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September 2007

Working Paper No. 07/180

Published in Health Economics 17 (8) pp.889-906 (2008)
Published as University of York Health, Econometrics and Data Group Working Paper number 07/12 (2007)

ISSN 1473-625X

CMPO Working Paper Series No. 07/180

Maternal Employment and Overweight Children: Does Timing Matter?

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September 2007

Winner of the student paper prize awarded at the 6th iHEA World Congress, Copenhagen, Denmark 8-11 July 2007

Abstract

Recent literature has shown consistent evidence of a positive relationship between maternal employment and children's excess body weight. These studies have largely focused on the effect of average weekly work hours over the child's life on its overweight status. The aim of this paper is to explore the importance of the timing of employment. Timing of maternal absences has been shown to matter for child cognitive and behavioral outcomes. This paper explores whether this timing effect also exists with respect to children's excess body weight. Data on a nationally representative British birth cohort are used to examine this, permitting a detailed exploration of the potential endogeneity of mother's employment.

The results show a significant positive correlation between full-time maternal employment during mid-childhood and the probability of being overweight at age 16. There is no evidence that part-time or full-time employment at earlier or later ages leads to a higher probability of being overweight at age 16. Subgroup analysis suggests this effect is driven by lower socio-economic groups. Various econometric techniques are used to explore whether employed mothers are systematically different from non-employed mothers, but there is no evidence that this unobserved heterogeneity biases the estimates.

Keywords: Childhood obesity; Maternal Employment; Timing of Employment; Overweight

JEL Classification: I12, J22

Electronic version: http://www.bris.ac.uk/Depts/CMPO/workingpapers/wp180.pdf

Acknowledgements

I wish to thank Carol Propper and Frank Windmeijer for advice and helpful discussions. Financial support from the ESRC is gratefully acknowledged. Sonia Bhalotra, Simon Burgess, George Leckie and Elena Cottini provided helpful comments on an earlier version. All errors are my own.

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CMPO is jointly funded by the Leverhulme Trust and the ESRC

1. Introduction

Over the past decades, obesity has become one of the major public health issues in the Western World. Rates of adult as well as childhood obesity are rising rapidly in many major economies[1]. The prevalence of obesity among preschool-aged children in the US has almost doubled between 1988-94 and 2003-04. For children aged 6-11, it rose from 11 to 19% (National Center for Health Statistics, 2007). The UK has also seen rapid increases: obesity rates for 2-10 year olds have increased from 10 to 14% between 1995 and 2003 (ONS, 2005).

This trend in childhood obesity is worrying for various reasons, the first of which is the child's health. The Association of Public Health Observatories (AC/HC/NAO 2006) predicted that, if the current trend in childhood obesity continues, the average life expectancy for children will be shorter than that for their parents. Additionally, obese children are more likely to grow up to be obese adults and obesity is found to be a causal factor in a number of chronic diseases and conditions including heart disease and type II diabetes.

Apart from strict health risks, childhood obesity has consequences for adult life, including lasting effects on self-esteem, body image and confidence (Must and Strauss 1999), and lower wages in adulthood, at least for white females (Averett & Korenman 1996, Cawley 2004). As obese children are likely to grow up as obese adults, this implies we need consider a much wider area than just health when studying the consequences of childhood obesity.

Another concern of (childhood) obesity is its cost to society. In the UK, the cost of treating diseases attributable to obesity in the National Health Service was £470 million in 1998 (AC/HC/NAO 2006). Additional indirect costs in terms of losses of earnings due to sickness or premature mortality amounted to £2.1 billion. By 2002, the direct costs were estimated to be about £1 billion (House of Commons Health Committee 2004).

[1] Adult obesity is defined as having a Body Mass Index (BMI, weight in kilograms divided by height in metres squared) of higher than 30. Being overweight includes those with a BMI between 25 and 30.

The main underlying cause of the rise in childhood obesity is simple; a continuous misbalance between calorie intake and expenditure. A more interesting question is *why* this balance has changed. There are several possible explanations for this that have received the attention from economists. One of these is television viewing, which has an impact on both calorie intake and expenditure. First, there is a displacement of physical activity. Second, metabolic rates decline when children are watching television (Klesges et al. 1993). Third, due to an increase in calorie consumption whilst watching, possibly due to fast food restaurant advertising on television (Chou, Rashad and Grossman 2005). Another possible explanation is the geographic variation in fruit and vegetable prices. Sturm and Datar (2005) argue that this partly explains the differential gain in BMI among elementary school children in the US. Food outlet density was not found to affect children's BMI.

The factor examined here is maternal employment. The increase in maternal labor force participation coincides with the rise in childhood obesity rates. In the US, employment rates for married women with children under six rose from 19% in 1960 to 60% in 2005 (US Census Bureau 2007). UK figures show that the economic activity rate for women aged 16-59 rose from 59% in 1971 to 74% in 2007 (Labour Force Survey 2007).

Recent literature has shown consistent evidence of a positive relationship between maternal employment and children's excess body weight (e.g. Anderson et al. 2003, Ruhm 2004). The main focus of these studies has been on the effect of average weekly work hours over the child's life on its overweight status. This paper explicitly examines the importance of the timing of employment with respect to the child's age. Specifically, it explores whether maternal employment at different ages of the child has differential effects on the child's weight later in life. Apart from Anderson et al. (2003), who show that the employment effect is not sensitive to whether the mother works in the first three years of the child's life, and Ruhm (2004), who focuses on several child cognitive and non-cognitive outcomes simultaneously in a cross-sectional setup, this is the first study that extensively explores this issue of timing of maternal employment in the context of childhood obesity. In addition, the use of a birth cohort permits a detailed exploration of the potential endogeneity of mother's employment.

The timing of maternal employment has been shown to be important for various child outcomes. Heckman (2000, 2007) emphasizes the importance of the early childhood years in shaping many adult outcomes; early investments in children promote the development of learning and social and emotional skills. Focusing on cognitive development, Waldfogel et al. (2002) find that 3 to 8 year old children whose mother worked full-time in the first year of life have significantly lower test scores. Ruhm (2000, 2004) finds negative effects of employment in the first three years of life on the verbal ability of 3 to 4 year olds, and cognitive development of 5 to 6 and 10 to 11 year olds. Gregg et al. (2005) find small negative effects of full-time maternal employment in the 18 months after childbirth on child literacy skills at age 7. Ermisch and Francesconi (2000) estimate that one extra year of pre-school full-time maternal employment reduces the probability of children achieving at least an A-level in secondary school.

The results of the analyses show a significant positive correlation between full-time maternal employment during mid-childhood and the probability of being overweight at age 16. There is no evidence that part-time or full-time employment at earlier or later ages leads to a higher probability of being overweight at age 16. Subgroup analysis suggests the effect is driven by the lower socio-economic groups. Various econometric techniques are used to explore whether employed mothers are systematically different from non-employed mothers, but there is no evidence that this unobserved heterogeneity biases the estimates.

The next section motivates why a link between maternal employment and childhood obesity may exist and discusses existing literature. Section three presents the theoretical and econometric framework. Section four describes the data and shows some descriptive statistics. The methodology is presented in section five and section six discusses the results. Section seven presents several robustness checks and section eight concludes.

2. Motivation and Literature

There are some hypotheses about possible pathways through which childhood weight problems and maternal employment could be related. When a mother decides to work outside the home, there are several changes in the household that can affect children's (and parents') balance of calorie intake and expenditure. First, all else equal, the mother spends less time at home. In this respect, it is important to distinguish between the different types of activities that mothers engage in. Nock and Kingston (1988) and Bianchi (2000) present evidence that employed mothers reallocate their time away from activities like housework and home making towards time with their children to compensate for the increased time in employment. Nock and Kingston's (1988) define housework as a set of activities that includes meal preparation. Perhaps due to working mothers' time-constraints and decreased energy levels, they spend less time preparing meals compared to non-working mothers.

Various studies have found a positive effect of maternal employment on expenditures on food-away-from-home (Horton & Campbell 1991, McCracken & Brandt 1987). For the US, Crepinsek and Burstein (2004) show that households with part-time and full-time employed mothers spend $3 to $4 more per Adult Male Equivalent at grocery stores than non-working mothers, $1 to $2 more at specialty stores (bakeries, fish stores, etc.), but $4 to $7 more on fast food and carry out, and $15 to $23 more on food bought and consumed away from home. This difference is found within each income group. Lin et al. (1996, 1999) show that food obtained away from home tends to contain more calories and (saturated) fat. Additionally, restaurant and fast food meals have increased in size and there is evidence that larger portions induce more eating (Rolls et al. 2004), although this portion size effect has not been found for children below the age of five (Rolls et al 2000). Other factors related to eating out also affect the energy intake, like convivial atmosphere and tendency to choose foods with high energy density (Rolls 2003).

Second, when mothers spend more time away from home, their children will spend more time in care of others. This includes different types of childcare, like that by family members, nurseries, or schools. The quality of this childcare is important, as well as the food provided in these settings. Many studies have looked at the effects of childcare quality on child cognitive and behavioral outcomes. They generally find that childcare quality matters (for a thorough review, see e.g. Vandell & Wolfe (2000)). For example, Peisner-Feinberg et al. (1999) find that pre-schoolers who are enrolled in higher-quality childcare have better language and math skills. Howes (1988) finds that children who attended higher-quality childcare had fewer behavioral problems and better work habits compared to those attending lower-quality programs. This suggests that, apart from child development, childcare quality may also affect nutritional intake and children's eating patterns.

Third, without parental supervision, children might make poor nutritional choices when buying or preparing their own snacks. Klesges et al. (1991) show that unsupervised and unmonitored children tend to choose unhealthy, highly caloric foods with low nutritional value. Both the threat of parental monitoring and actual parental monitoring lowered the number of non-nutritious foods chosen and total caloric content of the meal.

Similarly, unsupervised children may be more likely to stay indoors (watching TV, playing video games) as opposed to more active activities. Crepinsek and Burstein (2001) report that children of full-time working mothers are more likely to watch television or videos for more than two hours a day than children of non-working mothers.

Finally, when mothers join the labor force, the household income will increase, all else equal. Various studies (ONS 2005, Department of Health 2006) have shown that childhood weight problems are less common in higher socio-economic status families (as defined in terms of income, social class, or parental educational level). A higher income can allow parents to increase the spending on fresh and high-quality foods. Therefore, the additional household income can be argued to affect child health positively. On the other hand however, the mother's income could be viewed as 'extra' income to be spent on luxuries like restaurant meals, generally containing more calories (Lin et al. 1996, 1999). As Fertig et al. (2006) note, part of this additional income might also be given to the children as their weekly allowance. As children generally prefer buying sweets over healthier snacks, this could lead to a weight gain. This possible effect is likely to differ across socio-economic groups, since better-off families are more able to increase children's pocket money.

All of this suggests that, *a priori*, it is difficult to say what the likely effect of maternal employment on the child's weight is. The effects of a decrease in time and child supervision and an increase in income are likely to be non-linear, heterogeneous across different groups and even the direction of the effect cannot be stated with certainty.

There have been only a few studies that specifically explore the link between maternal employment and overweight children, most of which have focused on the United States. Using matched mother-child data from the National Longitudinal Survey of Youth (NLSY), Anderson et al. (2003) investigate this relationship for children aged 3 to 11. They find a positive correlation between maternal work intensity (in terms of hours per week over the child's life) and the probability that the child is overweight. They use various techniques to explore whether employed mothers are systematically different from non-employed mothers, but find no evidence that unobserved heterogeneity biases the estimates. They find that this relationship is confined to higher socio-economic status families, despite the fact that these children are least likely to have weight problems.

Ruhm (2004) also uses the NLSY in his study on the effect of maternal employment on general adolescent development. He also finds that children of working mothers on average experience more weight problems. Additionally, he finds larger effects for higher educated mothers compared to the lower educated, although these effects are not significant. To account for potential sources of bias, Ruhm includes employment in a period after the date of child assessment in addition to contemporaneous employment. As he states, since labor supply is unlikely to have causal effects on outcomes in a prior period, any significant estimates suggest model misspecification. He finds slight evidence of this reverse causation, suggesting that the estimates found earlier might be biased.

Some other studies that have looked at the relationship between maternal employment and overweight or obesity include Phipps et al. (2006), looking at Canadian children aged 6-11, Garcia et al. (2006), who use data on Spanish children aged 2-15, Takahashi et al. (1999), who use data on 3-year-old Japanese children, Classen and Hokayem (2005), looking at American children aged 2-18 and Crepinsek and Burstein (2001) who focus on 12-14 year olds. Although they do not attempt to address the issue of possible unobserved heterogeneity, all these studies find similar positive associations.

Finally, Fertig et al. (2006) examine the *mechanism* through which mothers' employment translates into children's weight gain. They investigate two relationships: 1) whether children's activities and meal routines affect their BMI, and 2) what the effect of maternal employment is on these activities. They then combine the two to identify the mechanism through which employment affects the child's BMI. They find that maternal employment is negatively associated with the number of meals consumed by children. Consuming fewer meals is in turn related to a higher BMI. In addition, maternal employment significantly decreases a child's BMI among lower educated mothers. They argue that these children stay in school longer where they participate in activities that reduce their BMI. Among higher educated mothers, employment increases time spent watching television, which in turn significantly increases the child's BMI. This suggests that the different employment effects are (partly) due to different consequences of a decrease in supervision.

3. Framework

3.1 Theoretical framework

Following Ruhm (2000, 2004), the economic model assumes that parents allocate their resources to maximize household utility. Household utility at time *t*, U_t, is a function of child health H_t, leisure time of the mother and father (L_{Mt} and L_{Ft} respectively) and household's consumption of goods and services G_t.

$$U_t = U(H_t, L_{Mt}, L_{Ft}, G_t). \tag{1}$$

Since this study looks at the child's weight, H_t is referred to as the child's weight-for-height.

Utility is maximized subject to a child 'weight' production function, a time and a budget constraint. The production function of child weight can be written as:

$$H_t = f(H_{t-1}, L_{Mt}, L_{Ft}, R_t, \zeta, \tau). \tag{2}$$

The child's weight is a function of the child's weight in the previous period, mother and father's leisure time, consumption of child-related goods and services R_t, unobserved child specific weight endowments ζ and unobserved parental characteristics τ. The parents' time constraint looks like:

$$L_{pt} + E_{pt} = T, \qquad p = M, F \tag{3}$$

so that total time *T* is divided between leisure (L_{pt}) and employment (E_{pt}). As Ruhm (2000, 2004) notes, the production function has several important characteristics. First, parental leisure is good for children, hence the partial derivative of L_{pt} is positive. This can occur through direct time investments or indirectly through reductions in stress, increased energy levels, and so forth. Second, higher incomes raise the parents' ability to purchase productive inputs and influence their time allocation decisions. However, in contrast to Ruhm's framework, where the main focus lies on the effect of employment on child cognitive development, the partial derivative of income is not necessarily positive. This is because increases in income could be spent on inputs that might increase the child's weight, like restaurant and fast food meals. The budget constraint bounds purchases of (child-related) goods and services by the amount of earned and non-earned income.

Solving (3) for *E* and recursively substituting in for lagged values of *H*, equation (2) can be rewritten as a structural production function of generic form as:

$$H_t = f\left(\mathbf{E}_{pt}, \mathbf{R}_t, \zeta, \tau\right), \tag{4}$$

where $\mathbf{E}$ and $\mathbf{R}$ are vectors of current and lagged values, as in $\mathbf{E}_{pt} = \left(E_{pt}, E_{pt-1}, ..., E_{p0}\right)$. However, as the consumption of child-related goods and services $\mathbf{R}$ is not observed, the empirical analysis does not directly estimate (4), but instead estimates the reduced form demand function of child weight

$$H_t = f\left(\mathbf{E}_{pt}, \mathbf{X}_t, \varepsilon\right), \tag{5}$$

where $\mathbf{X}$ is a vector of child and parental background characteristics and ε is a disturbance term. The employment coefficients from (5) give the net-effect of employment, combining effects of the increased income and decreased leisure.

Rosenzweig and Schultz (1983) refer to this as a "hybrid equation", where the unobserved inputs $\mathbf{R}$ are dealt with by including their determinants, like income and educational 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 between these technologies and parental preferences. However, since these tastes are generally not observed, the employment coefficients might be biased.

Ideally, $\mathbf{X}$ accounts for all other factors influencing the structural determinants of child weight. If this is not the case, the reduced-form estimates may be biased. Even if only information on the technologies of weight production were desired (and no preferences or tastes), the fact that the inputs in the weight production function are *behavioral variables* is problematic. The difficulty arises from the presence of exogenous health and developmental factors that can be known to the individual household, but not to the researcher. These unobserved differences in the child's endowment could be correlated with these inputs (like maternal labor supply). For example, mothers might decide not to work if their child has developmental or behavioral problems. This endowment heterogeneity can in turn affect the estimation of the child weight production function. Issues relating to this unobserved heterogeneity will be explained more fully below and explored in the empirical estimation.

3.2 Econometric framework

To investigate whether there is an effect of maternal employment on child weight-for-height, the reduced-form (5) is rewritten as:

$$H_{it} = \alpha + \sum_{j=0}^{t} \beta_j E_{it-j} + \gamma' \mathbf{X}_{it} + \zeta_i + \tau_i + e_{it}, \tag{6}$$

where H_{it} is a binary variable indicating the sex and age adjusted overweight status for child *i* at time *t* and E_{it-j} is an indicator for whether the mother works at time *t-j*. Current and lagged indicators for father's employment are included in the vector $\mathbf{X}_{it}$. This vector also refers to a set of child and family-specific control variables, which will be discussed below. ζ_i are time-invariant unobserved child-specific weight endowments, τ_i are unobserved parental characteristics, and e_{it} is an i.i.d. error term. Because the dependent variable measures the child's weight-for-height, a positive unobserved child or family specific effect means the child is heavier. Thus larger values for ζ_i and τ_i imply increased probabilities of the child being overweight and are therefore considered to be unhealthy.

The basic econometric specification can be written like:

$$H_{it} = \alpha + \sum_{j=0}^{t} \beta_j E_{it-j} + \gamma' \mathbf{X}_{it} + \varepsilon_{it}, \qquad (7)$$

where $\varepsilon_{it} = \zeta_i + \tau_i + e_{it} = \eta_i + e_{it}$.[2] The coefficients of E_{it-j} estimate the effect of maternal employment on the outcome of interest. Unbiased estimates are obtained if $Cov(E_{it-j}, \varepsilon_{it}) = 0$, meaning there cannot be any correlation between E_{it-j} and ζ_i, and between E_{it-j} and τ_i. To account for potential confounding factors related to mother's employment, the vector $\mathbf{X}_{it}$ is included. After controlling for these observables, if there remain any unobservable factors that are correlated with both H_{it} and E_{it-j}, the estimate of β_j may be biased.

Mother's employment can be correlated with maternal unobserved characteristics τ_i, which can in turn be correlated with the child's weight. For example, if working mothers generally are less interested in their children or less skilful in rearing them than non-working mothers, $Cov(E_{it-j}, \tau_i) > 0$. Given that larger values for τ_i imply higher weight-for-height (see above), $Cov(H_{it}, \tau_i) > 0$, the estimate of β_j is biased upwards. On the other hand, one can argue in the opposite direction. Mothers who decide to work might do so to increase their income so that they are able to provide their child with everything it needs, send their child to a good school or university, etc. This would mean that working mothers might be more productive in child rearing, leading to $Cov(E_{it-j}, \tau_i) < 0$. The positive relation between this unobserved effect and child's weight problems then results in an underestimate of β_j.

Likewise, maternal employment can be correlated with the child-specific endowment ζ_i. Studies that explore the effect of maternal employment on children's cognitive or behavioral outcomes often argue that the child's development can influence the mother's decision of whether or not to work (see for example Waldfogel et al. 2002, Han et al. 2001).

[2] Data is only available for one child per household, thus the family and child unobserved effect cannot be separated. η_i will therefore be used to indicate the combined unobserved time-invariant effect $(\eta_i = \zeta_i + \tau_i)$.

This indeed seems likely, although perhaps not applicable in the case of overweight children. It seems less plausible that mothers delay or stop their employment because their child is overweight.[3] I therefore assume that this simultaneity bias does not play a role in the child weight production function and thus that $Cov\left(E_{it-j},\zeta_i\right)=0$. However, if being overweight is correlated with other developmental and behavioral problems, this will have to be taken into account. This aspect will be explored this more fully in section 7.

4. Data and Descriptives

4.1. Data

This study uses data from a large British birth cohort; the National Child Development Study (NCDS). The NCDS is a nationally representative survey that follows up all those living in the UK who were born between 3-9 March 1958. To date, there have been seven follow-up interviews of the members of this cohort, providing a unique source to study the effect of maternal employment at different points in time on a child's weight problems.

The children are observed at birth and at ages 7, 11 and 16. At age 16, the sample size is 14,514. The analysis follows the common approach by others in listwise deleting to deal with item and unit non-response (see for example Blundell et al. 2004, Feinstein et al. 1998). Children in Local Authority care and those with single parents are excluded from the analysis (dropping 2.2% and 1.4% respectively). The final model contains 3350 individuals. All descriptive statistics are given using this sample.

The measure of child weight-for-height used in this paper is the sex and age adjusted overweight status at age 16, which is based on the child's BMI. The definition of overweight status in children is taken from the International Obesity Taskforce (Cole et al. 2000), which introduces international cut-off points for BMI in childhood that are linked to the widely used

[3] Also, the data used are from a period with much less awareness of obesity and the problems associated with it, making it even less plausible that mothers react to their children's weight by changing their work behaviour.

adult cut-off points of a BMI of 25 (overweight) and 30 (obese).

The analysis uses this binary indicator for a child's overweight status and not the continuous BMI measure for two reasons. First, it is not necessarily worrying if a child gains a few pounds. However, it is alarming if the child gains so much weight that it is clinically overweight and thus unhealthy according to the medical cut-off point. Second and more importantly, the BMI distribution is different from many other continuous distributions. In the left and right hand tail of the BMI distribution are those who are underweight and overweight, both of which are considered unhealthy. Only those in the middle of the distribution have a healthy weight for their height. Therefore, finding that a certain variable positively affects a child's BMI is not necessarily bad. In contrast, if it positively affects the child's probability to be overweight, this is considered unhealthy for the child.

BMI is a commonly used measure to indicate an adult's overweight status. However, BMI is a less straightforward measure for children, as they experience changes in body composition depending on age and gender. For example, adiposity rebound (AR) refers to the increase in BMI that occurs after a nadir observed in children around the age of 4 to 6. Various studies have shown that children displaying an early AR are at increased risk for adult obesity (e.g. Whitaker et al. 1998), but also that the timing of AR is not associated with dietary intake (Rolland-Cachera et al. 2001, Dorosty et al. 2000). This therefore suggests that the AR is an exogenous shock to the child, something that determined genetically. Nevertheless, it might affect whether children are classified as being overweight. Another gender and age specific change in body composition is puberty. The age of onset of puberty differs for girls and boys. It is normally between the ages of 8-13 for girls and between 10-15 for boys. At age 16, nearly all girls are fully developed and have reached their final height. Boys are not likely to grow taller after the age of 17 or 18 (BUPA 2007).

The analysis uses the child's binary overweight status at age 16 as the dependent variable. This is a more informative measure than that at earlier ages as it contains less measurement error for the reasons above. Additionally, the next section shows that the child's overweight status at age 16 is more predictive of adult weight than earlier measures of BMI.

The focus of this study is not only on *whether*, but also on *when* maternal employment affects the child's overweight status. The maternal employment indicators used in the analysis include pre-school employment, employment at age 7 and at age 11. In addition, the analysis explores the effect of different work-intensities by distinguishing between part-time and full-time work.

In the analysis, various child and family characteristics are included to attempt to control for child and family specific health endowments, as these could be correlated with the mother's choice to participate in the labor market. The basic controls included in the analysis can broadly be grouped under three headings. Child characteristics include gender, birth weight, an indicator for having a low birth weight (<2500 grams), being prematurely born, firstborn, breastfed and non-white. Family characteristics include a dummy for maternal smoking after four months pregnancy and the number of births to the mother, as this may affect the total time available. Mother and father's age, as well as region of birth dummies are also added as covariates. Finally, socio-economic status indicators are included, as these are shown to be important predictors for children's excess body weight. The empirical analysis includes the partner's current and lagged unemployment status, mother's education, father's socio-economic class at the child's birth and income[4]. These indicators are included as separate dummy variables to allow for non-monotonic relationships. The variables and their descriptives are presented in the Appendix.

As shown in the theoretical framework of section 3, the covariates exclude the child's overweight status at earlier ages: the model recursively substitutes in for lagged values of

[4] Unfortunately, respondents are only asked to report their income at age 16. Therefore, maternal employment is possibly endogenous, as the choice to join the labour force could be affected by the partner's income.

child weight. Another reason why the analysis explicitly excludes the child's lagged overweight status is because interest lies in obtaining estimates for the full impact of maternal employment. If maternal employment affects the child's weight, this could already have occurred at an earlier age. Lagged overweight status would then pick up part of the effect of the variable of interest. The analysis does not specifically look at *when* or *at what age* the child becomes overweight, rather, it looks at the full effect of employment on the child's overweight status *at age 16*.

A similar argument goes for not including the parent's overweight status. Once the child is born, any changes in maternal employment that affect a child's weight (via changes in eating patterns, use of spare time, etc.) are likely to also affect the parent's weight. This means that the coefficient on the parents' overweight status will pick up some of the effect of mother's employment. Instead, by including as many variables as possible at the time of birth, the analysis tries to estimate the full effect of mother's employment, including that due to changes in the *household's* behavior caused by the mother's decision to work. Accounting for parental overweight status at the child's birth would therefore be preferable, as this says something about their health endowment. Unfortunately, this information is not available.

4.2. Descriptives

The key outcome variable in the analyses is the child's sex and age adjusted overweight status at age 16. The proportion of overweight children remained relatively stable between ages 7 and 11 (8.8% and 8.5% respectively) and increased slightly at age 16 (9.8%).

The transition matrix below shows how consistent the child's overweight problem is over time, i.e. what percentage of children who are overweight at, say, age 7 are still overweight at ages 11 and 16. It is clear from this table that the majority of children have (and keep) a healthy weight, although this percentage decreases with age (the light grey cells). At the same time, the proportion of children who are (and stay) overweight increases with age (the darker grey cells). The matrix also presents the child's overweight status at age 23 to show what proportion of children who are overweight at age 16 are still overweight in adulthood. This is almost 61%, confirming that being overweight at age 16 is a relatively good predictor of the child's overweight status in adulthood.

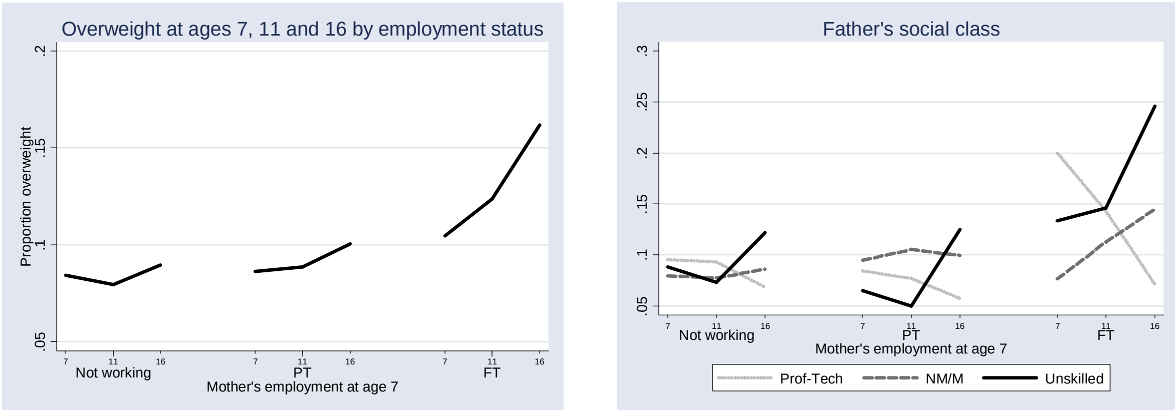
Table 1: Transition matrix of children's overweight status

		age 11		age 16		age 23	
		not	overweight	not	overweight	not	overweight
age 7	not	95.1	4.9	92.8	7.2	85.3	14.7
	overweight	50.9	49.1	60.5	39.5	54.7	45.3
age 11	not	100	0	94.3	5.7	86.2	13.8
	overweight	-	100	41.4	58.6	46.6	53.4
age 16	not	-	-	100	0	87.7	12.3
	overweight	-	-	-	100	39.4	60.6

The proportion of employed mothers varies with the child's age. Among pre-school aged children, 40% of mothers are employed. This drops to 28% at age 7 and increases sharply to 54% and 70% for those aged 11 and 16 respectively. A transition matrix of maternal employment (not shown) indicates that mothers often change employment status; it is not the case that mothers tend to stay in the work force once they have started working.

Figure 1 below looks at the raw data to explore whether there is an association between maternal employment and overweight children. The left panel presents the proportion of overweight children by mother's employment status. The graphs use mother's employment at age 7, although they are similar when using the indicators at other ages. All lines represent three observations, one for the proportion of overweight children at age 7, one for age 11 and one for age 16. Thus, each line represents the change over time in the proportion of overweight children. The line on the left is that for non-working, the middle for part-time, and the right for full-time working mothers.

Figure 1: Proportion of overweight children by mother’s employment status



Various things can be inferred from the graph. First, the proportion of overweight children generally increases with age for all employment categories. Apart from a drop in this proportion at age 11 for non-working mothers, the lines show an upward trend. Second, mother’s full-time employment is associated with the highest proportion of overweight children at all ages. Moreover, the slopes of the lines are steepest for full-time employment, meaning they experience the largest increases in the proportion of overweight children.

The right panel of Figure 1 presents a similar graph, but now each line is split up into three categories of father’s social class at the child’s birth: those with professional, managerial, or technical occupations; those with non-manual/manual skilled occupations; and those with partly skilled or unskilled occupations. The graph shows several things. First, full-time working mothers generally have the heaviest children in all social classes. Second, the higher classes show decreasing proportions of overweight with age, whereas the lower social classes show an upward trend. Children in higher classes experience more overweight than those in the lower social classes at age 7, similar overweight at age 11, and lower at age 16. Thus the relationship between maternal employment and overweight by social class seems to change as the children age. Graphs that distinguish between different levels of maternal employment in different income groups show very similar patterns as those found above.

5 Methodology

The descriptive statistics above show there is a significant raw correlation between maternal employment and the probability that the child is overweight. Using several different techniques, the econometric analysis explores whether this relationship is robust to various different model specifications.

The first analysis explores whether the effect of maternal employment on child overweight status at age 16 varies by *when* the mother works. A cross-sectional setup is used, controlling for an extensive range of family and child background characteristics to attempt to remove as much individual heterogeneity as possible. The dependent variable used is a binary indicator of whether the child is overweight at age 16.

$$H_{i,16} = \alpha + \beta_{PS} E_{i,PS} + \beta_7 E_{i,7} + \beta_{11} E_{i,11} + \gamma' \mathbf{X}_i + \varepsilon_{i,16} \quad (8)$$

Equation (8) includes all employment indicators simultaneously to explore the effect of different timings of maternal work, where $E_{i,PS}$ stands for pre-school employment, and $E_{i,7}$ and $E_{i,11}$ for employment at ages 7 and 11 respectively. It investigates whether there are differential effects of employment at different ages of the child, whilst simultaneously controlling for the mother's work history. It specifically examines whether early or later maternal employment is a stronger indicator for the child's overweight status. In addition, the analysis focuses on the effects of different intensities of work in terms of part-time and full-time jobs.

A second model investigates the effect of maternal employment on the probability that the child is overweight for different subgroups of the data. The variables for maternal employment are interacted with mother's educational level, father's social class at the child's birth, and income to allow for differential effects of maternal employment for children of different socio-economic backgrounds.

Any relation that is found in the above analyses might be driven by systematic differences between working mothers and non-working mothers in ways that are not observable to the researcher. This implies a need to examine the potential endogeneity of mother's employment. This is explored using two different approaches.

The first attempt to account for the unobserved individual heterogeneity is by specifying it as a function of those variables that proxy the unobserved effect. This is then included in the regressions to explicitly control for this unobserved heterogeneity. In the following cross-sectional model

$$H_{i,16} = \alpha + \beta E_{i,t-j} + \gamma' \mathbf{X}_i + \varepsilon_{i,16}, \qquad t\text{-}j = PS,\ 7,\ 11 \tag{9}$$

the error term can be decomposed into a time-invariant (child and parental) unobserved effect η_i and an i.i.d. error term $e_{i,16}$:

$$H_{i,16} = \alpha + \beta E_{it-j} + \gamma' \mathbf{X}_i + \eta_i + e_{i,16}. \tag{10}$$

The specification used in this analysis draws on ideas of Mundlak (1978), used in random effects models[5]. In the approach used here, the assumption is made that the unobserved individual effect is a function of mother's employment statuses in all periods. The analysis uses the mean work status over all ages of the child:

$$\eta_i = f\left(E_{it}\right) = \frac{1}{T}\sum_{i=1}^{T} E_{it} + v_i = \bar{E}_i + v_i \tag{11}$$

where $\bar{E}_i$ is a vector of two variables that include a mean part-time and a mean full-time employment. This is then included as a covariate in equation (9), leading to the following regression where $u_{i,16} = v_i + e_{i,16}$:

$$H_{i,16} = \alpha + \beta E_{it-j} + \gamma' \mathbf{X}_i + \bar{E}_i + u_{i,16}. \tag{12}$$

The thought behind this is that mothers who work more or longer during the child's life can be systematically different from mothers who never work. Following section 3.2, if

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[5] The original Mundlak specification parameterises the individual effect η_i and adds this to the random effect specification to remove the correlation between the individual effect and the covariates.

working mothers are systematically more or less skilful in rearing their children, it is possible that any effect found in the analysis above is not caused by their employment, but it is driven by the mother's unobserved ability, which is correlated to their employment status. Including a proxy for this ability will remove this unobserved effect. The estimated effect of maternal employment is then that over and above this heterogeneity.

In a second approach to account for the unobserved individual heterogeneity, the analysis makes use of the longitudinal structure of the data by using linear probability fixed effect models to remove the time-invariant unobservable family and child characteristics η_i. This study focuses on the effect of the different timings and intensities of employment on the child's probability of being overweight at age 16. However, the conventional setup of a fixed effects model does not allow for a specific exploration of these differential effects[6].

Therefore, the analysis adjusts the conventional panel data structure to allow for all measures of maternal employment to affect the probability that the child is overweight differently at the different ages. The estimating equation can be written as:

$$\begin{pmatrix} H_{i,7} \\ H_{i,11} \\ H_{i,16} \end{pmatrix} = \begin{pmatrix} \beta_{PS}{}^{7} E_{i,PS} + \beta_7{}^{7} E_{i,7} \\ \beta_{PS}{}^{11} E_{i,PS} + \beta_7{}^{11} E_{i,7} + \beta_{11}{}^{11} E_{i,11} \\ \beta_{PS}{}^{16} E_{i,PS} + \beta_7{}^{16} E_{i,7} + \beta_{11}{}^{16} E_{i,11} \end{pmatrix} + \begin{pmatrix} \gamma' \mathbf{X}_i \\ \gamma' \mathbf{X}_i \\ \gamma' \mathbf{X}_i \end{pmatrix} + \begin{pmatrix} \eta_i \\ \eta_i \\ \eta_i \end{pmatrix} + \begin{pmatrix} e_{i,7} \\ e_{i,11} \\ e_{i,16} \end{pmatrix}, \qquad (13)$$

where the first line refers to children aged 7, the second to age 11 and the third to 16. This setup allows for employment at age 7 to have a differential impact on the child's overweight status at age 7 ($\beta_7{}^{7}$), 11 ($\beta_7{}^{11}$) and 16 ($\beta_7{}^{16}$). The vector $\mathbf{X}_i$ consists of the before-mentioned variables and now also includes time dummies. The child's overweight status can

[6] For example, using two lags in a conventional fixed effects model would imply the following construction:

$$\begin{pmatrix} H_{i,11} \\ H_{i,16} \end{pmatrix} = \beta_1 \begin{pmatrix} E_{i,PS} \\ E_{i,7} \end{pmatrix} + \beta_2 \begin{pmatrix} E_{i,7} \\ E_{i,11} \end{pmatrix} + \beta_3 \begin{pmatrix} E_{i,11} \\ E_{i,16} \end{pmatrix} + \gamma' \begin{pmatrix} \mathbf{X}_{i,11} \\ \mathbf{X}_{i,16} \end{pmatrix} + \begin{pmatrix} \eta_i \\ \eta_i \end{pmatrix} + \begin{pmatrix} e_{i,11} \\ e_{i,16} \end{pmatrix}$$

where the coefficient β_1 represents the effect of maternal employment lagged two periods, while β_2 is the effect of a one-period lag. Hence, this model assumes that the effect of mother's pre-school employment on the overweight status at age 11 is the same as employment at age 7 on the overweight status at 16. The estimated coefficient will be an average of the two individual effects. In addition, the data do not distinguish between part-time and full-time employment at age 16, hence its lags cannot be used.

only be affected by employment at the same or previous ages.

Applying the within group transformation to equation (13) removes the child/family fixed effect η_i. However, taking mean deviations from each of the three employment variables at age 7 of the child ($E_{i,7}$ at age 7, 11 and 16) requires one of these to be removed due to perfect multicollinearity (and similarly for the indicators of pre-school employment). This problem is not found with the other employment indicators, as the specification does not include these for all three ages that the child's overweight status is observed.

A consequence of this setup is that not all effects of maternal employment are identified in the fixed effects specification. The analysis excludes the first line of equation (13), meaning that the estimate $\hat{\beta}_7^{16}$ (employment at age 7 on overweight at 16) is not observed directly. Instead, it is derived from two other estimates: the effect of employment at age 7 on overweight at age 16 *minus* the effect on overweight at age 7; $\left(\beta_7^{16} - \beta_7^{7}\right)$. Similarly, the fixed effects model estimates $\left(\beta_{PS}^{16} - \beta_{PS}^{7}\right)$ instead of β_{PS}^{16}.

Thus obtaining an estimate for β_7^{7} (and β_{PS}^{7}) will show whether the fixed effect estimates are over- or underestimated. If β_7^{7} is positive, the fixed effect estimate will be underestimated and visa versa. This way, it is possible to acquire an estimate for the specific timing effect of maternal employment at age 7 on overweight at age 16, β_7^{16} (and β_{PS}^{16}), whilst simultaneously taking account of the time-invariant unobserved fixed effect.

To obtain an estimate for β_7^{7} and β_{PS}^{7}, the child's overweight status at age 7 is regressed on pre-school maternal employment and that at age 7, with and without the usual covariates. However, the fixed effects analysis indirectly also accounts for all other indicators of maternal employment. Further specifications therefore include the average mother's part-time and full-time employment over the child's life (as in the Mundlak specification), and all employment statuses simultaneously (as the initial model, equation (8)) to look at the robustness of the findings.

6. Results

Table 2 below presents the results using equation (8). All six employment indicators– full-time and part-time indicators for pre-school, age 7 and 11 employment – are included simultaneously to allow for an exploration of the effect of different timings of maternal work status. The results are shown for two model specifications: column 1 uses a probit specification with the child's binary overweight status at age 16 as the dependent variable and presents the marginal effects. Column 2 presents the results of the Linear Probability Model (LPM). As the estimates are very similar, further analyses present the marginal effects of the probit specification (as in column 1).

When accounting for all employment indicators at current and previous ages of the child as well as the extensive list of covariates, full-time employment at age 7 of the child positively affects the child's probability of becoming overweight later in life. Children with a full-time employed mother at this age have an increased probability of being overweight of 5.5 percentage points. These results suggest that, when controlling for all observed employment spells of the mother, it is full-time work during mid-childhood that is positively and significantly associated with the probability that the child is overweight. Maternal employment earlier and later in the child's life does not matter once her other work statuses are controlled for. This suggests that both the intensity and the timing of employment with respect to the child's age are important factors in the relationship with the child's excess body weight. Similar results are found for analyses that use each indicator for maternal employment individually, not controlling for all other observed employment spells (results not shown). The strongest effect is found for full-time employment at age 7, although full-time pre-school employment also shows a marginally significant (positive) estimate. Further analyses will focus on mid-childhood employment in an attempt to explore this positive effect in more detail.

Table 2: Timing of effects

Children's overweight status at age 16

	(1) Probit		(2) LPM	
Pre-school PT	-0.009	(0.012)	-0.008	(0.013)
Pre-school FT	0.005	(0.021)	0.009	(0.022)
Age 7 PT	0.011	(0.014)	0.009	(0.014)
Age 7 FT	0.055**	(0.027)	0.057**	(0.023)
Age 11 PT	-0.010	(0.011)	-0.007	(0.012)
Age 11 FT	0.017	(0.016)	0.021	(0.016)
(Pseudo) R^2	0.05		0.03	
N	3350		3350	

* p<0.10, ** p<0.05, *** p<0.01, std errors in parentheses, other covariates controlled for.

In order to examine whether there are heterogeneous effects of employment across specific groups of individuals, mid-childhood maternal employment is interacted with family-specific variables. The analysis explores interactions of maternal employment with father's socio-economic class, income and mother's education. All specifications use non-employed mothers as the base line category.

The interactions of maternal employment with the categories for father's social class at the child's birth are presented in column 1 of Table 3. Table A2 in the Appendix shows the number of observations in each social group. Social class distinguishes between three categories: professional, managerial and technical (high), non-manual or manual skilled (med), and partly skilled or unskilled occupations (low). The results show an inverse relationship between father's social class and children's overweight status for mothers in full-time employment. Full-time employment in lower social class families is associated with an increase in the probability that a child becomes overweight of 12.7 percentage points. For the middle social classes, this is 6.1 percentage points and it is zero for the higher social classes.

Table 3: Subgroup analysis

Children's overweight status at age 16

	(1) Father social class		**(2) Income**		**(4) Mother education**	
Low: PT	0.028	(0.026)	0.003	(0.019)	0.021	(0.019)
Low: FT	0.127**	(0.055)	0.086**	(0.041)	0.068	(0.041)
Med: PT	0.011	(0.016)	0.014	(0.020)	-0.004	(0.020)
Med: FT	0.061**	(0.031)	0.037	(0.035)	0.067*	(0.036)
High: PT	-0.027	(0.028)	0.008	(0.024)	-0.008	(0.025)
High: FT	-0.016	(0.052)	0.089	(0.055)	0.052	(0.054)
Pseudo R^2	0.05		0.05		0.05	
N	3350		3350		3350	

* p<0.10, ** p<0.05, *** p<0.01, std errors in parentheses, other covariates controlled for.

In column 2, maternal employment is interacted with income, where income is split up into three groups. Maternal full-time employment again shows large positive effects, although this is only significant for the lower income group. The coefficient for the higher incomes is relatively large, but so is the standard error. This could be due to the relatively small number of observations in this category, as shown in Table A2 in the appendix.

The final column presents the results of the analysis that interacts mother's employment with her years of schooling. Education consists of three categories: less than or equal to 14 years (low), 15 years (med), and 16 or more years (high). The magnitude of the coefficients shows slight evidence of a social gradient in the effect of employment, although the effect is only significant for full-time working mothers with 15 years of education. Interacting maternal employment with the child's gender showed that both boys and girls have an equal increased likelihood to be overweight when their mother is working full-time (results not shown). Part-time employment does not affect boy's or girl's overweight status.

The above analyses show that, after controlling for a range of child and family-specific characteristics, there is still a strong correlation between mid-childhood full-time maternal employment and the probability that a child is overweight at age 16. The following analysis attempts to explore whether unobserved heterogeneity could be driving the results. The results of the Mundlak-like specification (equation (12)) are presented in Table 4. For mother's pre-school employment (column 1) and that at age 11 (column 3), the results show that the proxy for the unobserved heterogeneity is positive and highly significant. Over and above mother's ability or productivity, there is no effect of maternal employment on the child's weight. If anything, the marginal effects are negative. This would suggest that the results found in the separate regressions of children's overweight status on pre-school maternal employment and employment at age 11 were driven by unobserved heterogeneity.

Table 4: Mundlak specification

Children's overweight status at age 16

	(1) Pre-school		**(2) Employment Age 7**		**(3) Employment Age 11**	
Part-time	-0.007	(0.018)	0.021	(0.019)	-0.011	(0.015)
Full-time	-0.017	(0.024)	0.035	(0.030)	-0.013	(0.019)
Mean PT	-0.003	(0.026)	-0.028	(0.022)	0.001	(0.022)
Mean FT	0.085**	(0.035)	0.038	(0.029)	0.080**	(0.032)
Pseudo R^2	0.05		0.05		0.05	
N	3350		3350		3350	

* p<0.10, ** p<0.05, *** p<0.01, std errors in parentheses, other covariates controlled for.

On the other hand, the results using mother's employment at age 7 (column 2) show that the proxy for the unobserved heterogeneity is positive but insignificant. Furthermore, the marginal effect for full-time employment itself is also insignificant. Unlike the other regressions though, both effects now show a positive sign and are of equal magnitude. In addition, adding up the effects of the full-time and mean full-time employment gives an estimate that is similar, albeit slightly larger, in size to the effects found in the previous analyses. These results therefore suggest that the two effects cannot be separately identified.

This could be the case if there is only little variation in mother's employment status over time. However, as discussed in section 4.2, mothers do move between states of employment. This would suggest that part of the total effect of employment at age 7 is driven by the unobserved heterogeneity and another part by the mother's employment, but that it is not possible to distinguish between the two factors[7].

The second model that attempts to account for the unobserved individual heterogeneity makes use of the longitudinal structure of the data, estimating linear probability fixed effect models to remove the time-invariant unobservable family and child characteristics η_i. In this specification, the different timings of maternal employment are allowed to affect the child's weight differently at different ages. As was discussed above, this structure does not allow for the identification of all effects of maternal employment. Therefore, Table 5 first presents the estimated coefficients $\beta_7{}^7$ and $\beta_{PS}{}^7$, using four different model specifications. Column 1 does not include any controls and column 2 accounts for the usual covariates. Column 3 also includes the mean part-time and full-time employment over the child's life (as in the Mundlak-specification), and column 4 includes all employment statuses simultaneously (as in the initial model).

Table 5 shows that the effect of employment at age 7 on the probability that the child is overweight at age 7 is more or less zero. There is no evidence that $\beta_7{}^7$ is positive or negative and thus that the coefficient of interest might be underestimated or overestimated in the fixed effects specification. The results for maternal pre-school full-time employment show that the coefficient does not equal zero, but instead has an estimated effect of

[7] The effect of the indicators for mean part-time and full-time employment can be interpreted in two ways, depending on the focus of the analysis. First, it can be seen as a proxy for the unobserved heterogeneity. This is more applicable when the focus lies on the *timing* of employment, as in this paper. Second, if the analysis mainly focussed on the effect of an *accumulation* of employment over the child's life, the mean employment indicators could be interpreted as 'persistence' or 'permanent' effect. The individual employment estimates are then deviations from (variations around) this mean effect. Both interpretations lead to the same conclusion: that it is difficult to separate the employment effect from the unobserved heterogeneity / mean employment.

approximately 4 to 5 percentage points. This therefore indicates that the fixed effects specification is likely to underestimate the coefficient on pre-school employment.

Table 5: The effect of maternal pre-school employment and at age 7 on children's overweight status at age 7

Children's overweight status at age 7

	(1)		**(2)**		**(3)**		**(4)**	
PT, pre-school	0.002	(0.012)	-0.002	(0.012)	0.017	(0.020)	0.002	(0.012)
FT, pre-school	0.052**	(0.025)	0.042*	(0.024)	0.049	(0.037)	0.043*	(0.025)
PT, age 7	-0.001	(0.013)	0.000	(0.013)	0.015	(0.019)	0.001	(0.013)
FT, age 7	0.004	(0.021)	0.007	(0.021)	0.011	(0.027)	0.004	(0.021)
Other covariates			✓		✓		✓	
Mean employment					✓			
Work at other ages							✓	

* p<0.10, ** p<0.05, *** p<0.01, std errors in parentheses.

The results for the fixed effect model are presented in column 1 of Table 6. After accounting for the fixed unobserved heterogeneity and allowing for the different indicators of employment to affect the probability of being overweight differently, the results still indicate a strong positive effect of mid-childhood full-time employment. The effect of full-time pre-school employment is negative, although Table 5 showed that this is likely to be an underestimate. It is therefore not possible to comment on the significance of the effect. Nevertheless, these findings confirm the results found earlier; that *mid-childhood full-time* maternal employment significantly increases the probability that a child is overweight later in life. This finding remains even when accounting for fixed unobserved heterogeneity.

This suggests that unobserved heterogeneity does not play a role in the child weight production function. And if there is no correlation between the unobserved individual effects and the covariates, a random effects specification will give more efficient estimates than the fixed effects specification[8]. Column 2 presents the results of a pooled probit model and column 3 shows the average partial effects obtained from a random effects probit model.[9] The estimates in column 2 are very similar to the fixed effects results of column 1. Mid-childhood full-time maternal employment significantly increases the probability that the child is overweight. The average partial effect of full-time employment obtained from the random effect probit model (column 3) is smaller, but still relatively large. The discussion above argues that the coefficient on pre-school employment in column 1 is underestimated. This is indeed what the pooled and random effect probits show. The effect is no longer negative, but now equals zero.

Table 6: Fixed and random effect specifications

Children's overweight status at age 16

		(1) Fixed Effects		**(2) Pooled Probit**		**(3) RE Probit**
Pre-school	PT	-0.005	(0.015)	-0.007	(0.011)	-0.007
	FT	-0.033	(0.027)	0.004	(0.019)	0.004
Age 7	PT	0.006	(0.016)	0.009	(0.013)	0.007
	FT	0.065**	(0.027)	0.057**	(0.026)	0.038**
Age 11	PT	0.002	(0.014)	-0.008	(0.010)	-0.006
	FT	0.028	(0.020)	0.018	(0.015)	0.019
N_g		3350				3350
N		9449		9449		9449

* p<0.10, ** p<0.05, *** p<0.01, std errors in parentheses, other covariates controlled for.

Concluding, the first model specification showed that mid-childhood full-time employment increases the probability that the child becomes overweight. Taking account of the time-invariant unobserved heterogeneity in the fixed effects specification, the effect

[8] A Hausman test is not possible in this setup, because the estimates in the two specifications measure different things. Contrary to fixed effects, all estimates in the random effects model are identified.

[9] Although the joint distribution is mis-specified in the pooled probit model when within-individual observations are correlated, the marginal distributions for each period are correctly specified and the estimates are consistent. The random effect probit model uses 24 quadrature points and also gives consistent estimates, which are re-scaled to compute the partial effects presented in column 3.

remains and is of equal magnitude, suggesting that the previous findings are not driven by any unobserved heterogeneity.

7. Robustness checks

This section briefly discusses the set of robustness checks undertaken on the analyses above. These focus on the effect of mid-childhood full-time maternal employment. First, all analyses described above are repeated using OLS regressions redefining the child's BMI to be the dependent variable. Instead of looking at the effect of employment on the cut-off point of being overweight, this explores whether employment also shifts the general mean of the BMI. This therefore examines whether the actual BMI of children has increased, or whether the effect is due to an increase in the variation in BMI across children. The findings are presented in column 1 of Table 7, again showing a significant positive effect of mid-childhood full-time maternal employment. This suggests the employment effect is not restrained to the upper part of the BMI distribution, but in fact also shifts the mean BMI.

Column 2 presents results using interquantile regression analysis to explore the effect of employment on different quantiles of the BMI distribution. The reported estimates present the difference in coefficients of the quantile regressions (.75 – .25). The standard errors are obtained via bootstrapping and use 100 replications. The results show no evidence of significant differential impacts of employment at different quantiles of the BMI distribution. The estimate obtained for part-time employment is negative and relatively large, implying that the effect of employment is larger at the first quantile. However, the standard error shows is it not precisely estimated.

The BMI measure (and therefore also the overweight indicator) accounts for children's height when looking at their weight. To check whether the positive coefficient of maternal employment is due to an increase in child weight as opposed to a halt in the child's height, the child's weight is regressed on mother's employment status, child height, height squared and the usual covariates. In addition, a person's height is sometimes referred to as an indicator for nutritional status or living standards (Floud et al, 1990). Height has been shown to be positively correlated with general health (Smith et al. 2000), education (Magnusson et al. 2006), income (Meyer & Selmer 1999), and social class (Walker, 1988). Adding the parents' height in addition to the child's height therefore attempts to include a proxy for family's nutritional status or living standards. The results (not shown) are not sensitive to any of these inclusions. Furthermore, controlling for car ownership does not change these results. Finally, if the child's overweight status at age 16 is a good predictor of the overweight status in adulthood, we might expect to find similar results when looking at the overweight status at age 23. This is what the analysis shows (results not shown).

In addition to exploring the effect of maternal employment on the distribution of BMI, a sensitivity analysis was undertaken on the cut-off point of being overweight. As children experience changes in body composition depending on their age and gender, it is more difficult to identify this cut-point compared to adults. The sensitivity analysis therefore uses gender specific cut-points from the 75th percentile to the 95th percentile of the BMI distribution. The initial probit specification is run multiple times using the different cut-points to explore changes in the marginal effects and standard errors of maternal employment. All effects are positive and of similar magnitude. In general, the results (not shown) seem robust to the variation in cut-points; significant effects are obtained for cut-points varying between the 81st to 93rd percentiles[10].

Another way in which I have attempted to look at whether any unobserved heterogeneity is playing a role in the overweight equation is by regressing the child's overweight status on mother's future employment in addition to her mid-childhood employment. This idea has been used by Ruhm (2004), who interprets any large or significant

[10] For comparison, the cut-points used in the main analysis are the 89th percentile for girls and the 93rd for boys.

coefficient as evidence of model misspecification. One can also argue that a large or significant coefficient of future employment is picking up the mother's 'taste' for work. The coefficient of future employment can then be interpreted as the mothers' unobserved tastes or preferences with respect to her working status. The results (not shown) did not present any evidence of unobserved heterogeneity.

Table 7: Robustness checks

Children's overweight status and BMI at age 16

	(1) OLS, using BMI		(2) Interq. regr. (.75 - .25)		(3) Bivariate Probit		(4) Bivariate Ordered Probit	
Age 7 Working					0.980**	(0.480)		
Marginal Effect					0.150*	(0.083)		
Age 7 PT	0.086	(0.132)	-0.225	(0.142)			0.599	(0.442)
Marg. Effect PT							0.084	(0.061)
Age 7 FT	0.434**	(0.210)	0.030	(0.318)			1.206*	(0.660)
Marg. Effect FT							0.254	(0.177)
Pseudo R^2	0.05							
0.25 R^2			0.03					
0.75 R^2			0.04					
ρ					-0.488		-0.358	
ρ =0: p-value					0.113		0.211	
N	3350		3350		3350		3350	

* p<0.10, ** p<0.05, *** p<0.01, std errors in parentheses, other covariates controlled for.

The final two column of Table 7 present the results of two specifications that allow for the unobserved heterogeneity of the employment decision to be correlated with the unobservables in the child weight production function. So this allows for – say – mothers to decide not to work because their child is overweight. Column 3 uses a bivariate probit model with a binary employment indicator. The specification used in column 4 allows for differential effects of part-time and full-time employment, using a bivariate ordered probit model[11]. The results presented here do not include any exclusion restrictions[12].

As the bivariate models are measured on a latent scale, the estimates cannot be interpreted directly. The results therefore also present the marginal effects, calculated for each individual and averaged over all observations whilst allowing for possible selection into employment (i.e. $\rho \neq 0$; the marginal effects that do not allow for this selection have been presented in Table 2). The standard errors reported here are obtained by bootstrapping using 100 replications. The results in column 3 suggest there is a positive relation between maternal employment and the probability that the child is overweight. Column 4 distinguishes between part-time and full-time work, showing no significant effects because of relatively large standard errors. The estimate for the correlation coefficient is relatively large, but not significantly different from zero. This confirms the findings earlier, suggesting that there is no correlated unobserved heterogeneity between the two equations.

8. Discussion

The main focus of studies that have looked at the relationship between maternal employment and the probability that the child is overweight has been on the effect of average weekly work hours over the child's life. This study specifically explores the effects of different timings of maternal employment on the child's overweight status later in life, using rich data of a British birth cohort.

The results show that the timing of employment matters; it is mid-childhood as opposed to earlier or later maternal employment that positively and significantly affects the child's overweight status later in life. In addition, employment at this age is not associated

[11] Possible convergences to local maxima are explored by specifying different sets of initial values.
[12] As the specification is non-linear, it can be identified by its functional form and does not need any restrictions on the regressors. Finding suitable instruments proves difficult, since family variables like mother's wage and other family income, are also determinants of child health and are therefore not valid instruments (Ermisch & Francesconi 2000). Different attempted specifications have included several labour market indicators, but two-stage least squares models suggest the instruments do not have explanatory power.

with contemporaneous child weight (see Table 5), and – as mentioned above – mid-childhood employment is not a marker for permanent work status. This suggests that employment during mid-childhood sets up a pattern that persists through childhood into adolescence.

If mid-childhood is important, the next question is why. Unfortunately, this question cannot be addressed with the data used in this paper. However, there are some potential mechanisms. One possible explanation for this timing effect could be that food preferences and habit formations in children develop around that age. There are numerous studies on the former, but they do not support this hypothesis, instead arguing that the formation of food preferences begins very early in the child's life (see for example Birch & Fisher, 1998). Dietz (1997) however speculates that food and activity-related behaviors acquired early in the child's life are beginning to be expressed during mid-childhood. The literature on habit formation also is not helpful as it generally does not focus on children.

An interesting facet though, is that mid-childhood is a period that is characterized by many changes in body composition. A child's BMI generally declines after about one year of age until it reaches a minimum at around the age of 4 to 6. From then on, the BMI begins a gradual increase into adulthood, referred to as the adiposity rebound (AR). This is a normal pattern of growth that occurs in all children. Numerous studies have focused on the relation between children's early feeding patterns and the timing of the onset of AR. However, there is very little literature on the effects of nutrition and feeding patterns specifically in the post-AR period on adolescent and adult obesity.

During this phase in children's lives, the body goes through major changes. If mothers are substituting childcare at this particular time, this might have further consequences for the child. As discussed in section 2, various behaviors or routines in the household might change in reaction to mothers starting employment outside the home. For example, this can include a reorganization of time spent on different household activities, or changing children's (and parents') nutritional intakes and feeding patterns, both in and outside the home. In this important period, these changes may affect children's physical development, and perhaps also have longer-lasting effects.

At the same time, mid-childhood is the period when children start school. Perhaps the combination of mothers starting work and the child starting school has an effect on the child's weight. This hypothesis would suggest that the decrease in supervision due to maternal full-time employment is affecting the child's weight. Perhaps after-school activities differ for children whose mothers work compared to children whose mothers are at home.

Further work is therefore needed for a better understanding of the importance of children's feeding patterns, nutritional intakes and activities during their mid-childhood years on the physical development into adolescence and adulthood. This might shed more light on the various factors related to the rapidly rising obesity rates in the Western World.

References

AC/HC/NAO (Audit Commission, Health Care Commission, National Audit Office). 2006. "Tackling child obesity - First steps". London: The Stationary Office.

Anderson, P., K. Butcher, and P. Levine. 2003. "Maternal employment and overweight children." *Journal of Health Economics* 22(3):477-504.

Averett, S. and S. Korenman. 1996. "The economic reality of the beauty myth." *Journal of Human Resources* 31(2):304-30

Bianchi, S. 2000. "Maternal employment and time with children: dramatic change or surprising continuity?" *Demography* 37(4):401-14.

Birch, L. and J. Fisher. 1998. "Development of eating behaviors among children and adolescents." *Pediatrics* 101:539-49.

Brooks-Gunn, J., W. Han, and J. Waldfogel. 2002. "Maternal employment and child cognitive outcomes in the first three years of life: the NICHD study of early child care."

Child Development 73(4):1052-72.

BUPA. 2007. "Puberty". Available at: http://bupa.co.uk/members/asp/tng/puberty/.

Cawley, J. 2004. “The impact of obesity on wages.” *Journal of Human Resources* 39(2):451-74

Chou, S., I. Rashad, and M. Grossman. 2005. “Fast food restaurants advertising on television and its influence on childhood obesity.” *NBER WP 11879*.

Classen, T. and C. Hokayem. 2005. “Childhood influences on youth obesity.” *Economics and Human Biology* 3:165-87.

Cole, T. et al. 2000. “Establishing a standard definition for child overweight and obesity worldwide: international survey.” *BMJ* 320:1240-45.

Dietz, W. 1997. “Periods of risk in childhood for the development of adult obesity – what do we need to learn?” *The Journal of Nutrition* 127:1884-6S.

House of Commons Health Committee 2004. “Third Report”.

Crepinsek, M. and N. Burstein. 2004. “Maternal employment and children's nutrition”. *Electronig Publications from the Food Assistance and Nutrition Research Program.* Economic Research Service.

Department of Health. 2006. “Forecasting obesity to 2010”.

Dorosty, A. et al. 2000. “Factors associated with early adiposity rebound.” *Pediatrics* 105:1115-18.

Ermisch, J. and M. Francesconi. 2000. “The Effect of Parents' Employment on Children's Educational Attainment.” *IZA DP 215*.

Fertig, A., G. Glomm, and R. Tchernis. 2006. “The connection between maternal employment and childhood obesity: inspecting the mechanism.” *CAEPR WP #2006-020*.

Floud, R., K. Wachter, and A. Gregory. 1990. Height, health, and history: Nutritional status in the United Kingdom, 1750-1980. Cambridge: Cambridge University Press.

Garcia, E., J. Labeaga, and C. Ortega. 2006. “Maternal employment and childhood obesity in Spain.” *WP FEDEA, Madrid*.

Gregg, P. et al. 2005. “The effects of a mother’s return to work decision on child development in the UK.” *The Economic Journal* 115 (February) F48-F80.

Heckman, J. 2000. “Policies to foster human capital.” *Research in Economics* 54(1):3-56.

Heckman, J. 2007. “The economics, technology and neuroscience of human capability formation.” *IZA DP 2875*.

Horton, S. and C. Campbell. 1991. “Wife's employment, food expenditures, and apparent nutrient intake: evidence from Canada.” *Am. Agric. Econ. Assoc.* 73(3):784-94.

Howes, C. 1988. “Relations between Early Child Care and Schooling.” *Developmental Psychology* 24: 53–57.

Klesges, R., M. Shelteon, and L. Klesges. 1993. “Effects of television on metabolic rate: potential implications for childhood obesity.” *Pediatrics* 91(2):281-6.

Klesges, R. et al. 1991. “Parental influence on food selection in young children and its relationships to childhood obesity.” *Am. J. Clinical Nutrition* 53:859-64.

Labour Force Survey, ONS. Available from: http://www.statistics.gov.uk/statbase/

Lin, B-H., J. Guthrie, and J. Blaylock. 1996. “The diets of America's children: Influence of dining out, household characteristics and nutrition knowledge”. E.R.S. US Department of Agriculture, Washington, DC.

Lin, B.-H., J. Guthrie, and E. Frazao. 1999. “Nutrient contribution of food away from home.” In *American's Eating Habits: Changes and Consequences*, edited by E. Frazao, Washington, DC.: US Department of Agriculture, Economics Research Service.

Magnusson, P., F. Rasmussen, and U. Gyllensten. 2006. “Height at age 18 years is a strong predictor of attained education later in life: cohort study of over 950 000 Swedish men.” *Int J of Epidemiol* 35(3):658-63.

McCracken, V. and J. Brandt. 1987. “Household consumption of Food-Away-From-Home: Total expenditure and by type of food facility.” *Am Agric Econ Assoc* 69(2):274-84.

Meyer, H. and R. Selmer. 1999. “Income, educational level and body height.” *Annals of Human Biology* 26(3):219-27.

Mundlak, Y. 1978. “On the Pooling of Time Series and Cross Section Data.” *Econometrica* 46:69-85.

Must, A. and R. Strauss. 1999. “Risks and consequences of childhood and adolescent obesity.” *International Journal of Obesity* 23(Suppl 2):S2-S11.

National Center for Health Statistics. 2007. Prevalence of overweight among children and adolescents: United States, 2003-2004. http://www.cdc.gov/nccdphp/dnpa/obesity/

Nock, S. and P. Kingston. 1988. “Time with children: The impacts of couples' work-time commitments.” *Social Forces* 67(1):59-85.

Office for National Statistics. 2005. “Obesity among children under 11”. Joint Health Surveys Unit.

Peisner-Feinberg, E. et al. 1999. *The Children of the Cost, Quality, and Outcomes Study Go to School: Technical Report*.

Phipps, S., L. Lethbridge, and P. Burton. 2006. “Long-run consequences of parental paid work hours for child overweight status in Canada.” *Soc Sci Med* 62:977-86.

Rolland-Cachera, M., M. Deheeger, and F. Bellisle. 2001. “Early adiposity rebound is not associated with energy or fat intake in infancy.” *Pediatrics* 108(1):218-19.

Rolls, B., D. Engell, and L. Birch. 2000. “Serving portion size influences 5-year-old but not 3-year-old children's food intakes.” *Research and Professional Briefs* 100(2):232-4.

Rolls, B. 2003. “The supersizing of America: portion size and the obesity epidemic.” *Nutrition Today* 38(2):42-53.

Rolls, B. et al. 2004. “Increasing the portion size of a packaged snack increases energy intake in men and women." *Appetite* 42(1):63-9.

Rosenzweig, M. and P. Schultz. 1983. "Estimating a household production function: Heterogeneity, the demand for health inputs and their effects on birth weight." *Journal of Political Economy* 91(5):723-46.

Ruhm, C. 2000. "Parental employment and child cognitive development." *NBER WP 7666*.

Ruhm, C. 2004. "Maternal employment and adolescent development." *NBER WP 10691*.

Smith, G. et al. 2000. "Height and risk of death among men and women: aetiological implications of associations with cardiorespiratory disease and cancer mortality." *Journal of Epidemiology and Community Health* 54:97-103.

Sturm, R. and A. Datar. 2005. "Body mass index in elementary school children, metropolitan area food prices and food outlet density." *Public Health* 119:1059-68.

Takahashi, E. et al. 1999. "Influence factors on the development of obesity in 3-year-old children based on the Toyama study." *Preventive Medicine* 28:293-96.

US Census Bureau. 2007. The 2007 Statistical Abstract.

Vandell, D. and B. Wolfe. 2000. "Child Care Quality: Does It Matter and Does It Need to Be Improved?" Report prepared for the Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services.

Waldfogel, J., W. Han, and J. Brooks-Gunn. 2002. "The effects of early maternal employment on child cognitive development." *Demography* 39(2):369-92.

Walker, N., A. Shaper, and G. Wannamethee. 1988. "Height and social class in middle-aged British men." *Journal of Epidemiology and Community Health* 42:299-303.

Whitaker, R. et al. 1998. "Early adiposity rebound and the risk of adult obesity." *Pediatrics* 101(3):e5.

Appendix A

Table A1 presents some descriptives by mother's employment status at age 7 of the child. It shows that the proportion of overweight children is larger among full-time employed mothers. Also, there are more non-white and firstborn children among full-time working mothers. The number of births and the parents' age decrease with work intensity.

Table A1: Descriptive statistics by mother's employment status

	Not working		Part-time		Full-time	
	Mean	Std err	Mean	Std err	Mean	Std err
Child's overweight status, age 16	0.09	*0.29*	0.10	*0.30*	0.16	*0.37*
Female	0.48	*0.50*	0.53	*0.50*	0.51	*0.50*
Non-white	0.00	*0.06*	0.01	*0.09*	0.04	*0.20*
Birth weight (in grams)	3363	*520*	3386	*540*	3286	*486*
Binary indicator for having a low birth weight	0.05	*0.22*	0.05	*0.21*	0.06	*0.23*
Binary indicator for being prematurely born	0.04	*0.19*	0.03	*0.17*	0.04	*0.20*
Binary indicator for being firstborn	0.37	*0.48*	0.37	*0.48*	0.56	*0.50*
Binary indicator for being breastfed	0.72	*0.45*	0.77	*0.42*	0.72	*0.45*
Number of births to the mother	3.35	*1.63*	3.10	*1.44*	3.02	*1.48*
Mother smoked after 4 months pregnancy	0.28	*0.45*	0.31	*0.46*	0.40	*0.49*
Age of mother at birth	27.23	*5.13*	26.33	*4.97*	24.71	*5.20*
Age of father at birth	30.15	*5.62*	29.08	*5.41*	27.46	*6.03*
Father unemployed at age 7	0.01	*0.10*	0.02	*0.13*	0.03	*0.17*
Father unemployed at age 11	0.02	*0.14*	0.01	*0.12*	0.03	*0.16*
Father unemployed at age 16	0.03	*0.17*	0.01	*0.11*	0.04	*0.20*

Table A2 presents the socio-economic status indicators by mother's employment status. Some cells, particularly for full-time employment, contain a very small number of observations. This has to be taken into account when interpreting the results of the subgroup analysis. There seems to be a slight inverse gradient, in that there is a higher proportion of full-time working mothers in the lower compared to the higher social classes, although that does not hold for mother's education.

Table A2: Proportions of each socio-economic group by mother's employment status

		Not working		Part-time		Full-time	
		Mean	N	Mean	N	Mean	N
Mother's years of schooling	Low	73.87	1091	20.92	309	5.21	77
	Med	67.52	738	21.77	238	10.70	117
	High	76.03	593	17.95	140	6.03	47
Income	Low	70.83	799	21.45	242	7.71	87
	Med	69.78	845	22.21	269	8.01	97
	High	76.95	778	17.41	176	5.64	57
Father's socio-economic class at child's birth	Low	67.52	476	23.83	168	8.65	61
	Med	71.47	1463	21.10	432	7.43	152
	High	80.77	483	14.55	87	4.68	28