"The Effect of Full Day Kindergarten on The Cognitive Development of Children: a Longitudinal Study"

Extended Abstract.

1 Introduction

One of the most relevant social changes over the last decades in developed countries has been the increment in labour force partecipation of women. In particular, this change has mainly concerned married women with children.

Several studies have investigated the effect of such phenomenon. One of the most debated points is whether or not this new trend produces negative effects on children. This question rises naturally as a consequence of the generalized opinion that it is best for the child if the mother is the primary care giver and if she doesn't work outside home while the child is young. Although this attitude is gradually changing , as documented in Rindfuss (1996), it is still very popular among both common people and experts of childcare.

Quite surprisingly, there seems to be scarce evidence to support this position; rather, as argued by Bianchi (2000):

> "given the effort that has been devoted to searching for negative effects of maternal employment on children's academic achievment and emotional adjustment, coupled with the scarsity of findings (either positive or negative), it would appear that the dramatic movement into the labour force by women of chilbearing age in the US has been accomplished with relatively little consequence for children."

In fact a number of studies have shown that maternal employment may have some negative effects under very special conditions: when employment occurs early in the first year of life (Belsky and Eggeben, 1991; Blau and Grossberg, 1990; Han, Waldfogel and Brooks-Gunn, 2000); perhaps for middle-class children (Baydar and Brooks-Gunn, 1991; Desai, Chase-Lansdale and Michael, 1989; Greenstain, 1995) or when maternal employment is combined with other stressful conditions (Parcel and Menhaga, 1994).
Apart from these particular cases, maternal employment literature is in general agreement that having a mother in the labor force does not represent a developmental risk for children.

Obviously one of the most important moderators of the relationship between maternal employment and child functioning is the nature and quality of alternative cares that children experience.
In particular school-age children experience a wide array of after school activities. They may have peer groups of friends at school and partecipate in various after school or enrichment programs.

One of the opportunities available to working women with kindergarten or school age chldren are the full time childcare programs provided by schools; since full time is a quite popular option for working mothers, it is of key interest to understand if such a choice has some effect on cognitive performances of children. In our opinion the answer has a peculiar relevance under several points of view.
At a more theoretical or "academic" level, it can be seen as a further contribute to the general question addressed at the beginning: "is the maternal employment a source of disadvantage for the

children?"
Within this context it is obviously crucial to evaluate if alternative care providers are able to surrogate mathernal care so that this work can be ascribed to the large demoographic literature concerning the relationship between work and family (for an enlightning review, see Perry-Jenkins, Repetti and Crouter 2000). However, here we would like to stress two points that characterize the present paper.

1. great efforts have been devoted by researchers to study the effect of maternal employment during the first three years of child's life while there is an impressive scarcity in studies on middle childhood dynamics; we address this point.

2. the most papers assume as dependent variable the level of the children's cognitive achievement at a certain point in time; on the contrary this work analyses the effect of full time on the growth of cognitive achievement of the children, estimated on the basis of the cognitive scores over two years (collected two times each year). In our opinion, this longitudinal approach is more taylored to the main function of kindergarten: stimulating an improvment in cognitive skills.
   Moreover the cognitive level itself can be affected by a greater number of exogenous factors that, if not adequately controlled, disturb the relationship between full time and cognitive performances. This is exactly what we have experienced introducing the socio-economic index as a control variable in our model. It turns out that it affects significatively the intercept parameter (the level) and far less the slope parameter (the growth).

From a practical point of view we think that this study can be useful to address the choices of both families and policy makers. In fact the choice of full time involves the former in an obvious way: especially in countries, like the United States, in which full time may be oneorus in terms of money, each family has to make a well-reasoned choice, balancing costs and benefits. But an analisys of the effect of full time can be of interest also for policy makers, particularly in those countries in which the public administration itself undertakes the cost of full time as it shows the recent debate in Italy following the reform of the school.

2 Data and Methods

2.1 Dataset

In order to address the main questions stated above, we make use of *The Early Childhood Longitudinal Study–Kindergarten Class of 1998-99*, or *ECLS-K*, sponsored by the United States Department of Education, National Center for Education Statistics.
The Early Childhood Longitudinal Study program provides national data on children's status at birth and at various points thereafter, children's transition to nonparental care, early education programs, and school and children's experiences and growth through the fifth grade. ECLS-K also provides data to test hypotheses about the effects of a wide range of family, school, community, and individual variables on children's development, early learning, and early performance in school.
The study focuses on a nationally representative sample of approximately 22,000 children who enrolled in about 1,000 kindergarten programs (both private and public) during the 1998-1999 school year, their families, teachers and schools. About 25 students within each school are selected. Base year data were collected in the fall of 1998 and spring of 1999. Four waves of data collection were planned beyond kindergarten: fall and spring first grade, and spring third and fifth grades. All

data collection was completed in the spring of 2004 when most of the children were in fifth grade. Our analysis focuses on the first four waves.

Data collected during the kindergarten year can serve as baseline measures to examine how schooling shapes later individual development. The longitudinal nature of the study enables researchers to study childrens cognitive, social, and emotional growth and to relate trajectories of change to variations in childrens school experiences in kindergarten and the early grades.

The ECLS-K comprises 2794 variables, mostly describing the child's status during the period of observation. They can roughly be divided into two distinct categories: a first one dealing properly with child's cognitive performances and a second one dealing with their potential explanatory variables. Children's cognitive skills were evaluated in untimed one-on-one assessments, parent information came from telephone surveys and teachers filled out self-administred questionnaires.

The original dataset a total amount of approximately 17,000 children. Further modifications led to a final dataset with 2657 children. For details on these other adjustments, we remaind to the next subsection.

2.2 Variables used in our analysis

Cognitive Skills. Cognitive skills measured at various waves are our dependent variables.

To measure children's cognitive skills in each wave, we made use of *IRT* scale scores for direct cognitive assessment, as constructed by ECLS-K, and just sum over the scores obtained by children in math, read and general knowledge tests.

IRT made it possible to calculate scores which are particularly suitable for comarative purposes.

IRT has several other advantages over raw number-right scoring. By using the overall pattern of right and wrong responses to estimate ability, *IRT* can compensate for the possibility of a low ability student guessing several hard items correctly. If answers on several easy items are wrong, a correct difficult item is, in effect, assumed to have been guessed. Omitted items are also less likely to cause distortion of scores, as long as enough items have been answered right and wrong to establish a consistent pattern. Unlike raw scoring, which, in effect, treats omitted items as if they had been answered incorrectly, *IRT* procedures use the pattern of responses to estimate the probability of correct responses for all test questions. Finally, *IRT* scoring makes possible longitudinal measurement of gain in achievement over time, even though the tests administered are not identical at each point. The common items present in the routing test and in overlapping second-stage forms allow the test scores to be placed on the same scale, even as the two-stage test design adapts to childrens growth over time. The *IRT* scale scores in the database represent estimates of the number of items students would have answered correctly if they had taken all of the 72 questions in the first- and second-stage reading forms, the 64 questions in all of the mathematics forms, and the 51 general knowledge items. These scores are not integers because they are probabilities of correct answers, summed over all items in the pool.

For a reliable measure of cognitive skills, we eliminated from the initial dataset all the children having even a missing value in one test over the four waves. Moreover,in order to have a homogeneous sample, we dropped children with severe disabilities and attending special classes (as known in the first and fourth waves).

Month. MONTH is the time variable of the longitudinal analysis.

It represents the moment in time the child under exam has the direct child assessment in terms of the number of months from the beginning of the kindergarten.

We hypothesized that every child in the dataset:

1. starts the kindergarten in the same day (September, 1 1998)

2. has the direct child assessment in the same day for each wave

Under the previous assumptions, $MONTH$ assumes the same following values for every child:

$$\begin{array}{ll} 2\ (\text{October}, 31\ \ 1998) & 14\ (\text{October}, 31\ \ 1999) \\ 8\ (\text{April}, 30\ \ 1999) & 22\ (\text{April}, 30\ \ 2000). \end{array}$$

Moreover, we performed our analysis using $MONTH_2$ defined as:

$$MONTH_2 = MONTH - 2,$$

in order to facilitate the interpretation of the regression line intercept in terms of *initial status*.

Full time. FT is our main predictor variable.
It is a dichotomous variable indicating whether the child under exam attends a full-time class (FT=1) or not (FT=0) during kindergarten year.
Children with different values of FT between fall and spring of the kindergarten were deleted from the dataset; so that FT is treated as a time invariant variable.
It is important to notice that FT is a variable belonging to the *class* level of analysis; that means that the frequency of part time or full time program is a peculiarity of the class group and not of each child within the class. This motivates our choice of a model characterized by three levels: 'within child' level, 'between children within class' level and 'between classes' level (for further details, see section 2.3).

Socioeconomic Status. Socioeconomic Status (*SES*) plays the role of control predictor in our analysis, as usually in sociodemographical papers.
The variable was computed at the household level for the set of parents who completed the parent interview in fall-kindergarten or spring-kindergarten. The *SES* variable reflects the socioeconomic status of the household at the time of data collection for spring-kindergarten (Spring 1999).
The components used for the creation the *SES* were: father/male guardians education, mother/female guardians education, father/male guardians occupation, mother/female guardians occupation and household income. A hot deck imputation methodology was used to impute for missing values of all components of the *SES*.
As FT belongs to the *class* level of analysis, we decided to place our control predictor at the same level. For this purpose, we took into account for each class the mean of individual Socioeconomic Status calling it *SESCLASS*.
In oder to improve the interpretation of the regression parameters, we made use of a standardized version of *SESCLASS* whose name is *ZSESCLASS*.

2.3 Model

We developed a *taxonomy* of Multilevel Models (Bryk and Raudenbush 1992), which is a systematic sequence of models that, as a set, address our research questions. Every model in the taxonomy extended a prior model in some sensible way; inspections and comparison of its elements tell the story of predictors' individual and joint effects.
Each model is a *Multilevel Model* showing three different levels of analysis. Individual growth trajectories comprise the Level-1 Model; the variation in growth parameters among children within a class is captured in the Level-2 Model; the variation among classes is represented in the Level-3 Model. Composite forms for each model are provided.

The Unconditional Means Model

$$IRT_{tij} = \gamma_{000} + (\mu_{00j} + r_{0ij} + \epsilon_{tij}),$$

where:

$$\epsilon_{tij} \text{ i.i.d.} \sim N(0, \sigma^2_{tij}),$$

$$r_{0ij} \text{ i.i.d.} \sim N(0, \sigma^2_{0ij}),$$

$$\mu_{00j} \text{ i.i.d.} \sim N(0, \sigma^2_{00j}).$$

The Unconditional Growth Model

$$IRT_{tij} = \gamma_{000} + \gamma_{100} MONTH2_{tij} + [\mu_{00j} + r_{0ij} + (\mu_{10j} + r_{1ij}) MONTH2_{tij} + \epsilon_{tij}],$$

where:

$$\epsilon_{tij} \text{ i.i.d.} \sim N(0, \sigma^2_{tij}),$$

$$\begin{bmatrix} r_{0ij} \\ r_{1ij} \end{bmatrix} \text{ i.i.d.} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2_{0ij} & \sigma_{01ij} \\ \sigma_{01ij} & \sigma^2_{01ij} \end{bmatrix} \right),$$

and

$$\begin{bmatrix} \mu_{00j} \\ \mu_{10j} \end{bmatrix} \text{ i.i.d.} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2_{00j} & \sigma_{010j} \\ \sigma_{010j} & \sigma^2_{10j} \end{bmatrix} \right).$$

The Uncontrolled Effects of FT

$$IRT_{tij} = \gamma_{000} + \gamma_{001} FT_j + \gamma_{100} MONTH2_{tij} + \gamma_{101} FT_j MONTH2_{tij} [\mu_{00j} + r_{0ij} + (\mu_{10j} + r_{1ij}) MONTH2_{tij} + \epsilon_{tij}],$$

where the hyphoteses on residuals are as in the previous model.

The Controlled Effects of FT

$$\begin{aligned} IRT_{tij} &= \gamma_{000} + \gamma_{001} FT_j + \gamma_{002} SESCLASS_j + \gamma_{100} MONTH2_{tij} + \gamma_{101} SESCLASS_j MONTH2_{tij} \\ &\quad + \gamma_{102} FT_j MONTH2_{tij} + [\mu_{00j} + r_{0ij} + (\mu_{10j} + r_{1ij}) MONTH2_{tij} + \epsilon_{tij}], \end{aligned}$$

where the hyphoteses on residuals are as in the previous models.

A Tentative "Final Model" for the Controlled Effects of FT

$$\begin{aligned} IRT_{tij} &= \gamma_{000} + \gamma_{002} SESCLASS_j + \gamma_{100} MONTH2_{tij} + \gamma_{101} SESCLASS_j MONTH2_{tij} \\ &\quad + [\mu_{00j} + r_{0ij} + (\mu_{10j} + r_{1ij}) MONTH2_{tij} + \epsilon_{tij}], \end{aligned}$$

where the hyphoteses on residuals are as in the previous models.

Recentering Predictors to Improve Interpretation

$$
\begin{aligned}
IRT_{tij} &= \gamma_{000} + \gamma_{002} ZSESCLASS_j + \gamma_{100} MONTH2_{tij} + \gamma_{101} ZSESCLASS_j MONTH2_{tij} \\
&\quad + [\mu_{00j} + r_{0ij} + (\mu_{10j} + r_{1ij}) MONTH2_{tij} + \epsilon_{tij}],
\end{aligned}
$$

where the hyphoteses on residuals are as in the previous models.

3 Results and Conclusions

The table below summarizes the main results of our study.
Results reveal no statistically significative effect of full time (FT) on the variability in the mean growth trajectories between classes for what concerns the slope. For the intercept we register a slight (5 percent) negative effect (MODEL C). However, introducing the control variable SES (MODEL D), this effect disappears. Specularly the effect of SES on the intercept is strongly significative (0.1 percent) (MODEL D): it is supposed that children with higher social status are less likely to enroll full time program. Quite surprisingly, we find SES to have no effect on the slope (MODEL D); actually, we have not found a significative predictor that explain the variability in the slope of the mean trajectory between classes, neither FT nor SES. In fact there is a certain homogeneity between classes, or even between children, in the rate of cognitive growth while the difference in the cognitive scores is mainly due to the difference in initial status. This was also confirmed by our exploratory analysis of individual trajectories on a sample of children. This remark seems to support our choice of use a longitudinal model which takes into account both the initial status and the growth. Furthermore, the drastic reduction of the level-1 variance between MODEL A and MODEL B (coupled with an improvment of the goodness of fit) supports our choice of a linear longitudinal model to model the individual change in time.

		A	**B**	**C**	**D**	**E**	**F**
Fixed Effects							
γ_{000}	Intercept	101.88 ***	67.9536 ***	69.2380 ***	65.3924 ***	65.8673 ***	69.2450 ***
γ_{001}	FT			-2.3573 *	0.8874		
γ_{002}	SES				17.6826 ***	17.7034 ***	10.2498 ***
γ_{100}	Intercept		3.7692 ***	3.7933 ***	3,7818 ***	3.7731 ***	3.7731 ***
γ_{101}	FT			-0.04364	-0,03258		
γ_{102}	SES				0.05981		
Variances							
Level 1: within child	ϵ_{tij}	957.71 ***	88.1738 ***	88,1726 ***	88,1692 ***	88.1692 ***	88.1692 ***
Level 2: within class	intercept r_{0ij}	83.0161 ***	259.79 ***	259.66 ***	257.61 ***	257.52 ***	257.52 ***
	slope r_{1ij}		0.08002 ***	0.08045 ***	0.08022 ***	0.08067 ***	0.08067 ***
	covariance		1.8944 ***	1.8979 ***	1.8585 ***	1.8579 ***	1.8579 ***
Level 3: between classes	intercept μ_{00j}	172.32 ***	153.69 ***	152.56 ***	46.1259 ***	46.4390 ***	46.4390 ***
	slope μ_{10j}		0.08856 ***	0.08747 ***	0.08652 ***	0.08759 ***	0.08759 ***
	covariance		0.6380 *	0.6080	0.2820	0.2732	0.2732
Goodness of Fit							
AIC		104672	86259	86258	85827	85827	85827
BIC		104692	86302	86310	85889	85874	85874

Table 1: FT = full time; SES = socio-economic status. *** $p < 0.0001$; ** $p < 0.01$; * $p < 0.05$

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