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A Universal Childcare Expansion, Quality, Starting Age, and School Performance

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Abstract

In the first decade of the 2000s, the proportion of children aged one or two attending formal childcare in Norway more than doubled, from 38% to 79%. There was an especially large increase in public funding to childcare centers starting in 2003, which accelerated this attendance growth. The consequences of this expansion on children`s outcomes remain largely unknown. This paper study the effects of attending childcare on school performance by using the fact that the childcare expansion was greater in municipalities that had low pre-reform childcare coverage. The results do not indicate any average effect of the childcare expansion on test scores at age 10. Dividing the municipalities into groups by childcare quality as measured by pre-reform observables, the results show a positive effect on school performance in municipalities with high pre-reform quality and a negative effect in municipalities with low pre-reform quality. Further analyses suggest that not only quality differences between municipalities but also the age of entering formal childcare explain the findings.

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1 Introduction

There is an established consensus that high-quality targeted programs can have a positive impact on children's later life outcomes (Almond & Currie, 2010; Ruhm & Waldfogel, 2012; Heckman & Mosso, 2014). Meanwhile, there are still discussions in the literature on the consequences of public subsidized childcare programs (see examples of negative, no, and positive effects in Baker, Gruber, & Milligan, 2008; Gupta & Simonsen, 2010; Havnes & Mogstad, 2011, respectively). The main argument put forward for these differing findings is that children attending large-scale subsidized childcare programs have materially different profiles from the children in targeted programs and that the effect of attending childcare can vary for different types of children. For example, the consequence of attending childcare can vary for children from low or high socioeconomic backgrounds, by child age, by child personality, and based on the quality of the alternative modes of care as compared to the quality of the childcare program. Other important discussions in the literature are whether childcare has the potential to influence cognitive or non-cognitive outcomes or both, and whether the effects of childcare in early life persist through adolescence and into adulthood.[1]

This paper contributes to this debate by examining the consequences of a large expansion in public subsidized childcare following a 2003 reform in Norway. Outcomes of children in municipalities that on average experienced a large increase in childcare capacity is compared to the outcomes of children in municipalities that on average experienced a smaller increase in childcare capacity. Since the expansion mostly influenced one- and two-year-olds in some municipalities and three- to five-year-olds in others, this paper contributes evidence on the effects of childcare on children of different age groups. Unlike the studies using differential expansion across districts at the time of reform (Havnes & Mogstad, 2011; Felfe,

[1] Evidence from neurobiological studies shows that the level of stress hormones in children in childcare varies by childcare quality, time in care, age, and temperament (Gunnar & Donzella, 2001; Geoffroy et al., 2006; Lupien et al., 2009).

Nollenberger, & Rodŕıguez-Planas, 2015; Cornelissen et al., 2015; Felfe & Lalive, 2015), we contribute by using a slightly different estimation strategy, relying on expansions being stronger in municipalities with low pre-reform coverage. The advantage of this method is that endogeneity is less of a concern, since pre-determined characteristics of the municipality are used to identify high- and low-expansion municipalities. The outcomes available are national test scores performed at age 10. In addition,childcare quality is examined, since rich data on quality measures are available for childcare institutions. Recent reports on the importance of childcare quality for child outcomes have motivated this focus (e.g., Walters, 2015; Araujo et al., 2015). This paper contribute to this literature by examining the direct effect of a rapid expansion of coverage on child outcomes in municipalities with different pre-reform quality at childcare centers.[2]

The empirical strategy builds on studies that use differential expansions of public programs across districts to evaluate the impact of such programs. An early example of this procedure can be found in Duflo (2001, 2004), whose articles explore the consequences of a major primary school construction program in Indonesia in the 1970s. A notable feature of the expansion program was the intention to construct more schools in areas with relatively low school coverage. The results show clear positive impacts on years of completed education and adult earnings for those who were more exposed to the school construction program. Since the program led to a doubling of the number of schools in six years, Duflo (2001) also examines what happened to school quality. Focusing on the pupil-teacher rate, this indicated that that quality declined between the pre- and post-reform periods, but that there was no differential decrease between high-program and low-program areas.

[2] It is important to note that observable inputs are not randomly assigned to municipalities. If the effect of an expansion varies between municipalities with different observables, that may actually be due to differences in unobservable dimensions, different mechanisms in different types of municipalities, or groups of children being differently affected in different types of municipalities. Section 6 attempts to explore some of these issues.

The literature on the consequences of expansions of large-scale public childcare programs reports mixed effects on child outcomes. Analysis of such programs is most often performed in countries with both an advanced public childcare sector and high-quality administrative data. Canada, Denmark, Norway, and Germany are examples of such countries.[3] Baker, Gruber, & Milligan (2008) published an early paper on the analysis of universal childcare. A program to increase childcare availability was implemented in one Canadian province, Quebec, but not in the rest of the country. The coverage rate for children aged four and under in Quebec increased in the reform period, which lasted nine years, from about 43% to about 67%. The article compares the child outcomes in Quebec with other Canadian jurisdictions, finding negative effects on short-term behavioral and health outcomes for both children, who were assessed soon after leaving the program before age five, and for the program, since the effects were estimated not long after it was implemented.[4] The paper does not find that quality of care decreased by looking at indicators of staff qualifications (age, proportion full-time, proportion with some secondary education) in Quebec and the rest of Canada.

Havnes & Mogstad (2011) examined the effect of a large-scale childcare coverage increase mainly for children aged three to six in Norway in the 1970s. Studying a reform that took place several decades earlier allowed them to look at long-term outcomes, and they find positive effects on adult labor market participation and years of education. With regards to quality, they conclude that, if anything, childcare quality fell because child-teacher and child-staff rates increased more in those municipalities that expanded their coverage to a greater

[3] Evidence on the effect of a relatively large-scale program (compared to Perry Preschool or the Abecedarian Project) from the US is found in studies based on Head Start (Currie & Thomas, 1995; Ludwig & Miller, 2007; Garces, Thomas, & Currie, 2002; Deming, 2009; Bitler, Hoynes, & Domina, 2014; Walters, 2015). Gormley et al. (2005), Wong et al. (2008), and Fitzpatrick (2008) report on public preschool programs in different states.

[4] Lefebvre, Merrigan, & Verstraete (2008) similarly find negative effects using the same reform on preschool children's Peabody Picture Vocabulary Test scores. Baker, Gruber, & Milligan (2015) show that negative effects persist into young adulthood. Other studies pointing to negative effects of childcare (not based on expansions) are Bernal & Keane (2010) and Herbst & Tekin (2010).

degree. By looking more closely at the distributional effects of the same reform on earnings, Havnes & Mogstad (2015) show a positive effect driven by those at the lower end of the outcome distribution. Other evidence from Norway mainly that relies on causal identification methods different than capacity expansions are found in Drange & Havnes (2015), Drange & Telle (2015), and Drange, Havnes, & Sandsør (2016). They find either no effect or a positive effect of attending childcare.

Gupta & Simonsen (2010) examined a policy in Denmark that guaranteed access to childcare for certain cohorts in some municipalities. The study does not find any average effect of center-based childcare in Denmark on a range of measures of non-cognitive outcomes. They do find a negative effect of family daycare for boys with mothers with vocational-track education. Felfe, Nollenberger, & Rodŕıguez-Planas (2015) studied an expansion in childcare capacity in Spain and find positive effects, driven by girls and disadvantaged children, on reading and math scores at age 15. Cornelissen et al. (2017) looked at a capacity expansion aimed at 3-6 year olds in Germany, employing a marginal treatment effects (MTE) framework to show positive effects on children from disadvantaged backgrounds, which also manifests in the MTE analysis as a "reverse selection on gains": those that are less likely to participate are the same people that have the most to gain from childcare. Felfe & Lalive (2014) studied the effect of universal childcare before age three in Germany and find a positive effect for children from low socioeconomic backgrounds. Smaller increases in capacity appear to be more beneficial than larger increases.

The political motivation behind large-scale public childcare expansions and targeted childcare interventions differ to some degree, since the former is driven more by increasing the parental labor supply and the latter more directly at child development. Thus, ex ante, what to expect about the effects on children of large-scale expansions should be less clear. In this study, we find no average effect of a childcare expansion in Norway on 5th grade test

scores. Furthermore, we do not find any consistent evidence that childcare quality is affected by the expansion. Looking at the effect of childcare in municipalities with a high level of quality in childcare institutions before reform, as measured by a pre-reform indicator, the consequence of the expansion is positive on school performance. Negative effects are found in districts with low childcare quality before reform and are mainly driven by children with low socioeconomic status (SES). Further analyses were not able to show that childcare quality or maternal labor force participation were affected differently in municipalities with different levels of pre-reform quality. However, the children influenced by the expansion were of different ages in the two types of municipalities. In low-quality municipalities, the expansion largely affected one- and two-year-olds, while in the high-quality municipalities, the expansion primarily involved three to five-year-olds. This is an indication that childcare might be negative for the youngest children, especially in an environment of lower-quality childcare and positive for older children, especially in an environment of higher-quality childcare.

The study proceeds as follows. In section 2, background information on the institutional details of the reform and the childcare sector is provided. Section 3 describes the administrative data used and lays out the empirical strategy of difference-in-differences using pre-reform coverage rates as a predictor of childcare supply shocks. Section 4 presents the main results, while Section 5 focuses on childcare quality. Section 6 examines alternative mechanisms and Section 7 summarizes and concludes the paper.

2 Institutional details

The development of a public childcare sector in Norway is related to the increase in female labor market participation. In the mid-1960s, few mothers were active labor market participants, so there were relatively few childcare centers. As women's participation

accelerated in the 1970s, there was a corresponding increase in childcare attendance. In the early stages of the development of a public childcare sector in Norway, the focus was on offering alternatives to older children aged three to six years. This has changed over time, with the labor market attachment by mothers of younger children increasing substantially.

The 1990s were subject to three reforms that had important consequences for the public childcare sector. In 1993, maternity leave was extended up until children turned one, and the process of including six-year-olds in the school system was finalized in 1997. As a result, most children attending public childcare were aged between one and five after 1997. In 1998, the Cash-for-Care (CFC) benefit was implemented, providing a substantial cash incentive to parents that did not send their one- or two-year-olds to childcare. The reform showed that a price increase reduces childcare attendance, and mainly increase parental care for the youngest children (Andersland & Nilsen, 2016).

By the beginning of the 2000s, the public childcare sector in Norway was already well developed. About 41% of children aged one or two and about 84% of children aged three to five attended some form of public childcare in 2002.

[FIGURE 1]

Figure 1 shows the development of the proportion of one- and two-year-olds registered in childcare in Norway; the rapid increase in the coverage rate in the 2000s is readily apparent. This expansion is associated with "The Childcare agreement," a 2003 decision by the Storting, Norway's legislature, that changed several laws to increase childcare capacity. The most important elements were the equal treatment of childcare centers, the implementation of guaranteed childcare for those who wished it, and the implementation of a nationwide maximum price for childcare.

Norway's formal childcare system features both private and public operations. Both types of centers receive public subsidies and are subject to similar regulations. Before reform,

however, municipalities differed in the amount of subsidy provided to private childcare centers. The reform meant that all types of childcare centers were to receive the same subsidy amount. Moreover, municipalities were obliged to guarantee a place in public childcare by 2005 for all children by 1st September of the year following their birth. The government made plans to create 40,000 new childcare slots by 2005.

Before reform, prices could vary substantially between municipalities. Beginning in 2004, the monthly maximum price was set at 2,750 NOK (≈US$340), with plans for eventual decreases. A survey conducted in 2002 reports that municipal childcare prices averaged by parental income groups ranged from 2,044 to 2,937 NOK (Eibak, 2002). The introduction of a fixed price would thus largely affect high-income households in practice, since they paid the highest prices for childcare before reform.

To implement a maximum price, equal treatment of childcare centers, and guaranteed childcare slots, Norway's total public expenditure for childcare more than doubled from 2002 to 2005.[5] In addition to increasing regular funds, the government established a discretionary fund to help municipalities that would face particularly daunting challenges in fulfilling the reform requirements (Aamodt, Moennesland, & Juell, 2005). This fund would direct extra resources to those municipalities that had higher prices for and lower subsidies to private childcare centers before reform and to those considered likely to be unable to guarantee childcare slots for all who needed them by 2005. The specific amount of funds directed to each municipality was calculated centrally. The net effect was that more funds were directed at municipalities with less-developed childcare sectors. The discretionary fund amounted to 10.5% of Norway's total public funding for childcare in 2005.

Formal childcare in Norway is centrally regulated through the Childcare Act ("Barenhageloven"), which provides a set of common rules for childcare in municipalities

[5] Source: National Budgets 2002–2007.

throughout the country. The maximum number of children in full-time care per pedagogical leader (a childcare position type that requires certified education) is nine for children below three and eighteen for children from three to six years old. To become a pedagogical leader, one must complete three years of college education in the preschool teacher program. Childcare centers can apply to the municipality for temporary exemptions if they are not able to meet the educational requirements for staff. There are both caregivers with formal education and caregivers without pedagogical education working in childcare. The stated norm is one caregiver for three children below three and one caregiver for six children three or older. Childcare centers are normally open during daytime working hours, from 7 am to 5 pm, Monday to Friday. Statistics on the use of different forms of care arrangements can be useful for understanding alternative forms of care for one- and two-year-olds. A survey conducted by Statistics Norway in 2002 and reported in Pettersen (2003) shows that 44% of children in that cohort are cared for primarily by parents, 33% attend formal childcare, 12% have informal care arrangements, 4% are cared for by relatives, and 7% have other care arrangements. These figures make clear that a large increase in one- and two-year-olds attending formal childcare will be draw primarily from parental care and other informal care arrangements.

3 Data and empirical strategy

Data on cohorts born from 1998 to 2004 are used in the analysis. These cohorts were chosen because they were affected by the childcare expansion and because they are now old enough to provide data on school performance at age 10.[6] Information on childcare attendance comes from two sources. The measure of individual-level childcare attendance comes from Norway's CFC database. The CFC benefit was implemented in 1998 to provide a cash

[6] Table A1 shows the structure of the data.

transfer to families that did not send one- or two-year-old children to formal childcare. Families applied to the welfare agency to receive the benefit, stating whether or not their child attended childcare. From 1999–2012, a family would be eligible for the benefit simply by having a one- or two-year-old child who did not attend formal childcare fulltime. The welfare agency controlled this information by collecting monthly information from municipalities. As a result, individual-level childcare measure for all CFC-eligible children from 1998 onward are available. Children are classified as attending childcare in a given month if they were registered as attending above 10 hours per week that month. From these data, we also construct a measure of the total number of hours in childcare before age three.

Municipality-level childcare attendance rates, or coverage rates, are taken from the KOSTRA ("Kommune-Stat-Rapportering") database. KOSTRA is a national reporting scheme used in Norway for the administration, evaluation, and comparison of municipalities. Childcare centers report their numbers at the end of each year to their municipality, after which municipalities report the number of children in childcare to Statistics Norway. This database is used to calculate municipality-level coverage rates and municipality-level childcare quality measures.[7,8]

The third important source of information is the database on national exams, which were introduced in 2004 in order to evaluate how schools succeeded in developing students' skills in math, reading, and English. Students take the tests at the 5th, 8th, and 9th grade levels. Since the students in our sample are still very young, we can only examine the effects on 5th grade test scores. Since 2008, the tests in math and English have been electronically corrected. Depending on the subject and year, scores are given on a scale from 0 to 30 or 50.

[7] Figure A1 compares municipality coverage rates calculated from CFC data with KOSTRA coverage rates by year and across the largest municipalities.

[8] KOSTRA coverage rates and quality numbers are reported for most municipalities from 2001 onward. Since we use numbers registered in the second year after the cohort birth year, the 1998 cohort is excluded from the analysis using KOSTRA numbers. To compensate for this, the robustness section shows the main results without the 1998 cohort.

In this analysis, the distribution of points is standardized with means of 0 and standard deviations (SDs) of 1 by subject and year.

Information is also available on which school students attended when taking the test, municipality of residence by age, and parents' earnings and years of education. Earnings are measured in basic amounts used in the national insurance scheme.[9]

The empirical strategy follows previous literature on universal childcare by using a large expansion in capacity that varies across districts. The first step is to identify a pre-reform indicator for the intensity of expansion; examples of similar strategies can be found in Duflo (2001) and Løken, Lundberg, & Riise (2017).

[TABLE 1]

Table 1 shows the results from a regression of municipality-level coverage expansion for one- and two-year-olds from 2002–2007 on pre-reform municipality characteristics. It reveals that the pre-reform coverage rate (for one- and two-year-olds measured in 2001) is a strong predictor of capacity expansion. The 2003 reform led to a larger increase in childcare capacity in municipalities with lower initial coverage rates. A municipality with 10 percentage points (pp.) higher pre-reform coverage had a 4.75 pp. lesser increase in the coverage rate. This result accords with the regulatory changes following the reform that led to more funds being directed at municipalities with less-developed childcare sectors. The pre-reform coverage rate is therefore used as the indicator of the capacity expansion and the main regression (Equation 1) is:

$$Y_{it} = \alpha_1 + \alpha_2 Short_t + \alpha_3 Long_t + \alpha_4 (PreCoverage_i \cdot Short_t) + \alpha_5 (PreCoverage_i \cdot Long_t) + \alpha_6 X_{it} + \epsilon_{it} \quad (1)$$

[9] One basic amount was 92,576 NOK in 2016 ≈ US$11,443.

The cohorts in the sample were born between 1998 and 2004. $Short_t$ is an indicator for cohorts born in 2001 or 2002 and only partly affected by the reform, while $Long_t$ is an indicator for cohorts born in 2003 and 2004 and more significantly affected by the reform. $Short_t$ will also be an indicator for children that are affected by the reform when they are older, while $Long_t$ is an indicator for children that are more affected by the reform when they are younger. $PreCoverage_i$ is the pre-reform municipal level childcare coverage rates, measured in 2001, for one- and two-year-olds. X_{it} is a set of control variables including gender, mother's age, father's age, immigration status, parents' labor participation before child birth, parental years of education before child birth, and municipality dummies. Y_{it} are average scores on national tests in math, English and reading in the 5th grade. To correct for intragroup correlation in error terms, standard errors are clustered at the municipality level.

The specification assumes a linear relationship between the pre-reform coverage rate and outcome variables. Following Løken, Lundberg, & Riise (2017), municipalities above the 90th and below the 10th percentiles in the pre-reform coverage rate distribution are dropped from the analysis.[10] Municipalities with very high or low pre-reform coverage rates may behave differently than other municipalities in response to the reform because of their extreme pre-reform coverage rates. We show the sensitivity of the results to this restriction in the robustness section.

The interpretation of the coefficient in front of the interaction terms in Equation 1, with test scores as outcomes, is how changes in test scores from before to after the reform depend on pre-reform coverage levels. The coefficient is interpreted as an intention-to-treat (ITT) effect, since it is the total effect on children in municipalities more heavily exposed to

[10] Figure A2 shows the coverage rate distribution with lines indicating the 10th and 90th percentiles. Figure A3 explores how pre-reform characteristics relate to pre-reform coverage rates in municipalities. The figure reveals that municipalities with higher pre-reform coverage rates on average had higher female employment, lower male employment, larger cohort sizes, more private childcare centers, lower proportions of preschool teachers, and lower adjusted costs per care hour.

the childcare expansion. For our estimate to have a causal interpretation, we must assume that without the childcare expansion, the time trends in test scores in municipalities with high and low pre-reform coverage rates would have been the same.

[FIGURE 2]

Figure 2a illustrates the empirical strategy by showing the change in coverage rates from 2002 to 2007, compared to pre-reform municipal-level coverage rates of for one- and two-year-olds in 2001. There is a clear relationship between pre-reform coverage rates and capacity increases. Municipalities with a relatively high pre-reform coverage level of close to 0.6 showed an average increase in coverage level of about 0.2, while municipalities with a relatively low pre-reform coverage level of nearly 0.2 had an average increase in coverage level of about 0.4. Figure 2b shows that there is no significant relationship between pre-reform coverage levels and changes in test scores, which is the first sign that there was no average effect of the reform on test scores.

4 Results

This section begins the exploration of the effects of the expansion on test scores in detail. Estimations are carried out on both on the full sample and, in the next section, on subgroups of municipalities in an attempt to see if the effect of the expansion varied across different types of municipalities. Lastly, we explore the mechanisms behind the estimated results. Table 2 shows the effect of the expansion for children using a sample containing all municipalities.

[TABLE 2]

The first two columns in Table 2 show the results when the dependent variable is average national exam test scores with and without individual-level control variables. The short run coefficient is insignificant, small, and negative, while the long run coefficient is insignificant,

small, and positive. Including control variables changes the estimates only marginally. Thus, there are no conclusive signs that higher exposure to childcare expansion affected school performance at age 10. Columns 3–5 show the same estimations with individual controls by subjects: reading, English, and math, respectively. The only significant coefficient is in the short run effect for math. This may seem inconsistent with a positive effect of childcare since the expansion is much stronger in the long run. One explanation for finding significant effects in the short run but not the long run is that the effect of childcare is heterogeneous by age. The cohorts affected by the expansion in the short run estimate (born 2001–2002) were older when the reform began to take effect. This issue is discuss this in greater detail in Section 6.

Table 3 shows the robustness of the baseline results. The different specifications are indicated in the column headers.

[TABLE 3]

Column 1 repeats the baseline results from Table 2, while Column 2 excludes Norway's six largest cities from the estimation. The long run estimate changes sign, but both coefficients remain insignificant. Column 3 excludes the 25% smallest municipalities, with no significant effect on the estimates. Column 4 excludes municipalities with pre-reform coverage rates below the 15^{th} or above the 85^{th} percentile in the pre-coverage rate distribution. The short run coefficient appears to be somewhat sensitive to changing the pre-reform coverage cutoff rates, becoming negative and significant at the 5% level. Column 5 excludes the first cohort in the pre-reform period, while Column 6 excludes the first cohort in the post-reform period. Excluding cohorts has only a marginal impact on the size of the coefficients. Column 7 interacts predetermined municipal characteristics with cohort dummies to determine whether if municipalities with different observable characteristics demonstrate different trends. Observable characteristics used are female labor force participation, male labor force participation, and cohort size. Coefficients remain small and insignificant.

The estimates are generally robust to changes in the specifications. The only specification change that appeared to matter was changing the cutoff in the pre-reform coverage distribution, and even that change was observed only for the short run coefficient. This could be a sign that there are nonlinear effects but could also be an artifact of chance. In total, Table 3 show that the results are robust to a variety of specifications checks.

5 Childcare quality

Until this point, the focus has been on the average effect of the childcare expansion on child outcomes. This section has two main objectives. First, it explores how the expansion affects childcare quality. Second, it seeks to determine whether the effect of the expansion depends on pre-reform municipality-level childcare quality. To achieve these two objectives, good measures (or correlates) of municipality childcare quality must be obtained. The KOSTRA database provides a set of potential variables for this purpose. The quality measures available are "Children/staff rate," "Adjusted care hours/staff rate," "Proportion preschool teachers among pedagogical leaders," "Proportion preschool teachers among employees," "Cost per child," and "Cost per adjusted care hour."

The "Children/staff-rate" and "Adjusted care hours/staff-rate" measure how much exposure each child has to a caregiver (or group size) while in childcare. Staff is measured in person-year full-time equivalents; it's thus not sensitive to changes in the use of part-time staff. Adjusted care hours are the number of hours of childcare provided, adjusted for the age composition of the children, which is determined by multiplying the number of children below three by two and the number of children aged three by 1.5 and giving a factor of one to children aged three or older. In the time period we study, Statistics Norway has only calculated this measure for public childcare centers.

The general norms imply that the proportion of pedagogical leaders of employees is the same for personnel working with children aged one to two and children aged three to five. As a result, the proportion preschool teachers among employees should not be determined by the change in age composition. As mentioned, all pedagogical leaders are supposed to have preschool teacher education. "Proportion of preschool teachers among pedagogical leaders" should therefore not be affected by the change in age composition, even if childcare centers operate with different employment structures than those suggested by the norms. These proportions are calculated for all childcare centers within a municipality.

"Cost per child" and "Cost per adjusted care hour" are measures of how much municipalities spend on childcare. Since it costs more to keep younger children in childcare, "Cost per child" does depend on age composition. As with the adjusted group size measure, Statistics Norway has only calculated these measures for public childcare centers.

The selection of group size measures was motivated by the literature, which shows that class size matters (Krueger, 1999; Chetty et al., 2011). The municipality database does not include information on the experience of childcare employees, which has been shown to be an observable teacher characteristics that is a relevant correlate of teacher quality in the school literature (Rivkin, Hanushek, & Kain, 2005; Staiger & Rockoff, 2010), but it does include information on the education levels of employees in childcare centers. Since those measures are made at the municipality level, we argue that they do not necessarily reflect the quality of the individual childcare employees; rather, they reveal something about the overall quality of childcare in a given municipality. According to national regulations, pedagogical leaders are supposed to have a certificate in preschool education. A municipality that lacks a high proportion of preschool teachers among its pedagogical leaders suggests either that it has problems recruiting and retaining quality staff or that it is not strict in adhering to standards in childcare centers.

Three cautionary remarks are necessary. First, as Rivkin, Hanushek, & Kain (2005) note, there are large differences in teacher quality that are not easily captured by readily available observable characteristics. This suggests that our measures of municipality-level teacher education will capture only some quality differences across municipalities and centers. Second, even though these may be policy relevant variables, they do not measure the actual interactions in childcare centers as observed in Araujo et al. (2016). Lastly, observable inputs are not randomly assigned to municipalities. If the effect of the expansion varies between municipalities with different observables, that may actually be due to their being different on unobservable dimensions, that the mechanism is different in different types of municipalities, or that the groups of children affected are dissimilar in different types of municipalities. Section 6 offers an initial exploration of some of these issues.

5.1 Effect of expansion on observable inputs

With a large expansion in public subsidies to childcare centers it is not clear ex ante whether one should expect an increase or decrease in childcare quality. The expansion led to a doubling of the funding for childcare centers in just three years, so one could reasonably expect increased funding to enhance quality. However, a rapid increase in the number of children in childcare centers could also lead to lower quality by increasing group size and lowering the qualification and experience levels among the personnel. The literature reviewed in Section 1 suggests that if anything, quality normally falls with large-scale expansions.

To analyze the effect of childcare expansion on childcare quality, we estimate Equation 2, which has municipality-level quality measures as dependent variables:

$$Quality_{it} = \alpha_1 + \alpha_2 Short_t + \alpha_3 Long_t + \alpha_4 (PreCoverage_i \cdot Short_t) + \alpha_5 (PreCoverage_i \cdot Long_t) + \alpha_6 X_{it} + \epsilon_{it} \quad (2)$$

[TABLE 4]

Table 4 shows the results from these estimations. The dependent variable is average municipality level childcare quality from the year in which the children in each cohort turn two through the year in which they turn five. Information for the 1998 cohort is dropped, since we lack quality information for this cohort (data on quality measures only begins in 2001). Column 1 examines how age composition in childcare changes, Columns 2–3 examine the effect on measures of group size, Column 4–5 look at measures of the quality of staff, and Columns 6–7 examine how childcare costs are affected by the expansion.

Column 1 shows that children in municipalities with 10 pp. lower pre-reform coverage rates attended childcare centers with a 1.08 pp. higher proportion of children aged one or two in childcare in the short run, and a 2.21 pp. higher proportion of children aged one or two in childcare in the long run. This confirms the hypothesis that the proportion of children aged one or two in childcare centers was affected by the expansion; any analysis of how the expansion changes quality across time should take account of this reality.

Column 2 shows that the number of children per staff decreases in high-expansion municipalities. The long run estimates show a decrease of 0.17 (3.6% of the mean or 29% of the SD) children per caregiver in childcare in municipalities with a 10 pp. lower pre-reform coverage rate. Children are normally divided into groups by age, with a fixed number of adults responsible for each group. Even with the significant change brought on by the reform, children's exposure to adults may actually be unchanged, since the age composition in childcare changes.[11]

[11] The organization of childcare centers can be divided into "Avdelingsbarnehage" and "Basebarnehage". "Basebarnehage" allows for a more open organization that lets children roam between groups, although each child should still keep a main attachment to a specific group with a fixed number of adults (Vassenden et al., 2011). The more children are allowed to roam across age groups, the regular child pr. staff measure of childcare quality becomes important.

Column 3 shows no effect on adjusted care hours/staff for municipal childcare centers, indicating that there is no evidence that children's exposure to adults changes as a consequence of the expansion. Since private and public childcare centers are subject to the same regulations, it is likely that group size also remains unchanged in private childcare centers.

In addition to group size, employee education levels and amount of municipal spending on childcare may indicate how an expansion affects quality. Column 4 shows no change in the proportion of staff with preschool teacher education, while Column 5 similarly shows no significant increase in the total proportion of pedagogical leaders with preschool teacher education. Together, these are interpreted as meaning no average change in the education level of childcare center staff as a consequence of the reform. Column 6 shows that costs per child in childcare did increase as a consequence of the expansion, but Column 7 indicates that the increase is relatively smaller per age-adjusted care hour. Given that we do not find any evidence of a change in group size in public childcare centers or in employee education level, we are cautious about how to interpret this coefficient. It could mean that expansion leads to increased quality through other channels, but it could also mean that efficiency declines during a capacity buildup, since costs increase for the same number of age-adjusted care hours provided.

In sum, the results indicate that group size and education level among employees remain unchanged, while childcare costs increase to some extent. Since the increased costs are relatively small and may actually signal decreased efficiency instead of increased quality, we conclude that we are not able to reject the hypothesis that childcare quality is unchanged. Additional analysis of how changes in observable inputs relate to changes in child outcomes is provided in Section 6.

5.2 Effect on test scores of the child care expansion by municipality type

To uncover possible heterogeneity in effects across, municipalities are split into groups according to the proportion preschool teachers of employees and the proportion of preschool teachers among pedagogical leaders before reform. According to the norms and regulations, these proportions should stay constant across municipalities with different age compositions in childcare. Any observed variation is therefore more likely to be due to quality differences. These measures cover both private and public childcare centers. Table 5 shows the results of estimation carried out using subsamples.

[TABLE 5]

The table shows estimates of the short and long run coefficients from Equation 1, split into four panels. The dependent variables are average test score, reading score, English score and math score in Panels a), b), c), and d) respectively. In Columns 1–3, Equation 1 is estimated separately by dividing municipalities according to three quantiles in the distribution of pre-reform municipality-level proportion preschool teachers among employees. In Columns 4–6, the same approach is carried out using the proportion of preschool teachers among pedagogical leaders.

Since results are very similar across the two measures of quality, we choose to focus on the results in Columns 4–6. The long-run ITTs on average test scores show that the expansion affected test scores negatively among municipalities with the lowest proportion of preschool teachers among pedagogical leaders before reform, while expansion led to an increase in test scores in municipalities with the highest such proportion. The same is true when dividing municipalities according to proportion preschool teachers among employees. The long run effect shows that children in municipalities with 10 pp. lower pre-reform coverage rates increased test scores in high-quality municipalities by 0.041 SD, while it decreased by 0.028 SD in low-quality municipalities. This pattern is fairly consistent across

different test scores, but it is most prominent in the long run estimates, once reform has had time to be implemented and exert greater influence. Table A2 shows the robustness of results when dividing municipalities according to the proportion of preschool teachers among pedagogical leaders, with average test scores as the outcome as shown in Panel A in Table 5. The table shows that estimates for high-quality municipalities are robust to different specifications, while the estimates for low-quality municipalities are somewhat sensitive to the exclusion of large municipalities and flexible trends.[12]

One possible reason for why these measures may capture childcare quality is that they describe how easy it is for municipalities to hire quality personnel in childcare. Even though pedagogical leaders are supposed to have certified preschool education, the proportion that actually has this certification varies between municipalities. The regulations acknowledge that it may be a challenge to hire qualified personnel: they therefore allow municipalities to apply for exemptions. However, observable inputs are not randomly assigned to municipalities. There are thus alternative explanations that are discussed in the next section.

6 Alternative mechanisms and heterogeneous effects

The previous section indicated that the reason for positive effects of childcare on children's test scores in municipalities with a high pre-reform proportions of preschool teachers and negative effects on children's test scores in municipalities with low pre-reform proportions of preschool teachers could be quality differences between childcare centers in different types of municipalities. Table 6 allows us to explore alternative explanations.

[Table 6]

Column 1–3 in Table 6 show estimations of long run coefficients in Equation 1 on subgroups of municipalities split according to the proportion of preschool teachers among pedagogical

[12] See Section 6 for a further discussion of this issue.

leaders in a municipality. Each column shows results for estimations on subsamples, with row headings indicating dependent variables. Panel A) shows results using municipality-level childcare quality measures as outcomes, while Panel B) has parental labor force participation as outcomes, and outcomes in Panel C) are childcare attendance measures.

Panel A) shows that the children/staff rate decreases significantly in low-quality municipalities as a consequence of the expansion, while high-quality municipalities experience a smaller decrease in that measure. At the same time, there are no significant changes in the adjusted care hours/staff rate in any of the municipality groups. These results are consistent with a change in age composition in childcare centers that are different in the different municipality types, but does not indicate that different developments in group size can explain the observed differences in results between municipality types, because we observe no differences in adjusted care hours per employee. This pattern repeats itself in the results on the effect of the expansion on childcare costs. While the cost per child increases significantly with expansion in low-quality municipalities, we are not able to reject the null hypothesis of no change in costs per adjusted care hour in either high- or low-quality municipalities. The change in education level appears to be unaffected in all municipality types, although there does appear to be an increase in the education level among pedagogical leaders in low-quality municipalities. However, this cannot explain the negative effect of the expansion in these municipalities since, if anything, an increase in the education level of staff should translate into a positive effect on test scores.[13] Children/staff-rate decreases significantly in low-quality municipalities as a consequence of the expansion. If children are free to roam between groups, this would indicate an increase in quality due to increased caregiver exposure, but since we observe a negative effect for this group of municipalities, this does not appear to be a quantitatively important explanation. In sum, group size,

[13] The results shown in Table A3 show that the only significant change between high- and low-quality municipalities on quality measures is on the children/staff rate.

education level, and costs do not evolve very differently in the different municipality types, at least not in the direction expected from the differences in test scores.

Effects on parental labor force participation are displayed in Panel B). Parental labor force participation is defined as a parent's earning above two basic amounts in the national insurance scheme in the second year after a child's birth (Havnes & Mogstad, 2011, 2015). Increased labor force participation could explain a positive effect of the childcare expansion by increasing household incomes (Løken, 2010; Black et al., 2012; Dahl and Lochner, 2012; Løken, Mogstad, & Wiswall, 2012). A positive effect of the expansion is found on maternal but not paternal labor force participation. Importantly, the point estimates do not suggest that household income changes differentially in different municipality types. This suggests that income effects cannot fully explain the differences in results across different types of municipalities.[14]

Lastly, Columns 1–3 in Panel C) show the effects of the expansion on childcare attendance in different types of municipalities. The regressions suggest that expansion leads to a strong increase in childcare attendance before age three in low-quality municipalities, while the same effect is not observed in high-quality municipalities. This is consistent with the results on municipality-level coverage rates, which show a strong increase in experienced coverage rate for one- and two-year-olds in low-quality municipalities, while there is a much smaller increase in high-quality municipalities. The largest increase in coverage rates for three- to five-year-olds are found in high-quality municipalities. These findings are also consistent with the patterns on unadjusted group size and costs measures. The expansion leads to increased childcare attendance mostly for children aged one or two in low-quality municipalities, while it mainly increases attendance for children aged three to five in high-quality municipalities. The main alternative explanation for the negative effect observed in

[14] Table A4 shows results for the full sample, and Table A3 shows results from tests of different development in parental labor force participation in high- and low-quality municipalities. No significant difference is found.

low-quality municipalities is therefore that the effect of childcare on young children is negative. The positive effects observed in high-quality municipalities are then explained by positive effects of childcare for older children. This might be an important explanation for the mixed findings in the literature, since papers more often find positive effects for three- to five-year-olds (e.g., Havnes & Mogstad, 2011) and no or negative effects for one- or two-year-olds (e.g., Fort, Ichino, & Zanella, 2016)

Table A5 show the robustness of results shown in Table 6 by using pre-reform coverage rates for children aged one to five to estimate ITT effects. Panel c) reveals that this pre-reform indicator is associated with a shift of both more and relatively older children into childcare for low-quality municipalities. With the childcare quality explanation being the only explanation, we should expect to see stronger effects of the same sign. Column 4 in Panel d) shows that the effect in the low-quality municipalities is no longer significantly different from zero. This is consistent with the explanation that there are negative effects of attending childcare for children aged one or two in low-quality municipalities, while this is not necessarily so for older children. This robustness therefore suggests that the effects originally found in Table 5 are likely to be partly explained by the heterogeneous effects of childcare by starting age.

Table A6 shows the results from a regression of a municipality's pre-reform characteristics on a dummy indicating whether the municipality has a high or low proportion of preschool teachers among pedagogical leaders (excluding the group of municipalities in the middle). Before reform, the proportion of children in childcare was lower in municipalities that expanded coverage for the oldest children the most. We also note that differences in quality measures are statistically insignificant or small in measures other than the education level of employees. The average difference is 0.21 pp. in the proportion of preschool teachers among pedagogical leaders between the two municipality types. The difference is noticeable,

but indicates a very large return on better-educated childcare personnel if this is the only explanation behind the different effects. It therefore suggests that the municipalities differ according to unobserved measures, or that child age is an important explanation in the finding of different effects.

[TABLE 7]

It is possible to look at the heterogeneous effects of the expansion according to observables. Table 7 suggests that the positive effects found in municipalities that mostly expanded access to older children are driven by females and high-SES children, while the negative effects in municipalities that mostly expanded access to younger children are driven by females and low-SES children. The observed positive effects for females are consistent with other findings in the literature (Anderson, 2008; Havnes & Mogstad, 2011; Felfe, Nollenberger, & Rodŕıguez-Planas, 2015). The largest point estimate is the negative effect for low-SES children in municipalities that mostly expanded access to younger children.[15]

Not finding any positive effect for low-SES children is the most surprising item in Table 7. Differential effects by SES may indicate that the childcare quality to which each group is exposed could be different, if low-SES children are more likely to be exposed to lower quality childcare centers within municipalities.

7 Conclusion

Publicly subsidized childcare and targeted childcare programs differ in many respects. Previous research has shown mixed findings on the effect of large-scale public subsidized childcare programs on child outcomes. This study adds evidence to the literature by providing an analysis of a recent expansion in childcare capacity combined with new high-quality administrative data from Norway. Large expansions of universal childcare are costly, and

[15] Table A7 shows robustness for this finding. It confirms that the negative effect is driven by low-SES children, as the estimate is less sensitive to specification changes than when not restricting the sample based on child background characteristics.

analyzing the effects of these programs is important both for countries in which programs already have been implemented and for governments that are evaluating whether to implement similar public programs.

In contrast to earlier studies of the effects of public subsidized childcare expansions, we use a pre-reform indicator to identify municipalities with high or low expansions. In line with a Norwegian reform passed in 2003, we find that children in municipalities with low pre-reform coverage received increased access to childcare compared to those with higher pre-reform coverage. Using this pre-reform coverage measure as an indicator for childcare expansion, we do not find that the expansion has an average impact on test scores at age 10. The analysis proceeded by looking for heterogeneous effects by dividing municipalities according to observable inputs to childcare. Looking at the effect of the expansion among municipalities with a high level of childcare quality, as indicated by the proportion of preschool teachers among pedagogical leaders, we find positive and significant effects on child test scores of attending childcare. At the same time, we find a negative effect on children's test scores of the expansion in municipalities with the lowest proportions of preschool teachers among pedagogical leaders. Notably, the negative effects appear to be driven mainly by low-SES children. Further analysis was not able to show that childcare quality and maternal labor force participation were affected differently by pre-reform quality. However, the children influenced by the expansion were of different ages in the two types of municipalities. In low-quality municipalities, the expansion largely affected one- and two-year-olds, while the expansion mostly affected three- to five-year-olds in the high-quality municipalities. This is an indication that childcare might be negative for the youngest children, especially in an environment of lower-quality child care, and positive for older children, especially in an environment of higher-quality child care.

Given the significant increase in childcare coverage for the youngest children in recent years, it is important to know the relative significance of these two explanations. If the effect of attending childcare for young children is negative only in low-quality municipalities, then the proper policy implication will be to increase quality in these areas. More research is needed to understand the full effects on all one- and two-year-olds.

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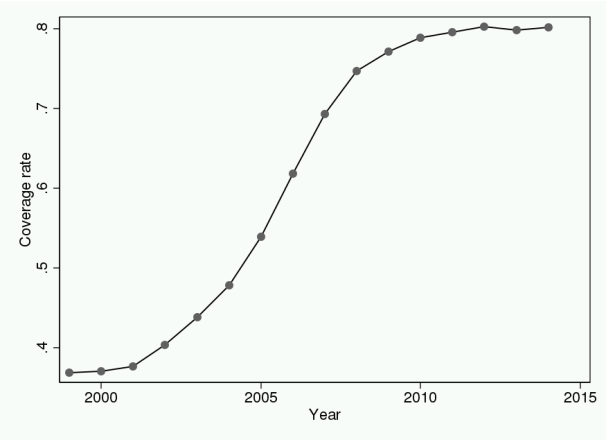
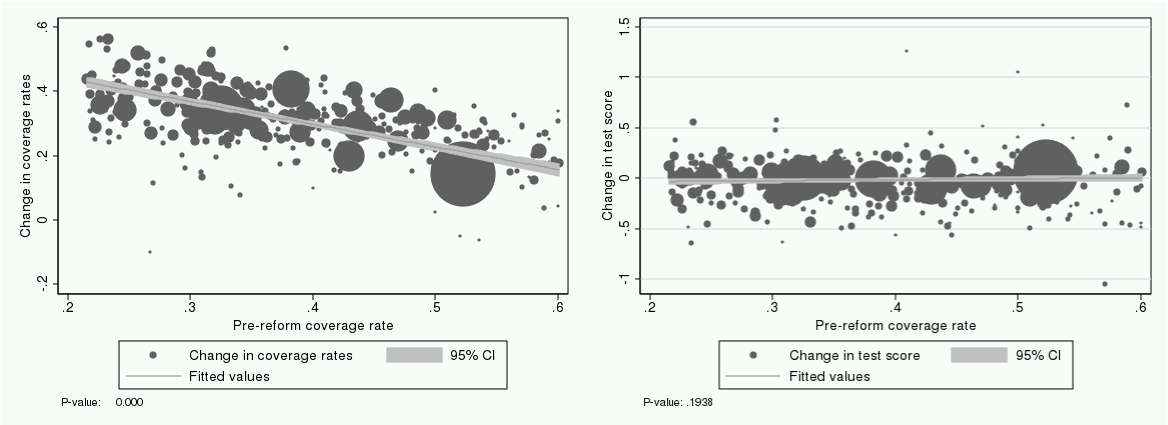
Figures

Figure 1 Coverage by year



Notes: Figure show childcare coverage measured at the end of year in official municipal statistics. A description of the data are found in Section

Figure 2 Reform effect



Notes: Figure a show change in coverage rate for 1-2 year old's from 2002-2007 by pre reform coverage rate (measured for 1-2 year old's in 2001). Figure b show change in test score from pre reform cohorts born 1998-2000 to post reform cohorts born 2003-2004 by pre reform coverage rates (Long ITT). Size of dots indicate cohort size of children in municipalities.

Tables

Table 1 - What predicts the childcare expansion?

Dependent variable:	Childcare coverage increase (2002-2007)
	(1)
Pre reform municipal level:	
Childcare coverage rate	-0.475***
	(0.049)
Female employment	-0.114
	(0.194)
Male employment	-0.111
	(0.255)
Size	0.000
	(0.000)
Constant	0.661***
	(0.220)
r2	0.243
N	420

Notes: Table show results from a regression of childcare coverage increase for 1-2 year old's on pre reform coverage and other municipal level characteristics. Pre reform coverage of 1-2 year old's measured in 2001 are used. Municipal level employment by gender are derived from registry data. Employment for persons between 25-39 in each municipality is measured. A person is employed if registered as working more than 100 hours that year. Size is the number of children born in the municipality in 1999. * p<0.10, ** p<0.05, *** p<0.01

Table 2 - Effect of expansion on school performance

Dep var	Average test score		Norwegian	English	Math
	(1)	(2)	(3)	(4)	(5)
Short ITT	-0.095	-0.099	-0.049	0.089	-0.121**
	(0.062)	(0.063)	(0.054)	(0.128)	(0.056)
Long ITT	0.104	0.083	0.186	0.072	-0.039
	(0.149)	(0.129)	(0.121)	(0.098)	(0.108)
Pre reform mean	0.011	0.011	0.026	0.037	0.029
Pre reform sd	0.992	0.992	0.956	0.940	0.962
R squared	0.034	0.117	0.108	0.069	0.113
N	318473	318473	315814	270947	315587
Indiv. controls		x	x	x	x
Munic. Dummies	x	x	x	x	x
Cohort Dummies	x	x	x	x	x

Notes: Table show ITT estimates from Equation 1. Dependent variable is average national standardized national test score at age 10 in Column 1-2, and subject specific test score in Column 3-5. Control variables are gender, mother age, father age, immigrant status, parents labor participation pre birth, parental years of education pre birth. Cohort- and municipality dummies included in all specifications. Standard errors clustered at municipal level in Column 1-3. * p<0.10, ** p<0.05, *** p<0.01

Table 3 - Robustness

	Baseline (1)	Excl. cities (2)	Excl. small (3)	Drop-15/85+ (4)	Excl. 1998 (5)	Excl. 2003 (6)	Flexible trends (7)
Short ITT	-0.099	-0.052	-0.098	-0.152**	-0.119	-0.096	-0.017
	(0.063)	(0.082)	(0.065)	(0.064)	(0.079)	(0.063)	(0.084)
Long ITT	0.083	-0.125	0.119	0.082	0.061	0.098	-0.037
	(0.129)	(0.094)	(0.126)	(0.154)	(0.111)	(0.161)	(0.105)
R-squared	0.116	0.092	0.115	0.117	0.116	0.115	0.118
N	318473	221111	298959	300099	272544	272177	318473
Ind. contr.	x	x	x	x	x	x	x
Munic. dum.	x	x	x	x	x	x	x
Cohort dum.	x	x	x	x	x	x	x

Notes: Table show ITT estimates from Equation 1. Dependent variable is average test score. Column 1 show baseline, Column 2 excludes the 6 largest municipalities, while Column 3 exclude the smallest(less than 300 obs). Column 4 excludes municipalities with pre-reform coverage rates below or above 15 or 85 percentile in the pre coverage rate distribution. Column 5 and 6 exclude cohort 1999 and 2003 respectively. Column 7 interacts predetermined municipal characteristics with cohort dummies to check if municipalities with different observable characteristics have different trends. Control variables are gender, mother age, father age, immigrant status, parents labor participation pre birth, parental years of education pre birth. Cohort- and municipality dummies included in all specifications. Standard errors clustered at municipal level. * p<0.10, ** p<0.05, *** p<0.01

Table 4 - Childcare quality

		Group size		Education level of staff		Costs	
	Proportion children aged 1-2 (1)	Children /staff (2)	Adj. care hours /staff (3)	Proportion preschool teachers (4)	Proportion preschool teachers of pedag. leaders (5)	Cost /child (6)	Cost /adj. care hour (7)
Short ITT	-0.108***	0.799***	-220.386	0.005	-0.004	-6576.222	0.354
	(0.016)	(0.158)	(264.561)	(0.008)	(0.016)	(4223.175)	(2.219)
Long ITT	-0.221***	1.656***	-225.893	-0.003	-0.054	-38100.452***	-6.058**
	(0.026)	(0.319)	(391.395)	(0.024)	(0.044)	(8904.850)	(3.008)
Pre reform mean	0.34	4.66	10951.30	0.33	0.90	92099.60	37.28
Pre reform sd	0.04	0.57	868.04	0.05	0.08	14863.72	5.31
Short ITT/mean	-0.31	0.17	-0.02	0.02	-0.00	-0.07	0.01
Long ITT/mean	-0.64	0.36	-0.02	-0.01	-0.06	-0.41	-0.16
Short ITT/sd	-2.78	1.41	-0.25	0.11	-0.05	-0.44	0.07
Long ITT/sd	-5.68	2.92	-0.26	-0.07	-0.69	-2.56	-1.14
N	275448	275495	266019	274900	275423	265715	265715

Notes: Table show estimate of Equation 2 using different measures of municipality level child care quality as outcomes. Dependent variable is average municipal level childcare quality from the year children in each cohort turn 2, until the year it turns 5. “Short” is a indicator for cohorts born 2001-2002 that are only partly influenced by the reform, while “Long” are indicator for cohorts born 2003-2004 that are more heavily influenced by the reform. “Short ITT” are the “Short ” indicator interacted with pre reform municipal level home care coverage rates, while “Long ITT” are “Long” indicator interacted with pre reform coverage rates. Means and standard deviation of quality measures are given, as well as the ITT-estimates size relative to these. Childcare quality information is missing from some municipalities in some years. Standard errors are clustered at municipality level. * p<0.10, ** p<0.05, *** p<0.01

Table 5 - Effect of expansion by municipality type

Dep. var.	Proportion preschool teachers			Proportion preschool teachers of pedag. leaders		
	Low	Mid	High	Low	Mid	High
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A) - Dep. var. - Average test score						
Short ITT	-0.041	0.063	-0.317**	-0.039	0.012	-0.112
	(0.073)	(0.113)	(0.154)	(0.083)	(0.113)	(0.168)
Long ITT	0.281*	-0.009	-0.347*	0.283*	0.057	-0.409**
	(0.156)	(0.145)	(0.189)	(0.163)	(0.139)	(0.165)
N	116539	104198	97605	107208	116806	94459
Panel B) - Dep. var. - Norwegian						
Short ITT	0.041	0.069	-0.285*	0.009	0.044	-0.081
	(0.062)	(0.101)	(0.151)	(0.079)	(0.103)	(0.159)
Long ITT	0.380***	0.006	-0.179	0.354***	0.047	-0.155
	(0.115)	(0.112)	(0.160)	(0.121)	(0.115)	(0.132)
Panel C) - Dep. var. - English						
Short ITT	0.314**	0.009	-0.380*	0.306*	0.062	-0.212
	(0.140)	(0.143)	(0.215)	(0.178)	(0.152)	(0.207)
Long ITT	0.225	0.085	-0.248	0.228	0.139	-0.284*
	(0.143)	(0.148)	(0.168)	(0.152)	(0.134)	(0.156)
Panel D) - Dep. var. - Math						
Short ITT	-0.073	-0.037	-0.252*	-0.037	-0.091	-0.147
	(0.082)	(0.101)	(0.127)	(0.092)	(0.098)	(0.130)
Long ITT	0.101	-0.072	-0.402*	0.133	-0.028	-0.504***
	(0.139)	(0.136)	(0.205)	(0.142)	(0.142)	(0.172)

Notes: Table show ITT estimates from Equation 1 split into 4 panels. Dependent variable are average test score, Norwegian score, English score and maths core in panel a), b), c) and d) respectively. In Column 1-3 Equation 1 is estimated separately by dividing municipalities according to pre reform proportion preschool teachers municipal distribution quantile 1-3. In Column 4-6 the same is done with proportion preschool teachers of pedagogical leaders, while Column 7-9 show the results for proportion pedagogical leaders. Individual controls listed in section 3, cohort dummies and municipality dummies included in all specifications. Standard errors clustered at municipal level. * p<0.10, ** p<0.05, *** p<0.01

Table 6 - Mechanism

	Municipality level quality			
	Low	Mid	High	N
	(1)	(2)	(3)	(4)
Panel A)				
Children /staff	2.388***	1.252***	0.788*	275495
	(0.343)	(0.336)	(0.403)	
Adj. care hours /staff	167.904	414.792	-960.935	266019
	(653.280)	(868.518)	(780.747)	
Prop.pre teachers	-0.033	0.017	0.057	274900
	(0.026)	(0.039)	(0.035)	
Prop. pre teachers	-0.117**	0.015	-0.029	275423
of pedag. leaders	(0.056)	(0.079)	(0.057)	
Cost /child	-38168.154***	-39231.407**	-15010.023	265715
	(9995.699)	(17703.621)	(11363.344)	
Cost /adj. care hour	-2.462	-12.169*	-1.195	265715
	(5.935)	(6.822)	(3.978)	
Panel B)				
Mother LFP	-0.092**	-0.052	-0.084**	321684
	(0.037)	(0.045)	(0.040)	
Father LFP	-0.039	0.008	-0.013	321684
	(0.029)	(0.019)	(0.042)	
Panel C)				
Months before age 3	-8.609***	-3.587**	-2.536	321684
	(2.003)	(1.576)	(1.806)	
Hours before age 3	-906.587***	-336.271**	-199.824	321684
	(224.604)	(158.986)	(189.619)	
Coverage rate 1-2	-0.665***	-0.239***	-0.140*	275495
	(0.048)	(0.060)	(0.079)	
Coverage rate 3-5	-0.192***	-0.258***	-0.358***	275495
	(0.031)	(0.038)	(0.062)	
Panel D)				
Average test score	0.283*	0.057	-0.409**	321684
	(0.163)	(0.139)	(0.165)	

Notes: Table show long run ITT estimates from Equation 1 split into 4 panels. Dependent variable are indicated in row header. Reform effect on measures of childcare quality, parental labor force participation, childcare attendance and test score are shown in panel a), b), c) and d) respectively. Equation 1 is estimated separately by dividing municipalities according to quantiles in the pre reform proportion preschool teachers municipal distribution. Total sample size indicated in the column most to the right. Control variables are are included in individual level regressions and listed in Section 3. Cohort dummies and municipality dummies included in all specifications. Standard errors clustered at municipal level. * p<0.10, ** p<0.05, *** p<0.01

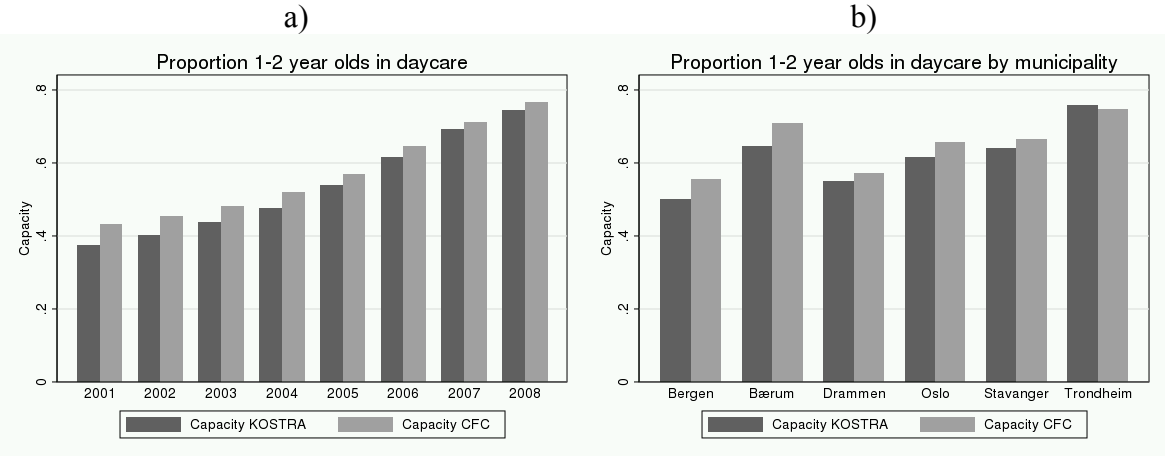
Table 7 - Heterogeneity by child characteristics

	Female	Male	Low-SES	High-SES
	(1)	(2)	(3)	(4)
Panel A) - Low quality municipalities				
Short ITT	0.030	-0.104	-0.058	-0.043
	(0.092)	(0.109)	(0.149)	(0.096)
Long ITT	0.325*	0.229	0.646***	0.177
	(0.183)	(0.178)	(0.130)	(0.196)
R-squared	0.147	0.155	0.145	0.145
N	53815	53393	24715	82493
Panel B) - Medium quality municipalities				
Short ITT	-0.029	0.064	-0.114	0.050
	(0.139)	(0.138)	(0.159)	(0.123)
Long ITT	0.067	0.051	0.188	0.030
	(0.147)	(0.158)	(0.165)	(0.155)
R-squared	0.098	0.095	0.100	0.092
N	58244	58562	26131	90675
Panel C) - High quality municipalities				
Short ITT	-0.072	-0.133	-0.107	-0.130
	(0.181)	(0.250)	(0.201)	(0.178)
Long ITT	-0.463***	-0.356	0.050	-0.577***
	(0.153)	(0.249)	(0.139)	(0.150)
R-squared	0.093	0.094	0.102	0.088
N	47052	47407	23552	70907
Ind. contr.	x	x	x	x
Munic. dum.	x	x	x	x
Cohort dum.	x	x	x	x

Notes: Table show ITT estimates from Equation 1. Dependent variable is average test score. Panel A, B and C show estimates on low, medium and high quality municipalities as measured by proportion preschool teachers of pedagogical leaders. Control variables are gender, mother age, father age, immigrant status, parents labor participation pre birth, parental years of education pre birth. Cohort- and municipality dummies included in all specifications. Standard errors clustered at municipal level. * p<0.10, ** p<0.05, *** p<0.01

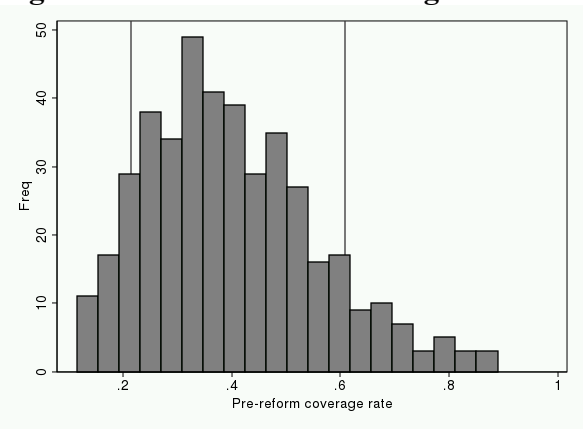
Appendix Figures

Figure A1 KOSTRA and CFC coverage rates



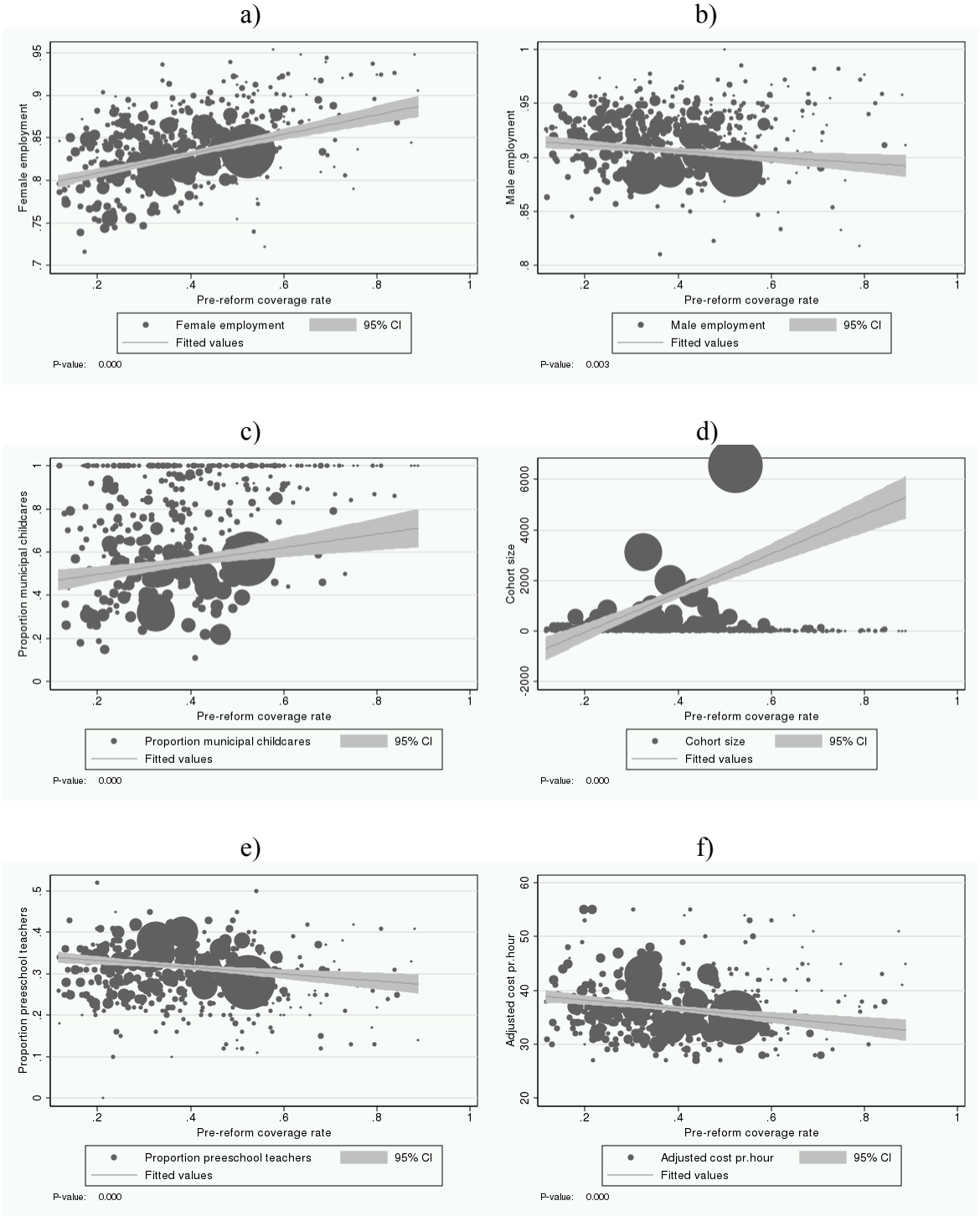
Notes: a) compares KOSTRA numbers to CFC numbers across years. CFC numbers are based on counting the number of children in childcare using the CFC database. CFC numbers are at the individual level. KOSTRA numbers are based on childcare centers' reporting the number of one- and two-year-olds in care to municipalities, which the municipalities then report to Statistics Norway; b) compares KOSTRA numbers with CFC numbers across the six largest municipalities in Norway for 2006. Correlations between CFC and KOSTRA across municipalities by year from 2000 through 2008 are as follows: 0.94, 0.94, 0.93, 0.94, 0.93, 0.89, 0.86, 0.87, 0.83.

Figure A2 – Pre-reform coverage distribution



Note: The lines indicate where the sample has been cut to exclude municipalities below the 10th and above the 90th percentiles; coverage rate measured in 2001.

Figure A3 Municipality descriptors



Notes: Figures show descriptions of municipalities; P-values show the significance of the slopes. Numbers are measured in 2001.

Appendix Tables

Table A1 - Data and insitutional details

Cohort	KOSTRA rates (1)	CFC data (2)	Exams 5th grade* (3)	Exams 8th grade (4)	Attendance 1-2 (5)	Reform (6)
1998		x	x	x	1999-2001	Pre
1999	x	x	x	x	2000-2002	Pre
2000	x	x	x	x	2001-2003	Pre
2001	x	x	x	x	2002-2004	Phase-in
2002	x	x	x		2003-2005	Phase-in
2003	x	x	x		2004-2006	Post
2004	x	x	x		2005-2007	Post
2005	x	x			2006-2008	
2006	x	x			2007-2009	
2007	x	x			2008-2010	
2008	x				2009-2011	
2009	x				2010-2012	
2010	x				2011-2013	

Notes: Table describe data and institutional details. *Math and English tests are electronically corrected from cohort 2000 and onward. *Lack English test scores for cohort born 2001 due to test being canceled.

Table A2 - Robusness II

	Baseline (1)	Excl. cities (2)	Excl. small (3)	Drop-15/85+ (4)	Excl. 1998 (5)	Excl. 2003 (6)	No controls (7)	Flexible trends (8)
Panel A) - Low quality municipalities								
Short ITT	-0.039	-0.064	-0.044	-0.037	-0.055	-0.037	-0.009	-0.128
	(0.083)	(0.137)	(0.088)	(0.091)	(0.093)	(0.083)	(0.081)	(0.141)
Long ITT	0.283*	-0.026	0.315*	0.314*	0.262*	0.411**	0.344*	-0.063
	(0.163)	(0.192)	(0.161)	(0.187)	(0.158)	(0.194)	(0.182)	(0.203)
R-squared	0.149	0.100	0.148	0.150	0.150	0.148	0.052	0.151
N	107208	56082	102299	101506	91942	91279	107208	107208
Panel B) - Medium quality municipalities								
Short ITT	0.012	0.034	0.005	-0.134	0.094	0.016	0.010	0.071
	(0.113)	(0.117)	(0.114)	(0.131)	(0.121)	(0.113)	(0.119)	(0.118)
Long ITT	0.057	-0.019	0.055	0.032	0.140	0.014	0.086	0.130
	(0.139)	(0.129)	(0.141)	(0.169)	(0.150)	(0.185)	(0.150)	(0.150)
R-squared	0.095	0.091	0.094	0.094	0.095	0.093	0.019	0.096
N	116806	102943	115704	107158	99768	99860	116806	116806
Panel C) - High quality municipalities								
Short ITT	-0.112	-0.182	-0.190	-0.129	-0.171	-0.109	-0.158	-0.301
	(0.168)	(0.168)	(0.170)	(0.186)	(0.165)	(0.167)	(0.169)	(0.195)
Long ITT	-0.409**	-0.425**	-0.400**	-0.469***	-0.466***	-0.582***	-0.468**	-0.400**
	(0.165)	(0.172)	(0.183)	(0.175)	(0.157)	(0.211)	(0.180)	(0.197)
R-squared	0.092	0.088	0.090	0.091	0.091	0.093	0.016	0.094
N	94459	62086	91438	91435	80834	81038	94459	94459
Ind. contr.	x	x	x	x	x	x		x
Munic. dum.	x	x	x	x	x	x	x	x
Cohort dum.	x	x	x	x	x	x	x	x

Notes: Table show ITT estimates from Equation 1. Dependent variable is average test score. Panel A, B and C show estimates on low, medium and high quality municipalities as measured by proportion preschool teachers of pedagogical leaders. Column 1 show baseline, Column 2 excludes the 6 largest municipalities, while Column 3 exclude the smallest(less than 300 obs). Column 4 excludes municipalities with pre reform coverage rates below or above 15 or 85 percentile in the pre coverage rate distribution. Column 5 and 6 exclude cohort 1999 and 2003 respectively. Column 7 interacts predetermined municipal characteristics with cohort dummies to check if municipalities with different observable characteristics have different trends. Control variables are gender, mother age, father age, immigrant status, parents labor participation pre birth, parental years of education pre birth. Cohort- and municipality dummies included in all specifications. Standard errors clustered at municipal level. * p<0.10, ** p<0.05, *** p<0.01

Table A3 - Testing for different change in high- and low-quality municipalities

	Children /staff	Adj. care hours /staff	Proportion preschool teachers	Proportion preschool teachers of pedag. leade	Cost /child teachers	Cost /adj care hour pr. child	Maternal LFP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A							
Diff	-1.601***	-1193.466	-0.030	0.086	23375.934	1.476	0.006
	(0.528)	(1039.278)	(0.046)	(0.079)	(15248.707)	(7.205)	(0.054)
N	174711	165964	186179	174639	165660	165660	203758
Panel B							
	Paternal LFP	Months	Hours	Coverage rate 1-2	Coverage rate 3-5	Average test score	
	(8)	(9)	(10)	(11)	(12)	(13)	
Diff	0.027	5.922**	690.523**	0.524***	-0.155*	-0.695***	
	(0.051)	(2.656)	(289.534)	(0.157)	(0.088)	(0.237)	
N	203758	203758	203758	174711	174711	201667	

Notes: Table show estimates of γ(9) from estimating:

$$Outcome_{it} = \gamma_1 + \gamma_2 Short_{it} + \gamma_3 Long_{it} + \gamma_4 (Short_{it} \cdot Highquality_{it}) + \gamma_5 (Long_{it} \cdot Highquality_{it}) + \gamma_6 (Short_{it} \cdot \Pr eCoverage_{it}) + \gamma_7 (Long_{it} \cdot \Pr eCoverage_{it}) + \gamma_8 (Short_{it} \cdot \Pr eCoverage_{it} \cdot Highquality_{it}) + \gamma_9 (Long_{it} \cdot \Pr eCoverage_{it} \cdot Highquality_{it}) + \gamma_{10} + \gamma_8$$

Highquality(it) is a dummy indicating 1 if the child was born in a high-quality municipality, and 0 if it belongs to a low quality municipality. The sample consists of only high and low quality municipalities. * p<0.10, ** p<0.05, *** p<0.01

Table A4 - Parental labor force participation

	Mother		Father	
	(1)	(2)	(3)	(4)
Short ITT	0.008	-0.004	-0.011	-0.024
	(0.018)	(0.024)	(0.011)	(0.015)
Long ITT	-0.055***	-0.082***	-0.012	-0.028
	(0.021)	(0.030)	(0.015)	(0.025)
Dep. var mean	0.537	0.537	0.879	0.879
Dep. var sd	0.499	0.499	0.326	0.326
R2	0.030	0.309	0.010	0.283
N	321684	321684	321684	321684
Indiv. controls		x		x
Munic. Dummies	x	x	x	x
Cohort Dummies	x	x	x	x

Notes: Table show ITT estimates from Equation 1. Dependent variable is parental labor force participation. Pre coverage are the childcare coverage rate for 1-2 year old's in the child's birth municipality registered in year 2001. Control variables are gender, mother age, father age, immigrant status, parents labor participation pre birth, parental years of education pre birth. Cohort- and municipality dummies included in all specifications. Standard errors clustered at municipal level in Column 1-3. * p<0.10, ** p<0.05, *** p<0.01

Table A5 - Mechanism II

Pre reform indicator	Coverage rate 1-5 year old's			N
	Low	Mid	High	
	(1)	(2)	(3)	(4)
Panel a)				
Child/staff	2.089***	0.226	0.017	275495
	(0.767)	(0.392)	(0.484)	
Adj. care hour/staff	-219.260	-563.015	-1358.814	266019
	(1016.264)	(573.476)	(1054.372)	
Prop. pre teachers	-0.031	0.058	-0.019	275423
of pedag. leaders	(0.094)	(0.092)	(0.065)	
Prop.pre teachers	-0.001	0.039	0.048	274900
	(0.039)	(0.043)	(0.040)	
Costs pr child	-34152.638**	-18409.958	-4829.755	265715
	(14399.130)	(15027.284)	(13464.052)	
Costs pr adj. care hour	-0.717	-4.706	-0.369	265715
	(6.640)	(5.640)	(5.299)	
Panel b)				
Mother LFP	-0.131**	-0.087*	-0.078*	321684
	(0.058)	(0.049)	(0.042)	
Father LFP	-0.032	-0.001	0.015	321684
	(0.041)	(0.016)	(0.039)	
Panel c)				
Months	-9.639***	-3.827**	-1.125	321684
	(3.413)	(1.769)	(1.984)	
Hours	-997.015***	-374.792**	-53.488	321684
	(375.889)	(177.379)	(206.763)	
Coverage rate 1-2	-0.822***	-0.239***	-0.015	275495
	(0.071)	(0.065)	(0.082)	
Coverage rate 3-5	-0.409***	-0.467***	-0.505***	275495
	(0.043)	(0.038)	(0.062)	
Panel d)				
Average test score	0.116	0.117	-0.478***	321684
	(0.275)	(0.153)	(0.149)	

Notes: Table show long run ITT estimates from Equation 1 split into 4 panels. Dependent variable are indicated in row header. Reform effect on measures of childcare quality, parental labor force participation, childcare attendance and test score are shown in panel a), b), c) and d) respectively. Equation 1 is estimated separately by dividing municipalities according to quantiles in the pre reform proportion preschool teachers municipal distribution. Pre reform coverage rates for 1-5 year old's are used as pre reform indicator of intensity of expansion. Total sample size indicated in the column most to the right. Control variables are are included in individual level regressions and listed in Section 3. Cohort dummies and municipality dummies included in all specifications. Standard errors clustered at municipal level. * p<0.10, ** p<0.05, *** p<0.01

Table A6 - Difference between municipality types

	Prop. 1-2 y old's (1)	Pre coverage 1-2 y. old's (2)	Pre coverage 3-5 y. old's (3)	Prop. pre teachers/ pedag. (4)	Prop. pre teachers (5)	Cost pr. child (6)	Adj. cost pr. care hour (7)
Panel A							
High	-0.050*	-0.076***	-0.047***	0.210***	0.091***	961.963	1.362*
	(0.029)	(0.012)	(0.010)	(0.007)	(0.005)	(1554.302)	(0.805)
Dep. var. mean	0.486	0.386	0.798	0.886	0.319	79531.650	34.446
Dep. var. sd	0.194	0.096	0.088	0.098	0.050	13098.657	5.676
R2	0.013	0.149	0.081	0.793	0.624	0.002	0.013
N	231	231	231	231	229	226	226
Panel B	Children /staff (9)	Children pr. pedag. leader (10)	Adj. care hours/ staff (11)	Prop. munic. childcare (11)			
High	0.301***	0.115	-60.110	-0.024			
	(0.087)	(0.521)	(118.559)	(0.028)			
Dep. var. mean	4.773	18.090	10846.398	0.524			
Dep. var. sd	0.660	3.706	928.824	0.202			
R2	0.050	0.000	0.001	0.003			
N	231	230	227	229			

Notes: Table show results from regressions of municipal characteristics on indicator for municipality with a high proportion of preschool teachers of pedagogical leaders. Only municipalities with highest and lowest proportion are included in the sample. * p<0.10, ** p<0.05, *** p<0.01

Table A7 - Robustness III - Low SES children, low-quality municipalities

	Baseline	Excl. cities	Excl. small	Drop-15/85+	Excl. 1998	Excl. 2003	No controls	Flexible trends
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short ITT	-0.056	0.134	-0.080	-0.148	-0.048	-0.071	-0.085	0.130
	(0.148)	(0.259)	(0.144)	(0.136)	(0.177)	(0.148)	(0.153)	(0.273)
Long ITT	0.651***	0.692***	0.681***	0.562***	0.660***	0.803***	0.630***	0.760***
	(0.130)	(0.252)	(0.131)	(0.142)	(0.145)	(0.166)	(0.124)	(0.271)
R-squared	0.146	0.107	0.146	0.148	0.146	0.148	0.030	0.148
N	24715	12235	23132	23506	20877	21177	24715	24715
Ind. contr.	x	x	x	x	x	x		x
Munic. dum.	x	x	x	x	x	x	x	x
Cohort dum.	x	x	x	x	x	x	x	x

Notes: Table show ITT estimates from Equation 1. Dependent variable is average test score, and sample is restricted to low-SES children. The table show estimates on low quality municipalities as measured by proportion preschool teachers of pedagogical leaders. Column 1 show baseline, Column 2 excludes the 6 largest municipalities, while Column 3 exclude the smallest(less than 300 obs). Column 4 excludes municipalities with pre reform coverage rates below or above 15 or 85 percentile in the pre coverage rate distribution. Column 5 and 6 exclude cohort 1999 and 2003 respectively, while Column 7 perform the estimation without controls. Column 8 interacts predetermined municipal characteristics with cohort dummies to check if municipalities with different observable characteristics have different trends. Control variables are gender, mother age, father age, immigrant status, parents labor participation pre birth, parental years of education pre birth. Cohort- and municipality dummies included in all specifications. Standard errors clustered at municipal level. * p<0.10, ** p<0.05, *** p<0.01

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