The Effect of Maternal Employment on Children's School Performance in 9th grade

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Abstract: Using a Danish data set that follows 125,000 Danish children from birth through 9th grade, we examine the effect of maternal employment during a the first three and first 15 years on a child's grade point average in 9th grade. We address the endogeneity of employment by including a rich set of household control variables, instrumenting for employment with a gender- and education-specific local unemployment rate, and by including maternal fixed effects. We find that maternal employment has a positive effect on children's 9th grade performance in two specifications and no effect in a third specification. By contrast, most of the existing literature, which has focused on children in the U.S. and U.K., finds no or a small negative effect of maternal employment on children's health and cognitive development. *(JEL J13, J22)*

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I. Introduction

The goal of this study is to examine the linkages between Danish mothers' employment and the 9th grade school performance of their children. There are numerous ways that maternal employment may predict child achievement. First, working longer hours brings more income to the family, which can be used to purchase inputs that are positively associated with school performance. Second, all else equal, a working mother will spend less time with her child than one who does not work. Depending on the quality of mother-child time together and the quality of the alternative, this may either improve or decrease child well-being. Third, maternal employment may improve school performance if working mothers serve as role model, motivating hard work among their children. It is important to note, however, that child characteristics may influence maternal employment itself. For example, mothers whose children are not doing well may reduce their work hours to invest more in child-rearing. Finally, there may be unobserved factors that are linked to both maternal employment and child achievement. Specifically, mothers with relatively high ability and education are both more likely to work and to have children who receive good grades in school. Failure to control for unobserved maternal characteristics is likely to bias the association between maternal employment and children's subsequent education outcomes.

A large body of research in the U.S. has examined the consequences of maternal employment for children (Korenman and Kaestner, 2005; Smolensky and Gootman, 2003; Blau and Currie, 2004; Ruhm, 2000, and Haveman and Wolfe, 1994). Looking across these studies, results are somewhat varied, with some studies showing that maternal employment in the first months of life is associated with small, but significant, declines in children's subsequent cognitive outcomes (Hill, Waldfogel, Brooks-Gunn, and Han, 2005), particularly when mothers worked more than 30 hours per week (Brooks-Gunn, Han, and Waldfogel, 2002). Despite the many attempts to identify the role of maternal employment on child achievement, only a fraction of the literature addresses endogenity issues, and by not doing so, potentially present results that are biased by unobserved factors.

This paper examines the effect of maternal employment on child grade point average in 9th grade using three different methods. Furthermore, it explores whether maternal employment improves children's educational performance by increasing the resources available for investing in human capital formation. Using detailed data from the Danish administrative registers on over 125,000 children born between 1987 and 1992, we examine linkages between a child's grade point average (GPA) in ninth grade and his/her mother's employment status and work hours during the first three years of the child's life, and separately during the first 15 years of the child's life.

We address the endogeneity of maternal employment in three different ways. First, we use the extensive data available from the Danish registers to control for many household and children's characteristics that may affect both children's educational outcomes and maternal employment decisions. The registers includes a rich set of characteristics, including whether a child was born prematurely, had low birth weight or a chronic health condition, the age of the mother when the child was born, and the percentage of the child's first 15 (or three) years that the mother spent in school. Second, we instrument for employment with the female unemployment rate, conditional on a woman's education level, in her local area in a particular year. Our identifying assumption is that the local unemployment rate affects a child's subsequent GPA by affecting the mother's employment choices only, and does not have a direct effect on GPA through, for example, school funding levels.[1] Third, we use maternal fixed effects to exploit differences in maternal employment between siblings within the same family.

In our preferred IV specification we find a positive association between the intensity of maternal employment in a child's first three years and a child's GPA at age 15. The child of a woman who worked 30 or more hours per week while her child was under the age of four is predicted to have a GPA that is 5.6 percent higher than an otherwise similar child whose mother worked between 10 and 19 hours per week. The effects of maternal employment are larger when we examine a mother's employment history over the child's first 15 years of life, indicating that the maternal employment effect is cumulative over

[1] In some of the IV regressions we include a full set of locality fixed effects that should capture time- -invariant market characteristics that may have a direct effect on schooling outcomes.

many years, rather than being focused only on a child's first few years. Including a mother's pre-birth income or contemporaneous income does not materially change the coefficient estimates, which indicates that the beneficial impact of maternal employment does not appear to occur due to greater available household resources. The positive relationship between maternal employment and a child's educational outcomes is present in the OLS and IV models but not when we include maternal fixed effects.

The remainder of this paper is divided into five sections: Section II reviews the literature and discusses differences between the Danish and the US context. Section III introduces the unique Danish register data and discusses how these data are superior to survey data. Section IV presents the three models and discusses in debt the advantages and short comings of our instrument. Section V shows the results for all three models. Section VI analyzes the results and concludes.

II. Review of the Literature and the Danish context

The goal of this study is to examine the associations between maternal employment patterns and the academic success of Danish youth. We begin by describing patterns of maternal employment in Denmark. We also discuss the broader literature on maternal employment and child well-being, much of which is focused on the U.S. context. As a way of understanding whether and how this broader literature is related to the current study, we next discuss differences between Denmark and the U.S in the social and policy context in which maternal employment takes place. Finally, we discuss how and why maternal employment might be associated with child well-being, and how this may play out specifically in Denmark.

Maternal employment in Denmark is among the highest in the OECD; among mothers of children aged 1-3 employment increased from 70% in 2002 to 80% in 2002, and from 76% to 82% for mothers of children aged 4-6 (Statistics Denmark, 2011). In contrast, while rates of maternal employment in the U.S. have increased dramatically in recent decades, they remain lower than those in Denmark. In 2008, 59.6% of U.S. mothers of children aged 0-3 were employed, as were 63.6% of

mothers with children under age 6 and 77.5% of those whose youngest child is aged 6-17 years old (Bureau of Labor Statistics, 2009).

While maternal employment rates are higher in Denmark compared to the U.S., work hours are lower, as the maximum number of weekly work hours is mandated at 37 hours per week (Greve, 2011). In contrast, a study using a U.S. sample found that 15% of mothers worked more than 35 hours per week over the child's lifetime, and that longer work hours were most common among mothers of teens (Ziol-Guest, Dunifon and Kalil, 2012). As noted below, studies have shown that high intensity maternal work hours are associated with detriments in child well-being. This suggests that maternal employment among U.S. mothers, which is of a higher intensity, may influence child well-being differently than the lower-intensity employment occurring in Denmark.

A more consistent line of research has documented a positive association between maternal work hours and BMI, or Body Mass Index, a measure of weight for height that represents an important measure of child health (Anderson, Butcher, & Levine, 2003; Chia, 2008; Phipps et al., 2006; Ruhm, 2008; Fertig, Glomm and Tchernis, 2008; Morrissey, Dunifon, and Kalil, 2010). The majority of these studies have taken place in the U.S. There is some evidence that the relationship between maternal employment and child BMI may be stronger among families with more advantaged mothers (Ruhm, 2008; Anderson et al., 2003; Fertig et al., 2006; Hawkins, Cole and Law, 2008; Fertig, Glomm and Tchernis, 2008; Ziol-Guest, Dunifon and Kalil, 2012). Additionally, several studies have identified high intensity maternal work (e.g., full-time work) as particularly deleterious for children's BMI (Ruhm, 2008; Scholder, 2008).

As noted by Anderson (2011), research finding a positive association between maternal employment and child BMI is not limited to the U.S. Studies from Canada (Chia, 2008; Phipps et al, 2006), Australia, the UK (Hawkins et al., 2008; Scholder, 2008), Germany and the Netherlands have found similar associations as well. One country where such a linkage has not been documented is Denmark. Greve (2011) found no association between maternal employment and BMI (at age 7) among Danish children; the high quality of Danish child care as well as increased contributions by Danish fathers were identified as key reasons for this divergence in findings.

Thus, while a large body of research has examined the influence of maternal employment on child well-being, the bulk of this has taken place in the U.S. context. Results from these studies are mixed, although there is evidence to suggest that early and intensive maternal employment may be detrimental for young children, and that maternal employment generally may be associated with poor child health. There is reason to think that maternal employment may influence children differently in other contexts, particularly countries with more family-friendly policies. As noted by Waldfogel and McLanahan (2011), the U.S. is unique in providing very little government support for working families. Indeed, the U.S. is "the only advanced country without paid maternity leave, and one of the few without paid paternity leave…[i]t is also unique among peer nations in not providing universal public access to preschool" (Waldfogel and McLanahan, 2011; p. 4). Compared to a total of 173 nations, in 2006, the U.S. was 1 out of only 4 that did not guarantee paid maternity leave (Ruhm, 2011). The most groundbreaking U.S. family policy is the Family and Medical Leave Act of 1993, which provides 12 weeks of unpaid parental leave, but only reaches about half of all employees (Ruhm, 2011).

Indeed, research suggests that parental leave confers benefits for children. Comparing data from OECD countries, Tanaka (2005) shows that paid parental leave is associated with reductions in infant and child mortality and low birth weight. Additionally, looking across 16 European countries, Ruhm (2000) finds that more generous paid leave is associated with a reduction in infant and child death, likely by increasing parental early investments in child health, including breastfeeding. In Norway, Carneiro, Loken and Salvanes (2010) found that an increase in maternity leave of 4 months was associated with a decline in high school dropout rates, while in Sweden, extended parental leave was associated with improvements in children's educational performance, but only among children with more educated mothers (Liu and Skans, 2010).

Danish child care is provided at the municipality level, with the local governments providing center-based care, as well as organizing a system of family-based care in private homes (Datta Gupta and Simonsen, 2010). The staff-to-child ratio in Denmark is among the lowest in the OECD (Datta Gupta, Smith and Verner, 2008). Additionally, Denmark spends 1.17% of its GDP on ECEC activities, with

households on average spending only 8% of their income on child care costs; in contrast, the U.S spends 0.35 percent of GDP on ECEC activities, and families spend on average 19 percent of their income (37 percent for single parent families) on child care (Ruhm, 2011). Denmark ranks second out of all OECD countries, behind only Iceland, on percent GDP spent on ECEC costs, while the U.S. is last. In Denmark, 63% of 0-2 year olds, and 94% of 3 year olds were in some time of formal child care, among the highest of all OECD countries. This compares to 31% and 39%, respectively, in the U.S. (Ruhm, 2011).

Research suggests that high quality early care experiences can lead to later school success (although these studies are mixed). A study in Norway found that the expansion of high quality formal child care led to improved education and earnings outcomes in adulthood (Havnes and Mogstad, 2009). Using data from Denmark, Datta Gupta and Simonsen (2010) find that, among Danish children, taking part in child care was not associated with children's behavior; however, taking part in family-provided day care (which is of lower quality) was associated with levels of behavior problems for boys with less-educated mothers. In Canada, Baker, Gruber and Mulligan (2008) found that the introduction of highly-subsidized child care in Quebec was associated with an increase in maternal employment, as well as negative outcomes for children, including illness, increased aggression and poorer parenting behaviors. In the U.S., prekindergarten is associated with higher reading and math skills, as well as higher levels of behavior problems. The positive benefits on academic outcomes are strongest and longer-lasting for more disadvantaged children (Magnuson, Ruhm and Waldfogel, 2007).

As noted by Christensen, Schneider and Butler (2011), the need for family-friendly supports does not end after early childhood. The school calendar often does not match well with the typical working parents' schedule, and countries differ in how well they meet the needs of working parents in terms of flexible workplace policies, school schedules, and afterschool care. For example, Denmark provides paid leave to care for children's health needs, and 5.5 paid weeks of leave per year, (that applies to all employees), while the U.S. does not (Earle, Mokimane, Heymann, 2011). Additionally, labor laws in Denmark mandate that employers provide leave to parents needing to tend to their children's educational needs.

Thus, work-family policies in Denmark differ dramatically from those in the U.S. As such, it is relevant to ask whether the findings suggesting some detrimental implications for children of maternal employment would remain when considering a different context; one in which family supports are more generous and available. To better understand how and why the linkages between maternal employment and child well-being may differ between Denmark and the U.S., we now discuss some of the theoretical mechanisms that may link maternal employment and child well-being. It should be noted that the current study examines a reduced-form association between maternal employment and child achievement and is not able to adjudicate between these various mechanisms.

Because maternal employment involves a trade-off between time and money, the findings (above) suggesting linkages between maternal employment child well-being imply that the influence of maternal employment on children relates to time use—either that of the mother, the child, or both—or to changes in economic resources. Mothers' employment patterns may be associated with both the quality and quantity of children's time with parents, key ingredients in healthy development (Shonkoff and Phillips, 2000). U.S. time-diary data show that working reduces the time mothers spend with children, although mothers protect quality time with children by cutting back least on activities directly engaging children (Bianchi, 2000). The time-related linkages between maternal employment and child well-being may be less relevant in Denmark, where, as noted above, there is more generous parental leave as well as limits on how many hours per week employees can work.

Employment may also be associated with children's time in non-parental care. As noted above, Denmark has a stronger system of investment in early care and education programs than does the U.S. As such, the quality of children's time experiences when not in parental care may be higher than compared to the U.S., ultimately leading to improvements in academic and other outcomes.

Household income is another channel through which maternal employment may influence children. Working brings increased income into the household, and studies consistently show that children benefit when economic resources increase (Duncan and Brooks-Gunn, 1997; Duncan, Ziol-Guest and Kalil, 2010). In the U.S. context, however, motherhood can reduce the economic benefits of

employment to a greater extent than in Denmark. As noted above, U.S. women are not guaranteed paid parental leave; additionally, they often pay a greater percentage of their income in child care costs compared to women in Denmark.

Thus, there are reasons to believe that associations between maternal employment and child well-being may differ in Denmark compared to the U.S., where the bulk of existing studies have taken place. These differences may be due to the very different work-family policies in the U.S. as compared to Denmark, and are such that the employment of Danish mothers may have neutral, or positive, associations with children's well-being. The goal of this study is to test this hypothesis by examining the associations between maternal work hours and academic outcomes among a large, national sample of Danish youth.

III. Data

Since 1980, data on all individuals living in Denmark have been collected and recorded in the administrative registers by the organization Statistics Denmark. The registers contains all public transfer payments between individuals and the federal/municipal government, such as income taxes, parental leave benefits, day care subsidies, unemployment benefits, and pension payments. Danish law requires individuals to inform the federal government of their residential location; individuals who fail to comply are not allowed to have a bank account or receive benefits from the state. As a result, we have information on the entire Danish population in the registers, and attrition only due to deaths or migration.

Our sample includes all children born in Denmark between 1987 and 1992 to mothers who had at least two children during this time period. We focus on this time period because the registers contain grade point averages (GPA) in 9th grade for these children, which for most Danish children is when they are 15 years of age. We restrict the sample to families with at least two children born in this time period to have a consistent sample between the ordinary least squares, instrumental variables, and maternal fixed effects models.

The dependent variable in our analysis is a child's GPA in 9th grade. For the measure to be comparable between students, we use a GPA from three 9th grade courses that all Danish students take:

Math, English, and Danish. Although some Danish schools offer additional subjects such as German, French and Chinese, we exclude these grades from the GPA measure because these subjects are taught for only a few hours per week and only in later grades. Each school reports the grades annually to the Ministry of Education, which in turn forwards the information to Statistics Denmark.

In all regressions we include birth-year and birth-month fixed effects to control for national GPA trends in Denmark and age effects within a grade. In most regressions we include a more complete set of control variables, including: indicators for a child's birth order in his/her family, the child's gender, the mother's age when the child was born, and the mother's education the year before the child was born. We measure a woman's education with six separate indicator variables: less than a high school degree, high school degree only, vocational school, short-term further education, bachelor degree, and master's degree or more. We use mothers' age when the child was born and her education as a proxy for pre-birth ability. Mothers who have their children early have both a higher probability of dropping out of school and being unemployed. When a mother decides on her labor supply, her decision will be affected by her number of children, where more children demands more home production, but also by the birth order of the child. Having a baby when she has other older children, the other children may help out at home, whereas having the first child may call for more time.

A woman's decision regarding whether and how much to work following a child's birth may be affected by the child's health (Powers, 2001). From the fertility register records we create indicator variables for children who were born prematurely (born earlier than the 37^{th} week), who had low birth weight (less than 2,500 grams), or who have chronic health conditions. The registers include the World Health Organization's (WHO) International Classification of Diseases (ICD) codes for all hospitalizations in Denmark. To classify a child as having a chronic health condition, we use the same definition of chronic diseases as Christoffersen et al. (2003): diseases that are non-psychological and persistent, such as diabetes. Because the codes do not specify disease severity, we classify children as being chronically ill if they were hospitalized for one or more of the designated chronic diseases between 1987 and 1996, a period when all of the children in our sample were at least five years old.

Although the registers do not record a person's race, they do indicate whether a person immigrated to Denmark or whether the previous generation of the family immigrated to Denmark. We include indicators for whether a child is a first- or second-generation immigrant. We estimate a woman's net income based on her wages and other cash transfers, taking into account interest deductions. In some regressions we control for the mother's income the year prior to a child's birth as an additional control for her ability. Income is measured in thousands of Danish Kroner, where a thousand Kroner is about $170. In unreported regressions we include the average income a woman received over her child's first three (or 15) years rather than her income prior to the child's birth. The latter measure allows us to explore whether maternal employment improves children's cognitive outcomes by increasing the amount of resources available to the household.

Although hours worked are not directly recorded in the registers, based on the magnitude of certain tax payments we can place mothers into one of four employment categories in each calendar year: fewer than 10 hours worked per week, on average for that year; between 10 and 19 hours per week; between 20 and 29 hours per week; or 30 hours or more per week. Individuals who work at least one-half of a calendar year will pay the ATP tax, and the magnitude of this tax allows us to infer whether they worked between 10 to 19, 20 to 29, or 30 or more hours per week on average. Thus, we assume that people working less than 10 hours per week are unemployed. Additional analyses using survey data, not shown here, indicate that the vast majority of mothers working 0-9 hours per week are indeed not working.[2]

Time spent on maternity leave is measured in the registers as being unemployed. During our sample period (children born between 1987 and 1992) Danish women were entitled to less than one-half a year of maternity leave: four weeks before the delivery; 14 weeks immediately following delivery; and 10 weeks of additional parental leave that could be shared between spouses. As a consequence, mothers who

[2] We cannot determine the actual work hours if people receive unemployment benefits for at least one-half of a calendar year; additionally, those who work fewer than 10 hours per week do not pay ATP. We assign people who receive unemployment benefits for at least one-half of a calendar year as working between zero and nine hours per week, although some of them may work more than 10 hours per week for part of the year.

used all of their maternity leave during this time period and then worked full-time for the rest of the year will be categorized as working 30 hours or more for the entire calendar year. People who did not make any tax payments and did not receive unemployment benefits are classified as unemployed. This could occur for adults out of the labor force or immigrants who have not yet formalized their citizenship.

We are interested in estimating the effect of a woman's work effort during her child's first three years and first 15 years of life, on the child's grade point average at age 15. To estimate a woman's average weekly hours worked during a child's first 15 years of life (and similarly for the first three year of life), we create four indicator variables for each adult for each calendar year: 1) unemployed; 2) working 10-19 hours per week; 3) working 20-29 hours per week; and 4) working 30 or more hours per week. In some regression specifications we include the percentage of her child's first 15 (or three) years a woman spent in each of these work-hour groups, as follows:

$$av\_work\_0 = \frac{\sum years\ unemployed}{15}$$

$$av\_work\_1 = \frac{\sum years\ working\ 10-19\ hours}{15}$$

$$av\_work\_2 = \frac{\sum years\ working\ 20-29\ hours}{15}$$

$$av\_work\_3 = \frac{\sum years\ working\ 30+\ hours}{15}$$

We observe the full 15-year employment history for 56 percent of the mothers. About 15 percent of the women have missing work hours information in a given year, and this missing rate is fairly constant over the 1987 to 2007 time period when the children in the sample are less than 16 years old. Work hours are missing for women who retire early or drop out of the labor force altogether. Therefore, if a mother has missing work hours information in a given year, we assume that she is unemployed or working less than 10 hours per week in that year. We exclude about five percent of the women who have missing work hour information for all 15 years when their child is under the age of 16; we exclude a

larger percent of women who have missing information for all three years when their child is under the age of four.

In some regression specifications we include an estimate of a woman's average hours worked per week over the first 15 years (or three years) of her child's life rather than a series of variables indicating the percentage of years working in each of the four hour categories. Having a continuous work hour variable is necessary for the two-stage least squares specification when we instrument for employment status with the contemporaneous unemployment rate in a woman's locality. Because the work hour categories are intervals, for purposes of estimating a continuous employment variable we assign hours in the middle of an interval (e.g., 15 hours per week for women working between 10 and 19 hours per week in a particular year). We assume that women working 30 or more hours per week actually worked 35 hours, and women working less than 10 hours per week were actually unemployed.

Figure 1 depicts the pattern of maternal employment by a child's age for the first 15 years of a child's life. About 72 percent of Danish mothers worked when their child was one year old, with the majority of the employed mothers working more than 30 hours per week. The percentage of mothers working more than 30 hours per week increases as children age, increasing from 40 percent when a child is one, to 52 percent when a child is five, to 65 percent when a child is 10, and to 70 percent when a child is 15 years old. The percentage of non-working mothers decreases as children grow up; by age 15, eighteen percent of the mothers are unemployed or working less than 10 hours per week. Twelve percent of the mothers work part-time (10 to 19 hours or 20 to 29 hours per week) when children are 15 years old, in contrast to 32 percent when children are one.

In Table 1 we examine common employment patterns for women in the sample. The Table reports the percentage of women by the number of years (out of 15) they spend in a particular work-hour category. Fifteen percent of the mothers worked 30 or more hours every year when their child was under the age of 16, and almost one-half worked 30 or more hours in at least 10 of these 15 years. Sixty percent of the women worked fewer than 10 hours (including zero) in at least one of the 15 years, although only

16 percent worked fewer than 10 hours in 10 or more of the 15 years. Many women worked 10-19 or 20-29 hours at some point when their child was under the age of 16.

Once we omit households with missing values, there are 138,803 children included in the analytic data set. We report sample statistics in Table 2, separately by the average number of hours per week that a mother worked during her child's first 15 years of life based on the continuous work hour variable. The children of women who work relatively long hours also have children with relatively high GPAs. While this relationship could be due, in part, to the beneficial effects of maternal employment, it could also be due to innate intelligence or a more conducive learning environment. Women who work relatively long hours also are more educated, are more likely to live in Copenhagen, tend to have children at an older age, and tend to have healthier children. These differences emphasize the importance of controlling for both children's and mother's characteristics in the regression models, and of trying to control for differences across employment categories in unobserved characteristics that affect children's GPAs. We elaborate on our approach to this challenge in the following.

IV. Method

Our basic empirical approach is to regress a child's GPA at age 15 on his/her mother's employment status and work hours during the first three years of the child's life, and separately during the first 15 years of the child's life. The regression coefficient on the maternal employment variable(s) would indicate whether maternal employment is positively or negatively associated with children's school outcomes later in life. In the ordinary least squares regression models, we regress child c's GPA in year t on the mother m's employment status during the child's first three or 15 years of life, and various control variables (X) for the child and mother:

$$(1)\quad Y_{c,m,t} = \beta_0 + \beta_1 H_{m,15} + \beta_2 X_c + \beta_3 X_m + \beta_4 \text{Income}_m + \varepsilon_{c,m,t}$$

We report results where H is either a continuous variable measuring a mother's average hours worked per week over the 15-year period, or a set of variables measuring the percentage of the 15 years a mother

spent working fewer than 10 hours a week, between 10 and 19 hours, between 20 and 29 hours, and 30 or more hours. We also report a similar set of results using a mother's work hours in her child's first three years of life. Standard errors are clustered by household to account for the fact that our data contain siblings.

There are advantages and disadvantages of using a child's grades at age 15 as the outcome measure. If a mother's employment decisions are associated with a child's grades in 9th grade, then these employment decisions are also likely to affect the child's lifetime earnings given the well documented relationship between school performance and occupational choices. However, it may be difficult to find an association because many factors other than maternal employment will affect a child's performance in 9th grade.

Working reduces the amount of time and/or energy a mother can invest in her child's wellbeing, but increases the ability to invest financially in her child's wellbeing. In some regression specifications we include the mother's income in year t-1, the year prior to the child's birth, in order to control for pre-existing resources the mother has available to invest in the child. In other analyses, we also include a control for income over the child's first 15 years (and three years) in order to adjust for the fact that a key mechanism through which maternal employment may influence children is through the additional financial resources such employment brings.

The greatest empirical challenge is that mothers with relatively high ability and education are both more likely to work and to have children who receive good grades in school, due to genetics, being in an environment that values education, and/or effective parenting. Without controlling for these potentially unobserved maternal characteristics, β_1 is likely to be biased upward (i.e., toward finding a beneficial association between maternal employment and children's subsequent education outcomes). The sample statistics in Table 2 confirm that in our data set this challenge is real. Children whose mother averaged more than 30 hours of working per week when the child was under the age of 15 have a 9^{th} grade GPA a full point higher than children whose mother averaged fewer than 10 hours of work per week.

We address the endogeneity of maternal employment in three different ways. First, we use the extensive data available from the Danish registers to control for many household and children's characteristics that may affect both children's educational outcomes and maternal employment decisions. To demonstrate the importance of controlling for a rich set of characteristics that are unavailable in some data sets, we first present regression results that control only for birth year and birth month. In subsequent regressions we add the full set of control variables. The controls include both household and child characteristics: child's gender, birth order, mother's education level, the parents' immigration status, whether a child was born prematurely, had low birth weight, or had a chronic health condition when young, and the age of the mother when the child was born. The third regression also includes the mother's income in the year prior to the child's birth as an additional control for the mother's ability.

Our second approach to address the endogeneity of maternal employment is to instrument for a mother's hours worked in year t with the unemployment rate in her municipality in the prior year among women with her education level. This approach is similar to that of Greve (2011), who uses the Danish register data to examine the effect of maternal employment on child obesity. She shows that a woman's employment status in 1999 (when the children in her sample are three years old) is negatively correlated with the unemployment rate in her municipality. There are 271 municipalities in Denmark, and the unemployment rate ranged from 2.2 to 11.0 across municipalities in 1999. Because we examine employment decisions for 15 years, we first calculate the average female unemployment rate in a woman's locality, stratified by education level, over the 15-year period when her child(ren) were under the age of 16. In the first stage of a two-stage-least-squares regression, we regress a woman's average hours worked per week over the 15-year period on the average unemployment rate in her locality (for women with the same education level), along with the other controls.

The gender- and education-specific unemployment rate in a municipality should affect whether women receive job offers and/or the wages offered conditional on a job offer. Identification in the IV model comes from variation in hours worked due to variation in the gender- and education-specific unemployment rate across markets (when municipality fixed effects are omitted) and across time, and

thus to variation in employment opportunities and wages. As we show below, the instrument is negatively correlated with the endogenous variable, average hours worked, and highly significant statistically.

The key identifying assumption is that variation in the female unemployment rate across municipalities and within municipalities over time does not affect children's subsequent GPAs, controlling for our rich set of child and household characteristics, other than through the effect on female labor supply. One concern is that municipalities with high unemployment rates may have low-quality schools, and thus low student GPAs, due to reduced tax revenues and reduced education funding or due to unobserved characteristics of parents and children who live in such localities. This is not likely to be as great a concern in Denmark as it would be in the United States. Although local tax revenues are an important financing source for education, there are large federal transfers in Denmark from rich to poor localities that are determined at the national level. Furthermore, the female unemployment rate has a smaller impact on local finances than the male unemployment rate, which we do not use directly in the estimation. Despite the high female labor supply, Denmark has one the most gender-segregated labor markets in the world. Women are concentrated in relatively low wage day care and teaching jobs in part in order to be close to their homes and children. Therefore, we expect the male labor market to exert greater influence on local budgets and school quality than the female labor market.

Nevertheless, in some specifications we include a full set of locality fixed effects to account for time-invariant municipality-specific factors that affect student outcomes. In these specifications the maternal employment coefficients are identified by changes over time in a municipality's female, education-specific unemployment rates.

Our third method of addressing the endogeneity of maternal employment is to use maternal fixed effects to control for differences between households in their children's abilities. The maternal employment coefficient in this specification is identified by differences in a mother's work intensity when two of her children were young. Recall that all women in our sample gave birth to two or more children between 1987 and 1992. In the maternal fixed effects model we do not know why a woman decides to

increase or decrease her employment level in the early years of the first and second (or more) children that we observe. Relative to the IV method, therefore, we are less confident that the maternal coefficient can be interpreted as the causal effect of an increase in the number of hours a mother works on a child's subsequent educational performance.

One reason a woman may change her work pattern between two adjacent children is due to childhood health problems; for example, mothers may reduce their work hours if a child is born in fragile health and may have learning disabilities (Neidell, 2000; Ruhm, 2004). This is the main empirical challenge of the maternal fixed effects model; a woman may decide not to work (much) if her child is experiencing a health or learning problem, where that problem could have an independent effect on the child's outcomes later in life. We address this concern by including controls for a child's health status, such as whether he/she had a low birth weight or was hospitalized early in life for a chronic health condition. To the extent that unobserved child health variables are important, however, we would expect the maternal employment coefficients to be biased upward in the maternal fixed effects model.

Another potential concern is that the employment decisions for women who have two or more children in a five-year period may differ from those of women who have only one child, such that the results from the maternal fixed effects model are not generalizable. In Figure 2 we display the 15-year pattern of employment separately for women with a single child born in our sample period (at the top) and women with two children born in the sample period (at the bottom of Figure 2). The employment patterns are similar for both groups of women.

As mentioned, the employment coefficients in the maternal fixed effects regressions are identified by mothers whose employment patterns differ across their children born between 1987 and 1992. In the first panel of Table 3 we depict mothers' employment patterns during the first three years of their children's lives for the older child (rows) and younger child (columns), based on the continuous work hour variable. About one-third of the women worked an average of 30 hours or more in both their older and younger children's first three years, and 8.5 percent of the women worked fewer than 10 hours on

average with both their children.[3] Women generally work more in the early years of their younger child's life than in the early years of their older child's life. For example, 43 percent of women averaged 30+ hours per week in the first three years of their younger child's life versus 40.5 percent for their older child. Twenty-four percent of the women in the first panel of Table 3 increased their average hours between their older child's and younger child's early years, whereas 16.5 percent decreased their average hours with the younger child.

V. Results

Coefficient estimates from the ordinary least squares regressions are reported in Table 4. In the first five columns we examine the association between maternal employment in a child's first three years and the child's GPA at age 15; in the remaining columns we examine the association between maternal employment in a child's first 15 years and the child's GPA at age 15. In the first three columns of Table 4, we report regression results that include a set of variables measuring the percentage of the child's first three years that a woman spent working between 10 and 19, 20 to 29 hours, and 30 or more hours per week relative to the omitted category (percentage of years working fewer than 10 hours per week). This specification allows for a non-linear effect of work hours on children's outcomes. When we only include birth-year and birth-month fixed effects in column one, the coefficients measuring the percentage of the child's first three years that a woman spent working between 10 and 19, 20 to 29 hours, and 30 or more hours per week are all positive and significant relative to the omitted category (percentage of years working fewer than 10 hours per week). The coefficients on the three work-hour variables increase monotonically as hours increase.

In the second column of Table 4 we include the full set of control variables previously described. The results indicate that working 30 hours or more per week while a child is under four years of age is

[3] Figure 2 understates the amount of variation because, for example, a woman who works 20 to 29 hours in year 1 and 30+ hours in years 2 and 3 with her older child and 30+ hours for all three years with her younger child will appear in the bottom right cell in Panel A of Table 2. That is, due to averaging work hours across multiple years, some women with variation in work hours appear on the diagonal.

associated with a 0.23-point increase in child GPA at age 15, compared to not working at all. The three employment coefficients increase monotonically, as before, and are substantially smaller once a more complete set of control variables is included. The decrease in the effect of maternal employment when including our full set of control variables suggests that we have accounted for some of the endogeneity of maternal employment compared to the results in column one. The magnitude of the association is relatively small: the child of a woman who worked 30 or more hours per week while the child was under the age of four would be predicted to have a GPA 0.18 points higher than an otherwise similar child whose mother worked between 10 and 19 hours.[4] The mean GPA in the sample is 8.15, so this implies an estimated increase of 2.2 percent in a child's GPA. In Appendix 1 we report coefficient estimates for the full set of control variables that are not reported in Table 4.

In the third column of Table 4, we include a measure of the mother's income one year prior to the year of birth. The coefficient on this variable is insignificant and including it does not change the coefficients on maternal work hours. In unreported regressions we replace this variable with a measure of a mothers' average income during the child's first three years (or first 15 years), and the results are qualitatively similar to those reported in column three.[5] The results are not sensitive to including a woman's income, nor whether the income is measured prior to the child's birth as a control for ability, or contemporaneously to measure resources available to the household.

In the fourth column of Table 4 we report regression results that include a continuous measure of the average number of hours per week mother worked while her child was under the age of four. The coefficient on a mother's average hours worked per week is positive, significantly different from zero, and indicates that an additional hour worked per week between ages zero and three is associated with a 0.0068-point increase in a child's GPA in adolescence. The predicted magnitude of working more than

[4] The coefficient on working 30 hours or more is significantly larger than the coefficient on working 10-19 hours at the one-percent confidence level. For this prediction we assume women who work more than 30 hours per week work 35 hours per week, and women who work between 10 and 19 hours per week work 15hours per week.
[5] Results are available from the authors by request.

30 hours per week is similar to that from the specification in column two. Including a mother's income prior to the child's birth in column 6 has no effect on the maternal employment coefficient.

In the final five columns of Table 4 we present results from a similar set of regressions that includes a mother's employment history over the child's first 15 years of life rather the first three years. The coefficients on maternal work hours remain positive and significant, and the magnitudes are larger than when examining maternal employment only in the first three years, suggesting that the effect of maternal employment accumulates for many years over a child's life, rather than being focused only on a child's first few years.

In column six, which includes only birth-year and birth-month fixed effects, there is no significant effect of mothers working 10-19 hours a week relative to the omitted category, but working 20-29 hours or more than 30 hours a week are strongly associated with a higher GPA for the child. In column seven of Table 4, which includes a full set of control variables, the results show that the percent of time a mother worked 20-29 and 30+ hours per week over the child's lifetime are associated with a 0.27 and a 0.30-point increase in the child's GPA at age 15, respectively, compared to working less than 10 hours per week. The latter coefficient implies an estimated increase of 3.7 percent in a child's GPA. As in the first set of regressions, the maternal employment coefficients are considerably smaller when we include detailed child and mother characteristics. As with the 3-year employment analysis, including a mother's pre-birth income hardly changes the maternal employment coefficients, nor does including a woman's average income received while the child is under the age of 16.

We next present results in Table 5 from the two-stage least squares models where we instrument for a woman's work hours with the female, education-specific unemployment rate in her locality during the first three or 15 years of her child's life.[6] The local unemployment rate is allowed to affect a woman's average hours worked in the first stage but is assumed to have no independent effect on the child's GPA

[6] Because we lag the unemployment rate one year, we actually use the year prior to the child's birth plus the first two years, and so forth for the 15-year analysis.

in the second stage. In each of the six first-stage regressions, the coefficients on the local unemployment rate are negative and significant, as expected, and the F-statistics are very large.

The second-stage maternal employment coefficients are positive, significant, and in the first three columns are about three times larger than the coefficients from the OLS specifications reported in Table 4. In the first column of Table 5, with a full set of mother and child control variables included, each additional hour per week of maternal employment during the first three years of a child's life is associated with a 0.023-point increase in a child's 9th grade GPA. The child of a woman who worked 30 or more hours per week while the child was under the age of four is predicted to have a GPA that is 0.46 points (or 5.6 percent) higher than an otherwise similar child whose mother worked between 10 and 19 hours per week. Adding a mother's pre-birth income in the second column of Table 5 has little effect on the results.

In Table 2 we show that women who work 30 or more hours per week when their child is less than 16 years old are better educated, have healthier children at birth, and had a higher income before a child's birth than women who work fewer hours. If the former women and their children also have unobserved characteristics that improve a child's educational performance relative to the latter group of women and their children, then one would expect the IV maternal employment coefficients to be smaller than the OLS coefficients, and perhaps even negative. The pattern that we actually observe indicates that selection appears to work in the opposite direction: conditional on the observed characteristics, women who work a relatively large number of hours appear to have unfavorable unobserved attributes with respect to their children's future educational performance. It is important to note that the Danish Register allows us to control for an unusually rich set of household and child characteristics.

One concern with the IV method is that localities with high unemployment rates may have low-quality schools, and thus low student GPAs, due to reduced tax revenues and reduced education funding and/or due to unobserved characteristics of parents and children who live in such localities. Although we argue in the method section that this is likely to be more important when examining male rather than female unemployment rates, in column three we include a full set of locality fixed effects in the IV estimation to allow for time invariant differences in education outcomes between localities. In this

specification we identify the effect of maternal employment on children's GPAs based on within-market changes over time in the female- and education-specific unemployment rate. The maternal employment coefficient is actually slightly larger in column three with the locality fixed effects included versus column two, and it is still significantly different from zero.

In the final three columns of Table 5 we report the IV results when analyzing women's work histories over their children's first 15 years of life. As with the OLS results, the maternal employment coefficients are larger in the 15-year versus the three-year time period, and in this case quite a bit larger. Based on the specification in column four of Table 5, the child of a woman who worked 30 or more hours per week while the child was under the age of 16 would be predicted to have a GPA 1.83 points (22.4 percent) higher than an otherwise similar child whose mother worked between 10 and 19 hours. Although this effect seems too large for the general population, one explanation is that the impact of maternal employment is large for the households who provide identification for the IV model. That is, the children of women who become employed (or work more hours if already employed) when the female, education-specific unemployment rate falls in a locality tend to do substantially better in school as a result relative to otherwise similar children whose hours are not affected by a change in the unemployment rate.

We report coefficient estimates from the maternal fixed effects regressions in Table 6. The maternal employment coefficients are insignificant in all six models – the first three focusing on a mother's employment in a child's first three years of life and the final three focusing on employment in a child's first 15 years of life. These results are in sharp contrast to the OLS and IV results, where children's grades are positively associated with greater levels of maternal employment. Including a full set of control variables for the child and the household does not affect the maternal employment coefficients much in the maternal fixed effects models, whereas it does matter in the OLS and IV models; in unreported regressions the maternal employment coefficients are insignificant even when we include only year fixed effects and a categorical variable for birth order.

Identification in the IV model comes from variation in hours worked due to variation between markets and within markets in employment opportunities and wage rates. Differences in employment patterns between siblings in the maternal fixed effects model, on the other hand, are less likely to be exogenous. We are more confident, therefore, that the IV model measures the causal effect of maternal employment on children's outcomes versus the maternal fixed effects model.

In Table 7 we report coefficient estimates on the maternal employment variable when we stratify the sample according to whether a woman has less than a high school degree (low education) or a high school degree or more (high education). Results are reported separately for the OLS, IV, and maternal fixed effects models.[7] The maternal employment coefficients in the maternal fixed effects models are insignificant when stratifying by education, just as they are for the sample as a whole. The OLS coefficients are positive and significant overall and in all sub-samples, with the association about 50 percent larger for mothers with low versus high levels of education. The IV maternal employment coefficients in the stratified samples are also positive and significant, with substantially larger values for low-education versus high-education mothers.[8] The beneficial impact of maternal employment on children's educational outcomes appears, therefore, to be stronger among less advantaged households.

VI. Conclusions

The goal of this paper is to estimate the causal effect of maternal employment on children's educational outcomes. Our paper makes several contributions to the literature. First, we take advantage of a unique data set that contains detailed household information and follows 125,000 Danish children from birth through 9th grade. This allows us to examine the impact of maternal employment over an extended period of time (i.e., a child's first 15 years of life) on an important, long-run outcome: grades in 9th grade. Second, we develop three different methods to address the endogeneity of maternal employment: including a rich set of household control variables, instrumenting for employment with the

[7] The sample size for the entire sample exceeds the sum of the sample sizes of the low-education and high-education sub-samples because we omit women who are missing education information.

[8] We include locality fixed effects in the IV models presented in Table 7.

gender- and education-specific unemployment rate in a woman's locality, and by including maternal fixed effects. Third, we explore whether maternal employment improves children's educational performance by increasing the resources available for investing in human capital formation.

Overall, several patterns emerge. The OLS and IV models produce a consistent set of results indicating that maternal employment is associated with an increase in children's grades. In our preferred IV specification, the child of a woman who worked 30 or more hours per week while her child was under the age of four is predicted to have a GPA that is 5.6 percent higher than an otherwise similar child whose mother worked between 10 and 19 hours per week. The beneficial effect of maternal employment is larger when examining a mother's full 15-year work history versus employment in a child's first three years only.

The OLS and IV analyses also indicate that the positive coefficient on maternal employment does not appear to be driven by increased maternal earnings, and thus increased resources available for investment in a child's human capital. This result is consistent with many U.S. studies and suggests that rather than being attributable to the additional resources mothers' bring into the household, maternal employment influences children's cognitive development through other channels. Although our data set is not well-suited to test the possible mechanisms, possible explanations include increased access to social support among employed mothers, improved mental well-being among mothers who work, and access to high quality child care. Future work is needed to better understand the mechanisms that may link maternal employment to improved child outcomes.

In the maternal fixed-effects model, on the other hand, the effect of maternal employment is not significantly different from zero. It is unclear why this is the case. One explanation is that in the IV model identification stems from plausibly exogenous variation in hours worked due to variation in employment opportunities and wage rates between markets and within markets over time. In the maternal fixed effects model, by contrast, differences in employment patterns between siblings are less likely to be exogenous with respect to a child's subsequent educational performance. We are more confident,

therefore, that the IV model produces an estimate of the causal effect of maternal employment on children's outcomes than the maternal fixed effects model.

A key point, however, is that in none of the three models presented here, including the maternal fixed effects model, do we find evidence of a negative association between maternal employment and children's grades. These results stand in contrast to recent studies in the U.S. that document small, negative associations between maternal employment and child well-being.

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Figure1: Maternal Employment during a Child's 1st 15 Years of Life

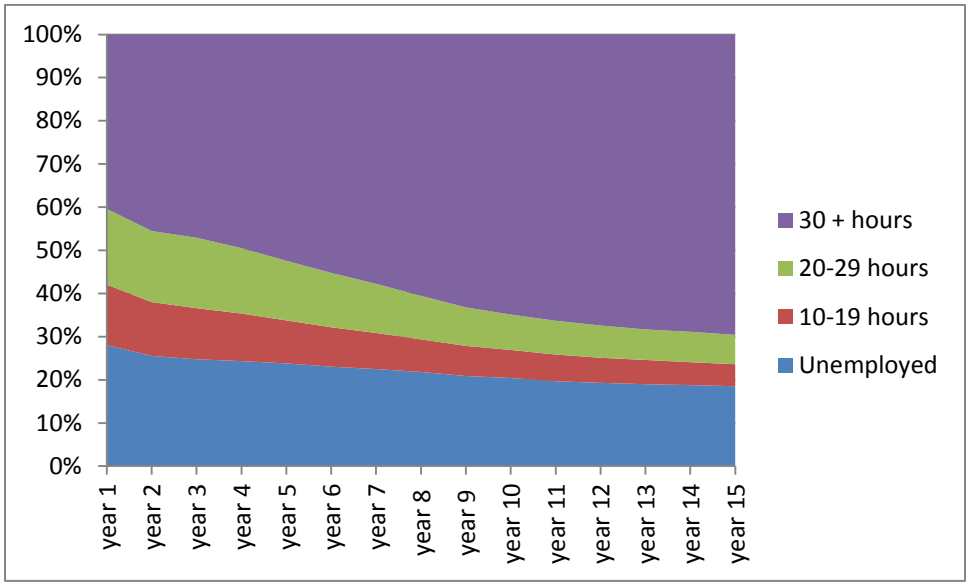
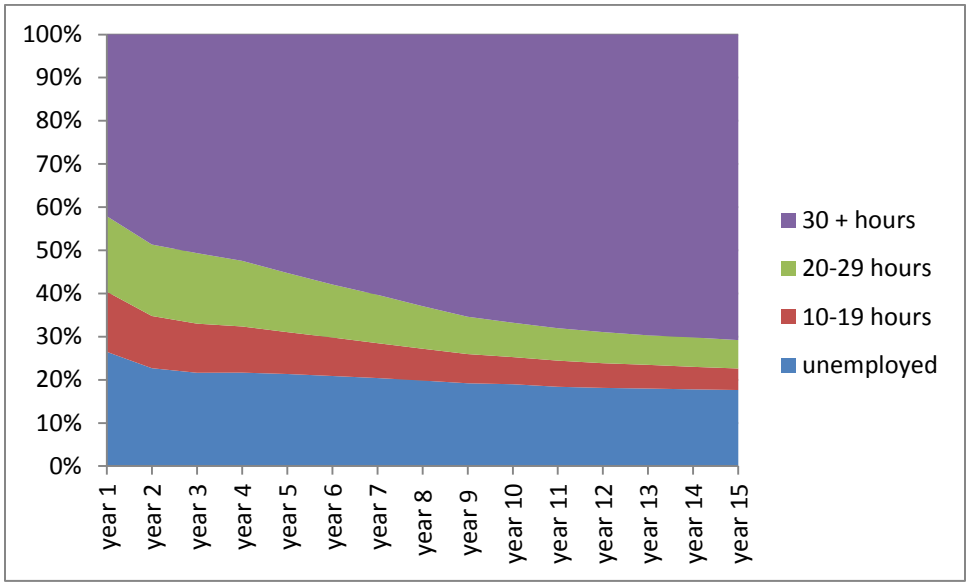


Figure 2: Maternal Employment during a Child's 1st 15 Years of Life

Mothers with One Child



Mothers with More Than One Child

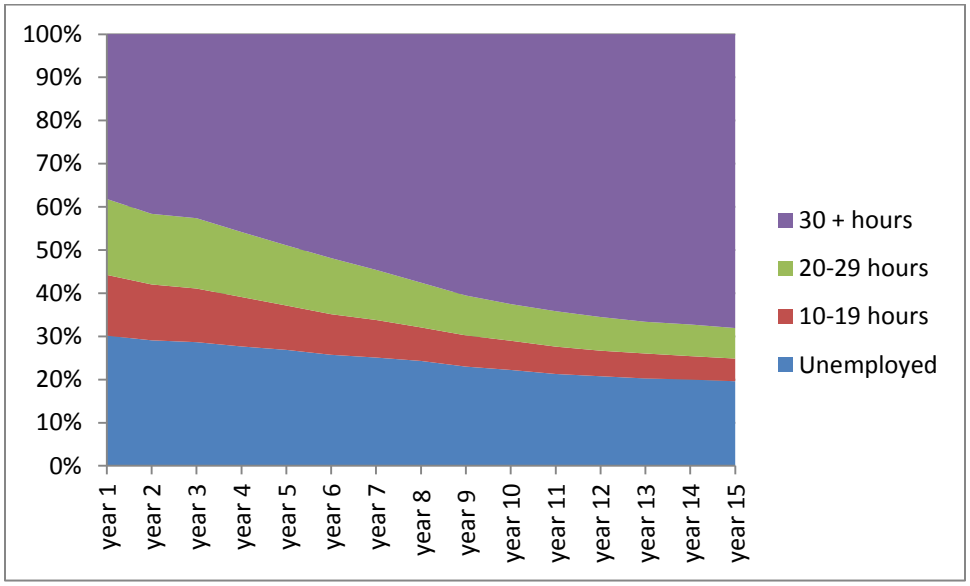


Table 1: Maternal Employment Patterns during a Child's 1st 15 Years of Life

Percentage of Women in the Sample

Years	0 to 9 hours	10 to 19 Hours	20 to 19 Hours	30+ Hours
0	39.7	42.6	32.6	11.8
1	10.3	23.6	23.6	4.8
2	7.9	24.8	17.4	4.1
3	6.2	9.1	11.6	4.0
4	4.9	4.9	6.8	3.9
5	4.0	2.6	3.8	3.9
6	3.4	1.3	1.9	4.2
7	2.9	0.6	1.0	4.7
8	2.6	0.3	0.5	5.0
9	2.4	0.1	0.3	5.4
10	2.3	0.1	0.2	5.8
11	2.2	0.0	0.1	5.9
12	2.2	0.0	0.1	6.4
13	2.3	0.0	0.0	6.9
14	2.8	0.0	0.0	8.3
15	3.7	0.0	0.0	14.9

Table 2: Sample Statistics by Level of Maternal Employment

	Mother's average work hours per week the child's first 15 years			
	0 to 9 hours	10 to 19 hours	20 to 29 hours	30+ hours
Observations	27,509	24,938	44,461	68,031
Children				
- Grade point average at age 15	7.6	8.0	8.1	8.4
- Female	48.3	48.8	48.1	48.2
- Born prematurely	4.8	5.3	5.2	4.2
- Low birth weight	4.9	5.1	4.8	3.9
- Missing low birth weight	26.7	7.1	2.5	0.6
- Chronically ill	6.4	7.2	6.8	5.9
Mothers				
- High school education	3.7	4.1	3.9	4.9
- Vocational school	12.9	29.0	40.7	40.0
- Short-term further ed.	1.8	3.3	3.9	5.3
- Bachelor degree	4.2	13.3	21.2	30.4
- Master degree or higher	2.1	4.6	4.7	6.7
- Percentage of child's first 15 years the mother was in school	2.9	7.0	6.7	2.3
- Residing in Copenhagen	24.2	26.2	23.5	30.4
- Residing in a city	37.1	49.6	55.4	53.5
- Residing in a town	7.5	11.6	13.4	11.9
- Residing in the outskirts	3.0	4.1	4.3	3.1
- Missing geography	28.3	8.5	3.5	1.1
- Age when child was born	25.9	26.1	26.7	28.3
- Mothers average income (0000)	9.9	12.2	13.6	16.0

Notes: the sample size in the regressions is smaller than the total observations in this Table because children with missing grade point average (GPA) information are omitted in the regressions.

Table 3A: Patterns of Maternal Employment in Child's 1st 3 Years of Life

Percentage of sample by mother's average weekly hours worked in child's first 3 years

		Younger Child				
		0 – 9 hours	10 – 19 hours	20 – 29 hours	30+ hours	Total
Older Child	0 – 9 hours	8.50	5.78	2.49	0.65	17.4
	10 – 19 hours	4.20	8.88	5.74	2.32	21.1
	20 – 29 hours	1.27	3.46	9.15	7.02	20.9
	30+ hours	0.54	1.59	5.45	32.9	40.5
	Total	14.5	19.7	22.8	43.0	100

Table 3B: Patterns of Maternal Employment in Child's 1st 15 Years of Life

Percentage of sample by mother's average weekly hours worked when child < 16 years old

		Younger Child				
		0 – 9 hours	10 – 19 hours	20 – 29 hours	30+ hours	Total
Older Child	0 – 9 hours	7.10	1.39	0.09	0.02	8.6
	10 – 19 hours	0.62	10.1	4.22	0.06	15.0
	20 – 29 hours	0.04	0.78	23.8	8.42	33.1
	30+ hours	0.00	0.02	0.83	42.5	43.4
	Total	7.8	12.3	29.0	51.0	100

Table 4: Ordinary Least Squares Coefficient Estimates

	Child's First 3 Years					Child's First 15 Years				
Model	1	2	3	4	5	6	7	8	9	10
Continuous work hours										
Average hours per week				0.0068**	0.0068**				0.00928**	0.00929**
				(0.00031)	(0.00031)				(0.00038)	(0.00038)
Catagorical work hours										
Percentage of time working (< 10 hours omitted):										
- 10 to 19 hours per week	0.1295**	0.0483**	0.0483**			-0.0357	-0.0338	-0.0338		
	(0.0197)	(0.018)	(0.018)			(0.043)	(0.039)	(0.039)		
- 20 to 29 hours per week	0.4019**	0.1557**	0.1557**			0.6439**	0.2673**	0.2675**		
	(0.0168)	(0.015)	(0.015)			(0.031)	(0.029)	(0.029)		
- 30+ hours per week	0.6328**	0.2253**	0.2253**			0.8119**	0.3012**	0.3015**		
	(0.0124)	(0.012)	(0.012)			(0.014)	(0.010)	(0.015)		
Pre-birth maternal income (000)			-0.00002		-0.00002			-0.00027		-0.00026
			(0.000)		(0.000)			(0.000)		(0.000)
Observations	125,928	125,928	125,928	125,928	125,928	138,803	138,803	138,803	138,803	138,803
R^2	0.08	0.23	0.23	0.23	0.23	0.09	0.23	0.23	0.23	0.23
Full set of control variables	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

Notes: the dependent variable is a child's grade point average at age 15. Basic control variables include indicators for birth year, birth month, child's birth order, child's gender, mother's education, whether the mother immigrated to Denmark. The comprehensive control variables also include an indicator for whether the child was born premature, whether the child was low birth weight (i.e., less than 2,500 grams), whether the child has a chronic health condition, and the mother's age when the child was born.

+ p<.10 *p<.05 ** p<.01

Table 5: Two-Stage Least Squares Coefficient Estimates with locality fixed effects

	Child's First 3 Years				Child's First 15 Years			
Model	1	2	3	4	5	6	7	8
Continuous work hours								
Average hours per week	0.0726**	0.0067**	0.0067**	0.0134**	0.0398**	0.0077**	0.0077**	0.0054*
	(0.0013)	(0.0015)	(0.0015)	(0.0020)	(0.0008)	(0.0017)	(0.0017)	(0.0022)
Pre-birth maternal income (000)			-0,0000				-0.0002	
			(0.0000)				(0.0000)	
Mothers' average income (000)				-0.0113**				0.0048*
				(0.0036)				(0.0024)
Observations	125,924	125,924	125,924	125,924	138,795	138,795	138,795	138,795
R^2	-0.19	0.23	0.23	0.23	0.08	0.23	0.23	0.23
Control variables	No	Yes	Yes	Yes	No	Yes	Yes	Yes
First-stage								
Unemployment rate in locality	-0.0799**	-0.0457**	-0.0457**	-0.0399**	-0.0738**	-0.0247**	-0.0248**	-0.0225**
	(0.0014)	(0.0021)	(0.0021)	(0.0020)	(0.0014)	(0.0027)	(0.0027)	(0.0028)
R^2	0.08	0.2	0.2	0.34	0.20	0.37	0.37	0.40
F-statistic	2290.1	307.6	307.7	158.0	75.6	19.0	19.0	7.8

Notes: the dependent variable is a child's grade point average at age 15. Basic control variables include municipality fixed effects, indicators for birth year, birth month, child's birth order, child's gender, mother's education, whether the mother immigrated to Denmark. The comprehensive control variables also include an indicator for whether the child was born premature, whether the child was low birth weight (i.e., less than 2,500 grams), whether the child has a chronic health condition, and the mother's age when the child was born.

+ p<.10 *p<.05 ** p<.01

Table 6: Maternal Fixed Effect Coefficient Estimates

	Child's First 3 Years			Child's First 15 Years		
Model	1	2	3	4	5	6
Continuous work hours						
Average hours per week			-0.0008			-0.0008
			(0.0006)			(0.0018)
Categorical work hours						
Percentage of time working (< 10 hours omitted):						
- 10 to 19 hours per week	0.0249	0.0247		0.1681	0.1670	
	(0.024)	(0.024)		(0.108)	(0.108)	
- 20 to 29 hours per week	-0.0059	-0.0061		0.1406	0.1394	
	(0.023)	(0.023)		(0.092)	(0.092)	
- 30+ hours per week	-0.0216	-0.0219		-0.0070	-0.0079	
	(0.020)	(0.020)		(0.065)	(0.065)	
Pre-birth maternal income (000)		-0.0003			-0.0004	
		(0.000)			(0.000)	
Observations	125,928	125,928	125,928	138,803	138,803	138,803
R^2	0.05	0.05	0.05	0.06	0.06	0.06
Full set of control variables	Yes	Yes	Yes	Yes	Yes	Yes

Notes: the dependent variable is a child's grade point average at age 15. Basic control variables include municipality fixed effects, indicators for birth year, birth month, child's birth order, child's gender, mother's education, whether the mother immigrated to Denmark. The comprehensive control variables also include an indicator for whether the child was born premature, whether the child was low birth weight (i.e., less than 2,500 grams), whether the child has a chronic health condition, and the mother's age when the child was born.

+ p<.10 *p<.05 ** p<.01

Table 7: Maternal Employment Coefficient Estimates When Stratifying by Mother's Education Level

	Child's First 3 Years			Child's First 15 Years		
	n	Coefficient	SE	n	Coefficient	SE
OLS						
- All women	125,928	0.0068**	(0.00031)	138,803	0.0093**	(0.00038)
- Low education	30,177	0.0108**	(0.00064)	32,798	0.0121**	(0.00070)
- High education	90,889	0.0070**	(0.00038)	94,316	0.0080**	(0.00051)
IV						
- All women	125,928	0.0253**	(0.00476)	138,803	0.1203**	(0.01820)
- Low education	30,177	0.0600**	(0.00254)	32,798	0.0544**	(0.00262)
- High education	90,889	0.0384**	(0.00192)	94,316	0.0183**	(0.00216)
Maternal Fixed Effects						
- All women	125,928	-0.00080	(0.00056)	138,803	-0.00079	(0.00180)
- Low education	30,177	0.00104	(0.00012)	32,798	-0.00239	(0.00389)
- High education	90,889	-0.00119	(0.00065)	94,316	-0.00137	(0.00227)

Notes: Dependent variable is a child's GPA in 9th grade (mean is 8.15). Table reports the coefficient estimates on the average hours per week a mother worked during her child's first 3 or 15 years of life. Low education is less than high school; high education is high school or more. IV models include locality fixed effects.

+ p<.10 *p<.05 ** p<.01

Appendix 1: OLS Coefficient Estimates on Full Set of Control Variables

Variables	Coefficient	SE
Birth-year indicators		
1987	-0.54723	(0.01074)
1988	-0.55835	(0.01041)
1989	-0.58230	(0.00969)
1990	-0.60749	(0.00940)
1991	-0.51891	(0.00969)
1992 (omitted)	-	-
Birth-month indicators		
January	-0.03372	(0.01504)
February	-0.00350	(0.01506)
March	-0.01674	(0.01462)
April	-0.01084	(0.01454)
May	-0.03722	(0.01464)
June	-0.05061	(0.01452)
July	-0.06002	(0.01454)
August	-0.06757	(0.01467)
September	-0,07266	(0.01479)
October	-0.06698	(0.01494)
November	-0.03520	(0.01529)
December (omitted)	-	-
Birth order	-0,19186	(0.00507)
Female indicator	0,30366	(0.00579)
Mothers' highest education prior to birth		
No education	-0,67581	(0.01708)
High school	0,02073	(0.02088)
Vocational school	-0,35725	(0.01569)
Short-term further edu.(omitted)	-	-
bachelor degree	0,09167	(0.01595)
Master degree or higher	0,48518	(0.01867)
Missing education	-0,39575	(0.02515)
Immigrant parents		
Child born outside Denmark	-0,38228	(0.09730)
Child born in Denmark	-0,25808	(0.02374)
Age of mother when she gave birth	0,05131	(0.00098)
Child has a chronic health condition	-0,10321	(0,01309)
Premature birth indicator	0,01715	(0,01741)
Missing premature birth	0,04090	(0,04148)
Low-birth weight indicator (<2,500g)	-0,11084	(0,01844)
Missing low birth weight	0,18160	(0,04871)
Constant	7.61161	(0.03439)

Notes: the dependent variable is a child's grade point average at age 15.