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Income Inequality, Inequality in Education, and Children's Schooling Attainment in Brazil

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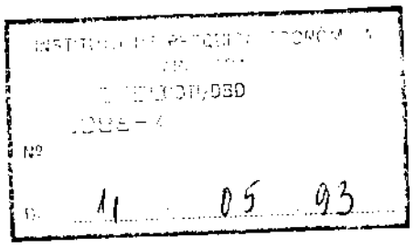

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SUMMARY

INCOME INEQUALITY, INEQUALITY IN EDUCATION, AND CHILDREN'S SCHOOLING ATTAINMENT IN BRAZIL*

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ABSTRACT

This paper analyzes the determinants of schooling attainment at the household level for 14-year-olds in urban regions of São Paulo and Northeast Brazil, using data from the 1982 PNAD. We find mean schooling of 4.75 years in São Paulo, and 3.25 years in the Northeast, both far short of the seven years of schooling that should have been completed by 14-year-olds. In attempting to explain the 1.5 year advantage in the schooling attainment of 14-year-olds in São Paulo, we find regional differences in the characteristics of parents that are consistent with the regional difference in child outcomes. Parents' schooling and income are considerably higher in São Paulo, and inequality in parental schooling is higher in the Northeast. Regression estimates imply substantial positive effects of parental schooling and income on child schooling attainment. Our results suggest that only a small proportion of the gap in schooling attainment between São Paulo and the Northeast can be explained by differences in parental characteristics, however. Using our regression coefficients and mean characteristics in each region to predict schooling attainment off 14-year-olds, we are able to explain less than 20 percent of the 1.5 year schooling gap between the Northeast and São Paulo. This suggests that child schooling attainment will be relatively unresponsive to improvements in the socioeconomic status of household per se. The results suggest that direct increases in the quantity and quality of schooling supplied may be able to eliminate a large fraction of the schooling gap between regions, even in the absence of substantial changes in the socioeconomic status of parents.

1. INTRODUCTION

Education in Brazil has at least four undesirable features. First, the average educational attainment is remarkably low even when compared to other countries with similar levels of per capita income and development. Secondly, the inequality in education is very high. For instance, Lam and Levison (1991) estimated a variance of years of schooling among males in Brazil that is 70 percent higher than the variance for males in the United States, even though mean schooling is over twice as high in the United States. A high degree of income inequality and a close link between education and income inequality are well documented features of the Brazilian economy.[1] It is clear that perhaps the most effective policy to reduce income inequality in Brazil is an educational expansion with emphasis on primary and secondary education. Such policy would simultaneously increase the level and reduce the inequality in education, with parallel impacts on the distribution of income.

A third prominent characteristic of education in Brazil is that the educational attainment of children and that of their parents and grandparents is highly correlated with the schooling of their parents and grandparents. This is not only and indication of lack of equal opportunity, but also suggests that there are limits on the extent of social mobility in Brazil. Increasing the quantity and improving the quality of the primary and secondary public school system in Brazil seems to be an essential policy to promote equal opportunity and foster social mobility.

A fourth feature that is specially important to this paper is the existence of large regional disparities in children's educational attainment. As with regional differences in many socioeconomic characteristics in Brazil [see, e.g., Reis and Barros (1991)], these differences are large, temporally stable, and difficult to explain. They are likely to reflect a very unequal regional allocation of the limited Brazilian investments in education.

Improvements in educational attainment, with special emphasis on primary and secondary education, seem to be an evident and important goal in Brazilian society. The objective of this paper is to shed some light on how this goal can be accomplished. We investigate how the

[1]See Ross and Park (Forthcoming) for the contrasts between Brazil and Korea with regard to education and income inequality.

schooling attainment of Brazilian children depends on the distribution of income and education of their parents. We have four major goals. First, we want to describe the current level of educational achievement among Brazilian children, differences in educational attainment across regions, and the patterns of educational mobility across generations. Secondly, we want to estimate a model which would permit us to disentangle the effect of parents' income from the effect of parents'education. Thirdly, we want to use this model to estimate and compare the impact of changes in the mean with the impact of changes in the degree of inequality in parents' income and education. Finally, using the same model, we want to verify how much of the large regional disparities in Brazil can be explained by regional differences in the distributions of parents' income and parents' education.

2. SETTING AND DATA

Our study is based on the 1982 Brazilian Annual Household Survey (PNAD-82). PNAD surveys are available for all years since 1976. We use the 1982 PNAD primarily because it included information on the educational attainment of grandparents. As we demonstrate below, information on grandparents' education is of particular value in trying to estimate the effect of parents' attributes on the schooling attainment of children. We perform the entire analysis separately for two important geographic areas in Brazil, the relatively poorer and less educated Brazilian Northeast and the richer and better educated state of São Paulo. The analysis is limited to urban areas. According to the 1980 Brazilian demographic census, 49 percent of the Brazilian population lives in these two geographic areas - 28 percent in the state of São Paulo and 22 percent in the Northeast region.

We limit the analysis to children born in 1968. These children should have all begun their schooling in the year they turned seven years of age, 1975, and would have turned 14 during the year of the survey.[2] We have chosen to use one "schooling cohort", and this cohort in particular, for several reasons. Since the opportunity cost of spending time in schoool is strongly dependent on the age of the child, the demand

[2]All of these children had their 14th birthday in the year of the survey, although roughly only three-quarters of them would have been 14 at the time of the survey in September. We will often refer to the children in the sample as 14-year-olds for convenience, although strictly speaking we will mean the cohort of children that turned age 14 in 1982.

for schooling will necessarily be dependent on age.[3] We know very little about the relationship between age and the value of time among Brazilian children, and have chosen to constrain the analysis to one age group in order to avoid one possible extra source of model misspecification. The fact that our data set is very large makes this choice feasible.[4]

Since we imagine the demand for schooling to be a household decision we use the household as our unit of analysis. An observation consists of a child born in 1968, with variables reflecting the characteristics of the child's parents and grandparents. Since we are primarily interested in the effects of the characteristics of parents on schooling outcomes, we restrict our attention to children with both parents

[3]See for example, Psacharopoulos and Arriagada (1986) and Levison (1991) on the tradeoff between schooling and work in Brazil.

[4]The choice of age 14 is motivated by three facts. First, Brazil has mandatory schooling up to age 14. Since children are expected to enter the first grade when they are age seven, they are expected to be attending the eighth grade in the year they turn age 14 in the absence of grade repitition or movements in and out of schooling. The eighth grade is the last grade of elementary school in the Brazilian school system and high school is not mandatory. Secondly, Brazilian labor legislation states that only children age 14 or older can work without special permission. Starting at age 12, children can work in special circumstances, but employers are obliged to certify that the children they employ are currently attending school. Thirdly, since this study rilies on information from a household survey, only children currently living with their parents can be included in the analysis. The use of older age groups would lead to increasing sample selection, since the probability of children leaving home increases with age.

present in the household.[5] Our sample of households with at least one child born in 1968 contains 1,604 hoseholds in the Northeast and 867 households in São Paulo. When we restrict the sample to those families for which we have complete data on the schooling of both parents and all four grandparents, and the income of the household head, the sample used for our regressions below, the sample sizes are 820 for São Paulo and 1,525 for the Northeast.[6]

3. SCHOOLING ATTAINMENT OF 14-YEAR-OLDS

We use as our outcome variable the number of years of completed schooling of each child. An alternative outcome variable would be the current school attendance of each child, a measure that would normally be expected to be a good indicator of ultimate school attainment. Current school attendance of 14-year-olds turns out to be a relatively poor measure of schooling attainment in Brazil, however. Table 1 demonstrates a number of important facts about the distribution of years of schooling controlling for region and whether the child was in or out of school at the time of the survey. As expected, the distributions in the table indicated that children in school at age 14 have higher

[5]This screening procedure leaves out of the sample all 14-year-olds whose father is not the head of the household in which they were residing at the time of the survey. This eliminates about 15 percent of children in the Northeast and about seven percent in São Paulo. We exclude this group since the main focus of the study is the relationship between parents' attributes and their children's schooling attainment. If poorly educated or low income parents are less likely to be in intact unions when the child is age 14, then our sample will tend to under-represent these economically disadvantaged children. This may lead us to overstate schooling attainment of all 14-year-olds in the two regions. Even if we have a non-random sample of all children, however, we will not necessarily have any systematic bias in the estimated effects of parental characteristics on schooling outcomes, providing the "schooling response function" we estimate below is the same for all families, independent of their current living arrangements.

[6]Although the overall populations in these two regions is roughly similar, the average sampling proportion for the PNAD was substantially higher in the Northeast (averaging around 1/200) than in São Paulo (averaging around 1/400), leading to our sample being almost twice as large in the Northeast.

school attainment than those out of school. The distributions also how, however, that among those 14-year-olds attending school there is a surprisingly high degree of heterogeneity in schooling attainment. In São Paulo, for example, over 50 percent of 14-year-olds currently attending school had completed less than six years of schooling. In the Northeast over 80 percent of the 14-year-olds enrolled in school had completed less than six years of schooling. Out of all 14-year-olds enrolled in school, only about seven percent in the Northeast and 20 percent in São Paulo had completed the seventh grade. In our data we cannot determine the extent to which these shortfalls result from intermittent attendance or grade repetition. As pointed in the papers by Gomes-Neto and Hanushek (Forthcoming), and Souza and Silva (Forthcoming) elsewhere in this volume, grade repetition is one of the most serious problems in the Brazilian educational system, and is no doubt a major explanation for the schooling attainment shortfalls identified here.

The table provides considerable evidence that grade repetition, and not simply dropping out of school, is responsible for the low levels of schooling attainment in the Northeast. The distribution of years of schooling for 14-year-olds currently attending school in the Northeast is similar to the distribution of years of schooling of those out of school in São Paulo. Those currently enrolled in the Northeast have only .4 year more schooling on average than those out of school in São Paulo (3.7 versus 3.3). Because of a very high repetion rate and large movements in and out of school in Brazil, it appears that current school attendance is a very imperfect predictor of completed years of schooling. Here we see an extreme manifestation of the problem of grade repetition. The most remarkable fact in Table 1 is that despite large regional disparities in school attainments - the average number of completed years of schooling in São Paulo is 1.5 year higher than the average in the Northeast - school attendance rates in the two geographic areas are almost identical. Attendance rates in both regions are around 80 percent, differing by only one percentage point. Based on these facts, we have chosen to use as our outcome variable the number of completed years of schooling instead of the child's current school attendance status.

Table 1. Years of Completed Schooling and Summary Statistics, by Current Enrollment Status 14-Year-Olds, São Paulo and Northeast Brazil, 1982

	São Paulo			Northeast		
	Out of School	In School	Total	Out of School	In School	Total
Percent Completing:						
< 1 Year	11.5	0.3	2.6	41.8	6.1	12.8
1 Year	6.1	1.5	2.5	14.5	9.0	10.0
2 Years	12.1	5.2	6.6	19.3	12.9	14.1
3 Years	15.1	8.0	9.4	11.1	16.1	15.1
4 Years	32.6	16.2	21.0	9.3	22.7	20.2
5 Years	17.6	22.8	20.9	1.7	14.5	12.1
6 Years	2.4	25.2	20.7	1.4	11.3	9.4
7 Years	1.8	20.0	16.3	0.5	6.8	5.6
8 Years	0.6	0.9	0.9	0.2	0.6	0.5
Mean Schooling	3.27	5.13	4.75	1.46	3.67	3.25
Std. Deviation	1.74	1.55	1.75	1.61	1.91	2.05
Percent < 4 Years	44.9	15.0	20.9	86.8	44.0	52.1
Percent < 6 Years	95.1	53.9	62.1	97.9	81.3	84.4
Weighted Pct. in Region	19.93	80.07	100.0	18.75	81.25	100.0
Sample Size			820			1525

Notes: Estimated from 1982 PNAD, using IBGE sample weights.

The basic features of the distribution of years of schooling for 14-year-olds in São Paulo and in the Northeast can also be seen in Table 1. The table reveals three important facts. First, schooling achievement in both regions is very low. Children who have been continuously enrolled from age seven to 14, as mandated by law, and who have not repeated a grade, should have completed seven years of schooling. Compared to this target of seven years, there is a gap in mean schooling attainment of 14-year-olds of 2.25 years in São Paulo, and a gap of 3.75 years in the Northeast.

Secondly, the schooling level in São Paulo is significantly higher than in the Northeast. The mean is 1.5 year higher in São Paulo, while the proportion with at least six years of schooling is 38 percent in São Paulo, compared to only 16 percent in the Northeast.

Thirdly, the Northeast, in addition to having a lower level of schooling has a more unequal distribution. The standard deviation is .3 year higher, even though the mean is 1.5 year lower. This inequality can be seen in the much high proportions of 14-year-olds with very low schooling attainments in the Northeast. Over half of the 14-year-olds in the Northeast have less than four

years of schooling, with 23 percent having completed one year or less.

3.1. Distribution of Schooling and Income for Parents

A principal purpose of our analysis below is to examine the extent to which the large regional differences in schooling outcomes documented in the previous section are a consequence of differences in the characteristics of households across regions. Household characteristics may determine child schooling attainment for a variety of reasons. As discussed by Beker (1975), higher income households may demand a greater quantity (and quality) of schooling for their children as a consumption good, or because they face lower costs of self-financing. Better educated parents may demand more schooling for their children due to taste differences, or they may have an advantage in helping their children succeed in school. We will not be able to identify why parental education and income affect schooling attainment, but will be interested in the reduced form effect working through a variety of demand and productivity related mechanisms. Our goal is to estimate, for example, how much higher schooling attainment would be in the Northeast if parents in the Northeast had the same characteristics as parents in São Paulo. We begin this analysis by investigating differences in the distribution of parents' characteristics in the two regions. Table 2 given summary statistics for the distribution of schooling and income of the parents of 14-year-olds in São Paulo and the Northeast.

As Table 2 reveals, the levels of educational attainment for both fathers and mothers are higher in São Paulo than in the Northeast. Fathers in São Paulo have mean schooling of 3.9 years, compared to 2.6 years for fathers in the Northeast. In São Paulo the schooling level of fathers tends to be higher than among mothers, while in the Northeast the distribution of education tends to be vy similar for fathers and mothers.

Table 2 also privides information on schooling inequality among parents in the two regions. Although São Paulo has a higher standard deviation of years of schooling for both mothers and fathers, this is more than accounted for by the higher means in São Paulo. The coeficient of variation of years of schooling is lower in São Paulo than in the Northeast, implying that by this measure the distribution of parents' schooling is more equal in São Paulo than in the Northeast.

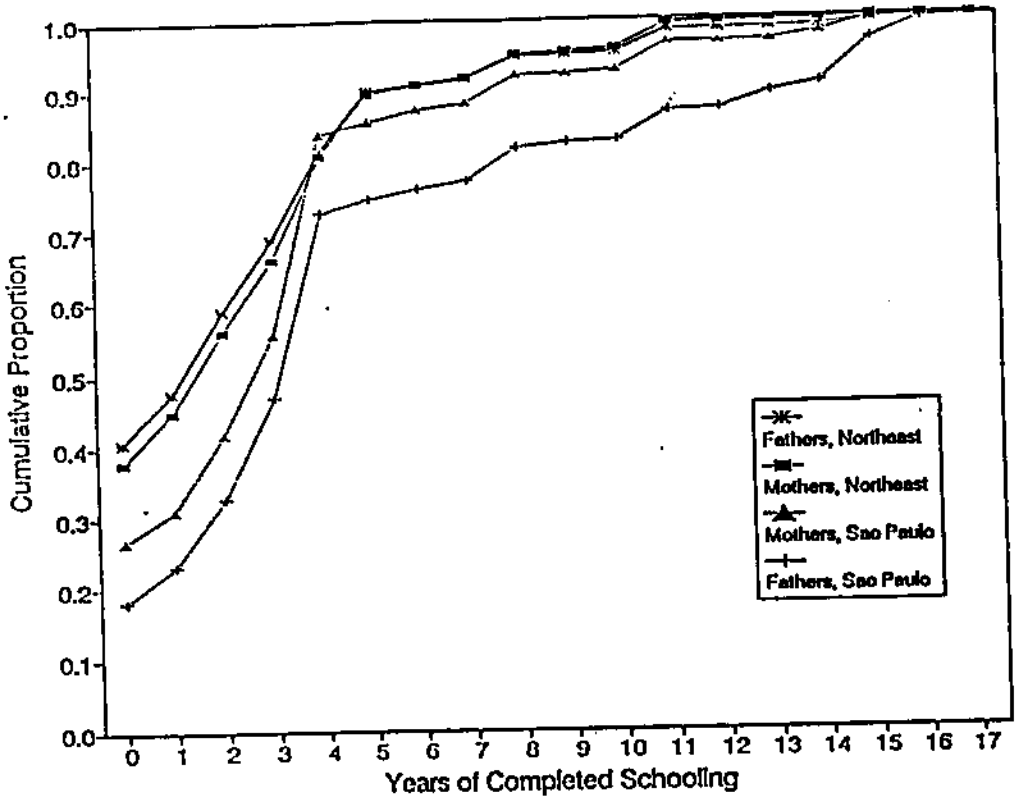
Table 2. Schooling and Income Distribution for Parents of 14-Year-Olds State of São Paulo and Northeast Region, Brazil, 1982

Characteristic	São Paulo	Northeast	Difference
Father's Schooling			
Mean (years)	3.92	2.57	1.35
Standard Deviation (years)	3.87	3.22	0.65
Coefficient of Variation	0.99	1.25	-0.27
Percent with:			
At least 1 year	79.1	57.9	21.2
At least 4 years	49.5	31.2	18.3
At least 6 years	18.7	10.8	7.9
Mother's Schooling			
Mean (years)	3.35	2.62	0.73
Standard Deviation (years)	3.40	2.97	0.43
Coefficient of Variation	1.01	1.13	-0.12
Percent with:			
At least 1 year	73.5	62.9	10.6
At least 4 years	45.4	34.0	11.4
At least 6 years	14.1	10.9	3.2
Correlation (Mother's Educ., Father's Educ.)	0.708	0.608	0.101
Head's Income (No. of Minimum Salaries)			
Mean	5.75	2.89	2.86
Standard Deviation	9.06	4.01	5.05
Coefficient of Variation	1.57	1.39	0.18

Notes: Estimated from 1982 PNAD using IBGE sample weights. Income is number of official minimum salaries earned in previous month.

Further detail on the distribution of parental schooling in the two regions is provided in Figure 1, which shows the cumulative distributions for single years of schooling for mothers and fathers in the two regions. The figure shows that the most pronounced difference between São Paulo and the Northeast is the proportion with very low levels of schooling. Although the educational advantage of parents in the Southeast can be seen throughout the educational distribution, the gap diminishes somewhat at higher levels of education, especially for women. As shown in Table 2, very low levels of schooling in the Northeast are even more characteristic of parents than for children. Over 40 percent of fathers and 37 percent of mothers in the Northeast have less than one year of schooling, compared to 20 percent of fathers and 26 percent of mothers in São Paulo.

Figure 1. Cumulative Distributions, Years of Completed Schooling
Urban State of São Paulo and Northeast Region, Brazil, 1982
Fathers and Mothers of 14-Year-Olds



Comparing Table 1 and 2, it is important to note that the completed schooling level of 14-year-olds in Brazil is already higher than the average level among both parents, indicating some improvement in educational attainment in Brazil from the last to the current generation. For example, while the mean schooling for fathers of 14-year-olds in the Northeast is slightly less than four years, the mean schooling of the 14-year-olds themselves is 4.7 years. For the Northeast, 14-year-olds have roughly 7 year more schooling than their fathers, 3.3 years compared to 2.6 years.[7]

One important determinant of intergenerational mobility in schooling is the degree of assortative mating on schooling in the marriage market. As shown in Table 2, there is a very high correlation in the schooling of mothers and fathers in Brazil. The correlation between husband's and wife's schooling is over .7 in São Paulo, and over .6 in the Northeast. This high correlation may play an important role, since strong positive assortative mating on schooling will tend to increase inertia in the distribution across generations.[8]

In addition to the schooling of parents we are also interested in the effect of household income on the schooling attainment of children. Table 2 shows that the mean income of household heads is almost twice as high in São Paulo, although some fraction of this may be due to cost of living differences. Income inequality, as measured by the coefficient of variation, is high by international standards in both regions, with somewhat greater inequality in São Paulo. The degree of inequality is potentially an important determinant of the mean level of schooling attainment in each region, as we discuss below.

4. EDUCATIONAL INTERGENERATIONAL MOBILITY

The previous discussion demonstrated that the educational levels of children and parents are positively related across regions. Next we investigate whether this relationship also holds within each region. This hypothesis is strongly confirmed by Figure 2 and 3. These figures present the cumulative distribution of single years of schooling among 14-

[7]See Lam and Levison (1992) for a more detailed analysis of improvements in the distribution of schooling in Brazil in recent decades.

[8]See Lam and Schoeni (1991) for an analysis of assortative mating in schooling in Brazil and its relationship to inequality in earnings.

year-olds conditional on their father's education. With a minor exception in the case of nine-11 years for fathers in São Paulo, the figures indicate that increases in the schooling of fathers leads to unambiguous improvements in the distribution of education among children, in the sense of first order stochastic dominance. The cumulative distribution based on mother's education, not shown here, show virtually identical patterns in the two regions.

Figure 2. Cumulative Distributions, Years of Completed Schooling
Schooling of 14-Year-Olds by Schooling of Father
Urban São Paulo State, Brazil, 1982

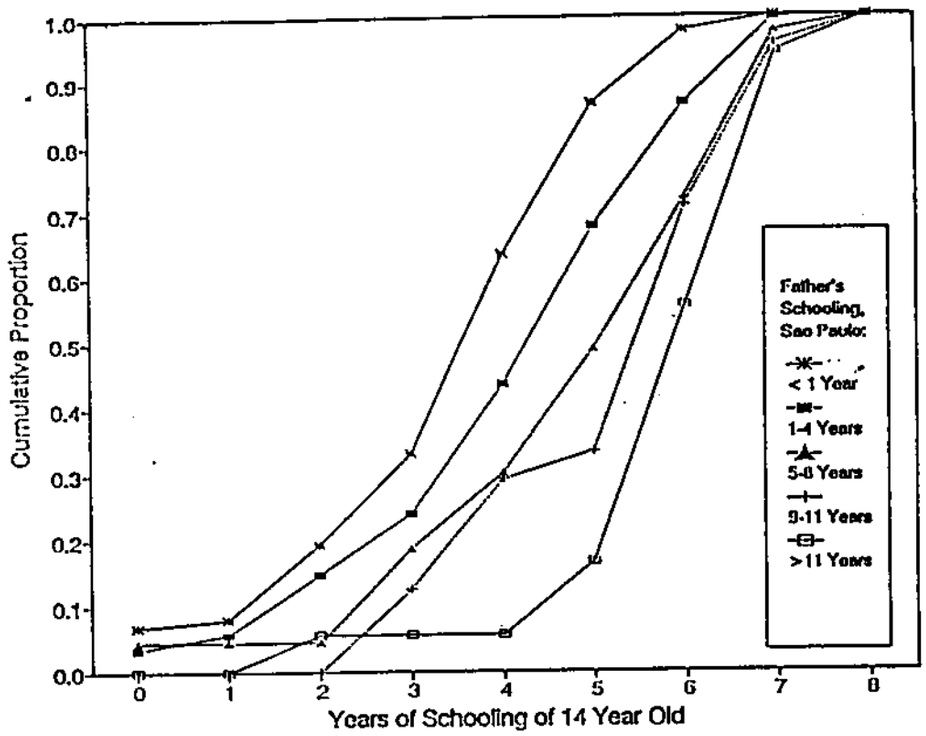


Figure 3. Cumulative Distributions, Years of Completed Schooling
Schooling of 14-Year-Olds by Schooling of Father
Urban Northeast Region, Brazil, 1982

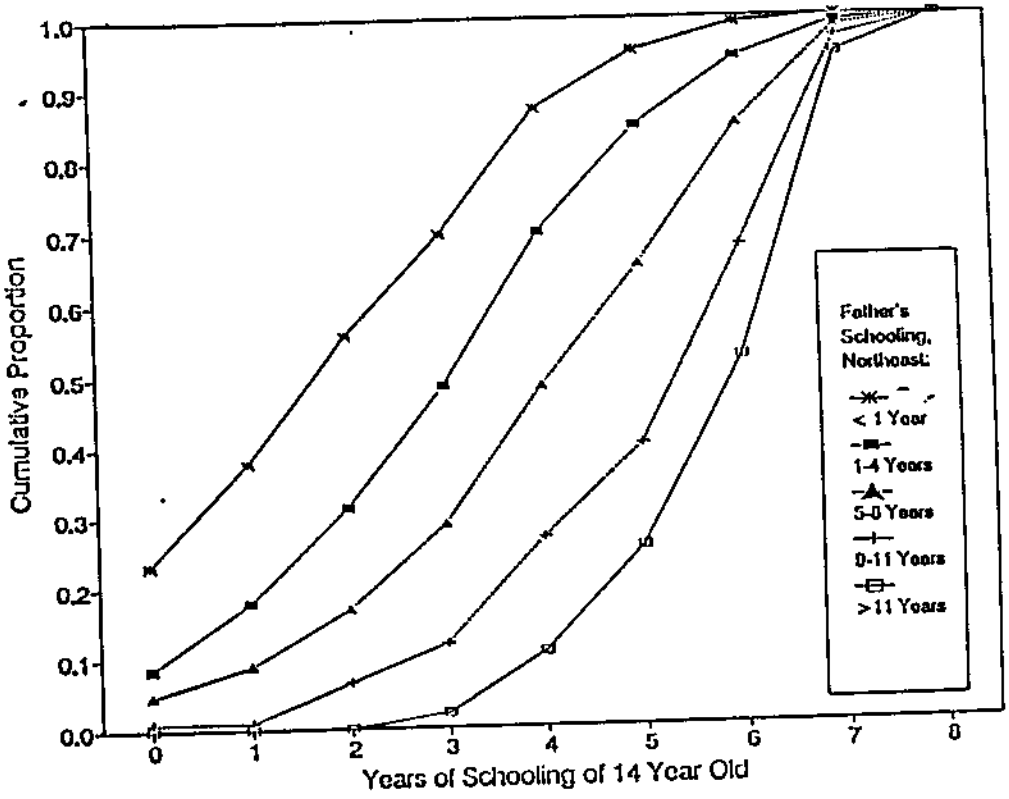
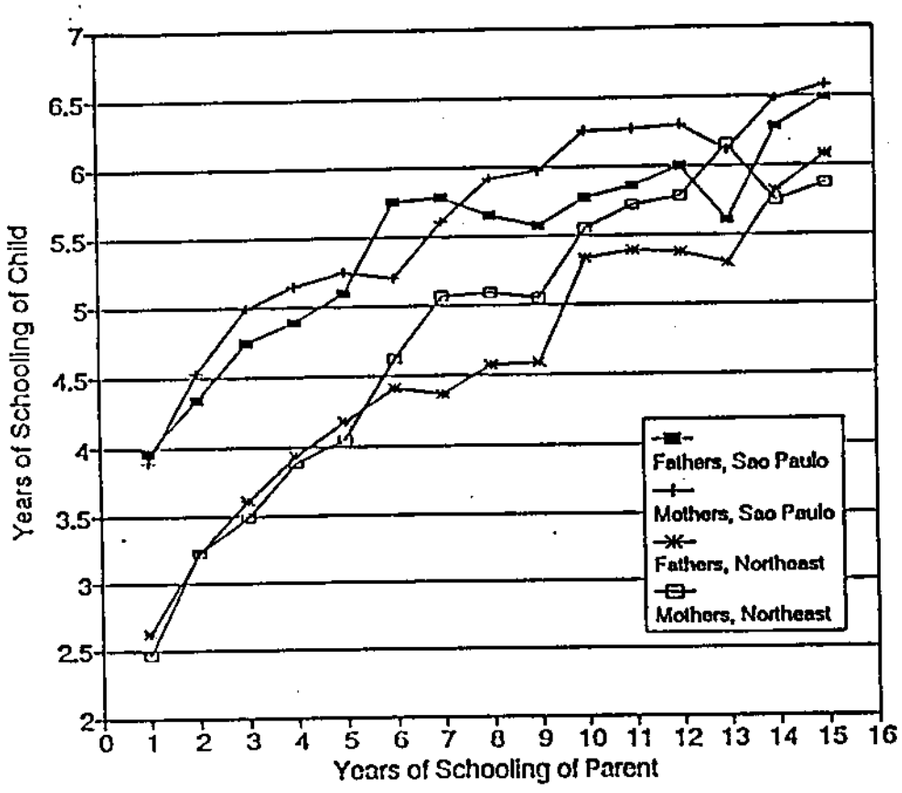


Figure 4 presents the mean schooling of 14-year-olds by single year of schooling of mothers and fathers in the two regions. The points are smoothed as three-year moving averages weighted by the cell sizes for each year of schooling. The figure reveals a steeper relationship between parents and children's education in the Northeast than in São Paulo, raising the hypothesis that parents' education may be a more important determinant of children's education in the Northeast than in São Paulo. At higher levels of parental education the mean years of schooling attainment among 14-year-olds shows little variations between the Northeast and São Paulo. There are substantially larger differences at low levels of parental schooling, however. For parents with less than four years of schooling there is roughly a one year advantage in the schooling attainment of 14-year-olds in São Paulo compared to 14-year-olds in the Northeast.

Figure 4. Mean Schooling of 14-Year-Olds by Years of Completed Schooling of Parents
Three-Year Moving Averages of Single Years of Schooling of Mother and Father
Urban São Paulo State and Northeast Region, Brazil, 1982



The patterns shown in Figure 4 provide an important picture of the relationship between parental schooling and child schooling in São Paulo and the Northeast. Although a precise answer requires the kind of multivariate analysis we will present below, the graph provides dramatic evidence that we are unlikely to explain the large gap in schooling attainment between these two regions by differences in the characteristics of parents alone. The fact that children whose parents have less than four years of schooling (a high proportion of all children) will on average attain a full year less schooling by age 14 in the Northeast than will comparable children in São Paulo means that there is clearly more going on the explain the schooling gap between the two regions than simply the differences in the characteristics of parents. The graph suggests that even if parents in the Northeast had the higher educational attainment of parents in the Southeast, it would still leave a substantial gap in the schooling attainment of children. This question will be addressed more formally below in the context of multivariate regressions.

Since we also have data on the schooling of grandparents we can look at intergenerational mobility in education across three generations. The schooling data for grandparents is coded categorically based on the reports of adult household about the education of their parents. Table 3 shows the distribution of schooling for each of the four grandparents of the 14-year-olds in the sample. It also shows the mean schooling of 14-year-olds for each category of grandparents' education.

The data for grandparents continue to show low overall levels of schooling and a substantial schooling gap between the Northeast and São Paulo. About 35 percent of fathers in São Paulo report that their fathers were illiterate, compared to 49 percent in the Northeast. The gaps between regions for grandparents' schooling are perhaps smaller than might be expected, especially for grandmothers. The proportion of mothers who report that their mothers were illiterate is 55 percent in São Paulo, compared to 57 percent in the Northeast. This small gap may reflect the fact that many of the respondents in São Paulo have migrated from the Northeast.

Table 3. Mean Schooling of 14-Year-Olds by Grandparents' Education
State of São Paulo and Northeast Region, Brazil, 1982

Schooling Of Grandparent	Father's Father %	Father's Father $\bar{S}_{14}$	Father's Mother %	Father's Mother $\bar{S}_{14}$	Mother's Father %	Mother's Father $\bar{S}_{14}$	Mother's Mother %	Mother's Mother $\bar{S}_{14}$
São Paulo								
Illiterate	34.8	4.1	51.1	4.3	32.7	4.1	55.0	4.3
Literate	16.4	5.1	12.8	5.1	20.8	5.0	13.4	5.0
1–3 Years	19.5	4.8	14.3	5.1	21.5	4.9	15.1	5.3
4 Years	14.9	5.7	11.1	5.7	16.0	5.4	11.0	5.8
5–8 Years	2.1	5.1	1.9	5.9	2.1	5.8	0.9	6.7
9–11 Years	2.1	5.2	1.8	6.3	2.1	5.8	1.7	6.5
University	1.4	6.5	0.2	7.0	1.2	5.3	0.1	5.0
Northeast								
Illiterate	48.9	2.7	58.2	2.8	46.7	2.7	57.2	2.8
Literate	22.1	3.6	17.0	3.6	25.9	3.4	20.2	3.4
1–3 Years	11.1	4.0	8.3	4.0	12.6	3.9	11.0	4.1
4 Years	4.9	4.9	4.3	4.8	6.9	4.8	5.5	5.1
5–8 Years	0.9	5.3	0.9	5.5	1.3	5.4	1.2	5.2
9–11 Years	0.7	5.5	0.7	5.6	0.6	5.5	0.7	5.7
University	0.5	5.0	0.2	5.0	0.3	6.0	0.0	–

Notes: Estimated from 1982 PNAD, using IBGE sample weights. Columns labeled % show frequency distribution for grandparents' education. Columns labeled $\bar{S}_{14}$ give mean schooling for 14-year-olds with grandparents in that category.

Table 3 also shows a strong positive relationship between the schooling of grandparents and the schooling of 14-year-olds. Children in both regions who have illiterate grandparents have mean schooling that is .7 to one year less than children with literate grandparents. We continue to see that simply controlling for family background is not likely to explain all of the large regional difference in child schooling attainment, however. Children in the Northeast with illiterate grandfathers have mean schooling of only 2.7 years, while children in São Paulo with illiterate grandfathers have mean schooling of 4.1 years.

5. THE HOUSEHOLD EDUCATION RESPONSE FUNCTION

In Barros and Lam (1991) we develop three alternative models to provide a framework for a causal interpretation of our empirical estimates. We briefly summarize those models here. We are interested in the

"household education response function" to variations in parents' education and household economic resources. Specifically, if e_p and y are the levels of parents' educations and household economic resources, respectively, then we will think of a function $f_o(e_p,y;h)$ that gives the education level of a 14-year-old child living in some household h. The derivative of f with respect to e_p indicates the response of children's education in each household to changes in parents' education, holding household economic resources constant. We are also interested in the response of children's education to changes in parents' education without holding constant the household economic resources. If g_o (h) denotes the household education response function to variations in parents' education allowing economic resources to vary with parents' education, then the derivative of g with respect to e_p indicates the total response of children's education to changes in parents' education, including both "direct" effects of parental schooling on child schooling, and "indirect effects" working through increased household resources.

Let E_c denote a child's education, let E_p be a vector denoting parents' education, and let Y be denote household economic resources. We assume that we can make a simple decomposition into a schooling response function shared by all households and a function that describes household level heterogeneity, so that for some household h:

$$E_c(h) = f_o(E_p(h),Y(h);h) = f_1(e_p,Y) + g(h).$$

This implies that heterogeneity across households takes the form a simple additive disturbance to the education response function. We refer to g as the household shifter and to f_1 as the population response function.

Given the joint distribution of schooling and income in the population, integrating over the f_1 function gives us the mean schooling of 14-year-olds in the population.[9] Our major goal is to estimate how household characteristics affect schooling attainment, i.e., to estimate the component f_1 of the response function. Based on this estimated f_1 we can simulate what the average education among 14-year-olds would be if we changed the distribution of schooling and income

[9]Note that in this case $E_c(h) = f_1(E_p(h), Y(h) + g(h)$ and therefore $\mu_{Ec} \equiv E[E_c] = E[f_1(E_p, Y)] \equiv \int f_1(e_p,Y)dF_{Ep,Y}(e_p,Y)$.

in the population.[10] For example, we want to estimate what the mean schooling attainment of 14-year-olds in the Northeast would be if parents in the Northeast had the same distribution of schooling and income as parents in São Paulo.

We consider three alternative sets of assumptions that would permit us to estimate f_1. The motivation and validity of each of these three models is directly related to how the household shifter, g, is generated. By construction, the household shifter permits the response function to differ across households. This shifter can be thought of as representing other resources available to the household, including family habits (persistence, discipline, etc.), and location decisions (proximity of good schools, for example), or unobserved resources (inherited wealth, extended family support networks) which permit otherwise equally educated and wealthy parents to have better educated children. Family habits and location decisions are forms of human capital and therefore dependent in principle on the same determinants of education and income. This joint determination is the source of our fundamental identification problem. Therefore, the assumptions underlying our three models are alternative attempts to achieve identification by putting bounds on the degree of joint determination.

5.1. The Random Response Case

The first model assumes that the household shifter g is independent of household income and schooling.[11] This is the case in which unobserved household heterogeneity that affects child schooling attainment is uncorrelated with observed household characteristics such as parental education and income. In this case we can estimate f_1 by regressing children's education on parents' education and household economic resources. The implied causal interpretation of parental education in this case is that if a randomly drawn parent had received an additional year of schooling, there would have been an increase in the schooling attainment of a 14-year-old in the household by the amount implied by our estimated function f_1.

One possibility to justify this model is to assume that the household shifter is generated a new each

[10] I.e., we will estimate $\mu^*_{Ec} \equiv \int f_1(e_p,Y)dF^*_{Ep,Y}(e_p,Y)$ for some alternative distribution F^*.

[11] That is, we assume that $g \perp (E_p,Y)$, and therefore that $E[E_c|E_p, Y] = f_1(E_p, Y)$.

generation in a way that is independent of all past history of the household and therefore independent of parents' education and income. If we think of the household shifter as a function of family habits and location decisions then we are assuming that parents' income and education, on the one hand, and family habits and location, on the other hand, are independently determined. Since this assumption may not be plausible we introduce two alternatives which rely on informartion on grandparents' education.

5.2. The Inherited Shifter Model

A common criticism of estimates of the effect of individuals' schooling on outcomes such as their earnings or the schooling attainment of their children is that schooling is correlated with a number of important unobserved variables. Schooling attainment, for example, may be influenced by "inherited" family background variables such as ability, taste for schooling, or access to schooling due to family connections or geographical location. One formalization of this argument is to think of an "inherited shifter" that affects child schooling attainment and is passed on across generations. In this case we may observe high correlations between parental schooling and child schooling without any direct causal link. Increasing the schooling of a randomly drawn mother will not necessarily increase the schooling of her child if we cannot change the value of this "inherited shifter." Since we observe grandparents' education in our sample as well as parents' education, we are interested in the potential role of grandparents' education to help identify the underlying education response function f_1.

The second model, then, assumes that the household shifter is a function of grandparents' education.[12] In this model we can estimate f_1 by regressing child education on parents' and grandparents' education and household economic resources. To the extent that the grandparents' education variables control for the unobserved family background variables that are correlated with parental schooling and income, we can recover the household response function f_1.

[12]If E_g is a vector denoting grandparents' education, then we assume the household shifter is a function of grandparents' education in the sense that $g(p)= f_2(E_g(p),g^*(p))$ and $g^* \perp (E_p,Y)|E_p$. It follows that $E[E_c|E_p,Y,E_g]=f_1(E_p,Y)+E[f_2(E_g,g^*)|E_g]=f_1(E_p,Y)+f_3(E_g)$, were $f_3(E_g)=E[f_2(E_g,g^*)|E_g]$.

5.3. The Non-Inherited Shifter Model

A quite different assumption is to assume that the household shifter is independent of grandparents' education, implying that grandparents' education is correlated with the children's education only because it had some direct effect on the education of the parents, not because it reflects persistent household beterogeneity across generations. In other words, the shifter is not "inherited" across generations, but does represent effects of unobservable parental characteristics such as taste for schooling or locational choices. Under these assumptions grandparents' education would be a valid instrument to identify the effect of exogenous changes in parental education. In this case, an instrumental variable procedure would estimate the responses of E_c to variations in E_p and Y.

We end up estimating simple models that represent the effects of parental schooling as quadratics in father's and mother's schooling and an interaction with mother's and father's schooling. When income is included in the regression we use a quadratic specification in the income of the household head. Given our specification, children's average completed years of schooling will therefore be given by

$$\begin{aligned}\mu_{E_c} &= F(\mu(e_f),\mu(e_m),\mu(y),\sigma(e_f),\sigma(e_m)cv(y),\rho(e_f,e_m)) \\ &= \alpha_0+\beta_0+\alpha_1\mu(e_f)+\alpha_2\mu^2(e_f)+\alpha_2\sigma^2(e_f)+\alpha_3\mu(e_m)+\alpha_4\mu^2(e_m)+\alpha_4\sigma^2(e_m) \\ &\quad +\alpha_5\rho(e_m,e_f)\sigma(e_f)\sigma(e_m)+\alpha_5\rho(e_m,e_f)\mu(e_m)\mu(e_f) \\ &\quad +\beta_1\mu(y)+\beta_2\mu^2(y)(1+cv(y)^2) \qquad (1)\end{aligned}$$

where e_f is the years of schooling of the father, e_m is the years of schooling of the mother, y is the income of the household head, $\mu(e_f) = E[e_f]$, $\mu(e_m) = E[e_m]$, $\sigma(e_f)^2 = Var[e_f]$, $\sigma(e_m)^2 = Var[e_m]$, $\mu(y) = E[y]$, and $cv(y)^2 = Var[y]/E[y]^2$. We add dummy variables for all four grandparents' schooling to estimate the "inherited shifter" model. We use these same dummy variables for grandparents' schooling as instrumental variables to estimate the "non-inherited" shifter model.

6. CHANGING THE DISTRIBUTION OF PARENTAL CHARACTERISTICS

The expression for children's average completed years of schooling in Equation (1) permits us to evaluate the effect of a number of hypothetical changes in the distribution of parental characteristics. Some of these relate directly to potential policy interventions, such as increases in mean income or income inequality. Others, such as changing the mean and variance of parental schooling, do not represent feasible policy interventions in the short-run, but provide insights into long-run implications of alternative schooling investment strategies. More specifically, we will be interested in evaluating how the following changes would affect the average number of completed years of schooling among 14-year-olds: the effect of increases in the average education of the mother and father, $\mu(e_f)$ and $\mu(e_m)$; the effect of increases in average income, $\mu(y)$; the effect of decreases in the inequality in education among parents, $\sigma(e_f)$ and $\sigma(e_m)$; and the effect of decreases in the degree of income inequality, cv(y). Of particular interest is the relative strength of these changes. The direct impact of these hypothetical changes in the distribution of household characteristics can be evaluated by computing the following derivatives:

$$\partial F/\partial\mu(c_f) = \alpha_1 + 2\alpha_2\mu(c_f) + \alpha_5\rho(c_m, c_f)\mu(c_m)\,,$$

$$\partial F/\partial\sigma(c_f) = 2\alpha_2\sigma(c_f) + \alpha_5\rho(c_m, c_f)\sigma(c_m)\,.$$

For derivatives of child schooling attainment with respect to income, we will look at the derivative of completed years of child schooling with respect to percentage changes in the mean of head's income, and with respect to unit changes in the coefficient of variation of head's income. Thus we will calculate:

$$\partial F/\partial\ln(\mu(y)) = [\beta_1\mu(y) + 2\beta_2\mu(y)(1 + cv(y)^2)]\frac{\mu(y)}{100},$$

which can be interpreted as the effect of a one percent increase in the mean of head's income on the mean years of completed schooling of 14-year-olds. Similarly, we will calculate:

$$\partial F/\partial cv(y) = 2\beta_2 \mu^2(y) cv(y),$$

which can be interpreted as the effect of a unit change in the coefficient of variation of head's income on the mean years of schooling of 14-year-olds.

We can also use these derivatives to compare the relative strengths of these hypothetical interventions, and to estimate the tradeoff between changes in one variable and changes in another. For example, we can consider how much we could lower the mean schooling of fathers if we simultaneously lowered the variance in the schooling of fathers in order to keep the schooling attainment of children constant. These tradeoffs can give us useful insights into the relative impact on child schooling of a change in, for example, inequality in parental income, versus a change in mean parental income. Using the implicit function theorem, the "tradeoff" between the mean of fathers' schooling and the standard deviation of fathers' schooling can be expressed as:

$$\left[\frac{d\sigma(e_f)}{d\mu(e_f)}\right]_{d\mu(e_c)=0} = \frac{-\partial F/\partial \mu(e_f)}{\partial F/\partial \sigma(e_f)} = \frac{-[\alpha_1 + 2\alpha_2 \mu(e_f) + \alpha_5 \rho(e_m, e_f)\mu(e_m)]}{2\alpha_2 \sigma(e_f) + \alpha_5 \rho(e_m, e_f)\sigma(e_m)}. \quad (2)$$

Analogous expressions can be derived for the other tradeoffs we present below, all of which can be expressed as ratios of the derivatives shown above.

7. EMPIRICAL RESULTS

In this section we present estimates of the three alternative models, each estimated for the two regions. Table 4 presents regressions using only education variables. Table 5 adds the earnings of the head and earnings squared to all the regressions. In all cases we estimate three alternative specifications. The first is an ordinary least squares regression using only the schooling of the mother and father. The second specification is an ordinary least squares regression that adds the schooling of all four of the 14-year-olds

Table 4. Response of Child's Schooling to Parents' Schooling
14-Year-Olds, São Paulo and Northeast Brazil, 1982

	São Paulo			Northeast		
	OLS I	OLS II	I.V.	OLS I	OLS II	I.V.
Father's Schooling (e_f)	0.1857^x	0.1529^x	0.2324	0.2685^x	0.2342^x	0.4462^x
	(0.0450)	(0.0472)	(0.3617)	(0.0352)	(0.0365)	(0.1799)
Father's School Squared	-0.0094^y	-0.0071	-0.0870	-0.0150^x	-0.0139^x	-0.0184
	(0.0045)	(0.0045)	(0.0624)	(0.0039)	(0.0039)	(0.0259)
Mother's Schooling (e_m)	0.3145^x	0.2662^x	0.9162^x	0.3676^x	0.3375^x	0.4724^x
	(0.0465)	(0.0481)	(0.3342)	(0.0384)	(0.0399)	(0.2872)
Mother's School Squared	-0.0148^y	-0.0116^y	-0.1277^y	-0.0181^x	-0.0170^x	-0.0291
	(0.0045)	(0.0045)	(0.0560)	(0.0049)	(0.0049)	(0.0543)
Fath School*Moth School	0.0047	0.0031	0.1532^z	0.0097	0.0097	0.0028
	(0.0066)	(0.0066)	(0.0908)	(0.0064)	(0.0065)	(0.0524)
Constant	3.4844^x	3.2568^x	2.8743^x	2.0106^x	1.8654^x	1.5923^x
	(0.1083)	(0.1239)	(0.3635)	(0.0735)	(0.0829)	(0.1770)
R^2	0.2435	0.2647	0.0946	0.2897	0.3001	0.1577
$F-$ Test		1.9270^y			1.8623^y	
Sample Size	820	820	820	1,525	1,525	1,525
Effect on Child's Schooling:						
$\partial\mu(e_c)/\partial\mu(e_f)$	0.1230	0.1049	-0.0861	0.2093	0.1807	0.3570
$\partial\mu(e_c)/\partial\mu(e_m)$	0.2284	0.1973	0.4856	0.2902	0.2659	0.3249
$\partial\mu(e_c)/\partial\sigma(e_f)$	-0.0617	-0.0472	-0.3050	-0.0766	-0.0694	-0.1127
$\partial\mu(e_c)/\partial\sigma(e_m)$	-0.0876	-0.0702	-0.4482	-0.0853	-0.0789	-0.1663
Tradeoff:						
$d\sigma(e_f)/d\mu(e_f)$	1.9933	2.2200	-0.2823	2.7311	2.6025	3.1675
$d\sigma(e_m)/d\mu(e_m)$	2.6067	2.8111	1.0836	3.4025	3.3715	1.9532

Notes: Standard errors in parentheses. Superscripts denote significance: $x = .01$, $y = .05$, $z = .10$. Estimated from 1982 PNAD. Effects and tradeoffs evaluated at the mean and standard deviation for the region. OLS I does not include grandparents' education. OLS II includes 12 dummy variables for categories of grandparents' education in the regression. The F-test reported is for the null hypothesis that all grandparents' education variables have coefficients equal to zero. The I.V. column reports results for the two-stage least squares regression in which grandparents' education variables are used as instruments.

grandparents as independent variables. The third specification is a two-stage least squares regression that uses the schooling of grandparents as instruments for the parents' own schooling.

According to the results in the first regression, an increase of one year of schooling of the father implies an increase in the schooling of the 14-year-old by .19 year in São Paulo, and by .27 year in the Northeast, evaluated when the father begins with zero year of schooling. Below the regression coefficients we present estimates of the derivatives evaluated at the sample mean values for each region of all relevant variables. Since the effect of parental education is concave, the derivative at mean schooling is smaller than the derivative at zero schooling. According to the results in the first regression, an increase of one year of schooling of the father implies an increase in the schooling of the 14-year-old by .12 year in São Paulo, and by .21 year in the Northeast, evaluated when the father has the sample mean schooling for that region.

The concavity of the relationship between parental schooling and children's schooling also implies that a mean-preserving spread in the schooling of parents (i.e., an increase in the standard deviation of schooling that holds mean schooling constant) would decrease mean schooling of 14-year-olds. As shown in the derivatives with respect to the standard deviations of father's schooling, an increase of one year in the standard deviation of father's schooling, holding the mean constant, would imply a decrease in the mean schooling of 14-year-olds of around .07 year in São Paulo and in the Northeast. The effects of a one year increase in the standard deviation of mother's schooling are roughly similar, implying a reduction in mean schooling attainment of 14-year-olds of around .09 year in both regions.

The table also shows the implied tradeoff between mean schooling and schooling inequality in determining the schooling of 14-year-olds. The results for the first regression for São Paulo in Table 4 indicate that if mean schooling of fathers were increased by one year, the standard deviation could increase by two years and the mean schooling of 14-year-olds would remain unchanged. Put another way, it would take a two year decline in the standard deviation of fathers'schooling to have the same impact on the mean schooling of 14-year-olds as a one year increase in the mean schooling of fathers. Reducing inequality in parental education thus appears to be a surprisingly weak instrument for improving the mean schooling of children when compared to increasing mean schooling of parents. The analogous

tradeoff for the Northeast in about 2.7 years for both mother and father, implying that it would take a 2.7 years decline in the standard deviation of either father's or mother's schooling to have the same impact on the mean schooling of 14-year-olds as a one year increase in the mean schooling of that parent.

The regressions labeled OLS II are OLS regressions that include the dummy variables for the education of the four gradparents in the regression. Given the large number of dummy variables for grandparents' education, few of the individual coefficients are statistically significant, and we omit them from the table. Although the coefficients for the grandparents' education variables are not included in the table, we do report the F-test for the joint significance of these variables. The grandparents' schooling variables are jointly significant at the .05 level in all regressions reported. Looking at the derivatives at the bottom of these columns, we see that the inclusion of the grandparents' education variables lowers the estimated effects of parental education somewhat. Controlling for grandparents' education, a one year increase in the schooling of the father implies a .10 year increase in the schooling of 14-year-olds in São Paulo, and a .18 year increase in the Northeast, evaluated at the sample means. Controlling for grandparents'education a one year increase in the schooling of the mother implies a .19 year increase in the schooling of 14-year-olds in São Paulo, and a .27 year increase in the Northeast. The fact that the estimated effects of parental schooling decline when grandparents' education is included in the regression provides some support for the argument that parental schooling represents omitted family background variables that influence child schooling outcomes. This implies that the true effect of an exogenous increase in parental schooling is smaller than implied by conventional estimates. The effect of controlling for grandparents' schooling, a rough control for family background, is to reduce the implied effect of parental schooling by about 15 to 20 percent. This is similar to the decline in estimated returns to schooling found by Lam and Schoeni (1991) when they include similar controls for family background in earnings equations for Brazil. Although these results give support to the argument that there is a "family background bias" in conventional estimates of the effect of parental schooling on child schooling outcomes, the bias appears to be modest.

The last regression in each table is the two-stage least squares regression, using the grandparents' schooling variables as instruments. These estimates would be appropriate if the correct causal model is the

"non-inherited shifter" model outlined above, implying, that grandparents' schooling do not pick up persistent household characteristics that affect schooling and are passed on across generations. These coefficients have large standard errors, and appear relatively unstable, suggesting that using grandparents' schooling variables as instruments leads to noisy predictions of parental schooling. These results must therefore be interpreted with caution. Looking at the derivatives at the botton of the columns, we see that using the grandparents' schooling variables as instruments produces higher estimates of the effects of parental schooling on the schooling attainment of 14-year-olds. Looking at the more stable estimates for the Northeast, these two-stage least squares estimates imply that a one year increase in the schooling of fathers would increase the schooling of 14-year-olds by .36 year.

Table 5 adds the income of the household head and income squared to all of the regressions. The specifications and samples are in all other respects identical to the regressions in Table 4. Estimated effects of parental schooling in these tables refer to effects holding the income of the household head constant. In addition, we present the implied tradeoffs between mean and inequality of parental schooling and income in determining the schooling of 14-year-olds.

Comparing the derivatives implied by the first regressions in Table 5 with the equivalent regressions without income in Table 4, we see that the implied effects of parental schooling are smaller when we hold income constant. This is not surprising, given the high correlation between schooling and income in Brazil. Evaluated at the mean, a one year increase in the schooling of the father implies a .10 year increase in the schooling of 14-year-olds in São Paulo, and a .18 year increase in the schooling of 14-year-olds in the Northeast. A one year incraase in the schooling of the mother, controlling for the schooling and income of the father, implies a .21 year increase in the schooling of 14-year-olds in São Paulo, and a .27 year increase in the schooling of 14-year-olds in the Northeast.

The direct partial effects of head's income we estimate are quite small. Continuing to look at the OLS estimates in the first column of Table 5, the derivatives $\partial \mu_C / \partial \ln(\mu_Y)$ imply that a 10 percent increase in the income of the head implies an increase

Table 5. Response of Child's Schooling to Parents' Schooling and Income
14-Year-Olds, São Paulo and Northeast Brazil, 1982

	São Paulo			Northeast		
	OLS I	OLS II	I.V.	OLS I	OLS II	I.V.
Father's Schooling (e_f)	0.1760*	0.1448*	0.2261	0.2593*	0.2309*	0.5917*
	(0.0449)	(0.0470)	(0.5640)	(0.0354)	(0.0367)	(0.3393)
Father's School Squared	-0.0108†	-0.0085*	-0.0896	-0.0184*	-0.0171*	-0.0374
	(0.0045)	(0.0045)	(0.3896)	(0.0039)	(0.0039)	(0.0364)
Mother's Schooling (e_m)	0.2955*	0.2481*	0.9246*	0.3418*	0.3180*	0.5211
	(0.0466)	(0.0482)	(0.0684)	(0.0380)	(0.0395)	(0.4050)
Mother's School Squared	-0.0141*	-0.0110†	-0.1303†	-0.0171*	-0.0162*	-0.0261
	(0.0045)	(0.0045)	(0.5249)	(0.0048)	(0.0048)	(0.0645)
Fath School*Moth School	0.0034	0.0017	0.1565*	0.0066	0.0069	-0.0215
	(0.0066)	(0.0066)	(0.0643)	(0.0063)	(0.0064)	(0.0840)
Head's Income	0.0504*	0.0504*	0.0129	0.1593*	0.1492*	-0.0200
	(0.0141)	(0.0141)	(0.0961)	(0.0239)	(0.0241)	(0.6431)
Head's Income Sqrd	-0.0003*	-0.0003*	0.0001	-0.0023*	-0.0021*	0.0111
	(0.0001)	(0.0001)	(0.3675)	(0.0006)	(0.0006)	(0.0256)
Constant	3.3854*	3.1627*	2.8528*	1.7791*	1.6769*	1.4630*
	(0.1111)	(0.1258)	(0.0055)	(0.0795)	(0.0869)	(0.5352)
R^2	0.2553	0.2764	0.0925	0.3126	0.3196	0.1186
$F-$ Test		1.9437†			1.2813†	
Sample Size	820	820	820	1,525	1,525	1,525
Effect on Child's Schooling:						
$\partial\mu(e_c)/\partial\mu(e_f)$	0.0992	0.0821	-0.1056	0.1744	0.1534	0.3635
$\partial\mu(e_c)/\partial\mu(e_m)$	0.2096	0.1791	0.4822	0.2620	0.2434	0.3496
$\partial\mu(e_c)/\partial\sigma(e_f)$	-0.0653	-0.0563	0.1476	-0.0919	-0.0821	-0.3309
$\partial\mu(e_c)/\partial\sigma(e_m)$	-0.0759	-0.0642	0.0632	-0.0719	-0.0654	-0.2520
$\partial\mu(e_c)/\partial\mu(y)$	0.0022	0.0027	0.0008	0.0035	0.0040	0.0013
$\partial\mu(e_c)/\partial CV(y)$	-0.0296	-0.0295	0.0064	-0.0521	-0.0489	0.2560
Tradeoff:						
$d\sigma(e_f)/d\mu(e_f)$	1.5189	1.4581	0.7151	1.8992	1.8685	1.0984
$d\sigma(e_m)/d\mu(e_m)$	2.7599	2.7905	-7.6258	3.6437	3.7241	1.3872
$d\mu(e_f)/dln(\mu(y))$	-0.0227	-0.0331	0.0074	-0.0201	-0.0258	-0.0035
$d\mu(e_m)/dln(\mu(y))$	-0.0107	-0.0152	-0.0016	-0.0133	-0.0162	-0.0036
$dCV(y)/dln(\mu(y))$	0.0759	0.0920	-0.1220	0.0672	0.0808	-0.0049
$dCV(y)/d\sigma(e_f)$	-2.2050	-1.9089	-22.9275	-1.7636	-1.6780	1.2926

Notes: Estimated from 1982 PNAD. Standard errors in parentheses. Superscripts denote significance: $x = .01$, $y = .05$, $z = .10$. Effects and tradeoffs evaluated at the mean and standard deviation for the region. OLS I does not include grandparents' education. OLS II includes 12 dummy variables for categories of grandparents' education in the regression. The F-test reported is for the null hypothesis that all grandparents' education variables have coefficients equal to zero. The I.V. column reports results for the two-stage least squares regression in which grandparents' education variables are used as instruments.

of only .02 year in the completed schooling of a 14-year-old child of the head in São Paulo, and .03 year in the Northeast, holding parental schooling constant. In other words, making a linear extrapolation using this derivative, it would take more than a 400 percent increase in the mean income of family head to raise mean completed schooling of 14-year-olds by one full year in São Paulo. Looking across the other columns of Table 5, we see that this magnitude does not vary dramatically across alternative specifications.

As was the case with parental schooling in the previous regressions, the negative coefficients on the income squared term in the regressions in Table 5 indicate a concave relationship between the schooling of 14-year-olds and the income of the head. This implies that a reduction in income inequality among heads, holding all other variables including the supply of schooling constant, would imply higher mean schooling of 14-year-olds. The derivative $\partial \mu(e_c)/\partial CV(y)$ summarizes the magnitude of this effect at the means. Using the São Paulo parameters and sample statistics in Table 5, a decrease in the coefficient of variation of 0.1, i.e., a reduction from the actual value of 1.57 to a value of 1.47 would increase average child schooling by .003 year. The derivative for the Northeast is larger, but still implies small effects. Even a drop in the coefficient of variation of 50 percent, from 1.5 to 1.0, would only increase mean schooling of 14-year-olds by 5 one-hundredths of a year. It is important to keep in mind that all of these hypothetical effects are based on the assumption that all other variables remain constant, including the supply of schooling. To the extent that changes in mean income and income inequality in a region lead to changes in the supply of quasi-public goods like schooling, the effects may be very different than the simple aggregation of household-specific effects calculated here.

The final derivatives in Table 5 show the tradeoffs between in the mean and inequality of parental schooling and the mean and inequality of parental income in affecting the schooling attainment of 14-year-olds. For example, the derivative $dCV_Y/d\ln(\mu(y))$ shows the change in the coefficient of variation of income that would just offset a given proportional change in income. For the case of São Paulo in the first regression in Table 5, the increase in child schooling resulting from a one percent increase in the head's income would be offset by a simultaneous increase of 0.076 in the coefficient of variation.

The tradeoff between changes in mean income and changes in mean parental schooling are especially striking. The

derivative $d\mu(e_f)/d\ln(\mu(y))$ implies that the effect of a one percent increase in the mean income of heads would be offset by a 0.02 year increase in the mean schooling of the father. Put another way, it would require about a 50 percent increase in mean parental income in order to have the same impact on schooling of 14-year-olds as a one year increase in the mean education of fathers. It would take roughly a 100 percent increase in mean parental income in order to have the same impact on child schooling as a one year increase in the mean schooling of mothers. The magnitudes for the Northeast are similar, with a one percent increase in parental income being equivalent to a .02 year increase in the schooling of fathers and a .013 increase in the schooling of mothers.

The results of other regression specifications provide very similar results. While the magnitudes of the effects vary somewhat across specifications, the general pattern remains that the effects of changes in either the mean or dispersion of head's income on the schooling attainment of 14-year-olds is surprisingly small. If taken literally, the results imply that there would be only very modest improvements in schooling attainment in response to even very large increases in mean income or very large reductions in income inequality among heads. A result that is very robust across specifications is that very little of the difference in the mean schooling of 14-year-olds in the two regions can be explained by differences in either mean income or inequality of income of household heads. As shown in Table 2, income inequality is actually lower in the Northeast than in São Paulo, implying that the effect of income inequality alone would actually lead to higher schooling in the Northeast than in São Paulo. We repeat the caveat that these estimates assume that the supply of schooling is held constant. If, as seems plausible, increases in mean income or decreases in income inequality lead to increases in the supply of schooling, then those effects will be in addition to the household level effects estimated here.

The magnitudes of the effects of parental schooling we estimate are quite similar to the estimates of other researchers in previous studies of education in Brazil. Souza (1979) presents regressions of child schooling attainment as a function of household characteristics using a family expenditure survey conducted in the city of Rio de Janeiro in 1967/68. He estimates regressions for children in narrow age groups, and includes as regressors family income, family size, dummy variables for location in the city, and the schooling of the mother. For children aged 14-15, similar to the sample we use here, Souza estimates a coefficient on mother's

schooling of 0.33 (1979, p.133), similar to the effect we estimate for both São Paulo and the Northeast. In São Paulo, our quadratic estimate for the effect of mothers's education implies that a one year increase in mother's schooling would increase child schooling by 0.31 year when the mother has zero schooling, and by 0.23 year when the mother has the mean schooling of 2.6 year.

Birdsall (1985) uses the 1970 Brazilian census to estimate the effects of parental and household characteristics on the schooling attainment of children of different ages. Independent variables include father's and mother's schooling, both entered linearly, and the log of father's income. Birdsall's estimates of the effects of parental education for urban Brazil are somewhat lower than ours. An increase in mother's schooling by one year implies an increase in the schooling attainment of children aged 12-15 in urban Brazil by .11 year, controlling for father's income, in Birdsall's estimates, compared to .21 and .26 for São Paulo and the Northeast, respectively, in our results. The effect of a one year increase in father's schooling is 0.08 year in Birdsall's study, compared to .10 in São Paulo and .17 in the Northeast in our results. An important contribution of Birdsall's analysis is the use of direct measures of schooling supply and quality, including measures of average teacher's schooling and the quantity of teachers per child in the region. Inclusion of these variables in her regressions increases the estimated effect of mother's schooling on child schooling attainment, and has little effect on the estimated effect of father's schooling.

The magnitude of our estimated effects of parental characteristics on child schooling attainment can be illustrated by using our regression coefficients to predict the difference in schooling attainment between São Paulo and the Northeast. The predicted difference in mean schooling attainment of 14-year-olds between São Paulo and the Northeast will be given by the differences in the mean values of all of the independent variables in a given regression multiplied by the regression coefficients for each variable. We can do such a prediction in two ways, using the coefficients we estimate for São Paulo and using the coefficients we estimate for the Northeast. Table 6 presents these calculations using the regressions based only on parental schooling and using the regressions that also include the head's income.

The first two rows of the table show that the actual difference in schooling attainment between São Paulo and the Northeast is 1.5 year. The first prediction

uses the regressions for the large sample that exclude the income variables. Given the differences in the means of the right-hand side variables shown in Table 2 and the regression coefficients for São Paulo in Table 4, we predict a difference in schooling attainment between the two regions of only .24 year. The predicted difference is only 16.1 percent of the actual difference, indicating that differences in the mean and variance of parental schooling explain only a small fraction of the gap in schooling attainment between the Northeast and São Paulo. When we use the regression coefficients for the Northeast we predict a slightly larger fraction of the total difference, 18.3 percent.

Table 6. Predicted Differences in Schooling Attainment Across Regions Based on Regression Coefficients in Tables 4 and 5

Actual Schooling in São Paulo	4.75	
Actual Schooling in Northeast	3.25	
Actual Difference	1.50	
	Predicted Using São Paulo Coefficients	Predicted Using Northeast Coefficients
Predicted diff. using regressions without income	0.241	0.273
Predicted difference/Actual difference	0.161	0.183
Predicted diff. using regressions with income	0.208	0.231
Predicted difference/Actual difference	0.140	0.155

The final rows of the table repeat this exercise using the regressions that include the head's income and its square. This exercise should be considered with greater caution, since it implicitly makes the strong assumption that income can be directly compared between the two regions, ignoring such problems as cost of living differences between the regions. The magnitude of the predicted difference is similar to the predicted difference based on the regressions that exclude income, with the predicted difference actually somewhat smaller when we use the regressions that include income. We explain about 15 percent of the actual difference between the Northeast and São Paulo based on these regressions.

Given the substantial differences in parental education and income between the Northeast and São Paulo, it is surprising that these differences do not appear to explain much of the large gap in schooling attainment of children between the two regions. Based on our estimates of the effects of parental schooling and income on child schooling attainment, less than 20 percent of the almost 1.5 year gap between the schooling of 14-year-olds in São Paulo and the Northeast would be eliminated if parents in the Northeast had the same characteristics as parents in São Paulo, holding the supply of schooling constant.

This surprising result appears to imply that elimination of the large schooling gap between regions in Brazil will depend more on supply-side policies than on changes in the distribution of income and schooling at the household level. To the extent that parental education may be a good indicator of the household's permanent income, our results imply that even substantial increases in mean income or reductions in income inequality in the Northeast would not eliminate the gap in long-term schooling attainment, in the absence of changes in the supply of schooling.

Parental schooling and income, variables that might be considered demand-side determinants of child schooling at the household level, do not appear to be the primary cause of the schooling gap between the poor Northeast and the richer Southeast in Brazil. This may be good news from a policy perspective, since equalizing the provision of schooling between the Northeast and São Paulo may be an easier policy to implement than eliminating the large differences in socioeconomic position of parents in the two regions. Increasing household income and reducing income inequality within and between regions in Brazil is clearly a desirable policy for many reasons. It does not appear in and of itself to be either necessary or sufficient to eliminate the gap in schooling attainment between regions, however. Our results suggest that it may be possible to eliminate much of this gap by policies aimed directly at the provisions of schooling. As indicated in the papers by Hanushek et alii (Forthcoming), Souza and Silva (Forthcoming), and James et alii (Forthcoming) elsewhere in this volume, investments in school quality in Brazil appear to have high returns in avoiding grade repetition and increasing schooling attainment. Our results are entirely consistent with a view that supply-side investments in schooling quality and quantity can have large payoffs even in the absence of substantial changes in income or parental schooling at the household level. Indeed our results suggest that large

increases in mean income or reductions in income inequality would be unlikely to have effects on schooling attainment in and of themselves, in the absence of increases in schooling quantity and quality.

8. CONCLUSIONS

This paper focuses on what might be considered the "demand side" of schooling in Brazil, attempting to explain the schooling attainment of a particular cohort of Brazilian children as a response to the schooling and income of parents. Looking at the cohort of children born in 1968, all of whom should have completed seven years of schooling by the time of the 1982 PNAD survey, we find mean schooling of 4.75 years in the urban region of the state of São Paulo, and 3.25 years in the urban Northeast. A major focus of this paper is attempting to explain this advantage of 1.5 year in the schooling attainment of 14-year-olds in São Paulo versus the Northeast. We find regional differences in the characteristics of parents that are consistent with the regional difference in child outcomes. Fathers in São Paulo have 1.3 year more schooling than fathers in the Norteast, and mothers in São Paulo have .7 year more schooling than mothers in the Northeast. The mean income of household heads in São Paulo is almost twice that of household heads in the Northeast, although income inequality among head is slightly lower in the Northeast. Inequality in schooling, as measured by the coefficient of variation, is higher for both fathers and mothers in the Northeast than in São Paulo.

Our regression estimates imply that a one year increase in the schooling of the mother increases schooling of 14-year-olds by around .3 year, with slightly larger effects in the Northeast. Increases in the schooling of the father have somewhat smaller effects. The effect of parental schooling on child schooling is concave, implying that reductions in schooling inequality among parents would increase the mean schooling of 14-year-olds in the population, even if mean schooling of parents remained constant. We also estimate a concave effect of the head's income on child schooling attainment. The effects of income appear to be quite modest, however. A 10 percent increase in the income of the head, holding the schooling of both parents constant, would increase child schooling attainment by less than one-tenth of a year. A reduction in the coefficient of variation of income from 1.5 to 1.0 would also increase child schooling attainment by less than one-tenth of a year.

Although differences in parental characteristics between the Northeast and São Paulo are consistent with the greater schooling attainment of 14-year-olds in São Paulo, our regression estimates suggest that only a small proportion of the gap in schooling attainment between São Paulo and the Northeast can be explained by these parental characteristics. Using our regression coefficients and differencs in mean characteristics between regions to predict the difference in mean schooling attainment of 14-year-olds, we are able to explain less than 20 percent of the 1.5 year schooling gap between the Northeast and São Paulo. This suggests that child schooling attainment may be disappointingly unresponsive to improvements in the socioeconomic status of households in the absence of changes in the quantity and quality of schooling being supfplied. It also suggests, however, that direct policy interventions directed at the supply side of schooling provision may be able to eliminate a large fraction of the schooling gap between regions, even while the gap in parental socioeconomic status between persists.

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