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Female employment and pre-kindergarten: on the unintended effects of an Italian reform*

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Abstract

We theoretically show that when mothers need to buy childcare services not only if they work but also if they want to search actively for a job, a reduction in the price of childcare will increase their likelihood of searching but may decrease their willingness to accept a job offer and therefore lower employment. We test these predictions empirically by means of a Regression Discontinuity design and find that the introduction in Italy of pre-kindergarten, a much cheaper alternative to day care for 2-year-old children, increased both participation in the labour market and employment of mothers of eligible children. This effect was driven largely by a significant decrease in the stated reservation wage. For a full evaluation of the polcy we finally provide evidence that pre-kindergarten did not affect children's cognitive development as measured at second grade.

Keywords: Childcare, Female Labour Supply, Public Services
JEL Classification: J13, J16, H41

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1 Introduction

Affordable childcare services are praised by the most recent economic literature as a powerful tool for developing children's human capital (Cunha and Heckman, 2007). Moreover, there exists a strong positive cross-country correlation between the availability of childcare services and the female labour market participation rate on the one hand, and the fertility rate on the other hand (OECD, 2011). On these grounds, both developed and developing countries have progressively adopted policies aimed at improving the availability and affordability of childcare services. Some of these policies consist in providing public financial support to families for their childcare expenses in the form of either vouchers or tax credits; others, instead, entail the direct provision of services.

In this paper we investigate the effects on mothers' labour supply decisions of a policy that consisted in sharply reducing the price of childcare. We call these effects 'unintended' because the policy we analyse was originally introduced neither with the aim of helping mothers to reconcile work and family responsibilities, nor with that of fostering early childhood development. Our paper couples a theoretical model with a reduced form empirical analysis. The combination of these two approaches allows us to shed light on the mechanisms that underlie the observed policy responses.

Our theoretical model is a job search model in which we assume that participating in the labour market requires buying childcare both when working and when searching for a job. This assumption is based on the evidence that women search less intensively than men, especially when they bear caring responsibilities inside the household (Krueger and Mueller, 2012). We show that, in this setting, a price reduction of childcare boosts female labour market participation, but has an ambiguous effect on the reservation wage and, therefore, on employment. In fact, the price reduction increases both the value of being employed, by increasing the returns from working, and that of being unemployed, by reducing the cost of not having a job. Which of these two opposite forces prevails depends on whether and how much the price of childcare differs between unemployed and employed mothers.

We test our theoretical predictions exploiting the introduction in Italy of pre-kindergarten, a much cheaper alternative to day care for 2-year-old children. Eligibility for pre-kindergarten is based on the child's exact date of birth through a discontinuous rule. This allows us to identify a causal effect of the policy through a *Sharp Regression Discontinuity* and validate it through a *Difference in Discontinuities* analysis. Our

results reveal that the possibility of accessing pre-kindergarten causes an increase of about 6 percentage points in maternal labour market participation, which translates into an increase in the probability of actually holding a job of about 5 percentage points. The latter effect is at least partly driven by a decrease in the stated reservation wage, which is reduced by about 180 euros monthly. Finally, for a full evaluation of the effects of the policy, we investigate whether early access to kindergarten affected children's development. We find no significant effects on children's cognitive abilities as measured through standardised tests administered at second grade.

We contribute to the existing economic literature in several ways. First, we are the first to model the relationship between the price of childcare and maternal labour supply in a job search framework. This allows us to focus on the extensive margin, which has been shown to be more responsive than the intensive one (Blundell et al., 2013). Indeed, previous theoretical contributions develop frictionless and static models in which childcare is used only when the mother works. In this setting, a permanent reduction in its price unambiguously increases female participation and employment by increasing net wages, with ambiguous effects on working hours, which has been the main focus of those analyses (Heckman, 1974; Blau and Robins, 1988). On the other hand, the most recent literature (Table 1) finds significant effects on the extensive margins and negligible effects on the intensive one. Secondly, compared with standard job search models, our model is innovative in its assumption that childcare is also, at least partly, needed by mothers who want to search for a job. Introducing this assumption, we find that reducing the price of childcare may even lower maternal employment by making mothers more choosy when deciding whether to accept or reject a job offer.

From the point of view of the empirical literature, our paper innovates on two dimensions. First, the richness of our dataset allows us to estimate the effect of a reduction in the price of childcare separately on employment and on labour market participation, defined as employment and active job search (ILO definition), and also on the stated reservation wage. To our knowledge, this last estimate has never been provided before and there is an increasing interest in exploring the determinants of reservation wages (Krueger and Mueller, 2016). Secondly, we focus on children aged 2 to 3, while most of the works, with the only exception of Goux and Maurin (2010), consider older children. Policy interventions at younger ages can be particularly effective in helping women who exited the labour market during pregnancy to re-enter it quickly. Indeed, long-lasting employment interruptions may be detrimental to workers' careers and job prospects (Arulampalam et al., 2001) and delayed interventions may be less effective as they are

more likely to target discouraged workers.

Our paper is also of first order policy relevance in the Italian context, where female labour market participation and employment rates are particularly low[1] and the proportion of women who stay out of the labour market two years after the child's birth is increasing over time: in 2012 it was 22.4%, whereas in 2000, it was just 18% (Istat, 2014). In spite of these figures, the Italian context has only been little analysed due to data limitations. The first notable contribution was Chiuri (2000) who showed that childcare rationing and the availability of informal care arrangements significantly depress maternal labour supply. More recently also Del Boca and Vuri (2007) focused on the availability of childcare services and Brilli et al. (2014) structurally estimated the effects of public childcare availability on both mothers' working status and children's test scores. With respect to these papers, we add evidence on the effects of a change in childcare prices rather than availability, and our identification strategy provides a cleaner estimate of the causal effect.

The remainder of the paper is organized as follows: Section 2 introduces our theoretical framework; the Italian institutional context is then presented in Section 3; Section 4 provides a short description of the dataset and illustrates the main features of our sample; our empirical strategy is then explained and discussed in Section 5; in Section 6 we report the results of the empirical analysis; Section 7 provides some specification checks. In Section 8 the analysis is extended to evaluate the effects of the reform on children's cognitive outcomes. Section 9 concludes.

2 Theoretical framework

That childcare responsibilities affect female labour supply has been widely documented by the economic literature over the last forty years. Early studies on this topic focused on the effects of childcare services on the *intensive* margin of labour supply (Heckman, 1974; Blau and Robins, 1988). In these studies, childcare is paid for each working hour and reduces the mother's net hourly wage. Under this assumption, a childcare price reduction increases the net hourly wage, with an ex-ante ambiguous impact on working hours, due to the interaction between a positive substitution and a negative income effect. Indeed, the empirical literature found that the elasticity of maternal working hours to the net wage rate has a negligible magnitude, i.e. female labour supply responds little in terms of hours of work, while estimates of the effects on the extensive margin tend to be positive

[1] In 2012 the participation rate of Italian women aged 15-64 was 53.5%, against the EU15 average of 67%. The employment rate was 46.1%, against the EU15 average of 59.4%.

and of considerable magnitude (Blundell et al., 2013). We therefore decide to focus on the extensive margin and model the relationship between the price of childcare services and female labour supply in a dynamic setting, employing the tools of job search models (Pissarides, 2000).

Unlike the standard models in which the cost of childcare is only borne if the mother works because otherwise she can take care of the child full time, we allow for the possibility that mothers need to buy childcare services when they search for a job as well. Indeed, job search models assume that search intensity is an important input of the matching function, so that workers who devote more time (Holzer, 1987) and effort (Shimer, 2004) to their search find a job more quickly. Recent studies based on time use surveys (Krueger and Mueller, 2012; Aguiar et al., 2013) have shown that women devote consistently less time to job search activities than men, the difference being especially large in countries in which female participation in the labour market is particularly low (e.g. Italy and Spain). Moreover, the existing estimates suggest that there is a significant negative relationship between job search intensity and family care duties, as married women and those with young or several children appear to search less actively (Krueger and Mueller, 2012; Di Addario, 2011). Finally Vikman (2010) showed that the availability of childcare facilities increases the probability of leaving unemployment by increasing mothers' search intensity.[2]

In the light of these findings, we believe that to describe accurately the effect of reducing the price of childcare on women's labour market outcomes, one needs to build a model in which childcare services are needed not only by women who have a job but also by those who are actively searching for one. Assuming that formal childcare services can be used by women only when they find a job is therefore not only unrealistic, because the enrolment decision can only be limited to a specific time period of the school year, but also in contrast with the most recent literature on job search intensity.

Our model allows for the possibility that the price paid for childcare by unemployed women is lower than that paid by employed women. This reflects the fact that kindergartens typically charge fees based on family income, so that a single-earner family would generally pay less. Alternatively, it may also proxy for the fact that women job seekers

[2]Elaborations on data from the Italian Labour Force Survey 2013, show that women with 0-2 years-old children are less likely to search actively for a job than other women and that the difference is largest during summer, when no formal childcare is available. Moreover, based on the data from the Bank of Italy's Survey of Households Income and Wealth 2013, it appears that 30% of unemployed women with a child aged 0-2 use childcare services.

can devote more time to looking after the child themselves than working women so that, for example, they may only need to use part-time childcare services and so pay less for them.

In what follows we introduce the model formally, describing the general set-up first and then deriving implications about the effect of lowering the cost of childcare on the mother's decision to search for a job (labour market participation) and to accept a job offer (employment).

2.1 The basic set-up

We consider a population of mothers with a young child who needs to be looked after. The mother is the only individual responsible for the care of the child. The timing of events is as follows. At time $t = 0$ the school year starts and the mother decides whether or not to enrol her child in formal childcare. Childcare services can be bought in the market only at the beginning of the school year. If she does not enrol her child, the mother remains out of the labour market, whereas if she wants to find a job she needs to buy childcare services. Therefore she incurs the cost of childcare before knowing whether she will get a job or not.[3] Conditional on enrolment, a mother may receive in any period t a job offer. If she accepts, she will be employed and never quit the job; in the case of rejection she remains unemployed and keeps searching for a job. At time $t = T$ labour market status is observed;[4] a mother can be (i) non-participant; (ii) job searcher (or unemployed); or (iii) employed.

The problem of the mother is the following. First, she chooses to participate or not given her expected job opportunities and the cost of childcare; second, conditional on participation, when a job offer arrives she decides whether to accept it or not. We assume that before time T no structural change occurs in the labour market and all relevant decisions - the participation status and the job-offer accepting rule - are taken at $t = 0$.[5]

[3]The type of care we are considering is formal childcare and we assume that free childcare is not available. An extension of the model consists in distinguishing between formal childcare, accessible only at the beginning of the school year and before the job search outcome is known, and informal childcare, needed only in case of employment. In this simplified version we assume the mother prefers formal care, even if she faces the risk of not finding a job, to informal care.

[4]In the empirical part this will be three quarters of the school year.

[5]The model is stationary to account for the effects of a *permanent* reduction in the search cost, as is the one described in section 3.

The mother maximizes her life-time utility:

$$\sum_{t=0}^{\infty} (1-r)^t u(c_t) \tag{1}$$

where $0 \leq r < 1$ is the discount rate and c_t is current consumption, which varies depending on her labour market status. The instantaneous utility from consumption $u(c_t)$ is assumed to be increasing and concave.

The value function of a mother choosing to stay out of the labour force (non-participant) is:

$$rV_o = u(\delta_o) \tag{2}$$

where δ_o is the stream of real returns from non-participation, which can be thought of as the value of home production. Moreover, a non-participating mother directly provides care for the child and no external care is needed.

Active mothers buy childcare services at a market price p. However, only a fraction $s < 1$ of the full price p is paid by unemployed mothers as they might have access to discounts or lower tariffs or use only part-time childcare services. Moreover, we assume that job seeker mothers still carry out home production δ_0.

A mother that looks for a job receives a job offer, which is fully described by a wage w drawn from a cumulative distribution $F(w)$, with probability λ. If the offer is accepted, the mother becomes employed, otherwise she continues to look for a job. We rule out the possibility of recalling a job offer. The continuation utility rV_s from looking for a job is the sum of the utility from the flow of real returns in the case of job seeking, $u(\delta_0 - sp)$, and the expected value from moving into employment at a future date t:

$$rV_s = u(\delta_o - sp) + \lambda \max\left[\int_w V_e(x)\, dF(x) - V_s; 0\right]. \tag{3}$$

When employed, the mother inelastically supplies one unit of labour at wage w and has to buy childcare services at price p. We rule out the possibility of layoffs and on-the-job search. The value function of being employed is:

$$rV_e = u(w-p). \tag{4}$$

where $w - p > \delta_o > \delta_o - sp$, otherwise there is no incentive for the mother to participate.

2.2 The participation decision

At time $t = 0$ the mother decides whether to participate in the labour market or not. The mother has no reason to revise her first decision afterwards and switch from participation to non-participation, or vice versa. At $t = 0$ the maximum of the value function of being non-participant is:

$$V_o = \max\left[V_s; u\left(\delta_o\right) + (1 - r)V_o\right]. \tag{5}$$

The condition for participation simply requires $V_s \geq u\left(\delta_o\right)/r$ and, if at $t = 0$ it is optimal to look for a job, it will be so in the following periods. To inspect the participation condition it is necessary to solve for V_s.

Combining equations (3) and (4) yields:

$$V_s = \frac{u\left(\delta_o - sp\right) + \frac{\lambda}{r}\int_w u\left(x - p\right) dF\left(x\right)}{r + \lambda} = \frac{u_s + \frac{\lambda}{r}\mathbb{E}\left(u_e\right)}{r + \lambda} \tag{6}$$

where $u_s = u\left(\delta_o - sp\right)$ is the per-period utility of consumption if unemployed and $\mathbb{E}\left(u_e\right) = \int_w u\left(x - p\right)$ is the expected utility of consumption in the case of employment.
A mother participates if $V_s \geq V_o$. It is straightforward to derive our first set of results.

Proposition 1 *A reduction in the price of childcare increases maternal participation as:*

$$\frac{\partial V_s}{\partial p} = -\frac{su'_s + \frac{\lambda}{r}\mathbb{E}\left(u'_e\right)}{r + \lambda} < 0. \tag{7}$$

Participating in the labour market is like a lottery: the mother pays the cost sp for participation in order to increase her consumption possibilities from δ_o to $w - p$. The lower the price p, the more participation is worthwhile: the "participation fee" of the lottery is lower and the net expected benefit is higher, creating incentives to exit from non-participation status.

Proposition 2 *When the probability of receiving a job offer is higher,*[6] *the effect of a reduction of p on maternal participation might be larger or smaller. It is larger only for sufficiently low values of s, the fraction of the full price of childcare paid in the case of unemployment:*

$$\frac{\partial^2 V_s}{\partial p \partial \lambda} = -\frac{\mathbb{E}\left(u'_e\right) - su'_s}{\left(r + \lambda\right)^2} = \begin{cases} \leq 0 & \text{if } s \leq \frac{\mathbb{E}(u'_e)}{u'_s} \\ > 0 & \text{if } s > \frac{\mathbb{E}(u'_e)}{u'_s}. \end{cases}$$

[6] We are interpreting λ independent of individual characteristics and determined by demand-side variables.

The lower price of childcare increases the mother's utility both when she is unemployed, by su'_s, and when she has a job, by $\mathbb{E}(u'_e)$. If the utility gain is higher when the mother works, women living in areas with a higher probability of finding a job will participate more than those living in areas with a lower probability. Since $\mathbb{E}(u'_e) < u'_s$ by definition, for the utility gain associated with the lower childcare price to be higher in the case of employment, the cost of childcare when unemployed has to be 'sufficiently low', as expressed in Proposition 2.

Finally, if wages are a non-decreasing function of marginal productivities or education levels (Becker, 1964; Mortensen, 1978; Mincer, 1997), the following result can be established:

Proposition 3 *The effect of reducing p on participation is larger for less educated mothers.*

Indeed, equation (7) is increasing, in absolute value, in the expected marginal benefit from employment, $\mathbb{E}(u'_e)$.
This result is driven by the concavity of the function u and by the assumption that less educated women face lower expected wages, which reflects their corresponding productivity. The higher the expected wage, the smaller is the benefit of a reduction of p in terms of utility.

2.3 The employment decision

A reduction of the fixed cost of participation, i.e. of childcare, not only makes participation less costly, but also affects the decision rule related to accepting a job offer or not. The decision rule is based on the definition of a reservation wage, R, the wage at which the agent is indifferent between accepting the offer or continuing to search and waiting for another offer:

$$\frac{u(R-p)}{r} = V_s. \tag{8}$$

Replacing (8) in equation (3) and after some manipulations, we get the following optimality condition:

$$u(R-p) - u(\delta_o - sp) = \frac{\lambda}{r}\int_{w\geq R}[u(x-p) - u(R-p)]\,dF(x). \tag{9}$$

On the right-hand side there is the discounted expected benefit of another period of search. On the left-hand side there is the opportunity cost, in the form of forgone earnings, of searching for another period. As the first is increasing in R while the second is decreasing, the existence of a unique solution of (9) is guaranteed.

The price of childcare affects both the cost and the benefit of searching, thus the reservation wage:

$$\frac{\partial R}{\partial p} = \frac{u'(R-p) - su'(\delta_o - sp) - \frac{\lambda}{r}\int_{w\geq R}\left[u'(x-p) - u'(R-p)\right]dF(x)}{u'(R-p)\left[1+\frac{\lambda}{r}(1-F(R))\right]}. \tag{10}$$

Indeed, lowering the price of childcare has an unambiguously negative effect on the discounted expected benefit of searching for another period, as the incentive to wait for a better offer is lower. The result is driven by the concavity of the utility function and reduces the reservation wage (the last term in equation (10); see Figure 2). On the other hand, the effect on the opportunity cost of search for another period is ambiguous, and depends on the relative gain in terms of utility associated with a lower price of childcare in the case of employment and unemployment. If the price reduction benefits more the employed mother, the cost of waiting for a better offer will be higher and this will induce the mother to accept a lower wage offer, reducing her reservation wage (the difference term in (10) is positive). If, instead, the price reduction benefits more the unemployed mother, then the opportunity cost of searching for another period will be lower and the reservation wage might increase (the difference term in (10) is negative). More in detail, if the discounted price reduction in case of unemployment and further job search is, in terms of marginal utility, greater than the discounted price reduction in case of employment at R, then the unemployed mother thus becomes more choosy in evaluating job offers after the childcare price reduction (the reservation wage increases). Again, it depends on the generosity of the welfare benefit in terms of childcare fee discounts for jobless mothers, as expressed in the following Proposition.

Proposition 4 *Let the probability of being employed be $h = \lambda F(R)$, which is the probability of receiving an offer higher than the reservation wage. It might be decreasing or increasing in the price of childcare:*

$$\frac{\partial h}{\partial p} = -\lambda f(R)\frac{\partial R}{\partial p} = \begin{cases} \leq 0 & \text{if } s \leq \bar{s} \\ > 0 & \text{if } s > \bar{s}, \end{cases}$$

where $\bar{s}$ is:

$$\bar{s} = \frac{u'_e(R)\left(1+\frac{\lambda}{r}\right) - \frac{\lambda}{r}\mathbb{E}_{w\geq R}(u'_e)}{u'_s}.$$

In the next sections we move to the empirical analysis, through which we aim to verify our predictions on participation and to shed light on the behavioural effect of a childcare

price reduction on the employment decision.

3 Institutional setting

Early access to kindergarten was regulated, for the first time, in 2003 by Law 53/2003, known as the "Moratti Reform" after the Minister of Education of the time. Differently from what happened in other countries, in Italy the introduction of pre-kindergarten was not driven by the idea of taking care of early childhood development, nor of encouraging female labour market participation. Instead, at least at the beginning, it was merely a consequence of the introduction of early access to primary school: in the attempt to reduce the age of high school completion from 19 to 18 years old so as to align the Italian school system to the other European ones, access to primary education was extended to children who turned 6 by 30 April of the school year, whereas before it was only allowed to those who turned 6 by the 31 December. Early access to primary education, though, entailed the risk of emptying kindergartens so, to avoid this, the Ministry decided to apply the same anticipation rule to allow 2-year-old children to access kindergarten (Figure 1).[7] This was a zero cost policy because it did not require any extra allocation of resources to kindergartens but simply established a *shift* in the age profile of pupils.[8]

Kindergartens, which are mostly public, cost significantly less than both public and private day care centres in Italy. According to Istituto Degli Innocenti (2011) the monthly rate for full-time service is, respectively, 394 euros in public day care centres, 487 euros in private facilities, and 130 euros in kindergartens. The monthly part-time rate is, in the same order, 296, 386 and 50 euros. In Italy there are no other notable alternatives to formal day care services such as registered child-minders, who take care of a small group of children in their own home and are particularly common in the United Kingdom and France. Hence, in the absence of grandparents who can look after the children, families generally choose to employ a nanny. While we can imagine that this option is always available, there is no doubt that its cost is much higher than that of a day care centre. Therefore the introduction of pre-kindergarten represented a reduction in the price of childcare in that it extended a low cost service to a population of families that had previously been excluded.

[7] Early access to kindergarten was regulated exactly like early access to school: it extended the possibility of enrolling to children who turned 3 by April of the school year, while previously children would be accepted into kindergarten if they turned 3 by December of the school year.

[8] We recognize that in the transition period the policy could have entailed additional costs due to the higher influx of children in the school system; however, we believe they have been negligible with respect to alternative policy interventions.

Single-earner families typically pay lower rates than two-earner families both for day care and for kindergarten. First, monthly rates are modulated according to a means test (ISEE, *Index of Equivalent Economic Situation*) based on family income. Second, discounts specifically addressed to single-earner families are also granted. Yet, the fee schedules are such that low income families pay approximately the same amount for day care and kindergarten, while high income families pay significantly more for day care. As a consequence, moving from day care to kindergarten implies a consistently larger discount for high income families than for low income ones (see Table 2).

Pre-kindergarten was introduced in the school year 2003/04 but implemented only gradually. Indeed, while the eligibility rule provided by the law required children to turn 3 by 30 April of the school year, until 2007/08 access to kindergarten was granted only to those who turned 3 by 28 February. In 2008/09, then, the cut-off date of birth for access to pre-kindergarten was further anticipated to 31 January by the newly appointed Government.[9] In this first phase pre-kindergarten was used quite extensively: in 2003/04 early students were 49 thousand, 9.1% of 2-year-olds, while in 2005/06 they were 71 thousand, around 13%. Among early students, most were located in the Southern regions and went to private kindergartens (Istituto Degli Innocenti, 2011).

The positive result registered prompted the legislator to think about the pedagogical and educational content of pre-kindergarten. As it did not feature any special programme for the very young, it was perceived as a way of forcing children's natural development pattern. A new phase of pre-kindergarten thus started with the school year 2009/10.[10] The new law established that kindergartens offering early access had to provide suitable places and equipment for 2-year-old children. Moreover, the eligibility rule was set at 30 April as originally established by the law (Table 3 summarizes the relevant changes in the access rule occurred in these years). Several things happened in this new phase of pre-kindergarten: (i) the number of children using the service increased: it reached 83 thousand in 2010/11, 86 thousand in 2011/12. These figures imply that the share of eligible children who were actually enroled in pre-kindergarten was over 40%. (ii) Public schools outnumbered private ones (differently from the first phase); in particular, there was a sharp decrease in the use of private schools in the South. (iii) There was a marked concentration of pre-kindergarten users in the South, which accounted for almost 50 thousand out of a national total of 86 thousand early students (58%); considering only

[9] Financial law 297/2006.
[10] Decree of the President of the Republic 89/2009.

public schools, this proportion rises to 67%. This geographical heterogeneity within the country, was at least partly explained by the availability of alternative childcare services, as shown in Figure 3.[11] The coverage rate provided by childcare services was between 14% and 17% in the North and in the Centre, while it ranged between 3.5% and 6% in the South. Inversely, the take-up rate by eligible children reached 60% in the Southern regions and remained below 30% in the Centre and in the North (Istituto Degli Innocenti, 2011).

4 Data and descriptive statistics

Our study relies on data drawn from the Italian labour force survey, which is a quarterly rolling panel dataset collected by Istat, the Italian statistical office. The dataset contains about 250,000 households, 600,000 individuals per wave, for whom detailed information about their labour market status, as well as their family structure and other socio-economic characteristics is collected.

We build a dataset that spans from the school year 2006/07 to the school year 2011/12; in our main specification (section 5.1) we use data from years 2009/10, 2010/11 and 2011/12, i.e. those in which the April 30 cutoff was used to determine pre-kindergarten eligibility; in our secondary specification (section 5.2) we also use data from school years 2006/07 and 2007/08 as "control group". For each year we select mothers whose youngest child is 2-3 years old. We decide to focus on the youngest child in the family because that is the relevant margin for a mother who has to decide whether to participate in the labour market or not: if she has a younger child who still needs to be looked after, the fact that the older one can be enrolled in pre-kindergarten will not affect her labour market participation decision. Our dependent variables of interest are an indicator of labour market participation, which equals one if the mother either actively searched for a job in the previous four weeks[12] or was employed in at least one quarter during the school year, and an indicator of employment that equals one if she was employed in at least one quarter during the school year. We exclude from our analysis the summer quarter as kindergartens are generally closed in those months and collapse observations by school year (since eligibility is constant over the three quarters). We trim the data at six months from the cutoff so that the resulting sample is made of mothers whose

[11] This is measured by Istat as the number of children enrolled in day care services over the reference population, and is referred to as "coverage rate".

[12] We apply the ILO definition of unemployed.

youngest child turns three between November 1 of the current school year and October 30 of the following school year. Considering our main empirical specification (section 5.1), the resulting sample is made of about 8,000 women, whose main characteristics are summarized in Table 4 where the sample is split between mothers of children who are eligible for pre-kindergarten and mothers of children who are not eligible.

The data confirm the widely known fact that Italian mothers are relatively old in comparison with mothers in continental Europe, and indeed the average age of mothers in our sample is above 34 years.[13] Second, the size of the households is small: on average there are fewer than four people in the household, which suggests not only that couples often have only one child, but also that it is rare for grandparents to live in the same household. Moreover, about 15% of women in our sample are single. In terms of education, it appears that almost one third of the women in the sample have at most reached compulsory school leaving level, 47% of them have a high school diploma, and about 21% have a college or higher education qualification. With respect to their labour market status, we observe that 60.3% are either searching for a job or are employed (labour market participants); of these about 90% are employed while the others are searching. We also report that the employed women in our sample work on average 26.5 hours per week, less than a full-time job, and earn slightly more than 1,000 euros per month. Moreover the labour force survey contains data on the reservation wage of all non-employed people:[14] we learn that the unemployed mothers in our sample would not work for less than about 770 euros per month.

5 Identification

Identification of a causal relationship between the price of childcare and mothers' labour supply choices potentially entails endogeneity issues in that mothers are likely to choose simultaneously the type and quality of childcare service to use and whether to supply labour. For example, having a well-paid job would allow mothers to afford more expensive childcare services. The institution of pre-kindergartens allows us to overcome this endogeneity issue by exogenously expanding the availability of a cheaper childcare service to a group of families whose only requirement is that their child must be born within a certain cut-off date. Therefore, as long as the child's exact date of birth is orthogonal to

[13] According to OECD data, the average age of first child bearing in Italy was in 2009 29.9 years old, the second highest after Germany and the UK (30 years old). The average across all OECD countries was instead 27.8.

[14] Specifically the survey asks: "What is the minimum (net) monthly pay you would be willing to work for?".

the household's observable and unobservable characteristics that may affect the mother's labour supply choices, we are able to identify a causal relationship.

Note that, because our data contain no information about actual use of pre-kindergarten, we are only able to identify the effect of pre-kindergarten *eligibility* rather than the effect of actual enrolment, i.e. we identify an *Intention To Treat* effect. Because not all eligible families used the service, the parameter that we identify will be smaller in magnitude than the treatment effect on the treated. Yet, this parameter is particularly interesting from a policy perspective: as pre-kindergarten is not compulsory and childcare and labour supply decisions are generally taken simultaneously, the policy maker will be most interested in the effect of providing families with the *possibility* of sending the child to school one year earlier.[15]

In this paper we aim to exploit the discontinuity in the rule that determines eligibility for pre-kindergarten in two ways in order to identify and estimate the parameter of interest. The first strategy is based on a standard *Sharp Regression Discontinuity* (SRD) (Thistlethwaite and Campbell, 1960), while the second one is a *Difference in Discontinuities* (Diff in Disc), a variation of the standard regression discontinuity in the spirit of Grembi et al. (2016).

5.1 Sharp Regression Discontinuity

The structure of the policy scheme allows us to implement a *Sharp Regression Discontinuity Design* (SRD) based on the exact date of birth of the youngest child in the household. Indeed, for the year 2005/06 and from 2009/10 until today, eligibility for pre-kindergarten is determined by the child's date of birth through a discontinuous rule: the law provides that while a child born on 30 April can enrol in kindergarten when she is 29 months old, a child born the day after, can only go to kindergarten one year later (equation (11)).

$$PK_{it} = \begin{cases} 1 & \text{if } dob_i \leq 30/04/t-3 \\ 0 & \text{otherwise} \end{cases}. \tag{11}$$

Exploiting this assignment rule, we aim to compare children whose date of birth falls within a small interval of the cut-off point, that is $30/04/t-3$; the underlying idea being that these children, and their mothers, will be identical for all characteristics with the exception of eligibility for pre-kindergarten.

[15]The parameter is thus a Local Intention to Treat effect of pre-kindergarten *use* on maternal labour supply, and a Local Average Treatment effect of pre-kindergarten *availability* on maternal labour supply.

We therefore regress the probability of the mother of child i being employed (or in search of a job) on a running variable that we build as the distance in days between the child's date of birth and the cut-off point. This distance will be positive for children born before the cut-off date (and thus eligible) and negative for children born after (and thus not eligible). Let $EM_i = 1$ if the mother of child i (who has no younger children in the household) is employed, and let p_i be a continuous variable measuring the number of days of distance between the child's date of birth and the cut-off point of the $30/04/t-3$, we can then estimate a regression of the type:

$$Pr(EM_{it}) \;=\; f(p_i) + \beta\; PK_{it} + \epsilon_{it} \tag{12}$$

where $f(\cdot)$ is a smoothing function and the parameter β will provide an estimate of the causal effect of *eligibility* for pre-kindergarten of the youngest child in the household on the mother's probability of being employed:

$$\hat{\beta}_{SRD} = \lim_{pi \to 0^+} E\left(EM_{it}|p_i\right) - \lim_{p_i \to 0^-} E\left(EM_{it}|p_i\right). \tag{13}$$

We run the same regressions also on a labour market *participation* indicator, on the stated reservation wage of unemployed mothers, on the actual wages paid to employed mothers and on their weekly hours worked.

5.2 Difference in Discontinuities

As described in Section 3, a child born by the end of April is entitled to enrol in pre-kindergarten in the school year in which she turns 3, but also to pre-school in the school year in which she turns 6. One may therefore be concerned that the relevant treatment is not eligibility for pre-kindergarten but rather prospective eligibility for pre-school. Indeed, the latter will also cause a drop in education costs, in that primary school is generally cheaper than kindergarten, although the difference is much smaller than that between day care and kindergarten (Figure 4). Therefore, one can imagine that parents anticipate this future saving and, by smoothing consumption, accept to pay a bit more for childcare when the child is below 3. If this were the case, the effect recovered through SRD would be an overestimate of the true effect of pre-kindergarten in that it would also include an anticipated effect of pre-school.

To overcome these doubts and isolate the effect of pre-kindergarten from other confounding effects caused by policies that share the same eligibility rule, we exploit the

changes in the policy criteria and implementation that we described in Section 3. We can estimate the effect of eligibility for pre-kindergarten in the years in which the eligibility cut-off for pre-kindergarten and pre-school were the same and in the years in which they were different, and then take the difference between the two (*Difference in Discontinuities*).

The estimating equation will be:

$$Pr(EM_{it}) = \sum_{k=0}^{q}(\delta_k p_i^k) + PK_i \sum_{k=0}^{q}(\gamma_k p_i^k) + T_t \left[\sum_{k=0}^{q}(\alpha_k p_i^k) + PK_i \sum_{k=0}^{q}(\beta_k p_i^k)\right] + \epsilon_{it} \quad (14)$$

where p_i is again the number of days of distance between the child's date of birth and the cut-off point of the $30/04/t-3$; T_t is an indicator variable for whether pre-kindergarten with 30 April cut-off is in place in year t, $T = \mathbb{1}(t = 2005/06 \text{ or } t \geq 2009)$; and q is the order of polynomial chosen for approximation of the smoothing function, we present estimates for $q = \{1, 2, 3\}$. In this setting the coefficient of interest is β_0:

$$\begin{aligned}\hat{\beta}_{\text{diff-in-disc}} = &\left[\lim_{pi\to 0^+} E\left(EM_{it}|p_i, T=1\right) - \lim_{p_i\to 0^-} E\left(EM_{it}|p_i, T=1\right)\right] + \\ &- \left[\lim_{pi\to 0^+} E\left(EM_{it}|p_i, T=0\right) - \lim_{p_i\to 0^-} E\left(EM_{it}|p_i, T=0\right)\right]\end{aligned} \quad (15)$$

which represents a Diff-in-Disc Intention to Treat ($ITT_{\text{diff-in-disc}}$) parameter.

Again, we run the same regressions on labour market *participation* and on the stated reservation wage.[16]

6 Results

6.1 Sharp Regression Discontinuity

Results obtained through SRD are presented in Figures 5 to 7 and in Tables 5 to 7 for all the main outcome variables.

The figures show the discontinuity in the outcome variable at the cut-off date $30/04/t-3$, which determines admission to pre-kindergarten in the academic year $t/t+1$. The

[16]Diff-in-disc estimates of the effect on paid wages and on the number of hours worked by employed mothers are available from the authors upon request.

horizontal axis represents the distance from the cut-off date of birth (p_i), observations to the right of the cut-off correspond to children who were born *before* the cut-off, i.e. are "old enough" to be eligible for attend the childcare service; observations to the left of the cut-off, conversely, represent children who were born *after* the relevant cut-off date, and so are "too young" to be eligible. The three graphs show the estimated discontinuity for the first and second order polynomial approximations and for local linear regression with triangular Kernel weights and a bandwidth of 60 days.[17] The grey lines are the estimated 95% level confidence intervals. The dots of the underlying scatterplots show the mean outcome in bins of one week's width (Lee and Lemieux, 2010). The discontinuities shown in the graphs correspond to the estimates reported in the tables. The reported ITT coefficient measures the height of the "jump" at the cut-off point, while the baseline is the value of the outcome variable at the discontinuity for the non-eligible individuals (the left-hand side of the discontinuity); for all specifications, standard errors are clustered at the level of region of residence and school year to account for the possibility that there may be spatial and serial correlation in the error terms (Cameron and Miller, 2015).

Consider first the effect of eligibility for pre-kindergarten on mothers' participation in the labour market: the graphs in Figure 5 show that there is indeed a large and significant difference in the likelihood of participating in the labour market between mothers of children born right before 30 April and mothers of children born right after. Moreover, the magnitude of this discontinuity is consistent across the three specifications proposed. Table 5 shows that this difference amounts to 4.8-7.1 percentage points depending on the specification chosen, over a baseline labour market participation rate of about 59% (i.e. a 8.1% increase). This positive and sizeable effect is consistent with our theoretical prediction of Proposition 1.

We then turn to the analysis of the effects of eligibility for pre-kindergarten on actual employment of the mothers (Proposition 4): the results, illustrated in Figure 6 and detailed in Table 5, show that the overall impact is positive and sizeable though less significant in statistical terms. Indeed, Table 5 shows that the magnitude of the effect

[17] Hahn et al. (2001) suggest to use *Local Linear Regression* (LLR) to approximate the function $f(\cdot)$, while Fan and Gijbels (1996) proved that Triangular Kernel weighted local linear regression performs optimally at the window boundary and thus also at the cut-off where the SRD requires most precision. As for the choice of the bandwidth, we do not use the optimal bandwidth derived by Imbens and Kalyanaraman (2010) because in our setting this produces under-smoothing and thus very noisy and unstable estimates. Rather, we decide to allow for the risk of having more bias but improve the smoothness of the relationship between the child's date of birth and the mother's employment status by choosing a larger bandwidth of 60 days. Anyway, we systematically report results obtained with our chosen bandwidth together with its half and its double and, in the specification checks, we show that our main results do not vary when we change the value of the bandwidth employed.

ranges between 3.1 and 6.2 percentage points over a baseline employment rate of about 53% (i.e. a 8.5% increase). The estimates appear to be stable across different empirical specifications, but hardly significant at standard statistical levels.

The finding that increased participation translates into increased employment suggests that the theoretical ambiguity highlighted in Proposition 4 seems to be solved in the direction of there being a positive effect on employment of reducing the cost of childcare. Note that the increase in employment, despite being smaller in magnitude, is not statistically different from that on participation. The fact that there is no significant increase in unemployment is consistent with our model and, in particular, suggests that the entry of more women in the labour force was coupled with a change in their job acceptance rules, so that it did not generate excessive queues for jobs. To understand whether this is the case, we also estimate the effect of pre-kindergarten eligibility on the stated reservation wage of unemployed women. The results are illustrated in Figure 7 and detailed in Table 6. These show that eligibility for pre-kindergarten determines a sharp drop in the stated reservation wage which passes from about 860 euros per month for the mothers of non-eligible children to less than 700 euros per month for the mothers of eligible children (a 19% drop). The magnitude of these effects, while large in absolute terms, is smaller than the difference between the average cost of day care and that of kindergarten. The reduction in the reservation wage is driven by the fact that employed mothers benefit more than unemployed ones from having access to pre-kindergarten. This happens because unemployed mothers already pay low rates for day care so that the marginal decrease in price they enjoy is lower (in terms of our model, s is "sufficiently small").

While no similar estimates are available for comparison when we look at the reservation wage, we can compare the effects on participation and employment rates to the previous literature summarized in Table 1. It turns out that our estimated effects are quite large: considering that the take-up rate is less than 50%, the actual treatment effect amounts to almost twice the reported coefficients. The magnitude of these effects is comparable to those found by Barua (2014) for the US, and to those found by Berlinski and Galiani (2007); Berlinski et al. (2011) for Argentina and by Schlosser (2011) for Israeli Arabs. On the other hand, estimates for continental and Northern Europe tend to be significantly smaller (Goux and Maurin, 2010; Havnes and Mogstad, 2011). We may further compare the magnitude of our estimated effects to those studies which directly addressed changes in the price of childcare. Blau and Currie (2006) report that the elasticity of female labour supply to childcare price ranges between -0.1 and -0.2. Our results are in line with

this literature in that the implied Marshallian elasticity is about -0.11 and -0.12 with respect to the price of private and public day care.

In Table 7 we estimate the effect of pre-kindergarten eligibility on the weekly hours worked by mothers. The results indicate that a decrease in the price of childcare of about 270 euros leads employed mothers to work about two and a half hours less per week, which is less than the 10% of the baseline of 27 weekly hours worked. The effect is quite small and confirms that adjustments of labour supply on the intensive margin are always limited as shown in the previous literature (Blundell et al., 2013). In turn, our results on hours worked suggest that the income effect, if any, associated with the provision of low cost childcare prevails over the substitution effect, thus reducing mothers' working hours.

As a final exercise we also estimated the effects on wages paid to employed mothers. If the possibility of using pre-kindergarten decreased the reservation wage of unemployed mothers, we would expect that women accepted lower paid jobs and so that the wages effectively paid decreased too. In Table 8 we see that pre-kindergarten eligibility generated a small, non statistically significant, drop in wages paid to mothers of eligible children of about 30 euros.

6.2 Difference in Discontinuities

In Figures 8 and 9 and in Table 9 we present the results of the Difference in Discontinuities estimation exercise.

On the vertical axis of the figures we now have the difference in outcomes between the period in which pre-kindergarten was in place with the cut-off at 30 April ($T = 1$) and the period in which it was abolished or had a different eligibility requirement ($T = 0$). Therefore the line to the left of the cut-off should not be different from zero, while that to the right is expected to be positive at the cut-off and decrease to zero as we move away from the cut-off.[18] As before, individuals to the left of the cut-off are the non-eligible ones, while those to the right are the eligible ones, i.e. mothers of children born before 30 April. The three graphs correspond to the three order of polynomial approximations employed. As for the SRD graphs, the grey lines are the estimated 95% level confidence intervals and each dot in the underlying scatterplot represents the mean of the outcome variable in bins

[18] Consider indeed that above 120 days from the cut-off, children are no longer pre-kindergarten eligible but kindergarten eligible, so the difference between the pre-kindergarten period and the non pre-kindergarten period should be zero for them. This prediction is in line with what we observe in the graphs.

of one week's width. The magnitude of the observed discontinuities is reported in Table 9.

When we estimate the effect of pre-kindergarten through the Diff-in-Disc approach, we only use parametric approximations of the smoothing function and present estimates for first, second and third order polynomial approximations.[19] The size of the window around the cut-off considered is the same as for the SRD estimates but the sample size is now almost twice as big because we are including in the regression seven years instead of four.

Visual inspection of the graphs already suggests that the effect estimated through diff-in-disc is large and significantly different from zero, both for participation in the labour market and for employment. Moreover, the magnitude of the effects seems consistent across the different polynomial specifications. Indeed, the regression results reported in Table 9 reveal that the effect of pre-kindergarten eligibility on participation is between 9.3 and 15.9 percentage points, while that on employment is between 7.5 and 13.6 percentage points. The estimated effect on the reservation wage is instead less precisely estimated than in the case of SRD, but it is still negative and not different in statistical terms. Compared with the SRD results, the diff-in-disc effects on participation and employment are considerably larger, which contradicts the theoretical reasoning for using a diff-in-disc approach. Indeed, one would expect the SRD to be capturing an additional positive effect of pre-school and so to be overestimating the effect of pre-kindergarten. Instead, Figure 10 shows that the (anticipation) effect of pre-school (in the central panel of the figures) is not significantly different from zero, but negative. This implies that taking the difference between the discontinuities in the two periods leads to an overestimation of the effect of pre-kindergarten. Assuming that this is due to noise in the estimates, we prefer to use the standard SRD strategy described in subsection 5.1.

6.3 Heterogeneous effects

To conclude our empirical analysis, we investigate several potentially important dimensions of heterogeneity in the effects.

First, in Table 10, we consider differences in the local labour market, and in particular in local labour demand across different regions. This exercise tests the predictions of our theoretical Proposition 2 and helps to understand what happens to employment. To proxy for the local probability of receiving a job offer we build a variable that is the ratio

[19] Grembi et al. (2016) refer to this estimation strategy as *splines* because the polynomials approximate the function on small enough intervals of data, yet the specification is fully parametric.

of the yearly number of vacancies per region (released by Istat) and the corresponding number of unemployed people, that is our vacancy rate. We then estimate the effects of pre-kindergarten separately on those regions in which the job finding rate is above the median and those in which it is below. The results reveal that, consistently with the predictions of our model, the increase in participation and employment is significantly larger where the vacancy rate is higher. Indeed, eligibility for pre-kindergarten increases participation by up to 14 percentage points where the vacancy rate is high, while the effect is hardly positive where it is low. Similarly, employment increases by up to 12.3 percentage points in labour markets where there is less congestion and is unaffected where there is more. The magnitude of the effects for high labour demand areas is very much in line with that of the effects estimated for the US (Cascio, 2009; Barua, 2014), as indeed are the baseline participation and employment rates.

Following the prescriptions of our model, the second dimension of heterogeneity that we consider is the level of education of the mothers. In Table 11 we split the sample into three subsamples according to the highest level of education of the mother. It now appears that the magnitude of the effect of pre-kindergarten availability is generally higher for less-educated mothers, as predicted by Proposition 3, but that the largest (though hardly statistically significant) effects are obtained on mothers with a high school diploma, presumably because these are the ones who marginally gain the most from entering the labour market.

A crucial dimension of heterogeneity that we explore is that of family income. Our model predicts that the reservation wage may increase in cases in which the implicit discount in passing from day care to kindergarten is very low. We argued that this may happen for low income families because these enjoy large discounts for day care (Table 2). To test this prediction we split our sample according to family income (Table 12).[20] The results obtained interestingly show that the estimated average increase in participation and employment is mainly driven by higher income families. Among less affluent families indeed the stated reservation wage remains unaffected (it even increases under second order polynomial parametric approximation).

As a final exercise, we try to understand how the household structure interacts with the provision of low cost childcare by splitting our sample between married and single mothers (Table 13). It turns out that the effect is concentrated among married women,

[20]The variable is built as the sum of all household members' labour income minus that of the child's mother.

whose propensity to participate in the labour market, and whose job search intensity, is traditionally lower. This result is particularly significant from a policy perspective because it shows that lowering the cost of childcare can indeed stimulate the labour market participation of a slice of the population that has traditionally been excluded.

7 Robustness Checks

In order for the Regression Discontinuity Design to yield consistent estimates the counterfactual conditional distribution of the outcome variable must be sufficiently smooth over the date of birth, i.e. the probability that a mother will decide to search for a job and find one is, in the absence of the policy, 'continuously' related to the age of the child (if we were to look at a *wider* window, we would expect such probabilities to be increasing over the age of the child, while they appear essentially flat when we restrict our attention to a 1-year-of-age window). While this assumption cannot be tested directly, it is common practice to assess its feasibility by checking that other variables usually associated with the outcome of interest do not also vary discontinuously at the threshold (Imbens and Lemieux, 2008). Figure 11 and Table 14 show that the estimated discontinuities for the main socio-economic characteristics of the mothers are not statistically significant.

Second, one may be concerned that the results of the SRD exercise are driven by some 'manipulation' of the forcing variable so that individuals self-select into the eligible group in order to benefit from the policy intervention. If this were the case, the SRD results would be biased and likely overestimate the impact of the policy (under the assumption that those who deliberately self-select into the eligible group are the most sensitive to the policy intervention). In this setting, a manipulation of the running variable would mean that mothers strategically choose when to deliver their baby so as to benefit from the possibility of anticipating entry to kindergarten. Although this may seem unlikely, especially given the frequency of changes in the policy rules, we formally test for the presence of manipulation of the forcing variable using the test designed by McCrary (2008). This is based on estimating the discontinuity at the cut-off in the density function of the running variable through Local Linear Regression techniques with triangular Kernel weights. Figure 12 shows the estimated discontinuity in the density of the forcing variable and confirms that the population density is smooth across the cut-off.

Our third robustness check is then a test of the sensitivity of our non-parametric results to the choice of the bandwidth. Figure 13 shows that the estimated coefficients,

both for participation and for employment, are very unstable and noisy for small values of bandwidth and then stabilize for quite large values (above 90 days). In particular, the figures show that our most preferred non-parametric specification is likely to provide only a conservative estimate of the true effect as this actually appears to get larger and statistically more significant for values of the bandwidth greater than the one we employ (60 days).

To make sure that our discontinuity is not due to fuzziness in the data, we estimate the same probabilities at the cut-off date for regular eligibility for kindergarten (turning 3 by 31 December of the academic year t). The absence of any significant discontinuity at the point of eligibility for kindergarten (Table 15) is a mere consequence of the fact that families can now anticipate the entry of their kids to kindergarten so that a child born on $1/1/t-2$ no longer has less chance of getting into kindergarten than a child born on $31/12/t-3$.

As a final check, we estimate our model on fathers: Table 16 shows that the effects on fathers are null both for their participation and for their actual employment status. This last finding reassures us that there is no need to include fathers in the decision making model and to build a household model of labour market participation and confirm the widely known fact that Italian women are typically the main caregivers inside the household.

8 Extension: effects on children's outcomes

A full evaluation of the reform requires analysing the effects of early access to kindergarten on children's cognitive development. While allowing more women to work or actively search for a job, pre-kindergarten may be detrimental for children mainly on the basis of two concerns: on the one hand, kindergarten may not be the most appropriate form of care for 2-year-old children for its pedagogical contents; on the other hand, anticipating access to kindergarten exposes very young children to interactions with older peers, which may hinder their cognitive development.

The literature has reached mixed results on these issues. As for the first, it has been suggested that what is the alternative mode of care (other formal arrangements or informal care provided by relatives or parents), children's age and their family background are crucial to determine the sign and magnitude of the effect of formal childcare attendance on the child's development. The conventional wisdom has established that formal childcare

for 0 to 2-year-old children is beneficial for children from low socio-economic background, while mixed results have been obtained for those coming from more affluent families (see Baker et al. (2008), Drange and Havnes (2015), Kottelenberg and Lehrer (2014); Fort et al. (2016) and Del Boca et al. (2016) for Italy). Regarding the second concern, instead, there is evidence that the oldest pupils in the classroom perform better than the youngest (Bedard and Dhuey, 2006). However, this performance differential reflects the effect of being older not only when entering school (entry age effect) but also when taking the test (test age effect). Indeed, the most recent literature has found that for the oldest pupils in the classroom the test age effect is positive and large, while the entry age effect is negligible and may even be negative (Angrist and Keueger, 1991; Smith, 2010; Black et al., 2011). Moreover, evidence is provided that the positive test age effect for the oldest tends to fade out over time (Crawford et al., 2013).

This section of the paper, thus, tries to assess whether the institution of pre-kindergarten generated a trade-off between female labour market participation, which was boosted, and children's cognitive development, which may instead be negatively affected. To this purpose, we estimate the effect of pre-kindergarten eligibility on children's cognitive test scores using INVALSI data. These are standardised tests administered at the end of the school year to the entire population of pupils in second, fifth and sixth grade. The tests evaluate children's language and mathematical skills and the dataset further contains information on pupils' demographics and socio-economic background.[21]

The INVALSI data, yet, do not contain information on the exact date of birth of children but, for school years 2011/12 to 2014/15 they recorded the child's month of birth. Thus, while we cannot replicate the empirical strategy that we used for maternal labour supply outcomes, we can still exploit changes across years in the pre-kindergarten eligibility rule and hence identify the effect of pre-kindergarten through a *Difference in Differences* estimation strategy. Specifically, we will exploit the fact the the eligibility rule for pre-kindergarten changed across school years (see Table 3), while that for pre-school remained constant over time. Depending on the year of birth, thus, some preschoolers had the possibility to anticipate both pre-kindergarten and pre-school, others only the latter. Our empirical strategy will rely on these differences to identify the effect of pre-kindergarten on children outcomes, isolating it from that of pre-school. Using data

[21] Table 18 provides the descriptitve statistics of the sample used for the analysis, i.e. second graders in school years 2011/12 to 2014/15.

from second graders, the earliest available outcomes, we estimate the following equation:

$$y_{it} = \alpha + \beta PK_{imt} + \phi_t + \phi_m + \gamma X_{it} + \epsilon_{it}. \tag{16}$$

The outcome variables of interest, y_{it}, will be the scores obtained by child i in school year $t-1/t$ in language and math. PK_{imt} is as a dummy variable that takes value one for children who, being born in month m, were eligible for pre-kindergarten in year $t-4$. As shown in Table 3, this eligibility rule was different across school years, so that, for example, children born between February and April 2007 were eligible for pre-school in 2012/2013 and also for pre-kindergarten in 2009/2010 (PK_{imt}=1), while those born in the same months in 2006 could anticipate entry to school but not to kindergarten (PK_{imt}=0). The inclusion of month of birth (for months ranging between January of year $t-8$ and April of year $t-7$) and year fixed effects effectively makes our design a difference in differences one, where the coefficient β identifies the treatment effect of interest, that of the interaction between being born in the months eligible for pre-kindergarten and the fact that in year $t-4$ the law established that these children could anticipate access to kindergarten.

Results are shown in Table 17. We find a negligible negative effect of early access to kindergarten on children's language scores, while no effect is found on numerical skills. Anticipating access to kindergarten by one year for children born in the first months of the year does not affect their learning skills, or at least not in a way that is still visible four years later.[22] Note that the coefficient we estimate is not biased by selection into pre-kindergarten based on individual unobservable characteristics because we compare eligible children with non eligible ones, no matter their compliance. We thus identify, again, an intention to treat effect and not the effect on the treated, i.e. on those who actually attended pre-kindergarten. The latter will likely be larger (more positive) to the extent that children who effectively anticipate access to kindergarten have higher unobservable skills than those who decide not to anticipate.

Our estimated null effect reflects both an entry age effect[23] and a mode of care effect. In the first case, the effect would be driven by differences in age, in that preschoolers who also attended pre-kindergarten were the youngest in their kindergarten class, while those who could not anticipate access to kindergarten were the oldest among peers. As mentioned before, the literature has found mixed results about the existence and magnitude of this effect. To shed some light on this we separately estimate the effect

[22] Figure 14 in the Appendix provides evidence that the common trend assumption is not violated.

[23] Our estimated effect is instead depurated of any test age effect in that children are compared within month of birth.

of anticipating access to kindergarten by two months only (as of the rule in place in 2007/2008) and that of anticipating by four months (as of the rule in place in 2009/2010 and 2010/11). Results are shown in Table 19 and reveal that anticipating access to kindergarten by two months only improved test scores in math by almost one and half percentage points, while a negligible negative effect is detected on language test scores. On the other hand, the effect for those who anticipated by four months is considerably smaller, thus suggesting that entry age does play a role with children who anticipate more performing worse than those who anticipate by two months only.

The second mechanism potentially driving our result is that deriving from the substitution of some alternative mode of care, formal or informal, with kindergarten. To this respect it becomes crucial to understand whether the possibility of anticipating access to kindergarten crowded out other formal care arrangements or just parental care. In this paper we argued that early access to kindergarten is a lower cost alternative to other formal arrangements, mainly day care centres. In Table 20 in the Appendix, indeed, we show that children who were eligible for anticipate access to kindergarten were less likely to attend day care at all. This estimate, about 4 percentage points (14%) decrease in day care use, represents a lower bound of the rate of substitution between day care and pre-kindergarten, because families could substitute only the last year of day care with pre-kindergarten. In the light of this finding, we can argue that pre-kindergarten was no worse than other forms of formal care nor of informal care, to the extent that it substituted both.

In turn, our final null effect of anticipating kindergarten suggests that, at least in the medium run, this type of formal care is no worse than other informal arrangements or day care centres and that interactions with older peers do not have any detrimental effect on children who anticipate access to kindergarten. In line with the previous literature (Fort et al., 2016), we only find a slightly negative effect on language test scores for girls coming from more affluent families, defined as those in which the father is white collar or manager (Table 21).

9 Conclusions

Female labour market participation and employment rates in Italy are among the lowest across Europe and the OECD countries. At the same time, public supply of childcare services remains scarce, with private services being very costly. Despite the clear positive correlation between these two variables, it remains unclear whether it is the *undersupply*

of childcare services that induces mothers to stay home and look after their children, or instead, whether it is the inadequate provision of childcare services that is caused by a lack of *demand* for them because women prefer to look after their children themselves. Our paper investigates this relationship providing first a theoretical contribution, a job search model that accounts for the effects of variations in the price of childcare services on maternal labour supply, and second a robust empirical analysis that allows us to identify such causal effects.

Our theoretical model innovates the existing literature in family economics by incorporating the mother's labour supply choices in a dynamic framework, accounting for the fact that job search requires time and mothers need to rely on childcare services not only when they have a job but also when they are looking for one. A similar model delivers a novel prediction, i.e. that lowering the price of childcare may prompt mothers not to accept low paid jobs by decreasing the cost of being unemployed. To avoid a similar distortion, childcare has to be provided at a sufficiently lower cost for unemployed mothers.

We further provide empirical evidence on the effects of providing low cost childcare to mothers of 2-year-old children. Exploiting the discontinuities in the rules that determine access to pre-kindergarten in Italy, we estimate that the policy leads to an increase in participation of mothers in the labour market of about 6 percentage points, which translates into an increase in the probability of actually holding a job of about 5 percentage points. We show that the latter effect is due not only, mechanically, to the induced increase in the number of women in the labour market, but also to changes in mothers' decision rules reflected in a significant drop in the reservation wage for unemployed women. Our analysis provides an estimate of some structural parameters, for example the elasticity of maternal labour supply to childare cost, that can be used in future research to simulate the effects of alternative policies such as targeted tax credits or active labour market policies that reduce search costs.

From a policy perspective, the present paper provides strong and robust evidence that increasing the provision of low cost childcare services generates a significant increase in female labour supply, especially among the categories that are most under-represented in the labour force, namely married and less-educated women. For the other women, though, the provision of low cost childcare services may represent a sort of income subsidy and may not produce any positive effect in terms of stimulating labour supply. For this reason a transfer conditional on the mother's working condition, in the spirit of those

adopted in the US or in the UK,[24] might be more effective in encouraging female labour supply. Moreover, the fact that pre-kindergarten eligibility causes a significant drop in the reservation wage suggests that a similar policy may also benefit employers who can hire women at a lower cost. On these grounds, an optimal policy may be the one that leads firms to internalize these benefits, for example by giving subsidies to those that provide childcare facilities directly.

There may be some concerns about the use of pre-kindergarten from the perspective of child development due, on the one hand, to the use of this type of formal care instead of others and, on the other hand, to the forced interaction of very young children with significanlty older peers. If the use of pre-kindergarten had negative effects on children's cognitive outcomes, the policy maker, when deciding whether or not to provide a low cost childcare service such as pre-kindergarten, would face a trade-off between promoting female labour market participation and maximizing children's cognitive development. To shed light on the overall welfare effects of the reform, we thus evaluated the impact of anticipating entry to kindergarten on children's cognitive outcomes at age 7. We find that early access to kindergarten did not affect children's learning skills on average, with a small positive effect for those who anticipated by two months only.

In turn our analysis showed that the institution of pre-kindergarten provides a strong case in favour of lowering childcare costs as it boosted female employment while producing no detrimental effects on children's development. Moreover, considering that maternal employment is associated to a lower probability of living in poverty, the increase in maternal labour supply may have benefited children on other dimensions not caught by standardised test scores, such as psychosocial outcomes and physical health.

[24]The Earned Income Tax Credit in the United States and the tax credit for childcare costs within the Working Tax Credit scheme in the United Kingdom.

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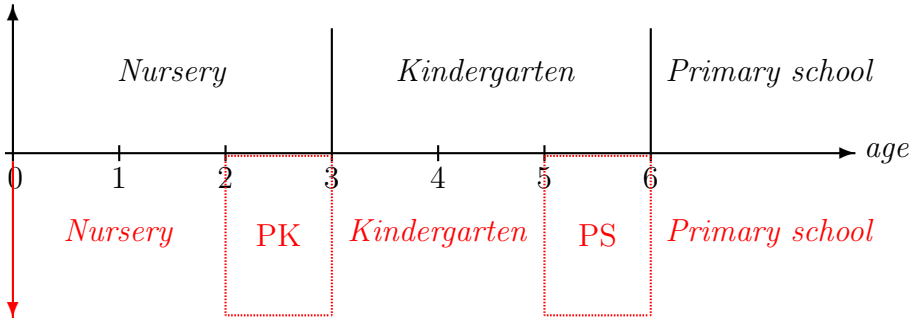
Table 1: Recent literature on the relationship between childcare services and female labour supply

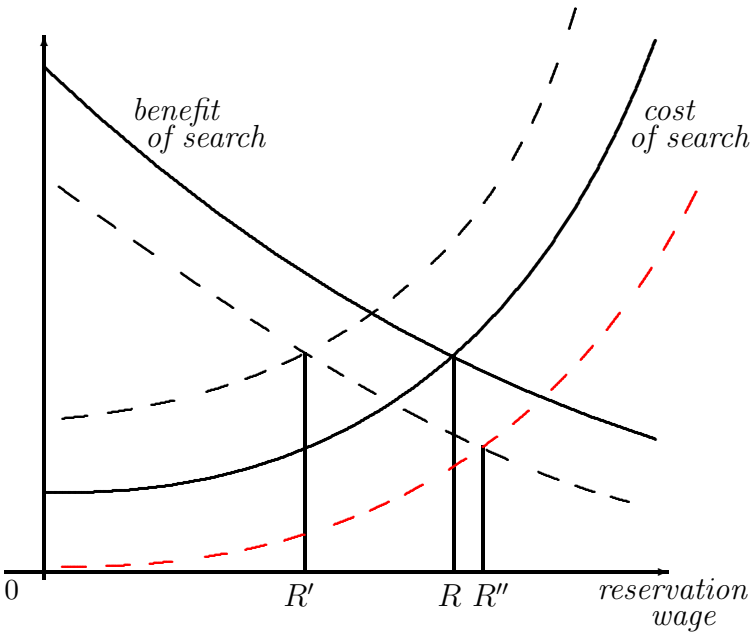
Authors	Country	Children's age	Empirical Strategy	Labour supply measure	Effect on mothers' labour supply	Baseline	Effect on weekly hours worked	Baseline
Gelbach (2002)	US	5	IV (quarter of birth)	Employment	+4 p.p.	70%	+2.71	15.6
Berlinski and Galiani (2007)	Argentina	3-5	DD	Employment	+7-14 p.p.	36%	Null	32
Baker et al. (2008)	Quebec (Canada)	0-4	DD	Employment	+7.7 p.p. (married mothers only)	53%	NA	NA
Cascio (2009)	US	5	DD	Employment	+7.5 p.p. (single mothers only)	58%	+2.78 (single mothers only)	21.85
Goux and Maurin (2010)	France	2 and 3	Fuzzy RDD (date of birth)	Employment	+3.6 p.p. (single mothers of 3-year-olds only)	79.7%	NA	NA
Fitzpatrick (2010)	US	4	Combined Sharp RDD and DD (date of birth)	Employment	Null	56%	Null	26
Fitzpatrick (2012)	US	5	RDIV (date of birth)	Employment	+12-19 p.p. (single mothers only)	68%	Null	32.9
Schlosser (2011)	Israel (Arabs)	2-4	DD	Participation and employment	+7.1 - +11.7 p.p. on part. +8.1 - +12.6 p.p. on empl.	10% 8.4%	+0.73	4.45
Berlinski et al. (2011)	Argentina	5	Fuzzy RDD (date of birth)	Employment	+6.6 p.p.	37%	+7.8	12.17
Havnes and Mogstad (2011)	Norway	3-6	DD	Employment	Null	24.5%	NA	NA
Herbst (2013)	US	0-12	DDD	Employment	+4.4 pp	21.4%	NA	NA
Barua (2014)	US	5-6	IV (quarter of birth)	Employment	+11 p.p. (married mothers only)	59%	+2.91	17.04
Nollenberger and RodrÌguez-Planas (2015)	Spain	3	DDD	Employment	+2.9 p.p.	29.3%	NA	NA

Figure 1: Childcare services in Italy by age of the child at the end of the calendar year



Notes: In black are childcare services for regular students, i.e. those who turn x by the end of the calendar year; in red are childcare services available to children who turn x by 30 April of the school year. PK stands for pre-kindergarten, PS for pre-school; they refer to the possibility of early access to the corresponding schooling level.

Figure 2: Effects of a price reduction of childcare on mother's reservation wage



Notes: The cost of an additional period of search is an increasing function of the reservation wage, while the benefit of search is decreasing, as depicted in the picture. The reservation wage R is the wage at which the cost and benefit of search are equal. Lowering the price of childcare unambiguously reduces the benefit of search, since there is less incentive to wait for a better offer. The effect on the cost of search for another period is instead ambiguous. If the price reduction benefits more the employed mother, the cost of waiting for a better offer is higher (the dashed black line). In this case the lower benefit and the higher cost reduce the mother's reservation wage to R'. If, instead, the price reduction benefits more the unemployed mother, the cost of search decreases (the dashed red line). In this case, the reservation wage increases to R'' as long as the cost of search decreases more, in absolute terms, than the benefit of search.

Table 2: Monthly rates for full time day care and kindergarten in the municipality of Rome (euro)

ISEE annual income	Day care fees	Kindergarten fees	Discount %
$\leq 5,165.00$	34.60	0	100
$5,165.01 - 15,000.00$	34.60 - 111.6	30 - 43	13.3 - 61.5
$15,000.01 - 25,000.00$	111.6 - 184.4	43 - 50	61.5 - 73
$25,000.01 - 30,000.00$	184.4 - 222.9	50 - 55	73 - 75
$30,000.01 - 45,000.00$	222.9 - 303.7	55 - 80	75 - 74
$\geq 45,000.01$	303.7	80	74

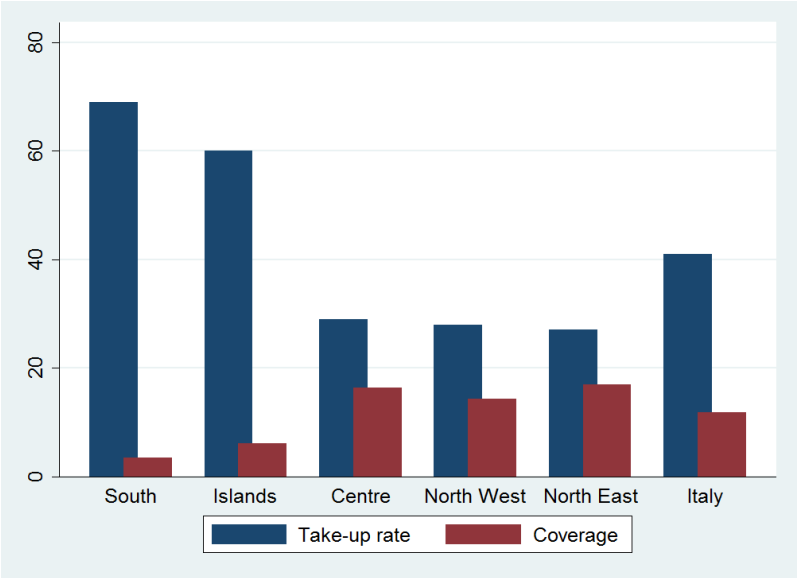
Notes: Fees are set by single municipalities. Kindergartens are free and fees are only required for school meals. Discount is the implicit discount of moving from day care to kindergarten.

Table 3: Summary of rules for access to childcare services,

School year $t/t+1$:	Access to kindergarten, child turns 3 by:	Access to primary school, child turns 6 by:
Until 2002/2003	31 December t	31 December t
2003/2004 - 2004/2005	28 February $t+1$	28 February $t+1$
2005/2006	28 February $t+1$	31 March $t+1$
2006/2007 - 2007/2008	28 February $t+1$	30 April $t+1$
2008/2009	31 January $t+1$	30 April $t+1$
2009/2010 onwards	30 April $t+1$	30 April $t+1$

Notes: Rules are for access to kindergarten and primary school in September of school year $t/t+1$ and refer to dates of birth within the school year. The different cutoff dates for the implementation of pre-kindergarten and pre-school were indicated, on a yearly basis, by the Ministry of Education.

Figure 3: Take-up and childcare services coverage rates, 2011



Notes: The take-up rate is computed as the number of children born between 1 January and 30 April 2008 who enrolled in pre-kindergarten, divided by one third of the total number of children born in 2008. Data on enrolments in pre-kindergarten are taken from Istituto Degli Innocenti (2011). The coverage rate is computed by Istat as the number of 2-year-old children attending public childcare facilities, divided by the number of 2-year-olds.

Figure 4: Childcare fees paid by a child born on 30 April and by a child born 1 May.

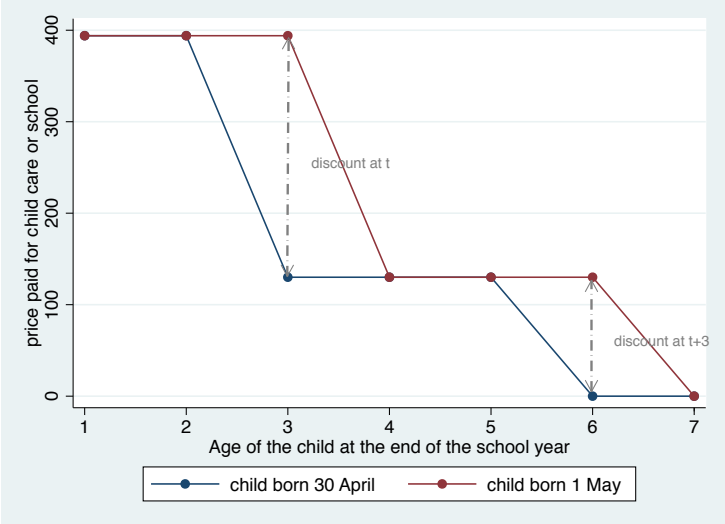
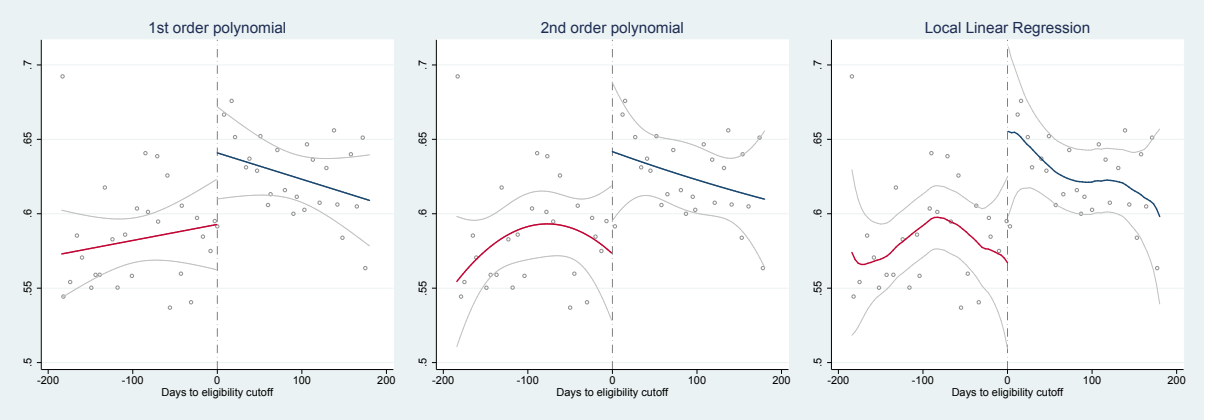


Table 4: Descriptive Statistics

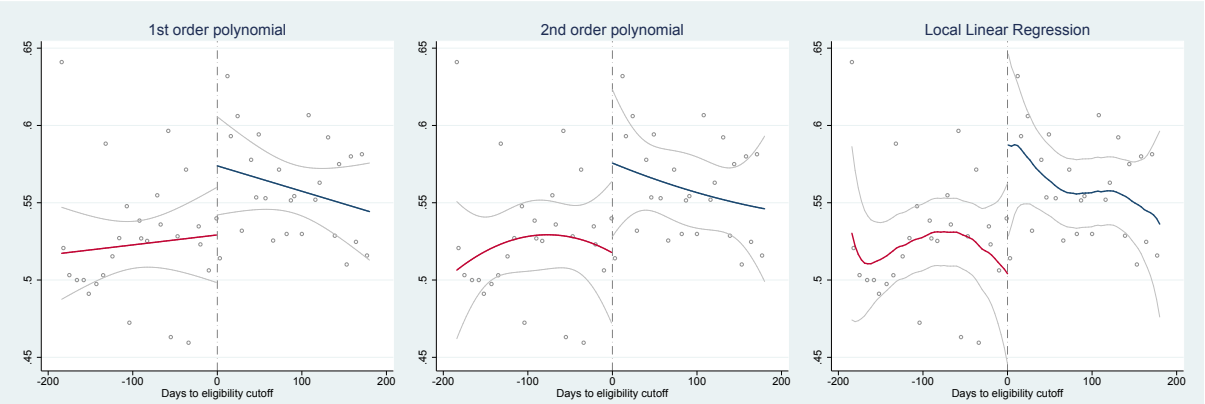
	(1) Total	(2) Non eligible	(3) Eligible	(4) (2)-(3)
Age	34.46	34.16	34.79	-0.631***
	(5.232)	(5.244)	(5.199)	
Single	0.154	0.156	0.153	0.003
	(0.361)	(0.363)	(0.360)	
Household size	3.822	3.801	3.845	-0.044*
	(0.907)	(0.916)	(0.897)	
North	0.485	0.477	0.495	-0.018
	(0.500)	(0.500)	(0.500)	
Centre	0.170	0.172	0.167	0.005
	(0.376)	(0.377)	(0.373)	
South	0.345	0.351	0.338	0.013
	(0.475)	(0.477)	(0.473)	
Compulsory school or less	0.316	0.315	0.318	-0.003
	(0.465)	(0.465)	(0.466)	
High school	0.470	0.468	0.472	-0.004
	(0.499)	(0.499)	(0.499)	
Higher Education	0.214	0.217	0.210	0.007
	(0.410)	(0.412)	(0.407)	
Labour market participation	0.603	0.583	0.625	-0.042***
	(0.489)	(0.493)	(0.484)	
Employed	0.540	0.523	0.559	-0.036**
	(0.498)	(0.500)	(0.497)	
Weekly hours worked	26.50	26.59	26.40	0.191
	(13.52)	(13.44)	(13.59)	
Wage	1064.1	1060.9	1067.3	-6.372
	(433.2)	(440.7)	(425.4)	
Reservation wage	770.1	793.3	747.4	45.931
	(257.6)	(262.1)	(251.5)	
Observations	8020			

Figure 5: Effect of eligibility for pre-kindergarten on mothers' labour market **participation** (Sharp Regression Discontinuity)



Notes: Each dot represents children born in one week. Dots to the right of the cut-off are children eligible for pre-kindergarten. The graphs show first and second order polynomial approximations, and local linear regression approximation with a bandwidth of 60 days.

Figure 6: Effect of eligibility for pre-kindergarten on mothers' **employment** (Sharp Regression Discontinuity)



Notes: Each dot represents children born in one week. Dots to the right of the cut-off are children eligible for pre-kindergarten. The graphs show first and second order polynomial approximations, and local linear regression approximation with a bandwidth of 60 days.

Table 5: Effect of eligibility for pre-kindergarten on mothers' labour market **participation** and **employment** (Sharp Regression Discontinuity)

	(1) 1st order polynomial	(2) 2nd order polynomial	(3) Local Linear Regression	(4) Local Linear Regression	(5) Local Linear Regression
Participation					
ITT	0.048***	0.069**	0.049	0.033	0.071**
	(0.007)	(0.033)	(0.044)	(0.064)	(0.033)
Baseline	0.593	0.573	0.567		
Bandwidth	180	180	60	30	120
Observations	8020	8020	8020	8020	8020
Employment					
ITT	0.045***	0.058	0.054	0.031	0.062*
	(0.009)	(0.030)	(0.045)	(0.070)	(0.032)
Baseline	0.529	0.518	0.504		
Bandwidth	180	180	60	30	120
Observations	8020	8020	8020	8020	8020

Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Figure 7: Effect of eligibility for pre-kindergarten on unemployed mothers' **reservation wage** (Sharp Regression Discontinuity)

Notes: Each dot represents children born in one week. Dots to the right of the cut-off are children eligible for pre-kindergarten. The graphs show first and second order polynomial approximations, and local linear regression approximation with a bandwidth of 60 days.

Table 6: Effect of eligibility for pre-kindergarten on unemployed mothers' **reservation wage** (Sharp Regression Discontinuity)

	(1) 1st order polynomial	(2) 2nd order polynomial	(3) Local Linear Regression	(4) Local Linear Regression	(5) Local Linear Regression
Monthly reservation wage					
ITT	-90.648*	-183.941**	-226.189***	-275.718***	-148.281**
	(55.009)	(74.611)	(77.568)	(77.530)	(60.427)
Baseline	805.381	886.730	900.601		
Bandwidth	180	180	60	30	120
Observations	439	439	439	439	439

Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Table 7: Effect of eligibility for pre-kindergarten on mothers' labour supply, **intensive margin** (Sharp Regression Discontinuity)

	(1) 1st order polynomial	(2) 2nd order polynomial	(3) Local Linear Regression	(4) Local Linear Regression	(5) Local Linear Regression
Weekly hours worked					
ITT	-1.776***	-1.795***	-2.240	-5.077***	-1.649
	(0.017)	(0.575)	(1.488)	(1.929)	(1.137)
Baseline	27.227	27.030	27.438		
Bandwidth	180	180	60	30	120
Observations	4327	4327	4327	4327	4327

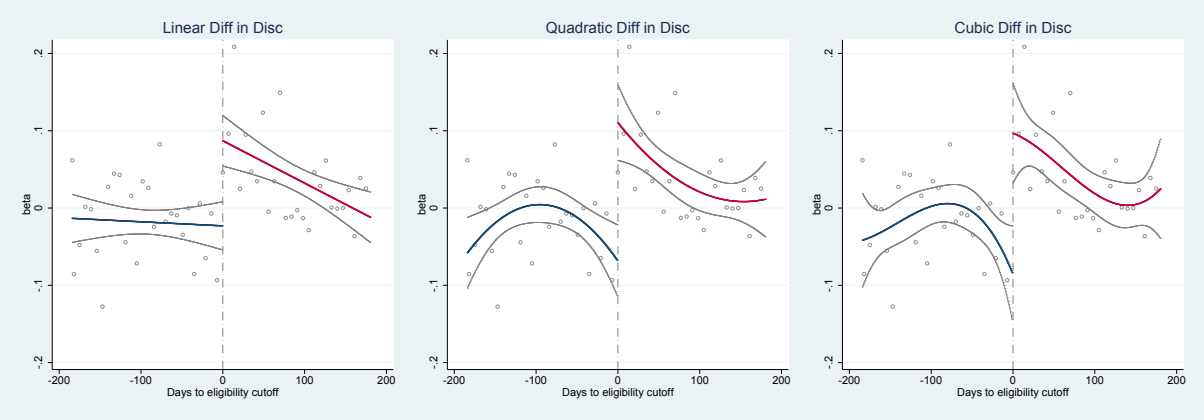
Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Table 8: Effect of eligibility for pre-kindergarten employed mothers' **wages** (Sharp Regression Discontinuity)

	(1) 1st order polynomial	(2) 2nd order polynomial	(3) Local Linear Regression	(4) Local Linear Regression	(5) Local Linear Regression
Monthly wage					
ITT	-34.943	-30.802	-71.898	-152.206	-25.113
	(43.221)	(35.817)	(57.417)	(93.315)	(40.575)
Constant	1,078.858	1,089.992	1107.339		
Bandwidth	180	180	60	30	120
Observations	3536	3536	3536	3536	3536

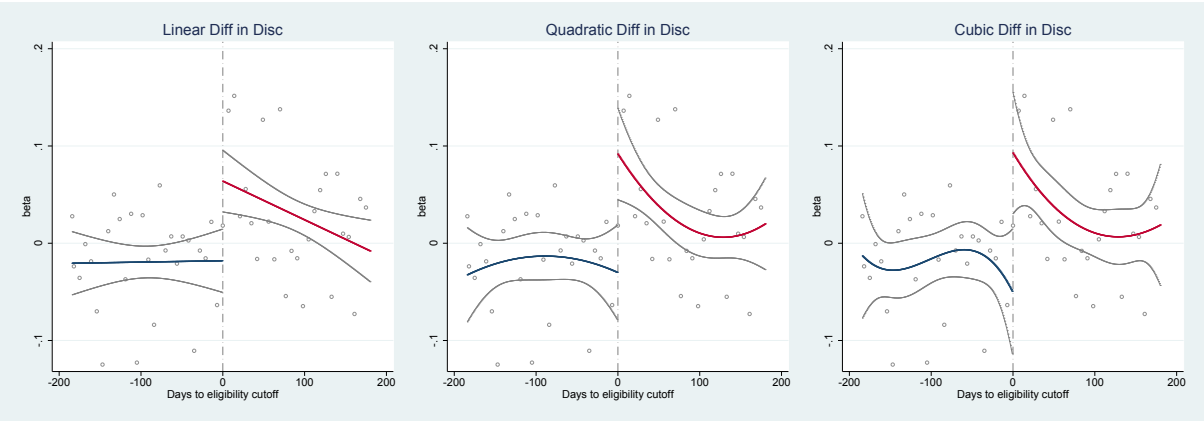
Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Figure 8: Effect of eligibility for pre-kindergarten on mothers' labour market **participation** (Difference in Discontinuities)



Notes: Each dot represents children born in one week. Dots to the right of the cut-off are children eligible for pre-kindergarten. The graphs show first, second and third order polynomial approximations of the treatment effect.

Figure 9: Effect of eligibility for pre-kindergarten on mothers' **employment** (Difference in Discontinuities)



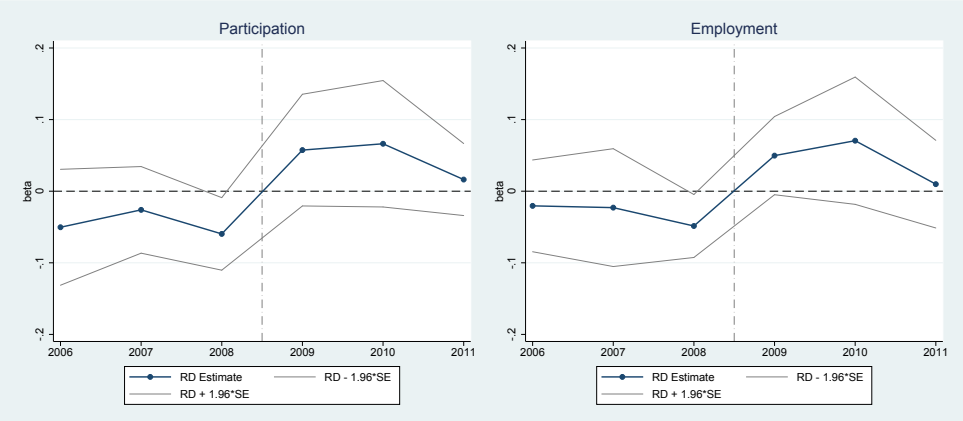
Notes: Each dot represents children born in one week. Dots to the right of the cut-off are children eligible for pre-kindergarten. The graphs show first, second and third order polynomial approximations of the treatment effect.

Table 9: Effect of eligibility for pre-kindergarten on mothers' labour market **participation** and **employment** and on **reservation wage** (Difference in Discontinuities)

	(1) 1st order polynomial	(2) 2nd order polynomial	(3) 3rd order polynomial
Participation			
ITT	0.093***	0.157***	0.159***
	(0.014)	(0.031)	(0.042)
Observations	16521	16521	16521
Employment			
ITT	0.075***	0.112***	0.136***
	(0.010)	(0.034)	(0.011)
Observations	16521	16521	16521
Reservation wage			
ITT	-114.856	-244.984	-141.861
	(71.043)	(161.023)	(169.343)
Observations	858	858	858

Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility.

Figure 10: Effect of eligibility for pre-kindergarten on mothers' **employment** (Difference in Discontinuities)



Notes: SRD by academic year t/t+1. Linear estimation with 95% confidence interval. Years in the central part of the figure are those in which the PK rule was not applied. Robust standard errors are clustered at region level.

Table 10: Effect of eligibility for pre-kindergarten on mothers' labour market status by probability of receiving a job offer (Sharp Regression Discontinuity)

	Low lambda			High lambda		
	(1) 1st order polynomial	(2) 2nd order polynomial	(3) Local Linear Regression	(4) 1st order polynomial	(5) 2nd order polynomial	(6) Local Linear Regression
Participation						
ITT	0.052**	0.004	-0.048	0.044***	0.131***	0.140**
	(0.024)	(0.047)	(0.067)	(0.009)	(0.035)	(0.058)
Baseline	0.526	0.544	0.545	0.656	0.598	0.590
Observations	4057	4057	4057	3963	3963	3963
Employment						
ITT	0.031	-0.014	-0.021	0.059***	0.127**	0.123**
	(0.028)	(0.044)	(0.067)	(0.019)	(0.049)	(0.062)
Baseline	0.452	0.476	0.458	0.601	0.555	0.552
Observations	4057	4057	4057	3963	3963	3963

Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Table 11: Effect of eligibility for pre-kindergarten on mothers' labour market status by educational level (Sharp Regression Discontinuity)

	Compulsory school or less			High school			Higher education		
	(1) 1st order polynomial	(2) 2nd order polynomial	(3) Local Linear Regression	(4) 1st order polynomial	(5) 2nd order polynomial	(6) Local Linear Regression	(7) 1st order polynomial	(8) 2nd order polynomial	(9) Local Linear Regression
Participation									
ITT	0.035***	0.078***	0.062	0.063	0.077	0.082	0.053***	0.026	-0.024
	(0.006)	(0.012)	(0.083)	(0.040)	(0.066)	(0.056)	(0.014)	(0.047)	(0.064)
Baseline	0.381	0.346	0.338	0.625	0.595	0.581	0.814	0.851	0.865
Observations	2536	2536	2536	3771	3771	3771	1713	1713	1713
Employment									
ITT	0.040	0.041**	0.054	0.051	0.078	0.093	0.060**	0.026	-0.018
	(0.026)	(0.018)	(0.069)	(0.052)	(0.054)	(0.058)	(0.025)	(0.050)	(0.072)
Baseline	0.307	0.304	0.281	0.554	0.515	0.499	0.780	0.830	0.837
Observations	2536	2536	2536	3771	3771	3771	1713	1713	1713

Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Table 12: Effect of eligibility to pre-kindergarten on mothers' labour market status by family income

	Low Family Income			High Family Income		
	(1) 1st order polynomial	(2) 2nd order polynomial	(3) Local Linear Regression	(4) 1st order polynomial	(5) 2nd order polynomial	(6) Local Linear Regression
Participation						
ITT	0.061	0.061	0.013	0.040***	0.074	0.080
	(0.038)	(0.091)	(0.054)	(0.005)	(0.047)	(0.059)
Baseline	0.564	0.570	0.581	0.618	0.574	0.555
Observations	3993	3993	3993	4027	4027	4027
Employment						
ITT	0.055*	0.049	-0.052	0.039***	0.065	0.114
	(0.028)	(0.081)	(0.057)	(0.008)	(0.043)	(0.066)
Baseline	0.491	0.506	0.513	0.563	0.527	0.497
Observations	3993	3993	3993	4027	4027	4027
Reservation wage						
ITT	-55.449	-67.902	-152.810*	-134.465***	-315.617***	-330.265**
	(95.417)	(105.925)	(79.857)	(43.781)	(66.646)	(144.598)
Baseline	762.748	814.095	851.114	855.557	975.413	965.593
Observations	227	227	227	212	212	212

Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Table 13: Effect of eligibility for pre-kindergarten on mothers' labour market status by marital status (Sharp Regression Discontinuity)

	Married			Single		
	(1) 1st order polynomial	(2) 2nd order polynomial	(3) Local Linear Regression	(4) 1st order polynomial	(5) 2nd order polynomial	(6) Local Linear Regression
Participation						
ITT	0.056***	0.082***	0.032	-0.016	-0.005	0.051
	(0.007)	(0.018)	(0.068)	(0.035)	(0.175)	(0.125)
Baseline	0.564	0.538	0.535	0.763	0.761	0.730
Observations	6781	6781	6781	1239	1239	1239
Employment						
ITT	0.054***	0.077***	0.074	-0.026	-0.047	-0.046
	(0.011)	(0.019)	(0.052)	(0.024)	(0.156)	(0.081)
Baseline	0.504	0.483	0.472	0.681	0.703	0.666
Observations	6781	6781	6781	1239	1239	1239

Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Figure 11: Discontinuities in baseline covariates

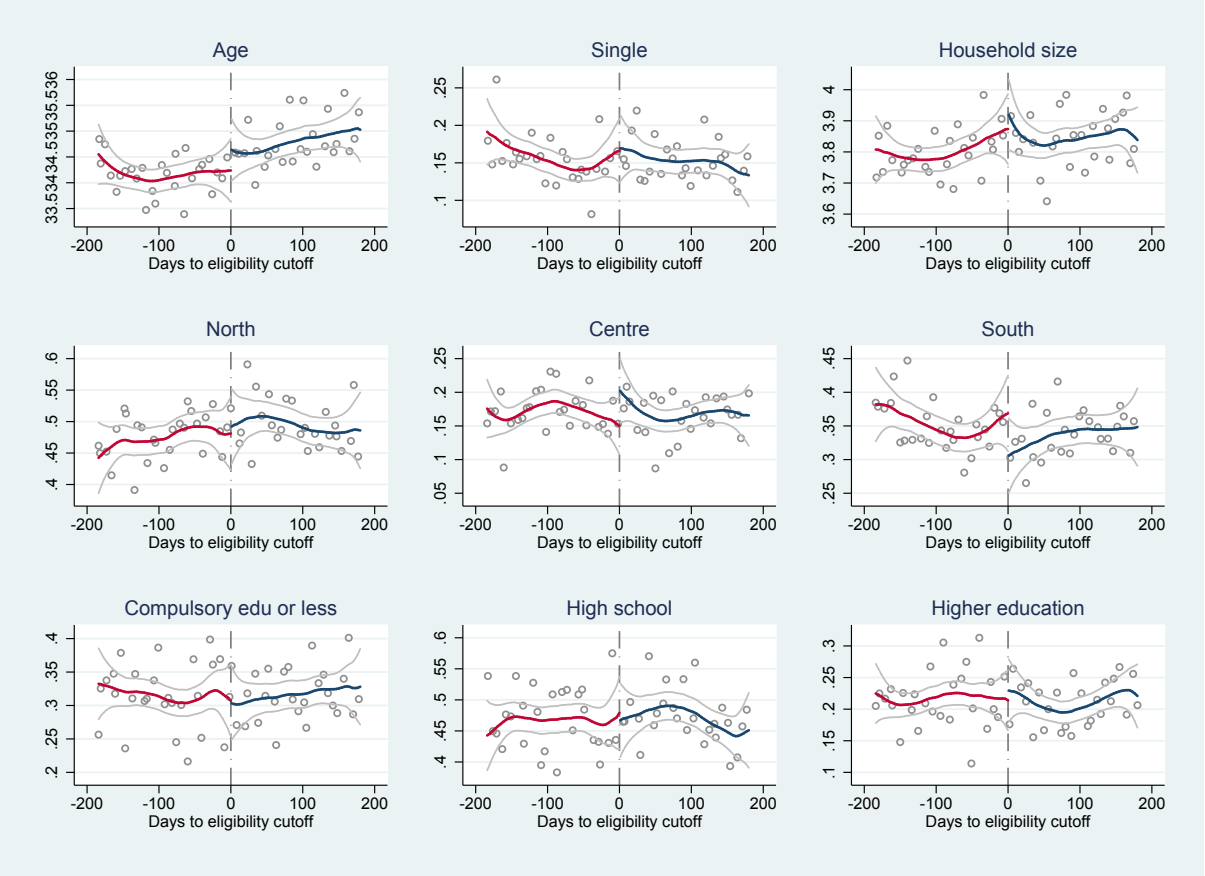
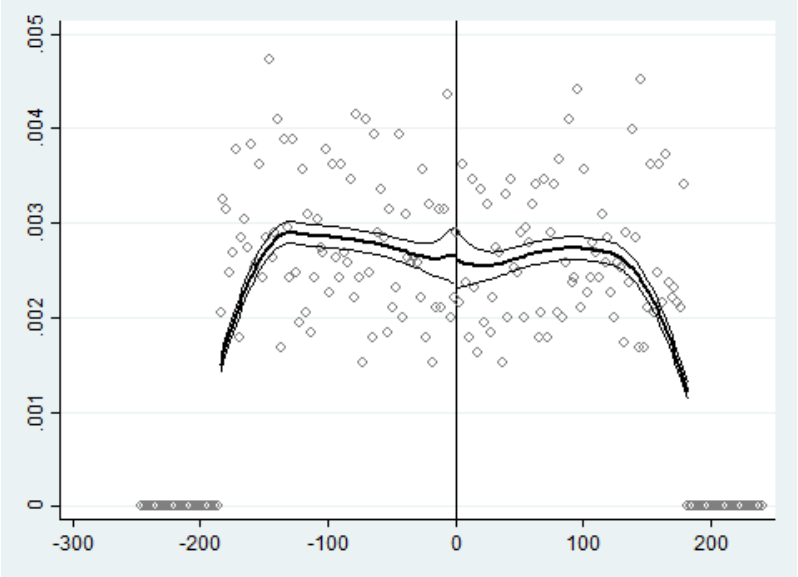


Table 14: Discontinuities in baseline covariates

	(1) Age	(2) Single	(3) Household Size	(4) North	(5) Centre	(6) South	(7) Compulsory Education or less	(8) High School	(9) Higher Education
ITT	0.410	-0.001	0.017	0.017	0.038	-0.055	0.019	-0.022	0.004
	(0.466)	(0.026)	(0.080)	(0.040)	(0.026)	(0.041)	(0.035)	(0.044)	(0.037)
Baseline		0.166	3.874	0.481	0.150	0.369	0.307	0.4790	0.214
Observations	8020	8020	8020	8020	8020	8020	8020	8020	8020

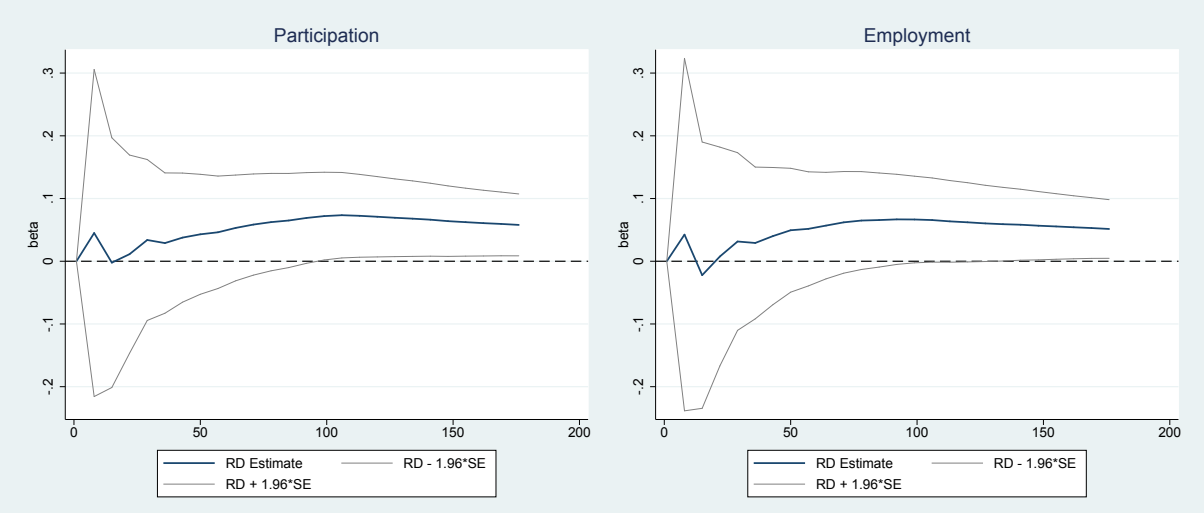
Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Figure 12: Test of manipulation of the running variable



Notes: McCrary test of manipulation of the running variable. Density distribution of sample on the two sides of the cut-off date.

Figure 13: Sensitivity to choice of bandwidth



Notes: Coefficients are obtained through Local Linear Regression with triangular Kernel and bandwidth of 60 days. Robust standard errors are clustered at region-year level and confidence interval is 95% level of significance.

Table 15: Falsification test: effect of eligibility to **kindergarten** on mothers' labour market status (Sharp Regression Discontinuity)

	(1) 1st order polynomial	(2) 2nd order polynomial	(3) Local Linear Regression
Participation			
ITT	0.006	-0.014	-0.037
	(0.020)	(0.032)	(0.043)
Baseline	0.603	0.591	0.571
Observations	8020	8020	8020
Employment			
ITT	0.005	-0.026	-0.051
	(0.021)	(0.028)	(0.040)
Baseline	0.540	0.541	0.524
Observations	8020	8020	8020

Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Table 16: Effect of eligibility to pre-kindergarten on fathers' labour market status (Sharp Regression Discontinuity)

	(1) 1st order polynomial	(2) 2nd order polynomial	(3) Local Linear Regression
Participation			
ITT	-0.008*	-0.000	-0.001
	(0.004)	(0.012)	
			(0.014)
Baseline	0.973	0.969	0.968
Observations	7708	7708	7708
Employment			
ITT	0.000	-0.002	-0.018
	(0.008)	(0.012)	(0.018)
Baseline	0.924	0.921	0.929
Observations	7708	7708	7708

Notes: Robust standard errors clustered at region-year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ITT is the estimated coefficient for Eligibility. The bandwidth used for non parametric estimation is 60 days. Baseline is the level of the outcome variable at the discontinuity for non-eligible individuals.

Table 17: Effect of eligibility to pre-kindergarten on children's test scores

	(1)	(2)	(3)	(4)	(5)	(6)
	Language test scores			Math test scores		
PK	-0.004***	-0.002***	-0.002***	-0.002	-0.000	0.000
	(0.000)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)
Female		-0.014***	-0.014***		0.015***	0.015***
		(0.003)	(0.003)		(0.003)	(0.003)
Immigrant 1^{st} gen.		-0.102***	-0.102***		-0.084***	-0.085***
		(0.006)	(0.006)		(0.007)	(0.007)
Immigrant 2^{nd} gen.		-0.078***	-0.078***		-0.066***	-0.066***
		(0.006)	(0.006)		(0.006)	(0.006)
Mother secondary education		0.043***	0.043***		0.044***	0.044***
		(0.002)	(0.002)		(0.002)	(0.002)
Mother tertiary education		0.075***	0.075***		0.075***	0.075***
		(0.005)	(0.005)		(0.004)	(0.004)
Father secondary education		0.033***	0.033***		0.034***	0.034***
		(0.002)	(0.001)		(0.002)	(0.002)
Father tertiary education		0.056***	0.056***		0.059***	0.058***
		(0.004)	(0.004)		(0.004)	(0.004)
Employment rate, province		-0.002*	0.000		-0.002***	0.000
		(0.001)	(0.001)		(0.001)	(0.001)
Female inactivity rate, province		0.000	0.001***		0.001	0.002***
		(0.001)	(0.000)		(0.001)	(0.001)
Constant	0.747***	0.793***	0.611***	0.666***	0.714***	0.502***
	(0.002)	(0.083)	(0.041)	(0.003)	(0.067)	(0.073)
Observations	1423680	1423680	1423680	1440158	1440158	1440158
R^2	0.0429	0.1114	0.1128	0.0139	0.0864	0.0889
Year FE	y	y	y	y	y	y
Month of birth FE	y	y	y	y	y	y
Region FE			y			y
Cluster school and cohort	y	y	y	y	y	y

Notes: Robust standard errors clustered at school and year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PK is the estimated coefficient for eligibility to pre-kindergarten. Sample includes school years 2011/12 to 2014/15. For each school year $t-1/t$, the sample is composed of children born between January $t-8$ and April $t-7$.

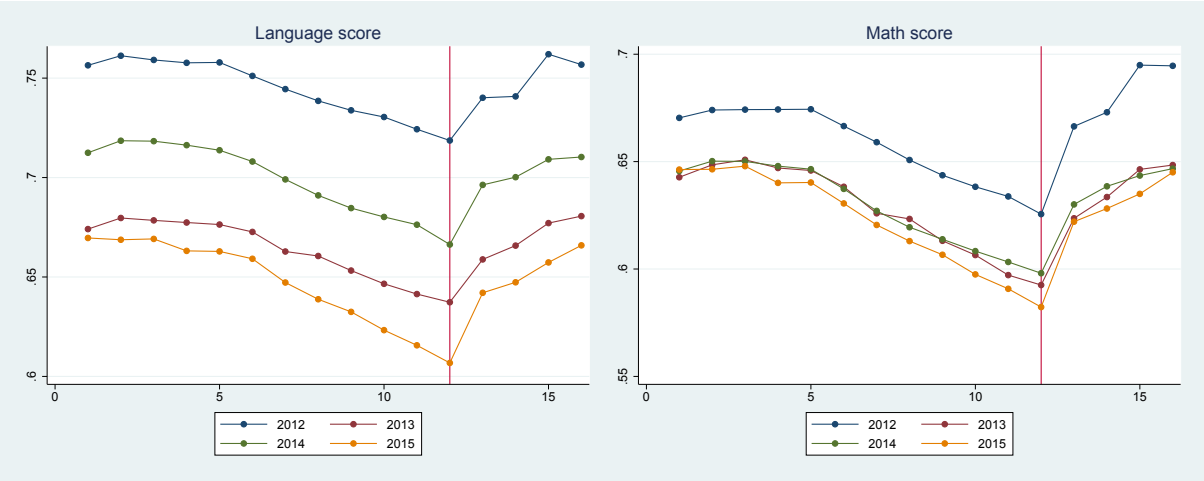
A Appendix: supplementary tables and figures

Table 18: Descriptive statistics, INVALSI sample 2012-2015

	(1) Regular students	(2) Pre-schoolers	(3) (1)-(2)
Math score	0.618	0.628	-0.010***
Language score	0.670	0.672	-0.001**
Female	0.513	0.456	0.057***
Immigrant 1^{st} gen.	0.023	0.010	0.012***
Immigrant 2^{nd} gen.	0.082	0.058	0.024***
Mother secondary education	0.487	0.444	0.042***
Mother tertiary education	0.205	0.269	-0.064***
Father secondary education	0.449	0.433	0.016***
Father tertiary education	0.157	0.220	-0.063***
Father not employed	0.074	0.088	-0.014***
Father blue collar	0.320	0.254	0.066***
Father white collar	0.415	0.419	-0.003*
Father manager	0.191	0.239	-0.048***
Mother not employed	0.412	0.476	-0.064***
Mother blue collar	0.140	0.079	0.061***
Mother white collar	0.345	0.318	0.027***
Mother manager	0.103	0.127	-0.024***
Attended daycare	0.358	0.346	0.012***
Attended kindergarten	0.888	0.852	0.036***
Observations	1,718,164	155,055	1,929,806

Notes: Mean values reported. For each school year $t-1/t$ pre-schoolers are all children born between 1 January and 30 April $t-7$. Sample includes all second graders enrolled in school years 2011/2012, 2012/2013, 2013/2014 and 2014/2015. *** p<0.01, ** p<0.05, * p<0.1.

Figure 14: Test of common trend assumption



Notes: Average score by month of birth and cohort. Points to the right of the red line are pre-schoolers.

Table 19: Effect of PK eligibility - difference between 28 February and 30 April cutoff rule

	(1)	(2)	(3)	(4)	(5)	(6)
	Language test scores			Math test scores		
PK 28-February	-0.010***	-0.006***	-0.007***	0.009***	0.014***	0.014***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Observations	732963	732963	732963	734093	734093	734093
R^2	0.0581	0.1243	0.1260	0.0149	0.0851	0.0880
Controls		y	y		y	y
Cohort FE	y	y	y	y	y	y
Month of birth FE	y	y	y	y	y	y
Region FE			y			y
Cluster school and cohort	y	y	y	y	y	y
PK 30-April	-0.004**	-0.001	-0.001	-0.003**	0.000	0.000
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	1056838	1056838	1056838	1072712	1072712	1072712
R^2	0.0179	0.0878	0.0892	0.0084	0.0813	0.0832
Controls		y	y		y	y
Cohort FE	y	y	y	y	y	y
Month of birth FE	y	y	y	y	y	y
Region FE			y			y
Cluster school and cohort	y	y	y	y	y	y

Notes: Robust standard errors clustered at school and year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PK 28-February and PK 30-April are, respectively, the estimated coefficient for eligibility to pre-kindergarten in 2007/08, with the 28-February rule and in 2013/2014 and 2014/2015, with the 30-April rule. For each school year $t-1/t$, the sample is composed of children born between January $t-8$ and April $t-7$.

Table 20: Effect of PK eligibility on the likelihood of attending day care

	(1)	(2)	(3)
	Daycare attendance		
PK	-0.043***	-0.040***	-0.038***
	(0.012)	(0.012)	(0.011)
Female		0.014***	0.015***
		(0.001)	(0.001)
Immigrant 1^{st} gen.		-0.047***	-0.052***
		(0.013)	(0.011)
Immigrant 2^{nd} gen.		0.076***	0.069***
		(0.009)	(0.010)
Mother secondary education		0.062***	0.059***
		(0.002)	(0.002)
Mother tertiary education		0.137***	0.132***
		(0.002)	(0.002)
Father secondary education		0.043***	0.044***
		(0.003)	(0.003)
Father tertiary education		0.096***	0.097***
		(0.004)	(0.004)
Constant	0.399***	0.286***	0.270***
	(0.007)	(0.007)	(0.010)
Observations	693219	693219	693219
R^2	0.0021	0.0228	0.0432
Cohort FE	y	y	y
Month of birth FE	y	y	y
Cluster school and cohort	y	y	y
Region FE			y

Notes: Robust standard errors clustered at school and year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PK is the estimated coefficient for eligibility to pre-kindergarten. Sample includes school years 2011/12 to 2014/15. For each school year $t-1/t$, the sample is composed of children born between January $t-8$ and April $t-7$.

Table 21: Effect of eligibility to pre-kindergarten on children's test scores. Heterogeneity analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Language test scores						
	Males	Females	Mother less than secondary	Mother secondary education	Mother tertiary education	Father not employed or blue collar	Father white collar or manager
PK	0.000	-0.003**	-0.003	-0.002***	-0.001	-0.002	-0.002*
	(0.000)	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)
Observations	701643	722037	425026	695605	303049	497579	803045
R^2	0.1090	0.1151	0.0907	0.0849	0.0784	0.1017	0.0955
Cohort FE	y	y	y	y	y	y	y
Month of birth FE	y	y	y	y	y	y	y
Region FE	y	y	y	y	y	y	y
Cluster school and cohort	y	y	y	y	y	y	y
	Math test scores						
PK	0.002	-0.001	-0.002	0.001	0.002	0.000	0.000
	(0.003)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.003)
Observations	709475	730683	430866	702995	306297	504552	810802
R^2	0.0918	0.0841	0.0777	0.0613	0.0558	0.0830	0.0700
Cohort FE	y	y	y	y	y	y	y
Month of birth FE	y	y	y	y	y	y	y
Region FE	y	y	y	y	y	y	y
Cluster school and cohort	y	y	y	y	y	y	y

Notes: Robust standard errors clustered at school and year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PK is the estimated coefficient for eligibility to pre-kindergarten. Sample includes school years 2011/12 to 2014/15. For each school year $t-1/t$, the sample is composed of children born between January $t-8$ and April $t-7$.