The impact of free, universal pre-school education on maternal labour supply[1]

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We estimate the impact of free, universal pre-school education for three year olds on maternal labour supply in England, exploiting discontinuities arising from date of birth eligibility cut-offs and geographical variation in the speed at which the entitlement effectively covered all children. The impacts using geographical variation in the roll-out imply that the expansion of the free entitlement, which increased the proportion of children in England who could access free part-time early education by around 50 percentage points between 2000 and 2008, led to a rise in the employment rate of mothers whose youngest child is 3 years old of around 3 percentage points, equivalent to about 12,000 more mothers in work. Given the estimated rise in the fraction of three year olds using some form of early education over the period, the implied IV estimate is that those mothers who used early education only because it was free were 25 percentage points more likely to work thanks to the free entitlement: although this is very imprecisely estimated, this is in the mid to upper range of estimates from studies from other countries, many of which look at the impact of access to longer hours of pre-school care.

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1. Introduction

Most OECD countries provide significant financial support for childcare, particularly of pre-school children, through direct provision of group childcare, subsidies to private and not-for-profit providers, or cash payments or tax breaks to parents using childcare. In 1997, the UK government announced a policy of universal, free, part-time early education for all 3 and 4 year olds in England, which became effective for 4 year olds from 2001 and for 3 year olds from 2005.[2] It is an expensive policy – costing at least an estimated £1.9 billion a year (NAO, 2012), and comprising the largest area of spending on children under five – and is part of the reason why, from lagging well behind most European countries in the early 1990s, the UK is now one of the highest spenders on pre-primary services in Europe (OECD, 2008).

Surprisingly, there has, to date, been no analysis of the impact of this provision of universal, free, part-time early education on maternal employment. This paper seeks to fill this gap. To do so, we implement two different empirical strategies exploiting two distinct sources of identification. First, we exploit the discontinuities that arise from date-of-birth cut-offs in entitlement to free part-time early education to provide causal evidence on the short-term impact of having a child eligible for free part-time early education. Second, we exploit geographical variation in the speed at which the free entitlement effectively covered all children, enabling us to look at the impact of offering a free part-time funded early education place during the time-period of the offer. In both cases, we focus on entitlement for three year olds, as these sources of variation are smaller or non-existent for four year olds. Of course, encouraging maternal employment is not the only (or even main) goal of early childhood programmes, and a related paper (Blanden et al, 2014) examines the impact of the same policy on children's test scores at ages 5, 7 and 11.

The impacts using geographical variation in the roll-out of free places imply that the expansion of the free entitlement, which increased the proportion of children in England who could access free part-time early education by around 50 percentage points between 2000 and 2008, led to a rise in the employment rate of mothers whose youngest child is 3 years old of around 3 percentage points, equivalent to about 12,000 more mothers in work. Given the estimated rise in the fraction of three year olds using some form of early education over the period, the implied IV estimate is that those mothers who used early education only because it was free were 25 percentage points more likely to work thanks to the free entitlement: this is in the mid to upper range of estimates from studies from other countries, many of which look at the impact of access to longer hours of pre-school care.

These effects in part reflect a considerable degree of deadweight, with the number of three year olds using childcare or early education rising by just 15 for every 100 children who become entitled to a free place (although Blanden et al. (2014) show that the number of hours of formal childcare being used by three year olds also rises over this

[2] It was extended to two year-olds in (roughly) the poorest fifth of families from September 2013, outside the period covered by our data.

period). Our results, then, are consistent with pre-school childcare or early education being an important facilitator of maternal employment, but show that the provision of free childcare or early education to all families is, at current levels of maternal employment, an inefficient way to increase female labour force participation in England, as these additional 12,000 women in work came at a cost of some £0.8 billion spending on additional early education places.[3]

This paper now proceeds as follows. Section 2 reviews the most closely related papers. Section 3 provides institutional background. Section 4 outlines our empirical approach. Section 5 describes our data sources. Section 6 presents the results of our date-of-birth analysis and Section 7 those of our geographical analysis. Section 8 concludes.

2. Previous literature

Estimating the link between the availability or price of formal childcare and parental labour supply poses significant technical challenges, not least because of a lack of plausible instruments to overcome selection bias (wages are observed only for those who work, and childcare prices and quantities are observed only for those who choose to use formal childcare): see Blau (2003), Blau and Currie (2006), and Brewer and Paull (2004) for further discussion of these issues. To overcome these challenges, researchers have typically used policy variation as (effectively) a way of generating instruments for the price or availability of formal childcare. This variation usually arises as a result of differential expansion of subsidised childcare or public education over time across geographical areas, or as a result of date-of-birth discontinuities in the rules determining eligibility for, or admission to, these programmes.

There exists a large and growing literature using such approaches to investigate the link between subsidised childcare and maternal labour supply. Bauernschuster and Schlotter (2013) summarise the literature to date, concluding that we should expect larger effects: a) if employment rates and childcare attendance are relatively low; b) there is significant deadweight (i.e. that new state-provided or subsidised childcare or early education crowds out private care to a significant extent; c) amongst women whose youngest child is affected by the policy.

Estimates from the existing literature are based on programmes offering different types of care in different contexts: some look at the impact of offering full-time care, others part-time care; some look at the impact of offering subsidised care, others free care. The care available is targeted at children of different ages, and the countries and periods of study differ in terms of average female labour market participation and alternative childcare provision.

Table 1 highlights some of these differences across studies. It shows that most previous studies have investigated the impact of offering free full-time childcare on maternal labour supply.[4] Most of these studies report relatively

[3] Based on hourly cost figures from NAO (2012) and the number of part-time equivalent children in the private, voluntary and independent sector in 2014 from DfE (2014).

[4] Some of these studies (e.g. Brewer and Crawford, 2010; Cascio, 2009; Fitzpatrick, 2012; Gelbach, 2002) focus on the impact of eligibility for compulsory schooling rather than optional pre-school care.

small intention-to-treat effects, even amongst mothers whose youngest child is affected. For example, Brewer and Crawford (2010), Fitzpatrick (2010), Goux and Maurin (2010) and Nollenberger and Rodriguez-Planas (2011) all estimate that lone mothers whose youngest child has access to free full-time care are around 2 percentage points more likely to be in work than lone mothers whose youngest child does not, even though these studies are based on children of different ages receiving care in countries with very different female labour market participation rates.[5] Two studies – Nollenberger and Rodriguez Planas (2011) and Cascio (2009) – also report average treatment effects on the treated for lone mothers whose youngest child is affected. Both are substantial – in the region of 30-40 percentage points – highlighting that there must be substantial deadweight associated with these policies.

The studies most comparable to our own are those estimating the impact of free part-time pre-school care on maternal labour supply. Berlinski and Galiani (2007) exploit variation in the pace of construction of buildings to house new pre-school places across Argentina, using a difference-in-differences strategy to identify the impact of access to free part-time pre-school education on maternal labour supply. The building programme started in 1993 and their study uses data from 1992 to 2000, at a time when female labour market participation stood at around 48%, but the economy had very high unemployment rates (around 14.5% over the period). They estimate a sizeable effect of access to free part-time pre-school places on take-up: for every 100 places provided, their study suggests that participation rose by 83 percentage points. The average treatment effect on the treated is smaller than in the studies of full-time care described above, however: they estimate effects of around 7-14 percentage points. This is consistent with the smaller number of hours on offer through this policy.

Berlinski et al. (2011) also look at the impact of access to free part-time pre-school education on maternal labour supply in Argentina during the 1990s, this time exploiting date of birth discontinuities in entitlement as their source of exogenous variation. They find a small effect of eligibility on pre-school attendance amongst three year olds (for whom participation is not compulsory) and a larger effect amongst four year olds (for whom it is), amounting to around a 5 percentage point difference for three year olds and a 30 percentage point difference for four year olds between children born just before and just after the academic year cut-off. For four year olds, they find sizeable (but not precisely estimated) effects of pre-school attendance on maternal labour supply, with mothers whose youngest child enters pre-school around 13 percentage points more likely to be in work and 19 percentage points more likely to work part-time, very similar to the magnitude of effects estimated by Berlinski and Galiani (2007).

The study closest to our own is Bauernschuster and Schlotter (2013), who exploit the introduction of a universal entitlement to pre-school education from the age of 3 in Germany in the 1990s, in which children were eligible to enter pre-school at the beginning of the school year following their third birthday. To do so, they make use of two identification strategies: the first exploits the differential rate of expansion of places across the country using a

[5] Cascio (2009) finds slightly larger intention-to-treat effects (of around 7 percentage points).

difference-in-differences strategy; the second exploits date-of-birth cut-offs in entitlement that were implemented in order to ration places in the early years of the policy (and never fully removed). The authors report that, in 1995, only 45% of mothers whose youngest child was aged 3-4 were in work in West Germany (in which most of the expansion of places occurred). Using data from 1991 to 2005, they estimate large and significant positive effects of entitlement to free part-time pre-school education on maternal employment: using their regression discontinuity strategy, they estimate that a 17 percentage point increase in enrolment gave rise to a 6 percentage point increase in employment, implying that a child enrolling in pre-school at age 3 increased the likelihood that their mother would be in work by around 35 percentage points. These estimates are substantially larger than those estimated by Berlinski and Galiani (2007) and Berlinski et al. (2011) and indeed very similar to those estimated by Cascio (2009) for full-time kindergarten in the United States between 1950 and 1990.

Our paper builds on these previous studies to identify the causal impact of access to free part-time early education in England. Like Bauernschuster and Schlotter (2013), we exploit two identification strategies: we take advantage of geographical variation in the speed of expansion of places following the announcement of a legal entitlement to a free part-time early education place in 1997; we also exploit date-of-birth discontinuities in eligibility after the legal entitlement came into force for three year olds (in 2004). In doing so, we provide the first evidence of the effect of this substantial public funding of pre-school education in England. We also examine the impact of the policy on a wider range of labour market outcomes than has been possible in most previous studies, looking at its effect at both the extensive and intensive margins.

3. Institutional background

In England, the academic year runs from September to August and is split into three terms, starting September, January and after Easter. Most children start full-time compulsory schooling in the September after they turn four. Since the early 2000s, local areas with responsibility for delivering education services – known as local authorities, of which there are around 150 in England – have, in addition, been obliged to offer free part-time early education for all three and four year olds. This entitlement has been in place for all four year-olds since 2001 and for all three year olds since 2004 – although there was variation in the speed with which local authorities were able to meet this requirement, especially for three year olds. (We return to this point below.)

When the policy was first introduced, the amount of free early education on offer amounted to 2.5 hours per day (12.5 hours per week) for 33 weeks a year. By 2010, hours had been extended to 15 per week across all areas of England, were available for 38 weeks a year, and could be taken with greater flexibility: in some settings, families could use the hours across three or four days, making it easier to combine with work.

Eligibility for these free places is determined by the child's birthday. Specifically, children become eligible for a free part-time early education place at the beginning of the term after they turn three. This means that children born

between 1 January and 31 March are eligible for a free place from 1 April of the year they turn three; children born between 1 April and 31 August are eligible for a free place from 1 September of the year they turn three; and children born between 1 September and 31 December are eligible from 1 January of the calendar year in which they turn four. This means that children born even one day apart (say 31 August and 1 September) are eligible for a free part-time nursery place some months apart.

The UK has a mixed market for childcare, and the operation of the free entitlement reflects this, with children allowed to take up their free entitlement in the maintained sector (i.e. in state-funded schools) or at centre-based childcare facilities run by private, voluntary or independent (PVI) organisations, including day nurseries (usually offering childcare 10 hours a day, all year round), playgroups, or, in very few instances, registered child minders. Maintained settings include a small number of nursery schools (i.e. schools providing early education exclusively) and a larger number of nursery classes attached to infant or primary schools (covering ages 3 to 7 or 3 to 11), together offering places to approximately 17% of four year olds (with a further 58% in full-time schooling) and around 38% of three year olds.[6]

Not all infant or primary schools have nursery classes and those that do have discretion over how many children to admit and when, so the majority of parents of three year olds take-up their free entitlement at a PVI setting. PVI settings wanting to provide the free entitlement not only have to satisfy the usual regulations that apply to those providing care for children under 8, such as registering with the Government regulator Ofsted (Office for Standards in Education), but also to deliver the Early Years Foundation Stage (and its predecessors), which defines a learning curriculum for the early years, as well as staff:child ratios and minimal staff qualifications. They tend to be, on average, lower quality than maintained settings, with less than 40% having at least one member of staff with a degree (Figure 6 of Gambaro et al., 2013). Most parents that use their free entitlement in the PVI sector are invoiced for the number of hours they have used, subject to a discount for the hours which are covered by the free entitlement. PVI settings are not allowed to prevent parents from using only those hours covered by the free entitlement, nor are they allowed to charge anything to parents for hours covered by the free entitlement. Parents may split their free hours between more than one provider.

Before turning more specifically to the details of our methodology, it is important to note that the free entitlement is not limited to working families and is not subject to an income test. Rather, its primary aim was to promote child development and ensure that all children are ready to start formal schooling at the age of five (HMT, 2004). In addition to the free entitlement, there were two other major programmes for supporting childcare in the UK during the period that we study. First, working families were able to claim the childcare tax credit (from 2003, the childcare element of the working tax credit), which rebated up to 80% (before 2005 and after 2012, up to 70%) of spending

[6] Source: Department for Education statistics for 2002 to 2007.

on formal childcare (subject to a generous cap) for working families who passed an income test. Second, from April 2005, employers could pay their employees childcare vouchers of up to £50 (later, £55) a week free of income tax and payroll taxes: these could only be used to pay registered, formal, child carers. In addition, many families in England use informal care from relatives and friends, as well as or instead of formal childcare (Bryson et al., 2012).

4. Estimating the impact of free, universal pre-school education on maternal labour supply

The main goal of this paper is to estimate the impact of free universal part-time early education for three year olds on maternal labour supply in England. We do so by implementing two different identification strategies. The first exploits the discontinuity in eligibility rules described in Section 3 to implement a regression discontinuity approach designed to identify the short-term impact of entitlement to a free part-time early education place. The second exploits variation in the rate of increase in the fraction of three year olds with access to a free part-time early education place across areas and over time, in order to implement a difference-in-differences style approach.

In both cases, we begin by estimating the intention-to-treat (ITT) effect of offering free part-time early education to three year olds. For the date of birth analysis, we make limited use of information on childcare use from the survey data that we use, but do not estimate a two stage least squares estimate of the impact of childcare use on maternal labour supply because of small sample sizes and imprecisely estimated effects. For the geographic analysis, we make use of aggregate data (at the LEA-year level) on both the use of early education and the availability of free places to estimate the impact of the use of early education amongst three year olds on their mother' labour supply (although this turns out to be estimated very imprecisely).

4.1. Date of birth discontinuities in entitlement to free universal part-time early education for 3 year olds

Our approach can be simply illustrated with the following example: consider children born between 1 April 2001 and 31 December 2001. Those born between 1 April 2001 and 31 August 2001 will be eligible to access a free part-time early education place in September 2004, while those born between 1 September 2001 and 31 December 2001 will only become eligible in January 2005. This means that, if we measure their mothers' labour supply between 1 September 2004 and 31 December 2004, the older children will be eligible for free part-time early education while the younger children will not. We exploit this discontinuity to examine the short-term impact of being entitled to a free part-time early education place (the treatment) on mothers' labour supply.

In this context, the effect of pre-school eligibility on maternal labour supply can be identified as the mean difference in outcomes for mothers whose children are born before and after the discontinuity point (Hahn et al., 2001). The underlying assumptions are that the relationship between the outcome and age of the child is smooth (continuous) and that mothers are not able to manipulate their children's eligibility. If this is true, then mothers with children born just before and just after the cut-off should have very similar observed and unobserved characteristics and this

would mean that, within a group of mothers with children born close to the cut-off, the allocation of treatment status is almost as good as random (Hahn et al., 2001; Lee and Lemieux, 2010).

As explained above, 1 September is one of only three eligibility cut-off dates. The other two cut-offs – 1 January and 1 April – can be exploited in a similar way to identify the impact of eligibility for a free part-time early education place among children born just before and after these cut-offs. However, we focus our analysis on the 1 September discontinuity, for three reasons. First, the length of the treatment period differs by discontinuity, because not all terms are exactly the same length. This makes it more difficult to pool discontinuities. Second, there is evidence that the likelihood of being able to access a place in the maintained sector (as opposed to the PVI sector) differs by term of birth, with those due to start nursery in September (i.e. those born in the summer term) most likely to secure a place at the time of eligibility. For example, Figure 1 shows that around 35% of August-born children enter maintained provision in the term in which they become eligible for a free part-time early education place, but only around 10% of September-born children are able to do the same. This suggests that the strength of the treatment effect may be stronger for the September discontinuity than it is for the other discontinuities. Finally, we observe information on childcare use in the survey data that we use only between October and December (and only in some years), so we can only estimate the first stage for this group of children.

To implement the regression discontinuity (RD) design described above, it is common practice to estimate a model of the difference in outcomes between mothers whose children are born within a window of width *h* around the cut-off point at a time when their treatment status differs:

$$y_i = \beta_1 Treat + g(Days_i) + \varepsilon_i \quad (1)$$

where y_i is the outcome of mother *i,* $Days_i$ is the distance in days between the child's date of birth and the cut-off date – for example, in the case of the September discontinuity, $Days_i$ equals 0 on 1 September, 1 on 31 August, -1 on 2 September, and so on – and ε_i is an error term.

Under the assumption that the time at which outcomes are observed does not vary systematically between mothers in the treatment and control groups, we can also express this in terms of the child's age (in days) at the time that the outcome was measured, A_i, as follows:

$$y_i = \beta_1 Treat + f(A_{i,t}) + \varepsilon_i \quad (2)$$

In both specifications, the dummy variable $Treat$ captures the child's eligibility for a free part-time early education place at the time of observation (during the term in which eligibility differs for those born before and after the cut-off date), taking the value 1 for children born before the discontinuity and 0 for children born afterwards. In the case of the September discontinuity, $Treat$ takes the value 1 for children born between 1 April and 31 August and

0 for children born between 1 September and 31 December. Under the assumptions that there is no systematic difference in the observable or unobservable characteristics between the mothers of children born before and after the cut-off date, the coefficient β_1 identifies the causal impact of eligibility for free part-time early education in the months immediately following the cut-off date.

To increase precision, it is also common to include demographic characteristics in the model (although it is not necessary for identification). With our data, it would be natural to augment the model above as follows:

$$y_{i,j,t,m} = \beta_1 Treat + \beta_2 X_{i,t} + \beta_3 Z_{j,t} + f(A_{i,t}) + \gamma_j + \delta_t + \rho_m + \varepsilon_{i,j,t,m} \quad (3)$$

where we have now added a subscript *j* to indicate the mother's local education authority (LEA), a subscript *t* for calendar year and a subscript *m* for calendar month. $f(A_{i,t})$ is a function of the child's age at time *t*; $X_{i,t}$ is a vector of maternal characteristics (educational qualifications, ethnicity, age, number and age of other children in the household); $Z_{j,t}$ is a vector of local labour market characteristics (unemployment rate, employment rate and average hourly wages in the mother's LEA of residence, measured in the quarter preceding the quarter of observation), γ_j is a set of LEA fixed effects, δ_t is a year fixed effect, ρ_m is a calendar month fixed effect and $\varepsilon_{i,j,t,m}$ is an error term.

This is a fairly standard semi-parametric or parametric RD design. However, we are able to exploit the longitudinal nature of the data at our disposal (explained in Section 5) to strengthen further the validity of our identification assumption. Specifically, we use up to 5 observations on each mother, starting from one year before the September of the year the child turns three, and up to three months after this date: this uses within-mother variation in labour supply over time to estimate mothers' fixed effects, and thus controls for all time-invariant differences between mothers of children born before and after the cut-off.

Equivalently, we effectively estimate the causal impact of eligibility for free part-time early education by comparing, between mothers of children born before and after the cut-off date, the change in maternal labour supply over the period in which entitlement to early education begins for the children born before the cut-off date. This weakens the assumption needed for us to be estimating a causal impact: it is harder to think of possible differences between the mothers of children born on each side of the cut-off that would not be accounted for by mother fixed effects.

With multiple observations on individual mothers, and the inclusion of mother fixed effects, our specification changes slightly to:

$$y_{i,j,t,m} = \beta_1 TreatXPost + \beta_2 Post + \beta_3 X_{i,t} + \beta_4 Z_{j,t} + f(A_{i,t}) + \alpha_i + \gamma_j + \delta_t + \rho_m + \varepsilon_{i,j,t,m} \quad (4)$$

where $y_{i,j,t,m}$ is mother *i*'s outcome in LEA *j* in year *t* and month *m*, *Post* is a dummy variable indicating whether the mother's outcome is observed after the cut-off point, $f(A_{i,t})$ is a function of the child's age at time *t*, and α_i is

an unobservable component specific to mother *i*. The age of the child relative to the discontinuity (or, equivalently, the position of the child's date of birth relative to the discontinuity) does not vary over time, and hence cannot be estimated in a fixed effects framework, but we can account for the child's age at the time of observation, and doing so ensures that the treatment effect is not contaminated by mothers' labour supply varying as children get older. Under the assumption that the time of observation does not vary systematically between the treatment and control group, this should capture an equivalent effect.

Naturally, with the inclusion of mothers' fixed effects, only the coefficients of those components of $X_{i,t}$ that vary over time will be identified. In this set up, the coefficient of interest becomes the coefficient on $Treat \times Post$, which identifies the causal effect of eligibility for free part-time early education on maternal outcomes under the assumption that there are no systematic differences in *time-varying* unobserved characteristics between mothers of children born on each side of the cut-off.

An important issue related to the implementation of this regression is the specification of the function $f(A_{i,t})$, which determines the relationship between the child's age and the mother's outcome. Age is not measured strictly continuously, so identification relies on a parametric specification of the underlying relationship between age and the outcome (Card and Lee, 2008). Misspecification of the functional form can generate a bias in the treatment effect β_1. A common practice in the RD literature has been to include polynomial functions in the regression model. This practice has the disadvantage of using data far away from the cut-off point to predict the value of Y at the cut-off point, which is unappealing since the assumption that there are no observable and unobservable differences between the mothers of children born on each side of the cut-off is less likely to hold. On the other hand, estimating the regression on a larger window around the cut-off point (a large bandwidth) increases the sample size available to estimate the regression and, as a result, can yield more precise estimates.

Finding the appropriate balance between the order of polynomial and bandwidth – and hence between precision and bias – is not a trivial issue (Lee and Lemieux, 2010). Table 2 reports means of observable characteristics of mothers with three year old children born up 14, 30, 60 and 90 days either side of the cut-off. The differences in mothers' age follow almost directly from the fact that the children in the two groups have (slightly) different mean ages. There is also some evidence that the mothers of children born after the cut-off are slightly more educated, a difference which increases and becomes significant as the window lengthens. Our conclusion from this is that a 30 day bandwidth offers sufficient sample size whilst maintaining balance across the covariates; preliminary work using optimal bandwidth techniques also corroborates this decision. Our main specification thus controls for the effect of child's age in days at the time of observation linearly and uses a 30 day window; however, we present a sensitivity analysis of our results to varying these two dimensions.

4.2. Geographical variation in roll-out of entitlement to free universal part-time early education for three year olds

The disadvantage of the identification strategy based on date-of birth discontinuities is that it enables us to estimate only the immediate impact of the offer of a free part-time early education place on maternal labour supply, as there is a difference in entitlement between children born either side of the discontinuity over only a short period. If parents did not start looking for work until their child was in nursery, or it took them a while to secure a job, then it may be that examining differences in employment only over this period will lead us to underestimate the overall impact of offering free part-time early education. We therefore implement another empirical strategy that exploits variation across local areas in England in the expansion over time of access to free places. This enables us to identify the impact of free part-time early education on the labour supply of mothers of three year olds over all the months in which they have an entitlement to free early education.

Figure 2 splits local authorities into four groups on the basis of the percentage point increase in funded places available to three year olds between 1998 and 2010 (this uses data collected by the UK Department for Education from English local education authorities, and was first used in Blanden et al. (2014)). It shows that there is substantial geographic variation in the expansion of funded places over time, with an average rise of 75 percentage points between 2000 and 2008 – the period on which we focus in this paper – amongst the quartile of local authorities experiencing the largest rises in funded places, compared to an average rise of less than 5 percentage points amongst the quartile of local authorities experiencing the smallest increases.

It is this variation over time and across areas in the availability of funded places which we exploit in our second empirical strategy, in which we effectively compare trends in the labour supply of mothers of three year olds in LEAs with rapid growth in the supply of funded places with trends in the labour supply of mothers in LEAs with slower growth in the supply of funded places. For this to provide an unbiased estimate of the intention to treat (ITT) effect of providing free part-time early education places on mothers' labour supply, the variation in the rate of expansion must be uncorrelated with any of the unobserved factors that affect mothers' labour market outcomes within a particular time period and LEA. However, it may be that the areas which experienced higher expansion in their supply of funded nursery places also experienced labour market trends that systematically differed from areas that experienced lower expansion in their supply of funded places.

To help protect against such threats, we add mothers of differently-aged children to the sample to act as a form of comparison group, in the hope that any unobserved LEA-level trends in outcomes are common to all the mothers in our sample. This means we estimate something akin to a difference-in-differences (DiD) approach:

$$y_{i,j,t,m} = \alpha_0 Treat + \alpha_1 Rate_{j,t} + \beta_1 Treat \times Rate_{j,t} + \beta_2 X_{i,t} + \beta_3 Z_{j,t} + d(A_{i,t}) + \gamma_j + \delta_t + \rho_m + \varepsilon_{i,j,t,m} \quad (5)$$

where $y_{i,j,t,m}$ is mother *i*'s outcome in LEA *j* in year *t* and month *m*, *Rate* is a measure of the fraction of 3 year olds living in a particular local education authority with access to a free part-time early education place, the dummy variable $Treat$ captures the child's eligibility for a free part-time early education place at the time of observation (based on his or her age), $X_{i,t}$ is a vector of maternal characteristics (the same as for the date of birth analysis described above), $Z_{j,t}$ is a vector of LEA-level characteristics including the local labour market characteristics described above plus LEA-specific time trends, $d(A_{i,t})$ is a function of the child's age at time *t* – in this geographic analysis, we use binary indicators for the child's month of birth - γ_j is a LEA specific effect, δ_t are year effects, ρ_m are calendar month effects and $\varepsilon_{i,j,t,m}$ is an error term.

The coefficient β_1 measures the impact of increasing the percentage of three year olds with access to a free part-time early education place from 0% to 100%. To provide a more direct comparison with the RD approach, and to understand whether the impact varies over time, we additionally estimate separately the impact during the first, second and third terms of a child's entitlement (assuming that the child continues to meet the criteria outlined above for inclusion in our sample).

We estimate (5) using mothers of three year olds (the treated group) and two year olds (the comparison group). This difference-in-differences style approach will not be valid if our suggested control group are also affected by the availability of free places. We help ensure this by omitting both those children who have turned three but not yet reached the date where they are entitled to a free early education place, and those children who are aged two when observed but who are in the term before they will become entitled to a free early education place. Additionally, when we estimate (3) on all mothers with a child aged two or three, we omit mothers with children of both ages.

We do not have information about each child's use of early education (as explained in Section 5, the questions on the use of childcare were asked of those interviewed in the autumn quarter, and not in every year, and with changes over time in the available options). But, as explained in Section 5.2, we do have LEA-level information on the number of children using some form of early education, whether paid for or not. We can therefore implement the following IV estimate of the impact of the use of early education on mothers' labour supply.

$$y_{i,j,t,m} = \alpha_1 Usage_{j,t} + \beta_2 X_{i,t} + \beta_3 Z_{j,t} + d(A_{i,t}) + \gamma_j + \delta_t + \rho_m + \varepsilon_{i,j,t,m} \quad (6a)$$

$$Usage_{j,t} = \alpha_2 Rate_{j,t} + \beta_5 Z_{j,t} + \gamma_j + \delta_t + v_{j,t} \quad (6b)$$

where $Usage_{j,t}$ is a measure of the total number of places accessed by three year olds in a particular LEA and year, both including and excluding funded places, and all other factors are as outlined above.

5. Data

5.1 Labour Force Survey

The primary source of data for our analysis is the British Labour Force Survey (LFS). Since 1992, the LFS has collected information on a quarterly basis on issues related to employment, such as hours of work and earnings, for a representative sample of households in Great Britain. The LFS has a longitudinal structure and aims to interview households for five consecutive quarters.[7] The survey collects information for every member of the household over the age of 15 and also reports the relationship between the head of household and every other member of the household (regardless of age). We use this information, combined with information on the full date of birth of all household members, to identify mothers with a three year old child during the period of interest.[8]

For our RD analysis, we focus on the period during which the free entitlement was a statutory requirement. Therefore, we define our sample as those mothers with a child that turned three between 1 January 2004 and 31 December 2013. For the reasons explained earlier, we focus on the September discontinuity, and so run our analysis on mothers of children born between 1 April at the earliest and 31 December at the latest. This means that, during the winter term (September to December) of the year in which the child turns three, mothers of summer born children serve as our treatment group and mothers of winter born children serve as our control group. We exploit the longitudinal nature of the data to look at within-mother changes in employment before and after the cut-off. That is, we define the "pre" period as (up to) the whole year before September of the year the child turns three and the "post" period as the period between 1 September and 30 November of the year the child turns three.[9]

For our geographic analysis, we focus on the period during which the availability and take-up of free places was still increasing – at different speeds in different local areas – and hence focus on mothers with two and three year old children (the former as a control group) during the period between 2000 and 2008.

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[7] As we show in Appendix Table 1, there is quite a lot of attrition between waves; but Appendix Table 2 – which uses a multinomial logit model to estimate the differences in characteristics between mothers that appear in 1, 2-4 or 5 waves – does not provide much evidence that this attrition is selective on the basis of the observable characteristics we have at our disposal.

[8] Using the variable about the relationship of each household member and the head of household, we define a mother as being a female that is either the head of household or the spouse or partner of the head of household, and where the household also contains children or step-children of the head of household. Given the information available, it is not possible to identify whether the child is the mother's biological child.

[9] We could, in principle, consider differences in labour supply in December as well. But December is an unusual month, both because a substantial proportion of it is covered by school and nursery holidays, and because it is affected by seasonal work. For these reasons, we do not consider the effect of the policy on mothers' labour supply in December.

Our outcomes of interest are measures of mother's labour supply in the week prior to the survey. In particular, we use: a binary indicator for whether the mother reports being in the labour force[10]; a binary indicator for whether the mother reports being in work; a binary indicator for whether the mother reports being self-employed; the number of hours the mother usually works per week; the number of hours the mother actually worked in the week prior to the survey; an indicator for whether the mother usually works more than 30 hours a week (full-time work); an indicator for whether the mother usually works no more than 30 hours a week (part-time work); an indicator for looking for work (equal to 1 if the mother is unemployed or inactive and looking for work, and 0 otherwise, defined across the whole sample). We also look at usual and actual hours of work among those who report being in work.

Both in our RD and DiD analyses, our regressions control for a set of characteristics about the mother, about the child and about the LEA of residence. Specifically, we control for a quadratic in the mother's age and the child's age, dummies for mother's highest educational qualification, ethnicity dummies, a dummy for whether she has a spouse living in the household, and indicators for birth order and family size.[11] We also control for the average employment rate, unemployment rate and hourly wages in the LEA of residence in the quarter preceding the quarter in which the mother's labour supply is observed (calculated from LFS data). We enter these local labour market variables with a lag in order to avoid reverse causality issues. Finally, all our regressions control for year and month effects.

In our RD analysis, we additionally include mother's fixed effects, which control for all time-invariant unobserved characteristics (therefore, ethnicity dummies drop out of our regressions). In our analysis exploiting the geographical roll-out, we also include LEA fixed effects and LEA-specific time trends. We cluster all standard errors at the LEA level in order to control for potential correlation in the residuals across LEAs.

In the Autumn quarter of selected years (2001-2003, 2005, 2007 and 2009), the LFS also collected information about childcare use for children between the ages of 3 and 14.[12] In particular, the head of household was asked about the type of formal and informal childcare provider(s) used, if any, in the week preceding the interview. Based on the information available, we construct an indicator of whether a child attends a subsidised childcare provider

[10] These variables are defined using the LFS variable on economic activity. A mother is defined as being in the labour force if she reports being employed, self-employed, other in work, shot-term sick or unemployed. A mother is defined as being in work if she reports being employed or self-employed.

[11] When we estimate effects on mothers of all three year olds, we control for the number of children aged under 2, between 3 and 4, between 5 and 9, between 10 and 15, and between 16 and 19. When we estimate effects on youngest child only, we include controls for the age distance between the youngest child and the next oldest child, and the total number of children under the age of 19 in the household. In robustness checks, we also controlled for whether the mother has any child in reception, Year 1, Year 2 and so on up to Year 8. Results were unchanged by the inclusion of these variables and we do not report tables.

[12] For 2001-2003, the data was collected from parents interviewed in September to November, but the data available to us was missing information from parents interviewed in September of these years, For 2005 to 2009, after the LFS switched its timing to match the calendar year, the data was collected from parents interviewed in October to December.

and an indicator of whether the child receives some informal childcare.[13] Because those accessing free part-time early education places in the maintained sector are restricted by term dates, we focus our attention on those answers that referred to term time.[14] Unfortunately the LFS does not ask parents about the number of hours of non-parental care provided to the child, which means that we cannot get an accurate estimate of the change in the number of hours of childcare use that occurred as a result of the policy. The fact that the information on childcare was only collected in the Autumn term, and only in select years, also means that it is not possible to use this data to estimate robustly a two-stage least squares estimate of the impact of taking up the free entitlement on mothers' labour supply.

5.2 Other data sources

For our geographical analysis, we make use of two measures: one is the fraction of three year olds with access to a free part-time early education place in each local authority; the other is the fraction of three year olds taking up an early education place (regardless of whether it is free) in each local authority. This data was originally put together and used by Blanden et al. (2014). To construct these measures, they divide the number of nursery places (funded or in total) in each LEA (as recorded in December each year, and collected by the Department for Education) by the number of three year olds in each LEA and year (based on National Population Statistics). As the information on early education places relates to those available in December each year, we merge a particular year's data to mothers whose child turns three between July of that year and June of the following year.

In our subgroup analysis for both identification strategies, we compare the impact of entitlement to a free part-time early education place on mothers living in LEAs which experienced above and below average increase in childcare participation compared to funded places over our period of interest. Following Blanden et al. (2014), we define "complier LEAs" as the 50% of LEAs which have a ratio of change in all childcare use to change in funded childcare above the median and "non-complier LEAs" as the 50% of LEAs that are below the median.

In robustness checks for our geographical analysis, we additionally make use of data at the LEA and year level recording the existence of other early years' initiatives; again, this was originally put together and used by Blanden et al. (2014). It comprises a measure of Sure Start Local Partnerships (centres that provide help and advice on child and family health, parenting, money, play sessions and, in some cases, childcare), of funding for other early years

[13] Using the variables "chatt", we define a subsidised provider of child care as being a playgroup or preschool, a day nursery or workplace crèche, a nursery school, an infant's school, a primary school or private school. Using the variables "chpeo", we define an informal provider as including the child's grand parents, non resident parent/ex-spouse/exp-partner, the child's brother or sister, other relatives, friends or neighbours, and other non-relatives.

[14] Using the variable "ctrm" of the LFS, we identify for every year the weeks in which children between the age of 3 and 14 report to be in term time and the weeks in which a majority of children in this age range report t be in half term. For our analysis of childcare use, we only select those observations that correspond to weeks in term time and not during those weeks, which we identified as half term.

initiatives, and a binary indicator for LEAs that piloted the extension of the free entitlement from 12.5 to 15 hours/week and from 33 to 38 weeks/year.

6. Results from a regression discontinuity (RD) approach

6.1 Results from main sample

As explained in Section 4, our preferred sample is mothers with three year old children who are born within 30 days of the 1 September cut-off. Estimates of equation (4) based on this sample, where child's age in days at the time of observation is controlled for linearly, are shown in Table 3, presented separately for mothers of all three year olds (top panel) and mothers whose youngest child is aged three (bottom panel).

Amongst mothers of all three year olds, those entitled to a free place see employment rates rise by 2.2 percentage points in the term after the free entitlement begins. The effect is slightly higher (2.8 percentage points) amongst mothers whose youngest children is aged three. In both cases, the additional employment is all part-time (fewer than 30 hours a week) work. There is also an impact on the fraction not in work but actively looking for work, as the impact on overall participation in the labour market is larger than that on employment alone. Our finding that the impact is greater for mothers with no younger children is in line with past studies (e.g. Berlinski et al., 2011; see also Brewer and Paull, 2006, for descriptive analysis from the UK), and we estimate our refinements to this base specification on that group only.

6.2 Heterogeneous effects by subpopulation

Different mothers face different constraints when making decisions about the use of childcare and the decision to work. To capture such variation, Table 4 estimates how the effects of access to a free part-time early education place varies by subgroup, namely by partnership status (top panel), education (middle panel) and family size (bottom panel) of Table 4. Although many of the estimates are somewhat imprecise, the point estimates suggest that the impact on employment is greater for mothers in couples than for lone mothers (who make up around a quarter of observations in our sample), and greater for those with middle to high levels of education than it is for those with lower levels of education.[15] There appears to be no variation by the number of (older) siblings in the family.

There is very little variation, though, in the impact on labour market participation (around 5 to 6 percentage points in all sub-groups considered). This may suggest that while all mothers respond in a similar way in terms of their decision to work, mothers in couples and those with middle to high levels of education are more likely to secure employment (conditional on looking) than lone mothers and mothers with lower levels of education. This is

[15] Those with middle or higher levels of education are defined as those having A-level (or equivalent) qualifications or above, while those with lower levels of education are defined as those having less than A-levels. In England, A-levels are typically taken at age 18, two years after the end of compulsory schooling. Approximately half of our sample falls into each education group.

corroborated by the effect on the proportion of out-of-work women looking for a job being higher for lone mothers and those with lower education levels than it is for mothers in couples and those with mid to higher level qualifications.

6.3. Robustness checks

Tables 5 and 6 report the results of a series of robustness checks on our main findings. Table 5 presents estimates with varying bandwidths (length of window) and changes in the way we control for the age of the child, while Table 6 runs a placebo test (described in more detail below).

Table 5 shows that a smaller bandwidth (14 days) produces point estimates for the impact on employment that are slightly larger than those with a 30 day bandwidth, but less precise: the 95% confidence interval of the impact on employment with a 14 day window is (-0.01, 0.07); for 30 days, it is (0.00, 0.06). Larger bandwidths produce point estimates for the impact on employment (and most other outcomes) that are smaller; however, for larger bandwidths, the sample of mothers do become more different from each other, particularly in terms of their levels of education. Moving to controlling for age with a quadratic has small effects on the estimated impacts. Overall, the finding of a small effect of entitlement to a free part-time early education place on the labour supply of mothers whose youngest child is aged three holds, although these estimates vary somewhat in magnitude and are not always significantly different from zero.

Although we can think of no reason other than the onset of eligibility for free early education that would differ between mothers whose youngest child turns three immediately before and immediately after the cut-off for entitlement to a free part-time early education place, it is possible that there is some other start of the school year effect being captured here. To explore this, we run a placebo test by implementing the same RD approach but, taking observations between September of the year the child turns 1 and November of the year the child turns 2. Table 6 reports these results and shows no significant differences in the likelihood of being in work between mothers whose youngest child is born in August and September.

6.4. Effect of childcare use on maternal labour supply

Table 7 presents estimates of the impact of entitlement to free part-time early education on the take-up of formal childcare (which could plausibly include settings able to offer the free entitlement) (top panel) and informal childcare (from family and friends) (bottom panel), and shows how it varies with the addition of controls.[16] Because of the relatively small numbers of families for which we observe childcare use – we have just 576 observations on

[16] Because we observe childcare information from the LFS in so few years, this analysis includes data from 2001 to 2003, before the entitlement to a free part-time early education place for three year olds became a legal entitlement (in 2004). It is possible that this may lead us to underestimate the impact of the availability of free part-time early education places on childcare use.

children of the relevant age – the results are sensitive to the choice of controls and the large standard errors mean that very few differences are statistically significantly different from zero.

Nonetheless, it provides some indicative evidence that, compared to children born just after the 1 September eligibility cut-off, those born just before (who are entitled to a free part-time early education place) are more likely to use formal childcare and less likely to use informal care. The fact that the impact on informal childcare use is bigger than the impact on formal childcare use suggests that there is some deadweight: there must be some parents who were previously using some combination of formal and informal childcare who, as a result of the introduction of the free entitlement, substitute away from informal childcare completely and start using more formal childcare.

Because our estimates of the impact of entitlement to a free part-time early education place on childcare use are relatively imprecise, we do not translate them into a formal two stage least squares estimate. We can, however, split the LEAs into two groups, defining the "compliers" as the 50% of LEAs in which the ratio of the change in all childcare use to the change in funded childcare is above the median. These complier LEAs, then, are more likely to contain mothers who would not have used early education in the absence of the free entitlement. Table 8 presents estimates of the impact of eligibility for a free part-time early education place in complier vs. non-complier LEAs.

In fact we find that, although the impact on labour market participation is slightly higher in complier than non-complier LEAs (although not significantly so), the impact on employment is greater in non-complier than complier LEAs. It is possible that this may arise because data on the availability and take-up of free early education places only covers the early part of our sample – LEAs are defined as compliers or non-compliers based on changes in the availability and take-up of free early education up to 2007, while the period covered by our RD analysis runs from 2004 to 2013 – and that once LEAs have converged towards (close to) full take-up of funded places, any remaining differences are more likely to reflect unmeasured differences in the availability or desire to work across areas. (Indeed, non-complier LEAs have higher employment rates and lower claimant counts than complier LEAs.)

7. Results from difference-in-difference approach

This section presents results from our second identification strategy, exploiting variation in the expansion of free part-time early education places across areas to identify the effect of entitlement to a free part-time early education place on mothers' labour supply. It differs from the RD analysis presented in the previous section in several ways other than the identification strategy. First, it focuses on an earlier time period, when there was greater variation in the availability and take-up of free part-time early education places: this analysis focuses on the period 2000 to 2008, while the RD analysis made use of data from 2004 to 2013. Second, the overall results in this section look at the impact amongst mothers of three year olds throughout their period of entitlement (i.e. from the term after their child's third birthday – when they first become entitled to their free place – until their fourth birthday), whereas the RD analysis focused on the first term after entitlement. (We do, however, show how the impact differs by term of

entitlement below.) Third, the RD analysis focuses just on those children born within a window around the September discontinuity, while this analysis focuses on children born in all months. For all these reasons, it is possible that the two strategies may give different results. We note below where the results corroborate or contradict those found using the RD identification strategy.

7.1 Results from main sample

Table 9 presents the results for mothers of all three year olds (top panel) and for mothers whose youngest child was aged three (bottom panel). The top panel shows that access to a free part-time early education place gives rise to a 4.1 percentage point increase in the likelihood of mothers being in work, most of which relates to part-time rather than full-time work. Because of the relatively small sample on which these estimates are based, however, none are significantly different from zero.

The bottom panel shows that, as was the case for the date of birth analysis, the effects of access to a free part-time early education place are stronger for women whose youngest child is eligible: the likelihood of being in work is 6.3 percentage points higher for women whose youngest child has access to a free part-time early education place. Again, it appears that there is a greater increase in part-time work (4.7 percentage points) than full-time work (1.6 percentage points), although the size of the standard errors means that these estimates are not significantly different from each other. In contrast to the RD results, the proportion of out-of-work women who report themselves to be looking for work is estimated to be slightly lower as a result of entitlement to a free part-time early education place.[17]

As was the case for the RD analysis, we explore all variants of the main effects focusing on mothers whose youngest child was affected by the policy. Table 10 explores the extent to which the estimated impact of the policy varies according to the term in which we observe mothers' labour market outcomes: specifically, whether we observe them in the first term after the child is entitled (similar to the date of birth RD estimates) or the second or third term after entitlement. It shows that the estimated impacts are marginally higher in terms two and three than in term one, but these differences are not significantly different from each other.

These estimates of the impact of eligibility for a free part-time early education place in the first term after entitlement are about twice as large as the RD estimates of the same effect. One plausible reason why this might be the case is the presence of anticipation effects: the RD analysis, by design, compares the labour market outcomes of mothers whose youngest child is in their first term of entitlement with those whose youngest child will become entitled in a few months' time, and may therefore underestimate the effect of entitlement to a free part-time early

[17] Details of other coefficient estimates are available in Appendix Table 3.

education place if mothers of children born before the discontinuity react to their forthcoming entitlement by starting to look for (and find) work.

Table 11 explores the potential implications of anticipation effects amongst mothers whose youngest child is affected using the geographical identification strategy. Our main specification includes, in our comparison group, observations on mothers of two year olds up until the start of the term before their third birthday. If we were to instead include observations during the term in which the child turns three as part of our control group (as we effectively do in the RD analysis), the top panel of Table 12 shows that the estimated effect of entitlement to a free part-time early education place on the likelihood of being in work would fall to around half of its original level. This suggests that mothers whose youngest children are about to become eligible for free part-time early education may already have started looking for work (and some may even have found work) in anticipation of their child becoming eligible for free part-time education, and thus that the RD estimates might understate the impact of entitlement to a free part-time early education on mothers' labour supply.

7.2 Subgroup analysis

Table 12 moves on to explore how the effects of access to a free part-time early education place vary by subgroup. In line with the RD analysis, the impact is larger for mothers with middle to higher level educational qualifications than it is for those with lower educational qualifications, although the estimated effects are, in many cases, not significantly different from each other. Here we find that lone parents are slightly more likely to be in work if they have access to a free part-time early education place for their youngest child than are mothers in couples (although these estimates are not significantly different from each other); but the effect on labour market participation is greater for mothers in couples. In line with the RD results, however, we find that, if they do move into work, lone parents are more likely to take up a full-time position (of at least 30 hours per week), while mothers in couples are more likely to move into part-time work.

7.3 Robustness checks

Table 13 presents the results of a series of robustness checks on our analysis. The top panel shows the effect of controlling for child's age in days at the time of observation (rather than their month of birth) and the effect of including additional controls for the presence of other early years' initiatives in the local area at the time of observation; neither makes very much difference to our results.

As described in Section 5, we assign information on childcare places from December each year to those children born between July of that year and June of the following year. The middle panel of Table 13 shows that allocating information on places from December of one year to those born between January and December of the following year also makes very little difference to our results (although the standard errors increase).

Finally, the bottom panel of Table 13 shows the results of a placebo test. For this, we look at the effect on mothers' labour supply of the fraction of funded places available in her LEA of residence five years into the future, using LFS data from 1993 to 2005, combined with information on funded places from 1998 to 2010. It shows that there is no difference in labour supply between mothers in areas which saw greater or smaller future expansion in places, which is reassuring, as it provides some support that our main identification assumption holds.

7.4 Effect of childcare use on maternal labour supply

Table 14 reports the first stage results of our two stage least squares estimate of the impact of accessing a free part-time early education place on mothers' labour supply. It shows the results of a regression of the fraction of three year olds taking up an early education place (whether funded or not) in the LEA on the fraction of three year olds with access to a funded place. The first column runs this analysis at the individual level, effectively weighting the LEA-level effect by the fraction of mothers with three year olds in each LEA. It suggests that, for every 100 extra funded places, 14 additional children move into early education, and hence that this policy involves a high degree of deadweight. Column 2 shows the results of a similar regression run at the LEA-level (without weights), with broadly similar results.

Table 15 presents the second stage results, showing the impact of accessing a free part-time early education place on mothers' labour supply, instrumenting the number of places taken up with the number of places funded at the LEA and year level. It shows that the effect of the policy on mothers' labour supply is much larger amongst mothers whose three year olds entered early education as a result of this policy. For example, it suggests that mothers who took up a free part-time early education place were 25 percentage points more likely to be in work, with this increase split approximately equally between full-time and part-time work. As is typical with IV estimates, however, the substantial increase in the standard errors associated with these estimates means that they are not significantly different from zero.

These estimates are corroborated by estimates of the different effects in complier and non-complier areas (shown in Table 16): in areas in which the ratio of the change in all childcare use to the change in funded childcare is above the median (complier LEAs), entitlement to a free part-time early education place has a sizeable impact on labour supply, while the effect is much smaller (and not significantly different from zero) in non-complier LEAs (who saw a relatively smaller change in the total number of places).

8. Conclusion

The policy of universal free part-time early education for all 3 and 4 year olds in England is a high-profile and expensive policy, and is part of the reason why, from lagging well behind most European countries in the early 1990s, the UK is now one of the highest spenders on pre-primary services in Europe. Although it is commonly

asserted by policy-makers that offering greater access to free formal childcare will make it easier for parents to work, there has, to date, been no evaluation of this policy on maternal labour supply. This paper fills this gap, using both the roll-out of the policy – which generated variation in the speed at which the free entitlement effectively covered all children across areas – and the steady state, exploiting date-of-birth cut-offs in entitlement.

Overall, we find that being entitled to free part-time early education does increase employment rates amongst mothers, especially for those with no younger children, and seems particularly likely to encourage mothers to move into part-time work. The two identification strategies give slightly different point estimates, with the impact of entitlement to a free part-time early education policy on employment, for example, estimated to be around twice as large using the geographic identification strategy based on the roll-out of places as the regression discontinuity analysis based on date of birth cut-offs (6.3 percentage points vs. 2.8 percentage points). We hypothesise that these differences may arise from the existence of anticipation effects amongst our control group in the RD analysis, although cannot rule out that there may be differences over time within areas that are correlated with both the increase in childcare places and the change in work patterns that are not fully captured by our rich econometric model and that may lead us to overestimate the impact of entitlement using our difference-in-differences strategy.

Our subgroup analysis focused on women whose youngest child was eligible for free part-time early education. Using both methods, we find that the effect on women with mid to higher level educational qualifications is stronger than the effect on those with lower level qualifications, especially for part-time work. There is also some evidence that the effects on part-time work are stronger for women in couples than for lone parents. We should note, however, that while the Labour Force Survey is reasonably well suited to the task of estimating the impact of free part-time early education on maternal labour supply – as it offers comprehensive data on mothers' labour market behaviour, and allows us to identify the exact age of children – it suffers slightly from relatively small sample sizes, especially for the questions on the use of childcare. Many of the effects estimates in this paper, especially for sub-groups of mothers, are thus reasonably imprecise and often not significantly different from each other.

The impacts using the geographical variation in the roll-out imply that the expansion of the free entitlement, which increased the proportion of children in England who could access the free entitlement by around 50 percentage points between 2000 and 2008, led to a rise in the employment rate of mothers whose youngest child is 3 years old of around 3 percentage points (the average employment rate of this group over the last decade was 56 percent), equivalent to about 12,000 more mothers in work. Given the estimated rise in the fraction of three year olds using some form of early education over the period, the implied IV estimate is that those mothers who used early education only because it was free were 25 percentage points more likely to work thanks to the free entitlement: although this is very imprecisely estimated, this point estimate is in the mid to upper range of estimates from studies from other countries, many of which look at the impact of access to longer hours of pre-school care.

Overall, then, the estimates in this paper are consistent with other studies in showing that childcare does help mothers of young children to work. However, the specific policy announced by the UK government in 1997 – of giving every three year old an entitlement to a free part-time early education place – had a relatively limited impact on maternal employment because many children were already living in LEAs which offered free early education, and many of the other children had parents who were willing to pay for some form of formal childcare or early education. It thus constituted a very expensive way of moving a small number of additional women into work: in 2014, a total of 378,000 part-time equivalent places were being funded in the PVI sector, at an average cost of (at least) £3.77 an hour, meaning that the additional places being provided free to parents through expansion of the free entitlement cost around £0.8 billion a year.

There is a growing consensus in the UK, from across the political spectrum, that extending the free entitlement – either by making more children eligible or by offering additional hours per week or weeks per year to children who are already eligible – will help more parents to work. It is certainly possible that extensions to the free entitlement could deliver greater benefits than those we have estimated, by making it easier for parents to combine with other forms of childcare or enabling them to access jobs with longer hours. But the extent to which such policies would transform parental labour supply – and whether universal entitlement offers good value for money – are far from clear.

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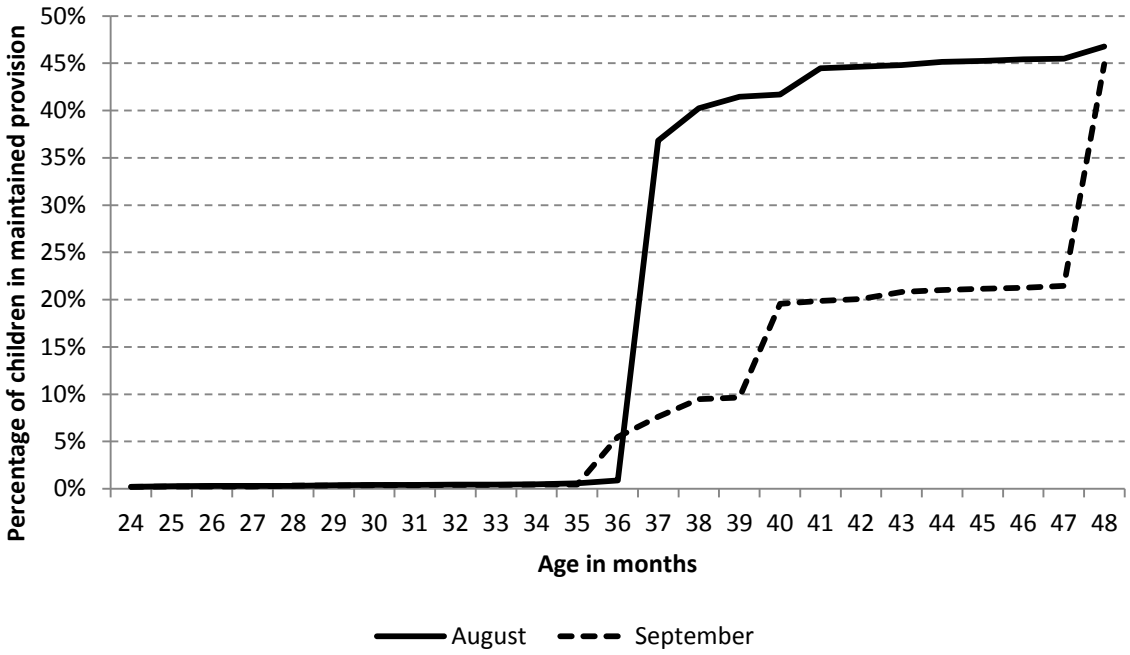
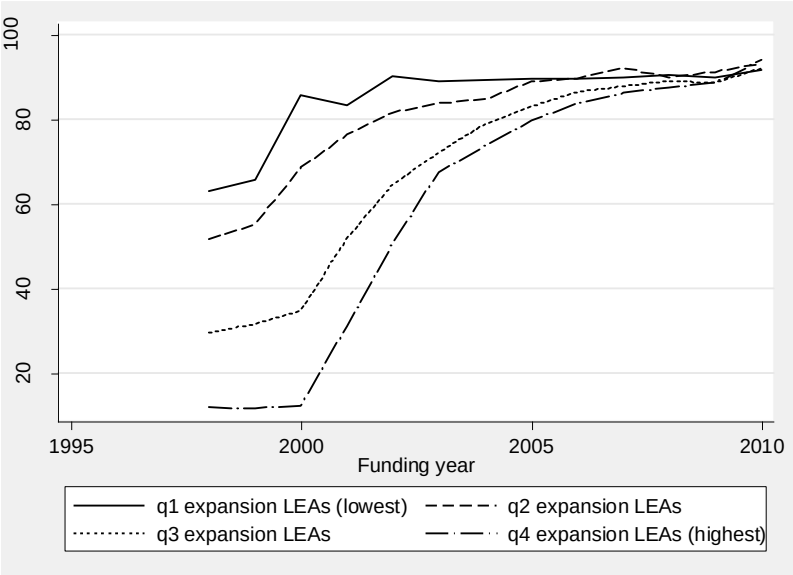
Tables and Figures

Figure 1: % of children accessing early education in the maintained sector by age and month of birth



Source: authors' calculations based on the Department for Education's National Pupil Database. Includes all children in state schools in England who started Year 1 (second year of formal schooling) between 2008 and 2012.

Figure 2: percentage of funded places on offer, by quintile group of LEAs with different rates of expansion



Source: Department for Education statistics, originally put together and used in Blanden et al. (2014).

Table 1 Summary of literature looking at the impact of different types of care on maternal labour supply

	Part-time	Full-time
Subsidised		• Baker et al. (2008); Lefebvre and Merrigan (2008) (Quebec, 1-5 yr olds) • Schlosser (2011) (Israel, 3-4 yr olds) • Havnes and Mogstad (2011) (Norway, 3-6 yr olds)
Free	• Berlinski et al. (2011) (Argentina, 3 yr olds) • Berlinski and Galiani (2007) (Argentina, 3-5 yr olds) • Bauernschuster and Schlotter (2013) (Germany, 3-6 yr olds; most focus on 3 yr olds)	• Goux and Maurin (2010) (France, 2-3 yr olds) • Nollenberger and Rodriguez-Planas (2011) (Spain, 3 yr olds) • Brewer and Crawford (2010) (England, 4 yr olds) • Fitzpatrick (2010) and Cascio and Whitmore Schanzenbach (2013) (Georgia f/t, Oklahoma f/t or p/t, 4 yr olds) • Sall (2014) (US, f/t or p/t, 4 yr olds) • Gelbach (2002), Cascio (2009) and Fitzpatrick (2012) (US, 5 yr olds)

Table 2 Comparing demographic characteristics of RD sample each side of the discontinuity, varying the window

	14 day window			30 day window			60 day window			90 day window		
	Born before cut-off	Born after cut-off	p-value of difference	Born before cut-off	Born after cut-off	p-value of difference	Born before cut-off	Born after cut-off	p-value of difference	Born before cut-off	Born after cut-off	p-value of difference
Mother's age (years)	32.1	32.2	0.58	32.01	32.33	0.93	31.97	32.47	1.00	31.96	32.51	1.00
Mother's age (years) squared	1067.5	1070.5	0.54	1059.5	1079.4	0.92	1057.3	1089.2	1.00	1057.1	1091.6	1.00
White	1.23	1.23	0.38	1.24	1.22	0.12	1.24	1.22	0.01	1.24	1.22	0.00
Mother has a partner	0.84	0.85	0.71	0.84	0.84	0.42	0.83	0.84	0.56	0.83	0.84	0.90
Number of children, aged 0-4	0.79	0.76	0.09	0.76	0.76	0.43	0.76	0.76	0.22	0.77	0.76	0.15
Number of children, aged 5-9	0.48	0.46	0.18	0.49	0.46	0.06	0.46	0.46	0.44	0.45	0.49	1.00
Number of children, aged 10-15	0.20	0.21	0.66	0.20	0.22	0.85	0.19	0.21	0.93	0.19	0.19	0.65
Number of children under 16-19	0.03	0.03	0.35	0.03	0.03	0.60	0.03	0.03	0.38	0.03	0.03	0.12
No educational qualifications	0.11	0.12	0.72	0.11	0.11	0.73	0.11	0.10	0.31	0.11	0.10	0.20
Other educational qualification	0.13	0.12	0.29	0.13	0.13	0.48	0.12	0.12	0.26	0.13	0.11	0.01
GCSE	0.26	0.26	0.58	0.25	0.26	0.75	0.25	0.27	0.95	0.25	0.27	1.00
GCE/A-level	0.17	0.20	0.90	0.19	0.19	0.61	0.20	0.20	0.72	0.19	0.20	0.95
Higher education	0.08	0.08	0.49	0.09	0.08	0.41	0.08	0.08	0.50	0.08	0.09	0.79
University degree or equivalent	0.25	0.22	0.08	0.24	0.23	0.11	0.24	0.23	0.07	0.25	0.23	0.01
Local average wages	13.41	13.56	0.82	13.54	13.64	0.75	13.56	13.61	0.69	13.57	13.64	0.83
Local unemployment rate	0.04	0.04	0.96	0.04	0.04	0.76	0.04	0.04	0.60	0.04	0.04	0.63
Local employment rate	0.79	0.79	0.15	0.79	0.79	0.40	0.79	0.79	0.23	0.79	0.79	0.44
Age of child from relevant cut-off	-7.38	6.97	1.00	-15.50	14.71	1.00	-30.56	29.69	1.00	-45.26	45.88	1.00
Sample size	718	773		1,554	1,537		3,161	3,010		4,705	4,640	

Table 3 – RDD estimates for 1 September discontinuity

	Dependent variable									
	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
Panel A - All mothers of three year old children										
Treat * Post September	0.035***	0.022**	0.004	0.030**	-0.005	0.430	0.515	-0.283	0.043	0.014
	(0.013)	(0.011)	(0.005)	(0.013)	(0.011)	(0.347)	(0.543)	(0.387)	(0.916)	(0.011)
Post September	0.480*	0.474*	0.190**	0.655**	-0.236	6.612	8.824	-6.092	5.501	-0.124
	(0.272)	(0.251)	(0.094)	(0.300)	(0.199)	(6.373)	(12.316)	(6.708)	(22.617)	(0.173)
Number of observations	8,719	8,719	8,719	8,651	8,651	8,651	8,680	4,631	4,660	8,719
R-squared	0.014	0.019	0.013	0.016	0.008	0.007	0.044	0.014	0.094	0.009
Number of individuals	3,915	3,915	3,915	3,896	3,896	3,896	3,906	2,154	2,167	3,915
Panel B - Mothers whose youngest child is three year old										
Treat * Post September	0.053***	0.028*	0.008	0.040**	-0.009	0.498	1.328**	-0.507	0.683	0.031**
	(0.017)	(0.014)	(0.006)	(0.017)	(0.014)	(0.447)	(0.598)	(0.451)	(1.012)	(0.014)
Post September	0.671*	0.646**	0.225	0.823**	-0.225	9.116	17.375	-9.300	24.716	-0.161
	(0.356)	(0.325)	(0.142)	(0.387)	(0.230)	(7.902)	(13.405)	(7.928)	(24.485)	(0.226)
Number of observations	6,791	6,791	6,791	6,739	6,739	6,739	6,755	3,755	3,771	6,791
R-squared	0.019	0.024	0.018	0.018	0.008	0.011	0.029	0.017	0.056	0.012
Number of individuals	3,093	3,093	3,093	3,080	3,080	3,080	3,086	1,772	1,779	3,093

Notes: The table shows RDD estimates of becoming eligible to a free childcare place on various maternal outcomes in the three months following the child's eligibility to a free nursery place. The variable "Treat" is an indicator that takes the value 1 if the child is born before the eligibility cut-off date and 0 otherwise. That is, with the 30 day bandwith used in the specification reported in this table, the variable "Treat" takes the value 1 if the child is born between August 1 and August 31 and 0 if the chid is born between September 1 and September 30. The variable "Post September" is a dummy that takes the value 1 for outcomes observed between September and November of the year the child turns 3 and the value 0 for outcomes observed in the 12 months before September of the year the child turns 3. The sample includes years between 2004 and 2013. Control variables includes the child's age, a dummy for whether the mother lives with a partner, dummies for mother's highest educational qualification, the number of children under 9 year olds in the household, between 10 and 15, and between 16 and 19. The regressions also have mother fixed effects, year and month dummies, and three variables measuring the average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceeding the quarter of observation. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 4 - Subgroup analysis for RDD estimates for mothers whose youngest child is three years old

	Dependent variable									
Subgroups:	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
Lone mothers	0.060*	0.013	0.003	0.017	-0.008	-0.104	0.997	-0.444	1.456	0.044
	(0.032)	(0.030)	(0.004)	(0.030)	(0.013)	(0.586)	(0.849)	(0.721)	(2.125)	(0.036)
N	1,630	1,630	1,630	1,615	1,615	1,615	1,622	647	654	1,630
Partnered mothers	0.054***	0.032*	0.011	0.044**	-0.007	0.727	1.272*	-0.279	0.475	0.033**
	(0.019)	(0.018)	(0.008)	(0.021)	(0.019)	(0.608)	(0.761)	(0.527)	(1.158)	(0.015)
N	5,161	5,161	5,161	5,124	5,124	5,124	5,133	3,108	3,117	5,161
Mothers with less than A-levels	0.056**	0.006	0.011*	0.004	0.004	0.230	1.697**	-0.468	3.126*	0.069***
	(0.026)	(0.021)	(0.007)	(0.022)	(0.015)	(0.511)	(0.719)	(0.592)	(1.652)	(0.025)
N	3,266	3,266	3,266	3,248	3,248	3,248	3,247	1,314	1,313	3,266
Mothers with at least A-levels	0.057***	0.054***	0.009	0.072***	-0.014	0.923	1.109	-0.546	-0.610	-0.004
	(0.019)	(0.019)	(0.010)	(0.027)	(0.023)	(0.617)	(1.015)	(0.562)	(1.352)	(0.015)
N	3,525	3,525	3,525	3,491	3,491	3,491	3,508	2,441	2,458	3,525
Mothers with at most one other child	0.052***	0.027*	0.009	0.047**	-0.016	0.367	1.285*	-0.495	0.654	0.035**
	(0.019)	(0.016)	(0.006)	(0.020)	(0.016)	(0.463)	(0.728)	(0.485)	(1.100)	(0.016)
N	5,267	5,267	5,267	5,226	5,226	5,226	5,242	3,189	3,205	5,267
Mothers with at least two other children	0.050	0.029	-0.002	0.015	0.012	0.977	1.322	-0.415	1.027	0.024
	(0.034)	(0.030)	(0.014)	(0.026)	(0.023)	(0.976)	(1.134)	(1.091)	(2.914)	(0.026)
N	1,524	1,524	1,524	1,513	1,513	1,513	1,513	566	566	1,524

Notes: See note to previous table

Table 5 - Robustness of RDD estimates to varying bandwidth and controlling for age linearly or quadratically

		Dependent variable									
		Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
Bdwith	**Function of age**										
	Linearly	0.043*	0.030	0.010	0.037	0.003	1.099*	2.009**	-0.097	0.987	0.016
		(0.022)	(0.022)	(0.009)	(0.024)	(0.019)	(0.654)	(0.968)	(0.557)	(1.470)	(0.018)
14 days	Quadratically	0.042*	0.034	0.011	0.037	0.007	1.140*	2.128**	-0.150	0.998	0.011
		(0.023)	(0.023)	(0.009)	(0.023)	(0.019)	(0.676)	(0.959)	(0.559)	(1.448)	(0.017)
	N	3507	3507	3507	3491	3491	3491	3489	1968	1966	3507
	Linearly	0.053***	0.028*	0.008	0.040**	-0.009	0.498	1.328**	-0.507	0.683	0.031**
		(0.017)	(0.014)	(0.006)	(0.017)	(0.014)	(0.447)	(0.598)	(0.451)	(1.012)	(0.014)
30 days	Quadratically	0.045**	0.021	0.008	0.036**	-0.010	0.341	1.234**	-0.740	0.408	0.032**
		(0.018)	(0.015)	(0.006)	(0.016)	(0.015)	(0.485)	(0.603)	(0.468)	(1.017)	(0.014)
	N	6791	6791	6791	6739	6739	6739	6755	3755	3771	6791
	Linearly	0.032**	0.017	0.009	0.020	-0.001	0.227	0.744	-0.390	0.413	0.015
		(0.014)	(0.012)	(0.006)	(0.013)	(0.011)	(0.380)	(0.508)	(0.340)	(0.796)	(0.010)
45 days	Quadratically	0.022	0.008	0.006	0.012	-0.001	0.057	0.579	-0.567	0.104	0.016
		(0.015)	(0.012)	(0.005)	(0.013)	(0.012)	(0.403)	(0.528)	(0.356)	(0.851)	(0.011)
	N	10343	10343	10343	10260	10260	10260	10294	5709	5743	10343
	Linearly	0.030**	0.018*	0.005	0.024**	-0.004	0.356	0.832*	-0.265	0.530	0.006
		(0.012)	(0.010)	(0.005)	(0.011)	(0.009)	(0.349)	(0.459)	(0.314)	(0.623)	(0.009)
60 days	Quadratically	0.018	0.009	0.001	0.012	-0.003	0.213	0.761	-0.233	0.566	0.005
		(0.013)	(0.011)	(0.004)	(0.012)	(0.010)	(0.350)	(0.478)	(0.301)	(0.672)	(0.009)
	N	13663	13663	13663	13562	13562	13562	13602	7626	7666	13663
	Linearly	0.021*	0.011	0.003	0.020*	-0.009	0.190	0.805**	-0.122	1.039**	0.003
		(0.011)	(0.010)	(0.004)	(0.011)	(0.009)	(0.303)	(0.391)	(0.268)	(0.526)	(0.008)
75 days	Quadratically	0.010	0.003	-0.000	0.009	-0.006	0.118	0.903**	-0.167	1.160*	0.001
		(0.012)	(0.010)	(0.004)	(0.011)	(0.010)	(0.315)	(0.443)	(0.266)	(0.616)	(0.009)
	N	16980	16980	16980	16836	16836	16836	16903	9451	9518	16980

90 days	Linearly	0.022**	0.012	0.005	0.015	-0.003	0.206	0.627*	-0.101	0.694	0.006
		(0.010)	(0.009)	(0.004)	(0.009)	(0.007)	(0.257)	(0.372)	(0.236)	(0.505)	(0.007)
	Quadratically	0.019*	0.008	0.001	0.012	-0.006	0.227	0.875**	0.010	1.078*	0.005
		(0.011)	(0.009)	(0.004)	(0.010)	(0.008)	(0.269)	(0.425)	(0.243)	(0.608)	(0.008)
	N	20581	20581	20581	20415	20415	20415	20488	11465	11538	20581
120 days	Linearly	0.022***	0.011	0.006	0.015*	-0.003	0.222	0.592*	-0.031	0.649	0.008
		(0.009)	(0.007)	(0.004)	(0.009)	(0.006)	(0.211)	(0.318)	(0.204)	(0.435)	(0.006)
	Quadratically	0.013	0.004	0.004	0.007	-0.003	0.083	0.674*	-0.056	0.944*	0.004
		(0.010)	(0.008)	(0.004)	(0.009)	(0.007)	(0.235)	(0.361)	(0.228)	(0.540)	(0.007)
	N	26977	26977	26977	26757	26757	26757	26855	15043	15141	26977

Notes: The table shows difference-in-difference estimates of the effect of an increase from 0 to 1 in the fraction of 3 year olds with a funded place in the LEA of residence, using mothers of two year olds as control group. The variable "Treat" takes the value 1 if the mother is observed between the beginning of the term after which the child turns 3 and the child's fourth birthday; it takes the value 0 if the mother is observed between the child's second birthday and the beginning of the term before the child turns 3. The sample includes years between 2000 and 2010. Control variables includes the mother's age and age squared, a dummy for whether the mother lives with a partner, dummies for mother's ethnicity, dummies for mother's highest educational qualification, the age distance of the youngest child to their oldest sibling, the total number of children under 19 year olds in the household, and dummies for the child's month of birth. The regressions also have LEA fixed effects, LEA-specific time trends, year and month fixed effects, average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceeding the quarter of observation. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 6 - Placebo test: RDD estimates for mothers whose youngest child is two

	Dependent variable									
	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
Treat * Post September	-0.020	-0.004	0.002	-0.020	0.015	-0.154	0.191	0.030	0.600	-0.023*
	(0.016)	(0.013)	(0.007)	(0.019)	(0.014)	(0.321)	(0.551)	(0.380)	(1.002)	(0.012)
Post September	0.671*	0.646**	0.225	0.823**	-0.225	9.116	17.375	-9.300	24.716	-0.161
	(0.356)	(0.325)	(0.142)	(0.387)	(0.230)	(7.902)	(13.405)	(7.928)	(24.485)	(0.226)
Number of observations	7,925	7,925	7,925	7,852	7,852	7,852	7,890	4,217	4,255	7,925
R-squared	0.019	0.020	0.010	0.014	0.015	0.018	0.016	0.021	0.029	0.007
Number of individuals	3,625	3,625	3,625	3,606	3,606	3,606	3,618	1,985	1,996	3,625

Notes: The variable "Treat" is an indicator that takes the value 1 if the child is born before the eligibility cut-off date and 0 otherwise. That is, with the 30 day bandwith used in the specification reported in this table, the variable "Treat" takes the value 1 if the child is born between August 1 and August 31 and 0 if the chid is born between September 1 and September 30. The variable "Post September" is a dummy that takes the value 1 for outcomes observed between September and November of the year the child turns 2 and the value 0 for outcomes observed in the 12 months before September of the year the child turns 2. The sample includes years between 2004 and 2013. Control variables includes the child's age, a dummy for whether the mother lives with a partner, dummies for mother's highest educational qualification, the number of children under 9 year olds in the household, between 10 and 15, and between 16 and 19. The regressions also have mother fixed effects, year and month dummies, and three variables measuring the average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceeding the quarter of observation. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 7 - RDD first stage estimates: 30 day window

	Specification								
	No covariates	Only child's age in days (entered linearly)		All covariates					All covariates except LEA fixed effects
				Child's age in days (linear)	Child's age in days (linear)*treat	Child's age in days (quadratic)	Child's age in days (quadratic) *treat		Child's age in days (linear)
Formal care									
Treat	0.045	0.099	0.112	0.048	0.026	0.050	0.050	0.022	0.096
	(0.039)	(0.083)	(0.081)	(0.107)	(0.105)	(0.106)	(0.106)	(0.136)	(0.078)
Treat * holiday			-0.036		0.108				0.002
			(0.109)		(0.126)				(0.108)
Number of observations	576	576	576	575	575	575	575	575	575
R-squared	0.003	0.004	0.034	0.409	0.410	0.409	0.409	0.410	0.155
Informal care									
Treat	-0.133***	-0.041	-0.051	-0.092	-0.104	-0.094	-0.092	-0.091	-0.046
	(0.038)	(0.071)	(0.075)	(0.093)	(0.103)	(0.094)	(0.094)	(0.191)	(0.076)
Treat * holiday			0.083		0.057				0.101
			(0.110)		(0.147)				(0.106)
Number of observations	576	576	576	575	575	575	575	575	575
R-squared	0.018	0.021	0.039	0.356	0.356	0.356	0.356	0.360	0.135

Notes: the variable "Treat" is an indicator that takes the value 1 if the child is born before the eligibility cut-off date and 0 otherwise. That is, with the 30 day bandwith used in the specification reported in this table, the variable "Treat" takes the value 1 if the child is born between August 1 and August 31 and 0 if the chid is born between September 1 and September 30. The sample includes years 2005, 2007 and 2009. The columns differ in terms of the control variables included in the model. Child's age is entered either linearly or quadratically, either with or without an interaction with the treatment dummy. The middle four columns include additional controls for whether the mother lives with a partner, dummies for mother's highest educational qualification, the number of children under 9 year olds in the household, between 10 and 15, and between 16 and 19. The regressions also have LEA fixed effects, year and month dummies, and three variables measuring the average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceding the quarter of observation. The final column includes all of these controls except LEA fixed effects. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 8 - RDD estimates for mothers whose youngest child is three years old, for complier vs. non-complier LEAs

	Dependent variable									
	Participates in the labour force	Employed	Self-employed	Works < 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
Mothers in non-complier LEAs	0.060*	0.049*	0.021**	0.039	0.005	1.490	1.048	-0.265	-1.116	0.021
	(0.030)	(0.028)	(0.010)	(0.035)	(0.026)	(0.968)	(1.200)	(0.760)	(1.616)	(0.023)
N	2,414	2,414	2,414	2,395	2,395	2,395	2,395	1,340	1,340	2,414
Mothers in complier LEAs	0.074**	0.010	-0.010	0.035	-0.011	-0.210	2.822*	-0.945	3.681	0.072***
	(0.035)	(0.032)	(0.007)	(0.039)	(0.030)	(0.719)	(1.478)	(1.130)	(2.530)	(0.027)
N	1,689	1,689	1,689	1,675	1,675	1,675	1,684	910	919	1,689

Notes: The table shows RDD estimates of becoming eligible to a free childcare place on various maternal outcomes in the three months following the child's eligibility to a free nursery place. The variable "Treat" is an indicator that takes the value 1 if the child is born before the eligibility cut-off date and 0 otherwise. That is, with the 30 day bandwith used in the specification reported in this table, the variable "Treat" takes the value 1 if the child is born between August 1 and August 31 and 0 if the chid is born between September 1 and September 30. The variable "Post September" is a dummy that takes the value 1 for outcomes observed between September and November of the year the child turns 3 and the value 0 for outcomes observed in the 12 months before September of the year the child turns 3. The sample includes years between 2004 and 2013. Control variables includes the child's age, a dummy for whether the mother lives with a partner, dummies for mother's highest educational qualification, the number of children under 9 year olds in the household, between 10 and 15, and between 16 and 19. The regressions also have mother fixed effects, year and month dummies, and three variables measuring the average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceeding the quarter of observation. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 9 - Difference-in-difference estimates. Sample: 2000 to 2008

	Dependent variable									
	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
Panel A - All mothers of three year old children										
3yr olds w/ funded place * Treat	0.027	0.041	0.014	0.039	0.002	0.724	1.055	-0.630	-0.030	-0.023*
	(0.028)	(0.028)	(0.016)	(0.037)	(0.025)	(0.908)	(0.899)	(1.291)	(1.434)	(0.012)
3yr olds w/ funded place	-0.055	-0.056	-0.021	-0.043	-0.016	-1.521	-2.200	-0.116	-1.788	0.011
	(0.037)	(0.039)	(0.020)	(0.043)	(0.035)	(1.422)	(1.371)	(1.849)	(2.029)	(0.016)
Treat	0.006	-0.008	-0.015	-0.023	0.014	0.070	0.329	0.830	1.488	0.020**
	(0.022)	(0.022)	(0.013)	(0.030)	(0.021)	(0.769)	(0.744)	(1.106)	(1.201)	(0.010)
N	*51,315*	*51,315*	*51,315*	*50,968*	*50,968*	*50,968*	*51,127*	*26,968*	*27,127*	*51,315*
R-squared	*0.185*	*0.198*	*0.034*	*0.105*	*0.088*	*0.178*	*0.145*	*0.109*	*0.102*	*0.024*
Panel B - Mothers whose youngest child is three year old										
3yr olds w/ funded place * Treat	0.048	0.063**	0.014	0.047	0.016	1.595	0.881	0.083	-0.963	-0.025*
	(0.031)	(0.031)	(0.016)	(0.036)	(0.028)	(0.975)	(0.911)	(1.270)	(1.307)	(0.013)
3yr olds w/ funded place	-0.063	-0.066	-0.025	-0.031	-0.037	-2.322	-1.515	-0.993	0.357	0.009
	(0.040)	(0.041)	(0.020)	(0.043)	(0.037)	(1.479)	(1.447)	(1.746)	(1.952)	(0.016)
Treat	-0.000	-0.015	-0.016	-0.028	0.013	-0.108	0.557	0.754	1.876*	0.020**
	(0.025)	(0.025)	(0.014)	(0.029)	(0.023)	(0.815)	(0.749)	(1.059)	(1.084)	(0.010)
N	*39,907*	*39,907*	*39,907*	*39,629*	*39,629*	*39,629*	*39,744*	*22,008*	*22,123*	*39,907*
R-squared	*0.174*	*0.190*	*0.037*	*0.102*	*0.091*	*0.171*	*0.136*	*0.109*	*0.076*	*0.030*

Notes: The table shows difference-in-difference estimates of the effect of an increase from 0 to 1 in the fraction of 3 year olds with a funded place in the LEA of residence, using mothers of two year olds as control group. In the top panel, we drop mothers who are observed to be in both the treatment and control group in the same quarter (i.e. who have both a two and a three year old child). The variable "Treat" takes the value 1 if the mother is observed between the start of the term after which the child turns 3 and the child's fourth birthday; it takes the value 0 if the mother is observed between the child's second birthday and the beginning of the term before the child turns 3. Control variables includes the mother's age and age squared, a dummy for whether the mother lives with a partner, dummies for mother's ethnicity, dummies for mother's highest educational qualification, the number of younger siblings, the age distance of the child to the next sibling, the total number of children under 19 year olds in the household, and dummies for the child's month of birth. The regressions also have LEA fixed effects, LEA-specific time trends, year and month fixed effects, average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceding the quarter of observation. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 10 - RDD estimates for mothers whose youngest child is three, allowing the treatment effect to vary across terms of entitlement

	Dependent variable									
	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
3yr olds w/ funded place * Treat	0.046	0.058*	0.016	0.046	0.011	1.385	0.612	-0.142	-1.331	-0.024*
	(0.031)	(0.031)	(0.016)	(0.037)	(0.028)	(0.969)	(0.914)	(1.273)	(1.320)	(0.013)
3yr olds w/ funded place * Treat	0.008	0.008	-0.005	-0.002	0.010*	0.420**	0.463*	0.497**	0.648*	-0.000
* 2nd term of entitlement	(0.007)	(0.007)	(0.003)	(0.007)	(0.005)	(0.206)	(0.245)	(0.212)	(0.338)	(0.004)
3yr olds w/ funded place * Treat	-0.000	0.009	-0.003	0.006	0.003	0.272	0.466	0.218	0.630	-0.002
* 3rd term of entitlement	(0.010)	(0.010)	(0.005)	(0.010)	(0.008)	(0.301)	(0.340)	(0.314)	(0.440)	(0.005)
3yr olds w/ funded place	-0.063	-0.065	-0.025	-0.030	-0.037	-2.267	-1.423	-0.953	0.465	0.009
	(0.040)	(0.041)	(0.020)	(0.043)	(0.037)	(1.473)	(1.445)	(1.754)	(1.957)	(0.016)
Treat	-0.001	-0.015	-0.016	-0.027	0.012	-0.101	0.576	0.755	1.897*	0.020**
	(0.025)	(0.025)	(0.014)	(0.029)	(0.023)	(0.813)	(0.750)	(1.060)	(1.089)	(0.010)
Number of observations	39,907	39,907	39,907	39,629	39,629	39,629	39,744	22,008	22,123	39,907
R-squared	0.174	0.190	0.037	0.102	0.091	0.171	0.136	0.109	0.076	0.030

Notes: The table shows difference-in-difference estimates of the effect of an increase from 0 to 1 in the fraction of 3 year olds with a funded place in the LEA of residence, using mothers of two year olds as control group. The variable "Treat" takes the value 1 if the mother is observed between the beginning of the term after which the child turns 3 and the child's fourth birthday; it takes the value 0 if the mother is observed between the child's second birthday and the beginning of the term before the child turns 3. Control variables includes the mother's age and age squared, a dummy for whether the mother lives with a partner, dummies for mother's ethnicity, dummies for mother's highest educational qualification, the number of younger siblings, the age distance of the child to the next sibling, the total number of children under 19 year olds in the household, and dummies for the child's month of birth. The regressions also have LEA fixed effects, LEA-specific time trends, year and month fixed effects, average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceeding the quarter of observation. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 11 - Anticipation effects. Difference-in-difference estimates. Sample: 2000 to 2008

	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours/wk	Usual weekly hours	Actual wkly hours	Usual weekly hours (if empld)	Actual wkly hours (if employed)	Looking for work (if inactive)
Panel A - Including the term before the child turns 3 in the control group										
3yr olds w/ funded place * Treat	0.023	0.036	0.003	0.041	-0.004	0.811	0.611	-0.035	-0.306	-0.015
	(0.026)	(0.027)	(0.014)	(0.030)	(0.021)	(0.788)	(0.752)	(1.024)	(1.066)	(0.010)
3yr olds w/ funded place	-0.038	-0.056*	-0.015	-0.049	-0.010	-1.833*	-1.531	-0.898	-0.526	-0.005
	(0.032)	(0.032)	(0.015)	(0.031)	(0.025)	(1.039)	(1.035)	(1.235)	(1.405)	(0.011)
Treat	0.011	0.007	-0.006	-0.026	0.032*	0.606	0.781	0.969	1.358	0.012
	(0.020)	(0.022)	(0.012)	(0.023)	(0.017)	(0.657)	(0.593)	(0.825)	(0.820)	(0.008)
N	*55,627*	*59,029*	*59,029*	*58,637*	*58,637*	*58,637*	*58,800*	*32,142*	*32,305*	*59,029*
Panel B - Including the term before the child turns 3 in the control group and allowing a different effect for summer borns observed in the Autumn										
3yr olds w/ funded place * Treat *Summer born observed in Autumn	0.002	-0.002	0.006	-0.009	0.007	0.136	-0.103	0.074	-0.302	0.000
	(0.011)	(0.012)	(0.006)	(0.011)	(0.008)	(0.344)	(0.353)	(0.331)	(0.453)	(0.005)
3yr olds w/ funded place * Treat	0.023	0.031	0.009	0.031	-0.002	0.793	0.779	0.182	0.220	-0.017
	(0.026)	(0.027)	(0.014)	(0.030)	(0.020)	(0.798)	(0.703)	(1.082)	(1.022)	(0.011)
3yr olds w/ funded place	-0.038	-0.028	-0.014	-0.001	-0.027	-1.502	-1.727	-1.514	-1.921	-0.005
	(0.032)	(0.032)	(0.016)	(0.032)	(0.031)	(1.224)	(1.227)	(1.514)	(1.729)	(0.012)
Treat	0.011	0.002	-0.013	-0.016	0.019	0.230	0.362	0.436	0.693	0.014*
	(0.020)	(0.021)	(0.011)	(0.023)	(0.016)	(0.634)	(0.546)	(0.864)	(0.802)	(0.008)
N	*55,627*	*55,627*	*55,627*	*55,263*	*55,263*	*55,263*	*55,410*	*30,579*	*30,726*	*55,627*
Panel C - Excluding the term before the child turns 3 in the control group and allowing a different effect for summer borns observed in the Autumn										
3yr olds w/ funded place * Treat *Summer born observed in Autumn	0.001	-0.006	0.007	-0.008	0.002	-0.043	-0.217	-0.132	-0.397	0.003
	(0.011)	(0.012)	(0.006)	(0.011)	(0.009)	(0.350)	(0.362)	(0.346)	(0.466)	(0.005)
3yr olds w/ funded place * Treat	0.048	0.065**	0.012	0.049	0.015	1.608	0.945	0.124	-0.839	-0.026**
	(0.032)	(0.032)	(0.017)	(0.037)	(0.029)	(1.003)	(0.922)	(1.291)	(1.323)	(0.013)
3yr olds w/ funded place	-0.063	-0.067	-0.024	-0.032	-0.037	-2.327	-1.541	-1.012	0.299	0.009
	(0.040)	(0.041)	(0.019)	(0.043)	(0.038)	(1.486)	(1.451)	(1.750)	(1.956)	(0.016)
Treat	-0.000	-0.016	-0.016	-0.028	0.013	-0.110	0.544	0.745	1.849*	0.020**
	(0.025)	(0.025)	(0.014)	(0.029)	(0.023)	(0.819)	(0.750)	(1.063)	(1.087)	(0.010)
N	*39,907*	*39,907*	*39,907*	*39,629*	*39,629*	*39,629*	*39,744*	*22,008*	*22,123*	*39,907*

Table 12 - Subgroup analysis for differences-in-differences estimates for mothers whose youngest child is 3 years old. Sample: 2000 to 2008

Subgroups:	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
Lone mothers	0.003	0.084	-0.016	0.012	0.068	3.249*	3.609*	2.698	4.052	-0.082**
	(0.074)	(0.072)	(0.023)	(0.077)	(0.049)	(1.948)	(1.897)	(3.847)	(3.837)	(0.039)
N	*9,449*	*9,449*	*9,449*	*9,406*	*9,406*	*9,406*	*9,417*	*3,596*	*3,607*	*9,449*
Partnered mothers	0.050	0.051	0.015	0.042	0.009	1.235	0.368	-0.133	-1.288	-0.011
	(0.035)	(0.034)	(0.019)	(0.040)	(0.033)	(1.158)	(1.063)	(1.331)	(1.281)	(0.012)
N	*30,458*	*30,458*	*30,458*	*30,223*	*30,223*	*30,223*	*30,327*	*18,412*	*18,516*	*30,458*
Mothers with less than A-levels	0.052	0.061	0.009	0.015	0.049*	2.075*	1.938	0.986	1.175	-0.029*
	(0.043)	(0.039)	(0.018)	(0.043)	(0.029)	(1.128)	(1.172)	(1.588)	(1.893)	(0.017)
N	*22,663*	*22,663*	*22,663*	*22,546*	*22,546*	*22,546*	*22,585*	*10,084*	*10,123*	*22,663*
Mothers with at least A-levels	0.065	0.085*	0.014	0.106*	-0.023	1.403	-0.134	-1.318	-3.372*	-0.019
	(0.046)	(0.046)	(0.030)	(0.058)	(0.045)	(1.421)	(1.494)	(1.661)	(1.902)	(0.015)
N	*17,078*	*17,078*	*17,078*	*16,922*	*16,922*	*16,922*	*17,001*	*11,837*	*11,916*	*17,078*
Mothers with at most one other child	0.063*	0.076**	0.023	0.074*	-0.002	1.153	0.446	-1.081	-1.929	-0.030**
	(0.034)	(0.037)	(0.018)	(0.043)	(0.030)	(1.087)	(1.057)	(1.286)	(1.321)	(0.013)
N	*30,604*	*30,604*	*30,604*	*30,386*	*30,386*	*30,386*	*30,478*	*18,356*	*18,448*	*30,604*
Mothers with at least two other children	0.038	0.057	-0.025	-0.006	0.068	3.678**	2.981	5.524*	3.933	-0.009
	(0.080)	(0.078)	(0.038)	(0.079)	(0.041)	(1.828)	(1.972)	(2.962)	(3.795)	(0.028)
N	*9,303*	*9,303*	*9,303*	*9,243*	*9,243*	*9,243*	*9,266*	*3,652*	*3,675*	*9,303*

Notes: The table shows difference-in-difference estimates of the effect of an increase from 0 to 1 in the fraction of 3 year olds with a funded place in the LEA of residence, using mothers of two year olds as control group. The variable "Treat" takes the value 1 if the mother is observed between the start of the term after which the child turns 3 and the child's fourth birthday; it takes the value 0 if the mother is observed between the child's second birthday and the beginning of the term before the child turns 3. The sample includes years between 2000 and 2008. Control variables includes the mother's age and age squared, a dummy for whether the mother lives with a partner, dummies for mother's ethnicity, dummies for mother's highest educational qualification, the age distance of the youngest child to their oldest sibling, the total number of children under 19 year olds in the household, and dummies for the child's month of birth. Complier LEAs refer to LEAs that have higher than median expansion rate in the fraction of 3 year olds with a funded place between 2000 and 2010. Non-complier LEAs are those with lower than median expansion rate. The regressions also have LEA fixed effects, LEA-specific time trends, year and month fixed effects, average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceding the quarter of observation. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 13 - Specification checks for differences-in-differences estimates for mothers whose youngest child is 3 years old. Sample: 2000 to 2008

Dependent variable:	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
A. Alternative control sets										
Age of the child measured in days	0.048	0.063**	0.014	0.047	0.016	1.595	0.881	0.082	-0.963	-0.025*
	(0.031)	(0.031)	(0.016)	(0.036)	(0.028)	(0.975)	(0.911)	(1.270)	(1.307)	(0.013)
N	*39,907*	*39,907*	*39,907*	*39,629*	*39,629*	*39,629*	*39,744*	*22,008*	*22,123*	*39,907*
Early years LEA controls	0.043	0.058*	0.012	0.043	0.014	1.508	0.796	0.175	-0.952	-0.021
	(0.031)	(0.031)	(0.016)	(0.037)	(0.028)	(0.969)	(0.919)	(1.285)	(1.371)	(0.013)
N	*39,328*	*39,328*	*39,328*	*39,051*	*39,051*	*39,051*	*39,166*	*21,684*	*21,799*	*39,328*
B. Other specification checks										
Alternative merging of LEA level info	0.067	0.067	0.008	0.051	0.017	1.746	0.798	0.160	-1.298	-0.014
	(0.042)	(0.044)	(0.022)	(0.046)	(0.035)	(1.395)	(1.282)	(1.628)	(1.636)	(0.017)
N	*39,907*	*39,907*	*39,907*	*39,629*	*39,629*	*39,629*	*39,744*	*22,008*	*22,123*	*39,907*
C. Placebo test										
Using fraction funded place 5 years later	-0.014	-0.014	-0.053**	-0.036	0.024	-0.040	-0.853	0.286	-1.084	-0.009
(1993-2005)	(0.037)	(0.039)	(0.021)	(0.043)	(0.028)	(1.102)	(1.104)	(1.455)	(1.690)	(0.015)
N	*45,732*	*45,732*	*45,732*	*45,506*	*45,506*	*45,506*	*45,603*	*24,606*	*24,703*	*45,732*
Using fraction funded place 5 years later	0.011	0.013	-0.059**	-0.039	0.055	0.917	0.538	0.897	0.213	-0.016
Non-complier areas (1993-2005)	(0.039)	(0.041)	(0.025)	(0.051)	(0.034)	(1.262)	(1.313)	(1.755)	(2.071)	(0.020)
N	*25,720*	*25,720*	*25,720*	*25,596*	*25,596*	*25,596*	*25,652*	*14,086*	*14,142*	*25,720*
Using fraction funded place 5 years later	-0.042	-0.049	-0.041	-0.056	0.005	-0.639	-2.713	0.613	-3.302	0.000
Complier areas (1993-2005)	(0.074)	(0.079)	(0.038)	(0.074)	(0.048)	(2.243)	(2.254)	(2.520)	(3.464)	(0.026)
N	*20,012*	*20,012*	*20,012*	*19,910*	*19,910*	*19,910*	*19,951*	*10,520*	*10,561*	*20,012*

Notes: The table shows difference-in-difference estimates of the effect of an increase from 0 to 1 in the fraction of 3 year olds with a funded place in the LEA of residence, using mothers of two year olds as control group. The variable "Treat" takes the value 1 if the mother is observed between the start of the term after which the child turns 3 and the child's fourth birthday; it takes the value 0 if the mother is observed between the child's second birthday and the beginning of the term before the child turns 3. The sample includes years between 2000 and 2010, but assigns mothers the fraction of three year olds with a funded place five years before their labour market outcome is observed. Control variables includes the mother's age and age squared, a dummy for whether the mother lives with a partner, dummies for mother's ethnicity, dummies for mother's highest educational qualification, the age distance of the youngest child to their oldest sibling, the total number of children under 19 year olds in the household, and dummies for the child's month of birth. The regressions also have LEA fixed effects, LEA-specific time trends, year and month fixed effects, average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceding the quarter of observation. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 14 - First-stage regression for the geographical analysis

Dependent variable: Fraction of three year old children in LEA using a childcare place	(1)	(2)
Fraction of 3 yr olds in LEA w/funded place	0.143***	0.191***
	(0.023)	(0.040)
N	*20,197*	*1,303*
R-squared	*0.834*	*0.944*

Notes: The table reports the coefficient on the fraction of 3 year olds with a funded place in the LEA of residence in a regression where the dependent variable is the fraction of 3 year olds taking up a childcare place in the LEA of residence. Column is at the individual level; Column 2 is at the LEA level. Both are based on data from 2000 to 2008 and include year and LEA fixed effects and LEA-specific time trends. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 15 - IV estimates. Sample: 2000 to 2008

	Dependent variable									
	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
Panel A - All mothers whose youngest child is three year old										
Fraction 3yr olds using childcare	0.143	0.248	-0.053	0.089	0.117	7.215	-0.833	6.005	-7.261	-0.197
	(0.330)	(0.332)	(0.164)	(0.330)	(0.251)	(10.841)	(11.134)	(11.756)	(14.489)	(0.123)
Observations	20,197	20,197	20,197	20,052	20,052	20,052	20,114	11,327	11,389	20,197
R-squared	0.178	0.195	0.050	0.113	0.105	0.172	0.141	0.131	0.094	0.043

Notes: The table shows IV estimates of the effect of an increase from 0 to 1 in the fraction of 3 year olds taking up a childcare place in the LEA of residence, using the fraction of 3 year olds in the LEA of residence with a funded place as an instrument. The regression is run on mothers observed between the beginning of the term after which the child turns 3 and the child's fourth birthday. Control variables includes the mother's age and age squared, a dummy for whether the mother lives with a partner, dummies for mother's ethnicity, dummies for mother's highest educational qualification, the number of younger siblings, the age distance of the child to the next sibling, the total number of children under 19 year olds in the household, and dummies for the child's month of birth. The regressions also have LEA fixed effects, LEA-specific time trends, year and month fixed effects, average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceeding the quarter of observation. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Table 16 - Differences-in-differences estimates for mothers whose youngest child is 3 years old, complier vs. non-complier LEAs

Subgroups:	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
Mothers in non-complier LEAs	0.034	0.029	0.037*	0.044	-0.014	0.089	0.213	-1.207	-0.903	-0.007
	(0.037)	(0.038)	(0.019)	(0.047)	(0.031)	(1.070)	(0.992)	(1.530)	(1.603)	(0.015)
N	*22,611*	*22,611*	*22,611*	*22,458*	*22,458*	*22,458*	*22,514*	*12,692*	*12,748*	*22,611*
Mothers in complier LEAs	0.084	0.141**	-0.041*	0.025	0.111**	5.491***	2.843	3.759*	-0.516	-0.069***
	(0.060)	(0.061)	(0.023)	(0.053)	(0.053)	(1.944)	(2.134)	(1.930)	(2.557)	(0.023)
N	*17,296*	*17,296*	*17,296*	*17,171*	*17,171*	*17,171*	*17,230*	*9,316*	*9,375*	*17,296*

Notes: The table shows difference-in-difference estimates of the effect of an increase from 0 to 1 in the fraction of 3 year olds with a funded place in the LEA of residence, using mothers of two year olds as control group. The variable "Treat" takes the value 1 if the mother is observed between the start of the term after which the child turns 3 and the child's fourth birthday; it takes the value 0 if the mother is observed between the child's second birthday and the beginning of the term before the child turns 3. The sample includes years between 2000 and 2008. Control variables includes the mother's age and age squared, a dummy for whether the mother lives with a partner, dummies for mother's ethnicity, dummies for mother's highest educational qualification, the age distance of the youngest child to their oldest sibling, the total number of children under 19 year olds in the household, and dummies for the child's month of birth. Complier LEAs refer to LEAs that have higher than median expansion rate in the fraction of 3 year olds with a funded place between 2000 and 2010. Non-complier LEAs are those with lower than median expansion rate. The regressions also have LEA fixed effects, LEA-specific time trends, year and month fixed effects, average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceding the quarter of observation. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.

Appendix

Appendix Table 1. Panel structure of the sample

Observations on the same individual	Number of individuals	Fraction of the sample
1	1,143	36.95
2	837	27.06
3	598	19.33
4	395	12.77
5	120	3.88
Total	3,093	100

Appendix Table 2. Estimates of a multinomial logit model where the dependent variable is the number of consecutive observations on the same mother

	B/w 2 and 4 observations	5 observations
Age	1.005	0.983
	(0.062)	(0.151)
Age squared	1.000	1
	(0.001)	(0.002)
Any partner	1.059	1.127
	(0.100)	(0.276)
Distance b/w 2 youngest children	0.993	1.066
	(0.016)	(0.040)
Nber of children 5-15	1.086	0.768
	(0.057)	(0.115)
Nber of children 16-19	1.009	0.782
	(0.217)	(0.480)
Other qualification	0.850	0.74
	(0.133)	(0.319)
GCSE	1.030	1.425
	(0.143)	(0.501)
GCE/A-level	1.144	0.721
	(0.170)	(0.299)
High educ	0.934	0.871
	(0.166)	(0.413)
Degree or equiv	1.045	1.168
	(0.159)	(0.457)
Child is born in September	0.954	0.934
	(0.072)	(0.180)

Note: This table reports coefficient estimates of a multinomial logit model where the dependent variable is a categorical variable taking the value 1 if only the mother is observed only in one quarter, 2 if the mother is observed between 2 and 4 consecutive quarters, and 3 if the mother is observed 5 consecutive quarters. The reference category is the first one. The sample includes mothers whose youngest child is born in August and September and who are observed during the 12 months preceding September of the year the child turns 3 and November of that year. This sample corresponds exactly to the sample used for the RDD estimates reported in Table 3.

Appendix Table 3 - Coefficients on selected control variables in difference-in-difference estimation for mothers whose youngest child is three years old

	Dependent variable									
	Participates in the labour force	Employed	Self-employed	Works less than 30 hours per week	Works 30 or more hours per week	Usual weekly hours	Actual wkly hours	Usual weekly hours (if employed)	Actual wkly hours (if employed)	Looking for work (if inactive)
Mother's age	0.058***	0.073***	0.004*	0.056***	0.017***	1.692***	1.465***	-0.181	-0.129	-0.016***
	(0.005)	(0.005)	(0.002)	(0.005)	(0.004)	(0.136)	(0.155)	(0.173)	(0.241)	(0.002)
Mother's age squared	-0.001***	-0.001***	-0.000	-0.001***	-0.000***	-0.022***	-0.019***	0.004	0.003	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.003)	(0.004)	(0.000)
Mother has any partner	0.122***	0.140***	0.012***	0.102***	0.038***	3.177***	2.735***	0.010	-0.094	-0.025***
	(0.010)	(0.009)	(0.004)	(0.009)	(0.007)	(0.267)	(0.270)	(0.290)	(0.343)	(0.003)
Number of children under 19 in HH	-0.090***	-0.091***	0.004**	-0.036***	-0.056***	-3.068***	-2.607***	-2.026***	-1.575***	0.001
	(0.003)	(0.004)	(0.002)	(0.004)	(0.003)	(0.104)	(0.095)	(0.157)	(0.142)	(0.001)
Other educational qualification	0.134***	0.113***	0.010**	0.082***	0.029***	2.666***	2.183***	0.895	0.259	0.022***
	(0.013)	(0.013)	(0.004)	(0.014)	(0.008)	(0.335)	(0.304)	(0.680)	(0.683)	(0.005)
GCSE grades A-C or equivalent	0.230***	0.220***	0.023***	0.164***	0.055***	5.117***	4.502***	0.592	0.414	0.012**
	(0.013)	(0.013)	(0.004)	(0.013)	(0.007)	(0.318)	(0.282)	(0.513)	(0.506)	(0.005)
GCE A-level or equivalent	0.295***	0.293***	0.055***	0.190***	0.102***	7.543***	6.804***	1.750***	1.704***	0.003
	(0.015)	(0.014)	(0.006)	(0.015)	(0.010)	(0.390)	(0.369)	(0.567)	(0.563)	(0.005)
Higher education	0.357***	0.361***	0.029***	0.230***	0.131***	9.724***	8.099***	2.413***	1.385**	-0.003
	(0.016)	(0.017)	(0.007)	(0.018)	(0.013)	(0.466)	(0.447)	(0.595)	(0.560)	(0.005)
Degree of equivalent	0.362***	0.359***	0.053***	0.163***	0.195***	11.115***	10.340***	4.226***	4.381***	0.007
	(0.013)	(0.014)	(0.006)	(0.014)	(0.011)	(0.429)	(0.440)	(0.563)	(0.599)	(0.005)
Mixed ethnicity	0.015	-0.017	-0.001	-0.070**	0.052	0.420	1.122	1.854	3.515**	0.032*
	(0.036)	(0.037)	(0.019)	(0.034)	(0.033)	(1.199)	(1.251)	(1.463)	(1.697)	(0.019)
Asian or asian British	-0.166***	-0.166***	-0.023***	-0.162***	-0.003	-2.891***	-2.512***	2.624***	2.230***	0.003
	(0.019)	(0.019)	(0.005)	(0.014)	(0.014)	(0.638)	(0.592)	(0.677)	(0.684)	(0.006)
Black or Black British	0.075***	0.049***	-0.029***	-0.111***	0.159***	4.670***	4.297***	7.102***	6.576***	0.033***
	(0.016)	(0.017)	(0.008)	(0.015)	(0.020)	(0.689)	(0.613)	(0.673)	(0.760)	(0.009)
Chinese	-0.063	-0.071	0.078**	-0.145***	0.078*	1.713	2.100	6.298***	6.737***	0.003
	(0.054)	(0.053)	(0.038)	(0.053)	(0.045)	(1.711)	(1.727)	(1.609)	(1.795)	(0.014)

Other ethnicity	-0.150***	-0.164***	-0.035***	-0.158***	-0.008	-2.850***	-2.315***	3.872***	3.623**	0.005
	(0.030)	(0.027)	(0.010)	(0.022)	(0.021)	(0.879)	(0.784)	(1.348)	(1.416)	(0.014)
Child is a step child to the HH's head	0.019	-0.033	0.004	-0.060*	0.028	0.349	0.079	1.836*	1.232	0.053***
	(0.033)	(0.034)	(0.016)	(0.032)	(0.027)	(1.078)	(0.999)	(1.102)	(1.250)	(0.018)
Lagged average hourly wage in LEA	0.001	0.001	0.000	0.000	0.000	0.016	0.015	0.008	0.011	0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.017)	(0.020)	(0.016)	(0.023)	(0.000)
Lagged unemployment rate in LEA	0.553*	0.180	-0.106	0.244	-0.094	6.171	10.977	7.961	17.429	0.412***
	(0.289)	(0.288)	(0.135)	(0.299)	(0.224)	(8.875)	(9.184)	(9.972)	(13.159)	(0.130)
Lagged employment rate in LEA	0.648***	0.601***	0.000	0.562***	0.027	11.676***	12.304***	-4.022	0.324	0.056
	(0.128)	(0.132)	(0.062)	(0.134)	(0.101)	(3.909)	(4.047)	(4.696)	(5.690)	(0.055)
N	*39,907*	*39,907*	*39,907*	*39,629*	*39,629*	*39,629*	*39,744*	*22,008*	*22,123*	*39,907*

Notes: The table shows the coefficients on control variables in the regression whose coefficients of interest are reported in Table 1-Panel B. The sample includes years between 2000 and 2008. The reference category for ethnicity is White. The reference category for educational equalifications is "No qualification". The regressions also have LEA fixed effects, LEA-specific time trends, year and month fixed effects, average unemployment rate, employment rate and hourly wage level in the LEA of residence and in the quarter preceeding the quarter of observation. The lagged local labour market variables refer to the quarter preceeding the quarter in which the mother's outcome is observed. Robust standard errors clustered at the LEA level in parentheses. *** 1% level of significance, ** 5% level of significance, * 10% level of significance.