the most widely used psychiatric scales and captures mood, somatic problems, problems in interactions with others, and issues with motor functioning, such as "I felt lonely," "my sleep was restless," and "I could not get going." The respondent is asked to respond to each item according to a 4-point Likert scale, with higher values corresponding to higher frequency of the item in the past week. For example, for the item "I felt lonely," mothers responded either "less than 1 day" (zero points), "1-2 days"

(1 point), 3-4 days (2 points), or 5-7 days (3 points). Scores range from 0 to 60, and a score of 16 or higher is suggestive of clinically defined depressive disorder. The CES-D scale, however, does not correspond to a DSM-IV diagnosis of major depression. It is used primarily as a screening tool for depression, not as a diagnostic tool (Eaton et al. 2003).

We create two measures of depression from the CES-D scale, a continuous measure of symptoms and a dichotomous indicator of depression. Because the CES-D is skewed to the right in these data, we use the natural log of the total CES-D score as the continuous measure (In this variable and in others where log values are used, the zeros are replaced with a value of 0.5). The dichotomous measure is a dummy variable indicating whether or not the respondent's CES-D score is equal to or larger than 16. This dummy variable is not equivalent to a psychiatric diagnosis of depression, but it does capture respondents who are experiencing many symptoms of depression, or several symptoms with high frequency, in the past week (Eaton et al. 2003).

Overall health: Every three months, SECC mothers rated their own health in the past 3 months, compared to other women their age. Mothers can report their health as poor (1), fair (2), good (3) or excellent (4). We combine the poor and fair rankings since the number of mothers reporting poor health was small. We use this rating as an outcome measure, as well as a dichotomous indicator that equals one if the mother reports her health in general is fair or poor. Since the question does not specify physical or emotional health, these variables may capture both physical and mental illness. Mothers reported on their health through home and telephone interviews every 3-4 months from the 1 month until the 54 month interview.

Parenting Stress: To measure parenting stress, we draw on two scales completed by SECC mothers during the home interviews. At the 1 month and 6 month interviews, mothers completed a 30-item version of the Abidin Parenting Stress Index, which is designed to measure parent-child relationship stress and risk for adverse parenting and child behavioral outcomes. The index includes items such as "I feel trapped by my responsibilities as a parent", "I enjoy being a parent" and "I feel capable and on top of things when caring for my baby." At the 15, 24 and 36-month interviews, mothers were administered a 20 item adapted form of the Parent Role Quality Scale, which is appropriate to measure parenting stress among parents of toddlers and pre-school age children. Mothers are presented with ten potential concerns and ten potential rewards of child-rearing, and are asked to rate how much these concerns and rewards reflect their own experiences in parenting. The scale includes concerns such as "feeling tied down because of the children" and "the unending responsibilities" and rewards such as "the love your child shows" and "seeing your child grow and change." For both measures of parenting stress, higher scores indicate a greater degree of parenting stress.

Maternal Sensitivity: Maternal sensitivity is measured using trained observers' ratings of videotapes of mothers' behavior toward their children in semi-structured play situations. At 6 and 15 months, mother/child interactions were observed in the child's home, while at 24, 36, and 54 months these observations were conducted in the laboratory. These interactions are designed to demonstrate the degree to which the mother responds in a sensitive way to the child's nondistress, intrusiveness (reverse scored), and positive regard (at the 6, 15, and 25 month assessments), and the mother's supportive presence, hostility (reverse scored) and respect for autonomy (at 36 and 54 months). Higher scores indicate higher degree of sensitivity to the child.

b. Maternal employment

Mothers provided employment information during each home interview (1, 6, 15, 24, 36 and 54 months) and most this information was updated during intervening telephone contacts every 3 to 4 months. For each of these potentially 16 time points, we created several measures of lagged maternal employment. As described in the next section, we use lagged measures to avoid problems with reverse causality. The measures are: (1) the number of hours worked per week measured at the home or telephone interview that was conducted 3 months prior (hours worked at last interview); (2) the average of weekly hours prior two assessments conducted 3 and 6 months ago (average hours worked over past 2 waves); and (3) the average weekly hours the mother worked up to and including the most recent prior assessment point (average hours worked in child's life). Based on these continuous measures of work hours, we also created three dummy indicators for: (1) worked 1 to 20 hours per week at last interview; (2) worked 21 to 39 hours per week at last interview; and (3) worked at least 40 hours per week at last interview.

Other covariates

To adjust for other factors that may confound an association between maternal employment and family outcomes, we estimate models that include extensive sets of controls for family socio-economic status, the mother's education and ability, the mother's attitudes towards employment, and the initial health endowment of the child. All models include the following measures: mother's age in years, number of years of education, size of household measured at 1-month interview, maternal race/ethnicity (dummy indicators for African-American and Other race with white as the baseline, dummy indicator for Hispanic), child's gender (dummy indicator for female), dummy indicator for child's birth order (second, third, fourth, or higher with firstborn as the baseline); dummy indicators of birth month of the child (all were born in 2001); dummy indicator for low birth-weight child (2500 grams or less); dummy indicator for premature child (born before 37 weeks gestation); dummy indicator for whether mother smoked at all during pregnancy; dummy indicator for any pregnancy complications; mother's standardized score on PPVT reading test administered at 36 month interview, and dummy indicators for each SECC site.

4. **Arellano-Bond (A-B) difference GMM methods** (Arellano & Bond, 1991)

In order to utilize the panel data advantage of the SECC data in identifying the effect of maternal employment on family wellbeing, Arellano-Bond (A-B) model is a good choice. First of all, A-B is a good fit for panel data with a large number of individuals and a small number of time periods, which is exactly how the SECC data is structured. Second, A-B model allows for dynamics by including lagged dependent variables, where the variables of interest about family wellbeing are state dependent, which also allows the inclusion of lagged dependent variables in the equation.

The following multivariate dynamic A-B model is specified following Bond (2002):

$$y_{it} = \alpha y_{i,t-1} + \beta x_{it} + \mu_i + \varepsilon_{it};\ -1 < \alpha < 1; i = 1, 2, \dots, N; t = 2, 3, \dots, T \quad (1.1)$$

Where y_{it} is an observation for individual i in period t, $y_{i,t-1}$ is the observation for the same individual in the previous period, x_{it} is a vector of current and lagged values of additional explanatory variables, μ_i is an unobserved individual-specific time-invariant effect, and ε_{it} is the disturbance term. The first-differencing transformation eliminates the individual effects μ_i:

$$\Delta y_{it} = \alpha \Delta y_{i.t-1} + \beta \Delta x_{it} + \Delta \varepsilon_{it};\ -1 < \alpha < 1; i = 1,2, \ldots, N; t = 3,4, \ldots, T \ (1.2)$$

Different moment conditions and number of instruments are available depending on different assumptions about the correlation between x_{it} and the two components of the error term. Assuming that ε_{it} is serially uncorrelated, x_{it} is correlated with μ_i and ε_{it} and earlier shocks, but uncorrelated with $\varepsilon_{i,t+1}$ and later shocks, the vector of instruments is $(y_{i1}, y_{i2}, \ldots, y_{i,t-2,} x_{i1}, \ldots, x_{i,t-2})$. The one-step and two-step first-differenced GMM estimation can be performed. If we assume that x_{it} is predetermined, meaning x_{it} and ε_{it} are uncorrelated, but x_{it} may be correlated with $\varepsilon_{i,t-1}$ and earlier shocks, then the vector of instruments becomes $(y_{i1}, y_{i2}, \ldots, y_{i,t-2,} x_{i1}, \ldots, x_{i,t-2}, x_{i,t-1})$. If we assume that x_{it} is strictly exogenous, then the time series $x_i' = (x_{i1}, x_{i2}, \ldots, x_{iT})$ are valid instrumental variables, and the vector of instruments becomes $(y_{i1}, y_{i2}, \ldots, y_{i,t-2,} x_i')$. The difference Sargan tests can be used to test the validity of the moment conditions between the alternatives. In addition, if we assume that x_{it} or Δx_{it} are uncorrelated with μ_i, then they can be instrumental variables in the levels equation. The Difference Sargan test can be used to test the assumption that x_{it} is uncorrelated with the individual effects.

In the case of SECC data, there are six variables about family well-being, log of CES-D scores, parenting stress, parenting quality, depression, poor/fair health and overall health. The time varying variables include no father at home, household size and lagged maternal employment. For the first-differenced equations, two or more lags of dependent and independent variables are used as instruments. For the level equations, two or more lags of the differences of dependent and independent variables are used as instruments. All the instruments are valid theoretically. But it's possible that they might be too weak and cause inconsistent estimations.

Bond (2002) showed that the pooled OLS and Within Groups estimators of the coefficient of the lagged dependent variable are biased in opposite directions, which can be used as the bounds for a consistent estimator. He also showed that the basic first-differenced Two Stage Least Squares (2SLS) estimator (Anderson and Hsiao 1981, 1982) is consistent, but not efficient, and GMM estimator is consistent and efficient. Therefore, for each dependent variable, six regressions are run, pooled OLS, within group, 2sls with one instrument, A-B two step, A-B one step, and A-B system. The difference between two step and one step is that in two step model, the weight matrix in the criterion is obtained through the consistent first stage estimators (Bond, 2002), while in the one step model, the weight matrix has 2's on the main diagonal, -1's on the first off-diagonals and zeros elsewhere. It is proven that under the assumption of homoscedasticity, these two GMM estimators are asymptotically equivalent. And finally, in the A-B system model, both the first-differenced equations and the level equations are estimated using lags and differences as instruments.

Based on the discussion above, the instruments for parenting stress and parenting quality are too weak, because the estimators of the coefficient for the lagged dependent variable fall out of the bounds. Among those consistent estimators, the A-B system performs better than 2sls, A-B two step and A-B one step, which are close to within group. The lagged maternal employment increases the log of CES-D scores significantly by 0.36 per 10 hours, and increases the chance of depression non-significantly. An additional ten hours of maternal employment significantly reduces the chance of poor/fair health by 1.3%, and significantly increases the overall health by 0.11 on a three point scale.

Limiting the sample to mothers who worked at least once doesn't make much difference except that more work hours doesn't reduce the chance of poor/fair health.

Dividing work hours into four categories, 0, 1 to 20, 21 to 39 and 40 plus, lead to similar results. All three non-zero categories significantly increase the CES-D score (except category 1 to 20, only marginally significantly) compared to category of 0 hour, and the longer the hours, the bigger the effect. All three non-zero categories reduce the chance of depression non-significantly, which is different from the result above, suggesting that the marginal effect of work hours is not a constant at different levels. All three non-zero categories significantly reduce the chance of poor/fair health, and significantly increase overall health compared to 0 hour.

5. Conclusion

In conclusion, maternal employment increases the chance of depression, but reduces the chance of poor/fair health, and increases the overall health. Our finding is consistent with that of Baker, Gruber & Milligan's in terms of maternal depressive symptom. But we didn't find that maternal employment associated with less effective parenting. Because of the lack of previous research of the effect of maternal employment on family wellbeing, we can't compare our other results with others'. It also seems odd that maternal employment increases the chance of depression, but increase the overall health. In order to explain this odd finding, more research needs to be done on more detailed data regarding the relationship between the two variables, depressive symptoms and overall health.

References

1. Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies 58(2)*, 277-297.
2. Baker, M., Milligan, K., 2008. Maternal employment, breastfeeding, and health: Evidence from maternity leave mandates. *Journal of Health Economics 27*, 871-887.
3. Baker, M., Gruber, J., Milligan, K., 2008. Universal Child Care, Maternal Labor Supply, and Family Well-Being. *Journal of Political Economy 116*, 709-856.
4. Barry TM, Dunlap ST, Cotton SJ, Lochman JE, Wells KC. 2005. The influence of maternal stress and distress on disruptive behaviors problems in boys. *Journal of the Academy of Child and Adolescent Psychiatry* 44: 265-273.
5. Belsky J. 1988. The 'effects' of infant day care reconsidered. *Early Childhood Research Quarterly* 3: 235-272.
6. Berger, L.M., Hill, J., Waldfogel, J., 2005. Maternity Leave, Early Maternal Employment and Child Health and Development in the US. *The Economic Journal 115*, F29-F47.
7. Berger, L., Brooks-Gunn, J., Paxson, C., Waldfogel, J., 2008. First-year maternal employment and child outcomes: Differences across racial and ethnic groups. *Children and Youth Services Review 30*, 365-387.
8. Baum, C.L. (2003). Does early maternal employment harm child development? An analysis of the potential benefits of leave taking. *Journal of Labor Economics* 21: 409-48.
9. Bianchi, S.M., 2000. Maternal Employment and Time with Children: Dramatic Change or Surprising Continuity? *Demography 37*, 401-414.
10. Bornstein, M.H. (ed.), 2002. Handbook of Parenting, Biology and Ecology of Parenting. Lawrence Erlbaum Associates. Place of Publication: Mahwah, NJ.
11. Brooks-Gunn J, Han WJ, Waldfogel J. 2002. Maternal employment and child cognitive outcomes in the first three years of life: the NICHD Study of Early Child Care. *Child Development* 73 : 1052-72.
12. Brooks-Gunn, J., Markman, L.B., 2005. The Contribution of Parenting to Ethnic and Racial Gaps in School Readiness. *Future of Children 15*, 139-168.
13. Campbell SB, Cohn JF, Meyers T. 1995. Depression in first-time mothers: Mother–infant interaction and depression chronicity. *Developmental*

Psychology 60 : 349-357.

14. Cawley, J., Liu, F., 2007. Maternal Employment and Childhood Obesity: A Search for Mechanisms in Time Use Data. *NBER Working Paper 13600*.
15. Chatterji, P., Markowitz, S., 2005. Does the length of maternity leave affect maternal health? *Southern Economic Journal 72*, 16-41.
16. Chatterji, P., Markowitz, S., 2008. Family leave after childbirth and the health of new mothers. *NBER Working Paper 14156*.
17. Cohn J, Matias R, Tronick EZ, Connell D, Lyons-Ruth K. 1986. Face-to-face interactions of depressed mothers and their infants. *New Directions for Child Development* 34: 31-45.
18. Coleman, J., 1988. Social capital in the creation of human capital. *American Journal of Sociology*, 94, S95 – S120.
19. Collins, W. A., Maccoby, E. E., Steinberg, L., Hetherington, E. M., & Bornstein, M. H. (2000). Contemporary research on parenting: The case for nature and nurture. *American Psychologist, 55*, 218–232.
20. Downey, G., Coyne, J.C., 1990. Children of depressed parents: An investigative review. *Psychological Bulletin 108*, 50-76.
21. Eaton WW, Muntaner C, Smith C, Tien A, Ybarra M. 2003. Center for epidemiologic studies depression scale: Review and revision (CESD and CESDR). In *The use of psychological testing for treatment planning and outcomes assessment*, 3rd edition, chapter 40, volume III, edited by M.E. Maruish. Mahwah, NJ : Lawrence Erlbaum Associates, pp.8-9.
22. Essex M, Klein M, Miech R, Smider N. 2001. Timing of initial exposure to maternal major depression and children's mental health symptoms in kindergarten. *British Journal of Psychiatry* 179: 151-156.
23. Feldman R, Sussman AL, Zigler E. 2004. Parental leave and work adaptation at the transition tp parenthood: Individual, marital, and social correlates. *Journal of Applied Developmental Psychology* 25(4) : 459-479.
24. Field, T. 1984. Early interactions between infants and their postpartum depressed mothers. *Infant behavior and Development* **7**: 517-522.
25. Gray RF, Indurkhya A, McCormick MC. 2004. Prevalence, stability, and predictors of clinically significant behaviors problems in low birth weight children at 3, 5, and 8 years of age. *Pediatrics* 114 : 736-743.
26. Gregg, P., Washbrook, E., Propper, C., Burgess S., 2005. The Effects of a Mother's Return to Work Decision on Child Development in the UK. *The Economic Journal 115*, F48-F80.
27. Hay DF, Pawlby S, Angold A, Harold GT, Sharp D. 2003. Pathways to violence in the children of mothers who were depressed postpartum. *Developmental Psychology* 39 : 1083-1094.

28. Hill, J.L., Waldfogel, J., Brooks-Gunn, J., Han, W., 2005. Maternal Employment and Child Development: A Fresh Look Using Newer Methods. *Developmental Psychology 41*, 833-850.
29. Ispa JM, Fine MA, Halgunseth LC, Harper S, Robinson J, Boyce L, et al. Maternal intrusiveness, maternal warmth, and mother-toddler relationship outcomes: Variations across low-income ethnic and acculturation groups. *Child Development.* 2004;75:1613–1631.
30. James-Burdumy, S., 2005. The Effect of Maternal Labor Force Participation on Child Development. *Journal of Labor Economics 23*, 177-211.
31. Kim-Cohen, J., Caspi, A., Moffitt, T.E., 2005. Prior juvenile diagnoses in adults with mental disorder. *Archives of General Psychiatry 60*, 709-717.
32. Lyons-Ruth, K., 1996. Attachment relationships among children with aggressive behavior problems: the role of disorganized early attachment patterns. *J Consult Clin Psychol 64*, 64-73.
33. Minkovitz, C.S., Stobino, D., Scharfstein, D., Hou, W., Miller, T., Mistry, K.B., Swartz, K., 2005. Maternal depressive symptoms and children's receipt of health care in the first 3 years of life. *Pediatrics 115*, 306-314.
34. NICHD Early Child Care Research Network, (1999). Chronicity of maternal depressive symptoms, maternal sensitivity, and child functioning at 36 months. *Developmental Psychology*, 35(5): 1297-1310.
35. NICHD SECC,www.nichd.nih.gov/research/supported/seccyd/.
36. Petterson, S.M., Albers A.B., 2001. Effects of poverty and maternal depression on early childhood development. *Child Development 72*, 1794-1813.
37. Qi, C.H., Kaiser A.P., 2003. Behavior problems of preschool children from low-income families: Review of the literature. *Topics in Early Childhood Special Education 23*, 188-216.
38. Riggio, H.R., 2006. Introduction: The Adaptive Response of Families to Maternal Employment: Part II – Family Perspectives. *American Behavioral Scientist 49*, 1303-1309.
39. Ruhm, C.J. (2004). Parental Employment and Child Cognitive Development. *Journal of Human Resources*, 39, 155-92.
40. Ruhm, C.J. (2008) Maternal employment and adolescent development. *Labour Economics*, 15, 958-983.
41. Steinberg, L., Sheffield-Morris, A., 2001. Adolescent development. *Annual Review of Psychology 52*, 83-110.
42. Steinberg, L. (2001). We know some things: Parent-adolescent relationships in retrospect and prospect. *Journal of Research on Adolescence, 11(1),* 1-19.

43. National Research Council and Institute of Medicine (2000). From Neurons to Neighborhoods: The Science of Early Childhood Development. Committee on Integrating the Science of Early Childhood Development. Jack P. Shonkoff and Deborah A. Phillips, eds. Board on Children, Youth, and Families, Commission on Behavioral and Social Sciences and Education. Washington, D.C.: National Academy Press.
44. US Bureau of Labor Statistics, Employment characteristics of families summary, USDL 09-0568, May 2009.
45. Waldfogel, J., 2002. Child Care, Women's Employment, and Child Outcomes. *Journal of Population Economics 15(3)*, 527-548.
46. Waldfogel, J., Han, W., Brooks-Gunn, J., 2002. The Effects of Early Maternal Employment on Child Cognitive Development. *Demography 39*, 369-392.

Table 2-1. Descriptive statistics for dependent variable depressive symptoms

Variable	N	Mean	Std Dev	Min	Max
No father at home	875	0.10	0.31	0	1
Total number of adults and children at 1 month	875	3.98	1.14	2	11
Mother's age	875	29.22	5.34	18	46
Mother's education	875	14.65	2.37	7	21
Female	875	0.50	0.50	0	1
Total family income before birth	866	56218.26	40649.79	2500	275001
ppvt-r standard scores for mothers	875	101.11	17.88	40	159
Mother smoked during pregnancy	875	0.21	0.40	0	1
Being prematurely born	863	0.04	0.20	0	1
Having a low birth weight	875	0.02	0.14	0	1
Hispanic	875	0.03	0.17	0	1
Black	875	0.09	0.28	0	1
Other race	875	0.06	0.24	0	1
Mother having a health problem during pregnancy	875	0.31	0.46	0	1
Employed	873	0.64	0.48	0	1
Hours of working	873	20.71	18.84	0	70
Secondborn	875	0.36	0.48	0	1
Thirdborn	875	0.14	0.35	0	1
Fourthborn or plus	875	0.05	0.22	0	1
Depressed	875	0.17	0.38	0	1
Log CES-D	875	1.72	1.05	-0.69	3.93

Table 2-2. Descriptive statistics for dependent variable overall health					
Variable	N	Mean	Std Dev	Min	Max
No father at home	748	0.10	0.30	0	1
Total number of adults and children at 1 month	748	3.94	1.13	2	12
Mother's age	748	29.05	5.25	18	46
Mother's education	748	14.71	2.34	7	21
Female	748	0.49	0.50	0	1
Total family income before birth	742	56388.15	39139.65	2500	275001
ppvt-r standard scores for mothers	748	101.17	17.09	40	159
Mother smoked during pregnancy	748	0.22	0.41	0	1
Being prematurely born	739	0.04	0.20	0	1
Having a low birth weight	748	0.02	0.14	0	1
Hispanic	748	0.04	0.19	0	1
Black	748	0.09	0.28	0	1
Other race	748	0.05	0.22	0	1
Mother having a health problem during pregnancy	748	0.31	0.46	0	1
Employed	748	0.58	0.49	0	1
Hours of working	748	18.59	18.91	0	94
Secondborn	748	0.36	0.48	0	1
Thirdborn	748	0.12	0.33	0	1
Fourthborn or plus	748	0.05	0.21	0	1
Poor/fair health	748	0.07	0.26	0	1
Overall health of mother at 1 month	748	3.43	0.62	2	4

Table 2-3. Descriptive statistics for dependent variable parenting stress					
Variable	N	Mean	Std Dev	Min	Max
No father at home	978	0.11	0.31	0	1
Total number of adults and children at 1 month	978	4.00	1.19	2	11
Mother's age	978	29.06	5.37	18	46
Mother's education	978	14.60	2.40	7	21
Female	978	0.49	0.50	0	1
Total family income before birth	966	55090.59	39433.50	2500	275001
ppvt-r standard scores for mothers	978	100.55	17.98	40	159
Mother smoked during pregnancy	978	0.21	0.41	0	1
Being prematurely born	964	0.04	0.20	0	1
Having a low birth weight	978	0.02	0.14	0	1
Hispanic	978	0.03	0.18	0	1
Black	978	0.09	0.29	0	1
Other race	978	0.06	0.25	0	1
Mother having a health problem during pregnancy	978	0.31	0.46	0	1
Employed	976	0.64	0.48	0	1
Hours of working	976	21.06	18.93	0	70
Secondborn	978	0.36	0.48	0	1
Thirdborn	978	0.14	0.35	0	1
Fourthborn or plus	978	0.05	0.22	0	1
Abidin parenting stress index at 1 month	978	50.24	9.76	26	81

Table 2-4. Descriptive statistics for dependent variable parenting quality					
Variable	N	Mean	Std Dev	Min	Max
No father at home	883	0.12	0.32	0	1
Total number of adults and children at 1 month	883	3.99	1.21	2	12
Mother's age	883	29.09	5.38	18	46
Mother's education	883	14.61	2.38	7	21
Female	883	0.49	0.50	0	1
Total family income before birth	873	56271.49	40613.72	2500	275001
ppvt-r standard scores for mothers	883	100.82	17.89	40	159
Mother smoked during pregnancy	883	0.21	0.41	0	1
Being prematurely born	872	0.04	0.21	0	1
Having a low birth weight	883	0.02	0.15	0	1
Hispanic	883	0.04	0.19	0	1
Black	883	0.10	0.29	0	1
Other race	883	0.06	0.23	0	1
Mother having a health problem during pregnancy	883	0.32	0.47	0	1
Employed	882	0.68	0.47	0	1
Hours of working	882	22.35	19.39	0	134
Secondborn	883	0.36	0.48	0	1
Thirdborn	883	0.14	0.35	0	1
Fourthborn or plus	883	0.05	0.23	0	1
Parenting qualtiy	883	9.54	1.56	3	12

Table 2-5: Effects of maternal work hours on maternal health and parenting, 1 mo.- 54 mo.

	Log CES-D						Parenting stress					
	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system
w_{t-1}	0.0017** (2.27)	0.0003 (0.30)	-0.064 (-1.02)	-0.014 (-1.20)	-0.009 (-0.28)	0.036** (2.22)	-0.035*** (-5.06)	-0.087*** (-7.02)	2.409 (0.18)	-0.194 (-1.15)	-0.080 (0.04)	-0.430 (-1.52)
y_{t-1}	0.517 (39.0)	-0.152 (-9.03)	-0.031 (-0.37)	0.020 (0.51)	0.036 (0.40)	0.136 (5.55)	0.510*** (49.06)	0.400*** (31.14)	-0.013 (-0.04)	-0.001 (-0.09)	-0.006 (-0.05)	-0.018 (-1.10)
No father at home	0.249 (5.39)	0.217 (3.15)	-0.631 (-0.34)	0.221 (1.29)	0.257 (0.63)	0.973 (2.67)	0.910 (2.11)	-0.079 (0.28)	105.2 (0.19)	3.51 (1.17)	3.22 (0.12)	-52.1 (-3.66)
Household size	0.074 (4.82)	0.026 (1.19)	0.454 (0.83)	-0.041 (-0.36)	0.042 (0.14)	0.195 (2.34)	0.140 (0.97)	0.077 (0.28)	-25.63 (-0.15)	-0.65 (-0.57)	-1.07 (-0.09)	12.9 (6.46)
n	4,270	4,375	4,375	4,375	4,375	4,375	3,808	3,912	3,912	3,912	3,912	3,912
Instruments	-	-	y_{t-2}	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$ $\Delta y_{t-2}-\Delta y_{t-5}$ $\Delta w_{t-2}-\Delta w_{t-5}$ $\Delta x_{t-2}-\Delta x_{t-5}$	-	-	y_{t-2}	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$ $\Delta y_{t-2}-\Delta y_{t-5}$ $\Delta w_{t-2}-\Delta w_{t-5}$ $\Delta x_{t-2}-\Delta x_{t-5}$
AR(1) test stat Pr > z	-	-	-2.39 (0.99)	-11.84 (1.0)	-5.65 (1.0)	-14.71 (1.0)	-	-	-0.19 (0.58)	-4.29 (0.58)	-0.89 (0.81)	-3.40 (1.0)
AR(2) test stat Pr > z	-	-	-0.64 (0.74)	1.44 (0.07)	1.20 (0.11)	2.64 (0.004)	-	-	-	-	-	-
Overiden. test	-	-	-	27.9 (1.0)	88.3 (1.0)	74.9 (1.0)	-	-	-	7.62 (1.0)	207108 (<.0001)	20.6 (1.0)

Notes: Table 5 only shows estimated coefficients and t-statistic on lagged work hours and lagged dependent variable. Models also include: whether father is in household, household size, and dummy variables for survey wave – estimated coefficients not shown.

Table 2-6: Effects of maternal work hours on maternal health and parenting, 1 mo.- 54 mo.												
	Parenting quality						Depressed					
	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system
w_{t-1}	0.002 (0.52)	0.001 (0.21)	1.452 (1.39)	1.16 (2.35)	1.256 (0.32)	-0.246 (-0.45)	0.0004 (1.25)	0.0003 (0.84)	0.004 (0.20)	-0.001 (-0.20)	0.003 (0.21)	0.0015 (0.43)
y_{t-1}	0.564 (33.8)	0.504 (25.9)	-1.073 (-5.59)	-0.68 (-3.29)	-0.614 (-0.34)	-0.944 (-5.46)	0.321 (22.55)	-0.112 (-6.79)	0.015 (0.21)	0.06 (1.70)	0.057 (0.59)	0.117 (4.80)
No father at home	0.318 (1.51)	2.11 (4.56)	-3.461 (-0.03)	43.2 (2.53)	32.6 (0.27)	357 (7.49)	0.108 (6.15)	0.068 (2.39)	-0.665 (-0.74)	0.068 (0.71)	-0.112 (-0.25)	0.475 (3.25)
Household size	0.337 (4.40)	0.948 (6.90)	15.6 (0.70)	42.4 (6.5)	42.8 (0.75)	-4.62 (-1.20)	0.024 (0.4.22)	0.005 (0.52)	0.389 (1.68)	0.144 (1.45)	0.217 (0.85)	0.050 (2.50)
n	3,448	3,532	3,532	3,532	3,532	3,532	4,270	4,375	4,375	4,375	4,375	4,375
Instruments	-	-	y_{t-2}	$y_{t-2}-y_{t-4}$ $w_{t-2}-w_{t-4}$ $x_{t-2}-x_{t-4}$	$y_{t-2}-y_{t-4}$ $w_{t-2}-w_{t-4}$ $x_{t-2}-x_{t-4}$	$y_{t-2}-y_{t-4}$ $w_{t-2}-w_{t-4}$ $x_{t-2}-x_{t-4}$ $\Delta y_{t-2}-\Delta y_{t-4}$ $\Delta w_{t-2}-\Delta w_{t-4}$ $\Delta x_{t-2}-\Delta x_{t-4}$	-	-	y_{t-2}	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$ $\Delta y_{t-2}-\Delta y_{t-5}$ $\Delta w_{t-2}-\Delta w_{t-5}$ $\Delta x_{t-2}-\Delta x_{t-5}$
AR(1) test stat Pr > z	-	-	-1.16 (0.88)	-4.68 (1.0)	-0.72 (0.77)	-2.98 (0.999)	-	-	-6.98 (1.0)	-10.65 (1.0)	-6.24 (1.0)	-13.75 (1.0)
AR(2) test stat Pr > z	-	-	-	-	-	-	-	-	-0.19 (0.57)	-1.09 (0.14)	0.46 (0.32)	1.54 (0.06)
Overiden. test	-	-	-	9.43 (1.0)	1.96E8 (<.0001)	38.9 (1.0)	-	-	-	23.56 (1.0)	1.46 (1.0)	21.03 (1.0)

Table 2-7: Effects of maternal work hours on maternal health and parenting, 1 mo.- 54 mo.

	Poor/fair health						Overall health					
	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system
w_{t-1}	1.918E-6 (0.01)	0.0008 (3.89)	0.0015 (0.46)	0.0016 (2.29)	0.001 (1.01)	-0.0013*** (-22.15)	0.0003 (1.13)	-0.0026 (-7.22)	-0.010 (-3.60)	-0.005 (-3.31)	-0.003 (-0.28)	0.011*** (12.9)
y_{t-1}	0.265 (30.56)	0.040 (4.40)	0.056 (4.23)	0.066 (5.50)	0.067 (5.05)	0.122 (12.96)	0.505 (66.33)	0.084 (9.42)	0.071 (5.92)	0.09 (8.44)	0.095 (1.16)	0.410 (38.3)
No father at home	0.026 (2.73)	-0.002 (-0.14)	-0.923 (-5.65)	0.088 (2.23)	0.078 (1.51)	0.128 (15.53)	0.080 (4.54)	-0.036 (0.20)	-0.767 (-2.72)	-0.353 (-4.30)	-0.349 (-0.65)	0.038 (1.21)
Household size	0.011 (3.20)	0.008 (1.80)	0.019 (0.40)	0.041 (2.98)	0.046 (2.49)	0.034 (19.04)	0.040 (6.00)	-0.016 (-2.04)	-0.065 (-1.14)	-0.116 (-4.24)	-0.122 (-0.62)	0.412 (40.4)
n	13,040	13,328	13,328	13,328	13,328	13,328	13,040	13,328	13,328	13,328	13,328	13,328
Instruments	-	-	y_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}, a?? y_{t-2}, Δw_{t-2}, Δx_{t-2}	-	-	y_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2} a?? y_{t-2}, Δw_{t-2}, Δx_{t-2}
AR(1) test stat Pr > z	-	-	-18.40 (1.0)	-18.14 (1.0)	-	-18.35 (1.0)	-	-	-21.42 (1.0)	-21.49 (1.0)	-6.64 (1.0)	-23.96 (1.0)
AR(2) test stat Pr > z	-	-	-1.03 (0.85)	0.01 (0.50)	-	1.36 (0.09)	-	-	-0.01 (0.51)	0.78 (0.22)	0.32 (0.38)	4.88 (5.3E-7)
Overiden. test	-	-	-	219 (1.0)	3.81 (1.0)	445.6 (1.0)	-	-	-	231.3 (1.0)	937 (1.0)	752 (1.0)

Table 2-8 Samples with non-zero hours in at least one stage

Table 2-8: Effects of maternal work hours on maternal health and parenting, 1 mo.- 54 mo.

	Log CES-D						Parenting stress					
	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system
w_{t-1}	0.0014 (1.63)	0.0003 (0.30)	-0.055 (-1.05)	-0.015 (-1.50)	-0.009 (-0.30)	0.026*** (1.60)	-0.038 (-5.02)	-0.086 (-7.09)	0.735 (0.57)	-0.19 (-1.29)	-0.043 (-0.03)	0.347 (1.56)
y_{t-1}	0.51 (35.3)	-0.148 (-8.30)	0.007 (0.08)	0.0185 (0.44)	0.044 (0.44)	0.143 (5.49)	0.510 (46.2)	0.402 (29.6)	-0.003 (-0.02)	0.007 (0.55)	0.0003 (0.0)	-0.01 (-0.60)
n	3,805	3,805	3,805	3,805	3,805	3,805	3,408	3,408	3,408	3,408	3,408	3,408
Instruments	-	-	y_{t-2}	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$ $\Delta y_{t-2}-\Delta y_{t-5}$ $\Delta w_{t-2}-\Delta w_{t-5}$ $\Delta x_{t-2}-\Delta x_{t-5}$	-	-	y_{t-2}	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$ $\Delta y_{t-2}-\Delta y_{t-5}$ $\Delta w_{t-2}-\Delta w_{t-5}$ $\Delta x_{t-2}-\Delta x_{t-5}$
AR(1) test stat Pr > z	-	-	-2.72 (0.99)	-10.97 (1.0)	-5.14 (1.0)	-14.92 (1.0)	-	-	-0.78 (0.78)	-4.13 (1.0)	-1.36 (0.91)	-4.54 (1.0)
AR(2) test stat Pr > z	-	-	-0.53 (0.70)	0.90 (0.18)	0.92 (0.18)	2.45 (0.007)	-	-	-	-	-	-
Overiden. test	-	-	-	33.3 (1.0)	107 (1.0)	70.9 (1.0)	-	-	-	9.87 (1.0)	211592 (<.0001)	20.1 (1.0)

Table 2-9: Effects of maternal work hours on maternal health and parenting, 1 mo.- 54 mo.

	Parenting quality						Depressed					
	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system
w_{t-1}	0.00004 (0.01)	0.0007 (0.10)	1.184 (1.51	1.20 (2.39)	1.78 (0.18)	-0.749 (-1.74)	0.0003 (0.94)	0.0003 (0.85)	-0.0002 (-0.01)	-0.004 (-0.60)	0.003 (0.31)	-0.0008 (-0.15)
y_{t-1}	0.569 (31.84)	0.513 (24.64)	-1.06 (-6.06)	-0.689 (-2.89)	-1.01 (-0.36)	-0.888 (-5.26)	0.304 (19.75)	-0.125 (-7.06)	0.059 (0.77)	0.069 (1.63)	0.049 (0.71)	0.116 (4.29)
n	3,080	3,080	3,080	3,080	3,080	3,080	3,805	3,805	3,805	3,805	3,805	3,805
Instruments	-	-	y_{t-2}	$y_{t-2}-y_{t-4}$ $w_{t-2}-w_{t-4}$ $x_{t-2}-x_{t-4}$	$y_{t-2}-y_{t-4}$ $w_{t-2}-w_{t-4}$ $x_{t-2}-x_{t-4}$	$y_{t-2}-y_{t-4}$ $w_{t-2}-w_{t-4}$ $x_{t-2}-x_{t-4}$ $\Delta y_{t-2}-\Delta y_{t-4}$ $\Delta w_{t-2}-\Delta w_{t-4}$ $\Delta x_{t-2}-\Delta x_{t-4}$	-	-	y_{t-2}	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$ $\Delta y_{t-2}-\Delta y_{t-5}$ $\Delta w_{t-2}-\Delta w_{t-5}$ $\Delta x_{t-2}-\Delta x_{t-5}$
AR(1) test stat Pr > z	-	-	-1.18 (0.88)	-4.25 (1.0)	-0.30 (0.62)	-3.40 (1.0)	-	-	-8.78 (1.0)	-10.05 (1.0)	-12.24 (1.0)	-13.22 (1.0)
AR(2) test stat Pr > z	-	-	-	-	-	-	-	-	-1.07 (0.14)	1.33 (0.09)	0.65 (0.26)	1.41 (0.08)
Overiden. test	-	-	-	7.58 (1.0)	4.32E7 (<.0001)	28.0 (1.0)	-	-	-	25.59 (1.0)	0.85 (1.0)	11.74 (1.0)

Table 2-10: Effects of maternal work hours on maternal health and parenting, 1 mo.- 54 mo.

	Poor/fair health						Overall health					
	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system
w_{t-1}	1.92E-6 (0.01)	0.0008 (3.89)	0.004 (0.09)	0.002 (3.15)	0.002 (1.53)	0.0002 (0.92)	0.0002 (0.75)	-0.0026 (-7.15)	-0.009 (-3.42)	-0.005 (-3.43)	-0.003 (-0.30)	0.01*** (12.18)
y_{t-1}	0.265 (30.6)	0.046 (4.79)	0.068 (5.10)	0.07 (5.94)	0.073 (5.28)	0.085 (14.7)	0.504 (62.8)	0.09 (9.62)	0.07 (5.51)	0.095 (8.51)	0.10 (1.20)	0.415 (37.5)
n	11,968	11,968	11,968	11,968	11,968	11,968	11,968	11,968	11,968	11,968	11,968	11,968
Instruments	-	-	y_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}, Δy_{t-2}, Δw_{t-2}, Δx_{t-2}	-	-	y_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}, Δy_{t-2}, Δw_{t-2}, Δx_{t-2}
AR(1) test stat Pr > z	-	-	-17.3 (1.0)	-17.06 (1.0)	-	-16.59 (1.0)	-	-	-20.25 (1.0)	-20.4 (1.0)	-6.48 (1.0)	-22.35 (1.0)
AR(2) test stat Pr > z	-	-	-0.58 (0.72)	0.05 (0.48)	-	0.38 (0.35)	-	-	0.26 (0.39)	1.25 (0.11)	0.49 (0.31)	5.13 (0.0)
Overiden. test	-	-	-	217 (1.0)	3.80 (1.0)	452.8 (1.0)	-	-	-	225 (1.0)	859 (1.0)	678 (1.0)

Table 2-11: Effects of maternal work hours on maternal health and parenting, 1 mo.- 54 mo. (Three categories of work hours)

	Log CES-D						Parenting stress					
	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system
Hours1to20	0.033 (0.75)	-0.04 (-0.85)	-2.46 (-1.43)	-0.019 (-0.24)	-0.038 (-0.15)	0.103* (1.64)	-1.20 (-2.96)	-2.57 (-4.41)	42.2 (0.45)	-3.30 (-0.54)	-1.48 (-0.03)	-39.4 (-0.94)
Hours21to39	-0.005 (-0.11)	-0.087 (-1.80)	-3.59 (-1.42)	0.016 (0.19)	-0.035 (-0.13)	0.213*** (3.55)	-0.825 (-2.09)	-2.94 (-4.95)	35.5 (0.52)	-6.17 (-1.38)	-4.41 (-0.10)	-9.78 (-0.32)
Hours40plus	0.064 (1.87)	0.009 (0.20)	-2.79 (-0.71)	0.03 (0.37)	0.038 (0.14)	0.251*** (4.69)	-1.26 (-4.0)	-3.67 (-6.51)	-3.91 (-0.04)	-10.98 (-1.83)	-9.14 (-0.18)	5.68 (0.21)
y_{t-1}	0.517 (38.96)	-0.152 (-9.06)	0.009 (0.08)	0.018 (0.48)	0.035 (0.38)	0.350 (18.49)	0.54 (54.0)	0.40 (31.1)	-0.05 (-0.45)	0.001 (0.09)	0.001 (0.01)	0.03 (0.64)
n	4,375	4,375	4,375	4,375	4,375	4,375	3,912	3,912	3,912	3,912	3,912	3,912
Instruments	-	-	y_{t-2}	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$ $\Delta y_{t-2}-\Delta y_{t-5}$ $\Delta w_{t-2}-\Delta w_{t-5}$ $\Delta x_{t-2}-\Delta x_{t-5}$	-	-	y_{t-2}	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$ $\Delta y_{t-2}-\Delta y_{t-5}$ $\Delta w_{t-2}-\Delta w_{t-5}$ $\Delta x_{t-2}-\Delta x_{t-5}$
AR(1) test stat Pr > z	-	-	-3.01 (0.99)	-12.28 (1.0)	-5.82 (1.0)	-16.5 (1.0)	-	-	-0.52 (0.70)	-4.89 (1.0)	-0.76 (0.78)	-1.32 (0.91)
AR(2) test stat Pr > z	-	-	-1.15 (0.87)	1.88 (0.03)	1.32 (0.09)	4.15 (<0.001)	-	-	-	-	-	-
Overiden. test	-	-	-	66.2 (1.0)	220.4 (1.0)	327.6 (1.0)	-	-	-	11.6 (1.0)	376854 (<.0001)	3.37 (1.0)

Table 2-12: Effects of maternal work hours on maternal health and parenting, 1 mo.- 54 mo.

	Parenting quality						Depressed					
	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system
Hours1to20	0.338 (1.64)	0.257 (0.80)	-18.1 (-0.22)	39.4 (3.68)	31.0 (0.67)	-28.1 (-1.0)	0.003 (0.19)	0.006 (0.32)	-0.35 (-.059)	0.027 (0.83)	0.055 (0.18)	-0.08 (-1.59)
Hours21to39	0.336 (1.68)	0.320 (0.95)	50.4 (0.20)	37.5 (2.47)	32.6 (0.57)	-56.1 (-1.19)	-0.007 (-0.43)	-0.017 (-0.84)	-0.118 (-0.09)	-0.008 (-0.21)	0.21 (0.67)	-0.049 (-1.01)
Hours40plus	0.234 (1.44)	0.217 (0.67)	166.2 (0.69)	62.2 (5.26)	35.8 (0.79)	70.5 (1.35)	0.016 (1.24)	0.014 (0.74)	0.42 (0.46)	0.029 (0.78)	0.001 (0.0)	-0.029 (-0.82)
y_{t-1}	0.572 (34.4)	0.503 (25.9)	-1.33 (-1.30)	-0.128 (-1.32)	0.094 (0.24)	-1.05 (-3.30)	0.32 (22.5)	-0.113 (-6.84)	0.03 (0.33)	0.058 (1.80)	0.067 (1.30)	0.194 (8.92)
n	3,448	3,532	3,532	3,532	3,532	3,532	4,270	4,375	4,375	4,375	4,375	4,375
Instruments	-	-	y_{t-2}	$y_{t-2}-y_{t-4}$ $w_{t-2}-w_{t-4}$ $x_{t-2}-x_{t-4}$	$y_{t-2}-y_{t-4}$ $w_{t-2}-w_{t-4}$ $x_{t-2}-x_{t-4}$	$y_{t-2}-y_{t-4}$ $w_{t-2}-w_{t-4}$ $x_{t-2}-x_{t-4}$ $\Delta y_{t-2}-\Delta y_{t-4}$ $\Delta w_{t-2}-\Delta w_{t-4}$ $\Delta x_{t-2}-\Delta x_{t-4}$	-	-	y_{t-2}	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$	$y_{t-2}-y_{t-5}$ $w_{t-2}-w_{t-5}$ $x_{t-2}-x_{t-5}$ $\Delta y_{t-2}-\Delta y_{t-5}$ $\Delta w_{t-2}-\Delta w_{t-5}$ $\Delta x_{t-2}-\Delta x_{t-5}$
AR(1) test stat Pr > z	-	-	-1.11 (0.87)	-6.04 (1.0)	-1.28 (0.90)	-5.09 (1.0)	-	-	-4.24 (1.0)	-10.83 (1.0)	-12.38 (1.0)	-14.56 (1.0)
AR(2) test stat Pr > z	-	-	-	-	-	-	-	-	-0.41 (0.66)	1.50 (0.07)	0.67 (0.25)	2.09 (0.02)
Overiden. test	-	-	-	92.0 (1.0)	6.32E7 (<.0001)	6.38 (1.0)	-	-	-	77.5 (1.0)	1.23 (1.0)	145 (1.0)

Table 2-13: Effects of maternal work hours on maternal health and parenting, 1 mo.- 54 mo.

	Poor/fair health						Overall health					
	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system	Pooled OLS	Within group	2sls	A-B two step	A-B one step	A-B system
Hours1to20	0.007 (0.83)	0.014 (1.37)	-0.02 (-0.23)	-0.056 (-1.86)	-0.036 (-0.76)	-0.063*** (-4.13)	0.009 (0.58)	-0.044 (-2.49)	-0.219 (-1.48)	0.011 (0.19)	0.037 (0.08)	0.42*** (10.49)
Hours21to39	0.010 (1.23)	0.036 (3.51)	0.135 (1.29)	0.004 (1.22)	0.015 (0.32)	-0.067*** (-7.06)	-0.025 (-1.61)	-0.112 (-6.31)	0.017 (0.10)	-0.094 (-1.52)	-0.041 (-0.09)	0.39*** (1098)
Hours40plus	-0.002 (-0.30)	0.031 (3.30)	0.162 (1.67)	0.075 (2.45)	0.05 (1.11)	-0.042*** (-4.95)	0.029 (2.28)	-0.109 (-6.66)	-0.607 (-4.0)	-0.249 (-4.13)	-0.153 (-0.33)	0.49*** (14.55)
y_{t-1}	0.265 (30.5)	0.04 (4.40)	0.06 (4.78)	0.072 (6.31)	0.067 (5.15)	0.123 (14.32)	0.507 (66.8)	0.084 (9.39)	0.065 (5.33)	0.09 (8.59)	0.094 (1.15)	0.434 (43.2)
n	13,040	13,328	13,328	13,328	13,328	13,328	13,040	13,328	13,328	13,328	13,328	13,328
Instruments	-	-	y_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}, Δy_{t-2}, Δw_{t-2}, Δx_{t-2}	-	-	y_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2}	y_{t-2}, w_{t-2}, x_{t-2} Δy_{t-2}, Δw_{t-2}, Δx_{t-2}
AR(1) test stat Pr > z	-	-	-18.3 (1.0)	-18.1 (1.0)	-	-18.3 (1.0)	-	-	-20.25 (1.0)	-21.3 (1.0)	-6.66 (1.0)	-23.28 (1.0)
AR(2) test stat Pr > z	-	-	-0.67 (0.75)	0.10 (0.46)	-	1.3 (0.10)	-	-	0.30 (0.62)	0.71 (0.24)	0.30 (0.38)	5.07 (0.0)
Overiden. test	-	-	-	230.7 (1.0)	3.91 (1.0)	499.5 (1.0)	-	-	-	258.9 (1.0)	997 (1.0)	822 (1.0)

Essay Three

The effect of the academic department quality on publication productivity

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The use of NSF data does not imply NSF endorsement of the research methods or conclusions contained in this report.

1. Background

Cumulative advantage(CA) was formally defined by Merton(1968) as “Matthew effect”, meaning “the accruing of greater increments of recognition for particular scientific contributions to scientists of considerable repute and the withholding of such recognition from scientists who have not yet made their mark”. Allison et al (1982) suggested that in science the key form of advantage is recognition from peers for published research. Scientists with advantage find it easier to get the resources that facilitate research such as grants, time, laboratories, stimulating colleagues, capable students. They are encouraged by their colleagues to continue to invest time and energy in research (Zuckerman and Merton, 1972). As a consequence their research productivity is likely to increase or at least stay at high levels, which earns more recognition. In contrast, scientists with little recognition get little resources or encouragement, which reduces their chances for future productivity and recognition.

A number of studies related CA with publication productivity (Bently and Blackburn, 1990; Clark and Corcoran, 1993; Creswell, 1985; Fox, 1985). Cole and Cole (1973) developed a dynamic theory of stratification in scientific careers based on the cumulative advantage theory. Zuckerman (1977) and Gaston(1978) continued to develop the CA theory as an explanatory principle for inequality.

Allison , Long and Krauze (1982) developed a scale-invariant inequality measure and a mathematical model to test the CA theory with cross-sectional data. They found an association between productivity, resources and esteem. Creamer and McGuire (1998) further pinpointed six factors contributing to CA, (a) earning a doctorate at a prestigious research oriented institution; (b) having an interest in research early; (c) having a prominent mentor; (d) early publication; (e) a job in research institution; and (f) an extensive network. Ramsden (1994) found similar results.

This paper will first test the evidence of increasing inequality with longitudinal data, focus on one factor, the effect of prestige of university department on publication productivity, and then examine the specific characteristics of prestigious departments that enhance publication productivity. Establishing the existence of CA is challenging. The essence of cumulative advantage, "the rich get richer at a rate that makes the poor become relatively poorer" (Merton, 1968), suggests increasing inequality. According to the "inverse square law" by Derek Price (1963), the square root of the population of publishing scientists produce half of the work. But there are two competing theories explaining the increasing inequality, one is CA, and the other is "sacred spark" (Cole and Cole, 1973) which emphasizes the ability difference. CA can operate through many channels, such as resources and esteem (Cole and Cole, 1973). Resources and esteem are scarce in scientific community, and should be rewarded to those who are productive. In this paper I will try to establish that CA operates through the quality of the department. If the effect of the department quality increases over time, then not only will it prove that increasing inequality implies CA, but also establishes at least one channel that CA operates through.

To prove the existence of increasing inequality requires collecting data from the same group of people which should be large enough for a long period of time which allows control over unobserved characteristics such as ability and motivation. The first task has been done before (Allison and Stewart, 1974), but only with cross-sectional data and with small samples (179 observations) including one or a few disciplines (Allison et al in 1982 examined a cohort of biochemists and chemists). This paper will use a large longitudinal data set including all majors, which is large enough and long enough. The second task was also studied before (Allison, Long and Krauze, 1982), but only with one single subjective rank number as a measure of the prestige. This study uses a subjective indicator extracted from many objective measurements. For the third task, there were many studies on this topic. For example, a positive relationship was found between the financial support (such as equipment and facility) and research productivity (Folger and Gordon, 1962; McAllister and Wagner,1981). Ruth and Gouet (1993) found that scientists who used the computer networks publish more. Collaboration grew exponentially among scientists (Beaver and Rosen, 1979a, 1979b). Internal scientific collaboration is active in all universities (Persson et al, 1997). Collaboration has often been associated with higher productivity (number of publications) or quality (citations) of published works (Pelz and Andrews, 1966; Blackburn, Behymer and Hall, 1978;Gordon, 1980; Presser, 1980; Abt, 1984; Beaver, 1979). Austin and Baldwin (1992) believed that collaboration increases productivity, and administrative support promotes collaboration. Hagstrom (1971) studied 125 science departments and found that scientists in high prestige departments engaged in significantly more informal scientific communication than other scientists. Some studies indicated that scientists rely more on informal channels such as communication with colleagues and attendance at conferences than on formal sources such as journals and indexing sources (Meadows, 1974; Styvendaele, 1977). This study found that one measurement is related to productivity, the Gini coefficient of publications in the department.

2. Data

2.1 SDR data

Despite the broad applications of the CA theory, "the quantitative evidence is tenuous and often equivocal," as Allsion et. al. pointed out. Strictly testing the CA theory empirically requires a high quality longitudinal dataset with rich information, which is very rare. One exception is the Survey of Doctorate Recipients (SDR). The Survey of Doctorate Recipients gathers information from individuals who have obtained a doctoral degree in a science, engineering and other fields. The SDR is conducted every 2 years and is a longitudinal survey that follows recipients of research doctorates from U.S. institutions until age 76. It represents some of the highest educated individuals in the U.S. workforce. The data base provides a comprehensive picture of the number and characteristics of individuals with training and/or employment in science, engineering or other fields in the United States.

The major advantage of SDR data is that it has rich information, such as demographics, detailed graduate majors, graduate school code, employer institution code for academic faculty, and the number of publications in the last two years, a standard measure of productivity for scientists. Therefore SDR is a good candidate for testing the CA theory. But there are drawbacks too. For example, there is no citation count for the publications, and only three waves of publication count are available.

Quantity of publications is a widely used indicator of research productivity, and citation is another . Allison and Stewart (1974) found that self-reported publication counts were highly correlated with the actual counts for chemists (r=.94). Some studies reported a positive correlation between the quantity and quality of publications (Pelz and Andrews, 1966; Cole and Cole, 1967; Lawani, 1986). Lawani (1986) suggested that the more research a person does, the better he gets with the demands of the literature in his field, and therefore the producer of quantity also becomes a producer of quality. Cole and Cole (1967) also suggested that when citation counts are not available, publication counts are roughly adequate as indicators of the significance of a scientist's work.

2.2 NRC data

Most studies used a single subjective rank as a measure of the prestige of the institution, such Roose and Anderson (1970), and Cartter (1966) ranks. But now there is a better measure available.

In the fall of 1995 the National Research Council (NRC) published, "Research-Doctorate Programs in the United States: Continuity and Change", a reference book with information about 3634 research-doctorate programs in 41 fields at 274 universities. A listing of the 3634 programs with selected data compiled from other files. The NRC data not only includes a subjective rank of doctorate programs, but also many objective measures of the program quality, including institutional information, publications from 1981 to 1992 identified with the faculty of the departments in the study, research grants from 1986 to 1992 identified with the faculty of the departments in the study, awards and honors from 1986 to 1992 identified with the faculty of the departments in the study, department size, and more. The NRC department rank was used by Hamermesh and Pfann (2009) to proxy the lower bound of individual reputation for the faculty in that department under the hypothesis that the reputation-maximizing collective's reputation forms a lower bound of the individual's.

A principal component is extracted from all the objective measures of program quality through principal component analysis to be used an indicator of the prestige of the program in place of the subjective rank. The first component explains about 50% of the total variance, and the scree plot displays a large break after the first component, both of which suggest that the first component is a good substitute for all objective measures. SDR and NRC data can be linked through institution code and program code. Therefore a measure of quality for the faculty department is available.

3. Methodological approach

I will proxy the prestige of the department with the first principal component extracted from a wealth of information about the quality of the department, and test the effect of working in a prestigious academic department on productivity

Because the ability and motivation are unobservable, and theoretically correlated with both productivity and the quality of the department, they have to be controlled to make sure that the effect of the rank of the department on productivity is not caused by ability or motivation but the resources of the department.

There are three ways to control the unobserved ability/motivation. First, a natural experiment approach is taken. The SDR data has a record of institution code and the reason people switch to new employers in each survey wave. Therefore faculty who switched to different universities with exogenous reasons (not related to productivity such as family reasons) constitutes a natural experiment group whose department quality is not correlated with their ability/motivation theoretically.

The second approach utilizes the longitudinal nature of the SDR data. The fixed effect model for panel count data was used.

The third way is modeled after Arellano-Bond (A-B) model. Use lags of dependent and independent variables as instruments for difference equations, and differences of dependent and independent variables as instruments for level equations. The advantage of A-B model is that there is no need for assumptions of the distribution of the error terms.

4. Literature review

The variable of interest is the institutional prestige. Some studies found a relatively strong relationship between productivity and institutional prestige (Blackburn, Behymer and Hall,1978; Lazarsfeld and Thielen, 1958; Allison and Long, 1990). Blackburn, Behymer and Hall used the prestige rating by American Council on Education and ran multiple regression and variance analysis. But the sample was cross-sectional. Lazarsfeld and Thielen found similar results also using a cross-sectional sample in social science from four-year colleges. Allison and Long used a sample of 179 job changes in four disciplines: physics, chemistry, mathematics , and biology. Their prestige measure is the quality rate by Roose and Andersen (1970). They confirmed that it is the prestige of the department that increases the productivity, not that the prestigious department recruits and retains productive faculty. But their sample was small and limited to only four disciplines.

The quality of the graduate program indicates not only partly the doctorate's ability, but also the doctorate's academic training, and therefore is included. The graduate department affects later publication (Crane, 1965), but that effect declines over time (Hargens and Hagstrom, 1967).

There are three measures of age correlates, age (Clemente, 1973, Cole, 1979, Pelz and Andrews, 1966), years of professional experience (Creswell, Patterson and Barnes, 1984), and years since receipt of doctorate degree (Allison and Stewart, 1974, Bayer and Dutton, 1977). Lehman (1953) found that age was negatively related with productivity.

Pelz and Andrews (1966) found that publication productivity peaked during the ages of 35 to 44 and 50 to 54.Bayer and Dutton (1977) found similar results. Kyvik (1990a) also found a curvilinear relationship between age and productivity.

Family can influence productivity (Horowitz, Blackbrun and Edington, 1984). Lowell, McCann and Reskin (1978) found that researchers with children publish fewer articles and articles of lower quality than those without children. Cole and Zuckerman (1987) reported that scientists who are married with children published more than the unmarried female scientists. Kyvik (1990a & b) found that women with children under 10 years of age published less than their male colleagues with similar aged children and women with older children.

Citizenship represents a lot of differences, such as language and culture, which may lead to difference in productivity. Some papers found that foreign-born scientists are more productive that native-born scientists (Sooho Lee, 2004, Lerner and Roy, 1984, Stephan and Levin, 2001 and 2003).

Gender gap in productivity is an old topic. Men publish more than women (Babcuk and Bates, 1962, Fulton, 1974a and 1974b, Blackburn, Behymer and Hall, 1978, Cole, 1979, Cole and Zuckerman, 1984, Kyvik, 1990a and 1990b), and the gender gap is narrowing (Cole and Zuckerman, 1984, Austin, 1978 and 1984, Long, 1992). Some papers found that women have heavier teaching and service loads than men, which has a negative consequence for research time and productivity (Park, 1996; Menges & Exum, 1983). There are similar statements in the literature on black and hispanic faculty (Garza, 1993; Banks, 1984).

Time spent on research and the number of students supervised are resources for publication production (Allison and Stewart, 1974). Some studies found that time spent on research was associated with productivity, and time on teaching and administration was negatively associated with productivity (Manis, 1951; Andrews, 1964; Harrington and Levine, 1986). Other studies didn't find such association (Voeks, 1962; Harry and Goldner, 1972; Dent and Lewis, 1976; Neumann, 1992).

Some studies found that faculty in higher ranks publish more than those in lower ranks (Blackbrun, Behymer and Hall, 1978, Creswell, Patterson and Barnes, 1984a, Wanner, Lewis and Gregorio, 1981, Dickson, 1983, Bently, 1990, Kyvik, 1990a). It is suggested that full professors have more opportunities for research and publication because they teach less, have better professional networks and more funds (Zainab, 1999). Tenure has little influence on productivity (Holley, 1977, Blackburn, Behymer and Hall, 1978, Neumann, 1979). Some studies found no effect of rank on productivity when relevant variables are controlled (Guyer and Fidell, 1973; Over, 1982; Wanner, Lewis and Gregorio, 1981).

Funding is an important determinant of research productivity. Folger and Gordon (1962) and Salisbury (1980) found a positive relationship between adequate amounts of financial support for research and publication productivity. McAllister and Wagner (1981) found similar results.

Other variables include the number of professional society membership (Creamer and McGuire, 1998), parental education, and the time between college and doctorate (Hamermesh, Pfann, 2009). The academic year for highest degree represents the cohort effect.

All the time-invariant variables will be controlled in the second approach, including the time-invariant unobservables.

5. SDR and NRC data summaries

Higher rank means higher quality. Table 1shows an even distribution among rank high, medium and low groups of academic departments. To test whether the rank based on the first principal component extracted from many indicators about program quality is robust, the Pearson correlation coefficient between the factor and the subjective rating in NRC data is calculated, which is 0.79 with p-value less than 0.01.

Table 2 shows the distribution of primary work activity in three years. The distribution is fairly stable over time, with higher percentage in research and teaching, and much lower percentage in other activity, including management and administration, computer applications and other.

The table above shows the means and standard deviations for all variables. The sample consists of only faculty on tenure track. There are two questions in the survey, one asks if the respondent is on tenure track, and the other asks about the respondent's tenure status. Among all faculty on tenure track, there are instructors, lecturers and others. They are kept in the sample because of the small sample size.

Table 3 summarizes all basic variables in SDR. Because the dependent variables, the number of publications in the last two years are non-negative counts, two models can be chosen, Poisson and negative binomial regression models. The dependent variables are characterized by overdispersion, i.e., the variance exceeds the mean. Therefore negative binomial regression model is chosen over Poisson model which requires the conditional mean equals the conditional variance.

The average age in 1993 is 45, which means that for half subjects, we are not able to observe their productivity before 45. And the average number of publications increased from 1995 to 2001, and then decreased in 2003, which is expected due to the aging effect per se. According to Stephan and Levin (1992, page 152), "scientists produce less output as they age. And the aging effect can be attributed to age per se and not to the fact that for some reason older scientists have different attributes, different values, or differential access to resources than do younger scientists."

About 95% of the samples are U.S. citizens, 78% are male, 91% were married, 46% had government support, and 83% are white. It took about 7.7 years on average to get Ph.D. after college. And everyone had 3.9 professional society memberships on average.

Following Allison et. al.(1974)'s choice of Gini coefficient as inequality measure, I calculated the Gini coefficient for the three years where publications are available. If the x values are placed in ascending order, such that each x has rank i, then the Gini coefficient can be calculated as:

$$G = \frac{2}{n^2 \bar{x}} \sum_{i=1}^{n} i(x_i - \bar{x})$$

where x is an observed value, n is the number of values observed and i is the rank of values in ascending order. G is a measure of inequality, defined as the mean of absolute differences between all pairs of individuals. The minimum value is 0 when all measurements are equal and the theoretical maximum is 1. A table for the inequality measure in 1995, 2001 and 2003 is created (table 4).

The Gini coefficient increased over time, which suggests that the gap between the highly productive and the less productive in science widens over time. Since the sample only consists of the same faculty on tenure track in all survey years, people who left faculty position for not getting tenure are excluded. There were 1204 people who were on tenure track in 1995 and left faculty position by 2001 publishing 5.9 papers in 1995 on average, and there were 419 people who were on tenure track in 2001 and left by 2003 publishing 6 papers in 2001 on average. It shows that people who left tenure track were less productive than those that stayed on the tenure track. Therefore the Gini coefficient in the table above would have become bigger over time due to attrition if those people who left faculty position were still included. Also the increase of Gini coefficient doesn't come from change in age or disciplinary composition, because it is the same group of people in all three years.

Next I will study the effect of quality of the department on publication productivity, and see if that effect contributes to CA.

6. Empirical model

Let Y_{it} denote the number of publications in the last two years, X_{it} denote the time-varying independent variables, Z_i denote the time-invariant independent variables, and ε_{it} denote the errors. The empirical model takes the following form:

$$Y_{it} = \alpha_t + \beta X_{it} + \gamma Z_i + \varepsilon_{it} \quad (1.1)$$

where $\alpha_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \alpha_3 t^3$. A scientist's productivity is expected to change over time, independent of changes in other variables. That change can be captured by α_t which can be referred to as the time structure for productivity (Long, Allison and McGinnis, 1993).

6.1 Natural experiment model

Some faculty switch to other universities for various reasons (for example, 1.pay, promotion opportunities; 2. Working conditions (e.g., hours, equipment, working environment); 3. Job location; 4. Change in career or professional interests; 5. Family-related reasons (e.g., children, spouse's job moved); 6. School-related reasons (e.g., returned to school, completed a degree); 7. Laid off or job terminated (includes company closings, mergers, buyouts, grant or contract ended); 8. Retired; 9. Some other reason;), which provide a natural experiment. For faculty who moved for family-related reasons, job locations, or school-related reasons, the quality of their departments can be considered not tied to their ability/motivation. For example, faculty who moved because the spouse moved switched to another department to be with the family, which would break the tie between ability and the department quality if there was such a tie. Faculty who moved for location reasons probably has strong preferences for certain locations (for example, preference of big city over small town or warm weather over cold weather), and therefore would break the tie between ability and the department quality. The same argument applies to school-related reasons, but not to other reasons. One may argue that people who switched to other departments can only switch to departments of lower quality. But 229 moved for exogenous reasons before 1997 and 235 before 1999. Among the 229, 17 moved up to a better department, and among the 235, 26 moved up to a better department. Table 5a summarizes the reasons for moving for each wave, and table 5b summarized the basic variables. People who switched for exogenous reasons are quite different from the whole sample, they are younger (39 vs. 45), more have kids under 6 (41% vs. 29%), more are associate professors (46% vs. 30%), less are male (65% v. 78%), and they have higher salary (72351 vs. 61890). Therefore the results may be biased due to the difference in sample. Fortunately a fixed effect model can be applied to control unobserved ability/motivation.

Even though there are three waves of the number of publications available, two regressions are run. First regression is run with the number of publications in 2001 as the dependent variable, and time-invariant variables and time varying variable measured in 1997 as independent variables. Second regression is run with the number of publications in 2003 as the dependent variable, and variables in 1999 as independent variables. Because the number of publications measures the publications in the last two years, and it usually takes a couple of years to publish a paper after it is completed, it would be appropriate to use the quality measure for the department in 1991 for publications in 1995, but that is not available, therefore the regression for publication in 1995 is not run. According to Long (1978) , after the third year in the appointment, scientists' productivity rates are more strongly affected by the quality of their academic departments, meaning that those in prestigious departments start to publish more, and those in less prestigious departments start to publish less. Long (1978) studied a group of biochemists for about 15 years. He regressed the productivity before the new appointment and other variables on the prestige of the department for the new appointment and found that the productivity prior to the new appointment didn't affect the prestige of the department for the new appointment. And then he regressed the prestige of the department and other variables three years ago on the current productivity and found that the prestige of the department three years ago affected the current productivity. A regression of publications in 2001 was run on quality measures in all previous years, i.e., 1993, 1995, 1997, 1999 and 2001, and only quality measure in 1997 is significant. Therefore quality measure in 1997 was chosen for the year 2001. And all other time-variant variables are constructed the same way as the quality measure, such as the tenure status, government support, children under 6, primary work activity, number of professional society membership and marriage. Someone may argue that the publication lag is quite different between social science and other disciplines. Table 12 lists the distribution of major groups of disciplines in the whole sample and the experiment sample. Table 13 shows the result of table 8 without the social science group (n=377), the coefficient on the quality measure remains the same. That shows excluding the social science group doesn't make a difference.

One criterion for assessing goodness of fit is the deviance. The deviance for a model M_0, based on a dataset *y*, is defined as (see reference 27, 65)

$$D(y) = -2\Big(\log\big(p(y|\hat{\theta}_0)\big) - \log\big(p(y|\hat{\theta}_s)\big)\Big).$$

Here $\hat{\theta}_0$ denotes the fitted values of the parameters in the model M_0, while $\hat{\theta}_s$ denotes the fitted parameters for the "full model" (or "saturated model"): both sets of fitted values are implicitly functions of the observations *y*. Here the full model is a model with a parameter for every observation so that the data are fitted exactly. This expression is simply −2 times the log-likelihood ratio of the reduced model compared to the full model. The deviance is used to compare two models - in particular in the case of generalized linear models where it has a similar role to residual variance from ANOVA in linear models (RSS). Suppose in the framework of the GLM, we have two nested models, M_1 and M_2. In particular, suppose that M_1 contains the parameters in M_2, and *k* additional parameters. Then, under the null hypothesis that M_2 is the true model, the difference between the deviances for the two models follows an approximate chi-squared distribution with *k*-degrees of freedom.

The deviance has an approximate chi-square distribution with *n-p* degrees of freedom, where *n* is the number of observations (1208) and *p* is the number of predictor variables (25), and the expected value of a chi-square random variable is equal to the degrees of freedom. Then, if our model fits the data well, the ratio of the Deviance to DF should be about one. In this case, it's 1.2, very close to 1. To confirm that negative binomial regression is a better fit than Poisson regression, I also run the Poisson regression and got 6.6 for Deviance /DF**,** indicating overdispersion. Therefore negative binomial regression is a much better fit than Poisson regression.

Table 6 and 7 show that statistically significant variables include: quality measure, tenure status, government support, other race, primary work activity, number of professional society membership. Increasing the quality measure by one standard deviation for the department in 1997 would increase the log of expected number of publications in 1995 by 0.23, holding other variables constant. In other words, the number of publications would increase by 26%, or 3.3 papers at the mean level. For 2003, it increases the log of publications by 0.14, or increase the number of publications by 15%, or 1.7 papers at the mean level. The coefficient for quality is bigger than that for the rest of the group for 2001, but smaller than that for the rest of the group for 2003, suggesting this natural experiment approach doesn't produce consistent estimates.

Compared to full professors, all other faculty publish less except associate professors. But the results are not significant except for other faculty. This result is consistent with some studies (Guyer and Fidell, 1973; Over, 1982; Wanner, Lewis and Gregorio, 1981).

The number of publications for faculty with government support is 1.4 to 1.6 times that for faculty without government support. Government support includes funding from all federal and state agencies, such as NASA, NIH, NRC, NSF, etc. This is consistent with the results of Folger and Gordon (1962), Salisbury (1980), and McAllister and Wagner (1981).

Faculty having research as primary work activity publishes as much as 1.2 times that of faculty having teaching or other activity as primary work activity. This result is consistent with many other studies (Manis, 1951; Andrews, 1964; Harrington and Levine, 1986).

Holding other variables constant, having one more professional society membership will increase the number of publication by 10%. This is consistent with the result of Creamer and McGuire (1998).

Even though the estimates in the two regressions are biased compared to the results of fixed effect model, they are biased in the same direction. Therefore they still show how the effect of the department quality changes over time. The coefficient on quality measure of the department decreases over time, suggesting that the effect of the quality of the department doesn't contribute to cumulative advantage in publication productivity, contrary to Fox's (1983) hypothesis.

6.2 Fixed effect model

$$Y_{it} = \alpha_t + \beta X_{it} + \gamma Z_i + \varepsilon_{it} \quad (1.2)$$

In the fixed effect model, $\varepsilon_{it} = \eta_i + \zeta_{it}$, where η_i is unobserved characteristics or heterogeneity, such as ability/motivation, and ζ_{it} is random errors. This model can be estimated based on Allison's (2005) fixed effect panel model with negative binomial distribution. Table 8 shows that the coefficient for quality measures is 0.13, significant after controlling for the unobservable. In other words, increasing the quality of the department by one standard deviation would increase the publication by approximately 14%, or approximately 1.7 papers at the mean level. This is consistent with some other studies (Blackburn, Behymer and Hall,1978; Lazarsfeld and Thielen, 1958; Allison and Long, 1990).

The coefficient of the quality measure is smaller in the fixed effect model than the natural experiment model, which suggests that the natural experiment model overestimates.

6.3 Two stage least squares estimation with instrumental variables

Since the SDR data is a panel data set, the lags of dependent and independent variables can be used to construct instrumental variables as in the Arellano-Bond (A-B) model (Bond, 2002). There are three advantages using A-B model. First of all, A-B is a good fit for panel data with a large number of individuals and a small number of time periods, which is how the SDR data is structured. Second, A-B model allows for dynamics by including lagged dependent variables, where the variables of interest are state dependent. Third, A-B model doesn't require a specific distribution assumption. The following multivariate dynamic A-B model is specified following Bond (2002):

$$y_{it} = \alpha y_{i,t-1} + \beta x_{it} + \mu_i + \varepsilon_{it};\ -1 < \alpha < 1; i = 1, 2, \ldots, N; t = 2, 3, \ldots, T \quad (1.3)$$

Where y_{it} is an observation for individual i in period t, $y_{i,t-1}$ is the observation for the same individual in the previous period, x_{it} is a vector of current and lagged values of additional explanatory variables, μ_i is an unobserved individual-specific time-invariant effect, and ε_{it} is the disturbance term. The first-differencing transformation eliminates the individual effect μ_i:

$$\Delta y_{it} = \alpha\Delta y_{i.t-1} + \beta\Delta x_{it} + \Delta\varepsilon_{it};\ -1 < \alpha < 1; i = 1,2, \dots, N; t = 3,4, \dots, T \ (1.4)$$

Bond (2002) showed that the OLS and Within Groups estimators for the coefficient of the lagged dependent variable are biased in opposite directions, which can be used as the bounds for a consistent estimator. In the A-B model, lagged variables are used as instruments for difference equations, and differenced variables are used as instruments for level equations. Both are valid instruments in theory, but they can be strong or weak in practice. It requires at least four time periods to run the A-B model. But because only three periods are available, GMM estimation can't be performed. Two stage least squares estimation is done instead.

According to table 9, lags are weak instruments for difference equation, the coefficient of the lagged dependent variable falls out of the bond, but the differences are good instruments for level equations. For every standard deviation of quality added, the number of publication increases by 2.1. The result is slightly larger than the fixed effect model result. Considering that due to the lack of time waves, full A-B model can't be performed, the fixed effect estimation should be more accurate.

7 Further study on department characteristics

Long (1978) discussed a variety of mechanisms for a departmental effect proposed by Crane (1970) and Hagstrom (1971). Prestigious departments may provide a scientist with more free time for research, superior physical resources, better research assistants, more stimulating colleagues, and stronger social support for doing research; and there may be a "halo" effect for being located at a prestigious department whereby papers and grant proposals appear more impressive to reviewers and to potential citers.

Since the quality measure for the department is statistically significant in all regressions, I will replace it with objective measures of the department quality in the NRC data and run all regressions again to find out what specific resources facilitate productivity. Table 10a and 10b summarize all the NRC variables. All the NRC variables included are intended to capture common characteristics of all academic departments, not discipline specific. Some variables are directly calculated from the questionnaire, such as the number of total faculty, and others are calculated by NRC, such as the percentage of faculty publishing. Total faculty and total number of doctorates are used to describe the size of the department. Blume and Sinclair (1973) found a positive relationship between individual productivity and department size. All other variables describe the productivity of colleagues in the department. Hargens and Hagstrom (1967) suggested that a scientist's productivity is influenced by the activity of colleagues. Blau (1973) indicated that discussion among colleagues promotes research involvement and interests.

Table 11 shows that one variable is marginally significant, the Gini coefficient of publications, indicating that a faculty who works in an academic department with lower inequality of faculty publishing publishes more than a faculty in other academic departments.

8 Conclusion

In conclusion, factors including department quality, government support, and number of professional society membership have strong and consistent effect on productivity. Significant differences are found among faculty with different primary work activity.

The effect of the department quality doesn't increase over time, and therefore doesn't contribute to the increasing inequality in publication productivity, and proves that CA doesn't operate through the channel of department quality. But that doesn't prove CA doesn't exist, because CA can operate through other channels, such esteem, which requires citation data that is missing in SDR data.

Further study on program characteristics shows that the Gini coefficient of publications has negative effect on faculty productivity, suggesting that a department with most of its faculty publishing is more conducive to publication than otherwise.

One major limitation of SDR data is the lack of quality measures for productivity. And the other limitation is that the number of publication is only collected in three years. To get a complete picture of how productivity is affected by factors aforementioned, longitudinal data with both quantity and quality measures collected in many years are needed, along with other basic information.

References

1. Abt, H.A. 1984. Citations to single and multi-authored papers. *Publications of the Astronomical Society the Pacific*, Vol.96: 746-749.
2. Allison, P.D. and Long, J.S. 1990. Departmental effects on scientific productivity. *American Sociological Review*, 55: 469-478.
3. Allison, P.D. and Stewart, J.A. 1974. Productivity among scientists: evidence for accumulative advantage. *American Sociological Review* 39: 596-606.
4. Allison, P.D.; Long, J. Scott and Krauze, Tad K.. 1982. Cumulative advantage and inequality in science, *American Sociological Review* 47: 615-625.
5. Allison, P.D.; 2005. Fiexed effects regression methods for longitudinal data using SAS, Cary, NC: SAS Institute Inc.
6. Andrews, Frank M. 1964. Scientific performance as related to time spent on Technical work, teaching or administration, *Administrative Science Quarterly*, 9: 182-193.
7. Austin, Anne E and Roger G. Baldwin. 1992.Faculty collaboration: enhancing the quality of scholarship and teaching. Eric digest. at: http://ericae.net/db/digs/ed347958. Html. Also published as ASHE-ERIC *Higher Education Repor*t no. 7. Washington, D.C. : George Washington University, School of Education and Human services.
8. Austin, Helen S. 1978. Factors affecting women's scholarly productivity, In: The higher education of women: essays in honour of Rosemary Park. New York: Praeger: 133-157.
9. Austin, Helen S. 1984. Academic scholarship and its rewards In: *Advances in motivation and achievement* Vol.2, edited by Marjorie W. Steinkamp and Martin L. Maehr. Greenwich, Conn: JAI Press.
10. Babchuk, Nicholas and Bates, Alan P. 1962. Professor or producer: the two faces of academic man. *Social Forces* 40: 341-348.
11. Banks, W. M. (1984). Afro-American scholars in the university: Roles and conflicts. *American Behavioral Scientist*, 27(3), 325–338.
12. Bayer, A. E. and Dutton, Jeffrey E. 1977. Career age and research professional activities of academic scientists. *Journal of Higher Education* 48: 259-282.
13. Beaver, D. de B and R. Rosen. 1979b. Studies in scientific collaboration: Part III. Professionalization and the natural history of modern scientific co-authorship, *Scientometrics*, Vol.1:231-245.
14. Beaver, Donald de B., and R. Rosen, "Studies in Scientific Collaboration." Part I. "The Professional Origins of Scientific Co-authorship," in *Scientometrics*, No. 1, 1978, pp. 65–84; Part II. "Scientific Co-authorship, Research Productivity, and Visibility in the French Elite," *Scientometrics*, No. 1, 1979, pp. 133–149.
15. Blackburn, R.T.; Behymer, C.E. and Hall, D.E.1978. Researc notes: correlates of faculty publications. *Sociology of education*. 51:132-141.
16. Blau, Peter. 1973. The organization of academic work. New York: John Wiley.
17. Blume, S.S. and Sinclair, Ruth. 1973. Chemists in British universities: a study of the reward system in science. *American Sociological Review*,

38: 126-138.

18. Cartter A.M. 1966. An assessment of quality in graduate education. Washinton Dc: American Council on Education
19. Clark, S.M. and Corcoran, M. 1993. Perspectives on the professional socialization of women faculty: a case of ccumulative disadvantage: Women in higher education: a feminist press. Nedham Heights, MA: *SHE Reader Series*, Ginn Press.
20. Clemente, Frank. 1973. Early career determinants of research productivity. *American Journal of Sociology* vol.79no.2:409-419.
21. Cole, Jonathan R. 1979. Fair science. New York: The Free Press.
22. Cole, Jonathan R. and Cole, Stephen. 1973. Social stratification in science. Chicago: the univ of Chicago Press.
23. Cole, Jonathan R. and Zuckerman, Harriet. 1984. The productivity puzzle: persistence and change in patterns of publication of men and women scientists, In: Advances in motivation and achievement: women in science. Greenwich, CT: JAI Press: 217-258.
24. Cole, Jonathan R. and Zuckerman, Harriet. 1987. Marriage, motherhood and research performance in science, *Scientific American* (Feb): 83-89.
25. Cole, S. and Cole, J.R. 1967. Scientific output and recognition: a study in the operation of the reward system in science. *American Sociological Review* 32:377-390.
26. Cole, S., 1979. Age and scientific performance. *American Journal of Sociology* 84, 958–977.
27. Collett, David (2003). Modelling Survival Data in Medical Research, Second Edition. Chapman & Hall/CRC. ISBN 1-58488-325-1.
28. Crane, Diana. 1965. Scientists at major and minor universities: a study of productivity and recognition. *American Sociological Review* 30:699-714.
29. Crane, Diana. 1970. The academic marketplace revisited. *American Journal of Sociology* 75: 953-64
30. Creamer, Elizabeth G and McGuire, Sharon P. 1998. Applying the cumulative advantage pespective to scholarly writers in higher education, *The Review of Higher Education*, vol.22, no.1: 73-82
31. Creswell, John J.; Patterson, Robert A. and Barnes, Michael W. 1984a. Enhancing faculty research productivity. Paper presented at the Meeting of the Association for the Study of Higher Education, Chicago.
32. Creswell, John W. 1985. Faculty research performance:lessons from the sciences and the social sciences. Washington : ERIC (ASHE-ERIC *Higher Education Report*, no.4).
33. Dent, P.L. and Lewis, D.J. 1976. The relationship between teaching effectiveness and measures of research quality. *Education Research Quarterly* (Fall): 3-16.
34. Dickson, Vaugh A. 1983. The determinants of publication rates of faculty members at a Canadian university, *The Canadian Journal of Higher Education* vol.12:2
35. Eckert, Ruth E. and Williams, H.Y. 1972. College faculty view themselves and their jobs. Minneapolis: University of Minnesota.

36. Folger, Anne and Gerald Gordon. 1962. Scientific accomplishment and social organization: a review of the literature. *The American Behavioral Scientists*, Vol.6: 51-58.
37. Fox, Mary Frank. 1983. Publication productivity among scientists: a critical review. *Social Studies of Science* 13, 285-305
38. Fox, Mary Frank. 1985. Publication, performance and reward in science and scholarship. In: J.C. Smart (ed). Higher education:handbook of theory and research. Vol.1: New York: Agathon Press: 225-283.
39. Fulton, Oliver and Trow, Martin. 1974a. Research activity in American women in the United States. In : Martin Trow (ed) Teachers and students. New York: McGraw-Hill: Chapter 6: 199-248.
40. Fulton, Oliver and Trow, Martin. 1974b. Research activity in American higher education, *Sociology of Education*, 47: 29-72.
41. Garza, H. (1993). Second-Class Academics: Chicano/Latino Faculty in U.S. Universities. In Building a Diverse Faculty, ed. J. Gainen and R. Boice. San Francisco: Jossey-Bass.
42. Gaston, Jerry 1978. The reward system in British and American science. New York: Wiley.
43. Gordon, M.D. and Presser S. 1980.A critical assessment of inferred relations between multiple authorship, scientific collaboration, the production of papers and their acceptance for publications, *Scientometrics,* Vol.2: 193.
44. Guyer,L. and Fidell, L. 1973. Publications of men and women psychologists: do women publish less? *American Psychologist* 28: 157-160.
45. Hagstrom, W.O. 1971. Inputs, outputs, and the prestige of university science departments. *Sociology of Education*, Vol.44: 375-397.
46. Hamermesh, Daniel S. and Pfann, Gerard A. 2012. MARKETS FOR REPUTATION: EVIDENCE ON QUALITY AND QUANTITY IN ACADEME. *Economic Inquiry*, Vol. 50: 1-16
47. Hargens, Lowell L. and Hagstrom, Warren O. Winter. 1967. Sponsored and contest mobility of American Academic scientists. *Sociology of Education* vol.40, no.1: 24-38.
48. Hargens, Lowell L., James S. McCann, and Barbara Reskin, "Productivity and Reproductivity: Professional Achievement and Marital Fertility among Research Scientists." *Social Forces* 57:154-63.
49. Harrington, M.S. and Levine, D.U. 1986. Relationship between faculty characteristics and research productivity. *Journal of Dental Education* vol.50, no.9: 518.
50. Harry, J. and Goldner, N.S. 1972. The "null" relationship between teaching and research. *Sociology of Education* 45: 47-60.
51. Holley, John W. 1977. Tenure and research productivity. Research in Higher Education 6 : 181-192.
52. Horowitz, Stephen M; Blackburn, Robert T and Edington, Dee W. 1984. Some correlates of stress with health and work/life satisfaction for university faculty and administrators. Paper presented at the annual Meeting of the Association for the Study of Higher Education, March, Chicago, Illinois.
53. Kyvik, Svein. 1990a. Age and scientific productivity: differences in fields

of learning. *Higher Education*, 19: 37-55.
54. Kyvik, Svein. 1990b. Motherhood and scientific productivity. *Social Studies of Science*, 20: 149-160.
55. Lawani, S.M. 1986. Some bibliometric correlates of quality in scientific research. *Scientometrics* vol.9, no.1-2: 13-25.
56. Lazersfeld, Paul F and Thielen, Wagner. 1958. The academic mind: social scientists in a time crisis. Glencoe, Ill. : The Free Press.
57. Lee, Sooho. 2004. Foreign-born scientists in the united states –do they perform differently than native-born scientists? PhD dissertation in School of Public Policy at Georgia Institute of Technology.
58. Lehman, Harvey C. 1953. Age and achievement. Princeton: Princeton University Press.
59. Lerner, Joshua and Rustum Roy (1984) Numbers, Origins, Economic Value, and Quality of Technically Trained Immigrants into the United States. *Scientometrics* 6(4): 243-259.
60. Long, John S. 1992. Measures of sex differences in scientific productivity. *Social Forces* vol.7, no.1:159-178.
61. Long, J. Scott. 1978. Productivity and academic position in the scientific career. *American Sociological Review*, Vol. 43, 889-908.
62. Manis, Jerome G. 1951. Some academic influences upon publication productivity. *Social Forces* 29: 269-272.
63. McAllister, P.R. and D.A. Wagner. 1981. Relationship between R & D expenditures and publication output for US colleges and universities. *Research in Higher Education*, Vol.15:3-29.
64. McAllister, P.R. and D.A. Wagner. 1981. Relationship between R & D expenditures and publi-cation output for US colleges and universities. *Research in Higher Education*, Vol.15:3-29.
65. McCullagh, Peter; Nelder, John (1989). Generalized Linear Models, Second Edition. Chapman & Hall/CRC. ISBN 0-412-31760-5.
66. Meadows, A.J. 1974. Communication in science. London: Butterworth.
67. Menges, R., & Exum, W. (1983). Barriers to the progress of women and minority faculty. *Journal of Higher Education*, 54, 123–144.
68. Merton, R.K., 1968. The Matthew Effect in Science, Science 159, 56-63.
69. Neumann, R. 1992. Perceptions of the teaching research nexus: a framework for analysis. *Higher Education*, vol.23, no.2: 159-171.
70. Neumann, Yoram. 1979. Research productivity of tenured and non-tenured faculty in US universities: a comparative study of four fields and policy implications. *The Journal of Educational Administration* 17: 92-101.
71. Over, Ray. 1982. Does research productivity decline with age. *Higher Education* vol.11 no.5: 511-520.
72. Park, S. M. (1996). Research, teaching, and service: Why shouldn't women's work count? *Journal of Higher Education*, 67(1), 46–84.
73. Parsons, Talcott and Platt, Gerald. 1968.The American academic profession: a pilot study. Grant G55B, National Science of Education.
74. Pelz, Donald C & Andrews, Frank M. 1966, Scientists in organizations: productive climates for research and development. New York: John Wiley.

75. Persson, O. et al, 1997. Research collaboration at Nordic Universities, *Scientometrics*, Vol.39, no.2: 209-223.
76. Presser, S. 1980. Collaboration and the quality of research. *Social studies of Science*, Vol.10: 95.
77. Price, Derek. Little Science, Big Science (New York: Columbia University Press, 1963)
78. Ramsden, P. 1994. Describing and explaining research productivity. *Higher Education* 28: 207-226.
79. Roose, Kenneth D and Anderson, Charles J. 1970. A rating of graduate programs. Washington, D.C.: American Council on Education.
80. Ruth, S. and R. Gouet. 1993. Must invisible colleges be invisible? An approach to examining large communities of network users. *Internet Research*. Vol.31, no.1: 36-53.
81. Salisbury, G.W. 1980. Research productivity of the state agricultural experiment station system: measured by scientific publication output. Bulletin 762. College of Agriculture, University of Illinois at Urbana-Champaign.
82. Stephan, Paula E and Sharon G. Levin (1992) Striking the Mother Lode in Science: The Importance of Age, Place, and Time. Oxford University Press.
83. Stephan, Paula E and Sharon G. Levin (2003) Foreign Scholars in U.S. Science: Contributions and Costs. In Science and the University, Ronald Ehrenberg and Paula Stephan (eds). University of Wisconsin Press, forthcoming.
84. Stephan, Paula E and Sharon G. Levin. (2001) Exceptional contributions to US science by the foreign-born and foreign-educated. *Population Research and Policy Review,* 20: 59-79.
85. Stephen R. Bond, 2002, Dynamic Panel Data Models: A guide to micro data methods and practice. Cemmap working paper CWP09/02.
86. Styvendaele, B.J.H.Van. 1977. University scientists as seekers of information: sources of references to periodical literature. *Journal of Librarianship*, Vol.9, no.4: 270-277
87. Voeks, V.W. 1962. Publications and teaching effectiveness. *Journal of Higher Education*. 33:212-218.
88. Wanner, Richard A; Lewis, Lionel S. and Gregorio, David I. 1981. Research productivity in academia: a comparative study of the science, social sciences, and humanities. *Sociology of Education* 54: 238-253.
89. Zainab, A.N. 1999. Personal, academic and departmental correlates of research productivity: a review of literature. *Malaysian Journal of Library & Information Science*, vol.4, no.2, December: 73-110.
90. Zuckerman, H.A.and Merton, R.K. 1972. Age, Aging, and Age Structure in Science (with Harriet A. Zuckerman). A Theory of Age Stratification. *Vo13. of Aging and Society*. New York: Russell Sage Foundation, 292-356.

Table 3-1. Distribution of departments by quality ranks

Department rank based on the principal component	Frequency	Percent
1	419	34.69
2	393	32.53
3	396	32.78

Table 3-2. Primary work activity over time

Primary work activity in 1993	Frequency	Percent
Research	554	45.86
Teaching	509	42.14
Other	145	12.00
Primary work activity in 1997		
Research	531	43.96
Teaching	515	42.63
Other	162	13.41
Primary work activity in 1999		
Research	517	42.80
Teaching	523	43.29
Other	168	13.91

Table 3-3. Summary statistics for SDR data

Variable	N	Mean	Std Dev	Min	Max
Number of publications in 1995	1208	11.01	11.33	0	96
Number of publications in 2001	1208	12.62	14.61	0	96
Number of publications in 2003	1208	11.66	14.75	0	96
Principal component for the department	1208	-0.06	0.95	-2.28	6.16
Faculty switched to different universities with exogenous reasons	1208	0.17	0.38	0	1
Principal component for Ph.D. program	1208	-0.83	1.45	-2.41	5.14
Age	1208	45.29	8.51	25	65
Children under age 6	1208	0.29	0.6	0	3
Years of full-time professional experience	1208	17.75	9.08	0	43
Other faculty in 1993	1208	0	0.06	0	1
Associate professor in 1993	1208	0.3	0.46	0	1
Assistant professor in 1993	1208	0.21	0.41	0	1
U.S. citizen	1208	0.95	0.22	0	1
Gender	1208	0.78	0.42	0	1
Government support	1208	0.46	0.5	0	1
Married	1208	0.91	0.29	0	1
Private school	1208	0.22	0.41	0	1
Asian	1208	0.08	0.27	0	1
Other race	1208	0.09	0.29	0	1
Primary work activity-teaching	1208	0.42	0.49	0	1
Primary work activity-research	1208	0.46	0.5	0	1
Primary work activity-other	1208	0.12	0.33	0	1
Number of professional society memberships	1208	3.85	2.4	0	20
Highest degree award academic year	1208	1976.98	8.89	1954	1992
Years between BA/BS and Ph.D.	1208	7.66	3.4	2	29
Supervising	1208	0.74	0.44	0	1
Father with education higher than high school	1208	0.62	0.49	0	1
Mother with education higher than high school	1208	0.55	0.5	0	1
Salary	1208	61,890	22,019	10,000	200,000

Table 3-4. Inequality measure Gini coefficient

Year	Gini
1995	0.485
2001	0.540
2003	0.569

Table 3-5a. Reasons for changing employer

Reasons for changing employer	1993	1995	1997	1999
Family related (exogenous)	66	*	*	*
Job location(exogenous)	113	14	10	10
School related(exogenous)	107	0	1	0
Change in interests	52	*	7	*
Working conditions	86	14	8	*
Laid off	8	*	*	*
Pay, promotion opportunites	133	18	18	14
Retired	*	0	0	0
Other reason	*	*	*	0

Note: cells that are less than or equal to 5 are suppressed and marked as *.

Table 3-5b. Summary statistics of faculty who changed employer

	Faculty switched before 1997 (n=229)				Faculty switched before 1999 (n=235)			
Variable	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
AGE	39.20	7.92	26	62	39.14	7.84	26.00	62
Children under 6	0.41	0.67	0	3	0.40	0.70	0.00	3
Tenure status-other	0.01	0.11	0	1	0.02	0.13	0.00	1
Assistant professor	0.24	0.43	0	1	0.09	0.29	0.00	1
Associate professor	0.46	0.50	0	1	0.55	0.50	0.00	1
U.S. citizen	0.90	0.30	0	1	0.90	0.30	0.00	1
Gender	0.65	0.48	0	1	0.65	0.48	0.00	1
Government support	0.55	0.50	0	1	0.65	0.48	0.00	1
Married	0.82	0.38	0	1	0.79	0.41	0.00	1
Private school	0.29	0.46	0	1	0.29	0.45	0.00	1
Asian	0.10	0.30	0	1	0.09	0.29	0.00	1
Other race	0.15	0.36	0	1	0.15	0.36	0.00	1
Primary activity-research	0.50	0.50	0	1	0.49	0.50	0.00	1
Number of professional society membership	3.83	2.08	0	12	3.80	2.17	1.00	15
Highest degree award year	1983.88	7.82	1957	1992	1983.89	7.74	1957.00	1992
Years between college and Ph.D.	8.23	3.79	2	24	8.19	3.75	2.00	24
Salary	72351	63459	42	900000	75546	32880	1925	225000
Indicator for supervision	0.55	0.50	0	1	0.64	0.48	0.00	1
Father's education	0.69	0.46	0	1	0.69	0.47	0.00	1
Mother's education	0.62	0.49	0	1	0.62	0.49	0.00	1

Table 3-6. Regression of publications in 2001 on independent variables in 1997 for the experiment group who moved for family reasons (n=229)

Variable	Estimate	Standard Error	Pr>ChiSq
Intercept	45.80	79.02	0.56
Quality measure in 1997	0.23	0.06	0.00
Ph.D. program quality	0.01	0.04	0.73
AGE	-0.02	0.04	0.65
Children under 6 in 1997	0.07	0.10	0.47
Full-time professional experience (t)	-0.21	0.08	0.01
t*t	0.01	0.00	0.00
t*t*t	0.00	0.00	0.00
Tenure status-other	-2.32	0.78	0.00
Assistant professor	-0.25	0.24	0.31
Associate professor	0.04	0.19	0.85
U.S. citizen	-0.24	0.21	0.26
Gender	0.16	0.13	0.19
Government support	0.36	0.13	0.00
Married	0.24	0.17	0.15
Private school	-0.15	0.13	0.24
Asian	-0.26	0.21	0.20
Other race	-0.21	0.16	0.19
Primary activity-research	0.21	0.12	0.08
Number of professional society membership	0.10	0.03	0.00
Highest degree award year	-0.02	0.04	0.59
Years between college and Ph.D.	0.01	0.04	0.87
Salary	0.00	0.00	0.40
Indicator for supervision	0.06	0.11	0.61
Father’s education	0.02	0.15	0.90
Mother’s education	-0.08	0.14	0.55
Dispersion	0.56	0.06	
Deviance	1.26		

Table 3-7. Regression of publications in 2003 on independent variables in 1999 for the experiment group who moved for family reasons (n=235)

Variable	Estimate	Standard Error	Pr>ChiSq
Intercept	-46.48	75.00	0.54
Quality measure in 1999	0.14	0.06	0.02
Ph.D. program quality	0.03	0.04	0.43
AGE	0.00	0.04	0.90
Children under 6 in 1999	-0.21	0.09	0.03
Full-time professional experience (t)	-0.11	0.10	0.27
t*t	0.01	0.00	0.15
t*t*t	0.00	0.00	0.09
Tenure status-other	-1.11	0.57	0.05
Assistant professor	-0.44	0.27	0.10
Associate professor	0.02	0.19	0.92
U.S. citizen	-0.21	0.21	0.31
Gender	0.16	0.13	0.22
Government support	0.48	0.14	0.00
Married	0.38	0.16	0.02
Private school	0.07	0.13	0.56
Asian	0.01	0.21	0.96
Other race	-0.06	0.16	0.70
Primary activity-research	0.26	0.13	0.04
Number of professional society membership	0.09	0.03	0.00
Highest degree award year	0.02	0.04	0.51
Years between college and Ph.D.	-0.01	0.04	0.72
Salary	0.00	0.00	0.05
Indicator for supervision	-0.02	0.13	0.88
Father's education	0.04	0.15	0.77
Mother's education	0.05	0.15	0.75
Dispersion	0.57	0.06	
Deviance	1.26		

Table 3-8. Fixed effects model with negative binomial distribution (n=3624, deviance=1.56)

Variable	Estimate	Standard Error	Pr>ChiSq
Intercept	1.50	0.32	<.0001
Quality measure	0.13	0.05	0.01
Children under 6	0.02	0.02	0.33
Tenure status-other	-0.50	0.20	0.01
Assistant professor	-0.07	0.06	0.23
Associate professor	0.03	0.04	0.53
Government support	0.18	0.03	<.0001
Married	0.08	0.05	0.10
Primary activity-research	0.02	0.03	0.41
Number of professional society membership	0.03	0.01	<.0001
Salary	0.00	0.00	0.26
Indicator for supervision	-0.01	0.03	0.85

Note: Fixed effect panel model with negative binomial distribution was run with number of publications as dependent variable and all time varying variables as independent variables.

Table 3-9. Two stage least squares instrumental variable model (n=1208)

	Pooled OLS	Within group	2sls Lags as IV for difference equation	2sls Differences as IV for level equations
Quality	0.93*** (0.23)	0.12 (1.36)	0.006 (1.39)	2.10*** (0.33)
y_{t-1}	0.66*** (0.02)	- 0.42*** (0.03)	0.75*** (0.04)	0.41*** (0.03)
n	1208	1208	1208	1208
Instruments	-	-	y_{t-2}, x_{t-2}	$\Delta y_{t-2}, \Delta x_{t-2}$
R-Square	0.70	0.88	0.32	0.40

Table 3-10a. Summary statistics of NRC variables in 1997

Variable	N	Mean	Std Dev	Min	Max
Total faculty FY 86-92	1208	32.10	23.15	2	173
Total Number of Doctorates FY 86-92	1208	62.17	59.33	2	439
Gini Coefficient for Citations During the Period 1981 to 1992	1208	167.52	127.41	14	867
Percentage of Program Faculty Publishing in the Period 1988 to 1992	1208	78.13	14.47	17	100
Gini Coefficient for Program Publications	1208	10.50	7.86	1.1	69.5
Gini Coefficient for Program Citations	1208	18.76	15.41	1.6	100
Rank Order of the Total Number of Citations Attributed to Program Faculty	1208	61.48	44.55	1	193
Rank Order of the Citation Density for the Program Faculty	1208	66.09	44.89	1	192.5

Table 3-10b. Summary statistics of NRC variables in 1999

Variable	N	Mean	Std Dev	Min	Max
Total faculty FY 86-92	1208	32.16	23.19	2	173
Total Number of Doctorates FY 86-92	1208	62.03	58.65	2	439
Gini Coefficient for Citations During the Period 1981 to 1992	1208	166.47	126.24	14	867
Percentage of Program Faculty Publishing in the Period 1988 to 1992	1208	78.09	14.46	17	100
Gini Coefficient for Program Publications	1208	10.44	7.82	1.1	69.5
Gini Coefficient for Program Citations	1208	18.67	15.34	1.6	100
Rank Order of the Total Number of Citations Attributed to Program Faculty	1208	61.30	44.50	1	193
Rank Order of the Citation Density for the Program Faculty	1208	65.97	45.04	1	192.5

Table 3-11. Fixed effects model with negative binomial distribution, replacing the quality measure of the department with objective measures (n=3624, deviance=1.56)

Variable	Estimate	Standard Error	Pr>ChiSq
Intercept	1.19	0.62	0.06
Total faculty FY 86-92	0.00	0.00	0.89
Total Number of Doctorates FY 86-92	0.00	0.00	0.33
Gini Coefficient for Citations During the Period 1981 to 1992	0.00	0.00	0.89
Percentage of Program Faculty Publishing in the Period 1988 to 1992	0.01	0.01	0.17
Gini Coefficient for Program Publications	-0.02	0.01	0.09
Gini Coefficient for Program Citations	0.00	0.01	0.72
Rank Order of the Total Number of Citations Attributed to Program Faculty	0.01	0.01	0.28
Rank Order of the Citation Density for the Program Faculty	-0.01	0.00	0.22
Children under 6	0.02	0.02	0.34
Tenure status-other	-0.48	0.20	0.01
Assistant professor	-0.08	0.06	0.17
Associate professor	0.02	0.04	0.61
Government support	0.17	0.03	<.0001
Married	0.08	0.05	0.10
Primary activity-research	0.02	0.03	0.44
Number of professional society membership	0.03	0.01	<.0001
Salary	0.00	0.00	0.27
Indicator for supervision	-0.01	0.03	0.82

Note: Fixed effect panel model with negative binomial distribution was run with number of publications as dependent variable and all time varying variables as independent variables, replacing the quality measure of the department with objective measures.

Table 3-12. Distribution of major groups of disciplines among the whole sample and the experiment sample

Major groups of disciplines	Whole sample (n=1208)		Natural experiment sample (n=229)	
	n	%	n	**%**
1 Computer and Math Sciences 2357 29734	109	9.02	15	6.55
2 Life and Related Sciences 14163 139458	331	27.40	61	26.64
3 Physical and related sciences 7330 112153	210	17.38	37	16.16
4 Social and Related Sciences 9027 150543	377	31.21	79	34.50
5 Engineering 6617 81560	181	14.98	37	16.16

Note: the Chi-square test between the two samples resulted in Chi-square 2.4 with p-value 0.66.

Table 3-13. Rerun of table 8 without major social science group (377 individuals) (n=2493, deviance=1.58)

Variable	Estimate	Standard Error	Pr>ChiSq
Intercept	1.44	0.33	<.0001
Quality measure	0.13	0.06	0.02
Children under 6	0.02	0.03	0.50
Tenure status-other	-0.74	0.23	0.00
Assistant professor	-0.18	0.07	0.02
Associate professor	-0.03	0.05	0.62
Government support	0.22	0.03	<.0001
Married	0.06	0.06	0.30
Primary activity-research	0.01	0.03	0.87
Number of professional society membership	0.04	0.01	<.0001
Salary	0.00	0.00	0.12
Indicator for supervision	0.07	0.04	0.06