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Daniela Del Boca

1.1 Introduction

Child development is the outcome of a production process in which the main inputs come from parents, formal and informal childcare providers, sometimes relatives, and schools. Especially when children are young, empirical evidence indicates that mothers' care is the most valuable input. In the last few decades, mothers' employments rate have increased markedly, raising concern that this may result in decreased time spent with children and lower rates of cognitive development in young children. Figure 1.1 shows mothers' employment rates for a subsample of OECD countries. Denmark, Finland, Netherlands (80%) are the countries where mothers' participation rates are highest. The United Kingdom and the United States exhibit employment rates similar to the OECD average of 68 percent. The Mediterranean countries of Italy, Spain, and Greece have the lowest rates of maternal employment.

Although there are some fears that high employment rates of mothers may be associated with poor child outcomes, this is not borne out by crude cross-national comparisons. One can make some comparisons across countries in cognitive performance of adolescents through the use of the PISA-OECD data. These data contain standardized test scores for adolescents aged 15 in several countries. Figure

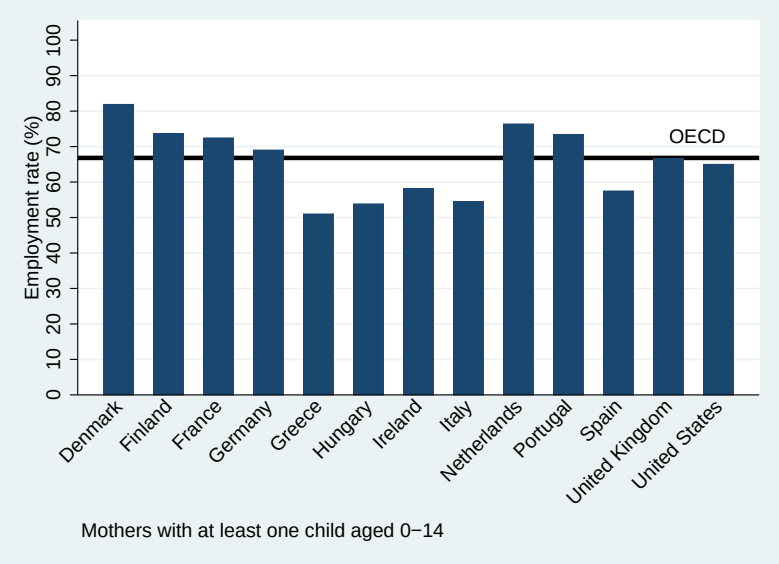


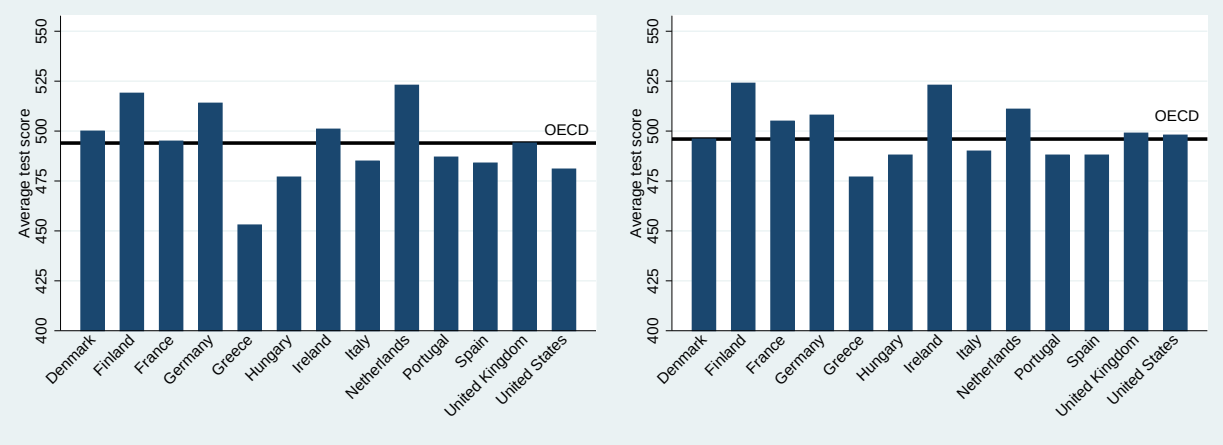
Figure 1.1: Maternal employment rates

Source: OECD

1.2 shows the international comparison in Mathematics and Reading performance (PISA 2012). Northern European test scores are the highest, while the UK and US are around the average. Countries with the lowest scores, such as Italy, Spain, and Greece, are the countries with very low employment rates of mothers. Of course, these countries vary in a large number of dimensions, not only the employment rates of mothers.

One potential explanation of these performance differences is the type and amount of investment in early education across countries. When both parents work, empirical evidence points to formal childcare as being the best substitute for parental time investments, especially for children from low-income families. In some countries the availability of external child care has remained low, especially for children under the age of three. Figure 1.3 compares childcare in different OECD countries.

Formal childcare enrolment is the highest in Denmark and the Netherlands, where it is mostly public. It is somewhat lower in the United Kingdom and the United States, where it is mostly private. In Italy and Germany, childcare is mainly public, but it is highly rationed. Given the importance of early investment



(a) *Mathematics* **(b)** *Reading*

Figure 1.2: Performance at standardized tests

Source: PISA (OECD) 2012

in children's development, intense interest has been generated in the formulation of policies, such as parental leave, and increasing the availability and quality of childcare services, a crucial substitute for parental time (Del Boca, 2015a).

In this part of the volume, we will examine the impact of early childcare (parental inputs and formal childcare) on several child cognitive outcomes. We will focus on the situation in three different countries, the United Kingdom, the United States, and Italy. Given the characteristics of the childcare system within each country and the data available, we focus on different aspects of the link between childcare and child outcomes in each institutional environment.

1.2 The economic approach to childcare

Since the child development process is inherently dynamic, economists use variants of a growth model to examine it. Some examples of this can be found in Carneiro and Heckman (2003), Todd and Wolpin (2003, 2007), and Del Boca, Flinn and Wiswall (2014). This growth process is considered to be separable over time, with the level of child development at age $t+1$ being a function of the child's state of development at the beginning of age t and investments in the child when she

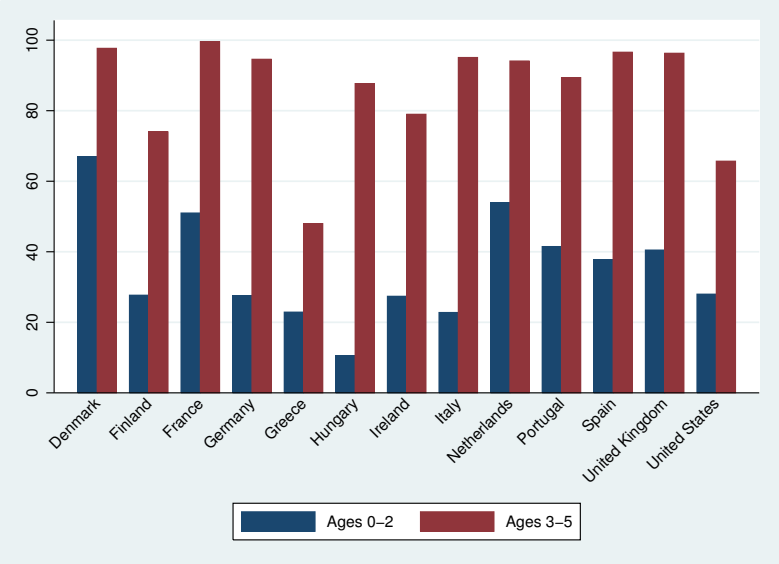


Figure 1.3: Enrollment in formal childcare by age and country

Source: OECD

is age t. These investments are taken to be made by several types of agents, all of whom have preferences over child outcomes. Foremost are the parents, but other relatives also may invest in and care for a child. When the child is young and not in the care of parents or relatives, formal or informal childcare services are typically provided by individuals such as childcare providers. While they are typically concerned with the child's welfare, generally speaking, their interest in the development of the child may be more limited. When the child enters formal schooling, at an age of five or six, she enters an institutional environment aimed at foster development. The extent to which it really fosters foster depends largely on the available resources. Finally, the child becomes an active participant in its own development during late childhood/early adolescence. Since we are focusing here on early childhood development, the most relevant actors to us are parents, other relatives and informal childcare providers, and formal childcare providers.

The growth model of child development has the general form

$$k_{t+1} = g_t(a)(x_t, k_t) \tag{1.1}$$

where k_t is the child's cognitive ability at age t, x_t is a vector of investments

when the child is age t, and g_t is a function that maps the age t investments and age t ability level at age $t+1$. Notice that we have allowed the relationship between the inputs and the previous period's level of development and the end of period cognitive level to change with the child's age. As Del Boca, Flinn, and Wiswall (2014) found, parental time inputs have different impacts on child development depending on the age of the child. When she is young, the mother's time inputs are particularly valuable. Empirical results in this literature (such as Cunha et al., 2010) indicate that children are more "malleable" when young.

In this dynamic production function framework, child development is a process, the outcome of which is determined by heritable endowments and the sequence of endogenous inputs. The end of the development process depends on the choices of all agents involved in the child's development. Family inputs are the most important in the first few years of a child's life, since cognitive and non-cognitive outcomes are largely determined early in life. High-quality childcare programs can partially substitute parental time when parents are at work and can contribute to growth in cognitive and non-cognitive outcomes, especially for children from more disadvantaged backgrounds.

In most of the empirical literature on child development and child outcomes, attention focuses on simple statistical relationships between observed and unobserved factors that can influence growth in cognitive and non-cognitive skills and a small set of measured characteristics. The results reported below largely follow this approach, and it is important to emphasize how the results we obtain can be related to an economic framework for looking at child development. This will allow us to put into context some of the results and to allow the reader to understand the assumptions being made in conducting the exercises reported below.

The first and most pressing issue is the estimation of the relationship. When speaking of the productivity of various forms of investment, such as the mother's or father's time or expenditures on goods purchased in the market that may enhance child development, it is crucial to obtain "good" estimates of this function. This is made problematic by two features that virtually every application shares. The first is that households are extremely heterogeneous, both in terms of observable and unobservable characteristics, so that there are, in fact, many production technologies to be estimated. In this sense, we should think most probably of a

set of production technologies, for each of the households in a sample.

The second issue is that inputs are not chosen randomly by parents and other agents involved in the child development process. In the economist's view of things, they are chosen to maximize the utility of the agent making the investment. Each individual involved in the development of a child presumably has their own objectives, some purely altruistic, others more goal-oriented for the individual involved. In the case of parents, they choose inputs carefully to aid in the development of their child, but child development is clearly not the only thing of relevance in terms of household welfare. This point is made clear in Del Boca, Flinn Wiswall (2014), where a distribution of household preferences over parental leisures, household consumption, and child "quality" is assumed to exist in the population. Their estimates (obtained under the assumption that all households shared the same production technology) indicate substantial dispersion in the sample with regards to the valuation of these difference components determining parental welfare. Their results made clear that households with children, on average, are very concerned with the development of their children, but that there is substantial variation in the weight given to child development across households.

Heterogeneity in child development technologies, household preferences, and household resources lead to endogeneity in the choices households make in terms of inputs in the child development process. Even under the strong assumption that all households share the same development technology, estimation of this series of functions using standard regression methods is likely to lead to biases in the results. This problem can only be dealt with by either having access to instrumental variables (e.g., Cunha et al., 2010) or by fully modeling the household investment process as in Del Boca, Flinn, and Wiswall (2014).

The potential impacts of early child investments have important policy implications. If families and institutions intervene early enough, they can positively influence a child's cognitive skills, socio-emotional abilities, and health in the short and long run. Early investments, such as making early childcare more available and affordable for low-income households, can also promote efficiency and reduce inequality.

1.3 Literature

1.3.1 The role of parental care

Several recent studies (for the United Kingdom, the United States, Germany, Denmark, and Norway) have analysed the impact of parental inputs on child outcomes. The results are often mixed concerning the size and the sign of the impact. The reasons concern the different methodologies used as well as the different measures of parental inputs (time and money), and the actors considered in the production function of cognitive skills and child outcomes considered.

Most socio-economic surveys lack appropriate measures of parental time spent in childcare, and so researchers have been forced to use proxy measures, such as mothers' employment. For example, in a recent analysis of the impact of US mothers' time on child cognitive outcomes, using data from the National Longitudinal Survey of Youth 1979 (NLSY79), mothers' time at work was considered to be equal to the time not spent with the child (Bernal, 2008). The estimation results indicate that when a child is quite young, mother's time in employment and child's time in (formal) childcare have a large negative impact on the child's test scores on standard cognitive ability tests at the time of entry into formal schooling.

A more accurate measure of parents' time investments in children is provided by time diary surveys, which usually contain detailed information about the amount of time parents spend engaged in various activities with their children. Very few studies have used direct measures of parents' time with their children to examine the relationship between parents' time investments and children's cognitive development. Time diary data show that women's entry into the labor force is associated with behavioral changes in time use that make employment status an inadequate proxy for maternal involvement with children. When time diary inputs are used in place of mothers' employment, some results change.

The size of the impact of mothers' inputs on child cognitive outcomes depends on the childcare substitutes available to the household. While the mother's time is widely recognized as a crucial input to a child's cognitive development, the father's time may be equally productive, especially at some stages of a child's life. In recent decades, fathers' time with their children has increased markedly, partly offsetting

the decline in mother's time.

Del Boca, Flinn and Wiswall (2014), drawing on time-use data find that both parents' inputs are important for children's cognitive development, with impacts differing depending on whether parents are actively engaged with the child during the time they are together or merely passively present but not interacting with the child. Impacts also differ with the phase of a child's life The study finds that parental time inputs are generally more productive than financial expenditures and that the impact of monetary transfers is small. The study also shows that while mothers' time is especially important for younger children, fathers' time becomes more important as children grow. The effect of time parents spend actively engaged with their children decreases with a child's age. However, fathers spend more time with their children as their children age, partly offsetting the decline in the effect of the time spent by mothers. When children grow older also their inputs in the cognitive development become important. Del Boca, Monfardini and Nicoletti (2016) find that child's own investments made during adolescence matter more than mother's investments. Children's self investments become more and more important in later stages of life, such as adolescence, when children start to take decisions independently.

1.3.2 The role of formal care in childcare centers

Recent studies in countries with different degrees of childcare availability indicate that external childcare plays an important role in child outcomes even if the impact varies significantly across countries and within countries across income and education level.

Some studies for the United States, where childcare is mostly private and unevenly regulated, report mixed result given the heterogenity of the supply (Herbst, 2015). The results vary significantly across families, children, and childcare type. Using the NLSY79 and focusing on single mothers, a study reports that informal care has significant negative effects on cognitive achievement, especially for children of more educated mothers, while formal center-based care has no adverse effect (Bernal and Keane, 2011). Other studies find instead positive results. For instance, Loeb et al. (2007) find that Reading scores of children who attended

a center-based arrangement were 1.2 points higher than those of children cared for by their parents, and their Math scores were 2 points higher. Further studies analyse also a public program aimed at offering public universal pre-kindergarten in Oklahoma: Gormley (2008) evaluate the Tulsa Pre-Kindergarten program, and find that high-quality preschool increases children's cognitive, language and motor skills scores with stronger effects for black children and for children of immigrant parents.

In Northern European countries, where formal childcare is mainly public, most analyses find a consistent positive impact in areas where public child care is more widely available and of higher quality. Because access to these programs is not limited to disadvantaged children, the results found for universal programs can be informative about the effects of different modalities of care on children across a wide range of socio-economic backgrounds. A recent analysis of the impact of a large increase in childcare supply in Norway in the 1970s shows strong and positive impacts on long term children's outcomes (such as years of education, college attendance, and earnings outcomes) especially for children of low-educated parents (Havnes and Mogstad, 2011). Datta Gupta and Simonsen (2010) evaluate the effects of the high-quality childcare in Denmark using the Strength and Difficulties Questionnaire index as an outcome to measure children's behavior. They distinguish between municipal-regulated preschool, less regulated family day-care services. They find that having attended preschool has a more positive effect on children's behavior than family day care arrangements and the effects is stronger for boys in families with lower educated mothers.

In the UK, when the government introduced a range of different forms of financial support towards the cost of formal center-based provision for children aged 3-5, the number of children in formal services almost doubled from 1.14 million to 2.15 million between 1999 and 2008. Among all children with working parents, the percentage in formal childcare rose from 24 percent in 1999 to 42 percent in 2010 (Bryson et al., 2013). Using UK data, Hansen and Hawkes (2009), and Del Boca, Piazzalunga and Pronzato (2014) compare the impact of parent's and grandparents' time with children with the impact of formal childcare. Children cared in formal childcare are better in tests concerning basic concepts development and problem-solving as well as school readiness but worse in naming objects. The

positive association between formal childcare and child outcomes is stronger for children in more disadvantaged households.

In Italy, public childcare availability is very different across regions, ranging between values close to 0 in some areas in the South to more than 20 percent in some areas of the North. Zollino (2008) has shown that here is a positive correlation between childcare availability and childcare demand, where the demand of the service is defined as the length of the waiting list; this means that in regions where childcare availability is higher, the number of applications increases. Brilli et al. (2016) using INVALSI data estimate the effects of childcare availability on children's performances at primary school, measured by Language and Math scores in second grade. They find a positive and significant effect of childcare availability on Language test scores, while they do not find any effect on Math. The authors find a strongest effect in areas where childcare availability is lower and for households with lower incomes.

In the next three sections we will focus on three countries US, the UK and Italy. In the first chapter we focus on the US and use the PSID-CDS data which provide time diaries on parental and child time use and focus on the impact of parental care on child cognitive outcomes. This chapter which is based on the structural model of Del Boca, Flinn and Wiswall (2014) takes into account endogenity of parental investments in their children and choice of child care. We use this data to study how parental childcare varies with employment, relate the parental time allocation to cognitive test scores of children, and estimate the relative productivity of parental childcare across childhood. We conclude with policy analysis and examine the effects of counterfactual policies transferring additional resources to the household on childcare and children's skill development.

In the second chapter we focus on the UK. We analyse the link between formal childcare and cognitive outcomes and simulate the impact of an expansion of childcare on cognitive inequality among children. We use the Millennium Cohort Survey (MCS), a panel dataset which provides very detailed information about several modalities of childcare as well as several child outcomes. Our results show that early formal care attendance is positively correlated with several cognitive outcomes, from age 3 up to age 11 and that attending formal care is particularly beneficial to children from low socio-economic backgrounds, who have usually less

inputs at home. We also simulate the effect that increased attendance of formal childcare has on differences in children's cognitive abilities. Our results show that childcare policies promoting increased attendance of formal childcare would help reduce disparities between children in term of their cognitive skills.

In the third chapter, we analyse the case of Italy, where the data on child care use are limited to cross section data. We explore the impact of child care provision both on mothers' work and child cognitive outcomes and take into account other peculiar characteristics of the childcare system related to rationing and selection criteria which give access to children from households with different characteristics. The positive impacts of childcare on child outcomes and mothers' employment seem to be stronger in municipalities where the selection criteria give priority to more disadvantaged households

In these two analyses we utilise regression estimates to perform counterfactual predictions. For example, we consider the impact of increasing the proportion of children in public childcare on inequality in outcomes later in life. Even if we could claim that our regression estimates are unbiased estimates of child development technologies, this type of exercise implicitly assumes that the same patterns in the data hold when the share of children in public childcare is dramatically increased. This is a question of "scaling" and the assumption is called into question when a significant change in the number of children in public childcare in contemplated. For example, if the capacity of public childcare is to be doubled, more teachers and buildings will be required. Will these new teachers be as qualified as the original ones? Will the additional students have the same characteristics as the original ones, or will they be more problematic and difficult to instruct? In a sense, these are issues that can only be dealt with in a general equilibrium setting, and no analysis, to our knowledge, has as yet been so ambitious.

1.4 Conclusions and policy implications

Most empirical studies confirm the hypothesis that early investments (private and public) in children are likely to significantly increase cognitive outcomes in the short and long run and are crucial to success later in life. The results of the analyses and policy simulations reported in the next three sections suggest that policies

encouraging and supporting parents' efforts to spend more time with their children during early stages of development and policies promoting the development of high-quality formal childcare have positive impacts on child outcomes. The results also show that the positive association between formal childcare and positive child outcomes is stronger for children in more disadvantaged households. Children in families with higher income and more education already receive substantial early investments within their families and have more resources and opportunities available to them. Low-income households often lack the resources needed to support and stimulate child development, so children in these families are likely to receive less investment from their families and to have access to fewer resources. Other characteristics of the childcare system in countries where it is publicly provided and rationed, such as selection criteria, are likely to impact chid cognitive outcomes in a similar way.

2 Parental Childcare and Child Development

Daniela Del Boca, Christopher Flinn, Matthew Wiswall

2.1 Introduction

In this chapter, we explore the allocation of parental time and its relationship with the child's cognitive test scores using data taken from the Panel Study of Income Dynamics, and a component of the PSID, the Child Development Study (PSID-CDS). This dataset provides nationally representative information on parental employment and earnings combined with detailed time diaries to study the types of parental care provide to children. These data also include measures of test performance of the children in the subsample at two or three points in time.

The PSID is a longitudinal study that began in 1968 with a nationally representative sample of about 5,000 American families. In 1997, the PSID began collecting data on a random sample of the PSID families that had children under the age of 13 in the CDS. Data were collected for up to two children in this age range per family. The CDS collects information on child development and family dynamics, including parent-child relationships, home environment, and time use. The entire CDS sample size in 1997 is approximately 3,500 children residing in 2,400 households. Follow-up data was collected in 2002 and 2007, allowing us to track the development of children as they age.

We first use this data to study how parental childcare varies with employment. We then relate the parental time allocation to cognitive test scores of children and estimate the relative productivity of parental child care across childhood. We

conclude this chapter with some policy analysis and examine the effects on childcare and children's skill development from counterfactual policies of transferring additional resources to the household.

While the analysis upon which we draw does not explicitly consider the impacts of childcare on child outcomes, it does attempt to carefully value the parents' contributions to child development. Most of the literature on childcare has stressed the impact that absence from the parents during the day may have on cognitive and non-cognitive development. The results we present could at least be used to bound how negative these impacts could be.

2.2 Parental Time Allocation

We first examine the allocation of various types of parental time. We utilize standard measures of parental labor supply derived from the PSID. For time with children, we use the CDS, which collected children's time diaries along with detailed assessments of children's cognitive development. For two days per week (one weekday and either Saturday or Sunday), children (with the assistance of the primary caregiver when the children were very young) filled out a detailed 24 hour time diary in which they recorded all activities during the day and who else (if anyone) participated with the child in these activities. At any point in time, the children recorded the intensity of participation for parents: mothers and fathers could be actively participating or engaged with the child or simply around the child but not actively involved. We refer to the first category of time as "active" time and the second as "passive." Importantly, our data includes both mother's and father's time with the child, in addition to labor supply information. We can then study whether an increase in fathers' active time off-sets the reduction in mother's time due to labor supply. Without this time heterogeneity, the trade-off between time in the market and time with children is much starker.

Table 2.1 breaks down parental labor supply by the age of the child. Mother's labor supply, both at the extensive and intensive margins, is related to the age of children but the father's labor supply is largely constant throughout the development period. For one-child families, the fraction of mothers working at all increases from 75 percent when the child is age 3 to 82-88 percent for older children. At

the intensive margin (i.e., for those supplying time to the market), the average hours of mother's work increases from 26 hours when the child is age 3 to nearly 40 hours when children are aged 12-15. For two-child families, the gradient of the labor supply response for mothers is even sharper, with mother's participation in the labor market increasing from 65 percent when the younger child is aged 3, to 89 percent when the younger child is aged 12-15. Average hours of work for the mother also increases as the child ages, but it is lower at each child age for mothers with two children than for mothers with a single child.

Table 2.1: Parent's Labor Supply by Child Age

	Fraction Working > 0 Hours					
	One Child		Younger Child		Older Child	
Child Age	Mother	Father	Mother	Father	Mother	Father
3	0.750	0.937	0.651	0.977	–	–
4-5	0.821	0.982	0.781	0.979	0.750	0.979
6-8	0.822	0.985	0.792	0.971	0.712	0.975
9-11	0.882	0.961	0.783	0.992	0.796	0.984
12-15	0.835	0.987	0.891	0.957	0.833	0.978
	Average Hours Working					
	One Child		Younger Child		Older Child	
Child Age	Mother	Father	Mother	Father	Mother	Father
3	26.38	44.38	23.53	44.98	–	–
4-5	37.63	44.58	24.48	45.76	35.19	44.91
6-8	38.44	45.69	25.96	45.02	32.64	46.26
9-11	38.08	44.46	28.02	45.26	32.31	46.43
12-15	39.83	43.13	35.76	47.52	36.36	46.33

Notes: Sample of intact households (mother and father present in household) with one or two children.
Source: PSID-CDS combined sample from 1997 and 2002 interviews and 1997, 1999, 2001, 2003 PSID core data.

Table 2.2 provides evidence on the allocation of parental time as the child ages.[1] For one-child families, mothers spend almost twice as much active time

[1] We do not consider other family members' care besides that of the parents. About one-fourth of households use relatives' care and its usage is relatively invariant across levels of education

with the children as do fathers when the child is aged 3-5. This gap in active time closes for older children. When the children are young, both mothers and fathers spend much more of their total child investment time actively interacting with the child rather than in passive engagement. For older children, the parents are spending closer to equal amounts of time in passive and active engagement as the amount of active time declines for both mothers and fathers. Because of the sharp reduction in active time with the child, the mother's average total time with the child declines substantially as the child ages. However, the total time the father spends with the child increases slightly, which is due entirely to an increase in the father's passive time engagement.

For two-child families, Table 2.2 presents descriptive statistics for total active and passive time, combining all time spent with the child whether or not the sibling was present and also receiving parental time. We see a similar age profile in time allocation for active time as in one-child families: both children receive substantially more active time with the mother and father when young. However, the amount of active time with the mother and father is lower on average for the younger child in a two-child family than for the only child in a one-child family. Given the sample restriction that both children be included in the CDS survey for two-child households, we do not have older (second born) children less than 4 years of age in the sample. Examining the patterns in passive time, we see that while average hours in active time with the younger child at age 3 is less for mothers with two children, the average amount of passive time is higher. The total time with the younger child at age 3 (active and passive) is about the same for one-child and two-child families. For older children (aged 12-15), it is clear that children in two-child families receive less active and passive contact time from both parents than do children in one-child families.

Table 2.3 disaggregates parental time allocation for two-child families into various joint time categories. The top row displays the time spent by mothers and fathers in active time with the younger child alone (without the other sibling present). Mothers spend on average 4.5 hours actively engaging with the younger child alone, and fathers spend on average 2.4 hours in active engagement alone with the child. By far the largest time investments are made when the children

and income.

Table 2.2: Parent's Time with Child by Child Age

	Active Time (Avg.)					
	One Child Families		Two Child Families			
			Younger Child		Older Child	
Child Age	Mother	Father	Mother	Father	Mother	Father
3	29.29	16.90	23.19	13.20	–	–
4-5	21.37	11.08	17.64	8.40	17.46	10.78
6-8	16.47	12.11	11.06	6.95	13.03	8.70
9-11	15.72	8.59	8.63	6.30	10.50	7.40
12-15	12.30	8.93	5.61	3.50	8.11	5.80
	Passive Time (Avg.)					
	One Child Families		Two Child Families			
			Younger Child		Older Child	
Child Age	Mother	Father	Mother	Father	Mother	Father
3	12.45	5.16	17.99	5.50		
4-5	13.22	6.37	20.10	8.12	16.93	8.28
6-8	9.47	8.07	11.10	6.07	16.68	6.96
9-11	10.88	8.08	7.08	4.84	9.69	5.22
12-15	15.22	13.19	5.59	5.57	7.18	5.35

Notes: Sample of intact households (mother and father present in household) with one or two children. Child age for two child families is the age of either the younger or the older child.
Source: PSID-CDS combined sample from 1997 and 2002 interviews and 1997, 1999, 2001, 2003 PSID core data.

both have active contact with a parent or when both children report passive contact. On average, active time for both siblings simultaneously accounts for 11.5 hours for the mother, and 7.1 hours for the father. Passive time for both siblings simultaneously accounts for 10.7 hours for the mother and 4.7 hours for the father.

Table 2.3: Joint Time Allocation of Parents

Younger {passive,active,none}	Older {passive,active,none}	Mother's Time	Father's Time
active	-	4.49	2.38
passive	-	4.08	1.90
-	active	1.20	1.22
-	passive	1.87	1.73
active	active	11.45	7.09
active	passive	2.45	0.93
passive	active	1.86	1.16
passive	passive	10.72	4.65

Notes: Sample of intact households (mother and father present in household) with two children.
Source: PSID-CDS combined sample from 1997 and 2002 interviews and 1997, 1999, 2001, 2003 PSID core data.

2.3 Productivity of Parental Time

We next examine how the different forms of childcare time provided by parents affect the children's cognitive development. Children's cognitive skills are conceived broadly to include language skills, literacy, and problem-solving skills and are measured with the Woodcock Johnson Achievement Test-Revised (Woodcock and Johnson, 1989). Given the wide range of ages to which the Letter-Word (LW) tests was administered, we use this test as our measure of child development. We use the raw scores on this exam rather than the age-standardized scores to all the measure to reflect growth in skill development as the child develops.

We formalize children's cognitive skill development through a production technology in which age $t+1$ child skills k_{t+1} is produced by the current level of child

quality, k_t, parental time investments in the child of the active and passive kind, and expenditures on the child, all of which are made when the child is age t. The production function we estimate takes the following form:

$$\begin{aligned}\ln k_{t+1} = \delta_{1,t}(a)\ln\tau_{1,t}(a) + \delta_{2,t}(a)\ln\tau_{2,t}(a) + \delta_{1,t}(p)\ln\tau_{1,t}(p) \\ + \delta_{2,t}(p)\ln\tau_{2,t}(p) + \delta_{3,t}\ln e_t + \delta_{4,t}\ln k_t\end{aligned} \tag{2.1}$$

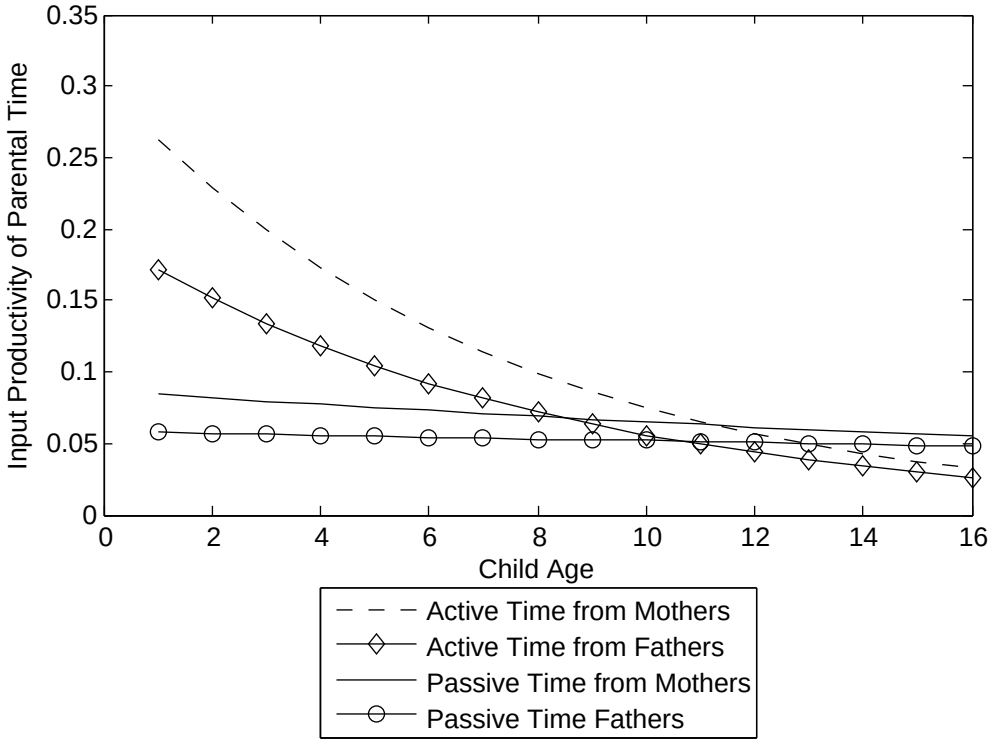
where $\tau_{1,t}(a)$ is active time by the mother, $\tau_{1,t}(p)$ is passive time by the mother, and $\tau_{2,t}(a)$ and $\tau_{2,t}(p)$ is father's active and passive time. Goods expenditures on the child are denoted by e_t. The δ parameters provide the productivity elasticities of each type of time, where each parameter indicates by what percent test scores increase in the next period following a 1 percent increase in the child input. We estimate the parameters of the model jointly with a function characterizing the preferences of the household, defined over the parents' leisure, household consumption, and child quality. In this way we solve the problem of endogeneity of input choices under the assumption that we have correctly specified the household's preferences and constraints.[2]

Figures 2.1 plots the estimated technology parameters. We see that for active time "flow" inputs into the dynamic production process (mother's and father's active time), the productivity of the input changes substantially over the child development process. As expected, mother's active time is the most productive input for young children, followed by the active time investment of the father. For young children, passive time from mothers and fathers has much lower productivity. The productivity of mother's and father's active time is declining with the child's age, while the productivity of the passive time of the mother and father is relatively invariant over the development process. By the time the child reaches age 12, the estimates indicate that passive time is about as productive as the mother's or father's active time investment. This change in the productivity of time as the child ages reflects the changing input mix of time revealed in the data. Fathers spend more time with their child as the child ages and much of this time is of a passive sort.

The declining productivity of active parental time makes intuitive sense given

[2]Details of the estimation method and results can be found in Del Boca et al. (2014).

Figure 2.1: Estimated Child Development Parameters by Child Age (1 Child Model)



our model specification. Once children attain the age of 5 or 6, they typically leave the home for significant periods of time each day for formal schooling activities. This amounts to a large, probably discontinuous, shift in the child quality production process. During the period of formal schooling, the child may increasingly be subject to inputs, both good and bad, from teachers and other students, which supplant the interactions that the child previously had with the parents. From the point of view of parental inputs, their input decisions have increasingly smaller effects on child outcomes as they are "crowded out" by these others.[3] While one could argue about the form of the dependence of the production process on the age of the child, it is reasonable to think that the impact of parental inputs is, in general, declining.[4]

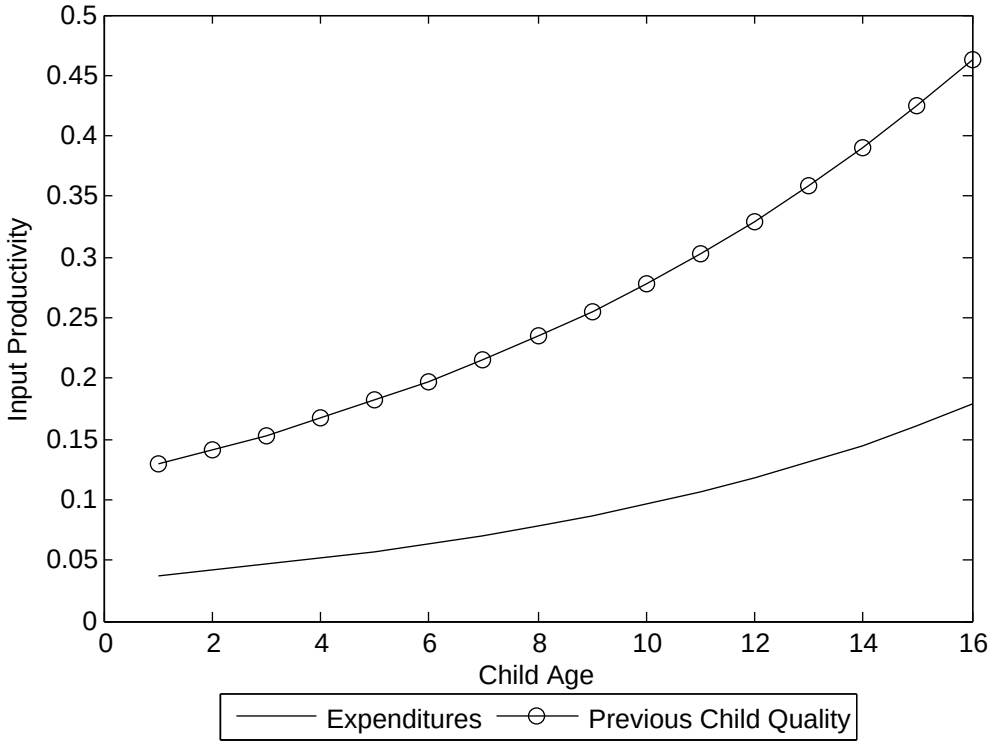
Figure 2.2 shows that the productivity of child goods expenditures (δ_{3t}) and the persistence of child quality (δ_{4t}) are increasing as the child reaches the upper age limit of our analysis. The former represents the increasing importance of child goods investments, perhaps through paid enrichment activities for the child. While we believe the latter trend may reflect a real characteristic of the development process, there is no doubt that it also reflects the some characteristics of the cognitive ability measure that we employ when estimating the production process.

One potential source of heterogeneity in the productivity of time is by the parents' productivity, when parental human capital affects the productivity of their time investments. We have also estimated versions of the model in which the productivity of each parent's time in producing child quality is a function of that parent's level of education. We found no evidence that these productivity parameters varied significantly by parental education. In general however heterogeneous productivity of investments could be quite important in assessing policy implications. The social planner would want to design policies to incentivize productive households to provide the most investments in their children.

[3]Of course, the parents continue to have a major impact on the factor inputs through their choice of the child's schooling environment. Liu et al. (2010) focus on this important aspect of child investment decisions.

[4]A few recent studies have pointed to the importance of the phenomenon of self-investment as the child ages (e.g., Cardoso et al. (2010)). The persistence we note in the child quality process as the child ages may be due to the child, and others, supplying inputs that are unobserved and persistent.

Figure 2.2: Estimated Child Development Parameters by Child Age (1 Child Model)



2.4 Policy Analysis

The policies we study provide a transfer amount to a one-child family each year during at least a portion of the development process. Motivated by the work of Cunha and Heckman (2008), in which it is argued that child investments in early years are more productive than are investments made in later years, we look at the efficacy of making monetary transfers to the household when the child is in the early stage of the development process as opposed to later years. We consider the impact on child outcomes at the end of the development process of three potential transfer patterns: (1) a \$500 transfer per week during the first half of the development process; (2) a \$500 transfer per week during the second half of the development process; and (3) a \$250 transfer per week during each week of the development process. These amounts have been selected so as to equate the total value of transfers under the three schemes.

We have examined the impact of the transfers using a "restricted" and "unrestricted" case. In the first, there is no constraint on how the transfer of x can be spent by the household. In particular, a household may spend less than x on child goods investment if it chooses to do so. In the restricted case, the household is monitored to ensure that at least x dollars are spent on the child. Alternatively, we could think of these as in-kind transfers that only have a value when used to increase the child's cognitive ability.

The results are presented in Table 2.4. The amounts are the *percentage change from baseline* for each of the transfer schemes. The first column contains the results from the unrestricted transfers case, for which we only consider the effect of a transfer of \$250 per week over the entire development period. We see that the transfers have a small impact on latent ability. However, by far the greatest impact in the column is associated with the parental labor supplies, which fall markedly. The time which is taken from labor market activity is spent on time investments with the child and on parental leisure. The reduction in earned labor income in the household is not necessarily a bad thing from the point of view of child development, because we have found that in most periods time expenditures of whatever type have a larger impact on cognitive improvements than do money expenditures. The patterns of substitution that are estimated result in relatively

small net impacts on cognitive ability at the end of this development period.

The remaining columns of the table contain the results of the experiments in which we change the size and dates of the transfer and restrict all households to spend at least as much money on the child as the transfer amount the household receives. The results in column 2 are directly comparable to those in column 1 since the transfer of $250 is received over the entire development period. We note larger average effects on child quality in the "constrained" case. This impact is largely due to the presence of households that put little weight on child quality. The requirement that $250 dollars be spent on the child in a given week is strongly binding for a substantial proportion of households with a low preference weight on child quality and/or low household income. This constraint also is seen in the lower percentage reductions in parental labor supply, since for households whose pre-transfer level of expenditures on the child was substantially less than the amount of the transfer, there is essentially no income effect from receiving it. The other behavioral responses are also dampened, with the exception being the enormous percentage change in money expenditures on the child.

The last two columns in Table 2.4 contrast the impacts of the timing of transfers on child outcomes. Since the size of the transfer has doubled in the periods in which it is received, we expect that a larger share of households will be impacted by the requirement that they spend at least $500 dollars in child investment during periods in which the transfer is received. In fact, we see this most clearly in the experiment in which transfers are made early in the development period. The percentage gain in child investment expenditures is huge, though the impact on final child quality is almost nonexistent. This is due to a number of factors, the most important probably being the fact that time investments in the child at younger ages are significantly more productive than are money investments and the fact that our model does not allow saving or borrowing by the household.[5]

The most successful transfer scheme from the point of view of increasing child quality is the one in which transfers are concentrated at the later stage of the

[5]If saving was allowed, households may simply wait to spend transfers received in periods in which child good expenditures were unproductive until they could be used in periods when they were more productive. In the PSID data we use, we don't find evidence of significant amounts of savings by a large majority of households, so this possibility may not have practical consequences for our policy exercises.

development process. The percentage change is over twice as large as the next best transfer scheme (in this metric), which gives the household half the weekly transfer over the entire development period. Once again, there is a very large impact on child good expenditures, but the important thing here is that the relative productivity of time inputs (with respect to money inputs) is less during this stage of the development process. While there is substantially more inertia in child quality at the end of the process, it is also the case that the money expenditures on child goods at this stage have a more direct impact on the end of process level of cognitive ability due to their temporal proximity.

2.5 Childcare

We have not explicitly considered the impact of childcare in this modeling and empirical exercise. This framework has been adapted by Brilli (2015) to add childcare decisions by the mother, although she does not model the father's contributions to the child. Her analysis is similar to that of Bernal (2008) in this respect, although she assumes exogenous wage offers to the mother whereas Bernal allows wage offers to be a function of previous labor supply decisions. Both papers focus on the early years of development, from ages 0 through 6.

Non-parental childcare is potentially as or more heterogenous than parental childcare. One source of heterogeneity is the broad array of options available: childcare can be formally provided in the market or informally provided by relatives and friends; it can be provided in a center-based setting or through decentralized home based arrangements. A second source of heterogeneity is the large variation in quality potentially present within each option.

Bernal concludes the labor market participation of mothers has significant negative impacts on the child's cognitive development, since time in child care is estimated to be a poor substitute for time with the mother. These results may be influenced by important assumptions in the model, such as the absence of time with the father in the production of child quality (and a possible substitute for the mother's time). As reported above, we find that father's time is a good substitute for the mother's particularly for children aged 3 and above). Of course, there is a question of whether the father is available to spend time with the child while the

mother is working, something not considered in our framework.

Due to the absence of time budget information, Bernal assumes that all time the mother does not spend at work is spent in child investment. We find that both parents consume substantial amounts of leisure time. This means that mothers, and fathers, have substantial scope for "softening" the impact of employment on child development by reducing their leisure consumption.

Table 2.4: Counterfactual Simulations: Untargeted and Targeted Transfers

	(1)	(2)	(3)	(4)
	Untargeted Trans.	Targeted Child Goods Transfer		
	\$250 in Non-Labor Income All Ages	\$250 in Child Goods All Ages	\$500 in Child Goods Ages 3-9 Only	\$500 in Child Goods Ages 10-15 Only
	Percent Change from Baseline			
Mean Latent Child Quality (Age 16)	1.61	4.628	0.024	9.42
Mean Hours Work (Mother)	-15.12	-10.36	-4.29	-10.69
Mean Hours Work (Father)	-12.62	-7.55	-3.78	-6.92
Mean Active Time w/ Child (Mother)	6.13	4.85	2.55	4.64
Mean Active Time w/ Child (Father)	8.22	6.17	3.81	5.32
Mean Passive Time w/ Child (Mother)	5.86	5.63	1.93	7.17
Mean Passive Time w/ Child (Father)	7.13	6.58	2.62	8.09
Mean Leisure (Mother)	5.32	3.01	1.17	2.88
Mean Leisure (Father)	8.53	4.33	2.14	3.62
Mean Child Expenditures	4.90	28.77	51.61	26.10
Mean Household Consumption	6.88	4.16	2.28	3.42
Mean Utility	6.13	4.41	2.86	3.73

Notes: All values are the percentage change from the baseline values given in prior tables. Experiment (1) provides \$250 in non-labor income per week to all households at all child ages. Experiment (2) provides a subsidy of \$250 in non-labor income for the household and sets child goods expenditures at a minimum level of \$250 at all child ages. Experiment (3) provides a subsidy of \$500 and sets child goods expenditures at a minimum level of \$500 for child ages 3-9 only; children at older ages receive no subsidy. Experiment (4) provides a subsidy of \$500 and sets child goods expenditures at a minimum level of \$500 for child ages 10-15; children at younger ages receive no subsidy. Mean Latent Child Quality (Age 16) is the latent value of child quality at the end of age 16 or the start of period $t = 17$, k_{17}.

Our estimates point to the importance of this effect. These are two reasons to suspect that Bernal's estimate of the deleterious impact of the mother's employment on child development may be overstated.

Brilli (2015) finds that the productivity of maternal time in producing child quality exceeds that of time spent in childcare, particularly for highly education mothers (recall that she does not consider the father's investment in the child). Since the mother takes these impacts into account when making her labor supply and investment decisions, the actual impact on child cognitive development is muted. Households that significantly value their child's cognitive development understand that having a mother (and father) spend time away at work will, in general, limit the growth in the child's development with respect to a situation in which this was the only concern in the household. As does our society when deciding on investments in education, the household realizes that there are opportunity costs associated with investing in the child and merely attempts to efficiently allocate the scarce resources at its disposal.

To provide some additional evidence on these key tradeoffs, we use the PSID-CDS time diary data to examine the types of parental care formal childcare substitutes for. The effectiveness of formal childcare in improving children's skills depends on whether childcare substitutes for lower quality types of care. Conditioning on the child's age, we find that a 1 hour increase in formal, outside the home, childcare, is associated with a reduction in the number of hours of mother's childcare by about 1/3 of an hour. There is almost no statistically significant relationship between formal childcare and father's care time. These numbers imply that formal childcare is mainly trading off with other types of non-parental care (perhaps care provided by grandparents, siblings, and others). When we turn to dis-aggregating the maternal care by the "active" and "passive" types, we find that a 1 hour of formal childcare reduces on average 0.14 hours of active mother's care and 0.21 hours of passive care. This suggests that formal childcare trades-off most strongly with passive maternal care, the less productive form of childcare.

2.6 Conclusion

We employ unique data from the PSID-CDS on investments in children to recover estimates of the child development process. We found that parental time inputs were more valuable in producing child quality than were money expenditures on children (at least those made by the household). The value of parental time inputs decreased with the age of the child, while there was some increase in the value of money inputs as the child matured.

These results are potentially important for the design of policies to increase the cognitive ability of children. As is demonstrated in the comparative statics exercises we perform using the estimated primitive parameters, changes in the nonlabor income of the household have limited impacts on the cognitive ability of the child. This result is due to the greater importance of time inputs in the growth of cognitive ability and the fact that gains in household resources are spread over parental leisure and household consumption in addition to child investment. The complex substitution patterns that are generated result in small gains in child cognitive ability.

3 Formal Childcare and Child Outcomes

Daniela Del Boca, Daniela Piazzalunga, Chiara Pronzato

3.1 Introduction

In this chapter we use data from the Millennium Cohort Study to analyze the link between early childcare attendance (at the age of 18 months) and child outcomes in the United Kingdom. As mentioned in the introduction of this book, the UK closely resembles the US in terms of maternal employment, greater expenditure on pre-kindergarten education, and higher cognitive performance at the age of 15 (PISA OECD). However, US childcare policies generally target disadvantaged children, while recent childcare policies in the UK adopt a more universal approach to coverage.

The availability of formal and affordable childcare for the very young (0-4) has traditionally been much lower in the UK than in other European countries. The earliest childcare policies for three and four year olds in the UK were introduced in the early 2000s. All four year olds since 2000 and all three year olds since 2005 have been entitled to free part-time nursery education. Childcare for the under-twos instead is mainly provided by the private market and therefore mainly serves children from families with a higher socio-economic status (West 2010). In 2013, free part-time education was also extended to disadvantaged two-year olds, making up about 40 per cent of all two-year olds. This policy involved no significant change in the amount of public services provided, as its intent was to make use of the considerable private market for childcare and early education that

has developed over the past decades.

The literature analyzing the link between formal childcare and children's cognitive abilities in the UK has focused on children from disadvantaged families. Using data from the Effective Provision of Pre-School Education (EPPE) project, a longitudinal study of early childhood development between the ages of 3 and 7, Mellhuish et al. (2005) investigate the effects of pre-school education for 3 and 4 year olds, finding that it can foster child development and reduce the disadvantages experienced by children from low socio-economic backgrounds. Children who had never attended pre-school had lower levels of attainment (having controlled for background factors related to the child, parent and home learning environment) than those who had spent at least some time in pre-school. Blanden et al. (2014) evaluate whether the introduction of free part-time pre-school education for all 3 year olds has increased the early educational attainment of children in England. Their results suggest that pre-school attendance has small but positive impacts on children's cognitive outcomes, and larger benefits for the most disadvantaged children, thus contributing to socio-economic mobility.

In this chapter, data from the MCS allows us to analyze the impact of formal childcare attendance on several child cognitive outcomes, making it possible to control for a large number of variables and previous cognitive outcomes. Our empirical evidence shows that attending formal childcare at 18 months has a positive affect on school readiness at age 3 and on other cognitive outcomes at ages 5, 7 and 11.

Here we focus on children under the age of two who are too young to be eligible for free part-time care provision. Our variable of interest thus mainly reflects the fact that parents chose for their children to attend private childcare. We evaluate the role of formal care in reducing inequality to analyse the effect that increased reliance on formal childcare has on differences in children's cognitive abilities. Our results show that childcare policies promoting increased attendance of formal childcare would help reduce disparities between children in term of their cognitive skills.

3.2 Methodology

To investigate the relationship between early childcare and child cognitive development, we refer to the human capital production function developed by Todd and Wolpin (2003): the cognitive achievement of the child is a function of family inputs and school inputs. To estimate the production function, we start with a basic regression that includes a large set of controls that may influence the cognitive development of the child and a dummy variable for attending formal care:

$$Y_{ia} = \beta_0 + F_{i18}\beta_1 + X_{i9}\beta_2 + Z_{ia}\beta_3 + \epsilon_{ia} \tag{3.1}$$

where Y_{ia} corresponds to a vector of the cognitive outcomes of the child i at age a; F_{i18} is the variable of interest, a dummy variable taking the value 1 if the main childcare modality at 18 months is formal care; X_{i9} is a vector of time-invariant characteristics of the child i and her family measured when she is 9 months old, Z_{ia} is a vector of time-variant characteristics of the child i and her family measured when she is a years old and ϵ_{ia} is the stochastic error. $\beta_0, \beta_1, \beta_3$ are the parameters to be estimated with OLS, and β_1 is the parameter of interest, the effect of formal care on child cognitive outcomes *ceteris paribus*.

We control for a large number of variables that might influence child development, but that might also be correlated with participating in formal care. These variables are measured when the child is 9 months old (X_{i9}), before the age when the outcomes are observed. We consider the child's characteristics (immigration status, sex, birth weight, whether s/he was breastfed for at least 1 month, accidents at home, hospital stays); the household's characteristics (other siblings, weekly equivalent income, if parents meet friends at least once a week, region of residence); the mother's characteristics (age, hours of work per week, education, employment status during pregnancy, monthly wage, unemployment status, experience of post-partum depression, a factor summarizing her feelings of tiredness and concern, a factor summarizing her feelings of irritability, whether she had lived with a single mother during childhood, whether she has a chronic illness, cigarettes smoked per day, whether she drinks at least once a week); and the father's characteristics (whether he is present, hours of work per week, monthly wage, a factor

summarizing his feelings of tiredness and concern, a factor summarizing his feelings of irritability, whether he had lived with a single mother during childhood, cigarettes smoked per day, whether he drinks at least once a week). These variables provide measures for the socio-economic background of the family, the "cognitive" characteristics of the parents (work, education, etc.), their non-cognitive characteristics, and their "investment" in the child (e.g. breastfeeding, smoking). In order not to lose too many observations, we replace missing observations of the control variables with 0 and construct four missing variable indicators (for the child, the household, the mother, the father).

In addition, we control for the following variables that can vary over time (Z_{ia}): the presence of the father at home, the presence of a new partner of the mother at home, household income, and the arrival of new siblings.

It should be kept in mind that since there may be omitted variables correlating both with the decision to enrol the child in formal care and with her cognitive outcomes, the results might be biased.

To improve our estimation, for the outcomes at age 5, 7, and 11, we include a dummy variable equal to 1 if the child has ever been in formal care between the age of 3 and 5 years (F_{i60})[1]: this variable captures later input choices.

$$Y_{ia} = \beta_0 + F_{i18}\beta_1 + X_{i9}\beta_2 + Z_{ia}\beta_3 + F_{i36}\beta_4 + \epsilon_{ia} \tag{3.2}$$

Then, we include previous outcomes to control for the past early cognitive abilities of the child Y_{ik}, in the spirit of the *value added* approach:

$$Y_{ia} = \beta_0 + F_{i18}\beta_1 + X_{i9}\beta_2 + Z_{ia}\beta_3 + F_{i36}\beta_4 + \sum_{k=1}^{a-1} Y_{ik}\beta_k + \epsilon_{ia} \tag{3.3}$$

By including the past output of the child production function in the estimated equation, we implicitly control for the set of past inputs as well as for the child initial endowment and previous development. For the outcomes at age 3, since there are no previous outcomes, we include child endowments at 9 months, i.e., three factor variables that summarize the motion, motor and communication de-

[1]Obviously, we cannot control for formal care after age 3 on outcomes at age 3.

velopment of the child. At age 5, in addition to child endowments at 9 months, we control for outcomes at age 3; at age 7, we include child endowments at 9 months, outcomes at age 3 and 5; etc.

The results estimated using specification 3 can be considered as a lower bound of the true effect, since part of the impact of being in formal care has been absorbed by previous cognitive outcomes. For this reason, our preferred specification is specification 2.

Chapter 2 show the importance of maternal and paternal time inputs: to investigate how changes in the family structure affect child development, and how it interacts with attending formal care. Considering the large increase in the number of single-parent households in the UK from approximately 3% in 1958 to 25% today (see ONS, 2015), we finally estimate if the effect of attending formal childcare changes when the father is absent, using as a baseline equation specification 2:

$$Y_{ia} = \beta_0 + F_{i18}\beta_1 + X_{i9}\beta_2 + Z_{ia}\beta_3 + F_{i36}\beta_4 + F_{i18} * DA_{i9}\beta_5 + \epsilon_{ia} \tag{3.4}$$

where DA_{i9} is a dummy equal to 1 if the father is not present.

We then turned our interest to the potential role of formal care in reducing inequality, using a simulation approach, to evaluate the reduction of disparities (in terms of cognitive abilities) if more children attended formal care. It is known that children attending formal care generally come from high socio-economic backgrounds, while formal care mainly benefits those from families of low socio-economic status.

We utilize the percentage of children with low scores in cognitive tests (with a test below or equal to the results of the first quartile of the original distribution).

We first compute the percentage of children with low scores in the current/observed situation. Then, we progressively increase the number of children in formal care, allowing all children in the first, second, ..., tenth decile of the income distribution to attend formal care, and increasing their cognitive outcomes accordingly, exploiting the different return to attend formal care by level of income, while controlling for all the other independent variables. One drawback to this approach is the results cannot easily be generalized, since they depend on the income distribution of families with children in the UK at a particular time. Nevertheless,

the exercise can be informative of the impact of formal care in reducing cognitive disparities.

The underlying equation for the simulation is based on specification 2 and is as follows:

$$Y_{ia} = \beta_0 + F_{i18}\beta_1 + \sum_{l=2}^{10} I_l\beta_l + \sum_{l,m=2}^{10} F_{i18} * I_l\beta_m + X_{i9}\beta_2 + Z_{ia}\beta_3 + F_{i36}\beta_4 + +\epsilon_{ia} \quad (3.5)$$

where I_l refers to the income decile and $F_{i18} * I_l$ to the interaction between attending formal care and the income decile.

3.3 Data

The MCS is a longitudinal survey conducted by the Centre for Longitudinal Studies (CLS) that tracks the lives of a sample of about 19,000 children born in the UK in the year 2000/2001. The first wave of the survey, which was carried out when the children were around 9 months old, focuses on the circumstances of the pregnancy and birth as well as the first few months of life. The first part of the survey also contains important information about the socio-economic background of the family into which the child is born. Subsequent waves (2 through 5) took place when the children were about 3, 5[2], 7 and 11[3] years old, and the main focus was on continuity and change in the family as well as the parenting environment to extract information about the child's development. A number of variables were added, to follow and track the development of the child.

In wave 1, the survey consists of 18,552 children. We exclude twins and children whose main caregiver (and also the main respondent) in wave 1 is not the mother, since childcare arrangements and the development of the child may be different. In addition, we lose around 10% of the sample at every new wave due to attrition. Our main independent variable is formal childcare attendance when the child is 18 months old. It is constructed using retrospective information in wave 2 (when the child is 3 years old); however, a number of mothers (around 2,000) did not answer

[2]At the start of primary school.
[3]At the start of secondary school.

these questions, and are excluded from the sample (probably because of a filter error in the questionnaire).[4] We further select only children with valid measures of all the cognitive outcomes used in the analysis. Our final sample consists of a balanced panel of 7,240 observations.

The MCS contains a number of child cognitive and non-cognitive outcomes: the first set of outcomes is assessed by the interviewer through standardized tests of cognitive abilities, taken from validated cognitive tests for children, and focuses on the child's ability to perform certain tasks; a second set is reported by the teacher (starting when the child is 5 and 7) and concerns abilities and behavior at school; a third set is reported by the mother and regards the child's behavior at home. We only consider the first set of outcomes, because it is available from age 3 and because it is the most objective: the fact that the mother's report may be highly biased and the teacher's evaluations may be influenced by comparison of the child with others in the class are factors we are not able to control for.

We study the effect of formal childcare on the following outcomes: Bracken School Readiness assessment (at age 3), Naming Vocabulary (ages 3 and 5), Picture Similarity (age 5), Pattern Construction (ages 5 and 7), Word Reading Score and the Number Skills (age 7), Verbal Score (age 11), and Spatial Working Memory Time, Strategy and Errors (age 11).

The Bracken School Readiness test is used to assess basic concept development; the Naming Vocabulary verbal test assesses the spoken vocabulary of the child; the Picture Similarity test measures children's non-verbal reasoning (Connelly, 2013); the Pattern Construction test assesses the spatial problem-solving ability of the child (Connelly, 2013). The Word reading test gives an indication of the child's reading skills. The Number skills test evaluates the child's abilities in the areas of numbers, shape, and measures. The Verbal Similarities assessment is considered a measure of the ability to apply previous learning and experience to new situations (Sullivan and Brown 2014). The Spatial Working Memory task (SWM) measures participants' ability to preserve spatial information; it is also thought to measure the ability to reason and solve problems without prior knowledge or experience (Sullivan and Brown, 2014). The key outcomes are Strategy, Time taken until last

[4]Information on childcare arrangements is also available from wave 1, but only for working mothers.

response, and total Errors. Additional details on how the tests are carried out and their interpretation can be found in the Appendix. Table 3.1 shows the statistics of child cognitive outcomes.

Table 3.1: Descriptive statistics of child cognitive outcomes

Child cognitive outcome	**Mean**	**Std. Dev.**
Age 3		
School Readiness	105.99	15.75
Naming Vocabulary	50.96	10.99
Age 5		
Naming Vocabulary	55.97	10.28
Picture Similarity	56.46	9.97
Construction Score	51.79	9.5
Age 7		
Construction Score	54.37	10.52
Word Reading	113.32	17.45
Number Skills	9.94	2.68
Age 11		
Verbal Similarities	59.62	9.36
Spatial Working Memory Strategy	34.2	5.21
Spatial Working Memory Time (seconds)	28.6	6.22
Spatial Working Memory Errors	34.35	18.26
Observations	7,240	

To facilitate interpretation of the results, we transformed the outcomes into z-scores, with mean 0 and standard deviation 1; all of variables were also transformed so that higher scores are indicative of better performance.

The main variable of interest was being in formal childcare at 18 months. The main respondent was asked about the childcare choices made. We used information from the second survey (when the child is 3 years old), because at this point all the mothers (not just the working mothers) were asked details about the type of childcare used since the first survey. We chose childcare at 18 months to acquire information about the period before the assessment of the first outcome (measured when the child was about 3 years old).

We classified as formal care every type of nursery or crèche (e.g. workplace,

local authority, private, nursery school, nursery in primary school), special day school (for children with special needs), playgroup and combined child/family center. 12% of children in our sample are in formal care. The alternative category includes all other modes of care: supplied by: parents, grandparents, other relatives, friends or child-minders. Children are most often cared for by their parents (59% of children in the total sample).

3.4 Empirical Results

What we find from the data is that early formal care attendance is positively correlated with several cognitive outcomes, from age 3 up to age 11 (Table 3.2). Using the first specification, formal care has a positive and significant effect on School Readiness at age 3, Picture Similarity at age 5, Number Skills at age 7 and Spatial Working Memory Errors at age 11. However, formal care at 18 months has a negative and significant effect on Naming Vocabulary at age 3.

These results are robust to the inclusion of formal care attendance between the ages of 3 and 5 and to the inclusion of past outcomes. When we include also past outcomes, there is a small reduction in the estimated coefficients and level of significance for Number Skills and Spatial Working Memory Errors, which nonetheless remain positive and significantly different from 0. However, it is important to keep in mind that in those cases we have added 8 (11) variables controlling for past outcomes, which are highly correlated with the outcome of interest, and absorb part of the variation. The effect of formal care is stronger when the father is absent (specification 4), significant at age 3, and it turns out to be positive also on Naming Vocabulary.

While we cannot interpret these results as causal, the inclusion of all past outcomes should largely reduce the bias due to unobserved heterogeneity. At the same time, it is encouraging to notice that the results are not particularly affected by the inclusion of the past attainment. Thus, we are confident in considering specification 2 as our preferred specification.

Table 3.2: The effect of formal care on child cognitive outcomes

	Specification (1)	**Specification (2)**[a]	**Specification (3)**[b]	**Specification (4)**[c]	
	Formal care 18 months	**Formal care 18 months**	**Formal care 18 months**	**Formal care 18 months**	**Formal c.* Dad absent**
Age 3					
School Readiness	0.06*	–	0.06*	0.03	0.25**
	(0.03)	–	(0.03)	(0.03)	(0.11)
Naming Vocabulary	-0.11***	–	-0.11***	-0.14***	0.23**
	(0.03)	–	(0.03)	(0.04)	(0.09)
Age 5					
Naming Vocabulary	0.01	0.00	0.03	-0.01	0.17*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.10)
Picture Similarity	0.10***	0.10***	0.10***	0.11***	0.09
	(0.04)	(0.04)	(0.04)	(0.03)	(0.12)
Construction Score	0.00	0.00	0.00	-0.00	0.11
	(0.04)	(0.04)	(0.03)	(0.04)	(0.11)
Age 7					
Construction Score	0.04	0.03	0.02	0.05	0.13
	(0.04)	(0.04)	(0.03)	(0.04)	(0.11)
Word Reading	0.01	0.01	-0.00	-0.00	0.15
	(0.03)	(0.03)	(0.03)	(0.04)	(0.12)
Number Skills	0.07**	0.07**	0.05*	0.07**	0.12
	(0.03)	(0.03)	(0.03)	(0.03)	(0.12)
Age 11					
Verbal Similarities	-0.01	-0.01	-0.01	-0.01	0.14
	(0.03)	(0.03)	(0.03)	(0.04)	(0.11)
SWM Strategy	0.03	0.02	0.00	0.00	0.13
	(0.03)	(0.03)	(0.03)	(0.04)	(0.11)
SWM Time	0.06	0.06	0.04	0.05	0.12
	(0.04)	(0.04)	(0.04)	(0.04)	(0.11)
SWM Errors	0.11***	0.11***	0.08**	0.10**	0.11
	(0.04)	(0.04)	(0.03)	(0.04)	(0.12)

* p¡0.1; ** p¡0.05; *** p¡0.01. Robust standard errors in parentheses.
Total number of observations: 7,240.
[a] Controlling also for formal care between age 3 and 5 y.o.
[b] Controlling also for formal care between age 3 and 5 y.o. and for past cognitive outcomes.
[c] Controlling also for formal care between age 3 and 5 y.o. and for the interaction with father absent of the father at home.

Interestingly, formal care between the ages of 3 and 5 is seen to have a negative effect on Naming Vocabulary at age 5 (specification 2, not shown[5]); this seems to confirm the fact that children benefit most from a one-on-one relationship with adults (their parents, grandparents or babysitter, for example) in terms of vocabulary (see also Del Boca et al. 2014b).

With respect to past outcomes (specification 3, past outcomes not shown[6]), child endowments at 9 months have a positive and significant effect on outcomes at age 3, while their effects tend to vanish on subsequent outcomes. On the other hand, as expected, all cognitive outcomes from age 3 have a positive and significant impact on subsequent outcomes, with School Readiness (age 3) being one of those with the largest predictive power, at least until age 7. In addition to obvious correlations (Naming Vocabulary at ages 3 and 5; Pattern Construction at ages 5 and 7), it is worth mentioning that Pattern Construction at age 5 is highly correlated with Number Skills at age 7, and that Pattern Construction and Number Skills at age 7 are highly correlated with Spatial Working Memory outcomes at age 11. These findings are important not only per se, but also to understand the possible cumulative impact that early formal care may have, if it improves those outcomes (e.g. School Readiness).

We then estimate if there is any difference in the effects depending on the gender of the child (Table 3.3). To this end, we apply specification 1 for outcomes at age 3 and specification 2 for outcomes at age 5, 7, and 11. Findings show that both the positive effect of formal care on School Readiness at age 3 and the negative effect on Naming Vocabulary at the same age arise only for girls, with the size being much larger than at the average. Moreover, among girls attending formal care also significantly improves Word Reading (age 7) and Spatial Working Memory Time (age 11). On the other hand, the positive effect of formal care on Picture Similarity and SWM Errors is similar for boys and girls, while the positive effect on Number Skills arise only among boys. These results may indicate that formal care influences the outcomes on which girls - or boys - outperform the other sex, namely vocabulary and school performance for girls and 'math' skills for boys.

[5]Available from the authors upon request.
[6]Available from the authors upon request.

Table 3.3: The effect of formal care on child cognitive outcomes: gender heterogeneities

	Formal care 18 months	
	Boys	**Girls**
Age 3		
School Readiness	0.02	0.09**
	(0.05)	(0.04)
Naming Vocabulary	-0.06	-0.17***
	(0.05)	(0.04)
Age 5		
Picture Similarity	0.10*	0.11**
	(0.05)	(0.05)
Naming Vocabulary	0.03	-0.02
	(0.04)	(0.04)
Construction Score	0.00	0.02
	(0.05)	(0.05)
Age 7		
Word Reading	-0.04	0.09*
	(0.05)	(0.04)
Construction Score	0.04	0.03
	(0.05)	(0.05)
Number Skills	0.14***	0.01
	(0.05)	(0.04)
Age 11		
Verbal Similarities	0.02	-0.03
	(0.05)	(0.04)
SWM Strategy	0.07	-0.03
	(0.05)	(0.05)
SWM Time	0.01	0.10**
	(0.06)	(0.04)
SWM Errors	0.13**	0.09*
	(0.05)	(0.05)
Observations	**3,522**	**3,718**

* p¡0.1; ** p¡0.05; *** p¡0.01.

Robust standard errors in parentheses.

Controlling also for formal care between age 3 and 5 y.o. for outcomes at age 5, 7, and 11.

We also examined the predictors of attending formal care[7]: *ceteris paribus*, household income is positively correlated with attending formal care, as is the number of hours the mother works. On the other hand, children are less likely to be enrolled in early formal care if the mother does not work, if the father is present, and if there are siblings. Interestingly, the development of the child at 9 months has no effect on attending formal care. An increase in household weekly equivalent income by £100 would increase participation in formal care by 2 percentage points. Increasing the percentage of mothers with a high level of education by 25 percentage points (from 43% to 68%) would increase the number of children in formal care by 1 percentage point. These results indicate that while formal care is more common in wealthier families, indirect policies are not enough for stimulating higher attendance rates.

Our next step was therefore to investigate the possible effects of a policy introducing free formal care for all children in the first, second, ..., tenth deciles of household income. The starting point was about 12% of children 18 months old attending formal care on average. Table 3.4 presents some descriptive statistics about the attendance of formal care and labour market outcomes of the mother by income decile. As expected, there are fewer children in formal care in the lowest deciles (about 5-6%), while the attendance rate reaches 16% in the 8th decile, 25% in the 9th, and 33% in the top decile. Simultaneously, the percentage of mothers working increases along the wage distribution, from 16% to about 80%, as well as the number of hours worked and hourly wage.

When we allowed for children of each decile to attend formal care, we increased that measure by about 9% each time, from an attendance rate of 22.7% up to 100%, when children from every family background are enrolled in formal care. We simulate the percentage of children with low scores only for those outcomes for which formal care has a significant effect. Figure 3.1 presents the results for School Readiness and Naming Score at age 3, Picture Similarity (age 5), Number Skills (age 7), and Spatial Working Memory (age 11). The red point/bar represents the baseline condition, i.e., with the level of attendance and the percentage of children

[7]These are the results of a regression in which attending formal care is the dependent variable, and all the control variables mentioned earlier are the independent variables. In addition, we also control for the child endowments at 9 months. The results are not shown for the sake of brevity, but are available from the author upon request.

Table 3.4: Formal care attendance and mother's labour market outcomes by income decile

Income decile	Obs.	Formal care 18 months (mean)	Mother working	Mother's hours of work[a]	Mother's hourly wage[a]
1	753	0.06	0.16	21.97	5.81
2	677	0.04	0.24	19.92	9.82
3	638	0.05	0.42	21.25	6.05
4	652	0.06	0.57	21.16	8.42
5	827	0.07	0.70	23.01	7.74
6	906	0.09	0.75	24.73	9.65
7	284	0.11	0.75	23.24	11.15
8	803	0.16	0.79	26.70	11.03
9	597	0.25	0.81	27.54	14.67
10	606	0.33	0.78	28.37	15.99
Mean	6,743[b]	0.12	0.59	24.64	10.63

[a] Among working mothers.

[b] Observations with missing income have been ecluded.

with an outcome below or equal to the first quartile as it is before the simulation. For all the cognitive outcomes, increasing the number of children in formal care reduces the the percentage of children with the outcome below or equal to the first quartile as it was before the simulation, i.e., it reduces cognitive disparities. The effect is particularly strong in the medium-long term.

3.5 Conclusion

In this chapter, we have explored the link between early formal childcare and child cognitive outcomes in the United Kingdom, controlling for a large number of individual and family characteristics and past outcomes. However, as our analysis does not address the issue of endogeneity of inputs, the empirical results obtained should be considered indicative rather than definitive. What we found is that attendance of formal childcare at 18 months has a positive effect on most child cognitive outcomes. Specifically, formal care has a positive and significant effect

on School Readiness at age 3, Picture Similarity at age 5, Number Skills at age 7, and Spatial Working Memory Errors at age 11. Further exploration of this link simulating the impact of a policy to increases the number of children attending formal childcare suggests that an increase in the number of children attending formal care would significantly reduce cognitive disparities among children. These results confirm previous findings for the UK showing that pre-school formal education improves the cognitive abilities of disadvantaged children. The limitation of our exercise is its implicit assumption that the same patterns in the data hold true when the proportion of children in childcare is dramatically increased.

Figure 3.1: Reduction of inequality on cognitive outcomes at ages 3 through 11

Note: the red point/line represents the baseline condition, before the simulation.

3.A The cognitive outcomes

The tests used in the MCS are derived from standardized tests: the Bracken Basic Concept Scale-Revised, the British Ability Scale II, the Progress in Math test, and the Cambridge Neuropsychological Test Automated Battery. The Bracken School Readiness assessment is used to assess basic concept development in young children, and is one element of the Bracken Basic Concept Scale-Revised (BBCS-R), which measures the comprehension of 308 functionally relevant educational concepts in 11 subtests or concept categories. Only 6 subsets are implemented for the Bracken School Readiness used in the MCS: colors (primary and basic), letters (knowledge of upper- or lower- case letters), numbers/counting (single and double-digits numbers and assigning a number to a set of objects), sizes (concepts that describe one, two and three dimensions), comparisons (the ability to match or differentiate objects), and shapes (including lines, circles, squares, cubes and pyramids). The BAS (British Ability Scale II) Naming Vocabulary Verbal test assesses the spoken vocabulary of the child. Children are shown individual test items from booklets of colorful pictures of objects and asked to name the objects. The scale measures language ability; picture recognition is also crucial, but unlikely to cause problems (Hansen, 2012). Low scores may also reflect reluctance to speak. For the BAS Picture Similarity test, children are shown a row of 4 pictures on a page and asked to place a card with a fifth picture under the picture most similar to it. This assessment measures children's non-verbal reasoning (Connelly, 2013). The BAS Pattern Construction test assesses the child's accuracy and speed in constructing a design by putting together flat squares or solid cubes with black and yellow patterns on each side. The test assesses the spatial problem-solving ability of the child (Connelly, 2013). In the BAS Word reading test the child reads a series of words presented on a card out loud, thus giving an indication of his or her reading skills. The Number skills test is adapted from the National Foundation for Education Research (NFER) Progress in Math test. In this assessment, children complete various tasks, covering the topics of numbers, shape, space and measures, and data handling. In the BAS Verbal Similarities assessment, the interviewer reads three words to the child and the child must say how the words are related. It is considered a measure of the ability to apply what have been previ-

ously learned and experienced to new situations (Sullivan and Brown 2014). The Spatial Working Memory task (SWM) is drawn from the Cambridge Neuropsychological Test Automated Battery (CANTAB). It measures participants' ability to preserve spatial information; it is also thought to measure the ability to reason and solve problems without prior knowledge or experience (Sullivan and Brown 2014). The task is to find tokens hidden in boxes in the display. The key outcomes are Strategy (use of a search sequence to complete the tasks in the most efficient way), Time taken until last response, and total Errors.

4 Childcare Related Outcomes and the Role of Selection Criteria

Daniela Del Boca, Chiara Pronzato, Giuseppe Sorrenti

4.1 Introduction

According to the Italian National Institute of Statistics (ISTAT), despite growth in the number of childcare users in Italy over the last decade, still only 13% of children aged 0-2 obtained a slot in the public childcare system in 2013. Childcare policies are usually driven by two main considerations: Firstly, childcare is an important factor in enabling maternal employment; and secondly, childcare attendance contributes to children's cognitive and non-cognitive development later in life (Heckman et al., 2003). These considerations are particularly salient in institutional contexts with low rates of maternal employment and below-average student performance.

Italy is a clear case where childcare provision would yield considerable social benefits, given that its maternal employment rate and student performance are both considerably lower than elsewhere in Europe. Maternal participation in the labor market in Italy is just 54.5%, as opposed to approximately 80% in countries such as Denmark or the Netherlands, and Italian students perform well below the OECD average in both mathematics and reading, as indicated by the PISA 2012 cross-country assessment of children's standardized test scores. In this chapter we explore the link between childcare attendance, maternal employment and child outcomes in Italy, taking into account important features of the Italian system, such as childcare rationing.

4.2 The Italian childcare system

In spite of the recent growth in private sector provision of childcare services, the Italian childcare system is still mainly public. The past decade has seen a gradual increase in public expenditure on childcare by the municipalities, as well as in the number of municipalities providing childcare services (Table 4.A). However, both demand and supply of childcare remain low. The demand of childcare did not grow for two reasons. Firstly, the strong relationships within the family and the low mobility have favoured a persistent and crucial role of grandparents in caring grandchildren. Grandparents' care is not only cheaper, but also more convenient, flexible and reliable. Secondly, fertility rates remain low except among immigrant households.[1] Concerning the supply side, only about half of the Italian municipalities manage to provide public childcare services, and this is likely to be a limiting factor for maternal employment and child development.

The territorial divide in childcare provision is striking, with significant heterogeneity in school availability (and quality) between the North and the South. The percentage of children enrolled in public childcare - or in childcare centers financed by the municipality - is also highly variable. On average, 3.5% of children aged 0-2 in the south are enrolled in public childcare, whereas this figure reaches approximately 17% in central and northern Italy. Regional variability is even more pronounced. As shown in Figure 4.1, the min-max range at the regional level is around 25 percentage points. All of the regions that have less than 10% childcare coverage are in southern Italy, while the three regions with more than 20% coverage are in the north.

These disparities in public childcare services are driven by many different factors, but the main one is the availability of financial and economic resources to ensure service sustainability. Since financial and economic constraints are a problem in many areas, childcare prices and the criteria for selecting children who will attend become essential elements in guaranteeing a sufficient level of service coverage. On the one hand, policy makers can adjust the fees families are charged so as

[1] Immigrant households, who on average have a larger number of young children 0-6, cannot enjoy the vicinity of grandparents but do not use formal childcare because of monetary, cultural and information constraints. Moreover, often immigrant mothers are less likely to work.

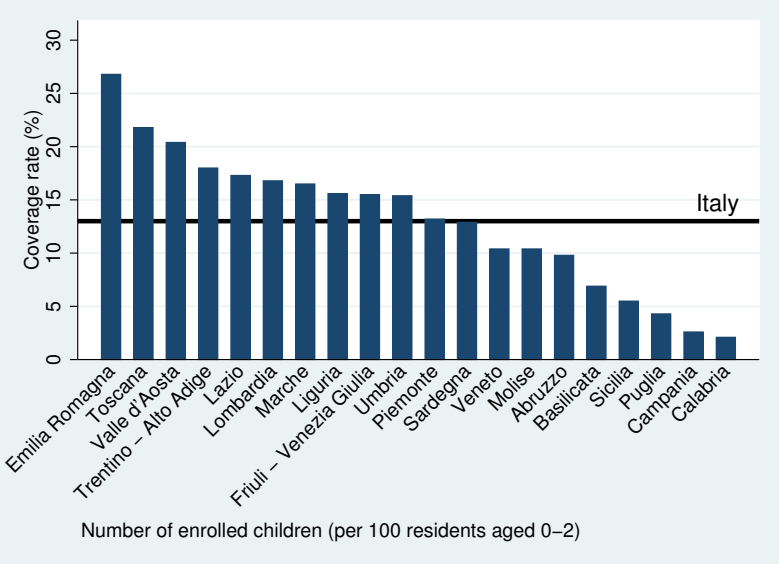


Figure 4.1: Childcare coverage across Italian regions

to guarantee at least partial coverage of childcare costs. On the other, municipalities can adapt their childcare selection criteria to regulate service access according to the social planner's needs and preferences. The pricing scheme and selection criteria are established by each municipality to best conciliate local families' demand for childcare with the municipality's financial constraints.

Childcare fees charged by each municipality are highly variable. For example, the average fee applied in Calabria in southern Italy is 164 euro, while a family with exactly the same characteristics is charged an average fee of 440 euro in Aosta Valley in northern Italy (Cittadinanzattiva, 2015). Section 4.5 provides a brief explanation of the possible effects of using different fee schemes.

The selection criteria applied by each municipality also vary widely. Almost all of the municipalities select individuals according to the same general criteria, although they assign these criteria different definitions and relative weights. Criteria such as children with disabilities or (family) risk of social exclusion are priority criteria in all municipalities. Other criteria refer to household composition, parental employment status and socio-economic conditions of the household. The choice of the set of criteria to be used is not free of concerns, as it generates numerous effects for the population and the municipality. We will simulate such possible

effects in the remainder of the chapter.

To sum up, the characteristics of the Italian case allow us to explore the effects of early childcare on maternal employment and child outcomes, as well as to evaluate the impact of different formal childcare selection criteria. In Section 4.3, we provide empirical estimates of the link between childcare provision and maternal employment. In Section 4.4, we report empirical estimates of the link between childcare and child outcomes. Finally, in Section 4.5 we take into account rationing in public childcare access together with fee schemes and formal childcare selection criteria. Simple simulation exercises indicate that the fees and selection criteria applied by each municipality impact the costs and benefits of childcare provision.

4.3 Childcare and maternal employment

The impact of childcare use on maternal employment is difficult to assess. The potential endogeneity of childcare use makes it difficult to interpret the results as causal. Here we compare two different empirical strategies of exploring the link between childcare and maternal employment in Italy.

The first strategy aims at understanding the effect of public childcare availability on maternal employment when the child is in the second grade of primary school (7 years old). The dataset used is from the Italian Institute for the Evaluation of the Education System (INVALSI), and it collects information about the parents' and children's characteristics such as parents' work and educational status, and children's gender and immigration status. The data set also contains a variable related to childcare attendance when the child was less than 3, but is not reliable due to the large number of missing variables (40%). To address this limitation, individual information about childcare attendance is substituted with childcare coverage at the provincial level experienced by each individual in the sample. As a result, the effect of interest should be interpreted as an Intention to Treat effect (ITT). Table 4.1 reports the main results of both OLS and GLS specifications. The GLS specification is implemented to take into consideration the error components at the provincial level.

Both the OLS and GLS coefficients of childcare provision on maternal em-

ployment are positive and statistically significant. The magnitude of the effect is sizable: an increase of 10 percentage points in coverage results in an increase of around 13-15 percentage points in the mothers' probability to be employed.

Table 4.1: Public childcare provision and mother's working status

Dependent Variable: **Mother's working status**	(1) OLS	(2) GLS
Childcare coverage	0.015***	0.013***
	(0.002)	(0.002)
Clusters	101	101
Observations	25,287	25,287

Note: Brilli et al. (2016). The following control variables are included in the models: Male (children), Non-Italian (children), Father tertiary education, Mother tertiary education, GDP per capita, Pre-primary enrollment rate, School size, School size squared, Private primary schools, Graduates, Employment rate public services, Employment rate health-social services. Standard errors are clustered at the provincial level and are robust for heteroskedasticity. Significance level: * p¡0.1; ** p¡0.05, *** p¡0.01.

This positive and significant relation is also confirmed in Pronzato and Sorrenti (2015), whose analysis was based on a representative panel dataset (EU-SILC) of Italian women observed between 2004 and 2010.[2] The advantage of a panel dataset is that it allows us to observe individual changes in employment status occurring during the period of observation. By selecting all the mothers with a child aged 0-3, one obtains a sample of 921 mothers with information about employment status both in the trimester preceding childbirth and when the child is three years old - therefore, at the end of early childcare. Unfortunately, the EU-SILC dataset does not provide childcare attendance figures, so regional childcare coverage at different points in time is used as the variable of interest instead. This choice was made in attempt to reduce potential bias generated by the endogeneity of childcare attendance. At the same time, the results (reported in Table 4.2) again need to be interpreted as an Intention to Treat Analysis (ITT). All the models

[2]The EU-SILC dataset (European Union Statistics on Income and Living Conditions) collects multidimensional microdata about income, social exclusion and living conditions across all the European countries. Both cross sectional and panel level data are available.

are estimated by the use of a Logistic regression model as the dependent variable takes the value of 1 when the mother is employed or 0 otherwise. The first column refers to the whole sample, while in columns (2) and (3) heterogeneous effects are investigated. The heterogeneous effects are based on the comparison between the childcare effect in the sub-populations of mothers who worked and those who did not work before childbirth.

The effect of childcare provision on maternal employment appears strongly significant and positive. Childcare availability affects mothers' employment through at least two different potential channels. Firstly, it increases the individual probability of a shift from unemployment to employment. Secondly, it helps employed women keep their job after childbirth. According to our estimates, a 1 per cent point increase in childcare provision is associated with an increase of approximately 0.6 percentage points in the individual mother's probability of working. This effect is driven by a specific sub-group of mothers, namely those who were unemployed at childbirth. For these mothers, childcare provision appears to be more important to conciliate their working needs with their maternal status. The coefficient for this specific sub-group of mothers is almost twice as large as the average effect found in the whole sample. In contrast, the effect for the group of mothers working before childbirth is positive, but considerably smaller in magnitude.

4.4 Childcare and children's outcomes

Evidence about the impact of childcare provision on children's outcomes in Italy is scarce, mainly due to the limited availability of appropriate longitudinal dataset for quantifying the link between early education (age 0-6) and future individual outcomes.

The INVALSI dataset allows estimation - with the same identification strategy shown in Section 4.3 - of the effect of an increase in childcare availability on children's outcomes measured as performance on standardized tests in Language and Mathematics.[3] The Intention to Treat effects of childcare availability are

[3]INVALSI assesses the abilities and knowledge of students enrolled in second, fifth and sixth grades. The dataset, in addition to test scores, collects a set of information about children's and parents' characteristics, making it possible to control for some observable characteristics likely

Table 4.2: Public childcare provision and mother's working status

Dependent Variable: Mother's employment	(1) Logit	(2) Logit	(3) Logit
Childcare coverage	0.28**	0.23	0.62***
	(0.11)	(0.19)	(0.20)
Sample	All	Working before childbirth	Not working before childbirth
Observations	921	374	547

Note: Pronzato and Sorrenti (2015). The following control variables are included in the models: Age, Age squared, Secondary school indicator, Tertiary school indicator, two-parent household indicator, Younger siblings indicator, Older siblings indicator. All the models also include regional and time dummies. Standard errors are clustered at regional level and robust for heteroskedasticity. Significance level: * p¡0.1; ** p¡0.05, *** p¡0.01.

reported in Table 4.3. Columns (1) and (2) report the coefficients for the Language test score, while columns (3) and (4) refer to the Mathematics test score. As in the case of maternal employment, both OLS and GLS specifications are estimated, so as to take into account the error components at the provincial level.

Childcare coverage at the provincial level largely affects children's performance as measured by the Language test score. The coefficient is positive and statistical significant. A 1% increase in availability is associated with an increase of around 0.23 points in test score.[4] In contrast, the effect on mathematics is negative, although very small in magnitude and not statistically significant. The Intention to Treat analysis provides interesting insights into the sign and size of childcare effects, although it also incorporates other channels in the overall estimated effect, such as peer and spillover effects due to related policies. Using ISFOL data, Del Boca, Pasqua and Suardi (2016) provide additional evidence on the impact of childcare attendance by using children's grades in high school as the outcome of interest.[5] They address the issue of endogeneity of childcare attendance using an

to affect test scores.

[4]This effect corresponds to around 0.85% of a standard deviation.

[5]The dataset used in this study is the Italian ISFOL-PLUS dataset, year 2008. The dataset

instrumental variable technique, and they find a positive and significant impact of childcare attendance.

Table 4.3: Public childcare provision and children's outcomes

Dependent Variable:	**Language test score**		**Mathematics test score**	
	(1) OLS	(2) GLS	(3) OLS	(4) GLS
Childcare coverage	0.233***	0.195***	-0.010	-0.001
	(0.062)	(0.069)	(0.042)	(0.055)
Clusters	101	101	101	101
Observations	33,708	33,708	33,708	33,708

Note: Brilli et al. (2016). The following control variables are included in the models: Male (children), Non-Italian (children), Father tertiary education, Mother tertiary education, GDP per capita, Pre-primary enrollment rate, School size, School size squared, Private primary schools, Graduates, Employment rate public services, Employment rate health-social services. Standard errors are clustered at province level and robust for heteroskedasticity. Significance level: * p¡0.1; ** p¡0.05, *** p¡0.01.

4.5 The role of selection criteria

One of the most peculiar aspects of the Italian public childcare system is the presence of rationing. In all Italian regions, demand for childcare is greater than supply, and in some Italian regions (e.g. Basilicata) only 2 out of 3 children have access to childcare.

In a context of excess demand, the social planner adopts a rationing system that allocates the available slots according to its own preferences and a series of constraints. The Italian case is particularly interesting in terms of the role of the social planner's choices in shaping the outcomes related to childcare provision. In fact, the decision-making process for childcare policies related to children aged 0-3 is highly decentralized. The central government establishes the common standards

provides information on each respondent's demographic characteristics, as well as a set of retrospective information on the individual's school grades at the end of junior high school, high school, and university; along with - in the 2008 wave only - information about the respondent's formal childcare attendance and mother's employment status when she/he was under age of three.

and minimum level of supply, the regions define the general management criteria, and each single municipality is responsible for the specific choice of fees, selection criteria and coverage. This decentralization is the primary source of territorial heterogeneity in terms of childcare supply. It also makes it possible for us to analyze the choices made and their social impact by comparing different municipalities. Each municipality establishes both a fee scheme and a selection rule to choose among applicants. Both choices are likely to generate several consequences and externalities at the social level.

Regarding the fee schemes applied, an extremely heterogeneous background appears when different geographical areas are compared. In Figure 4.2 we show an example based on a simple simulation exercise in which the population of childcare users is held constant, and the real fees from six Italian cities are applied.[6] By applying the same selection criteria, we obtain a minimum average fee of 110 euro (Rome) versus a maximum value close to 275 euro (Reggio Emilia). This variability underlies different preferences at the municipality level when it comes to establishing how much to charge childcare users. As already noted, the fee scheme chosen is one of the social planner's tools for selecting childcare demanders. The other tool is the choice of selection criteria to gain access to the service.

The use of selection criteria to address excess demand emerges from comparison across municipalities. Selection criteria applied by municipalities present two different sources of variation. At a first sight, criteria are similar in terms of household/individual characteristics used to assign scores to each applicant. Such similarity is only apparent as it is almost impossible to find two municipalities in Italy adopting the same selection criteria into formal childcare. Municipalities indeed use different ways to define criteria concerning the same characteristics, e.g. parental working status. The second source of variation concerns the relative weight assigned to each of the selection criteria adopted. Although the single criteria are similar across municipalities, the same does not apply in terms of the relative importance they are accorded.

Table 4.B shows the general characteristics of the selection criteria implemented

[6]The potential users are selected with Turin criteria from a representative sample of the Italian population of households with a child aged 0-3. The six sets of criteria are the ones implemented by the municipalities of Turin, Milan, Reggio Emilia, Bologna, Rome and Naples.

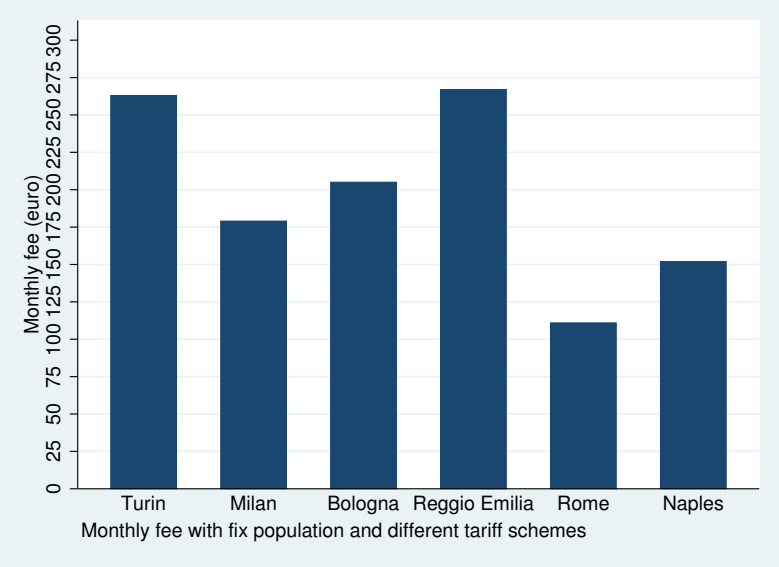


Figure 4.2: The effect of tariff schemes

throughout Italy. Priority status is granted in all municipalities to children with disabilities or coming from families with serious socio-economic problems. The other criteria usually implemented refer to parental working conditions (e.g., unemployment status, employment status, working conditions) and household conditions (e.g., single-headed family household, household economic resources). Surprisingly, approximately 18% of municipalities do not implement selection criteria, instead assigning slots according to ad hoc and informal selection rules. Apart from a different set of applied criteria, each municipality also assigns a different relative weight to each of the criteria. For instance, in around 16% of the municipalities, parental working status contributes to more than 60% of the maximum score attainable. Instead, in 7% of Italian municipalities parental working status accounts for less then 20% of the maximum score (Pavolini and Arlotti, 2013).

A similar framework is used to examine the costs and benefits of the heterogeneous choices made by the municipalities. We therefore empirically explored the impact of selection criteria both in terms of municipality revenues and childcare related outcomes. In particular, we performed a simulation of the effects of different - real - criteria used by six Italian municipalities on the same representative popu-

lation of Italian households demanding childcare service.[7] By applying a fixed fee scheme, a fixed acceptance rate of 50% and different - real - selection criteria to the same population of demanders, one can observe the effects induced by the choices made by each individual municipality.Admittedly, our analysis might be considered as a relevant, although not conclusive, starting point for further research aimed at understanding the effect of different policies applied to the childcare sector. A set of assumptions aimed at simplifying the analysis are at the basis of our results. The first simplification in our setting is the absence of a private childcare sector. This assumption makes our simulation an upper bound of the real effect induced by selection criteria, as many of the children excluded - by the public childcare system - are likely to obtain childcare benefits from the private sector. The second underlying assumption of our setting is that all families apply for a childcare slot in the public service. In particular, we assume that all the individuals in our sample decide to apply for a slot in the public childcare. This assumption, although particularly strict, is theoretically plausible as the public childcare is usually cheaper than the private counterpart. Moreover, we observe that the common practice in Italy is to apply for public childcare slots and only in case of unsuccessful application to move towards the private sector.[8] Finally, the results of our empirical exercise rely on a last assumption. We assume parental behavior not to be influenced by the selection criteria themselves.

After an introduction of the general empirical setting, our first finding concerns how much revenue a potential municipality would generate under the six different selection criteria schemes. Figure 4.3 summarizes the results by comparing the simulated monthly fee in euros per slot for each of the six different selection criteria.

The introduction of different selection criteria while maintaining both the number of slots and the applied fees sheds light on the considerable variation in terms of average monthly fee per childcare slot. The criteria from Turin and Bologna generate average fees of around 260 euros, but exceed 300 euros when the case of Milan, Reggio Emilia and Naples criteria are considered. The impact of selection

[7] See Del Boca et al. (2016) for further details about the simulation setting.

[8] Obviously, it cannot be completely excluded the possibility that some families decide to apply directly to the private childcare system, as it is more flexible or because they know that they will not be admitted in the public service. This possibility will partially violate the last two assumptions.

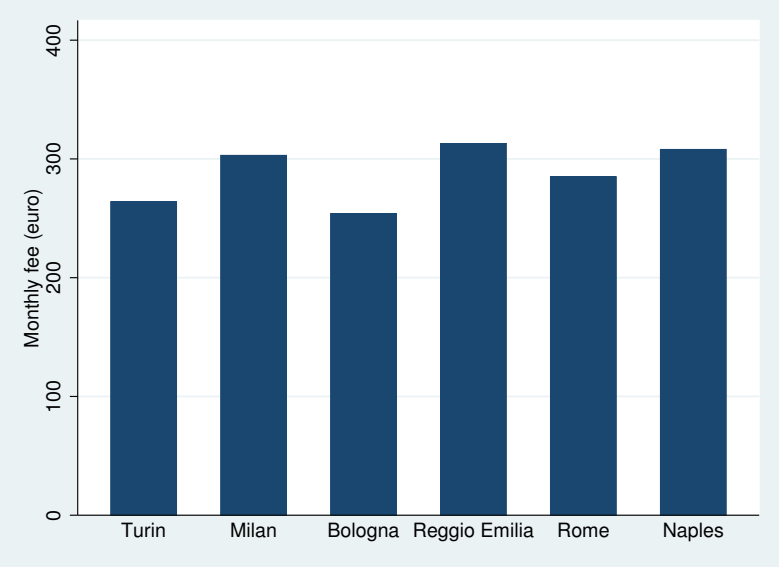


Figure 4.3: Selection criteria and municipality revenues

criteria is extremely important in determining the economic sustainability of childcare services. Municipalities collecting higher average fees are likely to reach better levels of economic sustainability of service. although the cost of economic sustainability should also be measured in terms of social benefits induced by childcare provision.

Maternal employment also proves to be potentially affected by the selection criteria for formal childcare, especially when the effect of childcare is heterogeneous across different sub-groups of mothers. In order to simulate the impact of selection criteria on maternal employment, we firstly estimate the childcare effect on maternal employment using a representative dataset of Italian childcare users.[9] In particular, we focus the attention on the effect of childcare attendance on the mother's work status when the child is seven years old. We also quantify the heterogeneity of such effect by comparing mothers working and not working at the moment of application for early childcare. The results of the estimates are reported in Table 4.4. Estimates show a remarkable effect of childcare provision on those mothers without a work when their child entered in childcare.

[9]More details on the dataset and the results are available in Del Boca et al. (2016)

Table 4.4: Heterogeneous effects of formal childcare on mothers' employment

	(1)	(2)	(3)
Dependent Variable: Mother's employment (child 7 y.o.	Mother not employed when child aged 3	Mother employed when child aged 3	Whole sample
Formal childcare (FCC)	0.253***	-0.032	0.278***
	(0.057)	(0.035)	(0.048)
FCC*Mother employed$_{child3}$			-0.334***
			(0.067)
Mother employed$_{child3}$			0.475***
			(0.049)
Observations	243	257	500
R^2	0.333	0.264	0.349

Note: Del Boca et al. (2016). All the models include controls for gender (child), age, presence of siblings, mother's and father's education, IQ score (child), single-parent household, house ownership and migrant status. Robust standard errors are reported in parenthesis. *** indicates significance at 1% level, **indicates significance at 5% level, * indicates significance at 10% level.

We exploit estimates in Table 4.4 to simulate the effect of different selection criteria. Figure 4.4 shows the comparison across cities when maternal employment is the outcome of interest.

The choice of selection criteria is associated with different levels of benefits when the benefit is defined as the increase in maternal employment compared to an initial benchmark with no childcare provision. Some municipalities, likely in response to low levels of women's employment, have chosen criteria geared towards increasing female participation in the labor force. The criteria adopted by Turin generate a potential increase in maternal employment of around 7 percentage points. On the contrary, Milan gives priority to a different group of less disadvantaged potential users and, unsurprisingly, in this case the gain is only around 2.5 percentage points.[10]

[10]This comparison between revenues and gains in maternal employment rates shows the trade-off stemming from different selection criteria. On the one hand, criteria such as those used in Turin seem to generate higher social benefits, while on the other, the criteria implemented in Milan guarantee greater economic sustainability of service. The latter could be decisive in being able to provide more slots in the following years or in increasing the quality of the service etc. It

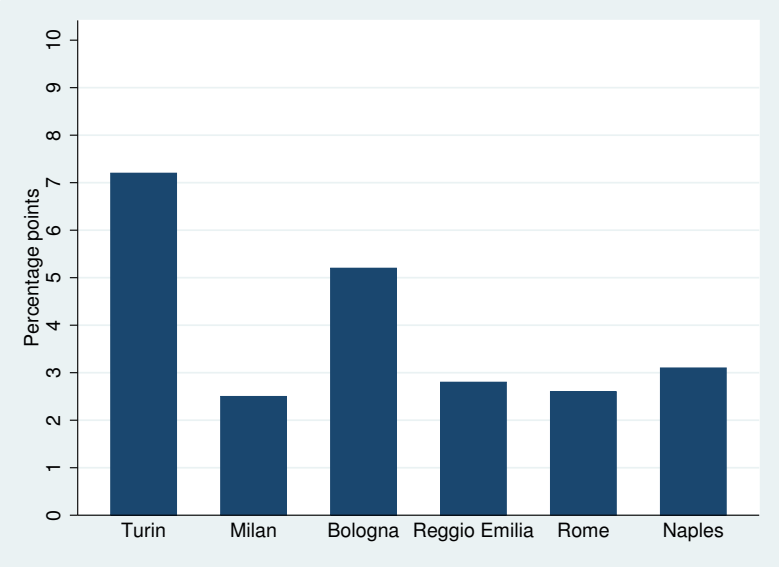


Figure 4.4: Selection criteria and maternal employment

Other benefits of childcare provision concern child outcomes. Here we repeat our simulation by considering two different types of child outcomes. Firstly, we present preliminary evidence on non-cognitive outcomes, and then we focus on some proxies for cognitive skills. In terms of non-cognitive skills, we have chosen attitude towards reading and pro-social behavior as the variables of interest, while performance on Mathematics and Italian standardized tests are used as measures of cognitive development. Table 4.5 reports the baseline estimates used to simulate children's non-cognitive benefits. The setting is similar to the one used for maternal working status. The sources of investigated heterogeneity relate to household composition (single-headed households and number of siblings) and parental unemployment. In Panel (a) we focus on attitudes towards reading, while in Panel (b) the outcome is pro-social behavior.[11] Pro-social behavior is measured in a 10-points scale compiled by the mother, where 10 indicates the highest pro-social behavior. Findings highlight a positive effect of childcare on reading attitudes. The effect is driven by children from disadvantaged backgrounds (i.e., living in a

is not the aim of this work to establish the set of criteria that must be implemented, since too many factors determine the final output.

[11] As for the case of maternal employment, further details about the dataset, the variables and the results are available in Del Boca et al. (2016).

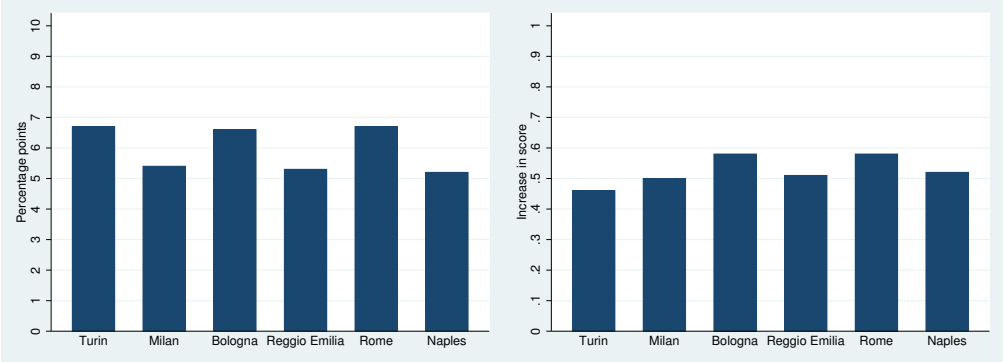
single-parent family, having siblings, or in a family in which the parents are unemployed). We also find a positive childcare effect on pro-social behavior for all the children, and particularly for children who live in a single-headed household or who have no siblings.

Table 4.5: Heterogeneous effects of formal childcare on children's outcomes: Like reading

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Both parents	One parent	No parental unemployment	Parental unemployment	Only children	With sibling	Whole sample
Panel (a) - Dependent Variable: Like reading							
Formal childcare (FCC)	0.113**	0.317	0.086	0.246***	0.106	0.152***	0.059
	(0.047)	(0.206)	(0.059)	(0.078)	(0.108)	(0.053)	(0.098)
FCC*Single-headed fam. hh.							0.229
							(0.189)
FCC*One parent unemployed							0.091
							(0.105)
FCC*Siblings							0.034
							(0.109)
Single-headed family household			-0.262	-0.157	0.228	-0.214*	-0.271*
			(0.284)	(0.114)	(0.188)	(0.112)	(0.160)
One parent unemployed	-0.069	0.185			-0.327**	-0.020	-0.097
	(0.055)	(0.633)			(0.156)	(0.059)	(0.074)
Observations	449	43	308	184	114	378	492
R^2	0.113	0.335	0.109	0.165	0.155	0.117	0.115
Panel (b) - Dependent Variable: Pro-Social behavior							
Formal childcare (FCC)	0.670***	1.813*	0.700***	0.705***	1.169***	0.592***	1.147***
	(0.158)	(0.910)	(0.197)	(0.263)	(0.297)	(0.186)	(0.327)
FCC*Single-headed fam. hh.							1.080*
							(0.639)
FCC*One parent unemployed							-0.336
							(0.353)
FCC*Siblings							-0.473
							(0.360)
Single-headed family household			-0.602	-0.067	0.010	-0.544	-1.157**
			(0.947)	(0.378)	(0.509)	(0.397)	(0.537)
One parent unemployed	0.308*	-2.230			-0.131	0.283	0.460*
	(0.183)	(2.798)			(0.431)	(0.210)	(0.246)
Observations	455	43	310	188	118	380	498
R^2	0.205	0.238	0.268	0.203	0.321	0.185	0.202

Note: Del Boca et al. (2016). All the models include controls for gender (child), age, presence of siblings, mother's and father's education, IQ score (child), single-parent household, house ownership and migrant status. Robust standard errors are reported in parenthesis. *** indicates significance at 1% level, **indicates significance at 5% level, * indicates significance at 10% level.

The simulated effect of childcare provision according to different selection criteria are graphically represented in Figure 4.5. Panel (a) depicts the case of attitude towards reading, while Panel (b) refers to pro-social behavior. With childcare slots assigned according to Turin's criteria, the increase in the number of children reporting a positive attitude towards reading reaches almost 7 percentage points; similar values are found using criteria from Bologna and Rome. According to the criteria applied in Milan, instead, the increase is 5.3 percentage points. Attitude towards reading is only one of the several outcomes possibly related to childcare attendance, and the effect of selection criteria strongly depends on the chosen outcome. If criteria such as those applied in Turin seem to out-perform those of Milan when reading is considered as outcome, the contrary is true when pro-social behavior is analyzed. Panel (b) shows a higher increase in pro-social behavior score for the case of Milan's criteria when compared to Turin.



(a) *Like reading* **(b)** *Pro-social behavior*

Figure 4.5: Selection criteria and children non-cognitive outcomes

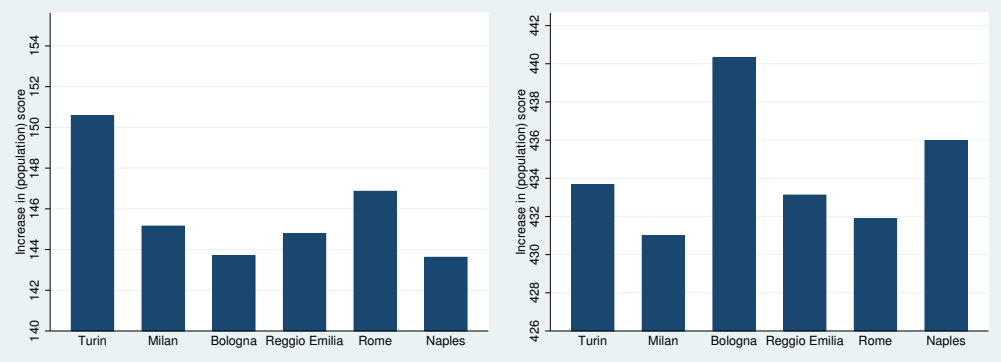
Figure 4.6 replicates the analysis considering cognitive skills as outcomes of interest. Before to simulate the effect of selection criteria, we estimate the impact of childcare provision on cognitive skills using a standardized test - INVALSI - performed by almost the entire Italian population of students aged 7 years old (second year of the elementary cycle of education).[12] We test heterogeneity according to a dual criterion. Firstly, we rely on the difference between migrants and natives

[12]Refer to www.invalsi.it for further details about the INVALSI test.

citizens and, secondly, we compare households with at least one parent with tertiary education with those households with no parents with tertiary education. Results, measured in terms of childcare effect on the mathematics standardized test score, suggest a higher impact of childcare for non-native children (0.53 vs. 0.21) and for children from households without parents with tertiary education (0.26 vs. 0.19). The case of the Italian language test score is particularly interesting because it shows a different process of skills acquisition.[13] On the one hand, the effect of childcare is similar when it comes to the analysis of the migration status (0.77 for immigrants vs. 0.74 for natives). On the other hand, the effect of childcare on linguistic skills is more pronounced for children with parents with tertiary education (0.68) with respect to the less educated counterpart (0.19). This difference is likely to be explained by complementaries between parental education, home environment, childcare attendance and the acquisition of linguistic skills. In terms of simulations, Panel (a) depicts the case of Mathematics. A municipality assigning 605 childcare slots, corresponding to a 50% acceptance rate in our dataset, generates an overall increase in Mathematics performance if Turin's criteria are adopted. When the criteria adopted by cities such as Bologna or Naples are applied, this increase decrease to around 143 points. In contrast, the benefits produced by Bologna and Naples are remarkably higher when compared to other municipalities in terms of children's knowledge of Italian. Panel (b) represents the case of linguistic skills and it highlights an increase of around 440 points for the case of Bologna, while the value is below 434 points when using Turin's criteria.

What bears noticing is that it is impossible to devise a universally optimal set of criteria to be adopted. The choice and the outcomes of different acceptance schemes are strongly dependent on the municipalities' preferences, constraints and population of potential users.

[13] A similar evidence strongly supports the idea that it is impossible to determine selection criteria that are universally preferable. This impossibility origins from the fact that the childcare effect is likely to be heterogeneous according to a multiplicity of dimensions. As a consequence, the choice of selection criteria might be always driven by municipality's preferences and community's needs.



(a) *Mathematics* **(b)** *Italian*

Figure 4.6: Selection criteria and children's cognitive outcomes

4.6 Conclusion

In this chapter, we have analyzed the costs and benefits of Italian childcare (child outcomes and maternal employment) by exploring the impact of the selection rules implemented by different municipalities. Our results show that childcare provision affects both child outcomes and maternal employment.

The selection criteria to gain access to childcare vary widely throughout Italy. These criteria are likely to play a significant role in shaping the benefits of maternal employment and child outcomes as well as contributing to the economic sustainability of the service. Economic sustainability is required in order to guarantee lasting, high-quality service, and consequently, its positive effects on long-term local development. Our findings indicate that the benefits for child outcomes and maternal employment seem to be stronger in municipalities where the selection criteria give priority to more disadvantaged households. However, in these circumstances, selected households are likely to be less able to contribute to the financial sustainability of the service.

4.A The public childcare system in Italy

	2003/04	2004/05	2005/06	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Users	146.152	150.110	159.909	165.214	176.262	192.944	201.640	201.565	193.160
Total expense (millions of Euro)	1.035	1.111	1.167	1.256	1.367	1.447	1.502	1.534	1.567
Expense by municip. per user (Euro)	5.823	5.996	5.960	6.174	6.343	6.126	6.085	6.177	6.549
Total expense per user (Euro)	7.082	7.401	7.298	7.602	7.755	7.500	7.449	7.610	8.112
Expense paid by users (%)	17,5	18,6	18,0	18,5	17,9	18,0	18,3	18,8	19,0
Municip. offering the service (%)	32,8	35,2	36,7	38,3	40,9	48,3	47,4	48,1	52,7

Note: data for 2006/07 not available.

4.B Selection criteria in public childcare: Typology of criteria

Municipalities that adopt selection criteria:	% of Municipalities
General ones and not explicitly defined and measured	18.5
Priority given to children with disabilities or coming from households with relevant socio-economic problems	100
Different treatment of single parents households depending on the reason why the child lives only with one parent	31.9
A specific score given in case of parent(s) employed	98.7
A specific score given depending if the parents works part-time or full-time	61.0
A specific score given in case of parent(s) unemployed	78.7
A specific score given in case of parent(s) unstable working condition (fixed-term contracts, etc.)	35.9
A specific score given in case of parent(s) who are students	69.7
A specific score given in case of parent(s) who are not participating in the labor market for other reasons	29.7
A specific score is given depending on the economic resources the household has	37.3

Note: Pavolini and Arlotti (2013).

References

[1] Bernal, R. (2008), "The Effect Of Maternal Employment And Child Care On Children's Cognitive Development," *International Economic Review*, 49:4, 1173–1209.

[2] Bernal, R., and M. P. Keane (2011), "Child care choices and children's cognitive achievement: The case of single mothers." *Journal of Labor Economics*, 29:3, 459–512.

[3] Biroli P., Conti, G. Del Boca, D., Giudici C., Heckman, L. and Pronzato, C. (2014). "Evaluating the Impact of the Infant Toddler Centers and Preschools Children: the Reggio Approach", mimeo, University of Chicago.

[4] Blanden, J., Del Bono, E., Hansen, K., Mac Nally, S. and B. Rabe (2014), "Early interventions and children's educational attainment. Evaluating the impact of free part-time pre-school education for 3 year olds in England" ISER (University of Essex).

[5] Blau, D., (1999), "The Effect of Income on Child Development", *Review of Economics and Statistics*, 81, 261-276.

[6] Brilli, Y. (2015), "Mothers' time allocation, child care and child cognitive development", EUI MWP Working Paper 03.

[7] Brilli, Y., Del Boca, D. and Pronzato, C. (2016), "Does child care availability play a role in maternal employment and children's development? Evidence from Italy." *Review of Economics of the Household*, 1: 27–51.

[8] Bryson, C., Brewer, M., Sibieta, L. and Butt,S. (2013), "The role of informal childcare: understanding the research evidence". Report Nuffield Foundation.

[9] Cardoso, R. A., Fontainha, E. and Monfardini, C. (2010), "Children and Parents' Time Use: Empirical Evidence on investment in Human Capital in France, Italy and Germany," *Review of the Economics of the Household,* 8, 479-504.

[10] Carneiro, P., and Heckman, J. J. (2003), "Human Capital Policy." In: Heckman, J. J., A. B. Krueger, and B. M. Friedman (eds). *Inequality in America: What Role for Human Capital Policies?* Cambridge, MA: MIT Press, 77–239.

[11] Cittadinanza Attiva (2013), "Gli asili nidi tra caro rette e liste d'attesa", Dossier Osservatorio Prezzi e Tariffe, Rome.

[12] Connelly, R. (2013), "Interpreting Test Scores", Millennium Cohort Study Data Note 2013/1, London: Centre for Longitudinal Studies.

[13] Cunha, F. and Heckman, J. (2008), "Formulating and Estimating the Technology of Cognitive and Noncognitive Skill Formation," *Journal of Human Resources*, 43, 738-778.

[14] Cunha, F., Heckman, J., and Schennach, S. (2010), "Estimating the Technology of Cognitive and Non-Cognitive Skill Formation," *Econometrica*, 78: 3, 883-931.

[15] Datta Gupta, N. Simonsen, M. (2010), "Noncognitive Child Outcomes and Universal High Quality Child Care", *Journal of Public Economics*, 94(1-2):30-43.

[16] Del Boca D. (2015a), "Child care arrangements and labor supply", IDB Working paper 88074 Inter-American Development Bank May 2015.

[17] Del Boca D. (2015b), "Child care Choices and Child Outcomes", IZA World of Labor March 2015.

[18] Del Boca, D. and Vuri, D. (2007), "The Mismatch between Employment and Child Care in Italy: the Impact of Rationing", *Journal of Population Economics*, 20(4), 805-832.

[19] Del Boca, D., Flinn, C. and Wiswall, M. (2014), "Household choices and child development."' *Review of Economic Studies*, 81:2, 137–185.

[20] Del Boca, D., Piazzalunga, D. and Pronzato, C. (2014), "Early child care and child outcomes : the role of Grandparents" IZA Discussion Paper 8565, Institute for the Study of Labor.

[21] Del Boca, D., Monfardini, C. and Nicoletti, C. (2016), "Self investments of adolescents and their cognitive development." *Journal of Labor Economics*, forthcoming.

[22] Del Boca, D., Pasqua, S. and Suardi, S. (2016), "Child care, Maternal Employment, and Childrens' School Outcomes. An Analysis of Italian Data", *European Journal of Population*, 32(2), 211-229.

[23] Del Boca, D., Pronzato, C. and Sorrenti G. (2016b), "When Rationing Plays a Role: Selection Criteria in the Italian Early Childcare System", CESifo Economic Studies, 62 (4), 752-775.

[24] Ermisch, J., and Francesconi, M. (2005), "Parental Employment and Children's Welfare," in *Women at Work: An Economic Perspective*, edited by Boeri, T., Del Boca, D., and Pissarides, C. Oxford: Oxford University Press.

[25] Felfe, C. and Lalive, R. (2014), "Does Early Child Care Help or Hurt Children's Development?", IZA Discussion Paper 8484, Institute for the Study of Labor.

[26] Gugl, E., and Welling, L. (2010), "The Early Bird Gets The Worm? Birth Order Effects In A Dynamic Family Model", *Economic Inquiry*, 48,690-703.

[27] Gormley, W. T. (2008), "The effects of Oklahoma's Pre-K program on Hispanic children", *Social Science Quarterly*, 89, 916-936.

[28] Hansen, C., and Hawkes, D. (2009), "Early childcare and child development" , *Journal of Social Policy*, 38:2, 211–239.

[29] Hansen, K. (ed.) (2012), "Millennium Cohort Study. First, Second, Third and Fourth Surveys, A Guide to the Datasets" (7th Ed.), London: Centre for Longitudinal Studies.

[30] Havnes, T. and Mogstad, M. (2011), "No Child Left Behind. Universal Child care and Children's Long-Run Outcomes", *American Economic Journal: Economic Policy*, 3, 97–129.

[31] Havnes, T. and Mogstad, M. (2014), "Is Universal Child care Leveling the Playing Field? Evidence from Non-Linear Difference-in-Differences", *Journal of Public Economics*, 127, 100-114.

[32] Heckman, J. and Masterov, D. (2007), "The Productivity Argument for Investing in Young Children," *Review of Agricultural Economics*, 29, 446-493.

[33] Herbst, C. (2015), "The rising cost of child care in the US", IZA Discussion Paper 9072, Institute for the Study of Labor.

[34] Hofferth, S., Davis-Kean, P., Davis, J., and Finkelstein, J., (1998), User guide for the Child Development Supplement of the Panel Study of Income Dynamics, http://psidonline.isr.umich.edu/CDS/usergd.html.

[35] Istituto degli Innocenti (2006), "I nidi e altri servizi integrativi per la prima infanzia", Quaderni del Centro Nazionale di Documentazione e l'Analisi per l'Infanzia n. 36.

[36] ISTAT (2010), "L'offerta comunale di nidi e altri servizi socio educativi per l'infanzia", Istituto Nazionale di Statistica Roma.

[37] Liu, H., Mroz, T., and Van der Klaauw, W. (2010), "Maternal Employment, Migration, and Child Development", *Journal of Econometrics*, 156, 212-228.

[38] Loeb, S., Bridges, M., Bassok, D., Fuller, B. & Rumberger, R.W. (2007), "How Much is Too Much? The Influence of Preschool Centers on Children's

Social and Cognitive Development". *Economics of Education Review*, 26, 52-66.

[39] Loken, K., Mogstad, M., and Wiswall, M., (2012), "What Linear Estimators Miss: Re-Examining the Effects of Family Income on Child Outcomes", *American Economic Journals: Applied Economics*, 4, 1-35.

[40] Lord, F. M. and Novick, M. (1968), *Statistical Theories of Mental Test Scores*. Reading MA: Addison-Welsley Publishing Company.

[41] Melhuish, E., Sammons, P., Siraj-Blatchford, I. and B. Taggart (2005), "Effective Pre- School Education. The Effective Provision of Pre-School Education (EPPE) Project: Final Report". Institute of Education: London.

[42] OECD (2012), "Family Data Base Public policies for families and children, Formal care and early education services."

[43] Office for National Statistics (2015), Families and Households. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/datasets/familiesandhouseholdsfamiliesandhouseholds

[44] Pavolini, E. and Arlotti, M. (2013), "Growing unequal: child care policies in Italy and the social class divide", mimeo.

[45] Pinheiro, J. and Bates, D., (2006), "Unconstrained Parametrizations for Variance-Covariance Matrices," *Statistics and Computing*, 6, 289-296.

[46] Pronzato, C. and Sorrenti, G. (2015), "When context does matter. Child care and maternal employment: trying to solve the puzzle", *CESifo DICE Report*, 13(1), 3-8.

[47] Sullivan, A. and Brown, M. (2014) "Cognitive development". In Platt, L. (ed) *Millennium Cohort Study Age 11 Survey Initial Findings*. London: Centre for Longitudinal Studies.

[48] Todd, P., and Wolpin, K. (2003), "On the Specification and Estimation of the Production Function for Cognitive Achievement," *Economic Journal*, 113, F3-F33.

[49] Todd, P., and Wolpin, K. (2007), "The Production of Cognitive Achievement in Children: Home, School, and Racial Test Score Gaps," *Journal of Human Capital*, 1:1, 91-136.

[50] West, A. (2006), "The pre-school education market in England from 1997: quality, availability, affordability and equity", *Oxford Review of Education*, 32(3): 283-301.

[51] Woodcock, R., and Johnson, M. (1989), *Tests of Achievement, Standard Battery [Form B]*. Chicago, IL: Riverside Publishing (Houghton Mifflin).

[52] Wrohlich, K. (2006), "Labor supply and child care choices in a rationed child care market", DIW Berlin Discussion Papers 1169.

[53] Zollino, F. (2008), "Il difficile accesso ai servizi di istruzione per la prima infanzia in Italia: i fattori di offerta e di domanda", Questioni di Economia e Finanza - Occasional Papers n. 30, Bank of Italy.