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Maternal Employment and Overweight Children:
Does Timing Matter?

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Abstract

Recent literature has shown consistent evidence of a positive relationship between maternal employment and children's excess body weight. These studies have mainly focused on the effect of average weekly work hours over the child's life on its overweight or obesity status. This paper attempts to explore whether the timing of maternal employment with respect to the child's age is an important factor in this relationship. Data on a nationally representative British birth cohort are used to examine this; the 1958 National Child Development Study.

The results show a significant positive correlation between maternal employment at age 7 of the child and the probability that a child is overweight at age 16. Additionally, the analysis shows it is full-time as opposed to part-time employment that increases the child's weight. Subgroup analysis suggests this effect is driven by the lower socio-economic groups. Various econometric techniques are used to explore possible unobserved heterogeneity, but there is no evidence that the estimates are biased.

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1. Introduction

Being overweight or obese has grown to be one of the major public health issues in the Western World. The actual size of the problem becomes clear by looking at the rapidly increasing obesity rates over the past decades and its consequences. Although obesity rates are highest in the United States, the United Kingdom is quickly catching up in this ‘obesity epidemic’. Figures based on the Health Survey for England 2003 (HSE) show that around a fifth of men and a quarter of women (aged 16+) are now obese (Department of Health 2006). Looking at proportions of overweight instead of (and not including) obese, the survey finds that 43% of men and 33% of women fall in this category. This means more than 50% of the English population is now overweight[1].

The prevalence in obesity among children has also been rising. Using the HSE, Jotangia et al. (2005) present obesity trends among 2-10 year old boys and girls from 1995 to 2003. They find a rise in obesity among boys from 9.6% in 1995 to 14.9% in 2003. In girls, this increased from 10.3% to 12.5%. Rates of overweight for boys increased from 22.5% to 29.6% and for girls from 22.9% to 25.9%. Using trend data from previous years of this survey, the Department of Health (2006) forecasts the proportion of overweight children to 2010. For boys and girls, they estimate an increase in of 2 and 6 percentage points respectively.

There are various concerns related to childhood obesity, on of which is the child’s health. The Association of Public Health Observatories (2005, in: Audit Commission, Healthcare Commission and National Audit Office (AC/HC/NAO) 2006) predicted that, if the current upward trend in childhood obesity continues, children will have a shorter life expectancy than 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 hypertension, heart disease and type II diabetes.

Apart from strict health risks, Must & Strauss (1999) review several developmental consequences associated with childhood and adolescent obesity. They state that the overweight status of the child, especially during middle childhood and adolescence, may have lasting effects on the child’s self-esteem, body image and confidence. Several studies have also looked at the relationship between obesity and other outcomes in life. For example, Cawley (2004) and Averett & Korenman (1996) look at the link between obesity and wages and find negative effects for white females. Cawley finds that a difference in weight of roughly 65 pounds is associated with a difference in wages of about 9 percent. As obese children are likely to grow up to be obese adults, this implies that we need to be looking at a much wider area than just health when examining the consequences of childhood obesity.

Another concern of (childhood) obesity is its cost to society. In 1998, the cost of treating diseases attributable to obesity in the National Health Service (NHS) was £470 million (AC/HC/NAO 2006)[2]. Additionally, 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 between £945 million and £1.1 billion (House of Commons Health Committee

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

[2] This sum does not include the impact of being overweight (but not technically obese), which can also be a significant risk factor for these diseases and conditions.

2004). If this trend continues, the annual cost to the economy has been estimated to be £3.6 billion by 2010 (Wanless 2004).

The main underlying cause of this rise in children's overweight and obesity rates is simple; a continuous misbalance between calorie intake and calorie expenditure. A more interesting question though, is *why* this balance has changed. Various studies report possible explanations. One of the causes often put forward is television viewing (see for example Robinson 2001, Storey et al. 2003). This can increase the child's weight via several mechanisms. First, there is a displacement of physical activity. Second, metabolic rates decline when children are watching television (Klesges et al. 1993). Third, because of increasing calorie consumption whilst watching, possibly due to fast food restaurant advertising on television (Chou, Rashad & Grossman 2005). Sturm and Datar (2005) argue that the geographic variation in fruit and vegetable prices in the US partly explains the differential gain in BMI among elementary school children. Food outlet density was not found to affect children's BMI.[3]

The factor I focus on here is that of maternal employment. When a mother decides to join the labour force, there are several changes in the household that can affect children's (and parents') balance of calorie intake and expenditure. This specific relationship has only been explored in a few other studies, mainly using US data. The focus of these studies has largely been on the effect of average weekly work hours over the child's life on the child's overweight or obesity status. Using data from the UK, the contribution of this article is that it focuses on issues around the timing of employment. Specifically, it examines whether maternal employment at different ages of the child has differential effects on the child's weight later in life. It uses a rich dataset of a cohort of children that is followed up over time, allowing for an exploration of the potential endogeneity of mother's employment.

The next section motivates the choice to explore the link between maternal employment and childhood obesity and discusses the existing literature on this. Section three presents the theoretical and econometric framework. Section four describes the data and shows some descriptive statistics. The methodology used in the analysis is presented in section five and section 6 discusses the results. Section 7 presents several robustness checks on the results and section 8 concludes.

[3] Another possible cause that has been mentioned in relation with general (adult) overweight and obesity is technological change (Philipson & Posner 1999, Cutler et al. 2003). The argument is that technological innovations have made it possible for food to be mass prepared far from the point of consumption, transported to the consumer, and consumed with lower time costs of preparation and cleaning. Komlos et al. (2003) hypothesize that the increase in obesity could partly be due to an increase in the marginal rate of time preference, where time preferences refers to the rate at which people are willing to trade current benefit for future benefit. Rashad et al. (2005) examine whether changes in state-level variables (like the per capita number of restaurants, gasoline tax and cigarette tax) could have affected habits and redefined social and cultural norms. With increasing female labour force participation, eating out has become more common; higher gasoline taxes might encourage individuals to be more physically active; higher cigarette taxes might discourage people to smoke, where quitting smoking is often related to an increase in weight. Gruber and Frakes (2005) however, do not find evidence that reduced smoking leads to weight gains.

2. Motivation and Literature

2.1 Motivation

There are many speculations that hypothesize in what ways childhood weight problems and maternal employment could be related. When a mother decides to work outside the home, there are several changes within a household. First, all else equal, the mother spends less time at home. Second and directly related to this, the child will spend more time in the care of others. Third, being away from home means there is a reduction in child supervision. Finally, there is an increase in family income. All these changes in the household can affect the child's calorie intake and expenditure in different ways, which are discussed below.

2.1.1 Decrease in mother's time spent at home

When looking at the potential effects of a reduction in the time a mother spends at home, it is important to distinguish between the different types of activities that mothers engage in. Time-use studies will provide a better insight in this. 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. Gershuny and Fisher (2000) indeed show that the time British women spend cooking has always been less for employed compared to non-employed mothers.

Various studies have found a positive effect of maternal employment on expenditures on food-away-from-home (Horton & Campbell 1991, McCracken & Brandt 1987, Kinsey 1983). 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 (Diliberti et al. 2004, Rolls et al. 2004), although this portion size effect is 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 density (Rolls 2003).

Changes in the household, like those described above, might differ by mother's work intensity. In addition, if the marginal productivity in home production differs between employed and unemployed mothers, there could be heterogeneous effects of maternal employment across different groups. Some literature suggests that this marginal productivity varies with mother's education, although the direction of the effect is ambiguous. A number of studies show higher educated mothers are more productive both in the workplace and at home compared to lower educated mothers (Michael 1973, Leibowitz 1974, Gronau 1980). Other studies however, argue the opposite; that higher educated women have lower home productivity (Graham & Green 1984, Sharp et al. 2004).

2.1.2 Increase in children's time spent in care of others

When mothers spend more time away from home, their children will spend more time in care of others. This includes several 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. Educated child carers might be very knowledgeable about different food types, whereas unqualified child minders might not be. Grandparents or family friends on the other hand might be more likely to 'spoil' the child by giving it sweets and unhealthy foods.

In a report on women and employment, Martin and Roberts (1984) show that approximately half of employed women made arrangements for family members to care for their children during work hours. The other half arranged for nursery (schools), childminder, or neighbours to watch the children. A study of 171 childcare centres in the United States examines the nutritional content of meals and snacks given to the children (Briley et al. 1993). They show that the menus typically contain 100% of the Recommended Dietary Allowances (RDA) for protein and the vitamins A, ascorbic acid, B12, and riboflavin. However, the menus contained an average of 42% of the iron needed and less than 56% of the kilocalories recommended.

2.1.3 Reduction in child supervision

Without parental supervision, children might make poor nutritional choices when buying or preparing their own snacks. Klesges et al. (1991) indeed 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. On the other hand though, they also show that the proportions of children who get at least 60 minutes of physical daily activity are identical for non-working, part-time and full-time working mothers.

2.1.4 Increase in household income

When mothers join the labour force, the household income will increase, all else equal. Various studies have shown that higher SES families (where this is defined in terms of income, social class, or parental educational level) have lower levels of overweight (Jotangia et al. 2005, Lamerz et al. 2005, Department of Health 2006). 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[4].

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 possibly lead to a weight gain. This possible effect however, is likely to differ across socio-economic groups, since better-off families are more able to increase children's pocket money.

[4] Diminishing returns would mean that the marginal increase spent on higher quality foods due to an increase in income for poorer families exceeds that of richer families.

All of this suggests that, *a priori*, it is difficult to say what the likely effect is of maternal employment on the child's weight. 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.

2.2 Overview of the existing literature

There have only been 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 between 3 and 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. Using various techniques to account for unobservable heterogeneity, they find no evidence that employed mothers are systematically different from non-employed mothers. Interestingly, they find that this relationship is driven by 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, higher educated mothers have bigger percentage point increases 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 labour 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.

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 use time diaries and interview responses from the Child Development Supplement of the Panel Study of Income Dynamics. 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 maternal employment affects the child's BMI. They find that maternal employment is negatively associated with the number of meals consumed by children, which in turn is negatively related to their BMI. In addition, maternal employment significantly *de*creases 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

The economic model[5] considers households to be productive entities, where parents allocate their resources in a way that maximises the household's 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 maximised subject to a child 'weight' production function, a time and a budget constraint. The production function of child weight can be written as:

$$H_t = f(H_{t-1}, L_{pt}, R_t, \zeta, \tau) \qquad p = M, F. \tag{2}$$

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 health endowments ζ and unobserved parental characteristics τ.

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. The parents' time constraint looks like:

$$L_{pt} + E_{pt} = T, \tag{3}$$

so that total time T is divided between leisure (L_{pt}) and employment (E_{pt}). Second, higher incomes raise the ability of parents to purchase productive inputs and influence their time allocation decisions. However, contrary to Ruhm's framework, the partial derivative of income with respect to the child's weight is not necessarily positive, as increases in income could be spent on inputs that increase the 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. Total income at time t, Y_t, is limited to the hourly wage rate multiplied by the hours at work plus any other non-labour sources of income (V_{pt}):

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

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

$$H_t = f(\mathbf{E}_{pt}, \mathbf{R}_t, \zeta, \tau), \tag{5}$$

[5] This draws heavily from Ruhm (2000, 2004)

where $\mathbf{E}$ and $\mathbf{R}$ are vectors of current and lagged values, for example $\mathbf{E}_t = (E_t, E_{t-1},..., E_0)$. However, as the consumption of child-related goods and services $\mathbf{R}$ is not observed, the empirical analysis does not directly estimate (5), but instead uses the reduced form demand function of child weight

$$H_t = f(\mathbf{E}_{pt}, \mathbf{X}_t, \varepsilon), \tag{6}$$

where $\mathbf{X}$ is a vector of child and parental background characteristics and ε is a disturbance term. The employment coefficients from (6) 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 *behavioural variables* is problematic. The difficulty arises from the presence of exogenous health and developmental factors that can be known to the individual household, but are not observed by the researcher. These unobserved differences in the child's endowment could be correlated with these inputs (like maternal labour supply). The endowment heterogeneity can in turn affect the estimation of the child weight production function. This will be explained more fully below.

3.2 Econometric framework

To investigate whether there is an effect of maternal employment on child weight-for-height, the reduced-form (6) is rewritten as:

$$H_{it} = \alpha + \sum_{j=0}^{t} \beta_j E_{it-j} + \gamma \mathbf{X}_{it} + \zeta_i + \tau_i + u_{it}, \quad j = 0,...,t \tag{7}$$

where H_{it} is a binary variable indicating the sex and age adjusted overweight status for child *i* at time *t*, E_{it-j} is an indicator for whether the mother works at time *t-j*, which represents both contemporaneous employment (*j=0*) and employment in earlier periods of the child's life. The vector $\mathbf{X}_{it}$ is a set of child and family-specific control variables, which will be discussed below. ζ_i are time-invariant unobserved child-specific health endowments, τ_i are unobserved parental characteristics[6], and u_{it} is an i.i.d. error term.

[6] In the analysis, the family and child unobserved effect cannot be separated, as the data does not observe multiple children in the household. η_i will therefore be used to indicate the combined unobserved time-invariant effect $(\eta_i = \zeta_i + \tau_i)$.

The basic econometric specification can be written like:

$$H_{it} = \alpha + \sum_{j=0}^{t} \beta_j E_{it-j} + \gamma \mathbf{X}_{it} + \varepsilon_{it} \tag{8}$$

where $\varepsilon_{it} = \zeta_i + \tau_i + u_{it} = \eta_i + u_{it}$. 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, this means $Cov(E_{it-j}, \tau_i) < 0$. Assuming that the mother's ability in rearing the children is inversely correlated with the probability of the child being overweight, i.e. $Cov(H_{it}, \tau_i) < 0$, the estimate of β_j is biased upwards. On the other hand, one can argue in the opposite direction. Market and home productivity could be positively correlated. Or 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, or more interested in their children, leading to $Cov(E_{it-j}, \tau_i) > 0$. A negative relation between this unobserved effect and child's weight problems would then result in an underestimate of β_j.

Likewise, maternal employment can be correlated to the child-specific endowment ζ_i. Many studies that mention this potential problem explore the effect of maternal employment on the child's cognitive outcomes (for example Waldfogel et al. 2002, Brooks-Gunn et al. 2002, James-Burdumy 2005). They argue that the child's cognitive development can influence the mother's decision of whether to work. This indeed seems likely, although perhaps not applicable in the case of overweight children. It does not seem plausible that mothers delay or stop their employment because their child is overweight. I therefore assume that this simultaneity bias does not play a role in the child weight production function and thus that $Cov(E_{it-j}, \zeta_i) = 0$. However, if being overweight is correlated with other developmental and behavioural 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 and rich 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 and 9 March 1958. To date, there have been seven follow-up interviews of the members of this birth cohort, providing a unique source to study the effect of maternal employment at different points in time on the child's weight problems.

The NCDS data is used up to and including the year when the child is 16 years old. The sample sizes are presented in Table 1. At birth, the cohort contains 18,133 observations. This decreases to 14,514 at age 16. One problem with this survey is that there is a lot of item and unit non-response. Most studies using this data however do not go into any detail with respect to the high non-response rates (see for example Blundell et al. 2004, Feinstein et al. 1998). The analysis in this paper follows this and uses listwise deletion, i.e. excluding all observations for which one or more variables have missing values. Other ways I have attempted to deal with the missing values are described in the appropriate sections. The final model contains 3350 individuals[7]. All descriptive statistics are given using this sample.

Table 1: NCDS sample sizes

Sweep	Year	Age	N
0	1958	0	18,133
1	1965	7	16,035
2	1969	11	14,975
3	1974	16	14,514

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 Body Mass Index (BMI, kg/m^2). The definition of overweight status in children is taken from the International Obesity Taskforce (Cole et al. 2000), who introduces international cut-off points for BMI in childhood that are linked to the widely used adult cut-off points of a BMI of 25 kg/m^2 (overweight) and 30 kg/m^2 (obese). Katzmarzyk et al. (2003) suggest links between this international classification and children's health risk factors (including blood pressure, total cholesterol, low-density and high-density lipoprotein cholesterol, triglycerides and glucose).

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 or loses 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, the BMI distribution is different from any other continuous distribution. In the left and right hand tail of the BMI distribution are those who are underweight and overweight, both of which are

[7] Children who are in Local Authority care are excluded from the analysis (dropping 2-3%), as having a mother who works does not matter if the child does not live at home (in terms of the time spent with the child, the meals cooked, and so on). Furthermore, only children in 'intact' families, i.e. those with two parents/guardians are included (dropping 3-6%). The literature on maternal employment and child's cognitive outcomes shows consistent evidence of a more positive impact for children of single mothers compared to two-parent families. This suggests that the two are systematically different. The analysis only looks at two-parent families.

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, for children this is more difficult, as children 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 (see for example Whitaker et al. 1998, Rolland-Cachera et al. 1984). Numerous studies have also shown that AR is not associated with dietary intake (see for example Rolland-Cachera et al. 2001, Dorosty et al. 2000). This therefore suggests that the AR is an exogenous shock to the child, something that is likely to be 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 at which puberty starts differs for girls and boys. The onset normally is between the ages of 8-13 for girls and between ages 10-15 for boys[8]. 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 [9].

The analysis uses the child's binary overweight status at age 16, as this is more informative than that at earlier ages for the reasons above. Assuming a child's overweight status at age 16 is a good predictor for overweight in adulthood, this looks at the effect maternal employment on children's weight-for-height when they enter adulthood, which is when most changes in their body compositions have already taken place.

One aim of this study is to explore whether maternal employment at different ages of the child has differential effects on the child's weight later in life. The maternal employment indicators used in the analysis include pre-school employment, employment at age 7 and at age 11. In addition, it looks at the effect of different work-intensities by splitting employment up into 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 labour 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) [10], being prematurely born, breastfed, and non-white. Family characteristics include a dummy for maternal smoking after four months of pregnancy, the number of births to the mother, mother and father's age, and region-dummies. Finally, socio-economic status indicators include mother's education, partner's unemployment status [11], father's socio-economic class at the child's birth and

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[8] However, a recent study has found a strong association between elevated body weights at all ages and the early onset of puberty in girls (Lee et al. 2007).

[9] http://bupa.co.uk/members/asp/tng/puberty/

[10] Some studies have shown that children with low birth weight are more likely to have health problems (Stein et al. 2006, McCormick et al. 1992), and behavioural and emotional problems (Reijneveld et al. 2006).

[11] To allow for the possibility that mothers do not necessarily quit their job if the partner finds employment, the analysis also includes lagged partner's unemployment. However, excluding these does not change the results.

income[12]. These indicators are included as separate dummy variables to allow for non-monotonic relationships. The variables and their descriptives are presented in Appendix A.

The covariates in the analysis explicitly exclude the child's overweight status at earlier ages, as interest lies in obtaining estimates for the full impact of maternal employment. If maternal employment affects the child's weight, this could already have happened at an earlier age. Lagged overweight status would then pick up some 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, meaning that the coefficient on the parents' overweight status will pick up some of the effect of mother's employment. This would over-compensate for the effect of working mothers on the child's overweight status. 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* behaviour 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 was relatively stable between the ages 7 and 11 (8.8% and 8.5% respectively) and increased slightly at age 16 (9.8%).[13]

Table 2: Transition matrix of children's overweight status

		age 7		age 11		age 16		age 23	
		not	overweight	not	overweight	not	overweight	not	overweight
age 7	not	100	0	95.1	4.9	92.8	7.2	85.3	14.7
	overweight	-	100	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 transition matrix above 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 age 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

[12] In both cohorts, respondents are only asked to report their income at age 16 of the child; income at birth or at other ages is not observed. Therefore, maternal employment is possibly endogenous, as the choice to join the labour force could be affected by the partner's income.
[13] Both the mean and the variance of the BMI measure increased over time.

almost 61%, confirming that being overweight at age 16 is a relatively good predictor of the child's overweight status in adulthood.

Figure 1 presents mother's employment over time. The figure shows a slight drop between pre-school employment and that at age 7. Employment then increases sharply to about 55% for children aged 11 and 70% for those aged 16.

Figure 1: Mother's employment

Table 6 shows the transition matrix of maternal employment. To look at the state dependence of each employment category over time, work status is split up into part-time and full-time wherever possible. The table shows that mothers often change employment status. For example, of all those who were employed full-time at age 7, 36.8% are not employed at age 11, 29.8% are employed part-time and 33.3% still have full-time jobs. With increasing child's age, the likelihood of a mother being employed increases, especially for part-time work. In particular, mothers tend to start working at age 16 of the child, which was also seen in Figure 1. The data does not distinguish between part-time and full-time employment at this age.

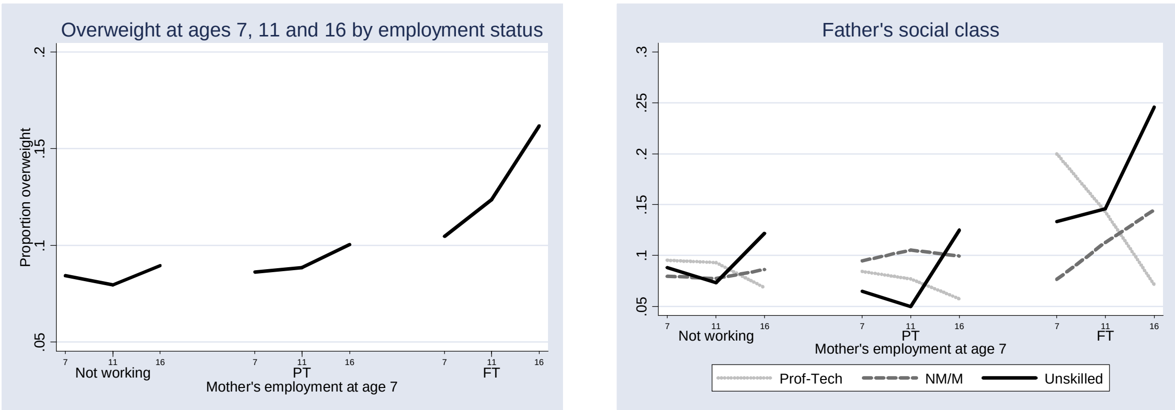
Table 3: Transition matrix of mother's employment

		Pre-school			Age 7			Age 11			Age 16	
		No	PT	FT	no	PT	FT	no	PT	FT	no	yes
Pre-school	no	100	0	0	88.8	7.4	3.8	61.0	29.5	9.6	39.1	60.9
	PT	-	100	0	50.4	44.0	5.6	25.1	53.3	21.6	16.6	83.5
	FT	-	-	100	29.4	26.4	44.2	24.2	23.6	52.2	17.8	82.2
Age 7	no	-	-	-	100	0	0	52.5	34.3	13.2	34.9	65.1
	PT	-	-	-	-	100	0	29.2	46.9	23.9	17.6	82.4
	FT	-	-	-	-	-	100	36.8	29.8	33.3	20.5	79.5
Age 11	no	-	-	-	-	-	-	100	0	0	47.6	52.4
	PT	-	-	-	-	-	-	-	100	0	15.0	85.0
	FT	-	-	-	-	-	-	-	-	100	13.0	87.0

The left panel of Figure 2 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 other employment indicators. All lines represent three observations, one for each proportion of overweight children (at age 7, 11 and 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.

Various things can be inferred from the graph. First, the proportion of overweight children has generally increased with age for all mother's employment categories. Apart from a drop in the proportion of overweight children at age 11 for non-working mothers (NCDS), the majority of 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 the full-time employed mothers, meaning they have the largest increases in the proportion of overweight children.

Figure 2: The proportion of overweight children by mother's employment status, by socio-economic class



The right panel of Figure 2 presents a similar graph, but here each line is split up into three to distinguish between three categories of socio-economic groups. The sample is divided into three groups 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 again shows several interesting things. First, full-time working mothers generally have the heaviest children in all social classes. Second, the higher social classes (the light grey dotted line) mostly show decreasing proportions of overweight over time, whereas the lower social classes show an upward trend. Children of higher social classes experience more overweight than those in the lower social classes at age 7 (the light grey dotted line lies *above* the black line), similar overweight at age 11, and lower at age 16 (the light grey dotted line lies *below* the black line). So the relationship between social class and overweight seems to switch around over time.

Graphs that distinguish between different levels of maternal employment in different income groups show very similar results as the ones found above, although slightly less pronounced. Two findings are robust over the different specifications though. First, maternal full-time employment is related to more childhood weight problems in all socio-economic groups. Second, the proportion of overweight children increases among the lower and decreases among the higher socio-economic groups. At age 16, the high socio-economic groups have fewer childhood weight problems than the lower socio-economics groups for all employment categories.

5 Methodology

The descriptive statistics above show there is a positive 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.

5.1 Exploring the timing of effects

First, the analysis adds in an extensive range of family and child background characteristics to attempt to remove as much individual heterogeneity as possible. It follows equation (8), but initially uses a cross-sectional setup. The dependent variable used is a binary indicator of whether the child is overweight at age 16.

$$H_{i,16} = \alpha + \sum_{j=0}^{t} \beta_j E_{it-j} + \gamma \mathbf{X}_i + \varepsilon_{i,16} \tag{9}$$

The model includes all employment indicators simultaneously to explore the effect of different timings of maternal work. It does not investigate the effect of an accumulation of mother's employment spells over the child's life *per se*. Rather, it explores whether early or late maternal employment is a stronger indicator for the child's overweight status. Instead of looking at the effect of each employment indicator individually, this examines the timing effects of maternal employment over and above the mother's work history. In addition, the analysis focuses on the effects of different work intensities in terms of part-time and full-time jobs.

5.2 Subgroup analyses

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, income, and the child's gender. This examines whether there are differential effects of maternal employment for children of different socio-economic backgrounds (and gender).

5.3 Exploring possible unobserved heterogeneity

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 potential endogeneity of mother's employment has to be investigated in order to look at whether the relationship that is found may be biased. This is explored using several different approaches.

1. *'Mundlak'-like specification*

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[14]

[14] Note that the model does not include all employment indicators simultaneously, but only uses one at the time.

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

the error term can be decomposed into a time-invariant (child and parental) unobserved effect η_i and an i.i.d. error term $u_{i,16}$:[15]

$$H_{i,16} = \alpha + \beta E_{it-j} + \gamma \mathbf{X}_i + \eta_i + u_{i,16}\,, \tag{11}$$

The specification used in this analysis draws on ideas of Mundlak (1978), used in random effects models[16]. In the approach used here, the assumption is made that the unobserved individual effect is a function of mother's employment statuses in previous and current periods. The analysis uses the mean work status over all ages of the child:

$$\eta_i = f\left(E_{it}\right) = \frac{1}{T}\sum_{i=1}^{T} E_{it} + v_i = \overline{E}_i + v_i \tag{12}$$

where $\overline{E}_i$ is a vector of two variables that include mean part-time and mean full-time work. This is then included as a covariate in equation (10), leading to the following regression where $e_{i,16} = v_i + u_{i,16}$

$$H_{i,16} = \alpha + \beta E_{it-j} + \gamma \mathbf{X}_i + \tau \overline{E}_i + e_{i,16}\,. \tag{13}$$

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. If (say) mothers who work many hours over child's life are indeed less interested in their children or less skilful in rearing them, including a proxy for this 'ability' will remove this unobserved effect. On the other hand, if mothers who work longer hours do so to earn extra money to be able to provide their child with anything it needs, including a measure of this 'commitment' will also remove this effect. The effect of maternal employment is then that over and above this heterogeneity.

2. Fixed effects

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 specification follows equation (11). 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[17].

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[15] where $\eta_i = \zeta_i + \tau_i$

[16] 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.

[17] For example, using a conventional fixed effects model and including two lags of maternal employment in the NCDS would imply the following construction:

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

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:

$$\begin{pmatrix} H_{i,7} \\ H_{i,11} \\ H_{i,16} \end{pmatrix} = \begin{pmatrix} \beta_7^{\ 1} E_{i,PS} + \beta_7^{\ 2} E_{i,7} \\ \beta_{11}^{\ 1} E_{i,PS} + \beta_{11}^{\ 2} E_{i,7} + \beta_{11}^{\ 3} E_{i,11} \\ \beta_{16}^{\ 1} E_{i,PS} + \beta_{16}^{\ 2} E_{i,7} + \beta_{16}^{\ 3} E_{i,11} + \beta_{16}^{\ 4} E_{i,16} \end{pmatrix} + \begin{pmatrix} \gamma \mathbf{X}_i \\ \gamma \mathbf{X}_i \\ \gamma \mathbf{X}_i \end{pmatrix} + \begin{pmatrix} \eta_i \\ \eta_i \\ \eta_i \end{pmatrix} + \begin{pmatrix} u_{i,7} \\ u_{i,11} \\ u_{i,16} \end{pmatrix}, \qquad (14)$$

where the first line refers to children aged 7, the second to age 11 and the third to 16. $E_{i,PS}$ is the indicator for pre-school maternal employment, $E_{i,7}$ refers to employment at age 7, and so on. This setup allows for (e.g.) employment at age 7 to have a differential impact on the child's overweight status at age 7 ($\beta_7^{\ 2}$), 11 ($\beta_{11}^{\ 2}$) and 16 ($\beta_{16}^{\ 2}$). The vector $\mathbf{X}_i$ consists of the before-mentioned variables and now also includes time dummies. The child's overweight status can only be affected by employment at the same or previous ages. So maternal employment at age 16 ($E_{i,16}$) can only affect children's weight at age 16 and not at 11 and 7.

Applying the within group transformation to equation (14) 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 indicators 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 however, is that not all effects of maternal employment are identified in the fixed effects specification. The analysis excludes the first line of equation (14). This means that the estimate of the effect of employment at age 7 on overweight at age 16 ($\hat{\beta}_{16}^{\ 2}$) is not observed directly. Instead, it is a subtraction of two other estimates: the effect of employment at age 7 on overweight at age 16 *minus* the effect on overweight at age 7; $\left(\beta_{16}^{\ 2} - \beta_7^{\ 2}\right)$. Similarly, the fixed effects model estimates $\left(\beta_{16}^{\ 1} - \beta_7^{\ 1}\right)$ instead of $\beta_{16}^{\ 1}$. Thus obtaining an estimate for $\beta_7^{\ 2}$ (and $\beta_7^{\ 1}$) will show whether the fixed effect estimates are over- or underestimated. If $\beta_7^{\ 2}$ 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; $\beta_{16}^{\ 2}$ (and $\beta_{16}^{\ 1}$), whilst simultaneously taking account of the time-invariant unobserved fixed effect.

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where the coefficient β_1 represents the effect of maternal employment lagged two periods, while β_2 is the effect of the one-period lag. Hence, this model assumes that the effect of mother's pre-school employment on the child's overweight status at age 11 is the same as mother's employment at age 7 on the child's overweight status at age 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. Including lags of different intensities of maternal work is therefore not possible.

To obtain an estimate for $\beta_7^{\ 2}$ and $\beta_7^{\ 1}$, 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), or all employment statuses simultaneously (as the initial model, equation (9)) to look at the robustness of the findings.

6. Results

6.1 Exploring the timing of the effects

The analysis below presents the results using equation (9). The first two columns include all different employment indicators 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. The table presents the marginal effects[18]. 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).

The results show that, 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.

Table 4: Timing of effects

Children's overweight status at age 16

	(1) Probit	**(2) LPM**	**(3) Probit**	**(4) Probit**	**(5) Probit**
Pre-school PT	-0.009	-0.008	-0.005		
	(0.012)	(0.013)	(0.011)		
Pre-school FT	0.005	0.009	0.038*		
	(0.021)	(0.022)	(0.021)		
Age 7 PT	0.011	0.009		0.008	
	(0.014)	(0.014)		(0.013)	
Age 7 FT	0.055**	0.057**		0.064***	
	(0.027)	(0.023)		(0.025)	
Age 11 PT	-0.010	-0.007			-0.01
	(0.011)	(0.012)			(0.011)
Age 11 FT	0.017	0.021			0.024
	(0.016)	(0.016)			(0.015)
Other covariates	✓	✓	✓	✓	✓
(Pseudo) R^2	0.05	0.03	0.05	0.05	0.05
N	3350	3350	3350	3350	3350

* p<0.10, ** p<0.05, *** p<0.01, standard errors in parentheses below marginal effects/coefficients

These results suggest that, when controlling for all observed employment spells of the mother, it is *early full-time* work[19] that significantly increases the child's weight. Maternal employment earlier and later in the child's life does not matter once all her previous 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. The final three columns of Table 4 look at the effect of each indicator for maternal employment individually and thus do not control for all observed employment spells. The results show significant positive effects of pre-school full-time employment and that of employment at age 7. As in the previous specification, the strongest effect is found for

[18] The marginal effects are calculated at the means of the independent variables. However, the results are the same when calculating individual marginal effects and averaging them over all individuals.

[19] I will use the term 'early' employment to refer to employment at age 7 of the child

full-time employment at age 7[20]. The following analyses will therefore focus on this early work in an attempt to explore this positive effect in more detail.

6.2 Subgroups analyses

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

Interacting maternal employment with the child's gender gives results presented in column 1 of Table 5. The findings illustrate that both boys and girls have an equal increased likelihood to be overweight when their mother is working full-time. Part-time employment does not affect a child's overweight status.

The interactions of maternal employment with the categories for father's social class at the child's birth are presented in column 2. Table A2 in Appendix A shows the number of observations in each social group. Social class is combined into 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. Early 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.

In column 3 of Table 5, 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. The number of observations in this category is quite small, as is shown in Table A2 in the appendix.

The final column presents the results of the analysis when interacting mother's employment with her years of education. The latter consists of three categories: less than or equal to 14 years of education (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.

[20] The BMI measure (and therefore also indicator for being overweight) accounts for the children's height when looking at their weight. To check whether the positive effect 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. Moreover, a person's height is sometimes referred to as an indicator for nutritional status or living standards (Floud et al, 1990), especially in the developing world. Height has been shown to be positively correlated with general health (Usher, 1996, Smith et al. 2000), education (Magnusson et al. 2006, Meyer & Selmer 1999), 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 the family's nutritional status or living standards. The results are not sensitive to any of these inclusions. Additionally, 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 child's overweight status in adulthood, we might expect to find similar results when looking at the overweight status at age 23. This is indeed what the analysis show.

Table 5: Maternal employment interacted with gender, mother's education, father's social class and income

Children's overweight status at age 16

	(1)	**(2)**	**(3)**	**(4)**
Maternal employment interacted with	Child's gender	Father's social class	Income	Mother's education
Girl - PT	0.018			
	(0.018)			
Girl - FT	0.065*			
	(0.034)			
Boy - PT	0.001			
	(0.017)			
Boy - FT	0.067*			
	(0.035)			
Low - PT		0.028	0.003	0.021
		(0.026)	(0.019)	(0.019)
Low - FT		0.127**	0.086**	0.068
		(0.055)	(0.041)	(0.041)
Med - PT		0.011	0.014	-0.004
		(0.016)	(0.020)	(0.020)
Med - FT		0.061**	0.037	0.067*
		(0.031)	(0.035)	(0.036)
High - PT		-0.027	0.008	-0.008
		(0.028)	(0.024)	(0.025)
High - FT		-0.016	0.089	0.052
		(0.052)	(0.055)	(0.054)
Other covariates	✓	✓	✓	✓
Pseudo R^2	0.04	0.05	0.05	0.05
N	3350	3350	3350	3350

* p<0.10, ** p<0.05, *** p<0.01, standard errors in parentheses below marginal effects

6.3 Exploring possible unobserved heterogeneity

The above analyses show that, after controlling for a range of child and family-specific characteristics, there is still a strong correlation between early full-time maternal employment and the probability that a child is overweight at age 16. The following analysis attempts to explore whether any unobserved heterogeneity could be driving the results.

1. 'Mundlak-like' specification

Working mothers could be systematically different from non-working mothers in ways not observable to the researcher, like their interest or ability in child rearing. It is therefore possible that it is not the employment that causes the child to become overweight. Instead, it is the mother's unobserved ability, which is correlated to their employment status that increases the child's weight. The next analysis therefore specifies this possible difference in unobserved ability as a function of all part-time and full-time employment spells over the child's life. This then directly control for the unobserved ability and the remaining effect of maternal employment is that over and above the ability-proxy.

Table 6 presents the marginal effects using a probit specification and a LPM. The findings are very similar both in sign and in magnitude. Starting with mother's employment pre-school (column 1 and 2) and that at age 11 (column 5 and 6), 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 (Table 4) were driven by unobserved heterogeneity.

Table 6: Mundlak specification

Children's overweight status at age 16

	Pre-school employment		**Employment at Age 7**		**Employment at Age 11**	
	(1) – Probit	**(2) – LPM**	**(3) – Probit**	**(4) – LPM**	**(5) – Probit**	**(6) – LPM**
PT	-0.007	-0.008	0.021	0.017	-0.011	-0.009
	(0.018)	(0.019)	(0.019)	(0.018)	(0.015)	(0.016)
FT	-0.017	-0.019	0.035	0.038	-0.013	-0.016
	(0.024)	(0.030)	(0.030)	(0.027)	(0.019)	(0.022)
Mean PT	-0.003	0.000	-0.028	-0.023	0.001	0.000
	(0.026)	(0.027)	(0.022)	(0.023)	(0.022)	(0.023)
Mean FT	0.085**	0.101***	0.038	0.050	0.080**	0.100***
	(0.035)	(0.038)	(0.029)	(0.033)	(0.032)	(0.036)
Other controls	✓	✓	✓	✓	✓	✓
(Pseudo) R^2	0.05	0.03	0.05	0.03	0.05	0.03
N	3350	3350	3350	3350	3350	3350

* p<0.10, ** p<0.05, *** p<0.01, standard errors below marginal effects/coefficients

The regression results of the child's overweight status on mother's employment at age 7 (columns 3 and 4) 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, the transition matrix of Table 2 shows 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[21].

A similar model specification is used to explore the robustness of this finding. When including a different total employment indicator that proxies the intensity of mother's work over the years, i.e. an indicator that increases with more work hours in terms of part-time or full-time employment, the results (not shown here) are similar.[22]

[21] The effect of the indicators for mean part-time and full-time employment in this analysis 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 maternal 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 also be interpreted as a type of 'persistence' or 'permanent' effect. The individual employment coefficients are then the deviations from (or variations around) this mean effect. Both interpretations however come to the same conclusions in that it is difficult to separate the employment effect from the unobserved heterogeneity / mean employment.

[22] 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 early employment. This idea has been used by Ruhm (2004), who interprets any large or significant 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 here) did not present any evidence of unobserved heterogeneity.

2. Fixed Effects

The second model that attempts to account for the unobserved individual heterogeneity makes use of the longitudinal structure of the data. Previous analyses already showed that the probit specifications and the LPM give very similar results, thus the next approach uses 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 in section 5.3, this structure does not allow for the identification of all effects of maternal employment. Specifically, it estimates the following:

$$\begin{aligned}(H_{i,11} - H_{i,7}) &= (\beta_{11}{}^1 - \beta_7{}^1)E_{i,PS} + (\beta_{11}{}^2 - \beta_7{}^2)E_{i,7} + \beta_{11}{}^3 E_{i,11} + (u_{i,11} - u_{i,7}) \\ (H_{i,16} - H_{i,7}) &= (\beta_{16}{}^1 - \beta_7{}^1)E_{i,PS} + (\beta_{16}{}^2 - \beta_7{}^2)E_{i,7} + \beta_{16}{}^3 E_{i,11} + \beta_{16}{}^4 E_{i,16} + (u_{i,16} - u_{i,7})\end{aligned}. \quad (15)$$

The coefficients that are identified are $\beta_{11}{}^3$, $\beta_{16}{}^3$, and $\beta_{16}{}^4$. The effect of employment at age 7 on overweight at age 16 ($\beta_{16}{}^2$, the coefficient of interest) is estimated as its own coefficient *minus* the coefficient of employment at age 7 on overweight at age 7; $(\beta_{16}{}^2 - \beta_7{}^2)$ (and similarly for maternal pre-school employment)[23]. Thus, by obtaining an estimate for $\beta_7{}^2$, it is possible to acquire an estimate for $\beta_{16}{}^2$ (and similarly for $\beta_{16}{}^1$). Table 7 therefore presents the estimated coefficients $\beta_7{}^2$ and $\beta_7{}^1$ based on four 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 7: 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	-0.002	0.017	0.002
	(0.012)	(0.012)	(0.020)	(0.012)
FT, pre-school	0.052**	0.042*	0.049	0.043*
	(0.025)	(0.024)	(0.037)	(0.025)
PT, age 7	-0.001	0.000	0.015	0.001
	(0.013)	(0.013)	(0.019)	(0.013)
FT, age 7	0.004	0.007	0.011	0.004
	(0.021)	(0.021)	(0.027)	(0.021)
Other covariates		✓	✓	✓
Mean employment indicators			✓	
Employment age other ages				✓

* p<0.10, ** p<0.05, *** p<0.01, standard errors in parentheses

Table 7 shows that the effect of maternal 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 $\beta_7{}^2$ is positive (negative) and thus that the coefficient of interested might be underestimated (overestimated) in the fixed effects specification. The results for maternal pre-school full-time employment

[23] Equation (15) omits the other covariates and its coefficients for simplicity.

show that the coefficient does not equal zero, but instead has an estimated effect of approximately 4 to 5 percentage points. This therefore indicates that the fixed effects specification is likely to underestimate the coefficient on pre-school employment.

The results for the fixed effect model are presented in column 1 of Table 8. 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 early full-time employment. The effect of full-time pre-school employment is negative, although equation (15) and Table 7 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, in that *early 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[24]. Column 2 presents the results of a pooled probit model.[25] The estimates in are very similar to the fixed effects results of column 1. Early full-time maternal employment still significantly increases the probability that the child is overweight and the coefficient is of similar magnitude. The discussion above argues that the coefficient on pre-school employment in column 1 is underestimated. This is indeed what the pooled probit shows. The effect is no longer negative, but now equals zero.

Finally, column 3 of Table 8 attempts to address the question of whether the data in the NCDS is missing completely at random (MCAR). Many of the included covariates are measured at the time of birth of the child and are time-invariant. Given that these are dropped in fixed effects specifications, it is possible to estimate this same model on a bigger sample. This bigger sample can include all observations even if the time-invariant variables contain missing values. It does not include 100% of the sample, as it still drops those observations for which any of the included variables are missing (like the child's overweight status), but it does increase the sample size considerably. If the two samples give similar results, the item non-response that is observed in the data is likely to be completely at random. Unfortunately, this way of addressing the missingness does not consider whether the data is missing at random (MAR), and so whether the pattern of missingness can be predicted from other variables in the data.

The results show the sample size increases from 3350 to 11978 individuals. With this, the standard errors decrease. Using this bigger sample, the coefficients have changed slightly, but most are not significantly different. The coefficient of interest is still significant, albeit marginally. The coefficient is positive and smaller than previously, although still relatively large. As in the first column however, this estimate is again not identified, because it

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

[25] A pooled probit or a random effect probit can both be used for this. The log-likelihood of the pooled probit model assumes that observations are independent across time and uses the product of the marginal distributions. Therefore, the joint distribution will be mis-specified if the within-individual observations are correlated. However, the marginal distributions for each time period are still correctly specified and the pooled probit estimates are consistent. The standard errors are robust to clustering within individuals.

estimates $\left(\beta_{16}{}^{2} - \beta_{7}{}^{2}\right)$ instead of $\beta_{16}{}^{2}$. The analysis in Table 7 cannot be performed on the larger sample, because of the inclusion of the time-invariant variables.

Table 8: Fixed and random effect specifications

Children's overweight status at age 16

		(1) Fixed Effects Smaller sample	(2) Pooled Probit	(3) Fixed Effects Larger sample
Pre-school	PT	-0.005	-0.007	0.005
		(0.015)	(0.011)	(0.010)
	FT	-0.033	0.004	-0.014
		(0.027)	(0.019)	(0.018)
Age 7	PT	0.006	0.009	-0.004
		(0.016)	(0.013)	(0.011)
	FT	0.065**	0.057**	0.035*
		(0.027)	(0.026)	(0.019)
Age 11	PT	0.002	-0.008	0.006
		(0.014)	(0.010)	(0.009)
	FT	0.028	0.018	0.015
		(0.020)	(0.015)	(0.013)
Other controls		✓	✓	✓
σ_u		0.2233		0.2651
σ_e		0.2223		0.2291
ρ		0.5023		0.5724
N_g		3350		11978
N		9449	9449	27483

* p<0.10, ** p<0.05, *** p<0.01, robust standard errors in parenthesis

Concluding, the first model specification in section 6.1 showed that early 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 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 robustness checks performed on the analyses described above. The robustness checks will focus on the effect of early full-time maternal employment. First, all analyses described above are done using OLS regressions with the child's BMI as 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 9, again showing a significant positive effect of early 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 of 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 different effects of maternal employment on the first and last quantile of the BMI distribution, suggesting that there is no differential impact of employment on the quantiles of BMI.

Table 9: Robustness checks

Children's overweight status and BMI at age 16

		(1) OLS Dependent variable: BMI	(2) Interquantile Regression .75 - .25	(3) Bivariate Probit No instruments	(4) Bivariate Ordered Probit No instruments
Age 7	Employed			0.980**	
				(0.480)	
Age 7	Part-time	0.086	-0.225		0.599
		(0.132)	(0.142)		(0.442)
Age 7	Full-time	0.434**	0.030		1.206*
		(0.210)	(0.318)		(0.660)
Marginal Effect				0.150*	
				(0.083)	
Marginal Effect PT					0.084
					(0.061)
Marginal Effect FT					0.254
					(0.177)
Other controls		✓	✓	✓	✓
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, standard errors in parentheses below marginal effects/coefficients

In addition to exploring the effect of maternal employment on the distribution of BMI, a sensitivity analysis is done 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-off 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 then run using this different cut-point 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 seem robust to the variation in cut-points; significant effects are obtained for cut-points varying between the 81st to 93rd percentiles.

Columns 3 and 4 of Table 9 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 in the employment decision equation. The specification used in column 4 allows for differential effects of part-time and full-time employment, using a bivariate ordered probit model[26]. The results presented here do not include any exclusion restrictions[27].

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. $\rho \neq 0$)[28]. 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 in the two equations.

[26] As this is not available as a standard estimation technique in many statistical programmes, I have written a programme for the log-likelihood function in Stata. An appendix detailing this is available from the author upon request. Monte Carlo simulations are performed to check whether the model is correctly specified, using 10,000 observations. The simulation results show evidence of correct specification. In both bivariate models, possible convergences to local maxima are explored by specifying different sets of initial values.

[27] As the specification is non-linear, it can be identified by its functional form and does not need any restrictions on the regressors. Thus in the absence of any additional instruments, identification strongly relies on the functional form, i.e. the normal distribution. Exclusion restrictions might therefore help in making the estimation results more robust to distributional misspecification (Monfardini & Radice, 2006). Possible instruments should be related to mother's employment, but not to the child's weight. Finding a suitable instrument proves to be difficult, since all other family variables, such as mother's wage and other family income, are also determinants of the child's health and therefore are not valid instruments (Ermisch & Francesconi 2000). Better instruments would be variables that are external to the mother to minimise the possibility of correlation with other variables (James-Burdumy 2005). Examples of instruments used by similar studies mostly include measures of local labour market and economic conditions, like regional (un)employment rates, wages of child care workers, etc. I have included several labour market indicators in other specifications, but as the data used in the analysis is from 1958 and the official labour market statistics do not date back this far, it is hard to find many such instruments. Including the instruments decreases the point estimate shown above and increases the standard errors considerably, suggesting the instruments might be weak. The results are then no longer significant. 2SLS specifications suggest the instruments are correctly excluded from the restricted model, but also that they do not have explanatory power.

[28] The probit marginal effects that do not allow for this selection have been presented in Table 4.

8. Discussion

The focus of most 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 on the child's excess body weight. 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 cohort. The results show that the timing of employment matters; it is *early* as opposed to later maternal employment that positively and significantly affects the child's overweight status.

Using subgroup analysis, Anderson et al. (2003) and Ruhm (2004) find that higher socio-economic status families are driving the positive results. Contrary to these results however, this study finds some evidence of heterogeneous effects in the opposite direction. The results indicate a social gradient in the effect of maternal employment in favour of the higher social classes.

This perhaps suggests that mothers in the higher social classes have better resources to purchase higher quality childcare and foods in their absence. Charles and Kerr (1988) consider various differences in knowledge and priorities between women in different social classes. Their study includes 200 women with at least one child of school age in 1982/83. There were significant class differences in awareness of innovations in nutritional theory, as well as in putting these into practice. They find that middle-class women were more informed and concerned about recent debates regarding the potential dangers to health in dietary practice. For example, they were most likely to mention issues such as the link between cholesterol and heart disease, cancer and food additives, and hyperactivity as a form of food allergy. In the 1980s, people also became increasingly aware of the importance attached to fibre in the diet. Higher social class women were more likely to express a desire to move towards increased consumption of fibre. They were also more likely to have made changes in their families' diets in response to information about dietary dangers or benefits. For example, the avoidance of sugar in beverages was more commonly displayed by higher class women.

During this period, most information on nutrition came from the mass media. The differential use of the media might therefore help to explain the different focus of concern. They indeed find that higher class families were more informed through the media. In addition, their results show that women in higher social classes were more likely to attach a high priority to the goodness of food, as opposed to the cost which was considered to be more important in the lower classes. Working class families had to constantly struggle financially to provide proper meals, and were often unable to do so. Charles and Kerr argue that this clarifies the seeming lack of importance attached to nutritional issues among working-class women. It is not that they are not concerned to feed their families properly; it is that they have other worries and concerns which have to take precedence.

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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 error	Mean	Std error	Mean	Std error
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 of 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 SES 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 subgroup analysis results. 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
	Medium	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
	Medium	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
	Medium	71.47	1463	21.10	432	7.43	152
	High	80.77	483	14.55	87	4.68	28