Do Borrowing Constraints Decrease Intergenerational Mobility? Evidence from Brazil

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Abstract

In this paper, we find evidence that suggests that borrowing constraints may be an important determinant of intergenerational mobility in Brazil. This result contrasts sharply with studies for developed countries, such as Canada and the US, where credit constraints do not seem to play an important role in generating persistence of inequality. Moreover, we find that the social mobility is lower in Brazil in comparison with developed countries.

We follow the methodology proposed by Grawe (2001), which uses quantile regression, and obtain two results. First, the degree of intergenerational persistence is greater for the upper quantiles. Second, the degree of intergenerational persistence declines with income at least for the upper quantiles. Both findings are compatible with the presence of borrowing constraints affecting the degree of intergenerational persistence, as predicted by the theory.

I. Introduction

In the last decade, several studies have attempted to estimate the degree of intergenerational mobility of economic status across families, both in developed and in developing countries.[1] One of the most widely used economic theories of intergenerational mobility is based on the existence of intergenerational borrowing constraints.

Several studies have analyzed the role of borrowing constraints in generating persistence of income status across generations.[2] The main idea is that credit constraints tend to increase persistence to the extent that investments in children among constrained families depend on family resources. This creates a link between income of parents and children in addition to any possible income correlation that may result from the transmission of ability across generations.

The most widely used approach is to estimate nonlinear regressions of log child's income when adult on log father's income.[3] Implicit in these studies is the assumption that regression would be linear in the absence of borrowing constraints. The nonlinearity is assumed to capture the fact that the constraint is less binding at different levels of father's income than at others.

One problem with this approach is that, as Grawe (2001) shows, depending on how unobservable ability affects wages, nonlinearities may result even in the absence of borrowing constraints. Moreover, borrowing constraints are consistent with any nonlinear pattern, depending on how constrained families are distributed across income classes.

[1] For recent evidence on developed countries, see Mulligan (1997) and Solon (1999), for the United States, Bjorklund and Jantti (1997), for Sweden, Dearden, Machin and Reed (1997), for Great Britain, Couch and Dunn (1997), for Germany, and Corak and Heisz (1999), for Canada. Solon (2002) presents evidence for several developed countries. Earlier studies include Behrman and Taubman (1990), Solon (1992) and Zimmerman (1992). For evidence on developing countries, see Lillard and Kilburn (1995), for Malaysia, Hertz (2001), for South Africa, Ferreira and Veloso (2003) for Brazil, and Birdsall and Graham (2000) and Behrman, Gaviria e Szekély (2001) for several Latin American countries. Grawe (2001) presents evidence for several developed and developing countries.

[2] See, for example, Loury (1981), Becker and Tomes (1986), Mulligan (1997), Grawe (2001) and Grawe and Mulligan (2002).

[3] Behrman and Taubman (1990), Solon (1992) and Grawe (2001) estimate a mobility regression including a quadratic term. Corak and Heisz (1999) use a nonparametric procedure to estimate the degree of intergenerational mobility in Canada.

In this paper, we implement a test of the presence of borrowing constraints using quantile regression, which was proposed by Grawe (2001). He shows that nonlinear regressions on the mean may be augmented by quantile regressions to better evaluate whether borrowing constraints can account for the observed nonlinearities in income regression.

The main idea is that an increase in child's ability results in a higher level of the efficient human capital, which makes it more likely for the family to be constrained. Since children in the highest quantiles tend to have higher ability, this implies that their parents will be more likely to be constrained. Hence, we would expect that the constrained families are the ones in the highest quantiles.

This reasoning suggests that, if observed nonlinearities at the mean regression result from borrowing constraints, then such nonlinearities must be evident in the upper quantiles, but not in the lower quantiles. Moreover, since income persistence is stronger among the constrained than the unconstrained, persistence will be higher in upper quantiles than in lower ones.

The empirical analysis is implemented for Brazil, using the mobility supplement of the PNAD 1996, a Brazilian household survey. The PNAD is a suitable data set for our purposes mainly for two reasons. First, it allows for a study of intergenerational persistence of economic status for a large developing country. Second, and particularly important for our purposes, the large number of observations of the PNAD allows for the estimation of nonlinear mean and quantile regressions, which are crucial for implementing the test for the presence of borrowing constraints proposed in Grawe (2001).

The mobility supplement of the PNAD 1996 provides information on the education and occupation of the household head's father, but it does not give information on the father's income. In order to construct a measure of father's income, we use a methodology proposed by Angrist and Krueger (1992) and Arellano and Meghir (1992) and applied by Bjorklund and Jantti (1997) to the study of intergenerational mobility.

We find that the degree of intergenerational persistence of income in Brazil is higher than the one observed for developed countries. We also find some weak evidence of a concave mobility pattern at the mean, which suggests that the degree of persistence declines with income. In order to test for the presence of borrowing constraints, we first perform quantile linear regressions. We find that persistence is higher at the upper quantiles, as predicted by the theory. Moreover, the concave pattern observed at the mean is only evident at the upper quantiles, which is also consistent with the model. The evidence thus suggests that borrowing constraints may be an important determinant of intergenerational mobility in Brazil.

The paper is organized as follows. In Section II we present the standard model of intergenerational borrowing constraints. In Section III we describe the empirical methodology and the PNAD data set. Section IV presents our empirical results, and Section V concludes.

II. A Model of Intergenerational Borrowing Constraints

In this section, we present a model of intergenerational borrowing constraints based on Grawe (2001).[4] We assume that a family lives for two generations. Each family is composed of a father and a son. The father is endowed with ability a_f and schooling level h_f, which produce wage income $w(a_f, h_f)$. The father also has access to financial assets x_f.

Parental investments in the child may take two forms. One possibility is to invest in the child's human capital, h_s. The other alternative is to invest in physical assets, x_s, which earn interest at rate r. The parent solves

$$
\begin{aligned}
&\max U\left(c_f, c_s\right) \\
&s.t. \\
&c_f + h_s + x_s = w\left(a_f, h_f\right) + x_f \qquad (1)\\
&c_s = w\left(a_s, h_s\right) + \left(1+r\right) x_s \\
&x_s \geq 0
\end{aligned}
$$

[4] See Becker and Tomes (1986), Mulligan (1997) and Mulligan (1999) for similar models of borrowing constraints.

where a_f is the ability of the son and c_f and c_s are the consumption of the father and the son, respectively. The restriction $x_s \geq 0$ captures the assumption that parents cannot borrow to finance human capital investments in their children.

For some families, the constraint $x_s \geq 0$ does not bind. Assuming there are diminishing returns to the investment in human capital $\left(w_{hh} < 0\right)$, parents will invest in physical assets and child's human capital in order to equate the marginal returns to the two forms of investment

$$w_h\left(h_s, a_s\right) = 1 + r \tag{2}$$

From equation (2), we can determine the amount of efficient investment in human capital as a function of child's ability and the interest rate, $h_s = h\left(a_s, r\right)$. If ability increases the productivity of human capital investments $\left(w_{ha} > 0\right)$ and the interest rate earned on assets is common to all parents, high-ability children will be given more human capital than low-ability children, that is, $h_a > 0$.[5]

The important point to note is that, for unconstrained families, human capital investments do not depend directly on parental income. As a result, child's earnings do not depend directly on parental income in general and parent's earnings in particular, among unconstrained families.

For some families, however, the constraint $x_s \geq 0$ will bind. The first-order condition when the borrowing constraint binds is

$$\begin{aligned} & w_h\left(h_s, a_s\right) = \left(1 + r\right) + \frac{\mu}{U_s} \\ & \mu > 0 \end{aligned} \tag{3}$$

[5] It should be noted that ability includes cognitive and physical skills, but characteristics such as race and gender should also be included if it is believed that they affect market wages.

where $U_s = \dfrac{\partial U}{\partial c_s}$ and μ is the Lagrange multiplier on the borrowing constraint. From (3), we can make two important observations. First, comparing with (2), we can observe that, since the opportunity cost of investing in the human capital of children of equal ability is higher for constrained than for unconstrained families, the latter will make larger human capital investments. Second, since μ and U_s depend on family resources, human capital investments will depend on family income among constrained families. As a result, child's earnings depend directly on parental income in general, and parent's earnings in particular, among constrained families.

The model described above thus has the following implication. If all families have the same ability, then the degree of intergenerational income transmission, also known as intergenerational persistence, should be zero for unconstrained families, and strictly positive for constrained families.

The major difficulty in testing the prediction above results from the fact that ability is unobservable and varies among families. Suppose, for example, that ability is transmitted from parents to children according to the following equation

$$a_s = \rho a_f + \varepsilon_a \tag{4}$$

where $E(\varepsilon_a) = 0$, $Var(\varepsilon_a) = \sigma_a^{\ 2}$ and $0 < \rho < 1$.

In this case, since ability is correlated with the wage rate, we would observe an empirical relationship between child's earnings and parental earnings even for unconstrained families due to the unobservable transmission of ability from parents to children. For constrained families, there would be two channels of intergenerational persistence: ability transmission and borrowing constraints.

If we assume that regression would be linear in the absence of borrowing constraints, the degree of persistence is given by[6]

[6] See Grawe (2001).

$$\begin{aligned}\beta\left(w_f\right) &= \gamma + \kappa\left(w_f, \bar{a}_s\left(w_f\right)\right)\\ \kappa\left(w_f, \bar{a}_s\left(w_f\right)\right) &> 0 \quad \text{if the constraint binds}\\ &= 0 \quad \text{otherwise}\end{aligned} \tag{5}$$

where w_f denotes father's earnings, $\bar{a}_s\left(w_f\right)$ is the expected ability of the son conditional on father's log earnings, γ is the degree of persistence in the absence of borrowing constraints and κ captures the effects of the borrowing constraint.

A higher level of father's earnings relaxes the constraint $\left(\kappa_1 < 0\right)$, since there are more resources available to finance human capital investments. Higher ability of the child tightens the constraint $\left(\kappa_2 > 0\right)$, since an increase in child's ability results in a higher level of the efficient human capital.

In order to test for the presence of borrowing constraints, the most widely used approach is to test for nonlinearities in income regression.[7] The nonlinearity is assumed to capture the fact that the constraint is less binding at different levels of parent's income than at others. In terms of equation (5), this is expressed by the dependence of κ on w_f.

One problem with this approach is that, as Grawe (2001) shows, depending on how ability enters the wage function, one may observe income nonlinearities even in the absence of borrowing constraints.[8] Moreover, borrowing constraints are consistent with any nonlinear pattern, depending on how constrained families are distributed across income classes. In order to observe this, we can differentiate β with respect to w_f in (5) to obtain

$$\frac{d\beta}{dw_f} = \kappa_1 + \kappa_2 \frac{d\bar{a}_s}{dw_f} \tag{6}$$

[7] As mentioned in the introduction, Behrman and Taubman (1990), Solon (1992), Corak and Heisz (1999) and Grawe (2001) are examples of this approach. See Grawe (2001) for a description of other approaches used in the literature to testing for borrowing constraints.

[8] In terms of equation (5), γ may also depend on w_f and $\bar{a}_s$.

Since there is a positive correlation between son's ability and father's earnings $\left(\frac{d\overline{a}_s}{dw_f} > 0\right)$, $\kappa_1 < 0$ and $\kappa_2 > 0$, the sign of (6) is indeterminate.

Grawe (2001) shows that quantile regression can augment mean regression to better evaluate whether borrowing constraints are the explanation for a nonlinearity in earnings regression.

The intuition is the following. As we observed above, an increase in child's ability makes it more likely for the family to be constrained. Since children in the highest quantiles tend to have higher ability, this implies that their parents will be more likely to be constrained. Hence, we would expect that the constrained families are the ones in the highest quantiles. In terms of equation (5), we would expect κ to be positive at the upper quantiles and zero at the lower quantiles.

This reasoning suggests that if we find nonlinearity at the mean regression and such nonlinearity is driven by nonlinearity in upper quantiles, then this is an evidence consistent with borrowing constraints.[9] In addition, if we find that the upper quantiles are steeper than the lower quantiles, this will be an additional evidence compatible with the presence of borrowing constraints. Otherwise, if none of these implications are observed, the credit constraint hypothesis will be less convincing. These implications will be tested in the empirical section.

III. Methodology and Data

In this section, we outline the tested econometric specifications, present the two-sample instrumental variable technique and descriptive statistics of our data. If we assume that the mobility pattern would be linear in the absence of borrowing constraints, we can derive three implications from the standard model of borrowing constraints. First, it implies that a regression of log child's income on log father's income will be nonlinear. Second, since income persistence is stronger among constrained families than for unconstrained families, persistence will be higher in upper quantiles than in lower

[9] If we assume that ability does not vary much across individuals at the upper quantiles, the relationship between persistence and father's earnings will tend to be concave at these quantiles, since a higher level of father's income relaxes the borrowing constraint $(\kappa_1 < 0)$.

quantiles. Third, the nonlinearities observed at the mean should be evident in the upper quantiles, but not in the lower quantiles.

a) Conditional Expectation and Quantile Estimations:

The econometric model typically used to assess the extent of intergenerational income mobility is given by

$$y_{s,i} = \alpha + \beta y_{f,i} + \varepsilon_i \tag{7}$$

where $y_{s,i}$ represents the son's permanent log earnings, $y_{f,i}$ represents the father's permanent log earnings, β is the elasticity of son's earnings with respect to the father's earnings, and ε_i is a stochastic term with

$$E(\varepsilon_i) = 0,\ E(\varepsilon_i y_{f,i}) = 0, \text{ and } E(\varepsilon_i^{\ 2}) = \sigma_\varepsilon^{\ 2}.$$

If $E(y_{f,i}) = E(y_{s,i}) = \mu$, then the parameter β is an inverse measure of the extent of regression toward the mean across generations. For example, if β is 0.5 then a father whose earnings exceed the mean (of father's income) by 20% expects his son's earnings to exceed the mean (of son's income) by 10%.[10] The measure $1-\beta$ is the degree of intergenerational mobility.

As indicated in Section II, the persistence parameter β will vary across income levels in the presence of borrowing constraints. In order to test for such possibility, we can extend Equation (7) to allow a general nonlinear pattern of intergenerational mobility across father's income level.

$$Y_{s,i} = \alpha + G(Y_{f,i}) + \varepsilon_i \tag{8}$$

where G(.) will take a particular form of a quadratic polynomial in our case:

$$Y_{s,i} = \alpha + \beta_1 Y_{f,i} + \beta_2 Y_{f,i}^2 + \varepsilon_i \tag{9}$$

Since other potential sources of nonlinearity may compete with borrowing constraints to generate a nonlinear pattern for the conditional expectation, we use a

[10] It is easy to see that, if the distribution of log earnings has the same mean over time, β is different from the correlation between father's and son's earnings only by the ratio of the standard deviation of father's and son's earnings.

quantile estimation procedure to better evaluate the presence of borrowing constraints as a key explanation for the low intergenerational mobility in Brazil.

In the same way that OLS measures the effect of explanatory variables on the conditional mean of the dependent variable, quantile regression measures the effect of the explanatory variables at any point in the conditional distribution, for example the median, the 90th percentile, the 10th percentile, and so on. As described by Koenker and Bassett (1978)[11], the estimation is done by minimizing equation (10):

$$\min_{\beta \in \Re^k} \sum_{i \in \{i: y_i \geq x_i\beta\}} \theta \left| y_i - x_i\beta \right| + \sum_{i \in \{i: y_i < x_i\beta\}} (1-\theta) \left| y_i - x_i\beta \right| \qquad (10)$$

where y_i is the dependent variable, x_i is the k by 1 vector of explanatory variables with the first element equal to unity, β is the coefficient vector, and θ is the quantile to be estimated. The procedure allows the coefficient vector β to vary across quantiles, which is appropriate for the case of testing the presence of borrowing constraints. [12]

For each given level of father's income, one should expect the lowest quantiles less likely to be constrained than the highest quantiles, as explained in Section II. In such case, according to equation (5), the intergenerational income persistence coefficient will be larger for the upper quantiles. Hence, in the presence of borrowing constraints, one should expect larger persistence estimates for those at the top of the son's conditional income distribution.

Nonetheless, there may be other causes of larger persistence at the top of the distribution, since we do not have information about how ability impacts the wage equation. The quantile approach allows us to test for the presence of nonlinearity at any point of the conditional distribution. As Equation (5) and Equation (6) should make clear, the function $\kappa(.)$ may take any particular form depending on how the unknown average ability varies with parental income. In order to test for nonlinearity on income for different quantiles, we estimate equation (9) for each 10% quantile.

[11] See also Koenker and Hallock (2001) for new applications of quantile regressions.
[12] From Equation (10), one can note that the quantile regression procedure does not have the same results as one would have if divided the sample on different sub-samples, based on quantiles, and run different OLS regressions for each of these sub-samples. All the observations are accounted on the minimization problem on the quantile method. They have different weights for each quantile, but they are not suppressed.

b) Data and Instrumental Variable Procedure:

Several studies take data on pairs of father and sons´ income and estimate the parameter β . Solon (1992) shows that an OLS estimate using annual measures of father's income yields a downward-inconsistent estimate of β . This happens because the annual income is an imprecise measure of parental permanent income. When a panel data is available, such bias may be reduced by averaging out several years of observations of father's income.[13]

In developing countries, even cross section data containing pairs of sons and fathers income are rare. This is the case in this paper, since the mobility supplement of the 1996 PNAD provides information on the education and occupation of the questionnaire responder's father, but it does not give information on the responder's father's income. In such situation, the use of an instrument for father's income may be a substitute for the actual father's income. As instruments for father's permanent income we use the father's occupation and education reported by sons.[14]

One problem we have to control for comes from the fact that the sample moments needed for the estimator are taken from two different samples. Statistical inference for such case (two-sample instrumental variable, TSIV) is discussed by Angrist and Krueger (1992) and Arellano and Meghir (1992), having been applied by Bjorklund and Jäntti (1997) to estimate intergenerational earnings mobility in Sweden and in the US.

In the first stage, we use data from four waves of PNADs (1976, 1981, 1986, and 1990) to obtain information on father's income, education and occupation.[15] The PNAD (National Survey of Household Sample) is an annual household survey conducted by the Instituto Brasileiro de Geografia e Estatística (IBGE).[16] It is important to note that these information are about our "synthetic fathers", not the fathers of the sons about whom we have information in the mobility supplement of the 1996 PNAD. We estimate a wage

[13] Examples in the literature are Solon (1992) and Zimmerman (1992) for the US.

[14] For the asymptotic statistical properties of instrumental variable estimators, see Solon (1992).

[15] The sample contains only males, aged between 25 and 65 years old, working 40 or more hours per week in all jobs, living in Brazilian urban areas. We use hourly wage as measure of labor income. Extremely high or low hourly wage are excluded from the sample. All regressions use the sampling weights provided by IBGE. No control variables are added in the first stage.

equation as function of educational and occupational dummies and interactions between year-of-birth cohorts and those variables.

In the second stage, the coefficients of the estimated wage equation are used to predict the income of the actual fathers, that is, the fathers of the sons about whom we have information in the mobility supplement of the 1996 PNAD. These sons reported their father's education and occupation when they (the sons) were 15 years old. Plugging this information (the education and occupation reported by the sons) in the wage function and using the estimated coefficients in the first step, we are able to find a substitute for father's income. Then, we regress the reported son's wage on the actual father's fitted wage variable to obtain the estimate of intergenerational income persistence, using as control variables four regional dummies, a quadratic polynomial on age, and a dummy for blacks and mulattos.

c) Construction of Occupational Variable and Descriptive Statistics of the Sample:

In order to do such TSIV procedure, we had to construct the occupational and educational variables of the fathers.[17] We use six groups of occupational categories, according to the classification proposed by Valle Silva (1974) and used by Pastore (1979) and Pastore and Valle Silva (1999) specifically to study intergenerational mobility of occupation, which is aimed to capture the amount of skills required to perform each task.[18]

One of the advantages of working with PNAD is the large number of observations. The sample used in the first stage contains 253,798 observations ("synthetic

[16] The sample is close to a nationally representative sample, though it is not fully representative of rural areas, especially in the region "North" (more sparsely populated).

[17] Since the PNAD-1996 does not provide information about the father's age, we assumed that the father was born twenty years earlier than the son. Grawe (2001) also assumes a twenty year age difference between generations for the US.

[18] We use Valle Silva (1974) occupational ranks to classify 927 activities. Valle Silva classifies occupation into six categories: high, medium superior, medium, medium inferior, low superior and low inferior. Examples of occupations in each category are the following: high type – engineers and large land owners; medium superior type - high school teachers and graduated bureaucrats; medium type - low graduated bureaucrats and topographer; medium-inferior type - automobile mechanic and specialized mine workers; low-superior type - self employers in agriculture; low-inferior type - house cleaners and office boys.

fathers”). The sample of males who reported father’s education and occupation used in the second stage contains 25,927.[19]

Table 1 shows the educational and wage mean for each of occupational categories. The sample contains 253,798 individuals (“synthetic fathers”). The average number of years in school varies from 13.1, for individuals classified in the most skilled occupational group, up to 2 for individuals at the very bottom of the occupational rank. The hourly wage rata varies even more, from 15.3 Reais per hour to 1 Real per hour, respectively for the highest and the lowest occupational rank.

Table 1:
Average Education and Real Wage, per occupational category

Category	Education	Real wage*	# indiv.	Frequence
High	13.11	15.3	10121	4%
M-S	9.73	9.58	21359	8%
M	8.57	5.22	37025	15%
M-I	4.9	2.73	96051	38%
L-S	3.19	1.63	61377	24%
L-I	2.05	1.07	27865	11%

PNAD 1976, 1981, 1986, 1990
OBS: Education corresponds to the number of years in school,
* Father's predicted real wage (R$/hour).

Table 2 shows information on the parent’s occupation and education attainment contained in the mobility supplement of the 1996 PNAD and the father’s predicted wage, that is, the result of the second stage described above. Some points in this table are worth emphasizing. With respect to education, 35% of those sampled have fathers with less than one year in school, and 86% of the sample reported having fathers with at most 4 years of schooling.

[19] The results reported throughout this paper use sample weights provided by IBGE to produce a representative sample of individuals for the Brazilian population. Sample sizes reported refer to the unweighted number of observations. All regressions and summary statistics are calculated using the sample weights.

Table 2:
Characteristic of Fathers, by schooling group, 1996 PNAD

Father's Schooling	Unweighted N	Weighted Percentage	Mean Wage*	Occupational Ranking					
				High	M-S	M	M-I	L-S	L-I
0	10,235	35.37	1.10	0.62	2.82	1.69	15.63	41.29	37.95
1-3	8,493	29.30	1.70	1.23	4.25	4.05	31.9	35.49	23.08
4	6,115	21.53	2.60	1.92	6.85	9.82	45.39	25.34	10.68
5-7	816	2.37	2.82	3.39	7.88	12.55	52.35	17.59	6.24
8	1,202	3.62	4.16	3.6	11.24	23.28	47.25	11.29	3.34
9-10	231	0.65	5.58	5.58	19.04	24.77	35.16	10.13	5.32
11	1,257	3.84	6.28	11.17	21.27	31.12	30.19	4.98	1.27
12-15	97	0.32	10.97	12.36	33.19	27.34	21.61	4.94	0.56
16	976	3.00	13.49	49.86	21.18	19.34	7.75	1.19	0.68
Total	29,422	100.00%	2.40	3.27	6.04	7.13	29.37	31.48	22.72

* Father's predicted real wage (R$/hour).

With respect to the father's occupation, as expected, the father's occupational rank captures cognitive skills not necessarily transmitted through formal learning. For example, 11% of fathers with completed high school education are classified as working in high skill activities. However, a strong positive correlation between occupational ranking and school attainment indicates formal requirements to be eligible for higher skill occupations. Finally, father's predicted wage is positively correlated to the number of years in school with some indication of convexity in schooling premium, since completing college education more than doubles the real hourly wage with respect to having a complete high school degree.

Table 3 presents some descriptive statistics on intergenerational mobility. One can see that the son's occupational rank is highly correlated to father's education, and this is likely to be a consequence of the channel through the investment in human capital. The probability that the individual perform a high-skill demanding task is 40.5% for those whose father has completed college and just 1.4% for those whose fathers have zero year in school. Reported wage rates are strongly correlated with father's education as well.[20]

[20] In addition, columns (4) and (5) show the proportion of sons who reported being black/mulattos and who reported living in Northeast (the poorest region). One can see that the proportion of blacks fall substantially for more educated fathers. The proportion of individuals living in Northeast is larger for those whose fathers have zero education as well.

Table 3:
Characteristics of the Sons, by Father's Schooling (Males Aged 25-64, 1996 PNAD)

Father's Schooling	Mean Schooling	Mean Wage	Blacks	Region NE	Occupational Ranks High	M-S	M	M-I	L-S	L-I
0	3.9	2.7	49.4	27.3	1.4	5.2	6.5	50.0	24.8	12.1
1-3	6.3	4.1	34.4	16.3	4.0	8.7	10.9	53.2	17.8	5.4
4	8.9	6.3	24.2	11.6	8.4	15.2	17.8	44.9	11.5	2.3
5-7	9.6	5.8	30.2	16.3	9.4	13.3	18.8	46.1	9.8	2.6
8	11.0	8.9	25.9	15.4	15.9	19.7	21.2	36.2	6.3	0.7
9-10	12.0	9.8	27.5	21.6	21.2	19.8	25.8	25.4	7.1	0.7
11	12.4	11.3	18.1	15.8	18.9	24.6	24.3	26.6	5.1	0.5
12-15	12.7	15.0	18.1	14.4	25.3	20.5	31.6	17.1	4.1	1.5
16	14.1	15.3	11.4	14.8	40.5	25.8	17.3	13.2	2.7	0.5

* Son's predicted real wage (R$/hour).

IV – Empirical Analysis

In this section, we perform the empirical analysis to check if borrowing constraints can be seen as a limiting factor to intergenerational mobility in Brazil. First, we assume the typical econometric model to assess the extent of intergenerational mobility specified in equation (7), which is characterized by a linear specification, and run the OLS and quantile regression.[21] Then, we assumed the nonlinear pattern of intergenerational mobility, the quadratic form as in equation (9), and do the empirical investigation by using the OLS and quantile approaches. The objective is to compare the results with the predictions of the theory outlined in section II.

Table 4 and Figure 1 report the results for the OLS and quantile regressions using the specification in equation (7). The degree of persistence is equal to 0.60 (see the first line in Table 4) when we use the OLS approach, which is an indication of very low intergenerational mobility. For example, Mulligan (1997) finds a range from 0.30 to 0.50 for the United States, and Grawe (2001) shows an estimated coefficient lower than 0.30 for Canada.

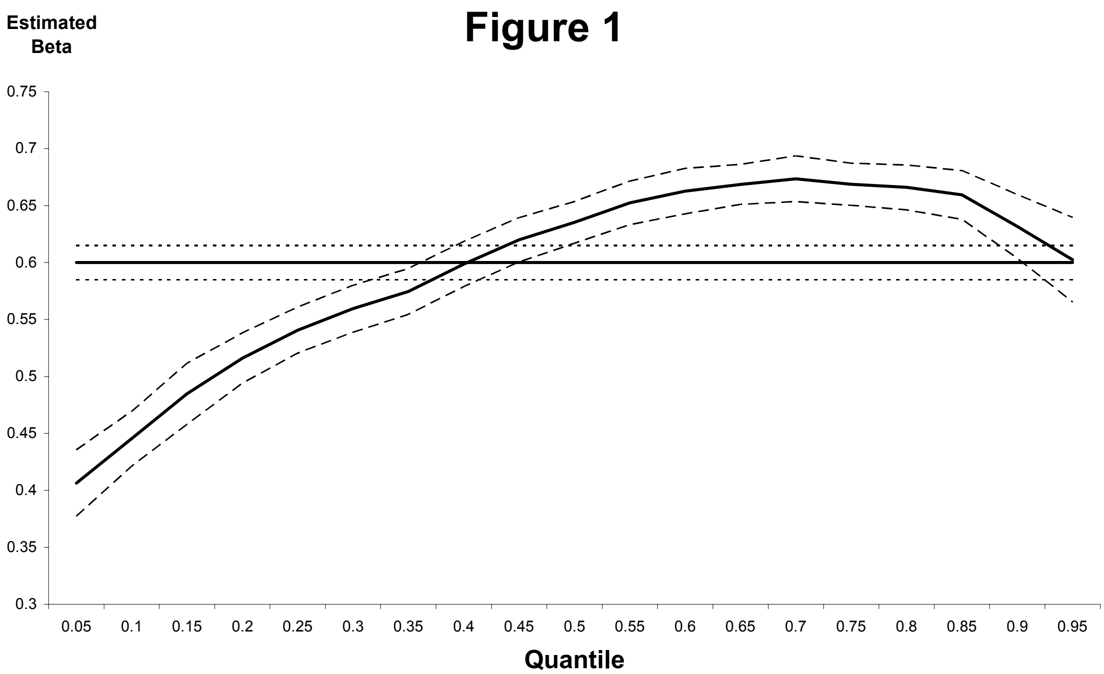
[21] Whenever the quantile approach was employed in this paper, we calculated the quantile regressions using 620 repetitions of bootstrap on State software. See Koenker and Hallock (2000) for further information on the adequate number of bootstraps.

Table 4:
Equation (1) - OLS and Quantile

	OLS Regression - 1	*Standard Error -2*
Linear Coefficient	**0,600**	0,008
Quantile	*Quantile Regression - 1*	*Standard Error*
0,10	**0,445**	0,012
0,20	**0,516**	0,011
0,30	**0,560**	0,010
0,40	**0,599**	0,010
0,50	**0,635**	0,009
0,60	**0,663**	0,010
0,70	**0,674**	0,010
0,80	**0,666**	0,010
0,90	**0,632**	0,014

Notes:
1 - The coefficients in bold are significant at 95%.
2 - Robust standard errors were calculated using White estimator of variance

Figure 1



The results obtained with the OLS regression are very different from the ones found with the quantile approach. Figure 1 shows that there is a significant difference between the OLS and quantile estimations for the lower quantiles (up to the 25th percentile) and for the higher quantiles (from the median to the 90th percentile). Mostly important, however, it is that the degree of persistence varies significantly across quantiles. The pattern is that the degree of persistence increases gradually with the quantiles, up to the 70th percentile. It ranges from 0.445 for the lowest quantile (10%) to 0.674 for the 70th percentile. The coefficients for the quantiles above 70th percentile are not significantly different from the one for the 70th percentile.

Hence, there are two important facts coming from the results obtained above. First, we find nonlinearity in the mean regression that is caused by non-linearity in upper quantiles. Second, the upper quantiles are steeper than the lower quantiles. As discussed in Section 2, the combination of these two facts may be explained by the existence of borrowing constraints. With a greater estimated coefficient for the upper quantiles, implying less mobility, one can infer that the abler children (and presumably high income ones), independent of the father's income, suffer more restriction on their education than the less able ones. Moreover, this difference in the coefficients for the upper quantiles with respect to the lower ones would signal a greater intergenerational mobility for the less able individuals, which do not suffer from credit constraint and the reverse for the abler individuals, which are more likely to suffer from it. Since children in the highest quantiles tend to have higher ability, they should receive greater investments in education and, as a result, their parents are more likely to be constrained. The greater degree of persistence found for the upper quantiles indicates that the constrained families are more likely to be the ones in the highest quantiles.

The results obtained above for Brazil contrast sharply with the ones found by Grawe (2001) for Canada and the United States and Eide and Showalter (1999) for the United States. They found that, contrary to the prediction of the credit constraint model, the degree of persistence is greater for the lower quantiles. That is, the lower quantiles are steeper than the upper quantiles. This difference in the results for Brazil and Canada and the United States should not come as a surprise. As pointed out by Grawe (2001), the more developed countries devote a considerable amount of public resources to education vis-à-vis the less developed ones. Hence, credit constraints may not play an important role anymore in the education decision in the developed countries.

We now turn to the empirical results using the non-linear pattern of intergenerational mobility, the quadratic form as in equation (9). Table 5 and Figures 2 (the linear coefficient) and 3 (the quadratic coefficient) report the results.

Table 5:
Equation (2) - OLS and Quantile

	OLS Coefficient - 1	*Standard Error - 2*
Linear Coefficient	**0,608**	0,016
Quadratic Coefficient	-0,004	0,008

	Linear Variable		**Quadratic Variable**	
Quantile	*Quantile Coefficient - 1*	*Standard Error*	*Quantile Coefficient - 1*	*Standard Error*
0,10	**0,404**	0,240	0,027	0,014
0,20	**0,436**	0,021	**0,048**	0,011
0,30	**0,469**	0,021	**0,052**	0,012
0,40	**0,507**	0,018	**0,052**	0,009
0,50	**0,582**	0,020	**0,030**	0,009
0,60	**0,646**	0,022	0,009	0,010
0,70	**0,723**	0,022	**-0,027**	0,010
0,80	**0,769**	0,024	**-0,054**	0,011
0,90	**0,822**	0,030	**-0,098**	0,014

Notes:

1 - The coefficients in bold are significant at 95%.

2 - Robust standard errors were calculated using White estimator of variance

Figure 2

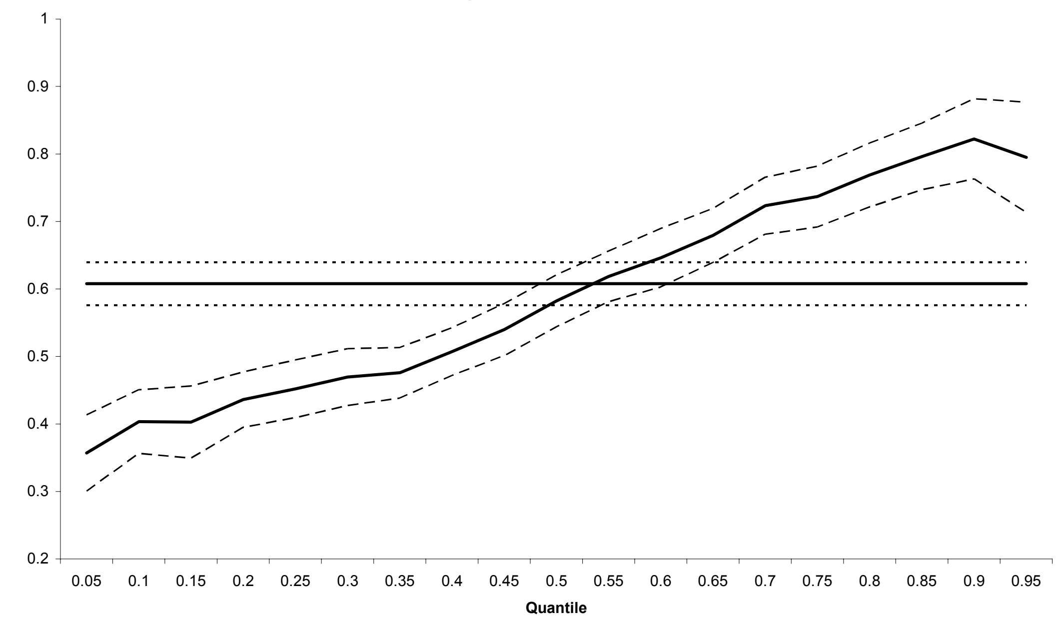
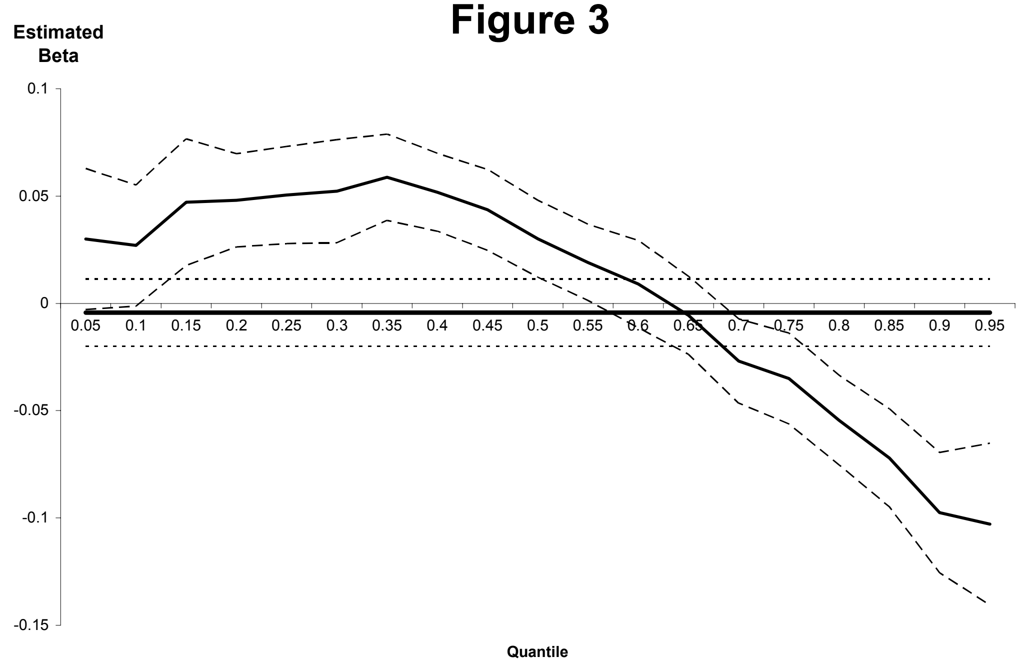


Figure 3



With respect to the degree of persistence, the results are similar to the ones obtained when the quadratic term was not added in the regression. That is, the pattern of non-linearity in the mean regression that is caused by non-linearity in upper quantiles and the fact that the upper quantiles are steeper than the lower quantiles also occur in this new specification. Hence, the arguments used above that suggest the existence of borrowing constraint for the families in the highest quantiles are still valid.

With respect to the quadratic term, there is some evidence of a concave pattern, even though the coefficient on the quadratic term is not statistically significant when we run OLS. However, when we adopt the quantile approach, most of the quadratic coefficients are significant for the different quantiles. These are the ones in bold in Table 5. It is interesting to note that the quadratic term is positive for the lower quantiles up to the 60th percentile, whereas they are negative for the upper quantiles.

Therefore, there is clearly a difference in the non-linear pattern from the upper quantiles with respect to the lower ones. The concave and convex patterns are observed, respectively, at the upper and lower quantiles. This pattern change can be seen as an additional evidence that borrowing constraints may play an important role in explaining the intergenerational mobility in Brazil.

It should be noted that the pattern found for the Brazilian case is very different from the ones obtained for Canada, Germany, and the United States in Grawe (2001). For those countries, the upper and lower quantiles have, respectively, convex and concave patterns.

V. Conclusion

In this paper, we implemented a test to check if borrowing constraints affects the intergenerational mobility in Brazil. We follow the methodology proposed by Grawe (2001), which uses quantile regression, and use the database on the mobility supplement of the 1996 PNAD, a Brazilian household survey.

The main idea is that credit constraints tend to increase persistence to the extent that investments in children among constrained families depend on family resources. This creates a link between income of parents and children in addition to any possible income correlation that may result from the transmission of ability across generations.

If we assume that the mobility pattern would be linear in the absence of borrowing constraints, we can derive three implications from the standard model of borrowing constraints. First, it implies that a regression of log child's income on log father's income will be nonlinear. The nonlinearity captures the assumption that the constraint is less binding at different levels of father's income than at others.

Second, since income persistence is stronger among constrained families than for unconstrained families, persistence will be higher in upper quantiles than in lower quantiles. Third, the nonlinearities observed at the mean should be evident in the upper quantiles, but not in the lower quantiles.

We tested these implications based on the PNAD data. The mobility supplement of the PNAD 1996 provides information on the education and occupation of the household head's father, but it does not give information on father's income. In order to construct a measure of father's income, we used a methodology recently applied by Bjorklund and Jantti (1997) to the study of intergenerational mobility.

The results may be summarized as follows. First, we found evidence of nonlinearity in the mobility pattern at the mean. In particular, there is some evidence of a concave pattern, even though the coefficient on the quadratic term is not statistically significant.

Second, we found that persistence is higher at the upper quantiles than at the lower quantiles, as predicted by the theory. Third, the concave pattern observed at the mean is only evident at the upper quantiles, which is also consistent with the model. The evidence thus suggests that borrowing constraints may be an important determinant of intergenerational mobility in Brazil.

One result that merits further investigation is that we found a convex mobility pattern at the lower quantiles. One possible interpretation of this result is that, because of the way in which ability and education affect wages, the mobility pattern is possibly convex even in the absence of borrowing constraints.

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