TEXTO PARA DISCUSSÃO Nº 193

MOTHER'S OR TEACHER'S EDUCATION? EDUCATIONAL STRATIFICATION AND GRADE PROGRESSION IN BRAZIL

Eduardo Luiz G. Rios-Neto
Juliana de Lucena Ruas Riani
Cibele Comini César

Maio de 2003

Ficha catalográfica

314.6(81)
R586m
2003

Rios-Neto, Eduardo Luiz G.

Mother's or teacher's education? educational stratification and grade progression in Brazil / Eduardo Luiz G. Rios-Neto; Juliana de Lucena Ruas Riani; Cibele Comini César - Belo Horizonte: UFMG/Cedeplar, 2003.

26p. (Texto para discussão ; 193)

1. Demografia da família – Brasil. 2. Educação – Brasil. I.Riani Juliana de Lucena Ruas. II. César, Cibele Comini. III. Universidade Federal de Minas Gerais. Centro de Desenvolvimento e Planejamento Regional. IV. Título. V. Série.

UNIVERSIDADE FEDERAL DE MINAS GERAIS
FACULDADE DE CIÊNCIAS ECONÔMICAS
CENTRO DE DESENVOLVIMENTO E PLANEJAMENTO REGIONAL

MOTHER'S OR TEACHER'S EDUCATION?
EDUCATIONAL STRATIFICATION AND GRADE PROGRESSION IN BRAZIL[*]

Eduardo Luiz G. Rios-Neto
Full Professor in the Demography Department at CEDEPLAR
Federal University of Minas Gerais – Brazil

Juliana de Lucena Ruas Riani
Student of Demography at CEDEPLAR
Federal University of Minas Gerais - Brazil

Cibele Comini César
Professor in the Statistics Department and at CEDEPLAR
Federal University of Minas Gerais

CEDEPLAR/FACE/UFMG
BELO HORIZONTE
2003

[*] The authors thank the support from Brazilian National Research Council (CNPq) and the Brazilian Ministry's of Education INEP (National Institute for Educational Studies and Research) for institutional support through a research grant on the demography of education in Brazil.

SUMÁRIO

1. INTRODUCTION

The title of this paper has a more limited meaning than what was in fact developed here. The title and abstract were based on what became a paper (Rios-Neto, César, and Riani, 2002) that stresses the trade-off between mother's and teacher's education. The availability of new data from the 2000 Brazilian Demographic Census changed the plan for this paper.

The spirit of the title still remains in the paper, to the extent that it deals with the debate about the determination of education attainment, contrasting family socioeconomic with school and community variables. In the previous version, the focus was between mother's education and teacher's education. In this paper, the focus is between mother's education and a large variety of school and community related variables.

The paper starts defining the main dependent variables, which are grade progression at first and fifth grades. A major innovation is the application of hierarchical linear model in grade progression equations, including socioeconomic variables at level one and school or community variables at level two. The paper tests some theoretical issues on educational stratification. It also bears policy implications with respect to the relative importance of some school related factors.

2. LITERATURE REVIEW

The publication of the Coleman Report in the 1960's stressed the importance of socioeconomic and status family variables and suggested the absence of school effects in educational achievement, a finding that was also extended to educational attainment studies. There were larger achievement differences within schools than among schools. This finding sparked a variety of studies in developed and developing countries, trying to capture the impact of school and educational policy variables in two main educational outcomes generally considered as dependent dimensions: education achievement and attainment (Buchmann, 2002).

There were attempts to reply Coleman's findings in the case of developing countries. The results were different in terms of educational achievement. School and teacher quality aspects were more important than family factors. Despite these findings, the role of socioeconomic status on educational outcomes was still a strong proposition in the case of developing countries. With respect to school factors, a generalization suggested the importance of less expensive inputs (textbooks, libraries, teacher training, etc.) in comparison with more expensive inputs (class size, teachers' salaries, science laboratories, etc.). Methodological issues about the ways that these impacts are estimated are still unsettled (Buchmann and Hannum, 2001).

Economists also stress the debate in the context of the educational production function. Teachers' variables (salaries, education, and training) and class size are two key elements in the debate. Todd and Wolpin (2003) and Hanushek (2002) are examples of comprehensive reviews focused on the determination of education achievement using the notion of value added. The debate

about the impact of class size on education achievement is quite strong among economists[1]. The propositions about the impact of teachers' characteristics and class size on education achievement can be generalized to education attainment. This paper benefits from the economic debate.

The sociological literature on the determinants of educational stratification deals explicitly with education attainment. Mare (1981) stresses the importance of distinguishing distribution and allocation aspects of educational stratification. When the education attainment variable is average schooling, then it is not possible to separate allocation and distribution effects. Grade progression is suggested as a better dependent variable for the study of education attainment. Mare's basic proposition with respect to the allocation effect suggests a declining impact of family socioeconomic status variables (SES) on the grade progression at higher grades. The children of families with low SES variables and achieving higher grades are selective with respect to motivation and ability. When there is an expansion of the school system and coverage, a greater spell of students at higher grades would lead to a declining impact of family SES variables on average schooling. This declining impact could be the result of changes in the grade distribution, even if the allocation effect had remained constant. The estimation of family determinants of educational attainment via grade progression would be sufficient to single out the allocation effect. Although Mare suggests a declining importance of SES variables on grade progression at higher grades, in a given period, he suggests that there is an increasing importance of SES variables through time, as the school system generalizes, due to a declining impact of selectivity (Mare, 1979).

The literature also stresses the role of community factors on education outcomes. Cultural and social capital are two examples along this line. Cultural capital is associated with high culture and the appreciation of Kantian aesthetic (appreciation of classic music, literature, high art, etc.), education is major determinant of the accumulation of cultural capital (Bourdieu, 1984). The role of cultural capital on education outcomes probably operates motivationally, via educational aspiration. Social capital is defined by Coleman (2000) as an asset derived from the interpersonal relationships. Social capital may be important to education outcomes due to the importance of peers, family-school groups, and resources mobilized by the community. Buchmann (2002) presents a review of these two aspects.

A conceptual framework presented by Buchmann and Hannum (2001) integrates family decisions about education (demand) with school and community factors (supply). Although a great deal of research effort has been devoted to the connection between each of these factors and the educational outcomes, there has been a limited research focus on the interaction between these factors and their potential impact on educational outcomes.

3. HYPOTHESES

The stratification literature reviewed above point to the importance of SES variables on educational attainment. Following Mare, if educational attainment is measured by grade progression at each grade, then the hypothesis is that the role of SES variables becomes less important as higher grades are studied.

[1] See the recent exchange between Hanushek (2003) and Krueger (2003).

The literature emphasizes the importance of mother's education in the determination of children's education attainment. It is hypothesized that mother's education is relatively more important than father's education or occupation in the determination of children's education attainment.

The literature testing Coleman's report propositions in the context of developing countries suggests that school inputs have strong effects on children's educational attainment. It is unclear whether teachers' education and class size are the main school dimensions explaining educational attainment, as less expensive inputs may play an important role. This point will be examined with Brazilian data.

Community factors associated with cultural and/or social capital are expected to play an important role on educational attainment.

4. GRADE PROGRESSION AS THE DEPENDENT VARIABLE – STYLIZED FACTS ABOUT BRAZIL

The works of Robert Mare are very important to demonstrate the relationship between grade progression and average years of completed schooling. They also show the superiority of grade progression for the study of educational stratification. The connection between the two variables is completely analogous to one developed by demographers linking parity progression ratios and fertility. We will draw on the parity progression ratio analogy to perform an exercise about the Brazilian historical pattern of education attainment.

Let us define:

$$e_k = \frac{P_{k+1}}{P_k} \qquad (1)$$

Then e_k is the grade progression probability to complete grade $k+1$ conditioned on having completed grade k.

Pk+1 = Number of people completing at least grade k+1
Pk = Number of people completing at least grade k

Now we define a set of formulas establishing the proportion of a group (e.g., a cohort) that have completed at least grade k.

$e_{0,0} = 1$ everyone completed at least grade zero.
$e_{0,1} = e_0$ (completed at least grade 1).

(2) ...

$e_{0,k} = \prod_{j=0}^{k-1} e_j$ Completed at least *k* years of study.

Letting "k" vary from 1 to 17, then the average years of study (*e*) is defined below:

$$(3) \qquad e = \sum_{i=1}^{\infty} \Pr(X \geq i) = \sum_{i=1}^{17} e_{0,i}$$

The formulas above entail a decomposition exercise, for example, on the education attainment of different age cohorts obtained from a survey at a given period (year). For example, we have calculated in Table 1 the grade progression probabilities (e_k) and the average years of education (*e*) for different cohorts, marked by the year they had 7 years of age (legal age for entering the first grade at elementary school), based on information obtained from the Brazilian 1998 PNAD- IBGE, a National Household Survey from the Brazilian Census Bureau that resembles the American CPS.

It is possible to decompose the variation in average years of study between two cohorts, for example, the oldest (41-45) and the youngest (81-85)[2].

$$(4) \qquad e(41\text{-}45) = \Sigma_j \, e_{0,j}(41\text{-}45) = \Sigma_j \, \Pi_j \, e_j(41\text{-}45)$$

$$(5) \qquad e(81\text{-}85) = \Sigma_j \, e_{0,j}(81\text{-}85) = \Sigma_j \, \Pi_j \, e_j(81\text{-}85)$$

Beginning with a situation given by equation 4, let us insert the grade progression probability of the 81-85 cohort, starting at grade i=J=16 and going up until grade i=J=1 in accordance with equation 6. Towards the end of the exercise we will have equation 5.

$$(6) \qquad e_{41-45,81-85,J} = \sum_{j=1}^{J} e_{0,j} + \sum_{i=J}^{16} e_{0,i} = \sum_{j=1}^{J} \prod_{j=1}^{J} e_j + \sum_{i=J}^{16} \prod_{i=J}^{16} e_i$$

The second column in Table 2 gives the application of equation 6 to the Brazilian case. The third column gives the absolute variation of equation 6 with respect to equation 5 for each grade progression attributed the value of 41-45 cohort. The fourth column gives the percent marginal contribution of each grade progression with respect to the observed change in average schooling between the cohorts 81-85 and 41-45, that is to say, with respect to equation 5 minus equation 4.

The decomposition exercise portrayed in Table 2 indicates that the historical Brazilian pattern of increasing education attainment is dominated by two grade progressions. Progression in the first grade of elementary school (e_0) is responsible for 53,6% of total increase in average completed years of study in the population. Progression in the fifth grade of elementary school (e_4) is responsible for 25,7% of the observed increase in completed years of study.

[2] We thank this formalization to Sergei Soares, IPEA, who commented on a previous decomposition leading to this more elegant formula.

A major conclusion of this exercise is that a study of educational stratification in Brazil should primarily focus on two grade progressions: e_0 and e_4 . This paper will focus on these two dependent variables. This is even more important if one intends to stress the allocation aspects of stratification, as opposed to distribution aspects.

TABLE 1

Grade Progression Probabilities by Grades and Age-Cohort
Brazil 1998

GPPs	1981-85	1976-80	1971-75	1966-70	1961-65	1956-60	1951-55	1946-50	1941-45
e0	0.909	0.898	0.879	0.870	0.845	0.811	0.759	0.708	0.666
e1	0.979	0.978	0.972	0.969	0.967	0.958	0.948	0.936	0.928
e2	0.958	0.956	0.948	0.942	0.936	0.911	0.893	0.872	0.859
e3	0.939	0.928	0.921	0.914	0.895	0.882	0.846	0.819	0.810
e4	0.875	0.844	0.827	0.778	0.696	0.625	0.556	0.484	0.460
e5	0.870	0.859	0.868	0.892	0.928	0.943	0.941	0.953	0.950
e6	0.896	0.898	0.905	0.919	0.927	0.933	0.943	0.942	0.951
e7	0.880	0.885	0.897	0.903	0.904	0.925	0.928	0.919	0.940
e8	0.789	0.763	0.743	0.755	0.751	0.758	0.745	0.708	0.699
e9	0.871	0.913	0.928	0.944	0.955	0.965	0.977	0.977	0.973
e10	0.818	0.884	0.904	0.915	0.926	0.928	0.940	0.951	0.930
e11	0.303	0.313	0.347	0.382	0.413	0.457	0.473	0.424	0.411
e12	0.735	0.891	0.915	0.942	0.950	0.958	0.979	0.978	0.957
e13	0.611	0.833	0.886	0.900	0.913	0.926	0.951	0.962	0.964
e14	0.540	0.786	0.823	0.842	0.856	0.861	0.904	0.899	0.911
e15	0.250	0.325	0.306	0.317	0.312	0.316	0.325	0.326	0.356
Years of Study = Π ei	7.0	6.8	6.6	6.5	6.0	5.4	4.6	3.9	3.5

Source: PNAD/IBGE 1998.

TABLE 2

Decomposition of Completed Years of Study by change in e_x comparing two Cohorts of Age at Entry in Elementary School: 1941-45 – Brasil

Cohort / Simulation	Average Completed Years of Study	Variation with respect to cohort 1981-85	Percent change attributed to change in e0,j
1981-1985	6.973	-	100%
1941-1945	3.491	3.482	0%
Up to e0(41-45)	5.107	1.867	53.6%
Up to e1(41-45)	4.878	2.096	6.6%
Up to e2(41-45)	4.505	2.468	10.7%
Up to e3(41-45)	4.136	2.838	10.6%
Up to e4(41-45)	3.239	3.734	25.7%
Up to e5(41-45)	3.312	3.661	-2.1%
Up to e6(41-45)	3.354	3.619	-1.2%
Up to e7(41-45)	3.391	3.582	-1.1%
Up to e8(41-45)	3.344	3.629	1.4%
Up to e9(41-45)	3.373	3.600	-0.8%
Up to e10(41-45)	3.396	3.578	-0.6%
Up to e11(41-45)	3.424	3.549	-0.8%
Up to e12(41-45)	3.444	3.530	-0.6%
Up to e13(41-45)	3.469	3.505	-0.7%
Up to e14(41-45)	3.487	3.486	-0.5%
Up to e15(41-45)	3.491	3.482	-0.1%
TOTAL			100.0%

Source: PNAD/IBGE 1998.

5. METHODOLOGICAL ASPECTS

The methodology chosen for estimation is the hierarchical linear model (multilevel). The dependent variables are the grade progression probability for grade 1 (e_0) and grade 5 (e_4). The first level estimates a logit (binomial) equation with individual/ family variables, the second level includes average variables at municipality level where the children live, that are regressed with the random coefficients.

A first estimation will test if the intercept and mother's education are random coefficients at level 2. Equations 7 to 10 formalize the model.

(7) Level 1: $$P(e_{ij}) = F\left(\beta_{0j} + \sum_{k} \beta_{kj} X_{kij} + \varepsilon_{ij} \right)$$

(8) Level 2: $$\beta_{0j} = \gamma_{00} + u_{0j}$$

(9) $$\beta_{1j} = \gamma_{10} + u_{1j}, k = 1$$

(10) $$\beta_{kj} = \gamma_{k0}, k > 1$$

A second estimation will include level 2 "Z" variables at the municipality level, they are possible determinants of the random coefficients. Equations 11 to 14 explain the model.

(11) Level 1: $$P(e_{ij}) = F\left(\beta_{0j} + \beta_{1j} X_{1j} + \sum_{k>1} \beta_{kj} X_{kij} + \varepsilon_{ij} \right)$$

(12) Level 2: $$\beta_{0j} = \gamma_{00} + \gamma_{01} Z_j + u_{0j}$$

(13) $$\beta_{1j} = \gamma_{k10} + \gamma_{11} Z_j + u_{1j}$$

(14) $$\beta_{kj} = \gamma_{kj}, k > 1$$

The statistical package HLM was chosen to estimate the multilevel model [3].

The proportion of the variance explained by the level 2 variables in the case of intercept (β_{0j} in equation 12)) and coefficient (β_{1j} in equation 13) are presented at the bottom of the tables, following the notions of conditioned and non-conditioned variances formula described below(Bryk e Raudenbush. 1992):

$$\%\ \textbf{of Explained Variance} = \frac{\hat{\tau}_{qq(non-conditioned)} - \hat{\tau}_{qq(conditioned)}}{\hat{\tau}_{qq(non-conditioned)}} \qquad (15)$$

[3] HLM is a statistical package developed by SSI- Scientific Software International.

6. DATA AND VARIABLES

Three data basis were merged to generate two data sets for the analysis of grade promotion in the first and the fifth grades. The micro level information were obtained from the Brazilian 2000 Demographic Census. For the determinants of promotion in the first grade, all children 10 years of age with both mother and father living in the household were selected from the Demographic Census, along with information about mother's education, father's education and father's occupation. For the determinants of promotion in the fifth grade, all children 14 years of age with both mother and father living in the household were selected from the Demographic Census, the same socioeconomic variables were selected.

The first set of macro level information was obtained from the Brazilian 2000 School Census, with information aggregated at the municipal level. The Brazilian Ministry's of Education Institute called INEP (National Institute for Educational Studies and Research) collects annual information from all private and public schools in the country -- information about school enrollments, teachers' education, class size, hours of class instruction, laboratories, etc. This information was collected for all Brazilian municipalities (5506 municipalities) in year 2000. The second set of macro level information was collected from the Brazilian Census Bureau's (IBGE) "Basic Municipality Information- MUNIC", a research presenting data collected from all municipalities in 1999. Five variables were collected from the MUNIC: if the municipality has a gymnasium, a library, a theater, a movie theater, and the municipalities' population size. The only macro level information obtained from the Brazilian Demographic Census is the schooling (average years of study completed) of the adult population (above 25 years of age) in the municipality.

Tables 3 and 4 below present the descriptive statistics of the variables for children aged 10 in 2000 (GPP 1st grade – e_0) and children aged 14 in 2000 (GPP 5th grade – e_4).

TABLE 3

Descriptive Variables – Children 10 Years of Age – Brazil - 2000

1st GRADE					
VARIABLE NAME - LEVEL 1	**N**	**MEAN**	**SD**	**MINIMUM**	**MAXIMUM**
aproved from 1st grade	316460	0,87	0,33	0,00	1,00
mother's education	316460	5,10	4,09	0,00	17,00
father's education	316460	4,82	4,21	0,00	17,00
father unprotected wage or domestic wage laborer	316460	0,17	0,37	0,00	1,00
father protected wage laborer	316460	0,28	0,45	0,00	1,00
father public servant	316460	0,04	0,18	0,00	1,00
father employer	316460	0,03	0,17	0,00	1,00
father self-employed	316460	0,30	0,46	0,00	1,00
father non-occupied	316460	0,19	0,39	0,00	1,00
VARIABLE NAME - LEVEL 2	**N**	**MEAN**	**SD**	**MINIMUM**	**MAXIMUM**
School Human Resources					
class size - 1st and 4th grades	5506	25,95	4,80	3,00	42,76
% teachers with college education - 1st and 4th grades	5506	0,19	0,22	0,00	1,00
daily hours of class - 1st and 4th grades	5506	4,24	0,33	3,16	6,45
Social Capital					
education of adult population (above 25) in the	5506	4,26	1,18	0,67	9,69
School Equipment					
% of schools with library	5506	0,72	0,41	0,00	1,00
% schools with sports court	5506	0,57	0,44	0,00	1,00
% schools with computer lab	5506	0,27	0,39	0,00	1,00
% schools with science lab	5506	0,33	0,42	0,00	1,00
Municipality Traits					
municipality has a gymnasium	5506	0,65	0,48	0,00	1,00
municipality has a library	5506	0,76	0,43	0,00	1,00
muncipality has a theater	5506	0,14	0,34	0,00	1,00
municipality has a movie theater	5506	0,07	0,26	0,00	1,00
% municipal schools among public schools	5506	0,15	0,32	0,00	1,00
% public schools	5506	0,88	0,23	0,00	1,00
Municipality Population Size					
population 0 to 4999	5506	0,26	0,44	0,00	1,00
population 5000 to 9999	5506	0,24	0,43	0,00	1,00
population 10000 to 14999	5506	0,16	0,36	0,00	1,00
population 15000 to 19999	5506	0,10	0,30	0,00	1,00
population 20000 to 49999	5506	0,16	0,37	0,00	1,00
population 50000 to 99999	5506	0,05	0,22	0,00	1,00
population 100000 to 199999	5506	0,02	0,14	0,00	1,00
population 200000 to 499999	5506	0,01	0,11	0,00	1,00
population 500000 to 999999	5506	0,00	0,05	0,00	1,00
population above 1000000	5506	0,00	0,05	0,00	1,00

TABLE 4

Descriptive Variables – Children 14 Years of Age – Brazil - 2000

5th GRADE					
VARIABLE NAME - LEVEL 1	**N**	**MEAN**	**SD**	**MINIMUM**	**MAXIMUM**
aproved from 5th grade	246898	0,84	0,36	0,00	1,00
mother's education	246898	5,58	4,11	0,00	17,00
father's education	246898	5,32	4,26	0,00	17,00
father unprotected wage or domestic wage laborer	246898	0,14	0,35	0,00	1,00
father protected wage laborer	246898	0,29	0,45	0,00	1,00
father public servant	246898	0,04	0,19	0,00	1,00
father employer	246898	0,04	0,19	0,00	1,00
father self-employed	246898	0,30	0,46	0,00	1,00
father non-occupied	246898	0,19	0,39	0,00	1,00
VARIABLE NAME - LEVEL 2	**N**	**MEAN**	**SD**	**MINIMUM**	**MAXIMUM**
School Human Resources					
class size - 5th and 8th grades	5503	32,14	5,71	8,00	58,93
% teachers with college education - 5th and 8th grades	5503	0,57	0,36	0,00	1,00
daily hours of class - 5th and 8th grades	5503	4,28	0,39	0,00	7,95
Social Capital					
education of adult population (above 25) in the municipality	5503	4,26	1,18	0,00	9,69
School Equipment					
% of schools with library	5503	0,72	0,41	0,00	1,00
% schools with sports court	5503	0,57	0,44	0,00	1,00
% schools with computer lab	5503	0,27	0,39	0,00	1,00
% schools with science lab	5503	0,33	0,42	0,00	1,00
Municipality Traits					
municipality has a gymnasium	5503	0,65	0,48	0,00	1,00
municipality has a library	5503	0,76	0,43	0,00	1,00
muncipality has a theater	5503	0,14	0,34	0,00	1,00
municipality has a movie theater	5503	0,07	0,26	0,00	1,00
% municipal schools among public schools	5503	0,15	0,32	0,00	1,00
% public schools	5503	0,88	0,23	0,00	1,00
Municipality Population Size					
population 0 to 4999	5503	0,26	0,44	0,00	1,00
population 5000 to 9999	5503	0,24	0,43	0,00	1,00
population 10000 to 14999	5503	0,16	0,36	0,00	1,00
population 15000 to 19999	5503	0,10	0,30	0,00	1,00
population 20000 to 49999	5503	0,17	0,37	0,00	1,00
population 50000 to 99999	5503	0,05	0,22	0,00	1,00
population 100000 to 199999	5503	0,02	0,14	0,00	1,00
population 200000 to 499999	5503	0,01	0,11	0,00	1,00
population 500000 to 999999	5503	0,00	0,05	0,00	1,00
population above 1000000	5503	0,00	0,05	0,00	1,00

7. PREVIOUS FINDINGS

As mentioned in the introduction, we have applied a similar methodology in a study previous to this paper (Rios-Neto, César, and Riani, 2002). There, the main issue was similar to the abstract and title submitted in the PAA program as the proposal for this paper. The paper estimates a hierarchical linear (multilevel) model in order to determine the grade progression probabilities (GPPs) for grades 1 (e_0) and 5 (e_4).

The research question and the methodology are similar in the two papers. The main difference is associated with the data basis. In the previous paper we had to combine several household surveys (PNADs, that are similar to the American CPSs) in order to define the level two variables. In the study of (e_0) there were 819 cells, given by 26 States, 9 metropolitan regions, all dimensions divided between rural and urban and applied to twelve years of survey (81, 82, 83, 85, 86, 87, 88, 90, 93, 95, 96 and 97). In the (e_4) there were 693 cells, applying the same categories previously mentioned to eleven years of survey (81, 82, 83, 84, 85, 86, 88, 89, 92, 93 and 95).

The relatively small number of cases at level 2 and the possible serial correlation, caused by the pooling of several household surveys over the years, favored multicolinearity of the variables at level 2. Few variables were included in the first estimations and one sole variable was chosen as the main focus: teachers' education.

Two important results were obtained in that paper. First, teachers' average schooling affected significantly two random coefficients in the determination of (e_0). It affected the intercept positively and mother's education coefficient negatively. Second, in the determination of (e_4), teachers' average schooling affected the intercept positively and significantly, but it was not statistically significant in the case of mother's education.

The first result pointed to a trade-off between mother's education and teachers' education in the determination of progression at first grade. The impact of teachers' education on first grade progression was more effective when mother's education was low. When mother's education is three years of study below the sample average, and teachers' education is 8,5 years of study (the lowest attainment for teachers), then three more years of mother's educational attainment causes the same impact on grade promotion as three and a half more years of teachers' educational attainment. The policy implication of this finding is clear: it is easier and cheaper to increase teachers' education than to increase mother's education, which would require a strong adult education program.

The second result seemed to confirm Mare's hypothesis, indicating that family's SES role on grade progression declines at higher grades. Teachers' education is no longer statistically significant in the determination of mother's education coefficient leading to grade progression in the fifth grade, which implies the absence of the trade-off discussed above. Fifth grade progression may not seem to constitute high education in the context of developed countries, but it is a relatively high educational attainment in developing countries – Brazilian average adult population's (and mother's) education attainment, measured in completed years of study, is around five years of this study (representing this educational level).

This paper utilizes a more restrict definition for teachers' education attainment, the percentage of teachers with college education. Nevertheless, it is a more complete study because it includes several other school input and community variables in the analysis – all of them cab be tested in terms of their trade-off with mother's education in the determination of grade progression.

8. CURRENT FINDINGS

We will perform the analysis contrasting Tables 5 and 6 below. They present the regression results of GPP determination for first and fifth grade. A HLM estimation for grade progression on first and fifth grades indicated that the null hypothesis suggesting that the intercepts in both equations were not random was rejected. Thus, a multilevel analysis of the intercept could be performed. The same type of test was performed for mother's education, indicating that the estimated coefficient was random for first grade and not-random for the fifth grade. A test using HLM estimation, not presented in the Tables, indicated that the null hypothesis about the non-random estimated coefficients of father's education could not be rejected for both first and fifth grades. These results confirm the previous study's findings, in the sense that mother's education is hierarchical in the first grade, but not in the fifth grade. They also confirm that mother's education is more prompt to a trade-off with policy and school variables than father's education.

In the case of first grade's random effect, the covariance between the intercept and mother's education is negative. This implies that the municipalities where the intercept is high also present lower values for the mother's education estimated coefficient. The percent of intercept's variance explained by level two variables is around 59% in the first grade, and around 78% in the fifth grade. In the first grade equation, the percent of variance in mother's education estimated coefficient explained by level two variables is around 31%.

Mare's hypothesis regarding the declining role of family's SES with the increase in grade progression is not confirmed in the level one coefficients obtained in Tables 5 and 6. All father's coefficients increased in the determination of GPP between first and fifth grade. The coefficient of mother's education increased a little, almost remaining constant. It is also important to notice that the impact of father's education on GPP is almost as important than mother's education – the extremely large sample size at level one rules out any possibility of multicolinearity. The only result that could be thought as bearing some resemblance with Mare's hypothesis is the absence of mother's education random coefficient in the fifth grade regression, as discussed in the previous paragraph.

We now turn to the analysis of the second level variables and their impact on the estimated random coefficients. Two types of analysis can be performed. First, the analysis of the direct effect of these variables on the intercept of both GPP regressions (first and fifth grades). Second, the analysis of the trade-off between mother's education and second level variables via indirect effect, which can be performed only on the GPP regression for the first grade.

The three variables under the label "School Human Resources" are statistically significant in both regressions. They present the expected sign. Class size affects negatively GPP in both grades, although the impact is stronger in the first grade. The percentage of teachers with college education

affects positively GPP, the effect is stronger in the fifth grade. The number of hours devoted to class on a daily basis affects positively both GPP, the effect is stronger in the first grade.

The education of adult population (above 25 years of age) affects GPP in both grades. The magnitude of the marginal effect is similar in both grades (similar coefficients and sample averages). This quite strong positive impact is hardly changeable by policy at the municipality. On the other hand, in the case of family decision making, the result indicates that families could benefit from living in municipalities with high adult population's education attainment. It is unclear whether this variable indicates the potential interaction of the student with their city fellows (social capital explanation) or the efficiency derived from the human capital stock in the municipality (human capital explanation).

The variables classified as "School Equipment" affect positively GPP in both grades, as predicted. This implies that the percentage of schools with library, sports court, computer laboratory, and science laboratory are positive determinants of grade progression. Two points deserve to be mentioned. First, the percentage of computer laboratory in the schools is not statistically significant in the first grade, while there is a strong positive marginal effect in the case of fifth grade. Second, although the percentage of science laboratory in the schools affects GPP positively in both grades, the marginal effect is stronger in the fifth grade.

Finally, the variables classified as "Municipality Traits" were not as important as the other groupings. Two results deserve special mention. First, there is a positive impact of municipality having a gymnasium on GPP, stronger on fifth grade. This result may be indicative either of more populist mayors and/or of a stronger "civic" culture derived from community sport orientation (this is a typical social capital equipment). Second, the percentage of municipal schools among public schools in the municipality affects negatively GPP in both grades. The negative impact is stronger in the first rather than in the fifth grade, the municipalities operate their education system more strongly in the first grade.

We now move to the analysis of the trade-off between second level variables and mother's education in the GPP at first grade. We mentioned previously that this analysis is not possible for the fifth grade, because we could not reject the hypothesis that the mother's education coefficient was not a random one.

The only variable with significant impact on the mother's education coefficient in the "School Human Resources" grouping is the number of hours devoted to class on a daily basis. It affects negatively the mother's education coefficient. The main implication of this result is that the GPP of children at the first grade with low educated mothers is more positively affected by longer stays in school than the GPP in the case of more educated mothers. A policy implication derived from this result is that full-time education would be more beneficiary of children with low educated mothers. The impact of the percentage of teachers with college education on the coefficient of mother's education is negative but not significant. This result may contrast with the previous findings from our prior paper. This result may be caused by the way that teachers' education is measured – average schooling there and percentage of teachers with college education here.

The education of adult population in the municipality impacts mother's education coefficient negatively. This is a strong negative substitution effect, but the policy implication is low since not

much can be done about adult education. Nevertheless, it is an important result for the families, those with low mother's education will benefit more from living in municipalities with high adult population's education attainment.

Three variables classified as "School Equipment" were negative and significant on mother's education coefficient: the percentage of schools with sports court, computer laboratory, science laboratory. Finally, the percentage of public schools had a negative and significant impact on mother's education coefficient.

TABLE 5

Regression Results – Hierarchical Linear Model –
GPP 1st Grade (Eo)

	Model 1	p-value	Model 2	p-value
Intercept	2,13354	0,000	-1,07777	0,000
School Human Resources				
class size - 1st and 4th grades			-0,02036	0,000
% teachers with college education - 1st and 4th grades			0,63497	0,000
daily hours of class - 1st and 4th grades			0,33811	0,000
Social Capital				
education of adult population (above 25) in the			0,42603	0,000
School Equipment				
% of schools with library			0,16352	0,000
% schools with sports court			0,10027	0,003
% schools with computer lab			0,04523	0,286
% schools with science lab			0,23732	0,000
Municipality Traits				
municipality has a gymnasium			0,07615	0,012
municipality has a library			0,00901	0,078
muncipality has a theater			-0,10073	0,016
municipality has a movie theater			0,07687	0,186
% public schools			0,20484	0,001
% municipal schools among public schools			-0,18968	0,000
Municipality Population Size				
population 5000 to 9999			0,04265	0,314
population 10000 to 14999			0,01227	0,787
population 15000 to 19999			-0,10690	0,041
population 20000 to 49999			-0,15182	0,003
population 50000 to 99999			-0,29366	0,000
population 100000 to 199999			-0,32707	0,001
population 200000 to 499999			-0,35745	0,002
population 500000 to 999999			-0,72847	0,000
population above 1000000			-1,10414	0,000

(Continue next page...)

	Model 1	p-value	Model 2	p-value
Mother's education	0,13197	0,000	0,44637	0,000
School Human Resources				
class size - 1st and 4th grades			-0,00016	0,819
% teachers with college education - 1st and 4th grades			-0,02582	0,194
daily hours of class - 1st and 4th grades			-0,03216	0,004
Social Capital				
education of adult population (above 25) in the			-0,02773	0,000
School Equipment				
% of schools with library			-0,00694	0,421
% schools with sports court			-0,01793	0,030
% schools with computer lab			-0,04666	0,000
% schools with science lab			-0,02138	0,044
Municipality Traits				
municipality has a gymnasium			-0,00668	0,359
municipality has a library			-0,01299	0,107
muncipality has a theater			0,01005	0,249
municipality has a movie theater			0,00660	0,553
% public schools			-0,04234	0,002
% municipal schools among public schools			0,01467	0,142
Municipality Population Size				
population 5000 to 9999			0,04233	0,001
population 10000 to 14999			0,03697	0,003
population 15000 to 19999			0,03178	0,022
population 20000 to 49999			0,05177	0,000
population 50000 to 99999			0,04901	0,002
population 100000 to 199999			0,05022	0,007
population 200000 to 499999			0,06197	0,004
population 500000 to 999999			0,09091	0,002
population above 1000000			0,10344	0,001
Father's education	0,08208	0,000	0,08665	0,000
father protected wage laborer	0,20269	0,000	0,20470	0,000
father public servant	0,31705	0,000	0,31747	0,000
father employer	0,24940	0,000	0,29868	0,000
father self-employed	0,09343	0,000	0,09692	0,000
father non-occupied	-0,05482	0,003	-0,04636	0,010
RANDOM EFFECT				
intercept	1,03384	0,000	0,42507	0,000
Mother's education	0,00928	0,000	0,00636	0,000
cov (intercept, mother's education)	-0,43500		0,19700	
% explained variance - intercept			0,58884	
% explained variance - mother's education			0,31466	

TABLE 6

Regression Results – Hierarchical Linear Model – GPP 5th Grade (E_4)

	Model 1	p-value	Model 2	p-value
Intercept	1,67071	0,000	-1,59537	0,000
School Human Resources				
class size - 5th and 8th grades			-0,00423	0,008
% teachers with college education - 5th and 8th grades			0,38328	0,000
daily hours of class - 5th and 8th grades			0,25646	0,000
Social Capital				
education of adult population (above 25) in the municipality			0,44314	0,000
School Equipment				
% of schools with library			0,11663	0,000
% schools with sports court			0,10581	0,000
% schools with computer lab			0,26808	0,000
% schools with science lab			0,36968	0,000
Municipality Traits				
municipality has a gymnasium			0,11621	0,000
municipality has a library			-0,01060	0,689
muncipality has a theater			-0,05914	0,065
municipality has a movie theater			0,07348	0,086
% public schools			0,05796	0,239
% municipal schools among public schools			-0,07245	0,036
Municipality Population Size				
population 5000 to 9999			-0,16769	0,000
population 10000 to 14999			-0,25914	0,000
population 15000 to 19999			-0,36279	0,000
population 20000 to 49999			-0,42789	0,000
population 50000 to 99999			-0,54090	0,000
population 100000 to 199999			-0,67378	0,000
population 200000 to 499999			-0,77169	0,000
population 500000 to 999999			-1,02967	0,000
population above 1000000			-1,38333	0,000
Mother's education	0,14273	0,000	0,14488	0,000
father's education	0,10831	0,000	0,11198	0,000
father protected wage laborer	0,26431	0,000	0,26610	0,000
father public servant	0,32839	0,000	0,32965	0,000
father employer	0,70136	0,000	0,74918	0,000
father self-employed	0,22307	0,000	0,22694	0,000
father non-occupied	0,11592	0,000	0,12306	0,000
RANDOM EFFECT				
intercept	0,94187	0,000	0,20548	0,000
% of variance explained - intercept			0,78184	

A synthetic way to analyze the marginal effects presented in Tables 5 and 6 is through the graphic simulation of marginal effects. The set of simulations associated with first grade includes the direct (intercept) and indirect (mother's education) effects, while the set associated with fifth grade includes only direct (intercept) effects.

Figure 1 below indicates the negative impact of class size on GPP at first grade. As the indirect effect is not statistically significant, the impact is mainly caused by the direct effect. The total effect caused by a reduction in class size from 45 to 25 is approximately the same as the impact of increasing mother's education by three years, moving from below to the average mother's education – the impact is to increase five percent points in GPP. Figure 2 indicates the direct and indirect effect of

daily hours of class on GPP at first grade. This is probably the strongest school result of all estimations, in the case of mother's education three years below the average, the marginal effect of increasing daily hours of class from 3 to 5,5 hours is equivalent to an increase in 6 years of mother's education. There has been a traditional debate about the relevance of full-time basic education in Brazil. Politicians proposing this policy have been criticized, since it is considered a too expensive policy. This simulation suggests that the returns would be quite high if such a policy could target families with low educated mothers.

FIGURE 1

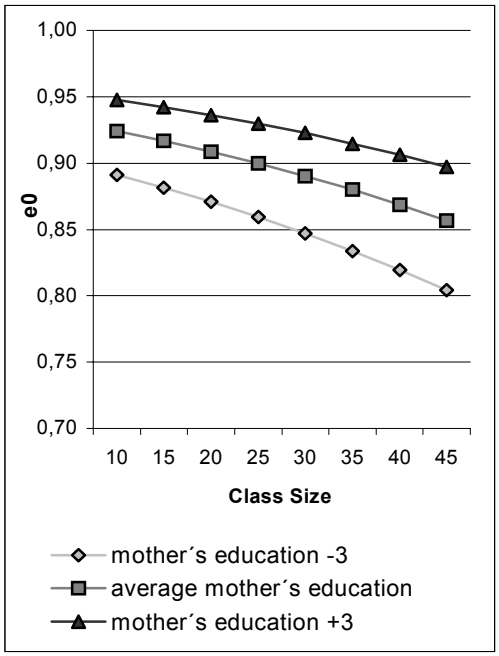
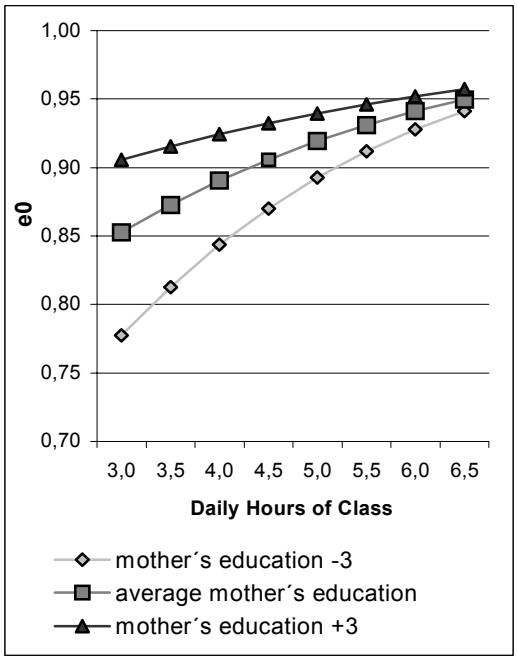


FIGURE 2



The education of adult population in the municipality generates strong direct and indirect effects on GPP at first grade, as indicated in Figure 3. In the case of low educated mothers (three years below the average), an increase in the education of adults, from one year to four years of study, is equivalent to increasing mother's education by six years. Despite limited policy implication, the GPP at first grade will be enhanced if low educated mothers decide to live in municipalities with highly educated adults.

The simulation in Figure 4 indicates that the percentage of schools with computer laboratory has a small effect on GPP at first grade. A small positive effect can be observed in the case of low educated mothers, although even there only at high percentage of computer laboratories at the schools.

FIGURE 3

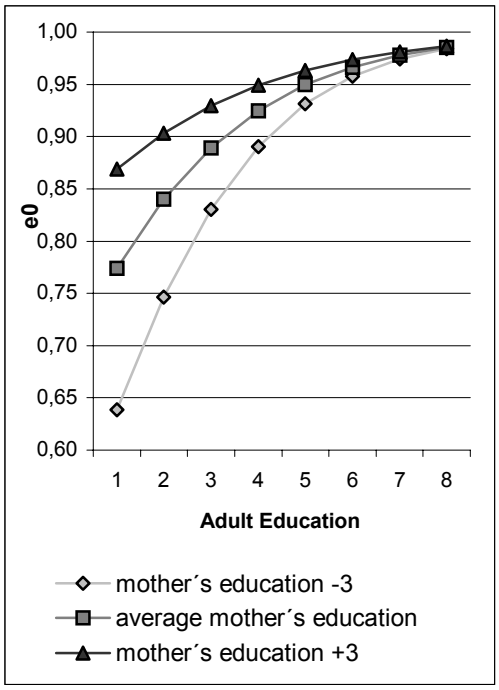
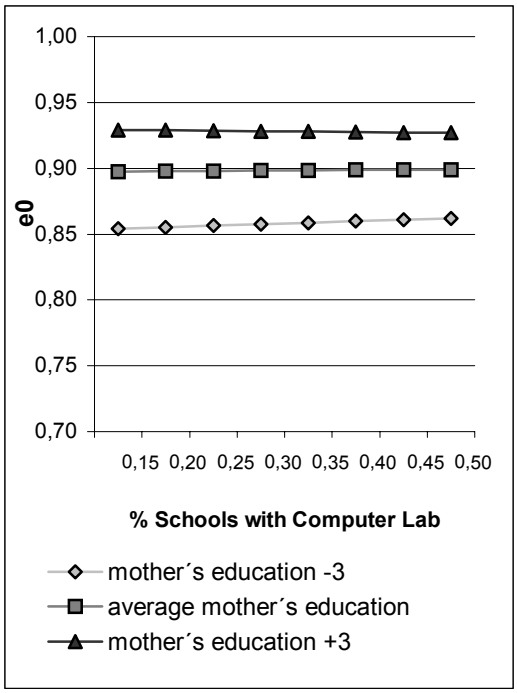


FIGURE 4



The percentage of public schools in the municipality does not increase GPP in any of the three categories of mother's education, as indicated in Figure 5 below.

FIGURE 5

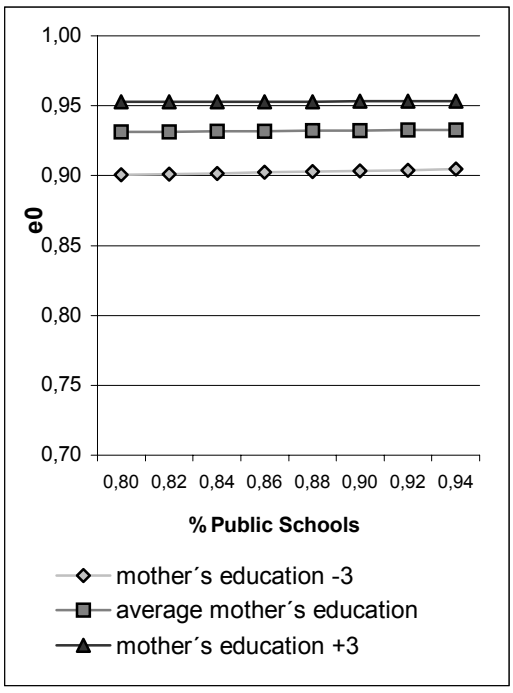


Figure 6 below indicates the negative impact of class size on GPP for fifth grade. The impact is smaller than in the first grade as already indicated. The simulations of marginal effects now include variation in both mother's and father's education, nearly all exercises will indicate that the latter is also an important determinant of grade progression. Figure 7 indicates the positive impact of daily hours of class on GPP at fifth grade, the impact is strong although the curves are less convergent than in the case of first grade, probably due to the lack of indirect effects.

FIGURE 6

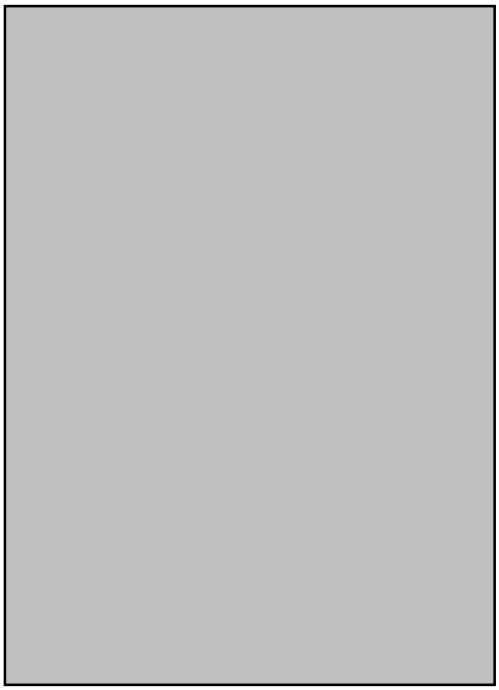


FIGURE 7

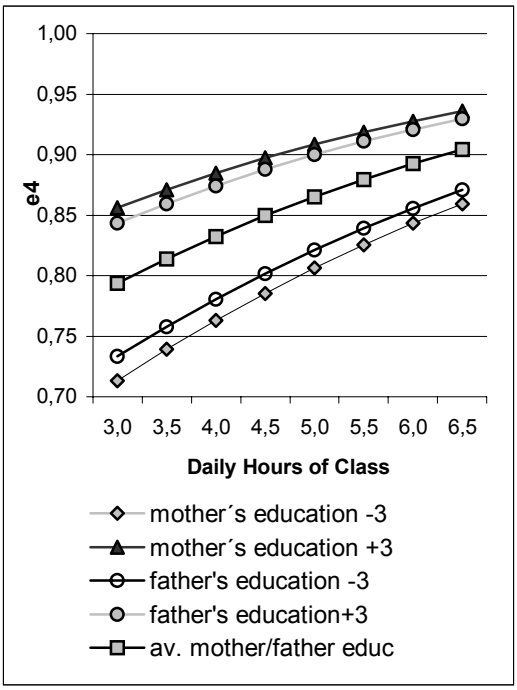


Figure 8 portrays the positive impact on GPP caused by the percentage of teachers with college education. Although the impact is positive, the slope is not as strong as the one observed in other macro level variables. The impact of adult education on GPP for the fifth grade is portrayed in Figure 9. The strong direct effect of adult education is portrayed in the non-linear curve as the average schooling increases. Notice that the curves present similar slopes for the different levels of mother's or father's education.

The four remaining figures (10 to 13) portray the impact of school equipment dimensions on GPP at the fifth grade. The interesting results are the stronger impacts of computer and science laboratories, when compared with the availability of libraries or sports court at the schools in the municipalities. Figure 14 portrays the cumulative effect of varying all school equipment at the same time, the cumulative effect can be perceived in the increased slope, indicating the returns in grade promotion at fifth grade form overall improvements in school equipment.

FIGURE 8

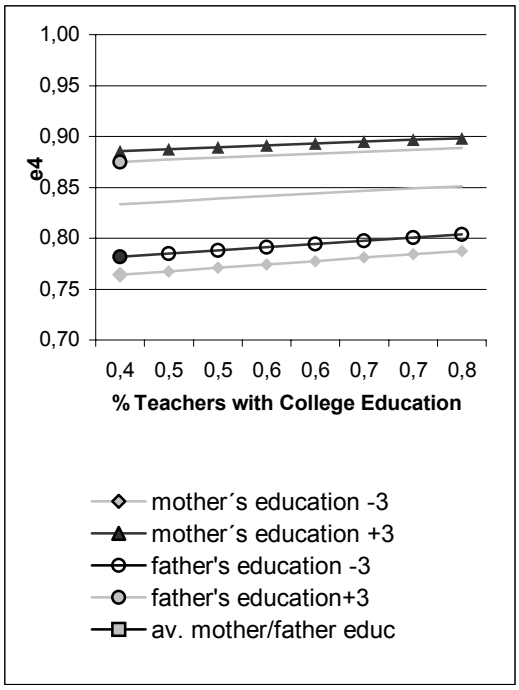


FIGURE 9

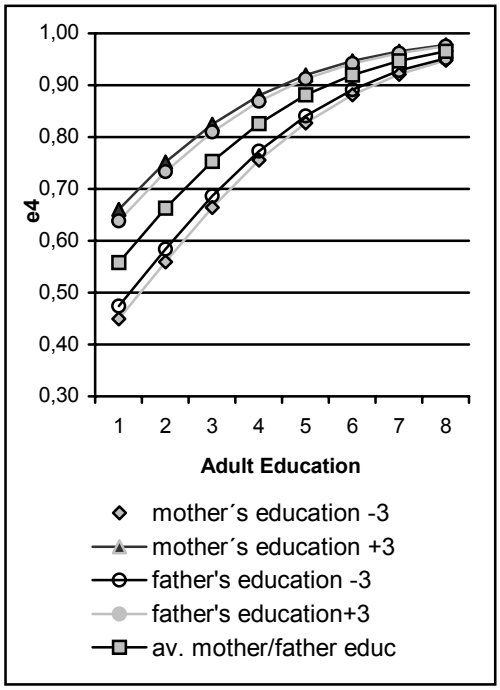


FIGURE 10

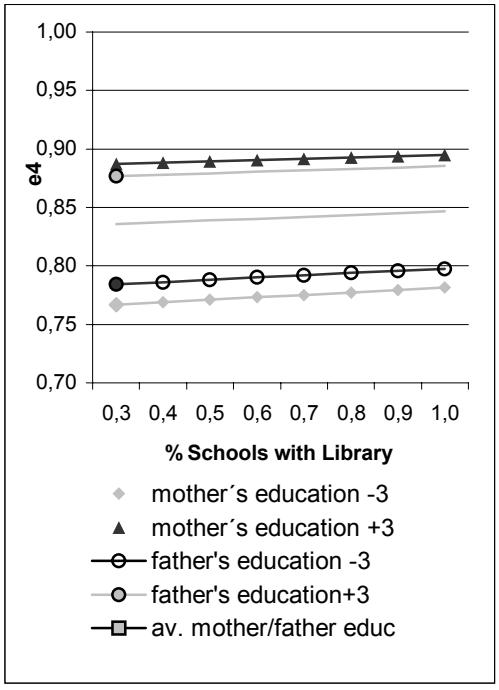


FIGURE 11

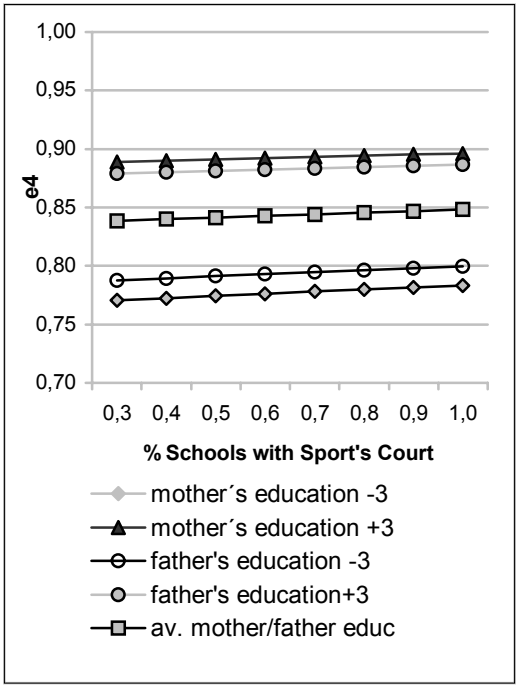


FIGURE 12

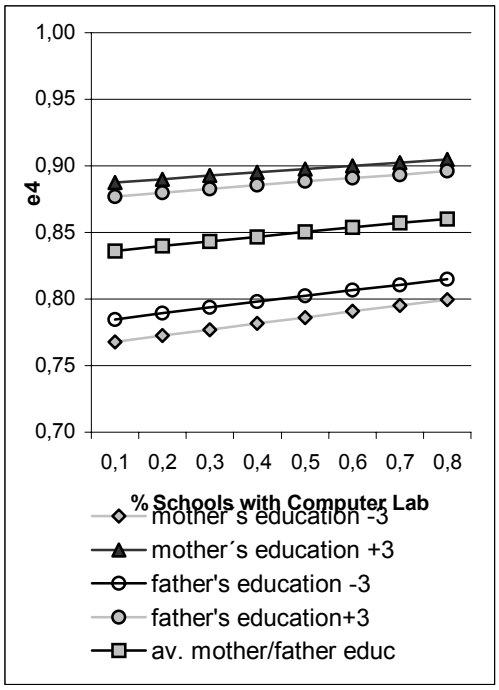


FIGURE 13

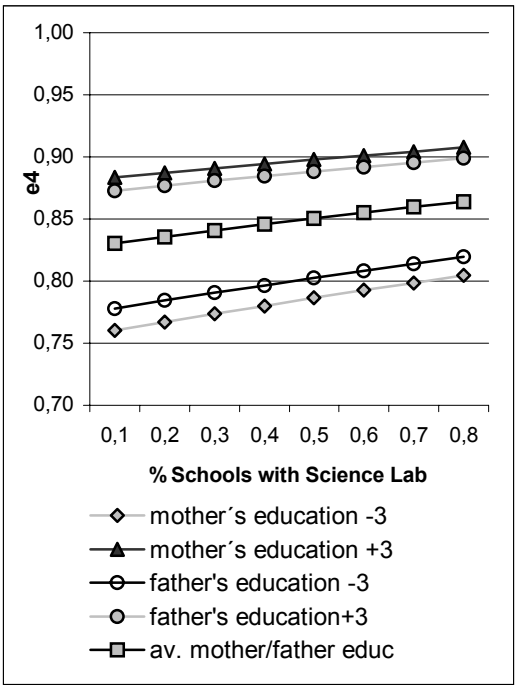
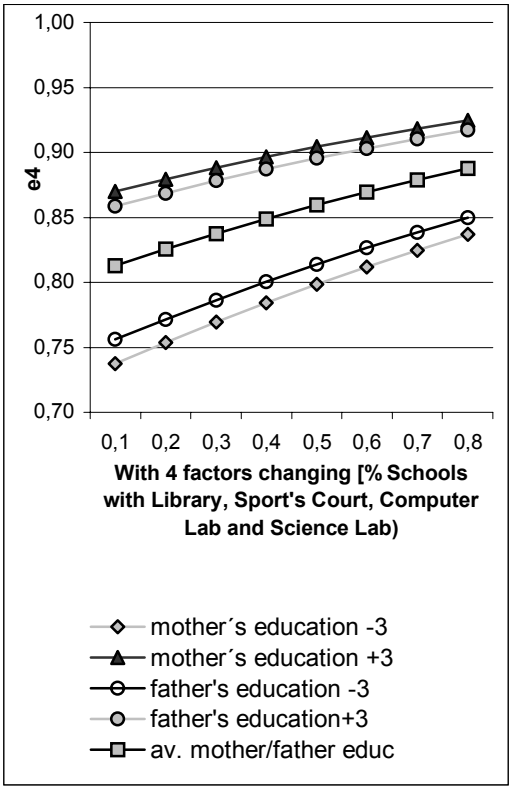


FIGURE 14



9. CONCLUDING REMARKS

This paper advances the knowledge about education stratification in Brazil. It starts with the definition of the dependent variable. Drawing on the analogy between Mare's grade progression and the demographic parity progression ratio, a decomposition exercise is set forth to demonstrate the relevance of grade progression at first and fifth grades for Brazilian education attainment.

The methodology applied in the paper is the hierarchical linear model. It seems an appropriate approach to contrast the role of family SES (level one) with school and community factor (level two) in the determination of education attainment.

The data set is a rather unique combination of good quality data in a developing country. It merges a large number of level one information obtained from the demographic census with a good quality school census. The advantage of merging the school census rather than aggregating demographic census variables is that the latter is a sample of all households while the former covers all schools in all municipalities.

A first finding to be highlighted is the importance of father's education, even controlling for mother's education. The huge amount of information at level one makes one not worry about multicolinearity. The result goes against part of the literature that denies importance of father's education when mother's education is controlled for. Another finding along family's SES is against Mare's proposition, at least comparing first and fifth grade, to the extent that SES aspects do not present a declining role.

The multilevel estimation indicates that family SES factors are important determinants of educational attainment, but they also show that school and community factors also play an important role. Human resource variables are more important in the determination of grade progression for the first as opposed to fifth grade – class size and daily hours of class are important cases. The percentage of teachers with college education is an exception, it is more important for the fifth grade. This result might have been different if the independent variable were teachers' years of education. School equipment variables are more important in the determination of grade progression at the fifth grade. The percentage of schools with computer and science laboratories are particularly important in this case.

The strong results found for the effects adult's education in the municipality do not bear policy implications. They are extremely relevant for the discussion about externalities, human capital growth models, and the discussions about social capital. The results may be relevant for poor families, their children could benefit with the migration from a low to a high educated municipality.

Finally, there is a trade-off or substitution effect between mother's education and level two variables for grade progression in the first grade. Daily hours of class is a good example, there is policy implication associated with this trade-off. When mothers are low educated, the provision of more hours of class might compensate for it leading to grade progression at the first grade.

REFERENCES

Bourdieu, Pierre (1984). ***Distinction. A Social Critique of the Judgement of Taste***, London: Routeledge & Kegan Paul.

Bryk, Anthony S. and Stephen W. Raudenbush. (1992). ***Hierarchical Linear Models: Applications and Data Analysis Methods***. Sage Publications, Newbury Park, California.

Buchmann, Claudia. (2002). Mearuring Family Background in Interational Studies of Education: Conceptual Issues and Methodological Challenges. Chapter 6, pp. 148-196. In Porter, Andrew C. and Gamoram, Adam (editors). ***Methodological Advances in Large-Scale Cross-National Education Surveys***, National Academy of Sciences, Washington, D.C.

Buchmann, C. and E. Hannum, (2001). Education and Stratification in Developing Countries: A Review of Theories and Research. In: ***Annu.Rev.Sociol***. 27: 77-102.

Coleman, James S. (2000). "Social capital in the creation of human capital". In: ***Knowledge and social capital: foundations and applications***, ed. Lesser, Eric L. pp. 17-67. Butterworth Heinemann, Boston, Oxford, Auckland, Johannesburg, Melbourne, New Delhi.

Hanushek, Eric A. (2002). Publicly provided education. In A.J. Auerbach and M. Feldstein, ***Handbook of Public Economics***, Vol. 4, Chapter 30, pp. 2046-2107, Elsevier Science B.V.

Hanushek, Eric A. (2003). The failure of input-based schooling policies. ***The Economic Journal***, 113 (February), F64-F98, Royal Economic Society.

Krueger, Alan B. (2003). Economic considerations and class size. ***The Economic Journal***, 113 (February), F34-F63, Royal Economic Society.

Mare, Robert D. (1979), "Social Background Composition and Educational Growth", ***Demography***, Vol. 16, N. 1, February, pp. 55-71.

Mare, Robert D. (1981), "Change and Stability in Educational Stratification", ***American Sociological Review***, Vol. 46, N. 1, pp. 72-87.

Raudenbush, Stephen et al. (2000). ***HLM 5: Hierarchical Linear and Nonlinear Modelling***. Scientific Software International, Lincolnwood.

Raudenbush, S.W , and A. S. Bryk. (2002) Hierarchical Linear Models: Applications and Data Analysis Methods. Advanced Quantitative Techniques in the Social Sciences Series 1. 2.ed. California: Sage.

Rios-Neto, Eduardo L.G., Cibele C. César e Juliana de L. Ruas Riani. (2002). Estratificação Educacional e Prorgressão Escolar por Série no Brasil. ***Pesquisa e Planejamento Econômico, PPE***, v.32, n.3, pp. 233-253, dezembro.

Todd, Petra E. e Kenneth I. Wolpin. (2003). On the specification and estimation of the production function for cognitive achievement. The Economic Journal, 113 (February), F3-F33, Royal Economic Society.