ISSN 2042-2695

CENTRE *for* ECONOMIC PERFORMANCE

CEP Discussion Paper No 1352

May 2015

Universal Pre-School Education: The Case of Public Funding With Private Provision

Joanne Blanden
Emilia Del Bono
Sandra McNally
Birgitta Rabe

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Abstract
This paper studies the effect of free pre-school education on child outcomes in primary school. We exploit the staggered implementation of free part-time pre-school for three-year-olds across Local Education Authorities in England in the early 2000s. The policy led to small improvements in attainment at age five, with no apparent benefits by age 11. We argue that this is because the expansion of free places largely crowded out privately paid care, with small changes in total participation, and was achieved through an increase in private provision, where quality is lower on average than in the public sector.

Keywords: Childcare, child outcomes, publicly provided goods
JEL codes: I21; I24; H44

This paper was produced as part of the Centre's Education and Skills Programme. The Centre for Economic Performance is financed by the Economic and Social Research Council.

We thank Rong Huang for valuable research assistance. We also thank the Department for Education, Mike Brewer, Sarah Cattan, Claire Crawford, Naomi Eisenstadt, Kitty Stewart, Anna Vignoles, Lorraine Dearden and Jane Waldfogel for data access, advice and comments. This work was funded by the ESRC Secondary Data Analysis Initiative under grant ES/K003232/1 and by the Nuffield Foundation.

Joanne Blanden University of Surrey and Centre for Economic Performance, London School of Economics. Emilia Del Bono, ISER, University of Essex. Sandra McNally, University of Surrey and Centre for Economic Performance, London School of Economics. Birgitta Rabe, ISER, University of Essex.

Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

1 Introduction

Recent research in the economics of human capital production has emphasised the importance of timely investments in child development, as differences in children's cognitive and non-cognitive skills emerge at early ages and early investments provide the foundations for later learning (Almond and Currie, 2011; Carneiro and Heckman, 2004; Cunha and Heckman, 2008). The large body of evidence on the importance of the early years has helped to build a consensus for the idea that the state should have an important role in encouraging investments in very young children. Pre-school education is one area where investments in children take place outside the family, so it is amenable to state intervention, and could be particularly important for children from disadvantaged backgrounds who may receive lower investments at home.[1]

The strongest evidence in support of early years interventions is based on the favourable evaluations of intensive child programs *targeted* at low income families, such as the Perry pre-school and Abecedarian projects in the US (Barnett, 1995; Karoly et al., 2005; Heckman et al., 2010). On the basis of these findings, in the last few decades many countries have introduced publicly funded *universal* pre-school schemes; hoping to achieve similar improvements in children's outcomes by means of less intensive interventions covering larger populations (see Felfe et al., 2014, for a recent review).

The growing body of literature evaluating these universal programs has shown that the impact of childcare on child outcomes is usually positive, with larger benefits experienced by the most disadvantaged children. However, an important caveat to keep in mind is that the policies which have seemingly generated improvements in children's outcomes are those in which universal access to childcare has been achieved through the expansion of *public provision* (Berlinski et al., 2008; Berlinski et al., 2009; Dumas and Lefranc, 2010; Havnes and Mogstad, 2011; Black et al., 2012; Dustmann et al., 2013; Felfe and Lalive, 2014; Felfe et al., 2014; Gormley and Gayer, 2005). By contrast, evidence from Canada and some US states shows that when increases in subsidised childcare availability is accomplished by a combination of public and regulated private providers the effects are not always clear-cut

[1] State support for childcare in the pre-school years is also thought to lead to a "double dividend" by both promoting child development and encouraging maternal employment (Strategy Unit, 2002, p.29).

(Baker et al. 2008; Fitzpatrick 2008). This suggests that, while early years education has the potential to be beneficial, the specifics of the policy matter.

In this paper we offer - to our knowledge - the first evaluation of a policy which made pre-school education universally available by providing state subsidies to *private sector* providers.[2] Using a census of children in primary schools, we identify the effects of this policy on children's early educational attainment by exploiting the staggered implementation of free universal part-time pre-school for three-year-olds across Local Education Authorities (LEAs) in England in the early 2000s. We provide a comprehensive analysis of this policy, documenting substantial crowding-out of privately paid formal care. Reductions in informal care arrangements were more common among disadvantaged families. We further explore the mechanisms through which the policy may have operated, including the possibility of income effects or changes in maternal employment. This is also the first paper to use microeconomic data to evaluate the causal effect of attending free part-time pre-school education on child outcomes in England.[3] As such, it complements evidence from detailed UK observational studies showing that high-quality formal childcare encourages child development.[4]

From 2004 in England all three and four-year-olds are entitled to a fully subsidised part-time nursery place (hereafter "free entitlement") during the school year, with similar policies in place in Scotland and Wales. Despite considerable state funds invested (about £2bn per year), little is known about the effects of these universal subsidies on children's outcomes. The evidence from aggregate data is not encouraging, however. The overall performance of English children after their first year in school did not improve over the early 2000s - when the free provision for three-year-olds was increasing - nor is it possible to detect a narrowing

[2]The closest examples are the policies implemented in Canada and in Georgia, where the increase in provision was achieved through a *mixture* of public and private sector providers. Baker et al. (2008) evaluate the impact of the $5 a day childcare policy in Quebec and find that it led to negative effects on a range of child outcomes, including social development and health. Fitzpatrick (2008) investigates the impact of the introduction of universal pre-K in Georgia. She finds no robust evidence of positive effects on the overall population, but some improvements in 4th grade reading and maths scores of children living in rural areas.

[3]Dickson (2008) uses LEA-level data to investigate the early roll-out of the policy, his results are in line with ours.

[4]The Effective Provision of Pre-School Education (EPPE) study is the central work in this area (Sylva et al., 2004). The results of this study cannot be interpreted as causal as they do not take into account selection of children into childcare other than by using a large set of control variables. However they show rather convincingly that a high-quality pre-school setting is very important in improving children's outcomes in a variety of domains.

of the gap between children from different social backgrounds over the same period (Merrell and Tymms 2011).[5]

The English arrangements for providing universal early education differ from the arrangements made in most other European countries. Before the free entitlement came into effect, free pre-school education in England was provided through public nurseries and nursery classes in primary schools. This free provision covered almost 40% of all three-year-olds and was mainly concentrated in inner cities and deprived areas. Universal access was achieved by offering private, voluntary and independent (hereafter "private") providers a fixed amount per eligible child (this started at £1,130 a year in 2000-2001 for 12.5 hours a week, or £2.74 an hour, see DfEE, 1999). In other European countries universal access was achieved by public provision of childcare.

The new free places are rather different from those already established. For a start, the private settings are heterogeneous with respect to the number of hours they operate, with day nurseries offering full-time places to accommodate working parents, and play groups operating only morning or afternoon sessions. Second, they are subject to looser regulations regarding staff qualifications, although child-to-staff ratios tend to be higher than in the public sector, as we shall discuss below. Third, in most cases the private providers are profit-making enterprises that compete for qualified staff in local labour markets and set prices according to local demand for childcare with the consequence that families in different local areas of the country have access to different quality of provision. This is why implementing universal provision through a private rather than a public sector expansion might lead to effects on children's educational outcomes and socio-economic gaps between children which are different from those observed in previous evaluations.

Our identification strategy is based on a difference-in-difference research design which exploits the fact that the entitlement for three-year-olds was phased in differentially across areas (LEAs), with the proportion of three-year-olds holding a free part-time nursery place rising from 36% to 87%, on average, between 1999 and 2007.[6] Our data consists of a large administrative dataset covering all students in state schools in England, and containing

[5]Stewart (2013) observes a reduction of socio-economic inequalities in school outcomes for children at age five between 2006 and 2011, but this was at a time when the free entitlement for three-year-olds was already available to most families.

[6]In our empirical analysis we cover only the period between 2002 and 2007.

information from teacher assessments at age five (reception year) and age seven (year 2), as well as national tests at age eleven (year 6, which marks the last year of primary schooling). As we cannot observe individual childcare participation, but only the availability of free places in the area, the parameter we will estimate is an intention to treat (ITT) effect, capturing the full impact of the policy, including a number of different behavioural responses which we examine in detail.

For our research design to work we must be confident that we can control for all area characteristics that might be correlated with the build-up of free places and at the same time influence child outcomes. We therefore model child outcomes as a function of observed child characteristics, area and cohort-fixed effects, a vector of time-varying characteristics of the area which capture labour market conditions as well as the presence of other early years initiatives, and the initial level of availability of free places interacted with cohort fixed effects. We offer a number of checks showing that our results are robust to alternative ways of taking into account unobserved and time-varying area-specific factors, including a placebo test where we assign future levels of free places to the children in our sample.

Our analysis produces three main findings. First, we estimate that a 10 percentage point increase in the proportion of three-year-olds covered by free places improves literacy and numeracy scores - as well as measures of social and emotional development - at age 5 by around 2% of a standard deviation. In order to interpret these effects, we investigate the extent to which the free entitlement increased total participation (whether in free or privately paid places) of three-year-olds in pre-school education. We find that the policy generated substantial crowd-out of privately paid formal care, with less than one in three free places leading to entry of a new child to pre-school. While children might still benefit through increased available family income, we find no increase in educational attainment in areas where the crowd-out was more pronounced, indicating no income effects.

Second, we find that the policy was not successful in narrowing the socio-economic gaps in educational achievement. We use all indicators of family background available to us (free school meal status, deprivation of the neighbourhood, and language spoken at home) to examine whether the effects are different by subgroups. Although the point estimates suggest that the effects are larger for more deprived children, the differences are usually not statistically significant and so small as to be economically negligible. This is despite the

fact that we find evidence that the most disadvantaged families responded to the policy by increasing pre-school participation and reducing the use of informal care arrangements and parental care.

Third, we show that improvements in children's outcomes caused by the policy are likely to be short-lived. Effects measured at age seven are never significantly different from zero, and at age eleven we find positive impacts on reading scores of the order of 0.6% of a standard deviation for each 10 percentage point increase in the proportion of three-year-olds covered by free places. Even though our outcome measures at ages five, seven and eleven are not directly comparable, they are strongly correlated with each other, so that it is hard to reject the idea that there is substantial fade-out.

There are two policy conclusions to be drawn from this study that might also apply to other contexts. First, we argue that policies aiming to achieve *universal* provision of pre-school education through subsidies directed to private sector providers should take into account existing levels of privately paid childcare. If crowd-out is substantial, the subsidy acts as a reduction in the costs of childcare to families, and policy makers need to specify that this is likely to be the main outcome of universalism. Secondly, it would seem very important that policies that open the door to "for-profit" providers in sectors where the benefits of introducing a competitive market have been highly debated - such as the education sector or the health sector - adopt strict guidelines to ensure that the good on offer is not of poorer quality than that supplied by the public sector.

2 Institutional background

There are 150 Local Education Authorities (LEAs) in England. They have had a duty 'to have regard for the need for' pre-school education since the 1944 Education Act. At this time, if pre-school education was provided for, this happened either in nursery schools or within nursery classes in primary schools. Such public provision was more likely to be found in politically left-of-centre inner-city areas (Lewis and Lee, 2002) and was mainly targeted at children from the most deprived families (DES, 1990). Funding was low compared with mainland Europe (Pugh, 1996). By 1999, 37% of three-year-olds had a publicly funded childcare place, with large variation between areas of the country.

In the 1970s and 1980s, the provision of childcare grew in the private, voluntary and independent sector. This consisted of voluntary short-session playgroups and private day nurseries. Some financial support was available from the government in the form of employer tax breaks and subsidies for those on low incomes.

In the late 1990s, more systematic provision of free pre-school education for four-year-olds was introduced. By 2000, there was universal free part-time pre-school for four-year-olds, consisting of 12.5 hours per week of childcare, during 33 weeks in the year, in 2.5 hour daily sessions. The policy of interest in this paper is the roll-out to extend this same provision to three-year-olds. The Department for Education initially provided funds for childcare places in 65 Local Education Authorities in 1999-2000 and across the country from 2000-2001. The aim was to complete the roll-out by 2004.[7]

At the time this policy was introduced, three-year-olds could already be receiving pre-school in two ways: in free publicly-provided settings or in paid-for private settings. Figure 1 gives an overview of the development of pre-school education of children aged three between 1999 (the year before the age three roll-out began) and 2007. A striking aspect of this graph is that in the year 2000 most three-year-olds (82%) were already receiving some type of pre-school education/care, which meant that the increase in access was not as dramatic as one might first expect; between 2000 and 2007 the total proportion of children in any type of pre-school setting increased by just 14.4 percentage points.[8] The really big change was the increase in the number of children receiving a free place; this percentage increased from 37.0% to 87.9% between 1999 and 2007, and this expansion happened entirely in the private sector. The Figure also shows that publicly provided places remained relatively stable over the period with a small increase from 37.0% in 1999 to 38.4% in 2007. Thus, a considerable proportion of pre-school places simply substituted private for public funding ("crowd-out").

As a consequence, many children continued to receive pre-school education in the same places as before although, in order to obtain government funding, private settings had to meet a quality threshold. In 2000 this was codified as the Curriculum Guidance to the Foundation Stage, which emphasised learning through play, ensuring that a range of stimulating activities were provided and that children's development across a range of areas was encouraged.

[7] After the period of interest in this paper, the entitlement was made more generous. For example in 2008, it was extended to 38 weeks per year.

[8] Data on all places is not available for 1999.

Childcare workers were required to plan learning activities and to observe and document children's progress towards early learning goals.[9] Since 2001 all settings are also subject to registration and inspection by the Government regulator Ofsted (Office for Standards in Education). Ofsted inspects early years settings to judge the quality of the provision, including the quality of the teaching and learning, and grades providers on a 4 point scale, from 'inadequate' to 'outstanding'.[10]

Despite the existence of a standardised curriculum, the type of early education experience that registered settings offer will vary depending on where children take up their place. Funding rates in the public sector are higher than for private providers (National Audit Office, 2012). Moreover, providers from different sectors have to comply with different child to staff ratios and requirements regarding minimum qualification of staff. Nursery schools and classes in public provision require that a qualified teacher is present, and have an adult-child ratio of 1:13 to reflect that well qualified staff are employed. In the private sector, on the other hand, requirements for qualifications are lower, but if there is no qualified teacher present then the adult-child ratio is increased to 1:8 (Gambaro et al., 2013). [11]

There is also a lot of variation between childcare settings in terms of the duration of a pre-school day. Public provision will usually be relatively restrictive in terms of hours available, often either five mornings or five afternoons, and usually will not extend outside school hours. Private day nurseries often focus on full-time care, so that the entitlement to free places acts only as a discount on fees, with few part-time places available. Private settings which evolved from community play-groups, on the other hand, generally offer care over more restricted hours, mostly spanning no longer than from 9am to 3pm.

[9]From 2003/4 the Foundation Stage was assessed at the end of children's first year in school through the Early Years Foundation Stage, used as an outcome variable in this paper. From 2008 the Foundation Stage was combined with guidance for younger children to form the Early Years Foundation Stage, but the broad goals have not changed.

[10]There has been some criticism of the regulator focus on health, safety and environment rather than pedagogical quality (National Audit Office, 2004; Mathers et al., 2012).

[11]Specifically, for private, voluntary and independent providers there is no requirement to employ qualified teachers, but all the managerial and supervisory staff needs to hold a level 3 childcare qualification, while at least 50% of the remaining staff has to hold a level 2 qualification in childcare, with child-to-staff ratios of 1:8 (Gambaro et al., 2013). Level 2 and 3 qualifications are achieved after 1 or 2 years of post-compulsory school training, which often can be on-the-job training, and attract those with the poorest academic records (Nutbrown, 2012).

To evaluate the impact of the free entitlement we need information on outcomes, and information on school achievements at age 5 is only available from 2002/3 whereas the policy started in 2000. This restricts our analysis to considering children who would have been eligible for a free place from 2001-2007. Between 1999 and 2002, the first years of the policy build-up, only 6% of the funded places were genuinely new capacity. In addition, it took some time for the quality requirements on providers of the free entitlement to be enforced. For both reasons it is better to focus on later years.

The identification strategy used in this paper relies on variation over time and across areas in the availability of free pre-school education. Figure 2 shows how coverage developed from 1999 to 2002 and through to 2007. Over the whole period we can see a substantial increase in free places, and that this increase was not uniformly distributed across areas: the North of England and areas around London as well as Cornwall already had a fairly high coverage in 1999 (implying high levels of existing public childcare), whereas the increase for most Southern areas of England was from a low level of coverage, in the 0-20% bracket. Looking at the changes between 1999 and 2002 it seems that the largest increases occurred in the North, but there was still substantial variation in the availability of places across the country in 2002. Substantial catch up occurred from 2002 to 2007 to ensure full coverage was achieved. Between 2002 and 2007 there was a dramatic increase in coverage in Southern England (from a very low base).

Figure 3 follows analysis in Brewer et al. (2014b) and gives more detail on the trajectory of the build up. LEAs are split into four quartiles based on the increase between 2002 and 2007 in the proportion of three-year-olds with access to a place and we plot the average coverage for each group in all years from 1999 to 2007. It is clear that the group with the largest build up over our period of observation has the lowest level of coverage in 2002. We take account of the importance of the baseline level by controlling for baseline-by-cohort effects in our empirical model. Notice that the trajectories of the build-up are rather different in the first years of the policy. Between 1999 and 2000, in particular, the strongest growth was found in areas with the most existing provision, and this is due to an explicit focus on serving the most disadvantaged areas first - another reason to focus the analysis on later years of the build up.

One question of interest is whether the policy benefited children differentially by social background (in terms of access). We use evidence from a survey of parents to try and understand how usage patterns changed by parental characteristics over the period.[12] Table 1 shows changes in the use of formal, informal, exclusive parental and other types of care in the years marking the beginning and end of our sample period (2001 and 2007). The first row shows that the overall proportion of three-year-olds in formal, centre-based childcare increased by 18 percentage points in the time-period considered, while the proportion of children being exclusively looked after by their parents decreased by 7 percentage points.[13]

The second to fourth panels of Table 1 show changes in childcare use by background. The data allow us to distinguish children by their family's income, housing tenure and social class. Looking first at the differences by family income, the table shows that children from families in the lowest income band increase the use of formal childcare considerably more than other children, and this is accompanied by a reduction in exclusive parental care. Children from the second lowest income band switched from informal childcare by family and friends to formal childcare. Housing tenure is another way of distinguishing the economic position of children, with renting families being more disadvantaged than home owners, in particular if they are social housing renters. Similarly to the pattern seen by family income, panel two shows a substantially larger increase in formal childcare among children from families living in rented accommodation than those living in owned houses, and a larger decrease in exclusive parental care. Finally, the fourth panel of Table 1 distinguishes families by their social class, based on occupation, and confirms the pattern seen for the other classificiations: a higher increase in formal childcare and higher decrease in informal and exclusive parental care among children from the lower two social classes (semi-skilled and unskilled; skilled manual) compared to children from the upper two social classes (skilled non-manual; professional and managerial).

Thus, the evidence suggests that the expansion of the free entitlement was re-distributional, with disadvantaged children switching out of informal care by family and friends and out of exclusive parental care into pre-school more often than their more affluent peers. Under the

[12]We use the 2001 Parents Demand for Childcare Survey and the 2007 Childcare and Early Years Provision: Parents Survey. Data was collected from 5,416 households in 2001 and 7,136 households in 2007.

[13]Note that children can be in more than one form of childcare, so that increases in formal care are not mirrored by decreases in other forms of care. The level of formal childcare use underlying the change is lower in both years (63% and 81%) than that derived based on data from the Department for Education (which is 84% and 97%), but the change between the years is quite comparable.

assumption that the quality of care received is higher in formal care than that delivered by parents, family and friends for these children, we expect treatment efffects to be higher for children from families of lower socio-economic status.

3 Empirical strategy

To estimate the effect of the expansion of free pre-school places on children's outcomes we rely on a difference-in-difference research design, exploiting the fact that the availability of free places grew more rapidly in some areas than others. This identification strategy rests on the assumption that the expansion of free places across LEAs and over time is independent of other time-varying and area-specific factors that might affect child outcomes. It is therefore essential that we control as comprehensively as possible for differences across time and areas.

Our main regression model, estimated by OLS over the sample of children who were aged three between 2002 and 2007, is defined as follows:

$$Y_{icl} = \beta_1 F_{cl} + \beta_2 X_{icl} + \beta_3 Z_{cl} + \mu_l + \gamma_c + \gamma_c * F_{2002_l} + e_{icl}, \quad (1)$$

where:

1. Y_{icl} is the outcome of interest for child i in cohort c and area l measured at ages five, seven and eleven, respectively.

2. F_{cl} is an indicator of the availability of free pre-school places in an area of residence for a given cohort of children. More precisely, it is the proportion of the population of three-year-olds in a free place in a specific area, which we take as measure of availability.

3. X_{icl} is a vector of child characteristics including gender, ethnicity (seven categories), free school meal status, language spoken at home, decile of neighbourhood deprivation and month of birth (to control for relative age at test effects).[14]

[14]Child characteristics are measured at age seven as information for the whole sample is not available at age five. Free school meal eligibility at age seven is a good proxy for low income at earlier ages, as research shows that children who are eligible for free school meals in any year will be affected by low income over longer periods of time. Likewise, changes in neighbourhood deprivation through moves tend to occur around the birth of a child, and even in these cases neighbourhood characteristics tend to remain stable (Rabe and Taylor, 2010).

4. Z_{cl} is a vector of area-specific characteristics that may affect child outcomes and are time-variant. We include labour market and local economic conditions that may favourably or adversely affect children and the presence of/or spending on other early years intiatives active in each area in the same period.

5. μ_l are area fixed-effects, which control for time-invariant unobserved area characteristics. These, for example, take into account the fact that the build-up of the policy was systematically related to pre-treatment levels of free childcare (in a way that is not time-variant).

6. γ_c are cohort fixed-effects which control for unobserved factors affecting each cohort.

7. $\gamma_c * F_{2002_l}$ interacts cohort fixed effects with levels of free pre-school places in the year 2002, the first year in our observation period. By adding this term we control for the fact that the build-up of the program could be systematically related to the pre-treatment levels of free childcare (in a way that is time-variant).[15] For example, we know that more affluent areas saw a more rapid expansion of free places as they had lower starting levels of free provision than other areas, and if these areas are also on a more favourable trajectory regarding child development this would cause our effect of interest to be upward biased.

8. e_{icl} is an idiosyncratic error term.

Although the variation in free places we exploit is at the area-level, equation (1) will be estimated at the individual (child) level. This is in order to exploit as far as possible the information we have about the characteristics of individuals in X_{icl}, as these are important explanatory variables in an education production function.[16]

An important question to ask is whether - after including the comprehensive set of controls just described - our measure of availability of free places has enough variation left to identify the effect of interest. We show in Table 2 the raw variation in available pre-school places, as well as the variation left after entering our various controls.[17] As we can see, over the period

[15]For a similar approach see Duflo (2001).

[16]The standard errors are always clustered at the area-level.

[17]The data and controls are explained in more detail in the next section. Rows 2-5 of Table 2 summarise the residuals of regressions of free places on the listed controls.

of our analysis the mean availability of free places is 80.14%, with a standard deviation of 13.55. Individual-level characteristics do not seem to explain a lot of the variation, while area and cohort fixed-effects eat up almost half of it. The variation is further reduced after considering local labour market conditions and other early years policies, but not by much. Finally, our flexible way of controlling for pre-treatment availability of free places brings the standard deviation down to 4.47, a third of the initial amount. This shows that we still have a substantial amount of variation to exploit.

The second question to consider is what is driving the remaining variation in F_{cl}. The expansion of free places was driven by a complex mixture of factors, including parental demand for pre-school places (determined by their wages and employment opportunities) and existing levels of provision. Both are controlled for in our analysis. According to accounts available of the build-up period, however, the key factor determining the speed of the implementation of the policy was the local ability to create new places (Harries et al., 2004). This depended in particular on the staffing of co-called Early Years Development and Childcare Partnerships (EYDCPs) which gave advice to existing and new providers applying to receive the government funding. The EYDCPs were composed of representatives from local government authorities, Training and Enterprise Councils, employers, parents, providers including out-of-school clubs, schools, and churches. They had responsibility for drawing yearly plans for the implementation of the free entitlement as well other early years initiatives, and for submitting these plans to the Department for Education and Employment for approval. The effectiveness of the EYDCPs and the way they operated within the Local Authority – according to "integrated" or "collaborative" modes, for example – differed widely across areas (Osgood and Sharp, 2000), and explains why the availability of free pre-school places grew more rapidly in some areas than others.

A remaining threat to identification is that, even when using our rich set of controls, we insufficiently control for area-level factors affecting child outcomes. In other words, there could be unobserved time-varying factors that are not captured by the observable time-varying controls we include in the model. In discussing our results we will present different specifications of the model, and show how sensitive our results are to incrementally including different sets of controls. Further, in our robustness analysis, we will show that our results are not sensitive to different ways of controlling for unobserved time-varying and area-specific

characteristics, including a placebo analysis that assigns childcare places available two years in the future to the children in our sample.

The estimated parameter, β_1, represents an Intention To Treat (ITT) parameter. This parameter captures the overall impact of the introduction of free early education, including a number of different behavioural reponses. For one, there is the participation effect. This needs to be considered in the context of the counterfactual care arrangement that would have been in place in absence of the policy. The counterfactual in this case is care provided by parents and by family and friends (informal care).[18] We expect positive (negative) effects on child outcomes if parental or informal care is of lower (higher) quality than the pre-school education provided in formal settings. Participation effects can also arise at the intensive margin if parents increase hours of childcare use as a result of the policy.

Second, there is the possibility of an income effect. This would accrue to families who were already using private childcare and continue to do so, with the free entitlement providing a discount on nursery fees. To the extent that parents invest this money back into their child (e.g., buying more books), this can still improve child outcomes (Black et al., 2014). Third, there may have been a quality effect, as settings which were eligible for funding also had to subscribe to the Early Years Curriculum. This may have improved quality after the funding was introduced even for children attending the same setting as before. Fourth, the policy may have had a maternal employment effect. One of the aims of the policy was to increase maternal labour supply, and if this was successful it could have effects on child outcomes through reduced maternal time available for child investments and/or an increase in available income. Therefore the treatment effect estimated using equation (1) is a weighted average of a number of possible implicit treatment effects with the weights given by the number of children/families affected by each effect. These potentially important mechanisms are analysed further in section 6 below.

[18] We think that the switch from public to private provision is very unlikely, as the proportion of three-year-olds in public places did not change over the time-period we consider.

4 Data

The empirical analysis is based on the National Pupil Database (NPD), which is available from the English Department for Education and has been widely used for education research. The NPD is a longitudinal register dataset for all children in state schools in England (a low proportion of children go to private schools at this age). It combines student-level attainment data with pupil characteristics as they progress through primary and secondary school.

Outcomes and observed background

We study the effect of early education on children at ages five, seven and eleven. Primary school in England begins with the reception year, which children generally begin at four in the academic year they turn five. From birth to the end of reception, at age five, the Early Years Foundation Stage sets standards for the learning, development and care of children in schools and pre-school settings. At the end of reception children are assessed by their teacher according to the Foundation Stage Profile. This measures achievements of children aged five against 13 assessment scales, with 9 points within each scale. The 13 assessment scales are grouped into six areas of learning which include personal, social and emotional development (hereafter Social Development); communication, language and literacy (hereafter Literacy); problem solving, reasoning and numeracy (hereafter Numeracy); knowledge and understanding of the world; physical development and creative development. We use as the age five outcome the standardised point scores in the main learning areas: Literacy, Numeracy and Social Development, as well as of the sum of the points in all assessment scales (Foundation Stage Profile total); all the scores are standardised separately by academic year.

School education from age five to 16 is divided into four Key Stages, and at the end of each Key Stage pupils are assessed against the National Curriculum. To date, the pupils affected by the roll-out of the free entitlement have been tested at ages seven and eleven. At age seven (end of Key Stage 1) teachers assess pupils according to carefully defined criteria which are the same across all primary schools and are subject to scrutiny by the schools regulator Ofsted. Following standard practice, we transform National Curriculum levels (7 distinct levels) achieved in Reading, Writing and Mathematics into point scores using Department for Education point scales. At age eleven we have test scores from national exams that are

externally set and marked for Reading and Maths for the cohorts we consider. As before, we standardise age seven and age eleven scores separately by academic year and subject.

In the NPD we observe some basic individual background variables, and we use these in our regressions to control for gender, eligibility for free school meals, ethnicity (white British, Indian, Chinese, Black, Pakistani/Bangladeshi, mixed and other), area deprivation deciles as measured by the Income Deprivation Affecting Children (IDACI) score of the neighbourhood of residence, and whether the child speaks English as the first language at home. We also control for birth month to account for relative age at test. We perform subgroup analysis by neighbourhood deprivation, free school meal eligibility and language spoken at home.

LEA-level controls

In our model we control for two sets of time-varying variables at the area level which might be associated with child outcomes. The first vector captures economic conditions that may favourably or adversely affect children through parental income and employment. This includes the proportion of working-age individuals with certain qualification levels (NVQ3 and NVQ4, roughly equivalent to High School and College), and the female employment rate derived from the Labour Force Survey. We lag the employment rates to account for the fact that childcare availability might affect current employment rates. We also include the mean hourly pay from the Annual Survey on Hours and Earnings (ASHE).[19]

The second set of area-level controls captures other early years initiatives that were active in the same time-period as the roll-out of free pre-school education for three-year-olds.[20] During the years from 2002 to 2007, substantial state funds were targeted to the most deprived areas of the country (Harries et al., 2004; Stewart, 2013). Among these, Sure Start Centres were a flagship policy, providing help and advice on child and family health, parenting, money, training and employment as well as play sessions and (in some cases) childcare (Eisenstadt, 2011). The centres were designed to be within 'pram-pushing' distance of disadvantaged families. In order to capture the likely exposure of children to this initiative, we count the number of Sure Start Centres available within each LEA in each

[19]Area-level measures of these variables are publicly available through NOMIS, the official repository of labour force statistics of the Office for National Statistics (https://www.nomisweb.co.uk/).

[20]The New Labour Government launched the National Childcare Strategy Green Paper: 'Meeting the Childcare Challenge' in May 1998 following its 1997 election platform.

year and weight these by the target population (all 0-4 year-olds).[21,22] To control for other policies, including Neighbourbood Nursery places (Smith et al., 2007) we use data on all spending on Early Years Services that was routed through LEAs (not including Sure Start and spending on the free entitlement itself). Again, we weight this using the population of 0-4 year-olds in each area. For both Sure Start Centres and spending on other initiatives we construct a three-year average around the year in which the child would be aged three to account for the fact that children would be able to benefit from these policies over a longer period of time.

Measures of free childcare availability and childcare take-up

Annual headcounts of three-year-olds receiving free childcare by LEA are available from the Department for Education (Department for Education, various years) with separate counts of children in public provision (nurseries and nursery classes in primary schools) and in the private sector at the end of each calendar year. The data is available from 1999, the year before the free provision for three-year-olds was introduced. Our measure of free part-time pre-school places is the sum of publicly provided places and free places in the private sector, divided by the population of three-year-olds in each LEA.

Information on total childcare participation (privately funded as well as free) in each LEA is also available from the Department for Education. Headcounts of children taking up places in the private sector, including both free and privately funded places, are available for years 2000 to 2007. There are some issues with the quality of this data which require us to carry out some adjustments.[23] Our measure of childcare take-up is the sum of public sector places and all places taken up in the private sector, divided by the population of three-year-olds.

[21]The population figures are population estimates from the Office of National Statistics.

[22]Of course the specific location of the Sure Start Centre, in later years known as Sure Start Local Partnerships, will matter to their likely effect on children's outcomes but, similarly to our measure of free places, we capture here only LEA average effects.

[23]In some years not all providers returned data to the Department for Education (DfE), so that the DfE revised the figures by assigning the average number of children of the providers that did return data to the missing providers. This ocurred in the years 2003-2007, with an estimated 3-4% of children missing in 2004, 2006 and 2007, and 14% (8%) missing in 2003 (2005). The data broken down by LEA were not revised by DfE, and we therefore adjust the data for 2003 and 2005 by interpolation and the data for 2003-2007 by increasing the counts in each LEA proportionally to the rate of unreported children in that year. More precisely, we first apply linear interpolation between the preceding and following year for years 2003 and 2005 and replace the data for a LEA if the interpolation leads to a higher count than the recorded count. This reduces the proportion of missing children to 5.4% in 2003 and 3.8% in 2005. We then increase the counts in each LEA by the proportion of children deemed by DfE to be missing in the returns overall, so that the count of children across all LEAs coincides with figures published by DfE.

We scale all childcare measures so that a unit change represents a 10 percentage point increase in the number of children covered by free pre-school places or taking-up a pre-school place. We merge these data to children observed in the National Pupil Database using their LEA of residence at age seven, as residence at age five is not available for all of them. To all children in an academic cohort we match the childcare census of the December after they turned three.[24]

Estimation sample

The analysis focuses on children attending early education from 2002 to 2007, as we can observe outcomes for these six cohorts of children at ages five, seven and eleven. As mentioned above, the Foundation Stage Profile at age five is not available for earlier years.[25] Our sample therefore includes six cohorts of children aged three in the years 2001/02-2006/07 with observations at age five relating to academic years 2002/03 to 2007/08, observations at age seven relating to academic years 2004/05 to 2009/10 and at age eleven to academic years 2008/09-2013/14.

From this sample we remove children living in Scotland or Wales but attending school in England, children in "special schools" that exclusively cater for children with specific needs, for example those who have physical disabilities or severe learning difficulties. Moreover, we exclude a small number of children who are younger or older than the children expected to belong to a particular school cohort.[26] Finally, we retain only pupils for whom we have non-missing outcomes and background characteristics. The main estimation sample includes six cohorts of children with 3.2 million observations.

Table 3 shows descriptive statistics for child outcomes at various ages. We display mean raw Foundation Stage Profile point scores at age five, raw point scores in Reading, Writing and Maths at age seven and raw test scores in Reading and Maths at age eleven. We show this separately for the whole sample, as well as by gender and free school meal status. The Table shows that girls outperform boys in all outcome measures at all three ages, with the exception of Mathematics at ages seven and eleven where boys perform better than girls on

[24]For September to December-borns of each cohort we could alternatively assign the previous year's census when these children are aged three. However, these children are only eligible to access free places from January so that the following census better captures availability.

[25]In 2002/03-2005/06 FSP data were collected only for a 10% sample of school children, and we calculate and use weights to ensure this subsample is representative of the full population.

[26]Note that there is no grade repetition in the UK.

average. Even larger differences can be found between children eligible for free school meals and other children. At age five the mean Foundation Stage Profile score of children on free school meals is 12% lower than that for children who are not eligible. At ages seven and eleven mean point scores of children from this disadvantaged group are 11 to 15% lower than those of other children. Summary statistics of individual and LEA-level controls are given in Appendix Table A1.

5 Results

In this section we present our main results, robustness checks and analysis by sub-group.

5.1 Main results

Our main set of results examines the effect of availability of free part-time pre-school education for three-year-olds on child educational attainment at ages five, seven and eleven. The top panel of Table 4 shows effects on standardised point scores in the Foundation Stage Profile (FSP) and the three key learning areas within the FSP. The second panel shows effects of free childcare availability on standardised point scores in Reading, Writing and Maths at age seven, while the bottom panel displays the effect on standardised scores in Reading and Maths at age eleven. Column (1) presents results of a model that controls for cohort and area fixed effects as well as individual characteristics. There is a positive and statistically significant effect of increasing availability of free places by 10 percentage points on various outcomes at age five but not much evidence of an effect at later ages. In column (2) we added in LEA-level controls capturing economic conditions and other early years initiatives in the observation period. Point estimates decrease somewhat for all outcomes, indicating that LEA-level economic conditions and early years investments are positively associated with child outcomes. The size of the standard errors however indicates that the results are not statistically different from those in column (1).

In column (3) we account for the interaction of cohort fixed effects with starting levels of free places in 2002 to net out differences in child outcomes correlated with differences in the speed of expansion due to unequal levels of provision in each LEA. These are our baseline results. Compared to column (2) we find that point estimates for some outcomes

are slightly lower, and for others slightly larger, but again the differences are very small and not statistically significant.

The baseline results for age five outcomes, displayed in column (3) of the top panel of Table 4, show that availability of free childcare has a positive effect on several outcome measures. Specifically, a 10 percentage point increase in the proportion of three-year-olds for whom free pre-school is available leads to an increase in the FSP score of 2.2% of a standard deviation. Positive and statistically significant effects of just under 2% of a standard deviation are also found for Literacy, Numeracy, and Social development.

To assess the magnitude of these effects, we can consider that the free entitlement policy increased the fraction of three-year-olds receiving free early education by around 50 percentage points (from an average of 37% to 88% between 1999 and 2007) so, if we assume linearity, we can extrapolate and say that the policy change improved children's outcomes by an average of 10% of a standard deviation overall. This compares to a FSM "penalty" of 59% of a standard deviation in Foundation Stage Profile scores and reveals that the overall impact of the policy was small. This is also true if we look at the increase in FSP points. On average children obtain 87.5 points out of 117 possible points. An increase of 10% of a standard deviation corresponds to an increase of 1.9 FSP points or a 2.2% improvement in points on average - again a small effect.

At age seven (middle panel of Table 4), our point estimates show very small (and slightly negative in the case of Mathematics) effects which are not statistically different from zero. For Writing, the point estimate is 0.2% of a standard deviation for a 10% point increase in childcare availability, which would increase point scores by just 0.1% compared to the average. Results for outcomes at age eleven can be found at the bottom of Table 4. Here we see a positive and statistically significant effect of access to free places on test results in Reading and a zero effect on Mathematics. The effect on Reading amounts to a 0.2% increase with respect to the mean for a 10 percentage point increase in free places. This is a very small improvement. Overall, these results indicate that the gains in children's academic outcomes at age five are not sustained through to the end of primary school.[27,28]

[27]This fade-out is a common empirical finding in many studies analysing early educational interventions. Cascio and Staiger (2012) investigate whether this is an artifact of the standardisation of test scores in a situation where the distribution of skills widens with age, but do not find evidence that this can fully account for it.

[28]Although children's attainment over the primary school years is not measured on the same scales, the

Columns (5) and (6) of the Table show results when cutting the data by gender. We can see at age five that point estimates are higher and more precisely estimated for boys than girls for all outcomes, indicating that boys benefit more from access to free places than girls. Differences in the effect of nursery attendance by gender are a fairly common finding in the literature (see for example Havnes and Mogstad, 2011; Felfe et al., 2014; Datta Gupta and Simonsen, 2010), but most authors find that girls benefit more from early education than boys. However, none of the gender differences we find are statistically significant. At ages seven and eleven the point estimates are very similar between boys and girls, and any differences are not statistically significant.[29]

5.2 Robustness checks

Before proceeding further with the analysis by sub-group and exploring possible mechanisms, we test the robustness of our main results, concentrating on outcomes observed at age five, where we find some impacts of the policy. We address here a number of concerns. Our first set of tests scrutinizes our main identifying assumption that the gradual roll-out of places is not related to anything else that predicts children's educational outcomes, given our controls. One way to check this is to carry out a placebo analysis where we assign to the cohorts of children in our sample free places two years into the future, i.e. we use places for the years 2004-2009 instead of 2002-2007. A child's performance should not be related to the availability of future pre-school places - apart from the fact that there is naturally serial correlation in availability of places over time when identifying estimates off a policy expansion. Therefore, if we find statistically significant effects of future places on age five outcomes, this could indicate that other factors that we are not sufficiently controlling for are biasing our results. Table 5 displays results for the placebo test in column (2), whereas column (1) displays our baseline estimates. We see that the effects of availability of free places

correlation of the test scores over time is very high. For example, the raw correlation between Numeracy at age five and Mathematics at age seven is 0.60, while the correlation between Literacy at age five and Reading at age eleven is 0.65.

[29] In Appendix Table A2 we display results for the other learning areas assessed at age five (Knowledge & Understanding of the World, Physical Development and Creative Development). As we can see, there is some evidence that the expansion in the availability of free places had a positive impact on these outcomes, and on Creative Development in particular, but the size of the effect is once again very small. We also consider whether the policy affected the likelihood that a child would be identified by the school as having Special Education Needs (SEN) because of learning difficulties or behavioural problems. As shown in the lower panel, there is no evidence that this was the case throughout the primary school years.

on child outcomes are no longer statistically significant when assigning future places, and all point estimates are considerably reduced, particularly for the Foundation Stage Profile score.

We further experiment with different ways of controlling for area-level time-varying characteristics and trends. In column (3) we present results of estimates that control - in addition to all the controls included in the baseline model - for a full set of interactions between the starting levels of our area-level economic controls (i.e. 2002 levels of female employment rates; hourly pay; proportion of working-age individuals qualified at NVQ3 (high school) and NVQ4 (college) level) and cohort fixed-effects. We find that our results hold, being only slightly smaller in magnitude than the baseline results in column (1) and mostly statistically significant. Next, in column (4), we control for area-specific time trends instead of including interactions of pre-treatment availability of free places and cohort fixed effects. This could be seen as an alternative way of checking that unobserved (and area-specific) drivers of the roll-out are not correlated with our measure of availability. Again, the results are qualitatively similar to what we saw before.

Our next robustness check addresses the concern that children may sort into schools of different quality depending on whether they have accessed pre-school education at age three. For example, if children with pre-school experience sorted into schools that are worse on average than other schools, the fact that the impacts of free places is so small could be the result of bad schools undoing the benefits of pre-school education. On the other hand, if children with pre-school experience sort into better schools, our estimated effects will be biased upwards. To guard against these sources of bias, we estimate our models using school rather than LEA-level fixed effects. This should eliminate all the school-level differences between children. Table 5 displays the results of this exercise for our four outcomes at age five in column (5). We can see that the point estimates in the models based on LEA and school-level fixed effects are very similar, indicating that sorting into different schools is not driving the effect. Note, however, that by using school fixed effects we cannot control for within school differences. For example it may be that schools concentrate their efforts on children who have not benefited from pre-school. In this case our effects of pre-school availability would be underestimated. This could be one reason why the effects of free place availability fade out over time, but we have no way of investigating this empirically.

Finally, recent work by Greaves et al. (2014) reveals sharp improvements in end-of-primary school tests from 1999 onwards which are part of wider improvements in educational outcomes in London. Given that we are relying on area-level changes in outcomes it is important to ensure that our results are not biased by these strong secular changes. We therefore allow for differential trends in outcomes among children educated in London by including in our model an interaction between a London dummy and a year trend. As column (6) of Table 5 shows, our results are robust to this check.

5.3 Heterogeneity

Our baseline results indicate a small positive impact of access to free childcare places on outcomes at age five which largely fade out by the end of primary school. However, it may be that larger positive effects are concentrated on subgroups of the population. In particular we are interested to see whether children from lower socio-economic backgrounds stand to gain more from the policy than their more affluent peers. Our descriptive analysis indicates that the policy displaced informal and parental care among lower socio-economic children. As this is likely to be, on average, of worse quality than formal pre-school education, we expect larger benefits for these children.

The subgroup analysis makes use of available indicators of family background, including free school meal eligibility, neighbourhood deprivation and language spoken at home. These measures each reflect slightly different things, with free school meal status capturing low family income[30] and neighbourhood deprivation capturing income deprivation of the area of residence, dividing neighbourhoods into tertiles. Families that do not speak English at home are not necessarily income deprived, but the children are likely to have difficulties with English that pre-school participation could address (see Dustmann et al., 2013).

Table 6 shows the baseline estimates for outcomes at ages five, seven and eleven in column (1). Columns (2) and (3) present the results when splitting the sample by free school meal status. We estimate sub-group effects by entering complete interaction terms into our model. We can see that point estimates are slightly higher for children from lower income families at

[30]Free school meal eligibility is linked to parents' receipt of means-tested benefits such as income support and income-based job seeker's allowance and has been used in many studies as low-income marker, however see Hobbs and Vignoles (2010) for some shortcomings.

ages five and eleven (but not at age seven). None of the differences are statistically significant and are mostly quantitatively small. For example, the estimated difference in standardised FSP scores between children with and without free school meal eligibility is 0.014, with a 95% confidence interval of (-0.02 to 0.05). Columns (4)-(6) show results by neighbourhood deprivation tertile. The differences in point estimates suggest higher effects of the policy on outcomes of children living in more deprived neighbourhoods (with the exception of age seven), but these differences are again not statistically significant (only the difference between top and bottom deprivation tertiles at age eleven is significantly different from zero at the 10% level).

Finally, columns (7) and (8) display results by language spoken at home. At all ages the point estimates are higher for children who do not speak English at home, and the group differences are higher than for the other group comparisons. For example, the estimated difference in standardised FSP scores between children who do and do not speak English at home is 0.026 with a confidence interval of (-0.01 to 0.07). In Literacy and Social development at age five, the benefits accruing to children for whom English is an additional language are four times higher than for children who speak English as their first language. However, standard errors are relatively large and group differences not statistically significant, with the exception of Mathematics at age seven.

In summary, we find no strong evidence that children from lower socio-economic backgrounds have benefited more from an improvement in access to childcare places than children from less deprived backgrounds. Despite the fact that the availability of a large estimation sample allows us to consider the effects for relatively small groups of the population, there are no statistically significant or - because of the small absolute size of the effect in each case - economically meantingful differences to highlight. This is not what we expected, based on our evidence of changes in childcare use and results from the previous literature (e.g. Dustmann et al. 2013; Felfe et al., 2014; Havnes and Mogstad, 2011). The next section explores the mechanisms that may be driving these results.

6 Mechanisms

In this section we explore the mechanisms - or implicit treatment effects - underlying the overall impact of the policy. Specifically, we investigate participation and income effects as well as impacts on maternal employment, and use results from other studies to comment on the role played by childcare quality.

6.1 Participation and crowd-out

The descriptive evidence presented in Figure 1 showed that the increase of free places in the early 2000s was not accompanied by an equivalent increase in the number of three-year-olds participating in pre-school. As discussed earlier, while free places went up by 20.4 percentage points between 2002 and 2007, our sample period, childcare participation increased by only 11.8 percentage points. We now examine the 'first stage' relationship more formally by estimating area-level regressions of total pre-school participation on the proportion of available free places and the same set of controls we use in our outcome equations, using population weighted means of individual characteristics as controls.[31]

We present in column (1) of Table 7 results for the whole sample. The estimated coefficient shows that between 2002 and 2007 only 2.8 genuinely new places were created for every 10 places that were funded. This confirms that the policy crowded out parental investments into pre-school education to a large extent, and primarily worked as a transfer of resources to parents who would have used paid-for childcare in absence of the policy, giving rise to possible income effects. In the first year of the roll-out funders received £1,130 per child, but the benefit to parents depends upon the fees which they would have paid under the previous private arrangement; these were likely to be greater than the funding received in most settings.

Given the large crowd-out we want to consider whether the effects from access to free places on child outcomes are a result of income transfers to parents (who might invest these into the development of their children, e.g. by buying books) or if they are primarily participation effects. To investigate this we split the areas in our sample into two halves,

[31] We omit initial level of places-by-cohort interactions here because they are highly collinear with our main variable of interest, free places.

a group where a high proportion of funded places led to increase in childcare participation ('complier LEAs') and a group where the crowd-out of parental investments was high ('non-complier LEAs').[32] Table 7 shows the first stage relationship for complier and non-complier LEAs in columns (2) and (3). In complier LEAs almost half (47%) of the increase in funded places led to increased pre-school participation, whereas in non-complier LEAs only around 22% of the expansion in funded places translated into higher take-up. We would expect that any observed effects in complier LEAs are driven primarily by more children participating in pre-school. In non-complier LEAs positive effects would be more likely driven by income effects.[33,34]

Table 8 displays the results of our estimates by LEA complier status, using a fully interacted model as before. Column (1) displays our baseline estimates, column (2) shows results for children living in complier LEAs and column (3) for children living in non-complier LEAs. Comparing columns (2) and (3) we can see that at all ages the point estimates are higher in complier areas. At age five results for these areas are sizable and precisely estimated, while results for the LEAs that did not translate free places into additonal take-up (high crowd-out areas) show no improvement of child outcomes as a result of expanding free places. The differences between complier and non-complier LEAs are statistically significant for all outcomes at 10% or higher. This suggests that the overall impact of the policy of making pre-school free are more likely to be driven by participation effects rather than income effects.[35] However, the results of Table 8 also highlight that the positive effects seen at age five fade out very quickly, even in complier LEAs. We also check whether in complier areas the benefits of the policy are concentrated on the most disadvantaged children by performing

[32]Specifically we split the areas in our sample in half based on the ratio between change in all childcare over our sample years and change in subsidized childcare over our sample years.

[33]Both complier and non-complier LEAs might have experienced improvements in childcare quality at the same time, as providers registered for funding status and had to comply with quality regulations. We are unable to separately identify such quality effects, but as both types of areas are similarly affected this should not affect the comparison of income vs. participation effects.

[34]Note that complier LEAs differ from non-compliers in key characteristics, with compliers being on average more deprived (see Appendix Table A3 for details on these differences). As we control comprehensively for differences in area characteristics this should not affect the comparison.

[35]Using the first stage estimates to scale up results (and therefore assuming that all effects were through participation) we can conclude that in absence of crowd-out a 10 percentage point increase in childcare availability would have increased the total FSP score by about 7.9% of a standard deviation (dividing the point estimates in column (1) of Table 8 by the corresponding first stage estimate in Table 7). For an individual taking up childcare who would not otherwise have done so, this implies an impact of 79% of a standard deviation.

subgroup analysis on children in complier areas. Results for age five outcomes are shown in Appendix Table A4, and demonstrate that patterns are similar as for the whole sample, with point estimates somewhat higher for more disadvantaged than less disadvantaged children but differences mostly not statistically different from zero.

6.2 Maternal labour market behavior

Another possible mechanism underlying the overall impact of the free entitlement is maternal labour supply. Increasing maternal labour supply was one of the aims of the policy. In principle, this could affect child outcomes negatively through a reduction in mothers' time available for child investments and/or positively through an associated increase in available income. In Table 9 we present estimates of the effect of childcare availability on different measures of maternal labour market behavior. These estimates are based on data from the Labour Force Survey for the time period 2002-2007 and focus on mothers with three year old children. As we can see, a 10 percentage point increase in coverage due to the expansion in free places has a very small effect on all of the measures of maternal labour market behavior considered in the Table and standard errors are large, i.e. any effects are not statistically significant. This is evidence that there are no significant or sizeable effects of the free entitlement on child outcomes operating through maternal employment.

In a related paper, Brewer et al. (2014b) estimate the effect of the free entitlement in England on maternal employment over a longer period (2000-2008) and using two-year-olds as control group in a difference-in-difference framework. The point estimates suggest positive effects on most outcomes, but these are not statistically significant. When focusing the analysis on mothers whose youngest child is aged three, the results indicate a statistically significant 0.6% increase in mother's employment for a 10 percentage point increase in available places. This indicates that - if anything - effects on maternal employment affected a subgroup of children, but this should not have a large impact on mean outcomes of all children.

6.3 Childcare quality

We have so far not offered an explanation about why the impact of free nursery places in England has been short-lived and unable to deliver the anticipated narrowing in socio-economic gaps in attainment. We know that crowd-out provides part of the explanation for the overall small impacts of the policy, but even in areas where crowd-out was lower the impact of the policy did not persist and was not much larger for more disadvantaged groups (Appendix Table A4).

A unique feature of the free entitlement in England is that the expansion relied exclusively on private settings to provide the new places. We have already stated that these nurseries have lower qualifications requirements for staff than do public nurseries, with studies showing that less than 40% of children in private nurseries have a teacher present, compared to 100% in public nurseries (Gambaro et al., 2013). The presence of a graduate is a key driver of observed quality, a finding confirmed by the evaluation of the Graduate Leader Fund which demonstrates that private settings which gained a graduate leader were able to improve the quality offered significantly compared with those who did not (Ranns et al., 2011).

Public nurseries also have higher quality based on detailed observation of classroom practice and adult-child interactions (Sylva et al., 2004). Although there has been some improvement in quality since the free entitlement came into effect, Mathers et al. (2007) show that gaps between publicly provided childcare and private settings remain. The lack of long-term effects we find in this paper might be a consequence of insufficient attention to the quality of the newly funded private places.

A close examination of the distribution of private settings by quality can also help to explain why the policy failed to close gaps by socio-economic status. Poorer children are somewhat protected in the UK because they are more likely to access high quality public early education (Gambaro et al., 2013). However, as the new places funded under the free entitlement were in private settings, we need to understand how that sector caters for those who are less privileged. Gambaro et al. (2013) show that private nurseries serving less advantaged children are likely to obtain worse quality inspection ratings than average and children are less likely to have contact with a graduate. This picture is confirmed by Mathers and Smees (2014) who use researcher-observed measures of quality and show that

disadvantaged children are usually in private pre-schools with poorer staff-child interactions and less support for language development. Although we have no way of testing this formally, this indicates that heterogeneity in access to good quality private providers by family background could explain why the free entitlement for three-year-olds was not successful in reducing socio-economic gaps in children's educational attainment.

7 Conclusions

The UK government spends almost £2 billion every year to provide universal part-time pre-school education to children aged three and four. Like many other OECD countries that have introduced universal childcare, the government is hoping to improve child outcomes, narrow attainment gaps between children from different backgrounds and increase female labour participation. In contrast to many other countries, universalism was achieved in England by paying private providers a fixed amount for all eligible children in their care, rather than by providing public childcare directly.

This paper exploits the staggered introduction of the entitlement to free pre-school for three-year-olds in England to investigate the effect of the policy on child outcomes at ages five, seven and eleven based on a census of children in primary state schools. In our empirical model we control extensively for area characteristics that might be correlated with the build up of free places and at the same time influence child outcomes. We find that a 10 percentage point increase in the proportion of three-year-olds covered by free places improves cognitive and non-cognitive outcomes at age five by 2% of a standard deviation. There are no apparent benefits by age eleven, however it is important to appreciate that our outcomes mostly measure educational attainment, so that it is possible that effects on other outcomes went unnoticed and that longer-term outcomes such as reduced crime (Heckman et al. 2010) may emerge in the future.

The positive effects observed at age five are the ITT effects which capture the full impact of the policy, and we investigate in detail the mechanisms underlying the effects. We observe that crowding out of privately paid formal care is substantial with less than one in every three newly funded places between 2002 and 2007 providing a genuinely new place. It is possible that positive effects come about because families have more money at their disposal, but

evidence suggests this is not the case. Maternal labour supply also does not seem to have been affected by the policy for the cohorts in our sample. Rather, the positive age five effects seem to be driven by increases in formal childcare use. Effects are small, in part, because participation did not increase very much.

We document that lower socio-economic status children have increased participation in formal pre-school most, switching out of care by parents, friends and family. However, contrary to expectations, disadvantaged children do not benefit substantively more from the free entitlement than their more affluent peers. One likely explanation is the fact that all the new places resulting from the policy were created in the private sector. This sector is subject to less regulation in England compared to publicly provided childcare, it has fewer qualified teachers and is less good in terms of pedagogical quality. There is evidence that private nurseries which serve poorer children are particularly bad on these measures, helping to explain why the policy had so little success in reducing gaps in cognitive development between children from different backgrounds. Quality issues could also be responsible for the substantial fade-out of the initial benefits observed at age five by age seven and eleven. We conclude that if universal childcare is to be achieved through expansion of private sector provision, as in our case, it is of paramount importance to set strict quality regulations to participating providers.

In the UK 2015 election campaign all political parties have pledged expansions in free childcare in terms of either more hours or the extension to younger children. Given the results we have found, it is hard to imagine that this will have a substantial positive impact on children's outcomes, although it will of course help family finances.

References

Almond, D. and J. Currie (2011), "Human Capital Development before Age Five", in: Ashenfelter, O., Card, D. (Eds.), *Handbook of Labor Economics*, vol. 4B. Elsevier, Amsterdam.

Baker, M., J. Gruber and K. Milligan (2008), "Universal Child Care, Maternal Labor Supply, and Family Well-Being", *Journal of Political Economy*, 116(4): 709-745.

Barnett, W. S. (1995)"Long-Term Effects of Early Childhood Programs on Cognitive School Outcomes", *The Future of Children*, 5(3): 2550.

Berlinski, S., S. Galiani and M. Manacorda (2008), "Giving children a better start: pre-school attendance and school-age profiles", *Journal of Public Economics*, 92(5-6): 1416-1440.

Berlinski, S., S. Galiani and P. Gertler (2009), "The effect of pre-primary education on primary school performance", *Journal of Public Economics*, 93: 219-234.

Black, S., P. J. Devereux, K. V. Løken and K.G. Salvanes (2014), "Care or cash? The effect of child care subsidies on student performance", *The Review of Economics and Statistics*, 96(5): 824-837.

Brewer, M., S. Cattan, C. Crawford and B. Rabe (2014) "The impact of free, universal pre-school eduation on maternal labour supply", available from https://www.iser.essex.ac.uk/files/projects/the-effect-of-free-childcare-on-maternal-labour-supply-and-child-development/maternalemp.pdf

Cascio, E.U. and D. O. Staiger (2012), "Knowledge, Tests, and Fadeout in Educational Interventions", NBER Working Paper No. 18038.

Carneiro, P., Heckman, J. (2004), Human Capital Policy. In: Friedman, B. (Ed.), *Inequality in America: What Role for Human Capital Policies*, MIT Press, Cambridge.

Cunha, F. and J.J. Heckman (2008), "Formulating, Identifying and Estimating the Technology of Cognitive and Noncognitive Skill Formation", *Journal of Human Resources*, 43(4): 738-782.

Datta Gupta, N. and M. Simonsen (2010) "Non-cognitive child outcomes and universal high quality childcare" *Journal of Public Economics*, 94(1-2): 30-43.

Department for Education and Science (1990), "Starting with Quality: Report of the Committee of Enquiry into the Quality of Education Experience Offered to Three and Four Year Olds". Rumbold Report. London: HMSO.

Department for Education and Employment (1999), "Early Years Development and Childcare Partnership Guidance 2000-2001."

Dickson, M. (2008) "The Effect of Free Pre-School Education on Childrens Subsequent Academic Performance: Empirical Evidence from England", University of Warwick, Unpublished Manuscript.

Duflo, E. (2001), "Schooling and labor market consequences of school construction in Indonesia: evidence from an unusual policy experiment", *American Economic Review*, 91(4): 795813.

Dumas, C. and A. Lefranc (2012), "Early schooling and later outcomes : Evidence from pre-school extension in France", in J. Ermisch, M. Jantti and T. Smeeding (Eds.) *From Parents to Children: The Intergenerational Transmission of Advantage*, Russell Sage Foundation, New York.

Dustmann, C., A. Raute and U. Schoenberg (2013), "Does Universal Child Care Matter? Evidence from a Large Expansion in Pre-School Education", unpublished manuscript.

Eisenstadt, N. (2011) *Providing a Sure Start*, Policy Press, Bristol.

Felfe, C. and R. Lalive (2014), "Does Early Child Care Help or Hinder Child Development?", IZA discussion paper, No. 8484.

Felfe, C., N. Nollenberger and N. Rodriguez-Planas (2014), "Universal Child Care and Childrens Long-term Cognitive Development: Evidence from a Natural Experiment", *Journal of Population Economics*, forthcoming.

Fitzpatrick, M.D. (2008) "Starting School at Four: The Effect of Universal Pre-Kindergarten on Children's Academic Achievement", *B. E. Journal of Economic Analysis and Policy*, 8(1).

Gambaro, L., Stewart, K. and J. Waldfogel (2013), "A question of quality: Do children from disadvantaged backgrounds receive lower quality education and care in England?" in L. Gambaro, K. Stewart and J. Waldfogel (2014) (Eds.) *An Equal Start? Providing quality education and care for disadvantaged children*, Policy Press, Bristol.

Gormley, W.T. and T. Gayer (2005), "Promoting School Readiness in Oklahoma", *Journal of Human Resources*, 40(3): 533-558.

Greaves, E., L. Macmillan and L. Sibieta (2014) "Lessons from London Schools for Attainment Gaps and Social Mobility". Social Mobility and Child Poverty Commission Research Report.

Harries, T., La Valle, I. and S. Dickens (2004), *Childcare: How Local Markets Respond to National Initiatives*, Department for Education and Skills Research Report RR526.

Havnes, Y. and M. Mogstad (2011), "No Child Left Behind: Subsidized child care and children's long-run outcomes", *American Economic Journal: Economic Policy*, 3(May): 97-129.

Heckman, J., S. Moon, R. Pinto, P. Savelyev, A. Yavis (2010) "The rate of return to the High Scope Perry pre-school Program", *Journal of Public Economics*, 94(1-2): 114-128.

Hobbs G., and A. Vignoles (2010), "Is free school meal eligibility a good proxy for family income?" *British Educational Research Journal*, 36(4): 673-690.

Karoly, L.A., Kilburn, R.M. and J.S. Cannon (2005). *Early Childhood Interventions: Proven Results, Future Promise*. Santa Monica, CA: RAND Corporation.

Lewis, J. and C. Lee (2002) "Changing Family Structure and Social Policy: Childcare services and social cohesion, UK report" Available from http://www.emes.net/what-we-do/research-projects/personal-and-social-services/tsfeps. Accessed 4th September 2014.

Mathers, S., K. Sylva and H. Joshi (2007), "Quality of Childcare Settings in the Millennium Cohort Study", Research Report S SU/2007/FR/025. HMSO, London.

Mathers, S. and R. Smees (2014) Quality and Inequality: Do three and four year olds in deprived areas experience lower quality provision, Nuffield Foundation.

Mathers S., Singler R., Karemaker A. (2012) Improving Quality in the Early Years: A Comparison of Perspectives and Measures. Family and Daycare Trust.

Merrell, C. and P. Tymms (2011), " Changes in Children's Cognitive Development at the Start of School in England 2001-2008", *Oxford Review of Education*, 37(3): 333-345.

National Audit Office (2004), "Progress in developing high quality childcare and early education accessible to all," National Audit Office, London.

National Audit Office (2012), "Delivering the free entitlement to education for three- and four-year-olds." National Audit Office, London.

Nutbrown, C. (2012), *Foundations for quality. The independent review of early education and childcare qualifications. Final Report.* London: DfE.

Osgood, J. and C. Sharp (2000), *Developing Early Education and Childcare Services in the 21st Century*, National Foundation for Education Research, Report 12.

Pugh, Gillian (1996), Contemporary Issues in the Early Years. 2nd edn. London: Paul Chapman Publishing.

Rabe, B. and M. Taylor (2010), "Residential mobility, quality of neighbourhood and life course events", *Journal of the Royal Statistical Society, Series A* 172(3): 531-555.

Ranns, H., S.Mathers, A. Moody, A. Karemaker, J. Graham, K. Sylva and I. Siraj-Blatchford (2011) "Evaluation of the Graduate Leader Fund: Evaluation Overview" Department for Education Research Report: DFE-RR144d.

Smith, T et al, K. Sylva and S. Mathers, I. La Valle et al and L. Dearden et al (2007) "National Evaluation of the Neighbourhood Nurseries Inititative Integrated Report" Sure Start Unit, Department for Education and Skills.

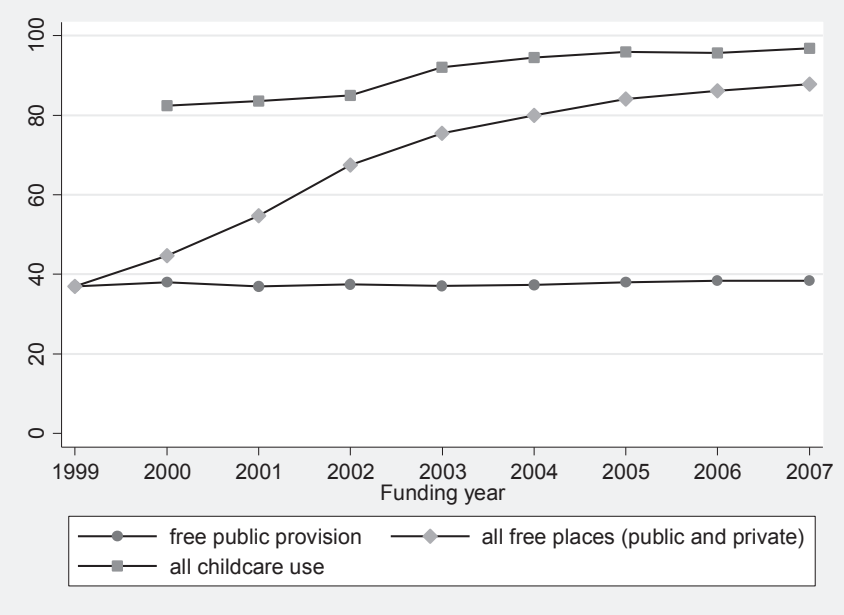
Stewart, K. (2013) "Labours Record on the Under Fives: Policy, Spending and Outcomes 1997-2010. Social Policy in A Cold Climate". Working Paper 4, Centre for Analysis of Social Exclusion. London: London School of Economics.

Strategy Unit (2002). Delivering for Children and Families: Interdepartmental Childcare Review. http://dera.ioe.ac.uk/8814/2/su%20children.pdf, accessed 31st July 2014.

Sylva, K., E. Melhuish, P. Sammons, I. Siraj-Blatchford and Brenda Taggart (2004)" Effective Pre-School Education", The Effective Provision of Pre-School Education (EPPE) Project: Final Report. Institute of Education: London

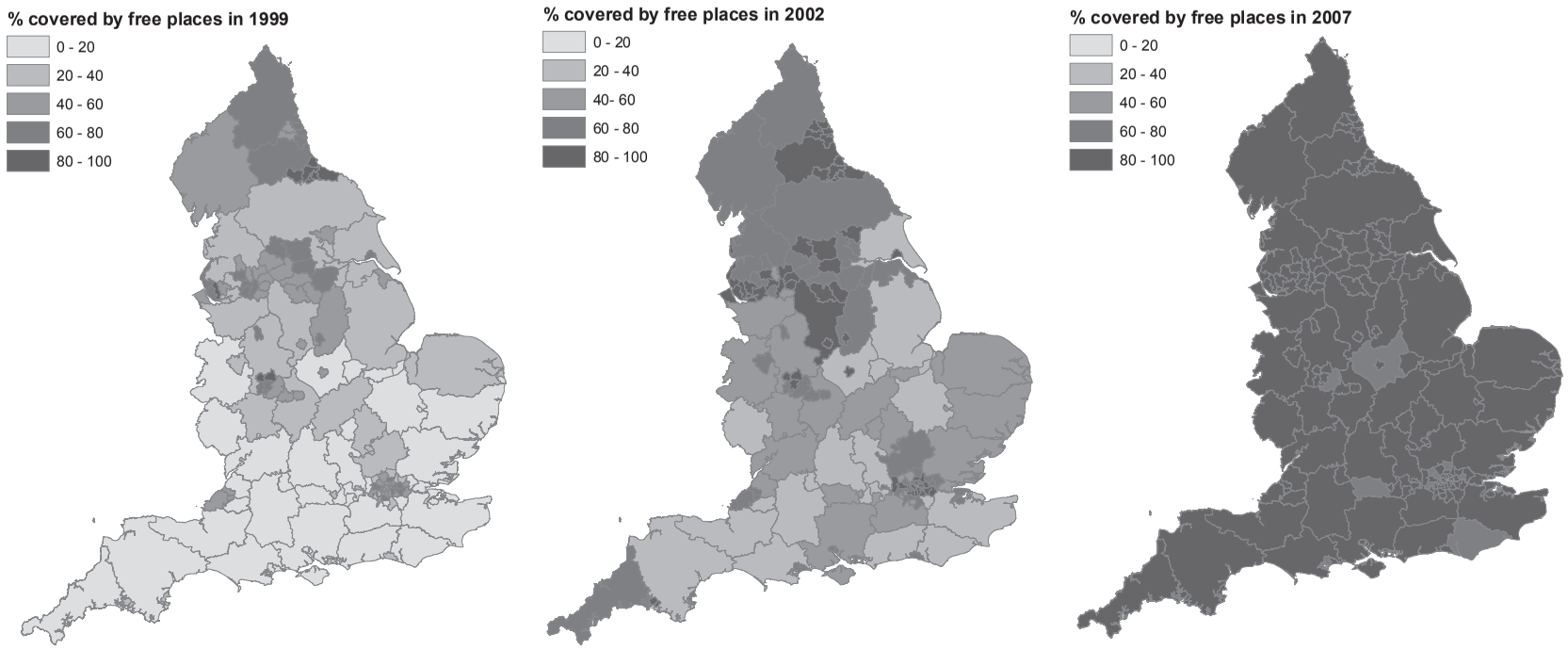
Ward, K., A. Sullivan and Bradshaw (2007) 'Income and Wealth' in K. Hansen and H. Joshi "Millennium Cohort Study Second Survey: Users Guide to Initial Findings' CLS, London.

Figure 1: Percentage of 3-year-olds in pre-school education



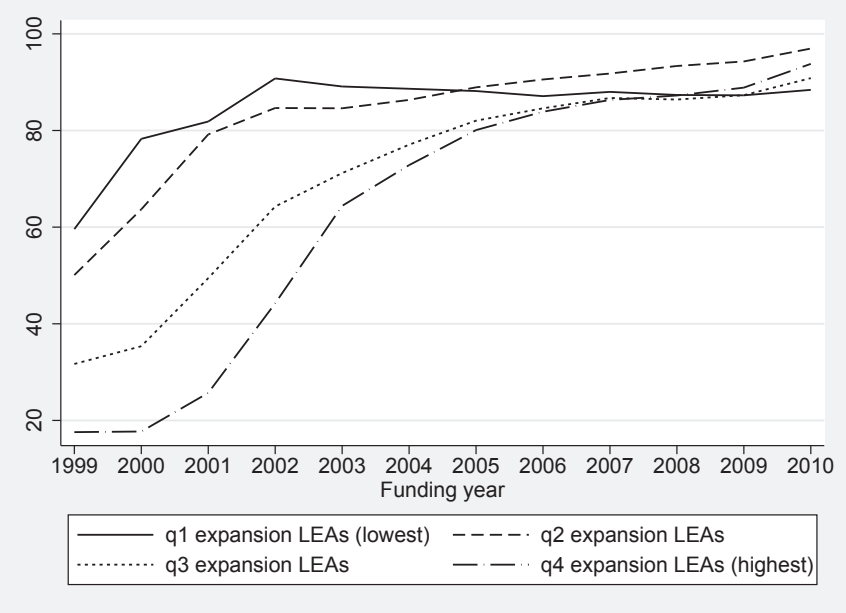
Notes: Department for Education LEA-level data, aggregated using Office for National Statistics population weights. All chidcare use includes free places and privately funded places.

Figure 2: Free nursery places for 3-year-olds across England, 1999, 2002 and 2007



Notes: Department for Education LEA-level data.

Figure 3: Expansion of free nursery places for 3-year-olds across England, 1999-2007



Notes: Department for Education data. The graph shows the build-up of free places by expansion quartile. Quartile 1 are the 25% LEAs that expanded least between 2002 and 2007, quartile 4 the 25% LEAs with most expansion between 2002 and 2007.

Table 1: Changes in childcare use 2001-2007 by parental background

	Δ formal care (centre based)	Δ informal care (family and friends)	Δ exclusive parental care	Δ other care (childminder, nanny, etc.)
	(1)	(2)	(3)	(4)
All	18.3**	-1.7	-7.1**	1.3
	(2.274)	(2.330)	(1.916)	(1.642)
		mean of childcare use in 2001		
	62.9%	*32.5%*	*20.3%*	*11.9%*
Family income				
Lowest income band	25.8**	0.7	-13.6*	2.0
	(5.847)	(5.771)	(5.431)	(2.703)
2nd income band	15.3**	-10.9*	-1.3	-2.9
	(4.668)	(4.633)	(3.952)	(3.199)
3rd income band	14.1**	0.7	-3.6	1.6
	(4.771)	(5.090)	(3.950)	(3.600)
Highest income band	15.6**	3.7	-8.2**	3.4
	(3.777)	(4.495)	(2.761)	(3.660)
Income missing	24.4**	-6.2	-8.7	-1.6
	(8.824)	(8.153)	(8.054)	(4.818)
Housing tenure				
Social or private renter	24.9**	-4.5	-10.9**	1.2
	(4.352)	(3.936)	(4.031)	(2.531)
Home owner	16.9**	1.2	-7.2**	2.4
	(2.570)	(2.918)	(2.040)	(2.121)
Social class				
Semi-skilled and unskilled	28.1**	0.2	-13.7**	-0.3
	(5.232)	(5.177)	(4.805)	(2.986)
Skilled manual	34.6**	-19.4*	-12.4+	4.8
	(8.529)	(8.202)	(7.800)	(4.726)
Skilled non-manual	16.0**	0.4	-9.5**	4.6+
	(3.776)	(4.024)	(3.086)	(2.675)
Professional and managerial	14.6**	1.9	-6.0*	-0.1
	(3.846)	(4.434)	(2.747)	(3.699)
Social class missing	2.7	-7.4	15.4**	-4.0
	(9.045)	(6.978)	(7.867)	(5.221)

Notes: Parents Demand for Childcare Survey 2001 and Childcare and Early Years Provision: Parents Survey 2007. Sample size is 592 in 2001 and 1,242 in 2007. Sampling weights applied. Income bands in 2001 are less than £10,400; £10,400-£20,799; £20,800-£31,999; £32,000+. Income bands in 2007 are less than £10,000; £10,000-£19,999; £20,000-£29,999; £30,000+. + p < .10, * p < .05, ** p < .01. Standard errors between parenthesis.

Table 2: Identifying variation in free places

	Mean	Std. Dev.	Min	Max
Free places	80.14	13.55	25.68	114.09
- net of individual characteristics	0.00	13.17	-57.87	38.14
- net of cohort and LEA FE	0.00	7.48	-53.87	60.43
- net of LEA characteristics	0.00	6.98	-52.50	66.28
- net of $places_{2002}$ * cohort FE	0.00	4.47	-77.85	83.95
N	3.2m			

Notes: National Pupil Database, 2003-2010. The first row summarises free places. Rows 2-5 summarise the residuals of regressions containing the controls listed in the Table; where individual and LEA-level controls are listed in Appendix Table A1.

Table 3: Summary statistics for child outcomes at ages 5, 7 and 11

	All		Girls		Boys		FSM		not FSM	
	mean	std dev	mean	std dev	mean	std dev	mean	std dev	mean	std dev
Raw Foundation Stage Profile (FSP) point scores (age 5)										
FSP total	87.48	18.58	90.17	17.46	84.84	19.32	78.44	20.13	89.36	17.71
Literacy	25.22	7.02	26.35	6.65	24.13	7.21	21.77	7.31	25.95	6.74
Numeracy	20.42	4.77	20.72	4.50	20.11	5.01	18.18	5.37	20.89	4.50
Social	21.09	4.33	21.80	3.99	20.40	4.54	19.42	4.68	21.44	4.18
Raw Key Stage 1 point scores (age 7)										
Reading	15.78	3.86	16.08	3.95	14.99	4.27	13.57	4.35	16.00	3.91
Writing	14.72	3.59	15.14	3.67	13.82	4.01	12.70	4.26	14.87	3.63
Maths	15.87	3.24	15.60	3.28	15.70	3.76	14.21	3.68	15.98	3.39
Raw Key Stage 2 point scores (age 11)										
Reading	30.99	9.29	32.03	9.07	29.98	9.40	27.06	9.44	31.80	9.05
Maths	68.94	20.44	67.67	20.37	70.19	20.42	60.81	21.13	70.61	19.88

Notes: National Pupil Database, 2003-2010. Weights applied for age 5 outcomes. FSM is eligible for free school meals. Literacy refers to the learning area communication, language and literacy; Numeracy is problem solving, reasoning and numeracy; Social is personal, social and emotional development.

Table 4: Effect of availability of free pre-school places on children's educational outcomes

	All FE X's (1)	All + LEA controls (2)	All + Places$_{2002}$ * cohort FE (3)	Girls (4)	Boys (5)
Standardised Foundation Stage Profile (FSP) point scores (age 5)					
FSP total	0.042*	0.030	0.022*	0.012	0.030**
	(0.021)	(0.019)	(0.010)	(0.011)	(0.011)
Literacy	0.018**	0.010	0.016+	0.005	0.026**
	(0.007)	(0.007)	(0.008)	(0.008)	(0.010)
Numeracy	0.021**	0.013+	0.016*	0.007	0.024*
	(0.007)	(0.007)	(0.008)	(0.009)	(0.009)
Social development	0.025**	0.014+	0.018+	0.012	0.023*
	(0.008)	(0.008)	(0.010)	(0.010)	(0.011)
N	1.2 m				
Standardised Key Stage 1 point scores (age 7)					
Reading	0.004	0.003	0.001	0.003	-0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Writing	0.005+	0.005	0.002	0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Maths	0.004	0.003	-0.001	-0.001	0.000
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
N	3.2 m				
Standardised Key Stage 2 point scores (age 11)					
Reading	0.001	0.003	0.006*	0.007**	0.005+
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Maths	-0.003	-0.001	-0.001	-0.002	-0.001
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
N	2.9 m				
Cohort & LEA FE	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes
LEA-level controls	No	Yes	Yes	Yes	Yes
Places 2002 * cohort FE	No	No	Yes	Yes	Yes

Notes: National Pupil Database, 2003-2010. Results are from separate linear fixed effects regressions, with weights applied for age 5 outcomes. Results for girls and boys are estimated jointly using complete gender interations. Availability of free pre-school is scaled from 0 to 10, so that a unit increase indicates a 10% point increase in available places. Literacy refers to the learning area communication, language and literacy; Numeracy is problem solving, reasoning and numeracy; Social development is personal, social and emotional development. Individual and LEA-level controls are listed in Appendix Table A1. Standard errors clustered at LEA level. + p < .10, * p < .05, ** p < .01.

Table 5: Robustness checks

	Baseline estimate	Placebo: future places	$Places_{2002}$ * economic variables	LEA* time trend instead of $Places_{2002}$ * Cohort FE	School FE	Controlling for London trend
	(1)	(2)	(3)	(4)	(5)	(6)
Standardised Foundation Stage Profile (FSP) point scores (age 5)						
FSP total	0.022*	-0.001	0.019*	0.032+	0.019*	0.022*
	(0.010)	(0.018)	(0.010)	(0.019)	(0.009)	(0.009)
Literacy	0.016+	0.009	0.016+	0.016*	0.013	0.017+
	(0.008)	(0.010)	(0.008)	(0.007)	(0.008)	(0.009)
Numeracy	0.016*	0.010	0.016+	0.013+	0.013+	0.018*
	(0.008)	(0.011)	(0.008)	(0.007)	(0.008)	(0.009)
Social development	0.018+	0.007	0.014	0.015+	0.016+	0.018+
	(0.010)	(0.014)	(0.010)	(0.008)	(0.010)	(0.010)
N	1.2 m					

Notes: National Pupil Database, 2003-2010. Baseline results are from separate linear fixed effects regressions, controlling for cohort and LEA fixed effects, 2002 levels of free places interacted with cohort fixed effects and individual and LEA-level controls listed in Appendix Table A1. Weights are applied. Results for girls and boys were estimated jointly using complete gender interactions. Availability of free pre-school is scaled from 0 to 10, so that a unit increase indicates a 10% point increase in available places. FSM is eligible for free school meals, EAL is English as additional language (non-native speaker). Literacy refers to the learning area communication, language and literacy; Numeracy is problem solving, reasoning and numeracy; Social development is personal, social and emotional development. Standard errors clustered at LEA level. + p < .10, * p < .05, ** p < .01.

Table 6: Effect of availability of free pre-school: sub-group analysis

	All	FSM	not FSM	affluent nbh	middle nbh	deprived nbh	EAL	not EAL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Standardised Foundation Stage Profile (FSP) point scores (age 5)								
FSP total	0.022*	0.034*	0.019*	0.010	0.019+	0.027+	0.044*	0.017+
	(0.010)	(0.014)	(0.009)	(0.011)	(0.011)	(0.014)	(0.018)	(0.009)
Literacy	0.016+	0.023+	0.015+	0.003	0.017+	0.024+	0.046**	0.012
	(0.008)	(0.013)	(0.008)	(0.009)	(0.009)	(0.013)	(0.017)	(0.008)
Numeracy	0.016*	0.026+	0.014+	0.003	0.016	0.023+	0.036+	0.013+
	(0.008)	(0.015)	(0.008)	(0.008)	(0.010)	(0.014)	(0.019)	(0.008)
Social dev.	0.018+	0.034*	0.014	0.005	0.016	0.021	0.046*	0.012
	(0.010)	(0.015)	(0.010)	(0.011)	(0.012)	(0.014)	(0.018)	(0.010)
N	1.2 m	0.2 m	1.0 m	0.4 m	0.4 m	0.4 m	0.2 m	1.0 m
Standardised Key Stage 1 point scores (age 7)								
Reading	0.001	-0.004	0.003	0.005+	0.001	0.001	0.008	0.003
	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.003)
Writing	0.002	-0.002	0.003	0.005	0.002	0.001	0.011+	0.003
	(0.003)	(0.005)	(0.003)	(0.004)	(0.004)	(0.005)	(0.006)	(0.003)
Maths	-0.001	-0.001	-0.000	0.001	-0.002	-0.001	0.011*	-0.000
	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.003)
N	3.2 m	0.6 m	2.7 m	1.1 m	1.1 m	1.1 m	0.5 m	1.8 m
Standardised Key Stage 2 point scores (age 11)								
Reading	0.006*	0.008+	0.006**	0.004	0.006+	0.013**	0.007	0.006*
	(0.002)	(0.005)	(0.002)	(0.003)	(0.003)	(0.004)	(0.005)	(0.002)
Maths	-0.001	0.003	-0.002	-0.001	-0.001	0.004	0.005	0.000
	(0.003)	(0.005)	(0.002)	(0.003)	(0.003)	(0.004)	(0.006)	(0.002)
N	2.9 m	0.5 m	2.4 m	1.0 m	1.0 m	1.0 m	0.4 m	2.5 m

Notes: National Pupil Database, 2003-2010. Results are from separate linear fixed effects regressions, controlling for cohort and LEA fixed effects, 2002 levels of free places interacted with cohort fixed effects and individual and LEA-level controls listed in Appendix Table A1. Weights are applied for age 5 outcomes. Results for groups are estimated jointly using complete interactions. Availability of free pre-school is scaled from 0 to 10, so that a unit increase indicates a 10% point increase in available places. FSM is eligible for free school meals. Literacy refers to the learning area communication, language and literacy; Numeracy is problem solving, reasoning and numeracy; Social development is personal, social and emotional development. Individual and LEA-level controls are listed in Appendix Table A1. Standard errors clustered at LEA level. + p < .10, * p < .05, ** p < .01.

Table 7: First stage: effect of free places on childcare participation

	(1) all LEAs	(2) complier LEAs	(3) non-complier LEAs
Free places	0.280**	0.465**	0.224**
	(0.045)	(0.164)	(0.049)
N	888	888	

Notes: Department for Education data, 2001-2007. Estimates are linear regressions at LEA level and include LEA and cohort fixed effects, population weighted LEA-means of individual characteristics and LEA controls listed in Appendix Table A1. Results by complier status are estimated jointly using complete interactions. Standard errors clustered at LEA level. + p < .10, * p < .05, ** p < .01.

Table 8: Income versus participation effects

	All	Complier LEAs	Non-complier LEAs
	(1)	(2)	(3)
Standardised Foundation Stage Profile (FSP) point scores (age 5)			
FSP total	0.022*	0.078**	0.000
	(0.010)	(0.027)	(0.011)
Literacy	0.016+	0.040**	0.003
	(0.008)	(0.013)	(0.010)
Numeracy	0.016*	0.048**	-0.001
	(0.008)	(0.012)	(0.009)
Social development	0.018+	0.055**	-0.003
	(0.010)	(0.015)	(0.012)
N	1.2 m	0.5 m	0.7 m
Standardised Key Stage 1 point scores (age 7)			
Reading	0.001	0.003	0.001
	(0.003)	(0.005)	(0.004)
Writing	0.002	0.003	0.002
	(0.003)	(0.005)	(0.004)
Maths	-0.001	0.002	-0.001
	(0.003)	(0.004)	(0.004)
N	3.2 m	1.4 m	1.8 m
Standardised Key Stage 2 point scores (age 11)			
Reading	0.006*	0.011**	0.003
	(0.002)	(0.004)	(0.003)
Maths	-0.001	0.003	-0.004
	(0.003)	(0.005)	(0.003)
N	2.9 m	1.3 m	1.6 m

Notes: National Pupil Database, 2003-2010. Results are from separate linear fixed effects regressions, with weights applied for age 5 outcomes. Results by complier status are estimated jointly using complete interations. Availability of free pre-school is scaled from 0 to 10, so that a unit increase indicates a 10% point increase in available places. Literacy refers to the learning area communication, language and literacy; Numeracy is problem solving, reasoning and numeracy; Social development is personal, social and emotional development. Individual and LEA-level controls are listed in Appendix Table A1. Standard errors clustered at LEA level. + p < .10, * p < .05, ** p < .01.

Table 9: Effect of childcare availability on maternal labour market behavior

	Participates in labour force	Employed	Works part time	Works full time	Actual weekly working hours (if employed)
	(1)	(2)	(3)	(4)	(5)
Free places (10ppt)	-0.003	-0.005	-0.002	-0.004	-0.196
	(0.067)	(0.070)	(0.079)	(0.059)	(2.982)
Cohort, month & LEA FE	Yes	Yes	Yes	Yes	Yes
Individual & LEA controls	Yes	Yes	Yes	Yes	Yes
Places 2002 * cohort FE	Yes	Yes	Yes	Yes	Yes
N	20,395	20,395	20,244	20,244	10,595

Notes: We thank Sarah Cattan, IFS, for producing this Table for us. Labour Force Survey, 2002-2007. The Table shows the effect of a 10 ppt increase in coverage of 3 year olds with funded places. Sample includes mothers observed between the beginning of the term after which their child turns 3 and the child's fourth birthday. Estimates include LEA, year and month of observation fixed effects and interactions of 2002 levels of free places with cohort fixed effects. Control variables include 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 total number of children aged 0-2, 3-4, 5-9, 10-15, and 16-19 in the household. LEA-level economic controls include average unemployment rate, employment rate and hourly wage level in the LEA of residence in the quarter preceding the quarter of observation. Contains the same early years controls as Table 2. + p < .10, * p < .05, ** p < .01. Standard errors clustered at LEA level in parenthesis.

Appendix Table A1: Summary statistics, Individual and LEA-level characteristics

	mean	std. deviation
Individual characteristics		
Female	0.49	
Eligible for free school meals	0.18	
No. of months older than August-born	5.48	3.48
English additional language	0.14	
White British	0.80	
Indian	0.02	
Chinese	0.00	
Black	0.05	
Pakistani/Bangladeshi	0.05	
Mixed ethnicity	0.04	
Other ethnicity	0.03	
IDACI deprivation score	0.23	0.19
LEA-level characteristics		
% 3-year olds with free childcare place/10	7.83	1.60
% qualified at NVQ4 level or higher (16-64)	25.19	6.58
% qualified at NVQ3 level or higher (16-64)	44.95	6.52
Employment rate (16-64), women	67.98	6.45
Mean gross hourly pay (2005 £)	12.03	1.92
No. of Sure Start Centres per 1000 children aged 0-4, moving av.	0.24	0.21
Other early years initiatives (2013 £), moving average	121.60	56.06

Notes: National Pupil Database, 2003-2010; Department for Education 2001-2007; Office for National Statistics; NOMIS workplace analysis. IDACI is Income Deprivation Affecting Children Index; deprivation is controlled for in the estimates using deciles.

Appendix Table A2: Effect of availability of free pre-school on other outcomes

	All FE X's (1)	All + LEA controls (2)	All + $places_{2002}$ * cohort FE (3)	Girls (4)	Boys (5)
Standardised Foundation Stage Profile (FSP) point scores (age 5)					
Knowledge & understanding of the world	0.020*	0.007	0.012	0.002	0.021*
	(0.009)	(0.009)	(0.010)	(0.011)	(0.011)
Physical development	0.020*	0.008	0.014	0.005	0.022*
	(0.008)	(0.008)	(0.009)	(0.009)	(0.010)
Creative development	0.023*	0.012	0.019+	0.014	0.025*
	(0.009)	(0.009)	(0.010)	(0.010)	(0.012)
Not having Special Educational Needs					
not SEN (age 5), mean: 0.91	0.003**	0.002*	0.002+	0.001	0.003+
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
not SEN (age 7), mean: 0.79	0.003**	0.002*	0.001	0.002*	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
not SEN (age 11), mean: 0.76	0.000	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cohort & LEA FE	Yes	Yes	Yes	Yes	Yes
individual controls	Yes	Yes	Yes	Yes	Yes
LEA-level controls	No	Yes	Yes	Yes	Yes
Cohort FE * places 2002	No	No	Yes	Yes	Yes

Notes: National Pupil Database, 2003-2010. Results are from separate linear fixed effects regressions, with weights applied for age 5 outcomes. Results for girls and boys are estimated jointly using complete gender interations. Availability of free pre-school is scaled from 0 to 10, so that a unit increase indicates a 10% point increase in available places. Individual and LEA-level controls are listed in Appendix Table A1. Standard errors clustered at LEA level. + p < .10, * p < .05, ** p < .01.

Appendix Table A3: Characteristics of complier and non-complier LEAs

	(1) complier LEAs	(2) non-complier LEAs	(3) difference (1)-(2)	(p-value)
Mean student characteristics (population weighted), 2002 cohort				
Eligible for free school meals	0.221	0.184	0.037*	(0.03)
No. of months older than August-born	5.468	5.463	0.005	(0.66)
English additional language	0.145	0.146	-0.001	(0.97)
White British	0.788	0.789	-0.001	(0.98)
Indian	0.025	0.025	0.000	(0.98)
Chinese	0.003	0.003	0.000	(0.75)
Black	0.064	0.045	0.019	(0.22)
Pakistani/Bangladeshi	0.041	0.057	-0.017	(0.22)
Mixed ethnicity	0.038	0.040	-0.002	(0.67)
Other ethnicity	0.040	0.040	0.000	(0.99)
Female	0.489	0.488	0.001	(0.56)
IDACI deprivation decile (affluent)	0.064	0.111	-0.047**	(0.00)
IDACI deprivation decile 2	0.075	0.099	-0.024**	(0.01)
IDACI deprivation decile 3	0.077	0.101	-0.025**	(0.00)
IDACI deprivation decile 4	0.079	0.100	-0.021**	(0.01)
IDACI deprivation decile 5	0.092	0.100	-0.007	(0.33)
IDACI deprivation decile 6	0.101	0.099	0.002	(0.70)
IDACI deprivation decile 7	0.109	0.093	0.016**	(0.01)
IDACI deprivation decile 8	0.129	0.093	0.037**	(0.00)
IDACI deprivation decile 9	0.136	0.093	0.043**	(0.00)
IDACI deprivation decile (deprived)	0.138	0.114	0.024	(0.30)
LEA characteristics, 2002				
Sure Start Centre coverage, moving average	100.30	89.47	10.830**	(0.01)
Other early years initiatives (£), moving average	0.141	0.088	0.054**	(0.00)
Free places (%)	80.44	63.45	16.990**	(0.00)
Mean gross hourly pay (£)	11.65	12.32	-0.670+	(0.09)
% qualified at NVQ4 level or higher (16-64)	22.56	24.77	-2.210+	(0.07)
% qualified at NVQ3 level or higher (16-64)	41.42	43.45	-2.030+	(0.08)
Employment rate (16-64), women	67.24	69.27	-2.030+	(0.06)
N	73	75		

Notes: National Pupil Database, 2004/05; Department for Education 2001/02; Office for National Statistics; NOMIS workplace analysis. IDACI is Income Deprivation Affecting Children Index. + p < .10, * p < .05, ** p < .01.

Appendix Table A4: Sub-group analysis for complier LEAs, age 5 outcomes

	All	FSM	not FSM	affluent nbh	middle nbh	deprived nbh	EAL	not EAL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Standardised Foundation Stage Profile (FSP) point scores (age 5)								
FSP total	0.078**	0.090**	0.074*	0.064	0.061*	0.082**	0.097**	0.068*
	(0.027)	(0.024)	(0.028)	(0.041)	(0.027)	(0.023)	(0.027)	(0.029)
literacy	0.040**	0.051**	0.038**	0.013	0.034*	0.057**	0.084**	0.031*
	(0.013)	(0.017)	(0.013)	(0.016)	(0.015)	(0.018)	(0.024)	(0.013)
numeracy	0.048**	0.062**	0.045**	0.020	0.039**	0.067**	0.084**	0.040**
	(0.012)	(0.020)	(0.012)	(0.014)	(0.015)	(0.019)	(0.026)	(0.012)
social	0.055**	0.081**	0.048**	0.020	0.043*	0.081**	0.113**	0.040*
	(0.015)	(0.020)	(0.016)	(0.018)	(0.018)	(0.020)	(0.027)	(0.015)
N	0.5 m							

Notes: National Pupil Database, 2003-2010. Sample includes complier LEAs only. Results are from separate linear fixed effects regressions, controlling for cohort and LEA fixed effects, 2002 levels of free places interacted with cohort fixed effects and individual and LEA-level controls listed in Appendix Table A1. Weights are applied. Results for groups are estimated jointly using complete interactions. Availability of free pre-school is scaled from 0 to 10, so that a unit increase indicates a 10% point increase in available places. FSM is eligible for free school meals. Literacy refers to the learning area communication, language and literacy; Numeracy is problem solving, reasoning and numeracy; Social development is personal, social and emotional development. Individual and LEA-level controls are listed in Appendix Table A1. Standard errors clustered at LEA level. + p < .10, * p < .05, ** p < .01.

CENTRE FOR ECONOMIC PERFORMANCE
Recent Discussion Papers

1351	David Atkin Benjamin Faber Marco Gonzalez-Navarro	Retail Globalization and Household Welfare: Evidence from Mexico
1350	Louis-Philippe Beland Richard Murphy	Ill Communication: Technology, Distraction & Student Performance
1349	Nicholas Oulton	Space-Time (In)Consistency in the National Accounts: Causes and Cures
1348	Gianluca Benigno Nathan Converse Luca Fornaro	Large Capital Inflows, Sectoral Allocation and Economic Performance
1347	Nitika Bagaria Barbara Petrongolo John Van Reenen	Can Helping the Sick Hurt the Able? Incentives, Information and Disruption in a Disability-Related Welfare Reform
1346	Mark Bryan Alex Bryson	Has Performance Pay Increased Wage Inequality in Britain?
1345	Christos Genakos Mario Pagliero Eleni Garbi	When Pressure Sinks Performance: Evidence from Diving Competitions
1344	David Marsden	The Future of the German Industrial Relations Model
1343	George Ward	Is Happiness a Predictor of Election Results?
1342	Nicholas Oulton Gavin Wallis	Integrated Estimates of Capital Stocks and Services for the United Kingdom: 1950-2013
1341	Camille Terrier	Giving a Little Help to Girls? Evidence on Grade Discrimination and its Effect on Students' Achievement

1340	Olivier Marie Ulf Zölitz	'High' Achievers? Cannabis Access and Academic Performance
1339	Terence C. Cheng Joan Costa-i-Font Nattavudh Powdthavee	Do You Have To Win It To Fix It? A Longitudinal Study of Lottery Winners and Their Health Care Demand
1338	Michael Amior	Why are Higher Skilled Workers More Mobile Geographically? The Role of the Job Surplus
1337	Misato Sato Antoine Dechezleprêtre	Asymmetric Industrial Energy Prices and International Trade
1336	Christos Genakos Svetoslav Danchev	Evaluating the Impact of Sunday Trading Deregulation
1335	Georg Graetz Guy Michaels	Robots at Work
1334	Claudia Steinwender	The Roles of Import Competition and Export Opportunities for Technical Change
1333	Javier Ortega Gregory Verdugo	The Impact of Immigration on the Local Labor Market Outcomes of Blue Collar Workers: Panel Data Evidence
1332	David Marsden	Teachers and Performance Pay in 2014: First Results of a Survey
1331	Andrea Tesei	Trust and Racial Income Inequality: Evidence from the U.S.
1330	Andy Feng Georg Graetz	Rise of the Machines: The Effects of Labor-Saving Innovations on Jobs and Wages

The Centre for Economic Performance Publications Unit
Tel 020 7955 7673 Fax 020 7404 0612
Email info@cep.lse.ac.uk Web site http://cep.lse.ac.uk