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Non-cognitive Child Outcomes and Universal High Quality Child Care

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Abstract:

Exploiting a rich panel data child survey merged with administrative records along with a pseudo-experiment generating variation in the take-up of preschool across municipalities, we provide evidence of the effects on non-cognitive child outcomes of participating in large scale publicly provided universal preschool programs and family day care vis-à-vis home care. We find that, compared to home care, being enrolled in preschool at age three does not lead to significant differences in child outcomes at age seven no matter the gender or the mother's level of education. Family day care, on the other hand, seems to significantly deteriorate outcomes for boys whose mothers have a lower level of education. Finally, longer hours in non-parental care lead to poorer child outcomes.

Keywords: Non-cognitive outcomes, publicly provided universal child care, pseudo-experiment
JEL codes: H4, I2, J13, J18

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1. Introduction

This paper investigates the relation between preschool care and child outcomes. Specifically, we consider effects on child outcomes of enrolment in universal publicly subsidized high quality center based child care and family day care for three-year-olds in Denmark vis-à-vis parental care. Center based care, or preschool, is the most common type of care for this age group: 63% of all three-year-olds were enrolled in this type of care in 1999. Furthermore, we investigate the effects of hours – the treatment intensity – given selection into a specific type of non-parental care.

High usage of child care clearly allows parents (or, more precisely, mothers) to participate in the labor market. A natural question to ask, however, is how children are affected by this choice. Child care may be viewed as simply 'taking care' of children, yet an alternative view is that child care is, in effect, a type of early childhood investment in the development of social and academic skills. Depending on the content of the care program, one may easily imagine a variety of effects from enrollment, which may also vary across children. This study focuses on the development of non-cognitive skills such as measures of emotional symptoms, conduct problems, hyperactivity/inattention problems, peer relationship problems, and pro-social behavior. Recent research points to the limited effect of public programs for disadvantaged children on IQ after early ages. The greatest impacts of these programs seem to be on socialization, crime reduction and on fostering integration; skills, which have been found to have an even larger payoff on the labor market than cognitive skills (e.g. Heckman, Stixrud and Urzua (2006)). As our outcome variable we use the *strength and difficulties questionnaire index* (SDQ); a standard behavioral measure in the child development literature, see e.g. Goodman (1997). We measure outcomes at age seven.

There exists a large literature on child development and non-parental care, especially on care for disadvantaged children. See Blau and Currie (2006), Currie (2001), and Ruhm (2004) for excellent surveys. Yet as pointed out by Currie (2001), the literature is rather silent about the effects of regimes with universal or large-scale preschool and family day care programs such as the Danish or Canadian one.[1] This is despite both public and academic interest, see Currie (2001). Two

[1] "Universal" preschool is also offered in certain states within the US. Examples are Georgia (since 1995), New York (1997), and Oklahoma (1998). California provides a program targeted at low-income children. See Blau and Currie (forthcoming).

exceptions are the recent paper by Baker, Gruber, and Milligan (2008) that investigates the introduction of a large scale child care program in Canada and a paper by Havnes and Mogstad (2009) that examines the impact on adult outcomes of children of married mothers of the introduction of universal, subsidized child care in Norway in the mid-1970s. Firstly, because universal programs are not limited to include disadvantaged children, but are offered to the entire population, our results will inform about the effects of modes of care for children across a range of different socio-economic backgrounds. Secondly, *exactly* because the group of children in for example preschool is not homogenous, the effects may not be the same had preschool been offered to disadvantaged children only. See e.g. Ammermüller and Pischke (2006) on peer-effects in primary schools. In other words, it may be hard to extrapolate from the findings from the literature on disadvantaged children to a regime with universal care programs, even for the group of children with adverse family backgrounds.

Another important contribution of our paper is the evaluation of effects of hours in non-parental care. See Blau and Currie (2006) for a survey of this literature. Some studies focus solely on the effects of maternal employment patterns and consider hours (or extent) of work, while others investigate the effects of child care characteristics on child outcomes and include a measure of hours in care. Common to these analyses is that they investigate the effect of hours for the pooled sample of children. Whether the studies include hours in a linear fashion or a set of dummies, part of the identifying variation will in this way stem from observations that are 'far apart' in terms of hours. The estimates must subsequently be interpreted as the effect of differences in hours *including* all indirect effects stemming from parents' different (labor market) behavior. Instead, we adopt a strategy similar to Behrman, Cheng, and Todd (2004); we consider the marginal effects on outcome incurred by increasing hours in a given type of non-parental care by a small amount. Performing local comparisons greatly decreases the likelihood of indirect effects and allows us to interpret the resulting estimates as direct effects of changes in hours. Furthermore, the estimator allows for selection *into* non-parental care to be based on unobservables, but conditional on choosing non-parental care, the choice between hours must be based on observables only. The cost is, of course, that we can only speak about the effects of smaller changes in hours relative to a given baseline.

Estimations are carried out using a longitudinal survey following children born in 1995. The survey holds information about children, mothers, and fathers and is linked to highly reliable

administrative registers providing us with crucial background information about the parents and their labor market behavior. We use this rich mine of information to estimate our parameters of interest, using OLS. Furthermore, we have access to plausible exogenous variation in the take-up of preschool via a pseudo-experiment generating waiting lists for preschool in some municipalities while guaranteeing open slots in others. See Simonsen (2005) for an evaluation of the effect of a similar policy on mother's employment following child birth. Presumably because of the difficulties in finding valid exogenous variation in the take-up of child care, only very few studies of the effects of child care on child outcomes employ IV estimation, see e.g. Blau and Grossberg (1992), James-Burdumy (2005), and Bernal and Keane (2008). Furthermore, according to Bernal and Keane (2008), the instruments used in the two first-mentioned studies are extremely weak.

Our results indicate that being enrolled in non-parental care at age three is neutral compared to home care. However, if one acknowledges that non-parental care is not a well-defined counterfactual, it becomes clear that the first result is not very informative.[2] We find that being enrolled in preschool vis-à-vis home care does not lead to significant differences in non-cognitive child outcomes no matter the gender or the mother's level of education. Family day care relative to home care, on the other hand, seems to significantly deteriorate outcomes for boys whose mothers have a lower level of education. All estimations suggest that preschool outperforms family day care for the overall population. However, when subdividing by child gender and mother's education level, we find that this is largely driven by the group of boys born to mothers with a vocational degree. In fact, some results indicate that girls whose mothers have higher education (at least a tertiary degree) show worse behavior when enrolled in preschool. Finally, increasing hours in family day care from 30-40 hours per week to 40-50 hours per week and hours in preschool from 20-30 hours per week to 30-40 hours per week leads to poorer child outcomes but only significantly so in the latter case. This is likely due to sample sizes.

The remainder of the paper is organized as follows: Section 2 provides a description of the data and the institutional set-up, Section 3 discusses child outcomes as well as the linkages between child care enrollment and child outcomes. Section 4 presents our empirical strategy, Section 5 the regression results and Section 6 the IV analysis. Finally, Section 7 concludes.

[2] See also a recent paper by Bernal and Keane (2008) who find significant differences in the effects of child care depending on the type of care.

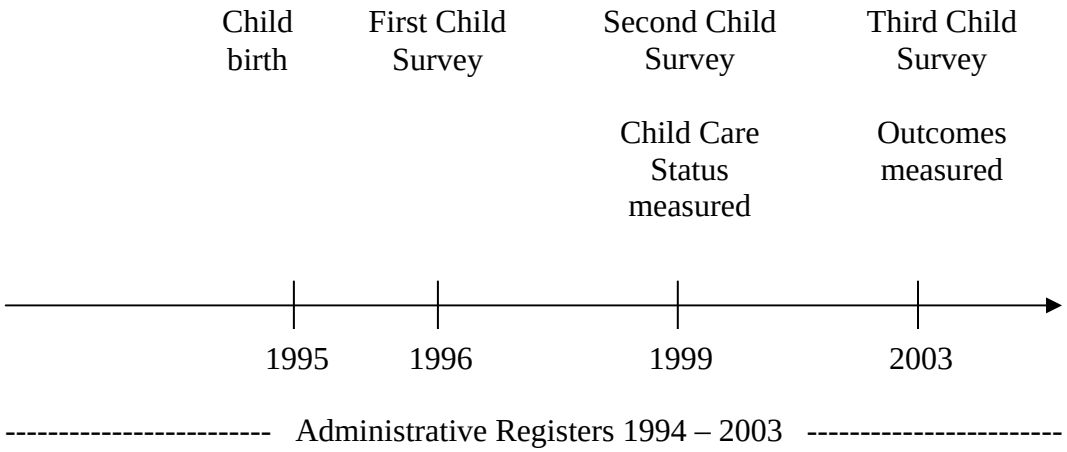
2. Data and Institutional Framework

We exploit a unique panel dataset on children's outcomes, modes of care, and parental background information, known as the Danish Longitudinal Survey of Children (DALSC). The data consists of repeated surveys of the primary parent (typically the mother) of about 6,000 children born between 15 September and 31 October 1995. The first survey took place when the children were 6 months old, the second when they were around 3½, and the third at age 7½ when the children had all started first grade (age 7 in Denmark). Thus, 3 waves of this data are currently available: 1996, 1999 and 2003.[3] The fathers of these children were surveyed separately in some of these waves. In addition, a special segment on children's health and welfare was added to the mother survey in 2003. This panel survey data has been merged to precise information on parents' educational attainment, labor market status, hours of work, wages and income in the period 1994-2003, extracted from Danish administrative registers. Child care enrolment status is measured in 1999 (age 3½) and child outcomes in 2003 (age 7½). Unfortunately, we do not have information about the child outcome of interest *prior* to treatment. In any case, behavioral skills such as self-control, frustration tolerance, delay of gratification etc. start to appear and become consolidated in the preschool years (Wakschlag et al. (2005)) so by age 7½, atypical behavior can be more easily distinguished from typical behavior. Figure 1 below shows the timing of our set-up.

[3] A fourth wave has been fielded in 2007.

FIGURE 1

TIMING OF SET-UP



2.1. The Organization of Day Care and Preschool Programs in Denmark

Danish child care is for the major part publicly provided and organized within the 271 municipalities,[4] which are typically smaller units with on average 50,000 inhabitants. Municipalities provide *nurseries* for children 0-2 years old, *preschools* for children 3-6 years old and *after-school programs* for school children, all of which are center based. In addition, municipalities organize *family day* care that takes place in private homes for children below the age of 14.[5] The municipality is free to decide on the distribution of the different types of care but must cover 'local needs' in terms of number of slots at a given age. Here we focus on care for three-year-olds: preschool and family day care.

Day care and preschool programs in Denmark (along with other Nordic countries) are characterized by both high quality expenditure levels per capita compared to other countries and usage, see Datta Gupta, Smith and Verner (2008) for an overview of the impacts of generous family-friendly schemes including publicly provided daycare in the Nordic countries. Requirements of

[4] The municipality of Bornholm is excluded from the analysis because it underwent a municipality reform during this period.
[5] In reality, though, children in family day care are much younger than 14, see below.

qualifications of child care staff are extensive compared to other EU (and OECD) countries and the number of children per staff is much lower, see OECD's Family Database. In Danish preschools, the average staff:child ratio is 1:7, whereas in the US and Canada, for example, the corresponding ratio is 1:12 (1:14 for teaching staff), in Spain 1:13, and France 1:19. In fact, according to OECD's Family Database, Denmark has the lowest average number of children per staff in preschools among all OECD countries.

In 1999 (when the children in our sample were three years old), the average yearly expenditures for a slot in center-based preschool for three-year-olds were approximately $8,000. This is significantly higher than the expenditures for, for example, the American Head Start Program aimed at low-income families, which costs around $5,000 per year, see Currie (2001), and roughly the same as the expenditures for the universal Canadian child care program, see Baker, Gruber, and Milligan (2008). Family day care is more expensive than center-based preschool; the average yearly costs are about $10,000.[6] This is presumably because staff:child ratios are higher (minimum of 1:5) for this type of care for the age group in question.[7]

The regulations of municipality provided child care institutions are described in the Law of Service (*Serviceloven*). The Law of Service offers general guidelines as to the content of municipality provided care, yet the specific details are decided by the institutions. Overall, institutions must supply care, education, and opportunities to play, all in co-operation with parents. The educational content of municipality provided care involves development of personal, linguistic, and physical skills. Furthermore, children must develop their understanding of nature and culture. Importantly, institutions are child-centered and focus on socialization rather than on a basic skills curriculum.

Preschool and family day care

The average *preschool* (that may be integrated with nursery centers for 0-2 year olds) facilitates about 60 children, who are split into smaller groups of about 20, and employs around 9 permanent teachers plus a number of assistants and other staff, thus allowing for considerable specialization of labor. Preschool teachers in permanent positions must have a degree in teaching (medium length

[6] For 0-2 year olds, family day care is the cheaper option.
[7] In the empirical analyses we condition on the determinants of parental income to account for selection into types of care based on income.

tertiary education or 15-16 years of education) and specialize in young children. Preschools may be owned by the municipality. No matter the owner status, the municipalities are required by law to monitor the institutions closely regarding educational content as well as safety and hygiene. Regulation of the former requires ensuring that the personnel have the necessary qualifications, whereas regulation of the latter includes accident-preventing measures, play-grounds, transport, sleeping facilities, toys, hygiene, and insurance schemes. Opening hours may vary across municipalities but again must 'cover local needs'. In general, opening hours in preschool during week days are between 6.30 am and 5.00 pm. The maximum number of children per preschool teacher is determined through collective bargaining between the municipalities and the preschool teachers' trade union (BUPL). The norm for 1999 was set at the 1997 collective bargaining. These institutional details will turn out to be important for our identification strategy described below.

In contrast, *family day care* takes place in private homes, and the carers are directly employed by the municipality. Again, the municipalities must approve the facilities and the qualifications of the carer. There may be up to five children in each home, and in some municipalities the carer's own children under the age of three enter into the total number of children in the family day care. The carer will then receive compensation from the municipality for taking care of her own children. Family day carers are not required to have a degree in teaching but are offered shorter (3-week) vocational courses. Family day care is more flexible in terms of hours, which can be arranged on an individual basis but typically with a ceiling at 48 hours per week.

Table 1 compares the educational level and the gender distribution of staff in preschools and family day care. Staff in preschools also includes assistants, managers, cleaning and kitchen personnel etc., whereas staff in family day care only consists of the carer herself. From this table, it is clear that children enrolled in preschools are met with higher qualified staff, even when non-teaching staff is included; staff in preschools is much more likely to have a degree in teaching compared to family day carers. Furthermore, there are nine times as many men employed in preschools as in family day care but even so, preschool carers are predominantly female.

TABLE 1

CHARACTERISTICS OF STAFF IN FAMILY DAY CARE AND PRESCHOOLS

	Family Day Care Mean	Preschool Mean
High school or below	0.38	0.29
Vocational degree	0.54	0.16
in paedagogics	0.00	0.01
Medium length further education	0.07	0.53
in paedagogics	0.02	0.50
Long further education	0.01	0.01
in paedagogics	0.00	0.00
Male	0.01	0.09

Source: 10% representative sample of the Danish population

Prices are set at the municipality level *once a year* and hold throughout the municipality for a given type of care. Parents pay a maximum of 33% of the total costs of providing care, and the price is reduced with lower income and number of siblings enrolled in public care. Parents with a yearly family income above around $ 60,000 (about 60 % of parents) pay the full price of child care while parents with a yearly family income below $ 20,000 (about 1 % of parents) do not pay for child care. See Simonsen (2005) for a detailed description of the pricing scheme. The subsidy scheme is the same for both preschool and family day care. As indicated above, the average yearly total costs (for three-year-olds) of family day care are higher than those of preschool. The maximum total yearly price for family day care (33% of total costs) is $ 3,500, while the corresponding maximum for preschool is $ 2,600.

Allocation of slots in child care

All children are eligible for municipality child care, including children born to unemployed parents.[8] It is in fact *illegal* to exclude certain groups of children from participating. This means that children's right to child care enrolment is not affected by their parents' transitions in and out of the labor market. Presumably, if child care does contribute to the development of social and academic skills, we may expect such disruptions to be detrimental to learning.

[8] The only exception occurs if one of the parents takes formal publicly supported maternity or child care leave aimed at the child in question. Siblings can still be placed in child care during formal leave, though.

Parents apply for child care (either preschool or family day care) by sending an application to the municipality; the child care institutions are not involved in the allocation process. Thus there is no institutional selection bias. Note that the application process is the same in each case, so it is not the case that children of parents who are disorganized and file late end up in family care. Parents enter the date from which care is needed. Upon application, children enter the waiting list. The municipality can decide whether birth date or date of application determines seniority and slots are assigned accordingly. 'Degree of need' is specifically not taken into consideration. Only if a child is disabled, is an immigrant, *or* if the child has older siblings enrolled in municipality provided care can he jump the waiting list. Therefore, we include whether the child is physically disabled, whether the mother is a non-native speaker and the number of older siblings as controls in our analyses below.

Parents may indicate whether they prefer preschool or family day care. However, children with the highest seniority are assigned the *first* open slot. If possible, municipalities will accommodate parents' preferences but they do not have the right to a specific slot.

Parents may decline the offer they are given.[9] If birth date is used to determine seniority, the only consequence of doing so is delaying the time until the child can enter child care. I.e. once the parents reapply, children will get the same position on the waiting list. It is clearly uncertain when the next slot is available and whether it will be of the preferred type. If seniority is determined based on time on the waiting list, the municipality may decide to blacklist parents for a limited period.[10]

Once the child is enrolled in care, he or she will no longer appear on the waiting list for alternative slots. This means that once a child is enrolled in, for example, family day care, he or she does not have the right to move to preschool.

This system generates four potential groups of parents: 1) Those who were granted a slot in the preferred type of care, 2) those who were granted a slot in the non-preferred type of care and declined the offer, 3) those who are indifferent, and 4) those who were granted a slot in the non-preferred type of care and accepted the slot (i.e. those who are weakly prefer to accept the non-

[9] We only have information about the type of slot accepted by the parents, not the slot offered at the outset.
[10] Unfortunately, we do not know which municipalities choose which seniority criterion.

preferred slot now compared to declining in order to wait for another slot that may be of the preferred type).

It is therefore unlikely to be – unconditionally – random which children end up in which types of care. Presumably, parents who have strong preferences for a given type of care and are willing and capable of waiting for a slot are different from parents who accept a non-preferred slot. Hence, their children may differ as well.

Guaranteed access to preschool (GAPS)

Because of the likely non-random selection into types of care, we look for variation in the take-up of preschool that is unrelated to child outcomes. We exploit the fact that the municipality must provide the 'necessary' number of slots in day care but they are free to decide on the distribution of slots in preschool vs. family day care. Therefore, some municipalities are capable of providing *guaranteed access to preschool* (GAPS). This means that all children have the right to a preschool slot within the municipality (but not to a specific slot).[11]

This policy generates potential variation in the take-up of preschool across municipalities. If parents on average value preschool over and above family day care, we should expect *GAPS* to increase the take-up of preschool.

Two sets of agents can affect whether parents face *GAPS*: the local government and the parents themselves. What determines whether a municipality provides *GAPS*? We will argue that it is optimal from the local government's point of view to aim for exactly meeting demand for slots in preschool: Having open slots is clearly costly in terms of teacher salaries and rent, which the municipality (by definition of open slots) is already committed to paying. On the other hand, providing too few slots causes dissatisfaction among municipality inhabitants and may affect voting behavior in the future. Further, remember that, as described in above, prices as well as the maximum number of children per preschool teacher in a municipality, the dominant quality parameter, are *fixed* within a given year. Municipalities can therefore not guarantee access to preschool in a calendar year by lowering quality, and there are large fixed costs associated with

[11] More precisely, the policy guarantees access to center based care (nurseries and preschools). For our purposes, the important feature is access to preschool

establishing new preschools. Nor can parents, in the short run, be forced to cover the costs of a lower-than-predicted number of children enrolled in preschool. Thus if funds are available (i.e. conditional on municipality characteristics), we expect most of the variation in the provision of *GAPS* to stem from unexpected variations in demand, for example due to variations in cohort size.

Therefore, *GAPS* information provides us with variation in the take-up of preschool, which is not a parental choice variable, and it has, arguably, no causal effect on child outcomes by itself. Of course, parents with more to gain from *GAPS* settle accordingly. Firstly, according to Simonsen (2005), there is very limited movement to and from municipalities providing advantageous child care policies. Secondly, there *is* municipality specific variation in child care policies over time, for example driven by changes in the age structure and composition of the population. A couple can therefore not be sure that a municipality will not change its policy. This does not, of course, exclude the possibility that people settle because of child care policies, but it decreases the probability. Thirdly, it is unlikely that the child care policy is the main driver for settlement when compared to job opportunities and prices of real property. Furthermore, in our empirical analyses we condition on the number of siblings, which is expected to capture part of the expected gains from living in a municipality with *GAPS.*

We realize, of course, that child care policies are likely to be correlated with other municipality specific characteristics, which may affect, on the one hand, the parents' decision of where to live and, on the other hand, the municipality's capability of providing services in general. To counter this, our conditioning set includes municipality characteristics, see below.

To shed light on the degree of selection into *GAPS*-municipalities, we estimate a probit for living in a *GAPS*-municipality conditioning on the variables from our main analyses below, see Appendix A, Table A1. In general, very few coefficients are significant at the 5 % level indicating that selection on observable characteristics is a minor problem. The number of preschool teachers at the average preschool within the municipality is negatively associated with *GAPS.* An extra preschool teacher per 100 children lowers the probability of the policy with roughly 4 percentage points. If this signals lower quality of preschools in *GAPS*-municipalities (beyond what is controlled for by number of preschool teachers) we will suspect a downwards bias of the effect of preschool using *GAPS* as an instrument. Indicators of enrolment in public care at age 0-2 are positively correlated

with the provision of *GAPS*. The correlation with nursery enrolment is to be expected since *GAPS* indicates easier access to center based care in general. The correlation with early enrolment in family day care is likely caused by *GAPS* municipalities having more child care slots of both types available for children aged 0-2. Finally, mothers with short tertiary education are about 4 percentage points *more* likely to live in *GAPS*-municipalities, whereas mothers who worked full time in 1996 are about 7 percentage points *less* like to do so. To conclude, there is no clear evidence that for example highly able parents locate in municipalities providing *GAPS*.

Interpretation of treatments: Enrolment patterns

It is important to keep in mind that most children in family day care and preschools have been enrolled in care before the age of three – and they continue in care until school age. To gain more insights into the enrolment patterns, we augment our survey data with administrative data from Statistics Denmark (the Day Care Register). Unfortunately, this data only cover 80 % of Danish children enrolled in child care, which causes some discrepancies between our survey data and the register data and makes the latter unsuited for formal analyses.[12] Furthermore, the timing of the two data sources is not exactly the same; the survey is collected from February – April, while the register data is from March. The data do, however, give a rough picture of prior and later enrolment. Table 2 shows enrolment from age 0-6½.

[12] Prior enrolment is included as a conditioning variable. In our sensitivity analyses we show results without conditioning on type of prior enrolment.

TABLE 2

ENROLMENT PATTERNS[a]

			Children at home in 1999 Age 3½	Self-reported Children in preschool in 1999 Age 3½	Children in family day care in 1999 Age 3½
Register data	1997 Age 1½	Nursery	0.15	0.13	0.02
		Family day care	0.23	0.36	0.58
		Missing (incl. home care)	0.62	0.43	0.40
	1998 Age 2½	Nursery	0.20	0.32	0.02
		Family day care	0.28	0.40	0.74
		Missing (incl. home care)	0.62	0.43	0.43
	1999 Age 3½	Preschool	0.38	0.75	0.17
		Family day care	0.08	0.03	0.66
		Missing (incl. home care)	0.51	0.17	0.17
	2000 Age 4½	Preschool	0.64	0.82	0.80
		Family day care	0.01	0.00	0.02
		Missing (incl. home care)	0.34	0.17	0.17
	2001 Age 5½	Preschool	0.69	0.81	0.80
		Family day care	0.00	0.00	0.00
		Missing (incl. home care)	0.29	0.17	0.18
	2002 Age 6½	Preschool	0.23	0.11	0.19
		After school care	0.42	0.66	0.61
		Missing (incl. home care)	0.35	0.23	0.20

[a]Enrolment in register data was recorded in week 10 (March) and self-reported enrolment was collected in the spring. During the period of interest, about 20% of the municipalities did not register day care information electronically. The children who do appear in the day care register data are either at home or living in a non-reporting municipality.

Here it is clear that the majority of children in family day care at age 3½ were also in family day care earlier on, whereas children in preschool at age 3½ have been placed in both family day care and center based nurseries. At age 4½, most children are in preschool. Conditional on prior enrolment, therefore, the treatment "participation in preschool relative to family day care at age 3½" roughly corresponds to evaluating the effect of about one extra (early) year of preschool. Although not as clean, the treatment "participation in preschool relative to home care at age 3½" is partly the effect of earlier entry into preschool and partly the effect of a larger propensity to ever enroll in preschool.

There is also a weak tendency for children in family day care at age 3½ to stay in preschool at age 6½ and consequently delay school start. This is possibly a consequence of the treatment, though it may also indicate that family day care children are weaker children. Because the register data are suboptimal in our context, it is difficult to make hard conclusions though. To account for this, our conditioning set includes a number of child related characteristics.

3. Child Outcomes and Non-Parental Care

There exist two strands of the literature on child outcomes – cognitive as well as non-cognitive – and non-parental care within the field of economics. One focuses largely on the effects of maternal employment in general and less on the alternative modes of care,[13] whereas another branch considers the effects of preschool interventions for disadvantaged children.

Overall, there is limited consensus in the literature about the effects of child care and maternal employment. One study that is relevant for our paper is that of by Baker, Gruber, and Milligan (2008). They evaluate a large scale change in the child care system in Quebec, Canada. The policy change implied that the out-of-pocket price for child care for 0-4 year old children cannot exceed $5 per day. While neatly exploiting the before-after Quebec-versus-other regions variation, the authors find that the effects on cognitive and non-cognitive child (and parent) outcomes at ages 2-4 and 6-11 of the transition to a regime with large-scale highly-subsidized child care are clearly negative.[14] On the other hand, another recent study by Havnes and Mogstad (2009) also investigating the impact of a large-scale expansion of day care – by exploiting a child care reform from 1975 in Norway, which induced variation in child care coverage across time and between municipalities – finds strong positive effects on children's long-run outcomes as adults.

Parcel and Menaghan (1994), Ruhm (2004), and Waldfogel, Han, and Brooks-Gunn (2002) all use US data (the NLSY) to investigate the effects of early maternal employment on cognitive outcomes

[13] Important exceptions are Bernal and Keane (2008) and Magnuson, Ruhm, and Waldfogel (2007). The former paper distinguishes between formal care (center-based care and preschool) and informal care, whereas the latter considers prekindergarten, preschool, and Headstart. Relatedly, Gordon, Kaestner, and Korenman (2007) investigate *health* outcomes and finds that greater time spent in center-based care is associated with adverse outcomes as measured by respiratory problems and ear infections.

[14] Note that Baker, Gruber, and Milligan (forthcoming) implicitly rely on the assumption that parents do not move to Quebec *because* of easier access to cheap childcare.

(the Peabody Picture Vocabulary Test) at age 3-6. Parcel and Menaghan (1994) also investigate behavior. Ruhm (2004) and Waldfogel, Han, and Brooks-Gunn (2002) find that early maternal employment leads to significantly worse child outcomes, though the latter study finds that later maternal employment has some positive effects for the group of non-hispanic whites. Parcel and Menaghan (1994) find modestly positive effects on verbal ability for the group of children born to mothers who hold high-complexity jobs.

Gregg, Washbrook, Propper, and Burgess (2005) exploit UK data (ALSPAC) to similarly investigate the effects of early maternal employment on cognitive outcomes for children age 4-7. They distinguish between formal and informal care and find negative effects of informal care, while formal care does not significantly affect child outcomes.

Magnuson, Ruhm, and Waldfogel (2007), using the Early Childhood Longitudinal Study, consider the effect of participating at age four in teacher-directed early education (Prekindergarten) versus other types of care. The results show that Prekindergarten leads to significantly better cognitive outcomes (measured at age five) but also increased levels of aggression and decreased self-control.

Parcel and Menaghan (1994), Ruhm (2004), Waldfogel, Han, and Brooks-Gunn (2002), Gregg, Washbrook, Propper, and Burgess (2005) and Magnuson, Ruhm, and Waldfogel (2007) all use regression techniques to evaluate treatment effects, thus relying on an 'conditional on observables' strategy. Realising that this may not sufficiently deal with the selection problem, Waldfogel, Han, and Brooks-Gunn (2002) also supply estimates using family fixed effects. A similar strategy is used by James-Burdumy (2005) also exploiting the NLSY. She finds negative effects on cognitive development of maternal employment in the first year of a child's life. Of course, while family fixed effects may clear out parental unobservables, mothers may still base their employment decisions on unobserved child specific ability. If so, using family fixed effects will not provide consistent estimates of the treatment effects.

There have been a few attempts within this literature to deal with selection problems using instruments. Blau and Grossberg (1992) estimate the effects of maternal employment in the NLSY and use work experience prior to childbirth as an instrument. Firstly, it is not clear that this variable will not directly affect child outcomes. Secondly, it is difficult to assess the predictive power of the

instrument since the first stage is not presented in the paper (see Bernal and Keane (2008) for a discussion of the strength of this particular instrument). Thirdly, with heterogenous treatment effects, the corresponding LATE will be identified by the group of children whose mothers would be employed after child birth if they were employed prior to child birth but not employed after child birth if they were not before. It is not obvious that this group of compliers constitute a particularly policy relevant group.

Apart from estimating family fixed effects models (see above), James-Burdumy (2005) also exploits county variation in the share of the labor force employed in services as an instrument for maternal employment. Even without considering the strength of this instrument (see Bernal and Keane (2008) for a discussion), it is not obvious how to interpret the LATE parameter.

Finally, Bernal and Keane (2008), again using the NLSY, distinguish between different types of care; they investigate the effect on cognitive ability of participating in formal care (center-based care and preschool) and informal care, both compared to home care, for children of single mothers. Their findings suggest that this group of children benefit from being enrolled in the former but experience adverse outcomes when participating in the latter, less expensive, option. For identification purposes, they instrument maternal employment (but not choice of type of child care) using benefit termination time limits and state variation in welfare policy rules.

One reason for the lack of consensus in the literature may stem from variation in the quality of non-parental care; high quality care may, for example, neutralize potentially negative effects of maternal employment, see also Gregg et al. (2005). Moreover, the content and structure of the child care programs – as demonstrated by Magnuson, Ruhm, and Waldfogel (2007) – are likely to affect outcomes as well; Stipek, Feiler, Byler, Ryan, Milburn, and Salmon (1998) suggest that employing structured, teacher-directed approaches at the preschool level results in relatively negative social climates and therefore negative effects on both cognitive and motivation outcomes.

For disadvantaged children, on the other hand, the literature suggests that participation in (expensive) programs aimed directly at this group is beneficial to participating children, in fact considerably more so than giving families of these children unrestricted cash transfers (Currie, 1994). One example of a successful intervention is the Head Start Program, see e.g. Currie (2001),

Currie and Thomas (1995, 1999), and Currie, Garces, and Thomas (2002). These studies mainly rely on family-fixed effects for identification. Other beneficial programs are the Perry Preschool Project, the Abecedarian Program, and the Chicago Child-Parent Centers; see Blau and Currie (2006) and Heckman and Masterov (2007). The two former programs are evaluated using random experiments, while the Chicago Child-Parent Centers program is evaluated using matching, see Reynolds, Ou, and Topitzes (2004).

The view that disadvantaged children benefit from high quality care is also put forward in Knudsen et al. (2006). This paper is a joint venture by an economist, a neurologist, a psychiatrist, and a sociologist. Among the conclusions from this paper is that interventions aimed at improving the situation for disadvantaged individuals should start as early as possible when the brain is more plastic. This is especially important because early learning is crucial for later learning (see Knudsen et al. (2006), p. 3):

"Both the mastery of skills that are essential for economic success and the development of their underlying neural pathways follow hierarchical rules in a bottom-up sequence such that later attainments build on foundations that are laid down earlier".

From the literature, therefore, we can infer that for evaluations of the effects of child care 1) the counter-factual state matters as does 2) the group under investigation. As described above, here we focus on a large-scale, high quality but expensive, publicly funded universal child care program for three-year-olds; a much under-researched area, see Currie (2001).

One issue is how modes of care affect child outcomes; another is the effects of the *intensity* of a given treatment. Specifically, one may be interested in assessing how the effect of placing a child in preschool for 20 hours differs from that of 45 hours. These two scenarios may lead to very different outcomes; one allows for substantial time with both parents *in addition* to time with peers, whereas the other to a higher degree restricts time with parents. Some studies focus solely on the effects of maternal employment patterns and consider hours (or extent) of work, see for example Bernal and Keane (2008), Gregg et al. (2005), Parcel and Menaghan (1994), and Ruhm (2004), while Blau (1999) investigates the effects of child care characteristics on child outcomes and include a measure of hours in care. Except for Bernal and Keane (2008) who instrument maternal employment using

benefit termination time limits and state variation in welfare policy rules, all studies use conditional on observables strategies and typically find that the more hours are spent away from the parents, the worse are child outcomes.

A separate question is how to choose relevant measures of *child outcomes*. Previously, the literature has focused more on cognitive outcomes (measures of IQ), yet Currie (2001) suggests that though they are important predictors of future economic outcomes, such measures are often flawed and she points to the use of measures of school readiness instead or in addition. Preschool teachers, for example, emphasize the importance of non-cognitive skills as prerequisites for learning and Cunha and Heckman (2006) find that non-cognitive skills promote the formation of cognitive skills (but not vice versa). Heckman, Stixrud and Urzua (2006) also show that non-cognitive skills are as important for school enrolment decisions as cognitive skills and Currie and Stabile (forthcoming) find that early mental health conditions as measured by Attention Deficit Hyperactivity Disorder (ADHD) diagnosed as early as age 4 affect future test scores and schooling attainment negatively.

Not only are early non-cognitive skills important prerequisites for learning, for performance on test scores and for schooling, they are also found to have long term consequences, see the evidence presented by Cunha, Lochner, Heckman, and Masterov (2006). In particular, measures of persistence, self-esteem, and optimism are found to affect not only schooling outcomes (and indirectly therefore, labour outcomes) but also the probability of teenage pregnancy, smoking, and earnings, see Carneiro, Crawford and Goodman (2007). The same point is made by Knudsen et al. (2006).[15] In line with this, Segal (2006) demonstrates that eighth grade behavior is as important for earnings as eighth grade test scores and Segal (forthcoming) finds that student behavior, at least during adolescence, is persistent.

Naturally, the optimal situation would be to have available both measures of cognitive and non-cognitive skills. Unfortunately, our data do not include cognitive outcomes for 7 year old children. At this age, children have just started school and in the Danish educational system there are no grades or nationalized tests in the lower classes. Presented with the evidence on the importance and long-term consequences of early non-cognitive skills, however, we choose as our outcome of interest a measure of non-cognitive skills based on the so called Strength and Difficulties

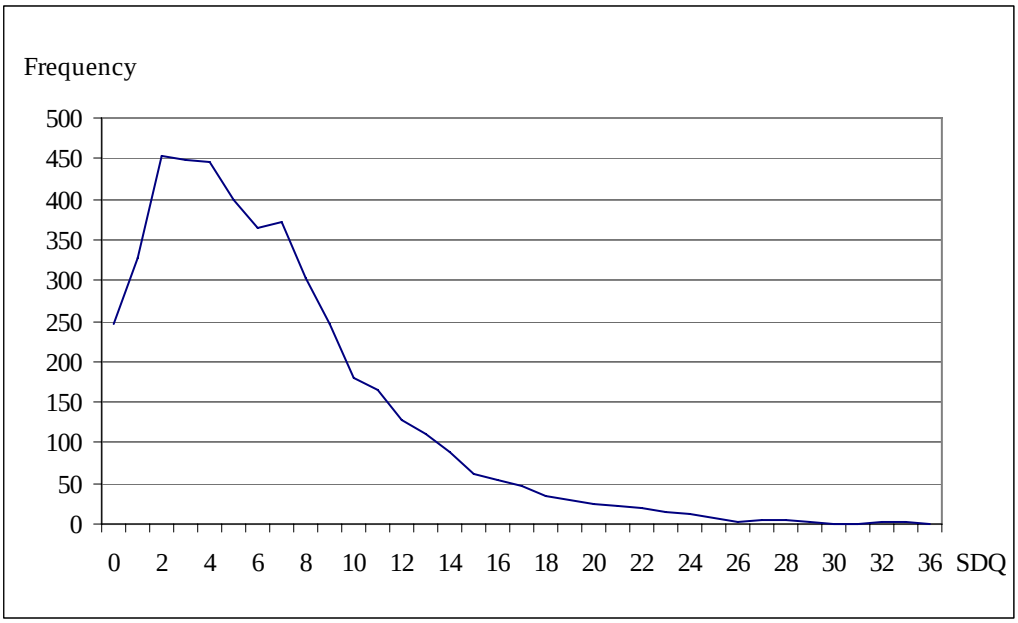
[15] Knudsen et al. (2006), p. 4: "Cognitive, linguistic, social, and emotional competencies are interdependent, all are shaped powerfully by the experiences of the developing child, and all contribute to success in the workplace".

Questionnaire (SDQ); a standard behavioral measure in the child development literature, see Goodman (1997) for a description of this measure and Andersen, Deding, and Lausten (2006) for a Danish application. The *SDQ* index is based on emotional symptoms, conduct problems, hyperactivity/inattention problems, and peer relationship problems. See Appendix A, Table A2 for a list of the questions used to construct the *SDQ* index and www.sdqinfo.com for further details. The measure takes on discrete values in the interval between 0-40, where 0 indicates no behavioral problems. Research suggests that the *SDQ* and Rutter questionnaires correlate highly and do equally well in terms of classifying behavior, see Goodman (1997). Also, the *SDQ* questionnaire offers additional advantages such as coverage of inattention, peer relationships, and pro-social behavior. Figure 2 below shows the distribution of the *SDQ* index in our sample. Differences in mean SDQ across countries arise due to slightly different sample definitions, i.e. differences in the age ranges and sex composition.

In our case, the questionnaire is filled out by the primary parent (most often the mother) of the child when the child is seven years old. Importantly, this means that our *outcome* is measured at a different (future) point in time than our *treatment*. Had this not been the case, or had the two types of information somehow been linked in the survey, one may have feared that mothers would be inclined to rationalize their choice of child care and overestimate good child behavior, which could bias our results below. Similar issues would occur with measurement errors. Clearly, even if mothers' responses are biased, as long as this is unrelated to choice of mode of care, it will not cause problems for our identification strategy. Since mothers are not asked to evaluate child behavior directly (perceptions of 'optimal' behavior may vary in some unobserved way with type of child care) but instead answer concrete questions ('does the child have at least one good friend', 'often loses temper'), it is much less likely that biases in mothers' responses will vary systematically with choice of child care. Furthermore, all children have started school at age seven and parents' reference points when evaluating child behavior are therefore the other children in school. Importantly, their (current) reference points do not depend on whether the child has been taken care of at home, in family day care, or in preschool as the type of school attended, which in most cases would be the neighborhood public school, would not vary by the kind of previous care arrangement.

FIGURE 2

DISTRIBUTION OF SDQ INDEX



Source: Data used for estimation purposes. SDQ below 14 is 'normal', between 14-16 is 'borderline', and above 16 is 'abnormal'. Danish mean for 7½ year olds 6.55, US mean for 4-7 year olds 7.4, UK mean for 5-10 year olds 8.6. See www.sqdinfo.com.

TABLE 3

TAKE-UP OF CARE 3-YEAR OLDS AND SDQ INDEX AT AGE 7[a]

	Share	Mean SDQ index
Home care	0.15	6.48
		(5.29)
Municipality family day care	0.16	6.80
		(5.15)
Municipality preschool	0.66	6.52
		(5.04)
Private care	0.03	5.83
		(3.93)
Other types of care	0.01	7.15
		(5.68)
Mean hours in non-parental care	30.88	
	(10.96)	

[a]Source: Own calculations, data used for estimation purposes

Table 3 above shows the take-up of different modes of care, parental and otherwise, and mean *SDQ* index (measured at age 7) along with mean hours in non-parental care.[16] We see that around a seventh of the children are taken care of at home (children of immigrants and children with more siblings are overrepresented in this group, see Table A4) and that municipality-run preschool centers constitute the most common type of non-parental care. Participation in center-based care is high in an international comparison; according to Currie (2001), in 1995 around 31% of American three-year-olds received such care. At the outset, there is little variation in child outcomes across types of care, and children spend on average 30 hours per week in non-parental care.

4. Parameters of Interest

This section first discusses potential parameters of interest and then considers identification of these parameters. In this paper, one goal of the evaluation is to measure the effect or impact of mode of care on our outcome variable, the strengths and difficulties index, *SDQ*, relative to some other type of care. More precisely, we consider the effects on child outcomes at age seven of participating at age three in some form of publicly provided child care compared to home care. That is, we ignore the small fraction of children participating in private and other specialized care. We also only include children whose *mother* filled in the questionnaire.[17] A second goal of the paper is to evaluate the effects of the intensity of treatment. Put differently, does it matter whether a child is placed in non-parental care for 30 hours compared to 20 hours conditional on choosing some type of publicly provided care such as preschool?

Consider first participation in a municipality provided child care program, *MP*, relative to home care. Let $MP = 1$ indicate participation in such a program, whereas $MP = 0$ indicates home care. Let SDQ_0 be potential outcome in home care and SDQ_1 the potential outcome in municipality provided care. We are now faced with the fundamental problem that we do not observe the same child both in home care and municipality provided care at the same point in time. In this paper, we consider the average effect of municipality provided care for the group of participants:

[16] *SDQ* is missing for 15 percent of the sample. Running mode specific probits, we conclude that the reporting problem is statistically unrelated (at the 5% significance level) to any observable characteristics in our conditioning set, see Table A3 for the list of variables.
[17] This is the case for 99% of the children in the survey.

(1) $$E\left[SDQ_1 - SDQ_0 \mid MP = 1\right]$$

Other parameters, for example focusing on the probability of abnormal child outcomes, may be of interest as well. The reason for estimating average effects is twofold: firstly, municipality provided care – our treatment - is designed to cover the needs of an average child and not so much children with abnormal behavior and needs. In fact, children with extreme problems are likely to be sent to special institutions and are fairly rare in our sample; 91% of children are classified as normal, see definition in Section 2. Therefore, we do not expect much action with regard to child care participation for borderline and abnormal groups. Secondly, (1) should be an extremely important input into the decision rule for parents of 'average' children. This group of parents is not necessarily afraid that their child will turn out to have extreme behavior, but may still – because there exists gradations of normal – care about whether sending their child off to be taken care of outside of the home will move child development in one or the other direction.

There is an obvious problem with the parameter defined in (1), however. In particular, (1) will be some weighted average of the effects of being enrolled in preschool and family day care. Thus, estimating the average effect of being enrolled in some type of municipality provided care does not result in an easily interpretable parameter, but does, nonetheless, correspond to the parameters being estimated in much of the literature.

We therefore continue to investigate whether participation in different types of municipality provided child programs results in different outcomes compared to home care. In order to do this, we need to extend our framework slightly. Let SDQ_j be the potential outcome, $j = 0,1,2$:

$$j = \begin{cases} 0 & if\ \ home\ care \\ 1 & if\ \ family\ day\ care \\ 2 & if\ \ pre-school \end{cases}$$

We consider the following parameters:

(2) $$E\left[SDQ_1 - SDQ_0 \mid FC = 1\right],$$

where *FC* indicates family day care participation. Thus, (2) is the average effect of participating in family day care compared to home care for the group of children enrolled in family day care. Furthermore, we consider

(3) $$E\left[SDQ_2 - SDQ_0 \mid PS = 1\right],$$

where *PS* indicates preschool participation. (3) is then the effect of participating in preschool compared to home care for the group of children enrolled in preschool.

All three parameters, (1) – (3), discussed above should be interpreted as the effects of a given type of care compared to the alternative home care, *including* any effects arising via parents' different labor market behavior and income in the two states in the year of treatment. In principle, we would like to adjust for these variables in the year where treatment is taking place to isolate the effect of mode of child care. Similarly, we would like to adjust for other variables, such as school quality, that are measured after treatment has taken place. Yet, exactly because such variables are affected by the treatment, this is not possible; see Rosenbaum (1984). This problem is common to all observational studies attempting to evaluate the effects of child care.

Finally, we consider the effects of participating in preschool compared to family day care for the group of children enrolled in preschool:

(4) $$E\left[SDQ_2 - SDQ_1 \mid PS = 1\right].$$

In considering this latter parameter, we avoid having to deal with the potential non-random selection out of non-parental care. If the 15% of children observed in home care were selected in some way not captured by the covariates in the model, we would expect that the difference between (3) and (2) would be far apart from (4). If, on the other hand, these estimates are similar, then children cared for at home can be considered a reasonable comparison group for children attending respectively, family day care and preschool, because the covariates adequately control for any differences between these groups.

For identification, we pursue both a conditional on observables as well as an IV strategy exploiting *GAPS*. We argue above that, conditional on observables, *GAPS* does not affect child outcomes and we can test whether *GAPS* affects the take-up of preschool. However, as pointed out earlier, treatment effects likely vary across individuals. For us to identify a meaningful parameter by using IV, we need an additional assumption, *monotonicity*, see Angrist, Imbens, and Rubin (1996) and Vytlacil (2002). This assumption implies that the instrument must affect individuals' behavior in one direction only. Because we have excluded the group of parents choosing home care from our analysis, we need an extended version of monotonicity, see Froelich (2004) for intuition and Appendix B for a formal proof. In particular, we need it to be the case that

1) parents who use preschool under a *GAPS* regime must not use home care in the absence of *GAPS*,
2) parents who use preschool in the absence of *GAPS* must use neither family day care nor home care under a *GAPS* regime,
3) parents who use family day care under a *GAPS* regime must use neither preschool nor home care in absence of *GAPS*,
4) parents who use family day care in the absence of *GAPS* must not use home care under a *GAPS* regime.

This essentially corresponds to monotonicity combined with independence of irrelevant alternatives assumed in a multinomial logit model. The information is summarized in Table 4 below along with the shares of our sample choosing each mode of care across the two regimes. A *no* indicates a state that must not occur under the extended version of monotonicity. We clearly see that more children are in preschool under the *GAPS* regime, and, similarly, fewer children are in family day care. These trends along with the fact that the share of children in home care under the *GAPS* regime is similar to the share in home care under the *no GAPS* regime – the difference in raw means is four percentage points – offer tentative evidence that the monotonicity assumption is fulfilled. Furthermore, a Hausman-McFadden test, see Hausman and McFadden (1984), of IIA cannot reject the hypothesis that the coefficient to *GAPS* in the equation comparing family day care and preschool is the same in a multinomial logit including all alternatives and one in which we only include family day care and preschool (t-statistic is 0.01). If it is the case, however, that for example more able parents who prefer a slot in preschool choose to keep their child at home instead of

sending her to family day care, we will expect the IV results to be upwards biased. See however Table A4 for means of selected variables across modes of care.

TABLE 4

STATES RUINING MONOTONICITY [a]

		GAPS=1			
		Preschool	Family day care	Home care	
GAPS=0	Preschool		no	no	0.58
	Family day care			no	0.22
	Home care	no	no		0.16
		0.81	0.04	0.12	

[a] 'no' indicates a state that must not occur under extended version of monotonicity

Given heterogeneous treatment effects and the monotonicity assumption, our IV procedure will estimate a *local* average treatment effect, not the average treatment effect:

(4') $$E\left[SDQ_2 - SDQ_1 \mid PS(GAPS) - PS(no\ GAPS) = 1, H = 0\right]$$

i.e. the difference in child outcome with and without preschool exposure for the group of children who would be enrolled in preschool if they live in a municipality that guarantees access to preschool but not otherwise. They would be children of parents who are either indifferent or are granted a slot in the non-preferred type but accepted the slot (Groups 3) and 4) on p. 10). In other words, these are children of parents who are truly affected by a limited supply of slots. Clearly, some children may not enroll in preschool under either regime, for example, if their parents are very selective in their choice of center or, along the same lines, if one of the parents has strong preferences for staying at home. Similarly, some children may always be enrolled in preschool. This may occur by sheer luck because there is a probability that a child is always granted a slot. (They would be children of parents in Groups 1) and 2) on p. 10). Always- and never-takers in the terminology of Angrist, Imbens, and Rubin (1996) do not contribute with any variation and therefore do not affect the parameter estimate.

The parameters presented in (1) – (4) and (4') are all concerned with comparing different types of care. As pointed out, another interesting question is whether the intensity of care matters. We follow Behrman, Cheng, and Todd and explore the following parameters:

(5) $$E\left[SDQ_1\left(t+\Delta t\right)-SDQ_1\left(t\right)\mid FC=1,t\right]$$

and

(6) $$E\left[SDQ_2\left(t+\Delta t\right)-SDQ_2\left(t\right)\mid PS=1,t\right].$$

(5) and (6) are the average effects of increasing time in a given type of publicly provided care from t to $t+\Delta t$ conditional on selecting municipality provided family day care or preschool and spending t hours in this type of care, respectively. Focusing on decisions on the intensive margin allows us to ignore the selection into a specific type of non-parental care. We assume that it is random – conditional on observables – whether children spend t or $t+\Delta t$ hours in non-parental care. As long as Δt is small, this seems to be a reasonable assumption. Furthermore, comparing children who spend similar hours in non-parental care bypasses the problem of large indirect effects stemming from variables such as mother's income and labor market status. As above, it is not possible to condition on these variables because they are affected by the choice of child care. The cost of our approach is clearly that we can only address effects stemming from local variations in the choice of hours.

5. Results

In order to determine what type of conditioning set is necessary for our regression estimates of the parameters of interest to be unbiased, we rely on the literature on child development and demand for child care for guidance. In the literature, a child's development is proposed to be a function of current as well as past mode and intensity of care, purchased inputs, and exogenous determinants (production shocks), see Ruhm (2004) for a sketch of such a production function approach. Furthermore, from the literature on demand for child care, e.g. Blau and Hagy (1998), we know that mothers' employment and the costs related to a given type of care are crucial factors.

Together, these models imply that we need a rich conditioning set describing firstly the types and the quality of available modes of child care. Furthermore, we need information about number of hours in non-parental care. That is, we must have information about the treatment. Here, we use

both information from the child panel about type and intensity of the chosen mode of care measured at survey date and municipality specific information from the Ministry of the Interior on quality of preschool as measured by average number of teachers per child enrolled in preschool, see Currie (2001) to control for any differences across municipalities. To proxy purchased inputs, mothers' employment, and costs related to a given type of care, we include detailed information on income and labor market history – also prior to giving birth – for the parents in our sample, see also Gregg et al. (2005). Presumably, including such information stemming from before the child is born informs about attachment to the labor market but also about ability. We also condition on past choices of child care, see discussion above. Finally, we need information about the catch-all category of 'production shocks'. Here, we use a variety of information correlated with both child outcome and choice of care. We include information about the child measured at time of birth (birth weight, gender, disabilities, number of siblings etc.), parents (geographic location, level of education, smoking behavior, immigrant status, whether the father took leave, whether the mother breast fed the child in question, whether the mother experienced post-partum depression following the birth of that child[18]), and municipalities (level of unemployment, number of immigrants, winner of most recent local government election, share of households with children out of all households in municipality). See Table A3 for a detailed description of the variables and Table A4 for means of selected variables set across modes of care.[19]

Although we employ an exhaustive set of controls, parental and child unobservables which correlate with both mode of child care and child behavior could potentially lead to bias in estimated impacts. One example mentioned by Bernal and Keane (2008) could be unobserved mother and child ability. High-ability mothers would be more likely to have high-ability children and would also be more likely to work and use child-care, while low-ability mothers may decide to compensate their children by spending more time with them at home. This would bias the impacts of out-of-home care on child behavior upwards. On the other hand, high-ability mothers may have stronger tastes for high child quality and may choose to spend time at home stimulating their children. Thus, the correlation could go in either direction. In terms of the choice between preschool and family care, one scenario could be that high-ability parents would prefer sending their children to a structured

[18] Maternal mental health has been found to be significantly linked to ADHD symptoms in children (e.g. Lesesne et al. (2003)).

[19] In Section 6, we investigate the sensitivity of our results to the exclusion of variables that are potentially endogenous: parental employment after birth but before age three, number of prior care facilities, had a child care arrangement at age six months, on waiting list at age six months. This does not affect our conclusions.

environment with educated personnel (preschool), biasing its effect upwards. Furthermore, parents of children with physical or mental difficulties may opt for family day care over preschool. Our model controls for parental age, education, previous work status, previous hourly wage, previous occupational status and previous leave length, which should adequately characterize parental ability and preferences for the large part. In terms of child endowment and ability, we control for birth weight and presence of disabilities.

Having discussed our conditioning set, we next present our estimation results. The first column in Table 5 shows selected coefficient estimates from estimating the effect of municipality provided care vs. home. That is, we attempt to uncover (1) above. We see that the parameter estimate to municipality provided program participation is positive, indicating that being enrolled in municipality provided care increases the SDQ index with 0.8 points. Yet, the estimate is not statistically significant at the 5% level. Remember that a higher value of SDQ index indicates adverse behavior. This result is in line with the findings in Andersen, Deding, and Lausten (2006), who, using the same data set as we do, investigate the effects of parents' labor market behavior on child outcomes.

As pointed out, however, (1) is not easily interpretable, and given the very different structures and contents of the two types of programs, we might expect the effects of the two to differ. To accommodate this, we shift attention to the effect of being enrolled in family day care relative to home care, (2), and the effect of preschool vis-à-vis home care, (3). Again, we estimate these parameters using OLS in a pooled model. The results are shown in the second column in Table 3. We see that family day care and preschool are indeed *not* the same and do not have the same effects on child outcomes. More precisely, being enrolled in preschool seems neutral compared to home care; the estimated effect is small, 0.4 SDQ points, and insignificant, whereas being enrolled in family day care significantly increases SDQ with 1.8 points. Note that parameter estimates should be seen relative to a mean of 6.6 SDQ points. The average effect of family day care roughly corresponds to the difference in mean SDQ between children born in a family where the mother has higher education and children born in a family where the mother has a high school degree or less education.

Consistent across the two models is that being breast fed, having high birth weight, not being disabled, and being born to a relatively older mother who does not smoke and who is not single is negatively correlated with SDQ. Similarly, children born to fathers with at least some tertiary education employed as higher management have lower SDQ. Put differently, these characteristics are correlated with better child outcomes.

As discussed above, a general finding in the literature is that children with poor socio-economic backgrounds benefit from being enrolled in high-quality programs. If treatment effects are heterogeneous, we will not expect the parameters in Table 5 below to be representative for all groups. To address this, we investigate whether the estimated effects differ with mothers' level of education.[20] Similarly, girls may be affected differently from participation compared to boys. Table 6 shows the effects of family day care and preschool compared to home care for different subgroups of the population.

Interestingly, there does seem to be important differences in *who* is affected by being placed in non-parental care. The result that preschool works as well as parental care holds true across all subpopulations considered, though some point estimates are relatively large but insignificant. However, the negative effect of family day care on child outcomes is clearly only significant in the case for boys, and then only when the mother has relatively low education (high school or below, or vocational degrees). Boys born to mothers with a high school degree or below will observe an increase in SDQ of 2.1 points compared to being taken care of at home. Similarly, boys born to mothers with a vocational degree experience a 1.5 point increase in SDQ, though this result is only significant at the 10% level.

[20] Mothers' and fathers' level of education correlate highly. Thus, we focus on mother's level of education only.

TABLE 5

SELECTED OLS COEFFICIENT ESTIMATES[a]

OUTCOME: SDQ, MUNICIPALITY PROVIDED PROGRAMS VS. HOME

MEAN SDQ HOME: 6.48, MEAN SDQ FAMILY DAY CARE: 6.80, MEAN SDQ PRESCHOOL: 6.52

	Model I		Model II	
Variable	Coefficient	Std. Error	Coefficient	Std. Error
Child care at age 3				
Municipality provided program	0.700	0.544	•	•
Family Day Care	•	•	**1.643**	0.648
Preschool	•	•	0.386	0.562
# prior non-parental care facilities	0.110	0.092	0.180	0.104
Preschool teachers	-0.037	0.052	-0.047	0.052
Nursery 1997	0.119	0.419	0.130	0.421
Nursery 1998	-0.255	0.376	0.167	0.237
Family Day Care 1997	0.143	0.237	-0.223	0.379
Family Day Care 1998	0.382	0.263	0.322	0.261
Had a child care arrangement at age six months	-0.279	0.183	-0.251	0.185
Waiting list in municipality at age six months	0.113	0.231	0.137	0.231
Child characteristics				
Girl	0.034	0.537	0.037	0.537
Birth month September	-0.018	0.153	-0.009	0.152
Siblings	-0.046	0.100	-0.041	0.101
Birth weight (in 1000 grams)	**-0.378**	0.119	**-0.373**	0.119
# hospitalizations	-0.057	0.248	-0.059	0.249
Physically disabled	**1.018**	0.451	**1.002**	0.445
Full term birth	0.023	0.138	0.019	0.138
Mother's characteristics				
Age	**-0.105**	0.027	**-0.107**	0.027
Vocational degree	-0.193	0.653	-0.201	0.654
Short tertiary	-0.163	0.836	-0.191	0.837
Medium or long tertiary	0.171	1.560	0.058	1.559
Labor market experience	-0.018	0.017	-0.016	0.018
Degree of year employed in 1996	0.468	0.311	0.475	0.312
Degree of year employed in 1997	-0.315	0.339	-0.329	0.340
Degree of year employed in 1998	-0.250	0.293	-0.261	0.292
Hourly wage 1995	-0.001	0.001	-0.001	0.001
Senior management level 1995	1.071	0.965	1.108	0.974
Higher management level 1995	**-0.724**	0.332	**-0.740**	0.331
Medium level employee 1995	-0.182	0.273	-0.168	0.274
Lower level employee 1995	-0.186	0.256	-0.194	0.255
Smoker	**1.092**	0.189	**1.096**	0.190
Single	0.762	0.721	0.770	0.722
Non-native speaker	0.948	0.730	1.009	0.729
Breast fed child in question	**-1.564**	0.545	**-1.550**	0.547
Postpartum depression	**1.876**	0.837	**1.821**	0.837

[a]See Datta Gupta and Simonsen (2007) for detailed description of variables. Cross terms between municipality provided program and mother's level of education and cross terms between municipality provided program and gender are included. Bold coefficients are significant at the 5% level and italic indicates significance at the 10% level. * indicates that the family day care coefficient is statistically different from the pre-school coefficient (5% level). All results robust to clustering at the municipality level.

Table continued next page

TABLE 5 CNTD.

SELECTED OLS COEFFICIENT ESTIMATES[a]

OUTCOME: SDQ, MUNICIPALITY PROVIDED PROGRAMS VS. HOME

MEAN SDQ HOME: 6.48, MEAN SDQ FAMILY DAY CARE: 6.80, MEAN SDQ PRESCHOOL: 6.52

Father's Characteristics:				
Vocational degree	**-0.548**	0.176	**-0.529**	0.175
Short tertiary	**-0.869**	0.279	**-0.846**	0.279
Medium or long tertiary	**-0.855**	0.356	**-0.843**	0.352
Labor market experience	0.001	0.014	0.002	0.014
Leave	0.136	0.196	0.136	0.197
Hourly wage 1995	-0.001	0.001	-0.001	0.001
Senior management level 1995	0.735	0.544	0.776	0.545
Higher management level 1995	-0.256	0.287	-0.250	0.288
Medium level employee 1995	-0.269	0.315	-0.263	0.315
Lower level employee 1995	0.285	0.221	0.298	0.221
# observations	4343		4343	
R^2	0.111		0.108	

[a]The full conditioning set is described in Table A3. Cross terms between municipality provided program and mother's level of education and cross terms between municipality provided program and gender are included. Bold coefficients are significant at the 5% level and italic indicates significance at the 10% level. * indicates that the family day care coefficient is statistically different from the pre-school coefficient (5% level). All results robust to clustering at the municipality level.

The literature on the effects of early maternal employment on child outcomes does not agree on whether boys fare better or worse from this compared to girls; see Ruhm (2004). Presumably, part of the explanation is the lack of information about the type and quality of non-parental care. However, Jacob (2002) finds that girls do have a lower incidence of behavioral problems in general, and Goldin, Katz, and Kuziemko (2006) document that girls have a much lower probability of participating in special education programs. Thus, boys are, at the outset, more vulnerable and therefore maybe more sensitive to their environment.[21]

Also, as demonstrated above, there are important differences between family day care and preschool. Specifically, preschool teachers are considerably more educated, having completed 16 years of education including a 4 year degree in pedagogics. Highly qualified teachers may be more effective in dealing with at risk children. Furthermore, preschool – even though a predominantly female sphere – does allow for some male supervision.[22] For obvious reasons, there exists very little evidence on the effect of teacher gender on child outcomes. According to Whitebook (1999),

[21] Boys in our sample have 0.8 points higher SDQ than girls.

[22] In our sensitivity analyses below we investigate whether the results vary if we exclude the small group of children whose fathers were not present when the children were one year old. We find no evidence of this.

98% of all American child care staff is female. From the literature on paternal absence and child behavior, however, there does seem to be some evidence that boys suffer more from an absent father than do girls, see e.g. Camara and Resnick (1988) and Mott, Kowaleski-Jones, and Menaghan (1997). Thus, both teacher qualifications and a greater degree of male supervision and role models are potentially more important for younger boys from low-educated backgrounds.

TABLE 6

OLS ESTIMATES[a]

OUTCOME: SDQ, MUNICIPALITY PROVIDED PROGRAMS VS. HOME

	Mean SDQ	# Obs	R^2	Family Day Care		Preschool	
				Coefficient	Std. Error	Coefficient	Std. Error
Children in municipality provided care[b]	6.55	4443	0.12	**1.808***	0.614	0.529	0.517
Girls of mothers with high school or below	6.88	668	0.175	-0.124	0.785	-0.566	0.740
Boys of mothers with high school or below	7.89	749	0.212	**2.090**	0.923	1.023	0.858
Girls of mothers with vocational degree	6.42	794	0.139	0.235	0.836	-0.250	0.808
Boys of mothers with vocational degree	7.06	859	0.123	*1.513*	0.818	0.696	0.779
Girls of mothers with higher education	4.79	600	0.147	-1.309*	0.936	-0.037	0.883
Boys of mothers with higher education	5.50	657	0.170	0.362	0.900	-0.900	0.808

[a]The conditioning set is described in Table A3. Bold coefficients are significant at the 5% level and italic indicates significance at the 10% level. * indicates that the family day care coefficient is statistically different from the preschool coefficient (5% level). Employing an F-test we reject the joint hypothesis that coefficients included in this table are equal. All results robust to clustering at the municipality level.

[b]No interactions with mother's level of education or gender as in Table 5

Another interesting question is whether parents should choose preschool over family day care, *given* that the child is not in parental care. If in fact the parametric linear model is correct and our conditional independence assumption holds true, we could easily answer this question and uncover (4) by comparing the two treatments in Table 6 above. Alternatively, one could restrict the sample to include only children in either family day care or preschool. This is our next step. Table 7 below

shows both the results from using OLS and our IV results exploiting municipality level variation in guaranteed access to preschool (*GAPS*).

Consider first the results from OLS. Note that if our conditioning set does a poor job explaining the selection out of home care, we will expect the effects of preschool relative to family day care to differ in Tables 6 and 7, which is not the case. Thus so far, there does not seem to be evidence that our conditional independence assumption is violated. Overall, children benefit from being enrolled in preschool relative to family day care. In particular boys born to mothers with vocational degree seem to benefit, though the effect is only significant at the 10% level. The only group for whom the estimated average effect is positive is that of girls born to mothers with higher education. They actually show *worse* behavior when enrolled in preschool and the estimated effect is fairly large (about 1.4 SDQ points). Thus, at least for these children, it seems that exposure to a larger and possibly more diverse group of peers is harmful in terms of behavior. This is actually also present in Table 6 above.

Consider next the results from estimating (4') using 2SLS. Firstly, note that the instrument is highly significant in all regressions[23] and works in the expected direction. We see that, qualitatively, the conclusions from our regression analysis are largely confirmed: preschool participation significantly improves child outcomes for the entire sample, though only at the 10% level. Allowing these effects to vary across gender and according to mother's level of education demonstrates again that this is driven by the group of boys born to mothers with vocational degree. The effect of preschool enrolment for the group of girls born to mothers with higher education is still positive and large but no longer significant. In fact, the size of all the parameter estimates is large when compared to the OLS analyses from above. Remember, though, that we are identifying off of a different population, namely the group of compliers. In addition, all standard deviations are large.[24]

[23] The t-statistic to the instrument is 11.00 in the regression using the entire sample and around 4 in all sub-population regressions. Staiger and Stock (1997) suggest as a rule of thumb that the t-statistic should be above $\sqrt{10}$.

[24] Interestingly, neither mother's level of education nor the gender dummy is significant in the first stage from the pooled model. Similarly, the coefficients to the instrument in the first stage across models are very similar and not statistically significantly different. This would have been the implication from selection based on expected gains.

TABLE 7

OLS AND IV ESTIMATES[a]

OUTCOME: SDQ, MUNICIPALITY PROVIDED PRESCHOOL VS. FAMILY DAY CARE

				OLS		IV			
	Mean SDQ	# Obs	R^2	Preschool		First Stage		Preschool	
				Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Children in municipality provided care[b]	6.55	4022	0.112	**-0.421**	0.213	**0.137**	0.027	*-2.533*	1.330
Girls of mothers with high school or below	6.85	593	0.167	-0.392	0.549	**0.164**	0.043	-3.598	3.237
Boys of mothers with high school or below	8.00	684	0.225	-0.952	0.632	**0.106**	0.040	2.058	4.845
Girls of mothers with vocational degree	6.40	743	0.100	-0.393	0.491	**0.134**	0.040	3.046	2.982
Boys of mothers with vocational degree	7.12	796	0.128	*-0.895*	0.537	**0.132**	0.034	**-7.397**	3.024
Girls of mothers with higher education	4.81	570	0.141	**1.378**	0.570	**0.121**	0.035	3.617	3.892
Boys of mothers with higher education	5.53	622	0.167	-0.490	0.515	**0.125**	0.039	-5.263	3.915

[a]The conditioning set is described in Table A3. Bold coefficients are significant at the 5% level and italic indicates significance at the 10% level. All results robust to clustering at the municipality level.

[b]No interactions with mother's level of education or gender as in Table 5

Effects of hours in care

Finally, we consider the effects of hours per week in family day care (5) and preschool (6) conditional on choosing a specific type of municipality provided care. We split hours in care into six categories: 10 hours or less, 10-20 hours, 20-30 hours, 30-40 hours, 40-50 hours, and above 50 hours. Unfortunately, because we are performing comparisons at the margin (comparing, for example, the group of children spending 20-30 hours in family day care with those spending 30-40 hours), the size of our data set does not allow us to construct estimates specific to gender and mother's level of schooling while maintaining power. Also, to the extent that children who spend plus-minus ten hours in a given type of care are different (or have different parents) in a way that is unobservable to us, the estimates may be biased, but the sign of the bias is unclear see discussion on page 27.

Table 8 below shows the results. We see that increases in hours from 0-10 to 10-20 and 10-20 to 20-30 are benign, no matter the choice of care. This is maybe not surprising since spending less than 30 hours in non-parental care allows for significant time both with the parents and with peers. Further increasing hours, however, seems to significantly worsen child outcomes, and this is significant in the case of preschool. Note that the size of the intensity effects in family day care correspond to those of preschool, but the low sample sizes in the former are plausibly the reason for their lack of significance.

TABLE 8

EFFECTS OF HOURS IN CARE[a]

OUTCOME: SDQ, MUNICIPALITY PROVIDED PROGRAMS

	Mean SDQ	# Obs	R^2	Family Day Care Coefficient	Family Day Care Std. Error	Mean SDQ	# Obs	R^2	Preschool Coefficient	Preschool Std. Error
10-20 hours vs. 0-10 hours				•	•	6.55	85	0.766	1.601	2.503
20-30 hours vs. 10-20 hours	6.45	124	0.697	-3.272	2.215	5.77	671	0.208	-0.476	0.600
30-40 hours vs. 20-30 hours	6.48	521	0.276	0.385	0.519	6.26	2383	0.128	**0.812**	0.222
40-50 hours vs. 30-40 hours	6.82	671	0.225	0.667	0.415	6.66	2507	0.119	**0.537**	0.223
Above 50 hours vs. 40-50 hours	7.36	267	0.328	3.389	4.102	7.20	751	0.161	0.525	1.394

[a]The conditioning set is the same as that of Table 5. Bold coefficients are significant at the 5% level and italic indicates significance at the 10% level. All results robust to clustering at the municipality level.

Sensitivity analyses

One might hypothesize that labor markets in larger cities are different from those of the provinces, and that this may affect child care policies as well. For example, the county of Copenhagen that includes the Danish capital and largest city with 500,000 inhabitants has implemented different child care policies compared to the rest of the country. We therefore re-estimate all models above excluding the county of Copenhagen. All results are robust to this. Secondly, dropping particularly disadvantaged children from the sample: children who have not been breast fed, children who have low birth weight, children who are physically disabled, immigrants and children brought up in single parent households renders our results unchanged. Thirdly, since having older siblings (aged 4-6) enrolled in either family day care or preschool allows a younger child to jump waiting lists, and one may worry that conditioning on sibling information do not sufficiently account for this, we exclude the part of the sample with siblings in the 4-6 age range. Again, parameter estimates are robust, though levels of significance are affected slightly because the sample is reduced considerably. Fourthly, we exclude lagged endogenous variables (parental employment after birth but before age three, number and type of prior care facilities, had a child care arrangement at age six

months, on waiting list at age six months) because they may introduce endogeneity bias. Our results are completely robust to this exercise. All results are available on request.

7. Discussion

This paper provides important new evidence on the effects on non-cognitive child outcomes of being enrolled in publicly provided care compared to home care. We use a longitudinal survey of children born in 1995 that is linked to large administrative registers and exploit plausible exogenous variation in the take-up of preschool. We find that, on average, participating in non-parental care is neutral compared to home care. Distinguishing between different types of non-parental care demonstrates, however, that preschool and family day care result in very different outcomes compared to home care. Preschool, where children are met with highly qualified staff in environments that allow for specialization of labor is found to be as good as home care no matter the gender and mother's level of education. Family day care, on the other hand, seems to reduce non-cognitive skills for boys born to mothers with low levels of education.

All estimations suggest that preschool outperforms family day care for the overall population. This is largely driven by the group of boys born to mothers with a vocational degree. In fact, girls whose mothers have some higher education show worse behavior when enrolled in preschool. However, because especially our IV estimates on the subsamples are noisy because of small samples it is difficult in most cases to rule out either large positives or negatives.

Our findings are not fully in line with the rather sparse literature on large-scale child care programs such as Baker, Gruber, and Milligan (2008) for the province of Quebec. There are, however, good reasons for this. Firstly, their paper evaluates the transition from one regime to another. As such, the study provides crucial information about the costs of switching from one regime to another, but the effects of a transition may not be a good indicator of the effects of the end-regime. For example, in Quebec the number of slots is increased by 400% in three years, and though the staff:child ratios were only decreased slightly (1:8 to 1:10 for 4-5 year olds), the increase in slots generated huge demand for new staff and locations. Newly hired staff is likely to be less experienced and may also be drawn from the lower end of the skill distribution. Similarly, a large number of mothers are

induced by the policy change to participate in the labor market. As the Quebec program came on top of existing child care programs for disadvantaged children, the women impacted were middle class mothers, who, in many cases, would have stayed home in the absence of the program. This group may not be representative of the population in general, in terms of the care they would have provided their children compared to the quality of daycare the children received.

Our findings also contrast to the existing studies within the child development literature which argue that non-maternal care has negative effects on behavior, for example, Belsky et al. (2007) who report increased externalizing problems (aggression) at age 12 following greater exposure to center based care during early childhood. These purely observational studies typically do not model the non-random selection into different types and quality of care. Furthermore, it should be kept in mind that Danish preschools are much less teacher-directed and to a larger extent focuses on socialization compared to the typical US preschool (prekindergarten) program. This may explain the differences in the results on non-cognitive outcomes, see Stipek et al. (1998) and Magnuson et al. (2007).

Interestingly, our conclusions regarding differences in the effects on behavioral skills of participating in preschool compared to the more informal family day care for the group of children of low-skilled mothers resonate with the findings by Bernal and Keane (2008) who investigate *cognitive* skills and those of Havnes and Mogstad (2009) who focus on long-term outcomes and who also find that much of the positive effect of educational attainment stems from children of low-educated mothers. Of course, any gains from center-based care in terms cognitive and non-cognitive outcomes should be compared to adverse health outcomes associated with this type of care, see e.g. Gordon, Kaestner and Korenman (2007).

Given the limited evidence in this area more analyses are clearly required. It would be particularly interesting to further investigate the extent of heterogeneity in the estimated effects using larger samples. Future work might also consider other outcomes including measures of cognitive skills, social participation and risky behavior and ultimately also making clearer the links between the development of such skills and long-term labor outcomes.

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Appendix A

TABLE A1

SELECTED MARGINAL EFFECTS FROM PROBIT[a]

OUTCOME: *GAPS* (0/1)

Variable	Coefficient	Std. Error
Prior child care		
# prior non-parental care facilities	**0.042**	0.006
Preschool teachers	**-0.036**	0.005
Had child care arrangement at age six months	0.018	0.016
Waiting list in municipality at age six months	-0.008	0.018
Nursery 1997	**0.139**	0.030
Nursery 1998	0.030	0.021
Family Day Care 1997	**0.105**	0.028
Family Day Care 1998	**0.072**	0.022
Child characteristics		
Girl	-0.017	0.013
Birth month September		
Siblings	0.011	0.009
Birth weight (in 1000 grams)	0.001	0.011
# hospitalizations	-0.011	0.021
Physically disabled	-0.009	0.032
Full term birth	-0.010	0.013

[a]See Datta Gupta and Simonsen (2007) for detailed description of conditioning set. Bold coefficients are significant at the 5% level and italic indicates significance at the 10% level.

Table continued next page

TABLE A1 CNTD.

SELECTED MARGINAL EFFECTS FROM PROBIT[a]

OUTCOME: *GAPS* (0/1)

Variable	Coefficient	Std. Error
Mother's characteristics		
Age	-0.001	0.002
Vocational degree	0.019	0.016
Short tertiary	**0.047**	0.025
Medium or long tertiary	0.043	0.037
Labor market experience	-0.001	0.001
Degree of year employed in 1996	**-0.069**	0.031
Degree of year employed in 1997	-0.017	0.031
Degree of year employed in 1998	-0.011	0.026
Hourly wage 1995	0.000	0.000
Senior management level 1995	0.047	0.105
Higher management level 1995	0.004	0.034
Medium level employee 1995	0.001	0.026
Lower level employee 1995	0.008	0.020
Smoker	-0.003	0.015
Single	-0.019	0.035
Non-native speaker	0.029	0.055
Breast fed child in question	-0.007	0.031
Postpartum depression	-0.068	0.051
Father's Characteristics:		
Vocational degree	-0.004	0.016
Short tertiary	*-0.039*	0.022
Medium or long tertiary	*-0.047*	0.026
Labor market experience	-0.001	0.001
Leave	-0.005	0.016
Hourly wage 1995	0.000	0.000
Senior management level 1995	-0.025	0.040
Higher management level 1995	0.027	0.029
Medium level employee 1995	0.025	0.027
Lower level employee 1995	-0.004	0.018

[a]See Datta Gupta and Simonsen (2007) for detailed description of conditioning set. Bold coefficients are significant at the 5% level and italic indicates significance at the 10% level.

TABLE A2

LIST OF QUESTIONS USED TO CONSTRUCT THE SDQ INDEX[a]

Considerate of other people's feelings
Restless, overactive, cannot stay still for long
Often complains of headaches, stomach-aches or sickness
Shares readily with other children, for example toys, treats, pencils
Often loses temper
Rather solitary, prefers to play alone
Generally well behaved, usually does what adults request
Many worries or often seems worried
Helpful if someone is hurt, upset or feeling ill
Constantly fidgeting or squirming
Has at least one good friend
Often fights with other children or bullies them
Often unhappy, depressed or tearful
Generally liked by other children
Easily distracted, concentration wanders
Nervous or clingy in new situations, easily loses confidence
Kind to younger children
Often lies or cheats
Picked on or bullied by other children
Often offers help to others (parents, teachers, other children)
Thinks things out before acting
Steals from home, school or elsewhere
Gets along better with adults than with other children
Many fears, easily scared
Good attention span, sees work through to the end

[a]Parents answer "not true", "somewhat true", or "certainly true". See www.sdqinfo.com for the score sheets.

TABLE A3

DETAILED DESCRIPTION OF VARIABLES

Variable	Description	Source
Child Care at age three:		
Home care, H	Dummy for being taken care of by parents or grandparents at home	Danish Longitudinal Survey of Children
Municipality family day care, FC	Dummy for being enrolled in municipality provided family day care in 1999 (at age three)	Danish Longitudinal Survey of Children
Municipality preschool, PS	Dummy for being enrolled in municipality provided pre-school care in 1999 (at age three)	Danish Longitudinal Survey of Children
Municipality provided program, MP	Dummy for being enrolled in either municipality provided family day care or pre-school in 1999	Danish Longitudinal Survey of Children
Private care	Dummy for being enrolled in privately provided care in 1999 (at age three)	Danish Longitudinal Survey of Children
Other care	Dummy for being enrolled in other types of care in 1999 (at age three)	Danish Longitudinal Survey of Children
Hours in non-parental care	Number of hours per week in non-parental care	Danish Longitudinal Survey of Children
# prior non-parental care facilities	Number of different care facilities a child has been enrolled in before the current at age three	Danish Longitudinal Survey of Children
Preschool teachers	Number of pre-school teachers per 100 children enrolled (municipality level)	Statistics Denmark
Arranged for care at age six months	Dummy for having care arrangements at age six months	Danish Longitudinal Survey of Children
Waiting list in municipality at age six months	Dummy for being subject to waiting list for municipality provided child care at age six months (may occur even within *GAPS* municipality)	Danish Longitudinal Survey of Children
Nursery 1997	Dummy for being enrolled in nursery in 1997	Statistics Denmark Day care register
Nursery 1998	Dummy for beingenrolled in nursery in 1998	Statistics Denmark Day care register
Family Day Care 1997	Dummy for being enrolled in family day care in 1997	Statistics Denmark Day care register
Family Day Care 1998	Dummy for being enrolled in family day care in 1998	Statistics Denmark Day care register
Child Characteristics:		
Girl	Dummy for being a girl	Danish Longitudinal Survey of Children
Birth month September	Dummy for being born in September (all children born in either September or October)	Statistics Denmark
Siblings	Number of siblings	Statistics Denmark
Birth weight (in 1000 grams)	Birth weight in 1000 grams	Danish Longitudinal Survey of Children
# hospitalizations	Number of hospitalizations before age three	Danish Longitudinal Survey of Children
Physically disabled	Dummy for being physically disabled	Danish Longitudinal Survey of Children
Full term birth	Dummy for full term birth	Danish Longitudinal Survey of Children

Table continues on next page

TABLE A3 CTD.

DETAILED DESCRIPTION OF VARIABLES

Mother's Characteristics:		
Age	Mother's age in years	Statistics Denmark
High school or below	Dummy taking the value one if the mother has a high school degree or less education	Statistics Denmark
Vocational degree	Dummy taking the value one if the mother has a vocational degree	Statistics Denmark
Short tertiary	Dummy taking the value one if the mother has a short higher education (13-14 years)	Statistics Denmark
Medium tertiary	Dummy taking the value one if the mother has a medium high education (15-16 years)	Statistics Denmark
Long tertiary	Dummy taking the value one if the mother has a long higher education (17 years or more)	Statistics Denmark
Labor market experience	Mother's labor market experience before giving birth (1995) measured in years	Statistics Denmark
Degree of year employed in 1996	Fraction of year employed one year after giving birth	Statistics Denmark
Degree of year employed in 1997	Fraction of year employed two years after giving birth	Statistics Denmark
Degree of year employed in 1998	Fraction of year employed three years after giving birth	Statistics Denmark
Hourly wage 1995	Hourly wage in 1995	Statistics Denmark
Senior management level 1995	Mother employed at senior management level in 1995	Statistics Denmark
Higher management level 1995	Mother employed at higher management level in 1995	Statistics Denmark
Medium level employee 1995	Mother employed at medium level in 1995	Statistics Denmark
Lower level employee 1995	Mother employed at lower level in 1995	Statistics Denmark
Lowest level employee 1995	Father employed at lowest level in 1995	
Smoker	Dummy taking the value one if the mother is a smoker	Danish Longitudinal Survey of Children
Single	Dummy for being a single mother	Danish Longitudinal Survey of Children
Non-native speaker	Dummy for being a non-native speaker	Danish Longitudinal Survey of Children
Breast fed	Dummy for having breast fed child in question	Danish Longitudinal Survey of Children
Postpartum depression	Dummy for experiencing postpartum depression	Danish Longitudinal Survey of Children
Disposable income in 1996	Income after tax in 1996	Statistics Denmark
Disposable income in 1997	Income after tax in 1997	Statistics Denmark
Disposable income in 1998	Income after tax in 1998	Statistics Denmark

Table continues on next page

TABLE A3 CTD.

DETAILED DESCRIPTION OF VARIABLES

Father's Characteristics:		
High school or below	Dummy taking the value one if the father has a high school degree or less education	Statistics Denmark
Vocational degree	Dummy taking the value one if the father has a vocational degree	Statistics Denmark
Short tertiary	Dummy taking the value one if the mother has a short higher education (13-14 years)	Statistics Denmark
Medium tertiary	Dummy taking the value one if the mother has a medium high education (15-16 years)	Statistics Denmark
Long tertiary	Dummy taking the value one if the mother has a long higher education (17 years or more)	Statistics Denmark
Labor market experience	Father's labor market experience before giving birth (1995) measured in years	Statistics Denmark
Hourly wage 1995	Hourly wage in 1995	Statistics Denmark
Senior management level 1995	Father employed at senior management level in 1995	Statistics Denmark
Higher management level 1995	Father employed at higher management level in 1995	Statistics Denmark
Medium level employee 1995	Father employed at medium level in 1995	Statistics Denmark
Lower level employee 1995	Father employed at lower level in 1995	Statistics Denmark
Lowest level employee 1995	Father employed at lowest level in 1995	
Leave	Whether father took leave in connection with child birth	Danish Longitudinal Survey of Children

Table continues on next page

TABLE A3 CTD.

DETAILED DESCRIPTION OF VARIABLES

Municipality and Regional Characteristics:		
Region 1	Residing in county of Copenhagen, 1999	Statistics Denmark
Region 2	Residing in counties of Frederiksborg and Roskilde, 1999	Statistics Denmark
Region 3	Residing in counties of Western Sealand and Storstrøm, 1999	Statistics Denmark
Region 4	Residing in county of Fuen, 1999	Statistics Denmark
Region 5	Residing in counties of Southern Jutland and Ribe, 1999	Statistics Denmark
Region 6	Residing in counties of Vejle and Ringkøbing, 1999	Statistics Denmark
Region 7	Residing in counties of Aarhus and Viborg, 1999	Statistics Denmark
Region 8	Residing in county of Northern Jutland, 1999	Statistics Denmark
Unemployment rate	Share of unemployed among women in municipality, 16-49 years of age, 1999	Ministry of Interior
Single parent children	Share of single parent children 0-17 years old in municipality, 1999	Ministry of Interior
Asylum seekers	# of asylum seekers per 10,000 inhabitants in municipality, 1999	Ministry of Interior
Third world immigrants	# of third world immigrants per 10,000 inhabitants in municipality, 1999	Ministry of Interior
Social Democrats	Largest party in 1997 municipality election is social democrats	Statistics Denmark
Conservatives	Largest party in 1997 municipality election is conservatives	Statistics Denmark
Liberals	Largest party in 1997 municipality election is liberals	Statistics Denmark
Child families	Share of families with children among all households within municipality	Statistics Denmark

TABLE A2

MEANS OF SELECTED VARIABLES BY MODE OF CARE[a]

	Home		Preschool		Family Day Care	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Child Care at age three:						
Hours in non-parental care	4.41	11.88	**33.02**	7.14	**34.37**	7.21
# prior non-parental care facilities	1.82	0.87	**2.75**	0.80	**1.95**	0.71
Preschool teachers	16.21	4.51	**17.23**	2.57	**16.75**	3.54
Arranged for care at age six months	0.29	0.45	0.32	0.47	**0.34**	0.47
Waiting list in munipality at age six months	0.16	0.37	**0.22**	0.41	0.20	0.40
Child Characteristics:						
Girl	0.47	0.50	0.48	0.50	0.49	0.50
Birth month September	0.37	0.48	0.39	0.49	0.34	0.47
Siblings	1.04	1.03	**0.77**	0.83	**0.81**	0.85
Birth weight (in 1000 grams)	3.48	0.65	3.50	0.60	3.53	0.58
# hospitalizations	0.89	0.32	0.88	0.32	0.91	0.28
Physically disabled	0.02	0.13	**0.04**	0.19	**0.04**	0.20
Full term birth	0.45	0.50	0.45	0.50	0.46	0.50
Mother's Characteristics:						
Age	27.84	4.90	**28.37**	4.61	28.23	4.34
Vocational degree	0.33	0.47	**0.37**	0.48	**0.42**	0.49
Short further	0.14	0.35	**0.23**	0.42	**0.20**	0.40
Long further	0.04	0.21	**0.07**	0.26	0.05	0.21
Labor market experience	6.19	5.88	**7.37**	5.81	**7.15**	5.50
Degree of year employed in 1996	0.40	0.35	**0.55**	0.35	**0.57**	0.34
Degree of year employed in 1997	0.44	0.42	**0.64**	0.40	**0.65**	0.39
Degree of year employed in 1998	0.46	0.43	**0.67**	0.39	**0.70**	0.38
Hourly wage 1995	129.17	59.87	**134.42**	73.93	127.34	60.72
Senior management level 1995	0.00	0.04	**0.01**	0.07	0.00	0.05
Higher management level 1995	0.06	0.23	**0.10**	0.30	0.07	0.26
Medium level employee 1995	0.12	0.33	**0.21**	0.41	**0.17**	0.38
Lower level employee 1995	0.33	0.47	0.34	0.47	**0.40**	0.49
Smoker	0.34	0.47	**0.30**	0.46	0.31	0.46
Single	0.06	0.24	**0.04**	0.19	**0.02**	0.15
Non-native speaker	0.03	0.17	**0.02**	0.13	**0.00**	0.07
Breast fed child in question	0.95	0.22	0.96	0.20	0.95	0.21
Postpartum depression	0.01	0.11	0.01	0.10	0.01	0.10
Income 1996 (1,000 DKK)	111	33	**118**	35	**119**	36
Father's Characteristics:						
Vocational degree	0.42	0.49	0.43	0.50	**0.50**	0.50
Short further	0.11	0.32	**0.15**	0.36	0.13	0.33
Long further	0.06	0.24	**0.10**	0.30	0.06	0.23
Labor market experience	10.48	5.79	**11.11**	5.73	**11.35**	5.41
Hourly wage 1995	158.93	53.48	**171.22**	87.75	**166.60**	75.64
Senior management level 1995	0.01	0.11	**0.03**	0.18	0.02	0.13
Higher management level 1995	0.09	0.28	**0.14**	0.35	0.09	0.28
Medium level employee 1995	0.09	0.29	0.12	0.32	0.09	0.28
Lower level employee 1995	0.39	0.49	0.40	0.49	**0.47**	0.50
Leave	0.13	0.34	**0.25**	0.43	**0.19**	0.39

[a]Bold coefficients indicate that means are significantly different (at the 5% level) from those of home care

Appendix B

This appendix extends the monotonicity assumption of Angrist and Imbens (1994) to cover the case with three treatments: home, *H*, family day care, *FC*, and preschool, *PS*. Specifically, we are interested in uncovering the following LATE ((4) from Section 6):

$$E\left[SDQ_2 - SDQ_1 \mid PS(GAPS) - PS(no\ GAPS) = 1, H = 0\right].$$

To establish the extended version of monotonicity assumption, the following indicators turn out to be useful:

$$D^1 = \begin{cases} 0\ DC \\ 1\ PS \end{cases}$$
$$D^2 = \begin{cases} 0 & H \\ 1\ PS\ or\ DC \end{cases}$$

Our instrument is the binary variable guaranteed access to preschool, *GAPS*. As in Angrist and Imbens (1994), we allow the outcomes of D^1 and D^2 to depend on the realization of *GAPS*: $D^1(GAPS)$ and $D^2(GAPS)$. Similarly, child outcome *SDQ* is (at the outset) allowed to depend on D^1, D^2, and *GAPS*: $SDQ(D^1, D^2, GAPS)$.

We assume that SUTVA and random assignment holds and make the following exclusion restriction:

$$SDQ\left(D^1, D^2, GAPS\right) = SDQ\left(D^1, D^2, GAPS'\right) \quad \forall\ GAPS, GAPS'\ and\ \forall\ D^1, D^2.$$

Thus,

$$SDQ\left(D^1, D^2\right) = SDQ\left(D^1, D^2, GAPS'\right) = SDQ\left(D^1, D^2, GAPS\right).$$

Furthermore, we assume a nonzero average causal effect of *GAPS* on D^1:

$$E\left[D^1(1) - D^1(0)\right] \neq 0.$$

Finally, we maintain the monotonicity assumption from Angrist and Imbens (1994) that

$$D^1(0) \leq D^1(1)$$

for all individuals in the population and extend with the assumption that

$$D^2(0) = D^2(1) = 1$$

for all individuals for whom we observe $D^2=1$.

Now we can show that the IV estimand

$$\frac{E\left[SDQ_i\left(1, D_i^1(1), D_i^2(1)\right) - SDQ_i\left(0, D_i^1(0), D_i^2(0)\right) \mid D_i^2 = 1\right]}{E\left[D_i^1(1) - D_i^1(0) \mid D_i^2 = 1\right]}$$

converges towards our parameter of interest from above. Consider first the nominator:

$$\begin{aligned}
&\left[SDQ_i\left(1, D_i^1(1), D_i^2(1)\right) - SDQ_i\left(0, D_i^1(0), D_i^2(0)\right) \mid D_i^2 = 1\right] \\
&= \left[SDQ_i\left(D_i^1(1), D_i^2(1)\right) - SDQ_i\left(D_i^1(0), D_i^2(0)\right) \mid D_i^2 = 1\right] \\
&= \left\{SDQ_i(1,1) D_i^1(1) D_i^2(1) + SDQ_i(0,1)\left[1 - D_i^1(1)\right] D_i^2(1) \mid D_i^2 = 1\right\} \\
&- \left\{SDQ_i(1,1) D_i^1(0) D_i^2(0) + SDQ_i(0,1)\left[1 - D_i^1(0)\right] D_i^2(0) \mid D_i^2 = 1\right\} \\
&= \left\{\left[SDQ_i(1,1) - SDQ_i(0,1)\right]\left[D_i^1(1) D_i^2(1) - D_i^1(0) D_i^2(0)\right] \mid D_i^2 = 1\right\} \\
&- \left\{SDQ_i(0,1)\left[D_i^2(1) - D_i^2(0)\right] \mid D_i^2 = 1\right\} \\
&= \left\{\left[SDQ_i(1,1) - SDQ_i(0,1)\right]\left[D_i^1(1) - D_i^1(0)\right] \mid D_i^2 = 1\right\}
\end{aligned}$$

The first step uses our exclusion restriction, while the last employs our extension to the monotonicity assumption. Using standard monotonicity, we get

$$\begin{aligned}
&E\left[\left\{\left[SDQ_i(1,1) - SDQ_i(0,1)\right]\left[D_i^1(1) - D_i^1(0)\right] \mid D_i^2 = 1\right\}\right] \\
&= E\left[SDQ_i(1,1) - SDQ_i(0,1) \mid D_i^1(1) - D_i^1(0) = 1, D_i^2 = 1\right] P\left[D_i^1(1) - D_i^1(0) = 1 \mid D_i^2 = 1\right]
\end{aligned}$$

It is straightforward to show that

$$E\left[D_i^1(1) - D_i^1(0) \mid D_i^2 = 1\right] = P\left[D_i^1(1) - D_i^1(0) \mid D_i^2 = 1\right],$$

which gives us our result.

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