

Day-Care Attendance And Child Development: In How Far Does The Quality Matter?

Drs. Robert Bauchmüller¹

Graduate School of Governance, Maastricht University

Dr. Mette Gørtz

AKF Danish Institute of Governmental Research

Dr. Astrid Würtz Rasmussen

Aarhus School of Business, Aarhus University

– January 2010 –

(This paper reflects work in progress; please do not quote without permission!)

Abstract

Earlier research suggests that children's development is shaped in their early years of life. This paper examines whether differences in day-care experiences during pre-school age are important for children's cognitive and language development at the age of 15. The analysis is based on class performance at the end of elementary schooling. We assess the effects of attended types and qualities of day-care institutions on various child outcomes as measured by school grades in mathematics, science, English and Danish for the whole Danish population as well as outcomes from the 2006 PISA Denmark survey and a 2007 PISA Copenhagen survey. We use administrative registries to generate indicators such as child-staff ratios, child-pedagogues ratios, and the share of male staff and of staff with non-Danish origins. Furthermore, we use information on the average levels of educational attainments, of total work experiences, ages and hourly wages of staff members. Those indicators show the expected correlations with children's development outcomes, better day-care quality being linked to better child outcomes ten years later. We use rich administrative information about the children's background as well as an instrumental variable approach based on wider geographic area aggregates to test whether those correlations reveal unbiased causal effects. The identification of truly effective quality characteristics of day-care centres enhances policymakers' resource allocation to make all children getting ready for school. [An initial focus on Danish final exam scores of 2008 for children, who attended day-care in 1995-1998 reveals a small but significant negative effect of a bigger number of children per day-care staff member.]

¹ Correspondence contact: Maastricht University, Graduate School of Governance, Postbox 616, 6200MD Maastricht, The Netherlands. E-mail: robert.bauchmuller@maastrichtuniversity.nl

1 INTRODUCTION

Most developed countries have extended their early childhood care and education (*henceforth abbreviated as ECCE*) coverage in recent years, not only to boost maternal employment but also to stimulate child development for disadvantaged children. Researchers from diverse fields within the social sciences and child development studies are increasingly acknowledging the importance of early childhood interventions in the form of day-care and pre-school education for enhancing children's development of cognitive and non-cognitive abilities and health conditions. According to this line of research, one way to disrupt the cycle of negative social heritage is to give children from all backgrounds access to high-quality ECCE to foster the development of valuable academic and social skills. Early investments have important multiplier effects on later development stages (Cunha, Heckman, Lochner, & Masterov, 2005).

However, an opposing view in the child development literature points out that family background and not school quality would be the most important determinant of early formation of skills and later human capital development and that boosting disadvantaged families' income would be the way to ensure that all children get a good and equitable start in life. The discussion follows the rich but still indecisive studies of the impact of school quality on earnings. Empirical evidence on the effectiveness of public investments in early childhood care and education institutions as well as family income transfers is of relevance for policymakers. Do early childhood interventions show the desired effects on children's cognitive and non-cognitive skills - making them ready for school and integrating those who grow up in underprivileged conditions? Esping Andersen (2006) argues that the assurance of quality ECCE could be the single most effective policy of homogenizing early childhood investments. Early childhood care and education investments are suspected to be an important factor in reducing inequalities in educational attainments and hence to contribute to reducing inequality of incomes (Esping Andersen, 2004).

While many countries have recently started to extend their ECCE provisions to cover more children and earlier ages, Denmark has been a good example of a country with extensive ECCE provisions already in the 1990s. The OECD's Family Database (2007a; 2007b) shows that, in comparison to other OECD countries, Denmark has had high quality ECCE institutions, high ECCE expenditure levels per capita, generous family-friendly schemes, substantial public investments in early childhood provisions, high requirements for staff qualifications, and a low number of children per staff member. The high-quality of services has been associated with Denmark's high degree of maternal employment and Europe's highest attendance rates of early childhood care and education arrangements - already at the early age of 1. High subsidies have been available, reducing the link between parental income and access to early childhood care and education. Despite the wide coverage of ECCE provisions in the 1990s, the variety in qualities of such provisions had been substantial. A large mix of early childhood care and education arrangements had been made available to serve the growing ECCE market. Each pre-school has been relatively independent in formulating their own pedagogical education plan based on specific

pedagogical principles and goals. And municipalities have had a high degree of autonomy in the decision of how to organize and allocate resources to ECCE institutions. Municipalities have been in charge of quality control.

Little is known yet about which pre-school quality characteristics are most beneficial for children. Furthermore, do disadvantaged children benefit over-proportionally? We will study such interaction effects of quality characteristics across subgroups such as boys versus girls, low versus high educated parents, native versus foreign origins etc. International and Danish evaluation studies of ECCE effects have been limited with respect to available information on the quality of attended services. Within this small but growing research field, the primary focus has been to evaluate whether access to any early childhood care and education attendance by type improves child outcomes. This paper extends the literature on ECCE arrangements in pre-school age by taking a closer look at the variation in child outcomes across pre-schools. And it adds to the scarce empirical evidence on outcomes of the Danish system, as an example of the often cited extensive early childhood care services in Scandinavian countries.

Despite few evaluation studies on short-term effects of such early childhood care (cf. Datta Gupta & Simonsen, 2007; Jensen, 2009), there has been little evidence available yet of long-term effects that last until the age of about 15 years or beyond. However, this age is crucial for the later performance in higher education and the labour market evidence. We provide new evidence for the impact of early investments on cognitive abilities at this crucial age, by studying PISA test scores taken at the age 15 and test grades from final assessments in the 9th grade of elementary schools (*Folkeskole*) as a child outcomes.

The paper combines insights from the literature on cognitive and non-cognitive development in ECCE arrangements in general with the growing literature on heterogeneity in pre-school quality measured through its impact on child cognitive (and non-cognitive) outcomes in the long-term. We estimate the effects of the variation in Danish day-care provisions on child educational outcomes. Therefore we address the following questions: In how far does the day-care experience of children in the mid 1990s vary in terms of quality? In what way do children aged 15 vary in terms of their development? Can differences in child outcomes be causally related to different qualities of day-care experiences? With day-care we refer to preschool (*børnehaver*) and age-integrated day-care (*aldersintegrerede institutioner*) provided to children at preschool ages of three to six years.

A revision of the literature on early childhood interventions is followed by a description of the Danish day-care provisions and the data that we have available to study them. We elaborate then on the applied quality indicators children per staff member, share of male staff and average education level of the staff and put forward how we want to study the effects of those quality factors on the child outcomes, with a reference to a possible instrumental variable approach [that will be included into the paper at a later stage]. Finally, we present and discuss the results of our estimation of a number of model specifications and close concluding remarks.

2 EARLY CHILDHOOD INTERVENTIONS REVISITED

The literature on the effects of the length and quality of education has grown substantially, facilitated by ever richer micro datasets and improved evaluation methods. The limitation of such data has, until recently, also prohibited the extension of the education evaluation literature to the study of early childhood interventions. At the same time, the literature on the economics of education has come to a focus on the contribution to cognitive and intellectual development of individual schools and teachers (cf. Heckman, 2008; Machin, McNally, Kramarz, & Quazard, 2006; Rivkin, Hanushek, & Kain, 2005). This literature emphasizes that only a fraction of the variation across schools can be explained by observable characteristics of the schools, whereas much of the heterogeneity is due to unobserved factors as e.g. the values and the quality of the management of the school, peer effects from other children at the school etc.

Todd and Wolpin (2003) formulate production function types of models of early child development (up to about 8 years of age) and child development at older ages (often around school-leaving age) taking both family and school inputs into account. These models all focus on children's cognitive achievement. Their general model of the school-quality-achievement relationship stipulates that achievement at the time of school entry depends only on family inputs and ability. Achievement at the start of the second year of school depends on the entire history of family inputs, school inputs and endowments (ability). The model specifies the decision rule for family inputs based on the achievement gains of the child, the family's permanent resources, the child's ability as well as the gains from schooling. The simplest specification of the model is the *contemporaneous specification* in which only contemporaneous inputs matter for child outcomes. A more realistic and general specification is the *value-added specification* in which the authors add a lagged baseline achievement measure. The latter measure is assumed to be a sufficient statistic for unobserved input histories and endowments. They use this model to evaluate the value-added in terms of child achievement of e.g. an exogenous change in class size or other changes in school inputs.

According to this 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 Heckman (2008) or Ruhm (2005) for a sketch of such a production function approach. Heckman (2008) formulates a technology for the production of non-cognitive and cognitive skills. Empirical applications of this model are used to test effects of inputs (from family or others) into the child development production function. Heckman (2008) emphasizes that there is considerable heterogeneity in child outcomes already in early childhood and that much of this heterogeneity can be explained by environmental factors such as family background. He argues that participation in targeted high-quality programs is beneficial for disadvantaged children. Currie (1993) stresses that such early interventions can be considerably more effective than giving families of disadvantaged children unrestricted cash transfers.

Furthermore, recent theoretical studies on child development and child outcomes suggest that skills beget skills and capabilities foster future capabilities through self-productivity and dynamic-complementarities. That is, higher stocks of skills in one period create higher stocks of skills in the next period, and stocks of skills acquired in one period make investment in future periods more productive (Cunha & Heckman, 2007; Heckman, 2008). Thus, early investments in children are often most fruitful and even more so if they are followed up by later investments, but this depends on the exact technology of skill formation. Cunha and Heckman (2007) demonstrate that some periods may be more effective in producing certain skills (sensitive periods), but it may also be the case that only one period is effective in producing a certain skill (critical period). For example, the early childhood is considered as a sensitive period for language acquisition and a critical period for brain development. Knudsen et al. (2006) conclude that interventions aimed at improving the situation for disadvantaged children should start as early as possible when the brain structure is more plastic. This is especially important because early learning is crucial for later learning (Heckman, Krueger, & Friedman, 2002).

The literature on early interventions emphasizes the importance of child development in early childhood for long-term outcomes, both cognitive-intellectual and non-cognitive, psycho-emotional and social abilities, cf. Heckman, Stixrud & Urzua (2006). Such long-term outcomes can be measured at adolescence, for example, in high-school enrolment and crime rates, health statistics, early pregnancies, job aspirations etc. Distant long-term outcomes can be measured in terms of labour market success, career outcomes, life expectancy etc. Evidence on ECCE effects on those outcomes, in particular longer term outcomes, is still scarce and often not valid across countries. Reynolds (1993) has argued that gains from pre-schooling experiences could fade out throughout later schooling, especially, if no sufficient continued support for children at risk would be assured. There have been only few studies looking at the long-term outcomes of pre-school attendance, but they by and large do not support Reynold's thesis. The evidence on long-term effects and possible fading out signs of early gains is still limited (Barnett, 1992; 1995). However, high quality and intensity of pre-schooling as in the case of Denmark suggest that early gains are likely to be preserved.

Schweinhart & Weikart (1981) examined the results of the Perry pre-school programme, a longitudinal experiment of an early educational intervention on children at risk. The two-year half-day pre-school programme was randomly assigned to a group of 65 African American 4-6 year old children of a full-sample of 123 children from 100 families between 1962 and 1967. Schweinhart & Weikart's evaluation of child outcomes at the age of 15 showed that children had persistent lower probabilities of being placed in special education and delinquent behaviour, and increased scholastic achievement and motivation for schooling and homework if they had attended Perry pre-schooling. A sensitivity analysis of those effects by Heckman et al. (2009) accounts for compromises that occurred in the randomization protocol returns. Still, the benefit estimates of the Perry programme remain statistically significant for both males and females and returns are shown to be above the historical return on equity.

Another well-known example of randomized social experiments is the Abecedarian programme in Chapel Hill, North Carolina. Children aged four months to five years, born in between 1972 and 1977, were selected randomly from a sample of 111 children in 109 families to follow a full-day programme. Follow up observations were carried out on the randomized treatment and control group until the age of 21 years. Campbell & Ramey (1995) have shown that attendance in the Abecedarian programme has shown similar positive effects in particular on cognitive child outcomes at ages 15. Despite a more extensive list of such studies of long-term outcomes of pre-school experiences for the Anglo-Saxon countries, there is still rather little evidence on effects of ECCE investments for other OECD countries.

Despite the evaluations of small scaled programmes, the international economic literature on day-care and child outcomes has also studied whether access to universal day-care improves child outcomes. These papers have typically made use of the introduction or expansion of day-care regimes. Baker, Gruber and Milligan (2008) evaluate a large scale change in the child care system in Quebec, Canada in the late 1990s. The policy change implied universal access to full-time child care for 0-4 year old children and an increase in the quality of care by raising formal qualifications of caregivers. Moreover, the out-of-pocket price for child care could not exceed \$5 per day. The oldest children (age 2 and older) typically entered centre-based care, whereas the younger children were placed in home-based care with a regulated provider. The authors neatly explore before-after Quebec-versus-other regions variation and find, that the effects of the transition to a regime with large-scale highly-subsidized child care on behavioural and motor-social skills at ages 0-4 are clearly negative. Due to the lack of data on these children at older ages, it cannot be investigated whether the negative effects are only short-run effects or whether they translate into long-run negative effects.

Few papers have considered the issue of the quality of care. Gregg et al. (2003), Bernal and Keane (2006), Waldfogel et al. (2002) and Datta Gupta and Simonsen (2007) are some exceptions, but all these papers measure quality as differences between types of care, i.e. formal centre-based care vs. informal private care, because they lack data on the actual parameters which can directly measure the quality of the care received by individual children across different pre-schools. Bernal & Keane (2006), using the National Longitudinal Survey of Youth, covering children born 1979, distinguish between different types of care; they investigate the effect on cognitive ability of participating in formal care (centre-based care and pre-school) 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.

Exploiting variation in access to different types of care across municipalities, Datta Gupta & Simonsen (2007) investigate the relationship between type and intensity of mode of day-care at the age of 3 and non-cognitive abilities when the children are 7 years of age. They analyze behaviour and abilities in a group of children that were taken care of at home versus children cared for in pre-school and private day-care. They find no significant differences in non-

cognitive skills when comparing children who attended pre-school versus children cared for at home. However, they find that private day-care seems to be negatively related to non-cognitive abilities for boys born by mothers with a low level of education. Moreover, the intensity of child care is important. An increase in the time a child spends in family day-care (from 30-40 hours to 40-50 hours per week) and pre-school (from 20-30 hours to 30-40 hours per week) has a significantly negative effect on child outcomes.

Gregg et al. (2005) show that formal care does not have adverse effects on child development. They also conclude that high quality centre-based care may neutralize potentially negative effects of maternal employment. On the contrary, the study by Blau (1999) suggest that on average, day-care characteristics have little association with child development.

The theoretical literature claims that early high quality investments are boosting child development, leading to better long term outcomes. Nonetheless, the evidence is still insufficient to support those claims, mainly due to data limitations. While there is some evidence for the more targeted investments on the disadvantaged children, there is little know yet about whether such effects can also be found for universal high quality day-care investments as there are in Denmark.

3 DANISH DAY-CARE PROVISIONS

In the mid-990s nearly two thirds of children at the age of 3 attended day-care in preschool or age-integrated institutions. Of the roughly 65,000 children of each birth cohort born in 1998 about 42% attended preschools (*'børnehaver'*) and about 26% age-integrated institutions (*'aldersintegrede institutioner'*). By international standards, this is a very high share. Today those figures are even higher; by 2004 94% of 3- to 6-year-old children were enrolled in a centre-based early childhood care or education centre. When children are 4 years old, 58% of those children attend a preschool and 33% go to age-integrated day-care centres (OECD Family Database, 2007). In the age group of 5-7 year old children, 98% are enrolled in a free kindergarten class in elementary school (*'Folkeskole'*). Centre-based care is usually available between 6.30 and 17.00, wrap around care is provided in fee-paying, integrated services or leisure-time facilities or in more flexible family-care arrangements. Moreover, there are 15-hours-per-week programmes for bilingual children who are not attending the day-care system yet.

Table 1: Child and day-care population

1998	Preschools		Age-integrated institutions		Child population
0 year	64	0.09%	1217	1.80%	67642
1 year	188	0.28%	8126	11.93%	68130
2 years	1860	2.63%	11663	16.47%	70834
3 years	30019	42.28%	20071	28.27%	71000
4 years	39146	56.99%	22025	32.07%	68686
5 years	40720	58.78%	21334	30.79%	69281
6 years	7873	11.90%	9679	14.63%	66139
7 years	191	0.29%	6504	9.94%	65440

Source: (Statistics Denmark, 1995-1998; figures per 01.01.1998)

Danish day-care provisions are voluntary but attended at large scale already 6-12 months after birth. In the 1990s municipalities extended their guarantees for a place in day-care so that today parents have the right to a place for their child in municipal day-care as of the moment when their child turns one year. Those guarantees have led to a substantial increase in the attendance of day-care centres, in particular for the age group below three years, and those attending age-integrated institutions or being cared for by municipal child minders. Parents can prioritize their preferred day-care institution among the day-care institutions in the municipality. However, once they limit their choice to a specific institution, parents usually forgo the right to a guaranteed day-care place and thus might have to wait quite long for a day-care place.

About 70% of Danish day-care facilities are operated by public and community services. Public provisions are supplemented by independent, non-profit providers and networks (about 30% of the market). Municipalities are in charge of allocating children to public day-care institutions. Parents have the right to a day-care place for their child. However, some centres have longer waiting lists. As excess supply is costly, municipalities try to distribute children so as to fill all centres. The position on the waiting list determines the access probability to a particular institution. Children with specific needs may jump the waiting list, and it is prioritized that younger siblings are enrolled in the same institution as their older sibling. Parents have some choice with respect to pre-selecting some preferred day-care centres. However, a municipal authority does the final allocation, which implies, to some degree, a mechanism that is unrelated to the individual parental choices. Furthermore, day-care fees are lower for siblings, and low-income parents can pay a lower fee than the normal parental fee for day-care.

The ambition to enhance day-care quality has been reflected in the harmonization of quality standards since the mid 1990s as well as in the recent policy of mandatory pedagogical education plans (*'pædagogiske læreplaner'*) which all pre-schools (*'børnehaver'*) are required to formulate, either independently or inspired by municipality level guidelines and principles. These plans explain in detail how each institution plan to shape their pre-school offering in order to enhance cognitive as well as non-cognitive skills. The overall aim of these quality related policies has been to emphasize the role that pre-schools play in preparing children for starting school. It is also meant as a tool to monitor the sector.

Across municipalities, there are relatively large differences in the resources spent on child care, including pre-school. Also, there are within-municipality differences across pre-school institutions in terms of pedagogical principles and aims, characteristics of the staff including e.g. level of education, experience, seniority, absence due to illness, the share of male teachers and quality of management, as well as peer group composition. There are substantial differences across pre-schools with respect to sickness absence among the personnel and general teacher turnover (Gørtz & Andersson, 2009). Thus, relatively large differences exist across institutions and municipalities regarding the options and possibilities offered to children and their families. The harmonization of Danish day-care quality standards started only in the mid 1990s; thus the quality variation at the pre-school level has still been high for the studied cohorts. However, in this time period there has been a significant use of informal care which is usually less monitored and regulated than formal care.

Despite the large coverage of day-care attendance, there has been, particularly in the beginning of the 1990s, an unequal distribution of endangered children between different preschools as well as between municipalities (Bryderup, 2003; Thyssen, 1991). Problems with larger inequalities in child development and in the opportunities of children are concentrated in bigger cities². Social segregation across day-care centres might increase inequality (Bryderup, 2003), but the early childhood interventions at such centres are at the same time regarded as having the potential to compensate inequality (Janet Currie, 2000; Reynolds, 1993). A crucial question is whether those children who are most in need of early childhood interventions are actually reached, whether the targeting of stimulation funds is successful. However, there is still little known about the efficiency in reaching the target population and whether the targeted interventions are effective.

4 DATA

Our data is primarily drawn from administrative register data in Statistics Denmark which is a genuine longitudinal data set (or panel data). The registers are comprehensive covering topics like socioeconomic status, education history and education level, employment and experience in the labour market, income and transfer income, country of birth and persons in living in the household etc. Most variables in the registers are available once a year in the period 1981-2007.

Apart from the general register data, we profit from the day-care institution register, which provides information about children in day-care by CPR-code since the year 1995. Statistics Denmark has developed a special procedure for linking the register's work place codes with the institution codes of the Day-care institution register (cf. Elwerts, 2009; Gørtz & Andersson, 2009). By international standards, this dataset is quite unique, since children and staff in day-care institutions are linked at the institution level. Those registers cover about 95% of municipalities, of which 93% reported figures at the level of individual institutions.

² The municipality of Odense is an exception, showing a less unequal distribution of endangered children between preschools (Christensen, 1996; Didrichsen, 1997; Jacobi, 1991). And some day-care centres with lower care quality show a concentration of weak social backgrounds (Thyssen, 1999).

3515 preschool and age-integrated institutions, 84% of all existing institutions, have successfully been matched for the year 1998. The duration (years being registered) of day-care attendance is derived from the day-care register. Those records also provide information on the type of ECCE institution (day-care, day nurseries, preschools and age-integrated institution) and the ownership (municipal, community, independent, private, or public). Payment information on parental contributions and waiting lists are available for a sub-sample of the municipalities.

This new merged dataset allows us to combine information about children in day-care institutions with the teachers in the same institutions. Thus, register information is used to generate indicators for family background factors such as parental education, household income and number of children. Even though we have information on those indicators at annual observations for the whole life span of the studied children, we focus on figures of the year 1998. Those family background factors presumably change little over that period. [Later on we might still account for a number of substantial changes in those indicators that are due to such serious events as, for example, parental divorces or becoming unemployed.]

Moreover, we retrieve information about the day-care staff (teachers) in pre-schools from the registers. This allows us to generate quality indicators for the day-care facilities of each child in day-care. Quality indicators are explained in detail in section 5.

We use a number of outcome variables for the children's late school cognitive outcomes. First, we benefit from the PISA surveys for a subset of the child population. Secondly, through the registers in Statistics Denmark, we have access to school administrative data from final exams for 9th graders ('Afgangsprøve FSA')³ for an almost complete cohort in the years 2006-2008.

PISA test scores reflect children's intellectual abilities at the age of 15. The observations of the international PISA 2006 study for the Danish sample as well as a PISA 2007⁴ study covering the whole municipality of Copenhagen has been linked to the before-mentioned register data and made comparable to each other.

Previous research has shown that early test scores are strong predictors for future educational and labour market outcomes, for example Connolly et al. (1992) and Currie and Thomas (2001). The PISA Consortium suggests that PISA performance at the age of 15 is closely related to subsequent child outcomes such as completion of high school and

³ These tests have been introduced in 1975 and are nationally comparable. The leaving examination at the end of 9th grade is compulsory; some children stay on for a 10th grade and are then tested again. Testing includes for all children an oral examination in Danish, English and Physics/Chemistry as well as a written examination in Danish and Mathematics. Additionally children take an examination in another randomly allotted subject. Private schools, attended by 12% of pupils in 2001/02, have the right to also use the national leaving examinations; however, their testing is not controlled by public authorities (Eurydice, 2008).

⁴ PISA Copenhagen 2007 used the same test design as the international study of PISA 2000. Other development domains than reading literacy are not easily comparable between PISA 2000 and 2006, though. When comparing test outcomes across the two PISA studies, we rely on research of the PISA consortium (OECD, 2007c) assuring that PISA 2006 reading literacy test outcomes are comparable to PISA Copenhagen 2007 reading test outcomes.

participation in post-secondary education (OECD, 2007c). A Danish study by Andersen (2005) has shown that the percentage of youth who had completed post-compulsory, general or vocational upper secondary education (*ungdomsuddannelse*) by age 19 was closely related to their PISA reading performance at age 15.

PISA 2007 Copenhagen allows us to merge a cohort with detailed information on the variations of peer group compositions as complete school populations of Copenhagen are covered by the testing. The cognitive outcome measures from elementary school records consist of 9th graders' school exit examinations. Performance scores in exit examinations of Danish, mathematics and English are averaged per pupil. In a study of social-background adjusted school averages Rangvid (2008) has linked those exam records to outcomes of a PISA 2004 study among all 9th graders at Copenhagen's school. Rangvid finds indicative evidence that 9th graders' exam scores and PISA test scores are positively correlated. In order to extend our analysis from the PISA samples to all pupils covered in the registers, we test the correlation between PISA 2006 as well as PISA Copenhagen 2007 and 9th graders' exam scores. We find a significant correlation between 9th grade outcomes and PISA test scores of 53-71%. 9th grade assessments that are available for nearly all children of given school year. [We focus for now on the 2008 written final exam in Danish, the day-care spells of the 2008 school year can be fully observed in the registers. We start with a look at Danish language skills day-care period is said to be a sensitive phase for language development. Later paper versions will cover test outcomes of more development domains and years.]

A non-cognitive measure for the attitudes towards learning and aspirations for the future can be developed from the student questionnaire that has been filled out by participants of the PISA studies. While the PISA 2006 questionnaire focused on science related aspirations and self-assessments, the PISA 2007 Copenhagen study (as based on PISA 2000) focused more on interests in reading and the practice of learning. A survey among parents adds information on the ISCED level that parents expect their children to reach.

5 QUALITY INDICATORS

The study of quality aspects of early childhood care and education is still a rather new field in the social science literature. Behrman & Birdsall (1983) stressed that looking at the *quantity* of schooling alone might be misleading as the variation in *quality* is substantial. This is likely to be also the case for pre-schooling. Classical quantity measures are the duration in day-care as measured by the number of years and weekly hours of attendance as provided in surveys or given in registry periods of administrative records. The study by Datta Gupta & Simonsen (2007) has used, for example, information provided by parents in the Danish Longitudinal Study of children (DALSC) to calculate day-care durations. In this paper we make use of registry records from Danish administrative registers that cover the whole child population. A first step towards assessing the impact of different day-care qualities is to make comparisons across different types of care provisions, be it formal, centre-based arrangements or informal, family arrangements of care. The types of care in Denmark are

described in Table 2. Usually, the informal type of care, '*kommunal dagpleje*', is mainly used for children up to the age of 3 years, whereas formal care is available up to the age of 6 to 7.

Table 2: Type of day-care institutions in Denmark (Formal care in bold letters)

Day-care institution	Age groups
Nursery day-care (' <i>vuggestue</i> ')	26wks - 3yrs
Municipal childminder with joint municipal-parent financing (' <i>kommunal dagpleje</i> ')	26wks - 3yrs (<i>varies by municipality</i>)
Age-integrated institution ('<i>aldersintegrerede institutioner</i>')	26wks - 3yrs, 3 - 6/7yrs , 6/7 - 14yrs
Preschool ('<i>børnehaver</i>')	3 - 6/7yrs

When assessing the quality of day-care, numerous quality aspects can be of importance, such as type and intensity of care, amount, qualification and motivation of staff, size of groups, availability of facilities and educational materials, accessibility and social composition of institutions, pedagogic approach and applied curriculum, cooperation with other institutions, parental involvement etc. Several international studies have used environmental rating scales to assess a variety of such quality factors in terms of composite indicators⁵.

We have information available on both children and employees in each day-care institution. This allows us to create a number of quality measures per institution. In this study we limit the analysis to three types of quality indicators per day-care institution [later versions of the paper will look at more indicators]: 1) the number of children per staff member with a particular focus of children per pedagogic staff (i.e. the child-to-teacher ratio); 2) the share of male staff members; and 3) the average education of the staff. Underlying the first indicator is the hypothesis that reducing the number of children per staff member results in more time being spent with each child. More time implies more attention to the child's individual needs and development, following the same argument as in the discussion on the impact of the child-teacher ratio in school research (cf. Card & Krueger, 1996). For the policymaker it is crucial to know what gains can be expected from investing into additional staff members. However, there might be an inference problem if children with special needs were placed in institutions with more staff per child and we would not be able to observe whether a child has such special needs. This problem will be taken into account by using measures for child-to-teacher ratios both on the institutional level but also on a municipality level. The latter measure average out the special needs children, assuming that there is an equal share of these children across municipalities. The second indicator is based on a rather recent discussion that links mounting school problems of boys to the lack of sufficient male role models in their early childhood. It assumes that boys need a different type of care which

⁵ See, for example, the environmental scales of the UNC/FPG Child Development Institute (2005), which are the *ITERS* for infants and toddlers, *ECERS* for early childhood, *FCCERS* for family day-care, and *SACERS* for children of school age. Applications of such scales can be found in the British EPPE study or the US American NICHD study.

presumably is provided by male staff. So this quality aspect seems particularly relevant for boys. Traditionally men have mostly been represented in the management of day-care institutions, but they are increasingly called for taking up pedagogic positions as well. In recent years Danish policymakers have encouraged men to take up more care jobs, despite little evidence whether those assumptions are confirmed. The third indicator is fundamentally based on the presumption that higher educated staff is better able to address the individual needs of a child and to emphasize learning and school preparation.

All indicators have been created by matching day-care addresses with work addresses and drawing information from basic registries for staff members working at those matched locations. The indicators are rather complete in terms of coverage and normally distributed (except the shares of male and non-Danish staff which show the expected skewness on a 0-to-1 scale). Child-staff ratios for age-integrated institutions are improved by making an assumption on the relative distribution of staff between earlier years 0-3 and later years 3-6. Quality indicators and day-care registries are on an annual basis and refer to the age of 6 when attendance of those institutions reaches its highest level⁶.

Table 3: Observed quality characteristics

	Obs.	Mean	Std.Dev.	Min.	Max.
Preschool					
number of children per staff member	21615	6.955	2.515	0.63	24
share of male staff members (0-1 scale)	22015	0.072	0.104	0	1
average of highest educ. attainments of staff members (2 digit coding)	21959	14.265	0.533	12	17
Age-integrated Institution					
number of children per staff member	10360	6.525	2.972	1.82	24.5
share of male staff members (0-1 scale)	11128	0.104	0.128	0	1
average of highest educ. attainments of staff members (2 digit coding)	11042	14.099	0.558	12	15.4

6 METHODOLOGY

The model we work with has the following form:

$$CO_{ijk} = \beta_0 + \beta_1 X_{ijk} + \beta_2 F_{ijk} + \beta_3 I_{ijk} + \varepsilon_{ijk} \quad (1)$$

The individual (i) child's outcome (CO) is determined by an average baseline score β_0 , which varies according to individual characteristics of the child (X), family background factors (F), quality

⁶ We account for the length of the attendance spells by controlling for the enrollment year. Day-care registers are collected as of 1995, thus we need to account for potential left censoring of day-care spells for test outcomes of the years 2007 and earlier. When studying outcomes of the year 2008 [\[as in the current paper version\]](#) we can observe an uncensored, full day-care spell of 3-6 years.

differences in the evaluated day-care institutions (I) as well as a general error term. Studying day-care effects, about ten years after attendance implies a rather large time gap between participation and testing. Changes in the family situation as well as the quality of available schooling might be of importance for long-term outcomes, too. However, it is difficult to account properly for the elementary school trajectory in the estimation model. We consider therefore that the test outcomes and the elementary schooling describe partly the same, so with the test outcomes we already cover part of the story of school trajectory. Even so, we absorb school fixed effects to account for variation in test scores that are due to school variation.

Unfortunately, we lack information on the initial development level of children. And there is some evidence, that attendance among infants (less than one year of age) is harmful for kids (e.g. Belsky & Rovine, 1988; Ruhm, 2000), so kids who experienced day-care before the age of 1 might have developed adversely. There may also be important selection effects involved here: who are the parents that send their kids to child care very early in life? Who are the parents that place children on a full-day as opposed to part-time basis? Controls on parental background factors might account for part of the variation in children's initial development. Similarly, left censoring in the day-care spells keeps us away from identifying whether children had attended any pre-preschool institutions, such as day-care centres ('*vuggestuer*'), and at which age the child got enrolled. We account for the length of the attendance spells by controlling for the enrolment year. Day-care registers are collected as of 1995, thus we need to account for potential left censoring of day-care spells for test outcomes of the years 2007 and earlier. When studying outcomes of the year 2008 [\[as in the current paper version\]](#) we can observe an uncensored, full day-care spell of 3-6 years.

The choice of day-care institutions is a function of the observable family backgrounds factors as well as unobserved determinants that are covered in the general error term. It is very likely, that some of those unobserved factors are also strongly related to the expected child outcome, causing endogeneity bias in the estimated coefficients.

$$I_{ijk} = f(F_{ijk}, E(CO_{ijk})) \quad (2.1)$$

When evaluating the impact of different day-care investments we are not only interested in predictive correlations but also in identifying the causal factors that improve child outcomes. Given the setup of linking day-care registers to age 15 test outcomes, we can be confident of the direction of causal interpretations - test scores have no impact on the received day-care attendance in the first place. However, we need to properly identify whether correlations between the day-care investment and the child outcomes are based on a true causal impact of the day-care experience or rather of a 'hidden' factor that could also be related to the parental choice for a specific day-care experience. Are certain parents more likely to choose a certain day-care institution, and do unobserved factors have an impact on those choices and the child outcomes at the same time? Our estimates might thus be spurious, e.g. when we cannot fully observe why parents decided to send their child to a particular institution. When they sent their child to a day-care centre why have they chosen for this specific arrangement (type, duration etc.)? We rely on a quasi-experimental method to address this selection bias. We work with instrumental variable

applications to try to overcome the selection problems mentioned above. Comparing the regression results including IV in the first step with the results excluding the IV can give us an indication of how much unobserved heterogeneity might bias our estimated day-care effects. [\[This paper reflects work in progress; the IV application will be added in the next step.\]](#)

The question is how these selection problems impact residential choices. Residential choices are determined in the following order: 1. choice of municipality, 2. choice of school district, and 3. choice of day-care institution. Parents take an initial decision to live in a specific municipality based on preferences for living quality, labour market opportunities and provisions of schooling and day-care. Perceptions about such provisions are determined, for example, by the level of contribution fees, the availability of institutions, and their perceived quality, and by feedback e.g. from neighbours and friends and experiences of siblings, or own religious/pedagogic tradition. Relevant might also be the peer group composition, e.g. the share of foreign (born) children or the share of impoverished. In general, municipal choices can be considered as of relatively low importance in making residential choices compared, for example, to the USA which has high residential mobility across municipalities. Secondly, parents select within a chosen municipality a school district in which they find the desired school quality for their child – district boundaries limit the school choice. Finally, parents decide upon a specific day-care institution. They can do that throughout the whole municipality by prioritizing a list of institutions. However, there is no guarantee for getting the first choice due to waiting lists in most municipalities.

If we do not account for such endogeneity bias we cannot identify true causal effects of those two treatments. We therefore use instrumental variables that include information about the treatments but not the child outcome. The use of instrumental variables as non-experimental empirical strategy is a preferred research strategy as it tries to make use of exogenous sources of randomness in the treatment allocation process that might make it possible to replicate an experiment and hence overcome potential biases that are due to unobserved factors (Angrist & Krueger, 2001). An instrumental variable is a variable that contains some information on the treatment assignment but is unrelated to the outcome. However, in the literature on pre-school evaluations the use of instrumental variables is still in its infancy as arguments on the IVs independence of the child outcome are often weak or as the IVs do not identify plausible effects of the pre-school treatment on the child outcome.

We can instrument for pre-school characteristics by using the overall characteristics of pre-schools at the municipal and county level. This instrumental variable approach exploits the variation in pre-schools across 278 municipalities and 14 counties to instrument for the quality of pre-school a child can attain in a certain area.

As parents may sort within municipalities according to which day-care institution they want to enrol their child in (i.e. the chosen pre-school within a district is not exogenously given), we might get a problem in relation to identifying the effect of the pre-school's characteristics on child outcomes. This will be a valid instrument if parents have already decided or are restricted to a certain geographical area because of job opportunities, for example. Even though they may sort within neighbourhoods, the instrument is still valid as long as the parents do not sort across counties based on pre-school institutions' characteristics. We need variation in the pre-schools

across counties in order to ensure the strength of this instrument. As there are eventually bigger differences among types of day-care between municipalities than within municipalities this seems to be a reasonable assumption. The links between parental socio-economic background and children's educational outcome might be effective via neighbourhood factors rather than via parental selection of day-care arrangements. But this will only strengthen the argument for using the instrumental variables approach for identifying the effect of pre-school on children's outcomes as sorting across either neighbourhoods or day-care institutions are taken care of using this method.

The procedure follows the procedure in (Dustmann & Preston, 2001) in which they instrument for the share of immigrants in a neighbourhood by using the share of immigrants in a larger geographical area. The application and discussion of aggregate regional indicators as instruments to better identify school quality effects can be found in Heckman et al. (1995) as well as Card & Krueger (1996). If 'better' kids sort into better institutions, we might overstate the effects of the institutions. The sorting bias should be smaller on an aggregated level; we would expect the effects to be smaller when applying the IV method.

Other sources of potential exogenous information on selection into pre-school treatment might be: the geographic distance between homes and chosen pre-schools combined with information on municipal borders as a limitation to pre-school choices to those who live close to it, demographic changes across municipalities/counties and year, the quarter of birth and variation in fertility, political majorities in local parliaments, the local unemployment rate or other measures of local business cycle determining the labour market competition of qualified day-care personnel, and waiting lists for enrolment including discontinuities in the rules to jump the list, e.g. for siblings and the disabled.

7 ESTIMATION RESULTS

In the following we present estimation results of six different estimation models: one model in which we include each quality indicators separately (models 1-3), two in which we pair wise combine the quality indicators (models 4-5) and finally a model in which we include the three quality indicators all combined. We are clustering our estimation at the individual day-care institution level to obtain robust standard errors and account for fixed effects that are related to the different schools at which the tests have been taken. [\[Given that the paper reflects work in progress we cannot provide yet the interaction terms of quality indicators with child and family background factors. Including them and applying the before mentioned IV approach will be done in a next step.\]](#)

We initially study the effects of the three quality indicators separately (models 1-3). We find that the child-to-teacher ratio (number of children per staff member) has a statistically significant effect. The share of male staff members and the educational level of staff members have no significant relationship with our child outcome measure. When we combine two or three quality indicators, the child-to-teacher ratio is still significant. In theory the three quality indicators are covering rather different aspects of the day-care quality. The empirical evidence confirms this by

keeping estimated coefficients rather constant across different specifications with various indicator combinations.

The fact that the child to staff ratio stays significant even after control for school fixed effects is somewhat reassuring. Although IV estimations will be added only at a later stage, we therefore expect that we can identify a true effect of these indicators. Initially we expected that many children who shared the same day-care institution also go to the same school. If school quality reflects then the day-care quality as parents like to select for their child, then we probably already account for part of the sorting bias by including the school fixed effects.

The results (cf. Table 4) confirm the typical expectations with respect to the directions and significance of coefficients controlling for child characteristics and family background factors. There is little change in those factors across the six different model specifications which are an indication for little correlation between them and the quality indicators.

Longer day-care spells are related to higher test outcomes; whereas additional years show decreasing returns (see negative sign of squared term). Boys show a substantially lower performance than girls, their Danish test scores are about half a standard deviation lower. Kids who belonged to the oldest in the final year of day-care before entering school and are thus also older when the tests are taken score lower. Being born in Denmark and having Danish born parents is related to significantly better test performance. Children who lived with single parents in 1998, their last year in day-care, show lower test scores, so do children who have relatively more siblings. For all observed children at least one parent had attended education at secondary school level (the baseline in our estimations). Higher parental education levels are related to better test performance of their children. Parental income has a significant impact on children's test outcomes, even though the effects are rather small – an increase of about 100% would be necessary to increase the test score by one unit (on a scale of -3 to 12).

Table 4: Estimation output

Dependent variable: written final exam in Danish at 9th grade in 2008

	1	2	3	4	5	6
Day-care indicators						
number of children per staff member	-0.015 (2.53)**			-0.015 (2.53)**	-0.017 (2.74)**	-0.017 (2.73)**
share of male staff members (0-1 scale)		-0.111 -0.75		-0.021 -0.13		-0.01 -0.06
average of highest educ. attainments of staff members (2 digit coding)			0.045 -1.54		0.049 -1.55	0.048 -1.53
Child characteristics						
length of day-care enrolment in years	0.204 (1.75)*	0.258 (2.25)*	0.259 (2.25)*	0.204 (1.75)*	0.202 (1.72)*	0.202 (1.72)*
length of day-care enrolment in years (squared term)	-0.033 -1.57	-0.041 (1.99)*	-0.041 (1.97)*	-0.033 -1.57	-0.032 -1.54	-0.032 -1.54
dummy for being male	-1.183 (36.94)**	-1.173 (37.35)**	-1.173 (37.24)**	-1.183 (36.94)**	-1.183 (36.92)**	-1.183 (36.92)**
age (in observed day-care period 1998)	-0.407 (8.46)**	-0.403 (8.45)**	-0.406 (8.52)**	-0.407 (8.45)**	-0.407 (8.45)**	-0.407 (8.45)**
dummy for being native (born by Danish born citizen)	0.879 (10.38)**	0.898 (10.73)**	0.891 (10.61)**	0.879 (10.38)**	0.881 (10.39)**	0.881 (10.40)**
Family background factors						
dummy for living in a single parent household	-0.318 (7.36)**	-0.311 (7.36)**	-0.314 (7.39)**	-0.318 (7.36)**	-0.318 (7.34)**	-0.318 (7.34)**
number of children in household	-0.219 (10.01)**	-0.209 (9.70)**	-0.207 (9.61)**	-0.219 (10.01)**	-0.218 (9.95)**	-0.218 (9.95)**
highest parental education: lower tertiary ¹	0.51 (8.91)**	0.526 (9.37)**	0.522 (9.27)**	0.51 (8.91)**	0.511 (8.91)**	0.511 (8.91)**
highest parental education: mid tertiary/bachelor	1.01 (26.52)**	1.004 (26.85)**	1.002 (26.72)**	1.01 (26.52)**	1.009 (26.48)**	1.009 (26.48)**
highest parental education: higher tertiary	1.514 (29.94)**	1.524 (30.68)**	1.521 (30.54)**	1.514 (29.94)**	1.514 (29.92)**	1.514 (29.93)**
logarithmic gross income per hh	0.059 (3.36)**	0.058 (3.35)**	0.058 (3.35)**	0.059 (3.36)**	0.06 (3.38)**	0.06 (3.38)**
Constant	8.115 (19.70)**	7.88 (19.54)**	7.255 (12.65)**	8.117 (19.68)**	7.425 (12.34)**	7.428 (12.26)**
Observations	28574	29594	29477	28574	28561	28561

Robust z-statistics in parentheses, clustered at day-care institution level

* significant at 5% level; ** significant at 1% level

¹omitted baseline: secondary education (primary education not observed)

test_score: mean 6.522, std.dev. 2.865, min -3, max 12

Fixed effects absorbed at school level

8 CONCLUSIONS

We find a significant relationship between the child-to-teacher ratio and child outcome. This result confirms our initial hypothesis, namely that it is better to reduce the number of children per staff member. It should be emphasized that this correlation is not necessarily a causal relationship. The paper discusses various possible instruments that could be relevant in instrumental variables estimation. Testing and applying the IV approach will be the subject of our future work on the paper.

We could not find any evidence for our second and third hypothesis which said that employing more male and better educated staff would be beneficial for the development of the children. That we could not identify effects yet, in particular for the share of male staff, might be due to the fact that we have not yet studied interaction terms. Boys are considered to potentially benefit more from male staff; children from low educated parents might benefit more from better educated staff. Looking at such interaction terms in the next step might thus reveal significant effects at least for sub-groups. Even though the evidence on the share of male staff and the average education of the staff is insignificant and the effect of the child to staff ratio being rather small, we cannot conclude yet that there are no effects or that they have faded out over the ten intermediary years since the day-care experience. Until now we focused on one child outcome, the 9th grad Danish test. Future work on this paper will entail applying the other test outcomes on various subjects, testing periods and types (e.g. 9th grade versus PISA). Including more outcome measures is likely to contribute to a more comprehensive picture of child development.

REFERENCES

- Andersen, D. (2005). *4 år efter grundskolen 19-årige om valg og veje i ungdomsuddannelserne* (transl.: 'Four Years after Basic Compulsory Education 19-year-olds on post compulsory education choices and paths'). Copenhagen: AKF.
- Angrist, J. D., & Krueger, A. B. (2001). Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments. *Journal of Economic Perspectives*, 15(4), 69-85.
- Baker, M., Gruber, J., & Milligan, K. (2008). Universal Child Care, Maternal Labor Supply, and Family Well-Being. *Journal of Political Economy*, 116(4), 709-745.
- Barnett, W. S. (1992). Benefits of Compensatory Preschool Education. *The Journal of Human Resources*, 27(2), 279-312.
- Barnett, W. S. (1995). Long-Term Effects of Early Childhood Programs on Cognitive and School Outcomes. *The Future of Children*, 5, 25-50.
- Behrman, J. R., & Birdsall, N. (1983). The Quality of Schooling: Quantity Alone is Misleading. *American Economic Association, American Economic Review*, 73(5), 928-946.
- Belsky, J., & Rovine, M. J. (1988). Nonmaternal Care in the First Year of Life and the Security of Infant-Parent Attachment. *Child Development*, 59, 157-167.
- Bernal, R., & Keane, M. P. (2006). Child Care Choices and Children's Cognitive Achievement: The Case of Single Mothers. *IPR Working Paper*, 09.
- Blau, D. M. (1999). The Effect of Child Care Characteristics on Child Development. *Journal of Human Resources*, 34(4), 786-822.
- Bryderup, I. (2003). *Grundlagspapir - Forskningsenheden i socialpædagogik* (transl.: *Discussion Paper - Research issues in social pedagogy*). Copenhagen: Institut for Pædagogisk Sociologi, DPU.
- Campbell, F. A., & Ramey, C. T. (1995). Cognitive and school outcomes for high-risk African-American students at middle adolescence: Positive effects of early intervention. *American Educational Research Journal*, 32, 743-772.
- Card, D., & Krueger, A. B. (1996). Labor Market Effects of School Quality: Theory and Evidence. *NBER Working Paper*, 5450.
- Christensen, E. (1996). *Daginstitutionen som forebyggende tilbud til truede børn - en undersøgelse af 769 daginstitutioner* (transl.: *Daycare services as preventive measure for children at risk - a study of 769 day-care institutions*). Copenhagen: SFI.
- Connolly, S., Micklewright, J., & Nickell, S. (1992). The Occupational Success of Young Men Who Left School at Sixteen. *Oxford Economic Papers*, 44(3), 460-479.
- Cunha, F., & Heckman, J. J. (2007). The Technology of Skill Formation. *American Economic Review*, 97(2), 31-47.
- Cunha, F., Heckman, J. J., Lochner, L., & Masterov, D. V. (2005). Interpreting the evidence on life cycle skill formation. In E. A. Hanushek & F. Welch (Eds.), *Handbook of the Economics of Education* (Vol. 1, pp. 697-812): Elsevier.

- Currie, J. (1993). Welfare and the Well-Being of Children: The Relative Effectiveness of Cash and In-Kind Transfers. *NBER Technical Working Paper*, 4539.
- Currie, J. (2000). Early Childhood Intervention Programs: What Do We Know? *JCPR Working Papers*, 169, 213-238.
- Currie, J., & Thomas, D. (2001). Early Test Scores, School Quality and SES: Longrun Effects on Wage and Employment Outcomes. *Worker Wellbeing in a Changing Labor Market*, 20, 103-132.
- Datta Gupta, N., & Simonsen, M. (2007). Non-Cognitive Child Outcomes and Universal High Quality Child Care. *IZA Discussion Paper*, 3188.
- Didrichsen, A. (1997). *Den professionelle omsorg og børns udvikling (transl.: Professional care and child development)*. Copenhagen: SFI.
- Dustmann, C., & Preston, I. (2001). Attitudes to ethnic minorities, ethnic context and location decisions. *Economic Journal*, 111(470), 353-373.
- Elwerts, K. O. (2009). *Retrieval of data for the project: day care and child development at school age. Project No. 992009*. Copenhagen: AKF.
- Esping-Andersen, G. (2006). Families, Government and the Distribution of Skills: Universitat Pompeu Fabra.
- Esping Andersen, G. (2004). Untying the Gordian Knot of Social Inheritance. *Research in Social Stratification and Mobility*, 21, 115-138.
- Eurydice. (2008). *Eurybase - The Information Database on Education Systems in Europe: The Education System in Denmark 2007/08*. Brussels: European Commission, Directorate-General for Education and Culture.
- Frank Porter Graham Center - Child Development Institute. (2005). Environment Rating Scales. Retrieved 9 October, 2009, from http://www.fpg.unc.edu/~ECERS/index_frames.htm
- Gørtz, M., & Andersson, E. (2009). Staffing in Day-Care Institutions and Teacher Sickness Absenteeism (AKF project: 702833) [Electronic Version]. *SOLE Annual Meeting 2009*. Retrieved 8 May from <http://client.norc.org/jole/SOLEweb/9319.pdf>.
- Gregg, P., Washbrook, E., & ALSPAC Study team. (2003). The Effects of Early Maternal Employment on Child Development in the UK. *CMPO Working Paper Series*, 03(070).
- Gregg, P., Washbrook, E., Propper, C., & Burgess, S. (2005). The Effects of a Mother's Return to Work Decision on Child Development in the UK. *Economic Journal*, 115(501), F48-F80.
- Heckman, J. J. (2008). Schools, Skills, and Synapses. *Economic Inquiry*, 46(3), 289-324.
- Heckman, J. J., Krueger, A. B., & Friedman, B. M. (2002). *Inequality in America: what role for human capital policies?* Cambridge, Mass.: MIT Press.
- Heckman, J. J., Layne-Farrar, A., & Todd, P. (1995). Does Measured School Quality Really Matter? An Examination of the Earnings-Quality Relationship. *NBER Working Paper*, 5274.
- Heckman, J. J., Moon, S. H., Pinto, R., Savelyev, P. A., & Yaditz, A. (2009). The Rate of Return to the High/Scope Perry Preschool Program. *IZA Discussion Paper*, 4533.

Heckman, J. J., Stixrud, J., & Urzua, S. (2006). The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior. *Journal of Labor Economics*, 24(3), 411-482.

Jacobi, A. (1991). Omsorgsarbejde og omsorgsformer i daginstitutionen (transl.: Care staff and types of care in day-care institutions). In *Omsorg for de 2-6 årige* (Vol. 3). Copenhagen: Institut for Pædagogisk Sociologi, DPU.

Jensen, B. (2009). *Effekter af indsatser for socialt udsatte børn i daginstitutioner - HPA-Projektet* (transl.: *Effects of interventions for socially vulnerable children in day care centers - HPA-project*) (1 ed.). Copenhagen: Denmark Pedagogical University (DPU) Press.

Knudsen, E. I., Heckman, J. J., Cameron, J. L., & Shonkoff, J. P. (2006). Economic, Neurobiological and Behavioral Perspectives on Building America's Future Workforce. *Proceedings of the National Academy of Sciences*, 103(27), 10155-10162.

Machin, S., McNally, S., Kramarz, F., & Quazad, A. (2006). Do Schools Make a Difference? The Respective Contributions of Pupils and Schools in Achievement in English Primary and Secondary Education. *unpublished paper*.

OECD. (2007a). *Babies and Bosses - Reconciling Work and Family Life: A Synthesis of Findings for OECD Countries* (Complete ed. Vol. 14).

OECD. (2007b). Family Database: Babies and Bosses - Key Outcomes of Denmark compared to OECD average.

OECD. (2007c). *Programme for International Student Assessment (PISA) 2006 - Science Competencies for Tomorrow's World (Volume 1: Analysis)*. Paris.

OECD Family Database. (2007). Babies and Bosses - Key Outcomes of Denmark compared to OECD average.

Rangvid, B. S. (2008). Arbejdsrapport for Formandskabet for Skolerådet: Skolegennemsnit af karakterer ved folkeskolens afgangsprøver - Korrektion for social baggrund (transl.: Working Paper for the Chair of the School Council: Average scores for exit tests by public school - adjustment for social background). *AKF Working Paper, 2008(1)*.

Reynolds, A. J. (1993). Effects of a Preschool Plus Follow-on Intervention Program for Children at Risk. *Developmental Psychology*, 30, 787-804.

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, Schools, and Academic Achievement. *Econometrica*, 73(2), 417-458.

Ruhm, C. J. (2000). Parental Employment and Child Cognitive Development. *NBER Working Papers*, 7666.

Ruhm, C. J. (2005). Maternal Employment and Adolescent Development. *Labour Economics*, 15(5), 958-983.

Schweinhart, L. J., & Weikart, D. P. (1981). Effects of the Perry Preschool Program on Youths Through Age 15. *Journal of Early Intervention*, 4, 29-39.

Statistics Denmark. (1995-1998). *Statistisk årbog* (transl.: *Statistical Yearbooks*). Copenhagen.

Thyssen, S. (1991). Omsorg i udviklingsmæssigt perspektiv (transl.: Care in an evolutionary perspective). In *Omsorg for de 2-6 årige* (Vol. 1). Copenhagen: Institut for Pædagogisk Sociologi, DPU.

Thyssen, S. (1999). Pædagogers kompetencer i relation til børn i daginstitution (transl.: Teachers' skills in relation to children in day-care institutions). *SFI Working Paper on Social Heritage*, 14.

Todd, P., & Wolpin, K. I. (2003). On the Specification and Estimation of the Production Function Cognitive Achievement. *The Economic Journal*, 113(F3-F33).

Waldfogel, J., Han, W.-J., & Brooks-Gunn, J. (2002). The Effects of Early Maternal Employment on Child Cognitive Development *Demography*, 39(2), 369-392.