Dispersion and Distortion of Intra-Household Human Capital in Low-Income Countries *

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Abstract:

Recent empirical work has found significant intra-household child specialization across labor market and education activities. Related recent theoretical work has explored the efficiency implications of such specialization and has identified potentially important distortions in the distribution of human capital across children in poor households. Connecting these literatures has been impeded by the difficulty in measuring human capital levels – particularly for children in the midst of the accumulation process. In this paper we approach this issue using the intra-household *dispersion* of the rate of progress through the education system as a proxy for the final dispersion of intra-household human capital. Focusing on intra-household dispersion avoids many of the problematic issues associated with measures of human capital *levels*. Using Brazilian data we identify a previously unreported relationship between the intra-household dispersion of this observable human capital (OHK) and household income. We explore various explanations and implications of this pattern, and argue that this relationship is consistent with the inefficient distribution of intra-household human capital suggested by recent theoretical work.

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I. INTRODUCTION

Intra-household specialization among children in low-income countries (LICs) has received increased theoretical and empirical attention in recent years. In particular, there is mounting empirical evidence that within poor households some children may be selected at a relatively early age to specialize in either labor or human capital accumulation activities. Such specialization need not in and of itself be troubling. The family, like any other institution, can only reap the benefits of comparative advantage through specialization. However, recent theoretical literature suggests specialization among poor households may reflect constrained responses to imperfections in human capital markets rather than efficient allocations based on comparative advantage.

This paper explores a previously unreported empirical pattern of intra-household specialization across the income distribution. Using Brazilian data our empirical analysis reveals a correlation between the *dispersion* of observable human capital (OHK) across children and household income. This relationship is strongly significant and robust to the measure of dispersion after controlling for household demographic structure and other factors. Our findings are also consistent with recent theoretical work that suggests distortions in the pattern of intra-household child specialization across education and labor market activities in poor households.

The conceptual and empirical challenges that accompany analysis of child human capital accumulation are considerable. In particular, direct measures of human capital levels for children in the midst of the accumulation process are scarce. However, our analysis avoids many of the problematic issues associated with measuring child human capital *levels* since it concerns the intra-household *dispersion* of OHK across the income distribution. Moreover, our proxy OHK – the rate of progress through the education system – emerges early in life in LICs and has potential biases that work against our results (thereby strengthening them). The remainder of the paper is organized as follows: Section II lays out the conceptual and empirical issues and also provides a literature review. Section III provides a description of the data and the empirical methodology. Section IV presents the empirical results. Section V summarizes, concludes, and outlines further directions for research.

II. Conceptual Issues and Literature Review

Overview

The allocation of child-time has been a principal focus of the vast child-labor literature (see Basu, 1999 and 2003 for surveys). Though child labor may be a concern in and of itself, it is the opportunity cost of child labor in human capital terms that, we believe, embodies much of the gravity of the topic. That is, if child labor did not impose a significant opportunity cost on the child's human capital stock, it would be far less troubling. Baland and Robinson (2000) provide a seminal model of the parent's decision to allocate child-time between labor market and human capital accumulation but do not consider parents' problem of allocation *across children*. Except in the case of a single-child household the parent's time allocation problem for children is thus considerably more complicated than suggested by the first generation of theoretical child-labor models. In particular, parents with multiple children must jointly determine the time allocation of tasks *across* all children as well as the allocation of time *for* each child. When children are heterogeneous it is natural to expect this parental allocation decision to involve specialization.

The inter-child time allocation decision has great consequence for the long-run distribution of human capital within the (dynastic) household. In a recent theoretical work, Horowitz and Wang (2004) examine incentives for specialization across children associated with innate heterogeneity. They demonstrate that for a poor utility maximizing household, the pattern of specialization implied by comparative advantage need not hold. In particular, an altruistic parent who cannot afford future utility balancing bequests may sacrifice the intra-household benefits of comparative advantage to balance their children's future utility. This effect may not occur among households who have sufficient income to balance children's future utility through bequests. This work therefore implies a relationship between income (or wealth) and the intra-household dispersion of human capital across children – which is our principal empirical result.

Household Education Progress Dispersion as a Proxy for Human Capital Dispersion

The final dispersion of human capital across children within a family is only observable when the accumulation process is "complete." In practice the process of human capital accumulation continues throughout a lifetime, with "experience" replacing education as the engine of capital creation. Therefore, the "completed" OHK profile of a household's children could typically only be observed in reconstructed families, or in the atypical families that do not disperse. Though a sufficiently long panel that tracks households after dispersion (i.e., allows the reconstruction of households) could record completed formal education of children, the question of when human capital accumulation is complete would remain. However, if patterns of intra-household human capital *dispersion* appear early and are relatively stationary through time, the problematic issues associated with estimating final human capital *levels* for the children of a household may be avoided.

In this paper we will present evidence that patterns of intra-household human capital dispersion *do* typically emerge early and that the demographically adjusted intra-household dispersion of educational progress is the best available proxy for the final dispersion of siblings' human capital in many low-income countries. The power of this proxy is typically far greater in low-income countries than in high-income countries because of the prevalence of delay due to grade repetition, late matriculation, and school withdrawal. Our use of the intra-household *dispersion* of relative progress through the education system as a proxy for the final dispersion of sibling human capital is one of the principal innovations of this paper and we believe this technique may have wide-spread applicability in low-income countries.

The use of progress through the education system, rather than ultimate achievement (were it available) as a proxy for human capital also addresses the potential problem of education as a consumption good. If education is a normal good, final achievement may be positively correlated with income. However, even in this case there is little theoretical basis to expect any consumption effect to influence the rate of progress through the system. That is, education as a consumption good would be manifest in either higher final achievement or higher quality of education, not as grade repetition.

Child Specialization and School Performance -- Literature

We now review some of the empirical evidence of intra-household specialization across children. Incentives for parents to allocate child time in a manner that generates specialization include increasing returns to education, education capital market imperfections, and innate heterogeneity of children. One early paper in this area is Chernichovsky's (1985) analysis of school enrollment and attendance in rural Botswana. He finds: "…some children may be assigned to school and kept there on a comparatively regular basis, while others may be assigned to household and farm tasks." Similarly, Cartwright and Patrinos (1999) find evidence of specialization in urban Boliva. In a Peruvian study Patrinos and Psacharopoulos (1995) also find the number of siblings, and their activities to be an important influence on child labor. In Punjab Pakistan, Burki and Fasih (1998) find that the probability of a child being able to specialize fully in education (no market labor) is strongly influenced by the number of other children in the 10 to 14 year age cohort. In addition to these treatments of intra-household child specialization, further discussion and numerous other references to specialization in child labor-education activities can be found in Grooaert and Patrinos (1999, eds.).

Other recent empirical works that explore child time allocation between work and school include Akabayashi and Psacharopoulos (1999), who use time-log data from Tanzanian. Ravallion and Wodon (2000) exploit a targeted school stipend in Bangladesh to test the extent to which child labor displaces schooling. Interestingly (and of relevance to our result), they find that much of the displacement effect is indirect. That is, labor may first displace complementary (to schooling) human capital activities such as homework, before school attendance directly. In this same vein, Akabayashi and Psacharopoulos (1999) and Ravallion and Wodon (2000) suggest simple measures of substitution of hours-in-school hours versus work hours may miss other deleterious effects of child labor on human capital accumulation. Such indirect channels of substitution are consistent with our proxy for the dispersion of intra-household human capital.

The child-specialization documented in the literature reviewed above can be manifest in diverse ways: from the extreme case where one child is chosen to matriculate and another to work, to the more subtle forms where some children are given more time for homework or reduced household chores. Indeed, specialization could even manifest in forms that are likely invisible in economic data such as the when some children simply receive more encouragement to succeed in school than others. These types of parental attitude effects are well documented in the sociology literature (see for example Bachman 2002). However, regardless of its form, patterns of parental allocation of their children's time should effect the dispersion of academic performance across children. What is important for our motivation is that the effects of specialization are manifest in an observable academic performance variable at a fairly early age. Delay is precisely such a variable.

The Rate of Education Progress and Final Education Attainment

There exists a well established (inverse) correlation between delayed educational progress and final academic achievement. Indeed, this link is accepted as foundational in the education literature (for discussion and survey of this relationship in the U.S. see Meisels and Liaw 1993; Byrnes and Yamamoto 1989, Peterson et al. 1987). Evidence of the inverse correlation between the rate of education progress and final achievement also exists for low-income countries – see, for example, Bedi and Marshall (2002) and Barro and Lee (1999, 2000,), and Lee and Barro (2001). There is also direct evidence linking grade repetition to the innate distribution of human capital within the household. For example, Currie and Thomas (1995) find that *within* families, higher child IQ scores are powerfully correlated (inversely) with grade repetition.[1] This further strengthens the case for our proxy since the intra-household distribution of innate ability is almost certainly strongly correlated with the final distribution of human capital within the household (after controlling for demographic structure, including gender and birth-order effects).

As noted above, delayed educational progress can have numerous causes. In most environments the principal causes are grade repetition, late matriculation, and withdrawal. Ideally, we would like to distinguish these causes of delay as their correlation with final educational attainment may be different. However, most household-level survey data (including the data we employ) cannot assign delay to a specific cause. It is reasonable, therefore to consider the implications of aggregating the causes of delay generally.

We first note a semantic point: each child's rate of progress should map to a unique delay and we use both terminologies (progress and delay), depending on context. "Delay," in the generic sense, occurs when a student displays a level of education achievement below the "idealized" level for their age.[2] Returning to the sources of delay, though their aggregation is not ideal, it has economic rationale. Namely, in the low-income countries, delay, regardless of its source, likely imposes similar opportunity costs for the child. For example, sixteen year olds who have completed 6 years of education instead of the idealized 9, likely face similar opportunity costs in the decision to matriculate for a seventh year regardless of the source of the delay. That is, the student whose three year delay is due to repetition and the student who matriculated late would likely both be viewed by the labor

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[1] The precise test administered to children was the Peabody Picture Vocabulary Test (PPVT).

[2] By "idealized" we mean the grade attained for a child who begins matriculation at the normal age and has no grade repetitions or withdrawal. It is possible, either through early matriculation or through "skipping" grades for a student to be ahead of "idealized" progress – that is, to exhibit a negative delay.

market as a sixteen year old with six completed years of education. This is due, in part, to the fact that in many low-income countries the cause of the delay may not be easily verifiable by the labor market.

Education Policies

Potential correlations between education policies, delay (repetition), school quality, and income could muddle the signal between income and the dispersion of observable human capital. Fortunately, the effect of the principal channel of this correlation is to strengthen our results. Specifically, since school quality is generally positively correlated with income, poor children have less incentive to stay in school, all else equal. This *level effect* – that poor children have lower academic achievement than the rich – will tend to *reduce* the intra-household delay dispersion of the measure we adopt for poor children. Since our principal finding is that children in poor households have *greater* dispersion of delay, our effect must dominate the level-effect associated with lower achievement levels. We therefore interpret our results as indicative of a lower bound of distortion. The precise impact of the *level-effect* on our measure of dispersion will be developed in the following section.

A second issue associated with education policies that vary with income concerns promotion standards. In some settings higher delay rates may be indicative of higher school quality (rather than lower student capability).[3] In Brazil it is likely that the reverse

[3] See Harbison and Hanushek 1992 and Psacharopoulos and Velez 1991. While this may seem to contradict the use of delay as an inverse measure of human capital recall that our focus is intra-household delay dispersion. Since children in a given household typically attend schools with similar promotion standards, demographically adjusted repetition rates remain a negative signal of academic progress.

is true – at least at the lower end of the school quality distribution.[4] That is, in very poor schools low standards and resources result in (near) automatic promotion. Again, however, our dispersion results can not be attributable to this factor since automatic promotion would reduce intra-household dispersion and we find increased dispersion in the poorest families. Finally, one might question whether the intra-household *dispersion of school quality* varies systematically with income. For example, within a given household some children may attend primary school and others secondary school. If inter-school promotion standards varied systematically across the income distribution, the dispersion signal we identify could reflect inter-school promotion heterogeneity rather than household specialization. We think this possibility is neither likely nor problematic in our case. In addition to the likelihood that children in a given household attend schools with similar promotion policies, at the lower end of the income distribution most children do not advance to secondary school. Moreover, in controlling for the demographic structure and location variables of the household we are controlling to some degree for the fact that within a household, children may attend different schools.

Measures of Progress/Delay and Measures of Dispersion

One of the most natural measures of the rate of educational progress is the ratio of current educational attainment and the idealized level of attainment. For example at a given time let $education_{ih}$ be the completed years of schooling for child i in a household h, age_{ih} the age of child i in a household h, and let *entry* denote the expected age of initial

[4] It is also possible that very rich schools have high promotion rates due to high parental investment in all children. This would suggest a non-monotonic relationship between delay dispersion and income. Again, however, our estimation reveals a powerful and robust negative correlation between income and intra-household delay dispersion.

school attendance in the particular environment. Then the measure of education progress is: $P_{ih} = \frac{education_{ih}}{age_{ih} - entry}$, where the denominator represents the "idealized" education attainment. With this measure $P_{ih} = 1$ indicates idealized progress, $P_{ih} < 1$ indicates some delay, and $P_{ih} > 1$ indicates accelerated progress. Thus, this measure indicates actual progress relative to idealized progress in percentage terms.

As our ultimate concern is the intra-household *dispersion* of educational progress across children it is important to consider the dispersion properties of a measure of delay. Many measures of dispersion (e.g., Coefficient of variation, Theil, Gini) of the P_{ih} above exhibit *scale independence* in that they are insensitive to proportional scaling of all children's education level within a household. As a simple example consider two demographically identical households – each with two fifteen year old children. Suppose that in the first household the children have completed the first and second grades while in the second household they have completed the fourth and eighth grades. A scale-independent inequality index would assign the same delay dispersion (for the P_{ih} above) to both households. However, one may prefer a measure which reflects the fact that absolute inequality is greater in the second household. A generalized measure of delay that allows both scale independence and scale dependence in dispersion can be obtained by simply adding a constant to the measure above. That is, now define the measure of progress as:

(1) $$P_{ih} = K + \frac{education_{ih}}{age_{ih} - entry}, \qquad K \geq 0 \ .$$

Note that when $K = 0$ the dispersion of educational progress in the two households described above would be identical for scale independent measures such as Theil, Gini, and

Coefficient of Variation. However, when $K \geq 1$, inequality would be greater in the second household and if $0 < K < 1$ inequality is lower in the second household.

For the measure where $K = 1$ perfect delay (zero progress) implies $P_{ih} = 1$, some delay implies $1 < P_{ih} < 2$, and adequate or fast progression implies $P_{ih} \geq 2$. In this paper, we present results for the case where $K = 1$. It is critical to note the following points in this regard. First, the scale dependence introduced by this functional form *works against* our principle empirical result – and therefore strengthens it. That is, we find greater dispersion in the poorest households – where the education *levels* are the lower whereas our measure dampens dispersion in households with proportionally lower education levels. Second, we have also estimated regressions for the cases of $K = 0$ and $K = 5$ and the results are similar (indeed, as expected, the correlation between intra-household dispersion and income is stronger with the scale-independent measure $K = 0$). Finally, given our context of intra-household dispersion of education attainment we believe that *we should* distinguish between the households such as the two described above, and that it is most natural to adopt a measure that maps to greater dispersion for household two.

III Data Description and Empirical Methodology

Introduction

Our use of the intra-household dispersion of education delay as a proxy for the final intra-household education dispersion requires an environment where the rate of progress through the education system in highly sensitive to academic performance. In the U.S., for example, where grade repetition is relatively rare, the proxy is likely to have less general applicability than in an environment where it is more common. In this section we will present evidence that Brazil constitutes a near ideal environment for application of our technique. As we will demonstrate, delay due to repetition in Brazil is pervasive.

Data Description – The Brazilian PNAD

The data used in this study come from the 2001 Brazilian Household Surveys, called Pesquisa Nacional por Amostragem a Domicílio (PNAD), which are administered by Instituto Brasileiro de Geografia e Estatística (IBGE), the Brazilian Census Bureau. The PNAD is an annual labor force survey (similar to the Current Population Survey in the United States) that covers all urban areas and the majority of the rural areas in Brazil.[5] The sample is based on a three-stage sampling design. With the exception of the first stage, the sampling scheme is self-weighted, and the sampling varies across regions and over time. Each PNAD surveys approximately 85,000 households.

Sources of Delay in the PNAD Data

Brazilian law requires that children attend school from age seven to fourteen.[6] If a child progresses without delay, they will have completed the upper primary education by the age of 15. Given these specific institutional features our measure of school progress is $P_{ih} = 1 + \frac{education_{ih}}{age_{ih} - 6}$.[7] Figure 1 below shows the percentage of children in our sample attending school by age levels, and the percentage of all children experiencing some delay

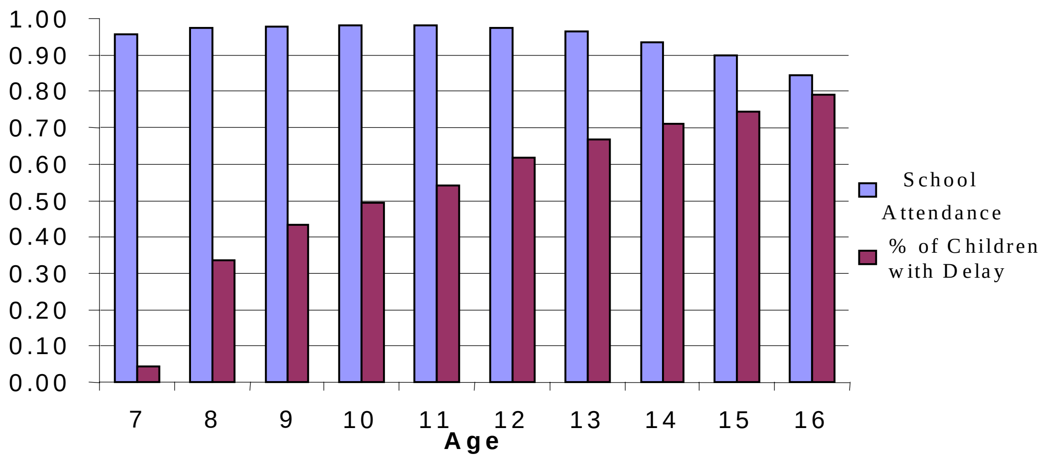
[5] The principal excluded area is the rural Amazon.

[6] The required age of attendance is being raised to sixteen years.

[7] For children not attending school we assign the highest completed years of schooling. For children attending school we assign the corresponding years of schooling for the grade the child is currently attending.

according to our measure.[8] As Figure 1 illustrates, more than 95% of seven year-old children attend school and over 90% are still attending at age 13. Though withdrawal accelerates after age 13, the decline is modest for a low-income country with 85% still attending at age 16. On the other hand, around 30% of eight-year-old children have experienced some delay and this percentage increases monotonically -- reaching nearly 80% for 16 year-old children. The implication for our analysis is that repetition is pervasive in Brazil while withdrawal and late matriculation are only relative small contributors to our measure of delay.[9]

Figure 1: School Attendance and Delay by Age Brazil 2001



Evidence that grade repetition, rather than late matriculation and withdrawal, is pervasive in Brazil can also be found independently of our data. For example, Fletcher and Ribeiro (1988) find a first grade repetition rate of 54% and a 27% repetition rate among

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[8] We define a child is delayed if P < 2.

[9] Late matriculation and early withdrawal was common in Brazil until the school expansion of the mid 1900's allowed near universal access to school. We also verify that throughout our cohort, whose oldest children first matriculated in 1992, school attendance among the seven year-old children has been at least 90%. Menezes-Filho (2003) provide additional evidence that by the beginning of the 1990's the vast majority of the Brazilian young children were attending school.

third graders. The same authors estimate a repetition rate of 20% and a drop out rate of 18% among fourth graders. This pattern is also corroborated by Mello e Souza and Silva (1996) who find that the likelihood of withdrawal only increases dramatically after the (lower) primary curriculum is complete. This is consistent with findings that child labor in Brazil increases with age and a child not at school is more likely to work in the labor market than a child in school (e.g., Kassouf, 2001). Again, this constitutes ancillary evidence that that the withdrawals in our sample are likely to be permanent.

Prior literature examining delay in Brazil has found family background and school quality to be important correlates. Psacharopoulos and Arriagada (1989) analyze the determinants of grade attainment, literacy, withdrawal, and child labor among 7 to 14 year-old children in Brazil in 1980. They found that parents' education is the most significant factor associated with these outcomes. Similarly, Mello e Souza and Silva (1996) (using the 1982 PNAD special questionnaire) find that children living in poorer households are more likely to repeat, increasing the opportunity cost of staying in school and leading to an earlier permanent withdrawal. Barros and Lam (1996), also using the 1982 PNAD, find a strong correlation between the education of the parents and the school attainment of 14 year-old children. They also find some indirect evidences that school quality is positively associated with the school attainment among these children. Finally, Gomes-Neto and Hanushek (1996), using a unique data set from Northeastern Brazil in 1983 and 1985, examine the determinants of grade repetition. They found that the most important factors determining school repetition in this environment was student achievement levels, the availability of grade levels, and school quality. The availability of grade levels is not however a factor causing repetition in our sample as the full upper and lower primary curriculum are now near universally available.

Empirical Methodology

As discussed above, we want to investigate the relationship between household income and the dispersion of the children's school-progress, holding all else equal. To this end define

$$(2) \qquad D_h = f(Y_h; X_h)$$

where D_h is a measure of school-progression dispersion in household *h*, Y_h is household income, and X_h is a vector of all other variables that affect dispersion. Our interest is with the sign of $\frac{\partial f(.)}{\partial Y_h}$. Empirically, we specify $f(.)$ as a linear function of household income (or our instruments for household permanent income) and a vector of other observable household characteristics. We estimate OLS regressions of the form:

$$(3) \qquad D_h = \alpha + \beta_1 FE_h + \beta_2 ME_h + \delta' X_h + \varepsilon_h$$

where the instruments of household income are the father's and mother's education. We construct separate dummies for fathers and mothers educational attainment (FE_h and ME_h, respectively), which correspond to the following categories: illiterate (zero years of schooling); some lower primary or completed primary education (one to four years of schooling); some upper primary or completed upper primary education (five to eight years of schooling); some high school or completed high school education (nine to eleven years of schooling); and some college or completed college education (twelve or more years of schooling). The vector X_h consists of parents' age, the number of sons and daughters by each age level, a rural dummy, a metropolitan area dummy, and state dummies. By including the number of sons and daughters for each child's age by gender, we control for the complete demographic structure of the household. The parameters to be estimated are α, $\beta's$, and δ. We assume the error term, ε_h, is i.i.d. normally distributed. We also run regressions with the father's and the mother's reported current log-income and with dummies for each decile of parents' income.[10]

Measures of Progress/Delay and Measures of Dispersion

As discussed above, our measure of progress of child *i* in household *h* is $P_{ih} = 1 + \frac{educa_{ih}}{age_{ih} - 6}$, where $P_{ih} = 1$ indicates zero progress, some delay implies $1 < P_{ih} < 2$, and adequate or fast progress implies $P_{ih} \geq 2$. The mean P_{ih} across households is 1.845 and its maximum is 4 (see Table A.1 in the appendix).

We utilize four measures of dispersion of P_{ih} within households. The Theil Entropy Measure $\left(\frac{1}{N_h} \sum_{i=1}^{N_h} \frac{P_{ih}}{P_h} \log\left(\frac{P_{ih}}{P_h} \right) \right)$, the Gini coefficient $\frac{N_h + 1}{N_h - 1} - \frac{2}{N_h (N_h - 1) P_h} \sum_{i=1}^{N} \rho_{ih} P_{ih}$ (with ρ_i the rank of individual *i*'s progress within household), the coefficient of variation $\left(\frac{1}{N_h} \sum_{i=1}^{N_h} (P_{ih} - P_h)^2 \right)^{\frac{1}{2}} / P_h$, and the proportion of children with some delay in a household (pdelay) is $N_{P<2}/N_h$ where N_h is the number of children in household *h*, P_h is the household's mean *P*, and $N_{P<2}$ is the number of the household's children with some delay. The Theil index ranges from 0 to 16.69 with a 0.518 mean. The Gini coefficient has a mean value of 0.0627 with a minimum of 0 and a maximum of 0.561. The coefficient of variation

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[10] The results are similar when year of schooling variables or dummies for each year of schooling are used. We assign value zero for log-income when income is zero.

across households runs from 0 to 0.793 with a mean of 0.094. The average proportion of delayed children across households is 0.517, its minimum is 0 and maximum is 1.

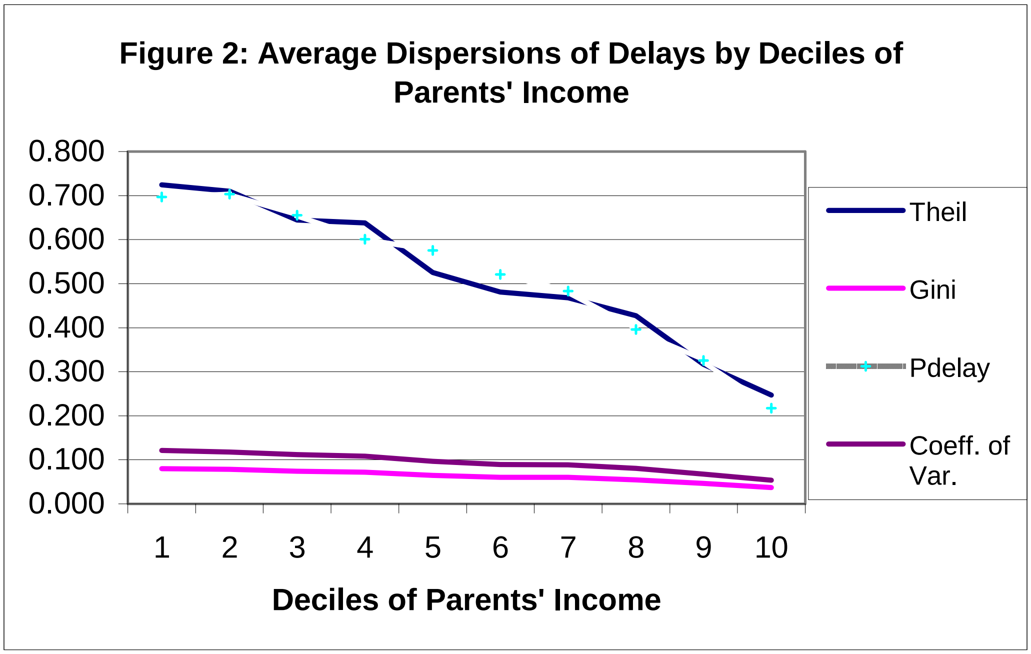
IV. Empirical results

Sample Selection

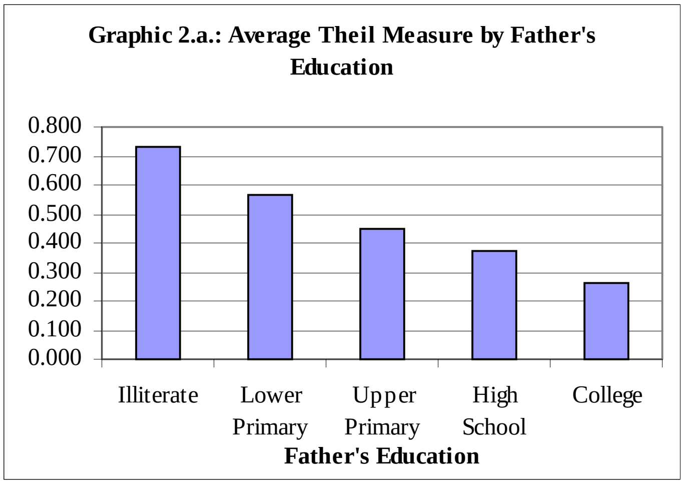
Our unit of analysis is a household and the sample selection consists of all two-parent households with at least two children aged seven to sixteen years inclusive. The selection of a sample with two-parent households is acknowledgement that time allocation decisions in a single-parent household may be governed by different processes than those in two-parent households. Our sample restriction to households' containing at least two children reflects our focus on the intra-household *distribution* of OHK across children. The children's age restriction follows from the school entry age of seven in Brazil and the fact that, in principle, children are expected to have completed their fundamental education by age sixteen.[11] Finally, all observations for which the age difference between the head of the household or spouse and the oldest child is 14 years or less are excluded. The final sample consists of 14,315 households and the summary statistics are presented in Table A.1 of the appendix.

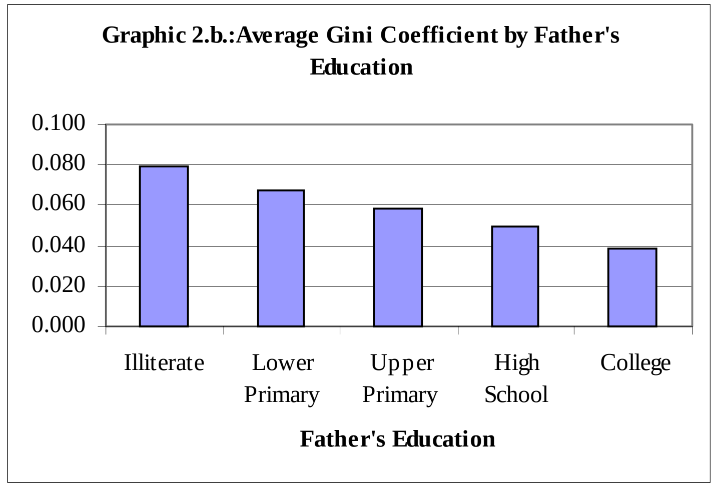
Figure 2 below depicts the averages of our four dispersion measures by parents' income deciles. The parents' income is the sum of the father and mother's incomes. The graphics shows a robust pattern of monotonically decreasing delay dispersion as parental income increases.

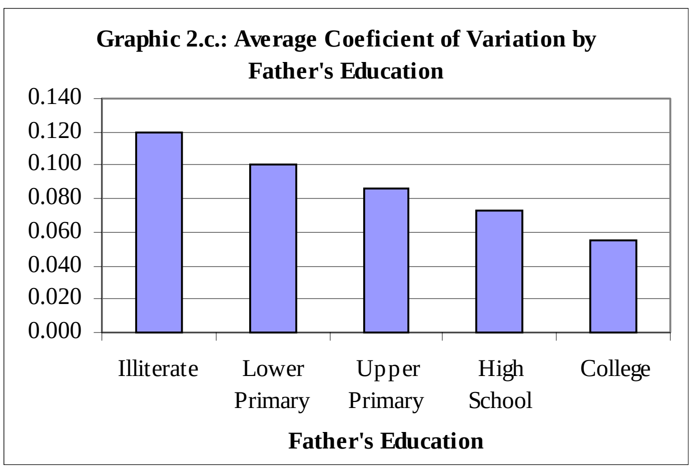
[11] Our results are not sensitive for the choice of upper-bound age. We replicate our estimations using fifteen and seventeen years old as alternative upper-bounds and the results are similar.

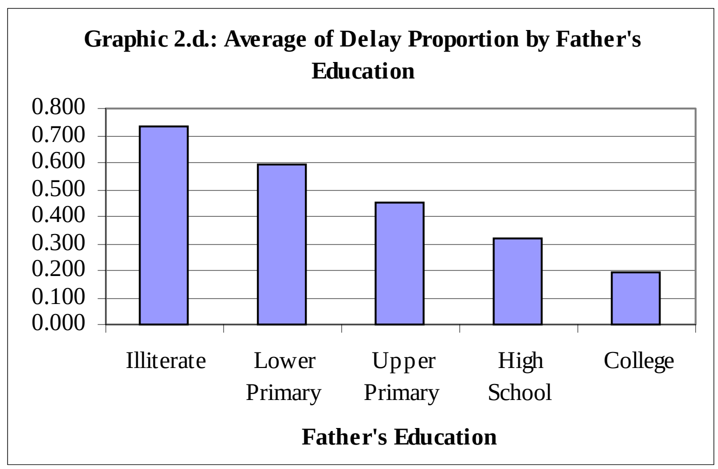


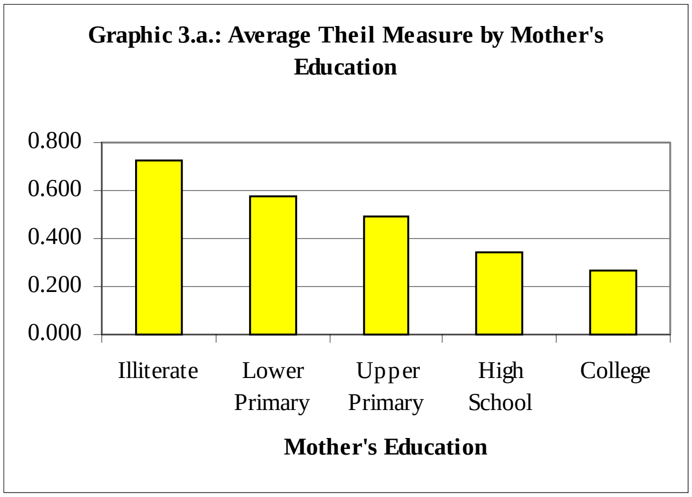
Figures 3.a. to 3.d. and 4.a. to 4.d. below present the mean of each of the four dispersion measures by father and mother education categories. Again, there is clear consistent monotonic negative correlation between delay dispersion within households and father's (and mother's) education level.

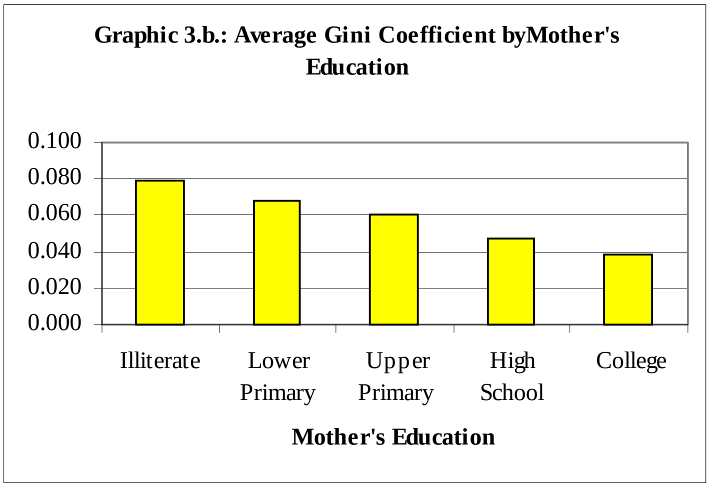

Graphic 2.a.: Average Theil Measure by Father's Education
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Illiterate
Lower Primary
Upper Primary
High School
College
Father's Education

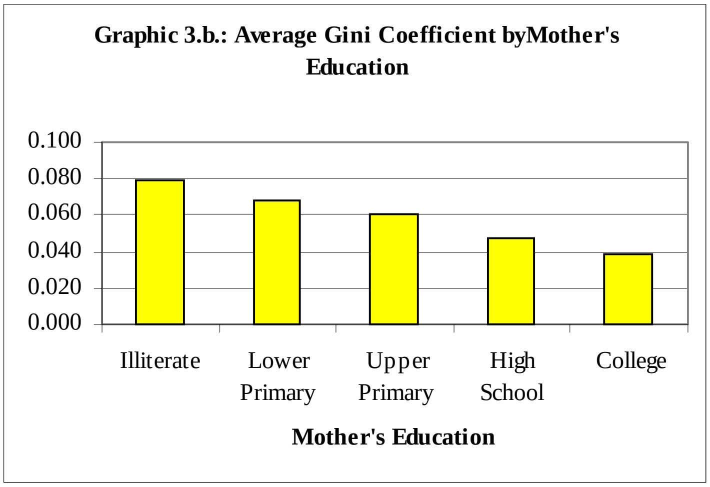

Graphic 2.b.:Average Gini Coefficient by Father's Education
0.100
0.080
0.060
0.040
0.020
0.000
Illiterate
Lower Primary
Upper Primary
High School
College
Father's Education

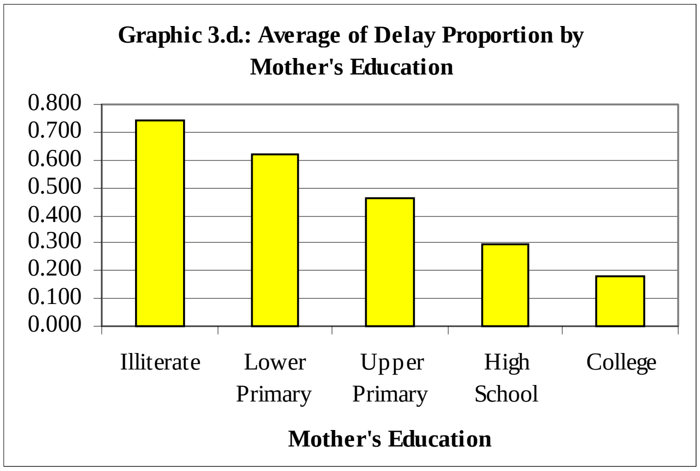

Graphic 2.c.: Average Coeficient of Variation by Father's Education
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Illiterate
Lower Primary
Upper Primary
High School
College
Father's Education


Graphic 2.d.: Average of Delay Proportion by Father's Education
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Illiterate
Lower Primary
Upper Primary
High School
College
Father's Education









Obviously, these are unconditional correlations and there are other factors that are correlated with parent's income or education that affects the delay dispersion. One of these factors is surely family composition. Although our dispersion measures partially compensate for the fact that poor households typically have a greater number of children than rich families (since they are normalized by the number of children) they do not address birth-order, child-spacing, or gender effects. These can only be addressed through control of the complete demographic structure of the household. This we accomplish through variables for the number of all children at each age by gender for ages zero to nineteen and above. Our regressions therefore include forty variables for children's age in each household. Children who are not included in our measure of delay dispersion because they are too young or too old for mandatory matriculation are nevertheless included in our demographic control variables since their presence may affect the other children's time allocations. Similarly, adults presented in the households are included in the variable nineteen years old and above.

In addition to household demographic structure the dispersion of delay can also be correlated with the different regions -- people living in the Northeast region of Brazil are on average poorer than those living in the Southeast region of the country. Moreover, since the education system is decentralized across states, educational policies may vary across states and affect poor and rich households differently. In order to control for these potential biases we include dummy variables for the state, metropolitan, and rural-urban locality.

Table 1 presents regression results for the Theil Measure, Gini Coefficient, Coefficient of Variation, and Proportion of Delay measures of delay dispersion, where the right-hand side variables are a set of dummies for each deciles of parents' income (the first decile is the omitted category) plus the parents' ages, family composition, and locality variables. The results are clear and robust across all measures: there is a monotonic decrease of dispersion as parents' income increases, holding family composition and locality constant. Note that for ease of presentation the (forty) control variables for the demographic structure of children are not incorporated in Tables 1-4, but are presented in the Appendix. The omitted categories of the locality controls are urban non-metropolitan areas and the state of São Paulo. For each regression we perform an F-test of the joint equality of all decile dummies and reject the null hypothesis at 1% level. The current income of fathers and mothers or their income deciles may not be a good predictor of the parents' permanent income due to its short-run variations or measurement error issues. For these reasons we instrument permanent income with father's and mother's education variables, a very good predictor of permanent income.

Tables 2.a. to 2.d. present the results of the regressions for the Gini, Theil, Coefficient of Variation, and Proportion Delayed measures, respectively. For each of these tables, the first column contains the results when the father's log-income and mother's log-income are the explanatory variables. The third column shows the results when the parents´ education category dummies replace their reported log-incomes. The fourth column presents the results when both sets of parents' log-incomes and education category variables are included. All these specifications include parents' ages, family composition variables, and locality dummies as additional controls.[12]

Examining the results reveals a robust pattern of a monotonic decrease of delay dispersion across the income distribution as well as across the education distribution. The first column of each Table 2.a. to 2.d. show that conditional on mother's (father's) log-income (and the other controls), the greater the father's (mother's) log-income, the smaller the delay dispersion is.

The second column of these tables presents the results of the regressions where the log-income variables are replaced by the education category dummies. The F-test for the joint equality of all the education category variables are computed for the father and mother

[12] Again, the omitted education category is illiterate (Zero years of schooling), the omitted locality categories are the urban non-metropolitan areas and the São Paulo state.

separately and shown at the bottom of the tables. The null hypothesis of joint equality is rejected for all cases. The results for these regressions are very robust: there is a monotonic negative correlation between delay dispersion and parents' education. Given the mother's (father's) education (and the other controls), a better educated father (mother) is associated with a more equal delay dispersion among sons and daughters of the same household.

Finally, the fifth column of Tables 2.a. to 2.d. presents results when parents' log-income and education variables are used along with the other controls. Again, the patterns obtained before remains. That is, controlling for each parent log-income (and the other controls), there is a negative correlation between parent education and delay dispersion. This suggests that there is an education effect over and above the income effect. Conversely, holding both parents' education and one parent's income constant, the greater the other parent income is, the more equal the dispersion is. It suggests that there is an income effect over and above the education effect.

V. Summary and Conclusion

A significant relationship between the intra-household *dispersion* of OHK and income may reflect a correlation between income and the intra-household distribution of innate talent, systematic a-priori propensities to specialize across the income distribution (i.e., "cultural" or class preferences regarding child specialization that vary with income), or a differential propensity to specialize in response to environmental factors which vary with income. We are a-priori skeptical of the first and second explanations, and believe that the differential patterns of intra-household dispersion we observe across the income distribution reflect "rational" responses to environmental constraints.

The negative relationship between household income and intra-household dispersion of observable human capital our analysis reveals is extremely robust. It is not affected by adopting different measures of dispersion or by varying the sample selection criteria. Though anticipated by recent theoretical work, this regularity has heretofore been unexplored empirically. Beyond establishing the existence of an unexplored pattern of intra-household specialization, we believe this empirical regularity has important implications for the evolution of income distribution in the dynastic household. In particular, there has been little research that explores inequality in inter-generational upward mobility within the household. Our results suggest that within poor households, upward mobility may be highly unequal across children. Future research will explore this issue in-depth.

Though this paper has established the existence of an empirical regularity between the intra-household delay dispersion and household income, the cause of this regularity has not been subject to formal testing. As noted at the outset, differing distributions of innate talent within households across the household income distribution could also account for the regularity. From our prospective, however, the natural explanation concerns the differing constraint set faced by households across the income distribution. Further exploration of the specific causes of greater dispersion in education attainment in poor households is also the subject of ongoing research.

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Table 1: OLS Regressions of Delay Dispersion Measures on Parents' Income Deciles

	GINI		THEIL		CV		PDELAY	
Variables	**Coeff.**	**Est. Error**	**Coeff.**	**Est. Error**	**Coeff.**	**Est. Error**	**Coeff.**	**Est. Error**
Decile One	Omitted category		Omitted category		Omitted category		Omitted category	
Decile Two	-0.001	0.002	0.008	0.036	-0.002	0.003	0.006	0.012
Decile Three	-0.005 **	0.002	-0.060	0.037	-0.007 **	0.003	-0.015	0.012
Decile Four	-0.005 **	0.002	-0.038	0.037	-0.007 **	0.003	-0.060 ***	0.012
Decile Five	-0.010 ***	0.002	-0.105 **	0.037	-0.014 ***	0.003	-0.083 ***	0.012
Decile Six	-0.012 ***	0.002	-0.112 ***	0.037	-0.018 ***	0.003	-0.121 ***	0.012
Decile Seven	-0.011 ***	0.002	-0.110 ***	0.038	-0.017 ***	0.004	-0.145 ***	0.012
Decile Eight	-0.015 ***	0.002	-0.134 ***	0.038	-0.022 ***	0.004	-0.218 ***	0.012
Decile Nine	-0.022 ***	0.002	-0.218 ***	0.038	-0.033 ***	0.004	-0.284 ***	0.012
Decile Ten	-0.030 ***	0.002	-0.264 ***	0.039	-0.044 ***	0.004	-0.383 ***	0.013
F(8, 14235)	26.89 ***		9.22 ***		26.60 ***		198.03 ***	
R-squared	0.121		0.122		0.140		0.359	
# OBS	14,315		14,315		14,315		14,315	

Note: (i) *** significant at 1% level; ** significant at 5% level; * significant at 10% level.
(ii) The additional variables include both parents' age, rural area dummy, metropolitan area dummy, and state dummies.
(iii) The omitted regions are urban non-metropolitan areas and the State of Sao Paulo.
(iv) the F-test tests the joint equality of the decile dummy coefficients

Table 2.a.: OLS Regressions of the Gini Coefficient of Delay Dispersion

Variables	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error
Father's Log-income	-0.0029 ***	0.0003			-0.0015 ***	0.0003
Mother's Log-income	-0.0010 ***	0.0002			-0.0003 *	0.0002
Father's Education						
Illiterate			Omitted Category		Omitted Category	
Lower Primary			-0.005 ***	0.002	-0.005 ***	0.002
Upper Primary			-0.010 ***	0.002	-0.010 ***	0.002
High-School			-0.013 ***	0.002	-0.011 ***	0.002
College			-0.018 ***	0.003	-0.015 ***	0.003
Mother's Education						
Illiterate			Omitted Category		Omitted Category	
Lower Primary			-0.005 ***	0.002	-0.004 ***	0.002
Upper Primary			-0.008 ***	0.002	-0.008 ***	0.002
High-School			-0.016 ***	0.002	-0.015 ***	0.002
College			-0.019 ***	0.003	-0.017 ***	0.003
Father: F(3, 14236)			8.91 ***		6.14 ***	
Mother: F(3, 14236)			16.56 ***		12.11 ***	
R-squared	0.114		0.123		0.124	
# OBS	14,315		14,315		14,315	

Note: (i) *** significant at 1% level; ** significant at 5% level; * significant at 10% level.
(ii) The additional variables include both parents' age, rural area dummy, metropolitan area dummy, and state dummies.
(iii) The omitted regions are urban non-metropolitan areas and the State of Sao Paulo.
(iv) the first F-test tests the joint equality of the father's education dummy coefficients.
The second F-test tests the joint equality of the mother's education dummy coefficients.

Table 2.b.: OLS Regressions of the Theil Measure of Delay Dispersion

Variables	Coeff.		Est. Error	Coeff.		Est. Error	Coeff.		Est. Error
Father's Log-income	-0.0253	***	0.0047				-0.0135	***	0.0051
Mother's Log-income	-0.0102	***	0.0030				-0.0052	*	0.0032
Father's Education									
Illiterate				Omitted Category			Omitted Category		
Lower Primary				-0.079	***	0.025	-0.075	***	0.025
Upper Primary				-0.127	***	0.029	-0.120	***	0.029
High-School				-0.130	***	0.034	-0.116	***	0.034
College				-0.191	***	0.047	-0.168	***	0.048
Mother's Education									
Illiterate				Omitted Category			Omitted Category		
Lower Primary				-0.064	***	0.026	-0.062	***	0.026
Upper Primary				-0.086	***	0.030	-0.081	***	0.030
High-School				-0.155	***	0.034	-0.140	***	0.035
College				-0.166	***	0.048	-0.136	***	0.050
Father: F(3, 14236)				2.91	**				
Mother: F(3, 14236)				3.92	***				
R-squared	0.119			0.123			0.123		
# OBS	14,315			14,315			14,315		

Note: (i) *** significant at 1% level; ** significant at 5% level; * significant at 10% level.
(ii) The additional variables include both parents' age, rural area dummy, metropolitan area dummy, and state dummies.
(iii) The omitted regions are urban non-metropolitan areas and the State of Sao Paulo.
(iv) the first F-test tests the joint equality of the father's education dummy coefficients.
The second F-test tests the joint equality of the mother's education dummy coefficients.

Table 2.c.: OLS Regressions of the Coefficient Variation of Delay Dispersion

Variables	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error
Father's Log-income	-0.0042 ***	0.0004			-0.0022 ***	0.0005
Mother's Log-income	-0.0014 ***	0.0003			-0.0005 *	0.0003
Father's Education						
Illiterate			Omitted Category		Omitted Category	
Lower Primary			-0.008 ***	0.002	-0.008 ***	0.002
Upper Primary			-0.016 ***	0.003	-0.014 ***	0.003
High-School			-0.018 ***	0.003	-0.016 ***	0.003
College			-0.026 ***	0.004	-0.022 ***	0.004
Mother's Education						
Illiterate			Omitted Category		Omitted Category	
Lower Primary			-0.007 ***	0.002	-0.007 ***	0.002
Upper Primary			-0.012 ***	0.003	-0.011 ***	0.003
High-School			-0.023 ***	0.003	-0.022 ***	0.003
College			-0.028 ***	0.004	-0.025 ***	0.005
Father: F(3, 14236)			9.15 ***		6.35 ***	
Mother: F(3, 14236)			15.68 ***		11.32 ***	
R-squared	0.133		0.142		0.143	
# OBS	14,315		14,315		14,315	

Note: (i) *** significant at 1% level; ** significant at 5% level; * significant at 10% level.
(ii) The additional variables include both parents' age, rural area dummy, metropolitan area dummy, and state dummies.
(iii) The omitted regions are urban non-metropolitan areas and the State of Sao Paulo.
(iv) the first F-test tests the joint equality of the father's education dummy coefficients.
The second F-test tests the joint equality of the mother's education dummy coefficients.

Table 2.d.: OLS Regressions of the Proportion of Delay

Variables	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error
Father's Log-income	-0.0366 ***	0.0016			-0.0140 ***	0.0016
Mother's Log-income	-0.0137 ***	0.0010			-0.0029 ***	0.0010
Father's Education						
Illiterate			Omitted Category		Omitted Category	
Lower Primary			-0.054 ***	0.008	-0.050 ***	0.008
Upper Primary			-0.091 ***	0.009	-0.084 ***	0.009
High-School			-0.172 ***	0.011	-0.158 ***	0.011
College			-0.206 ***	0.015	-0.181 ***	0.015
Mother's Education						
Illiterate			Omitted Category		Omitted Category	
Lower Primary			-0.053 ***	0.008	-0.052 ***	0.008
Upper Primary			-0.142 ***	0.009	-0.137 ***	0.009
High-School			-0.265 ***	0.011	-0.253 ***	0.011
College			-0.315 ***	0.015	-0.292 ***	0.016
Father: F(3, 14236)			71.02 ***		54.69 ***	
Mother: F(3, 14236)			215.98 ***		182.11 ***	
R-squared	0.316		0.390		0.393	
# OBS	14,315		14,315		14,315	

Note: (i) *** significant at 1% level; ** significant at 5% level; * significant at 10% level.
(ii) The additional variables include both parents' age, rural area dummy, metropolitan area dummy, and state dummies.
(iii) The omitted regions are urban non-metropolitan areas and the State of Sao Paulo.
(iv) the first F-test tests the joint equality of the father's education dummy coefficients.
The second F-test tests the joint equality of the mother's education dummy coefficients.

Table A.1: Unweighted Sample Statistics

Variables	N	Mean	Std Dev	Minimum	Maximum
Age-Grade Distortion Measures					
Average of Age-Grade Distortion	14,315	1.845	0.252	1.000	4.000
Gini Coefficient of Age-Grade Distortion	14,315	0.063	0.065	0.000	0.561
Theil Index of Age-Grade Distortion	14,315	0.518	1.028	0.000	16.686
Coefficient of variation of Age-Grade Distortion	14,315	0.094	0.096	0.000	0.793
Proportional Delay	14,315	0.518	0.390	0.000	1.000
Father's Characteristics					
Age	14,315	41.811	8.098	23.000	98.000
Log of Income	14,315	5.596	1.773	0.000	10.820
Education Category					
Illiterate	14,315	0.189	0.391	0.000	1.000
Some or Completed Lower Primary	14,315	0.360	0.480	0.000	1.000
Some or Completed Upper Primary	14,315	0.232	0.422	0.000	1.000
Some or Completed High School	14,315	0.152	0.359	0.000	1.000
Some or Completed College	14,315	0.067	0.250	0.000	1.000
Mother's Characteristics					
Age	14,315	37.574	6.442	23.000	81.000
Log of Income	14,315	2.794	2.765	0.000	10.597
Education Category					
Illiterate	14,315	0.154	0.361	0.000	1.000
Some or Completed Lower Primary	14,315	0.359	0.480	0.000	1.000
Some or Completed Upper Primary	14,315	0.260	0.439	0.000	1.000
Some or Completed High School	14,315	0.165	0.371	0.000	1.000
Some or Completed College	14,315	0.062	0.242	0.000	1.000
Number of Male Persons by Age					
Zero Years Old	14,315	0.015	0.121	0.000	1.000
One Year Old	14,315	0.020	0.141	0.000	2.000
Two Years Old	14,315	0.024	0.155	0.000	2.000
Three Years Old	14,315	0.031	0.175	0.000	2.000
Four Years Old	14,315	0.036	0.189	0.000	2.000
Five Years Old	14,315	0.044	0.206	0.000	2.000
Six Years Old	14,315	0.048	0.215	0.000	2.000
Seven Years Old	14,315	0.108	0.315	0.000	2.000
Eight Years Old	14,315	0.113	0.321	0.000	2.000
Nine Years Old	14,315	0.115	0.323	0.000	2.000
Ten Years Old	14,315	0.131	0.341	0.000	2.000
Eleven Years Old	14,315	0.128	0.339	0.000	2.000

Twelve Years Old	14,315	0.134	0.344	0.000	2.000
Thirteen Years Old	14,315	0.140	0.353	0.000	2.000
Fourteen Years Old	14,315	0.136	0.348	0.000	2.000
Fifteen Years Old	14,315	0.122	0.331	0.000	2.000
Sixteen Years Old	14,315	0.118	0.327	0.000	2.000
Seventeen Years Old	14,315	0.053	0.225	0.000	2.000
Eighteen Years Old	14,315	0.051	0.221	0.000	2.000
Nineteen Years Old and Above	14,315	0.144	0.457	0.000	5.000
Number of Female Persons by Age					
Zero Years Old	14,315	0.018	0.133	0.000	2.000
One Year Old	14,315	0.020	0.142	0.000	2.000
Two Years Old	14,315	0.024	0.156	0.000	2.000
Three Years Old	14,315	0.031	0.175	0.000	2.000
Four Years Old	14,315	0.034	0.183	0.000	2.000
Five Years Old	14,315	0.042	0.204	0.000	2.000
Six Years Old	14,315	0.043	0.205	0.000	2.000
Seven Years Old	14,315	0.104	0.311	0.000	2.000
Eight Years Old	14,315	0.117	0.325	0.000	2.000
Nine Years Old	14,315	0.114	0.323	0.000	2.000
Ten Years Old	14,315	0.129	0.338	0.000	2.000
Eleven Years Old	14,315	0.132	0.343	0.000	2.000
Twelve Years Old	14,315	0.134	0.347	0.000	2.000
Thirteen Years Old	14,315	0.131	0.343	0.000	2.000
Fourteen Years Old	14,315	0.126	0.336	0.000	2.000
Fifteen Years Old	14,315	0.115	0.323	0.000	2.000
Sixteen Years Old	14,315	0.103	0.309	0.000	2.000
Seventeen Years Old	14,315	0.041	0.200	0.000	2.000
Eighteen Years Old	14,315	0.038	0.193	0.000	2.000
Nineteen Years Old and Above	14,315	0.094	0.354	0.000	5.000
Locality Controls					
rural	14,315	0.192	0.394	0.000	1.000
metarea	14,315	0.332	0.471	0.000	1.000
Rondónia	14,315	0.014	0.119	0.000	1.000
Acre	14,315	0.008	0.090	0.000	1.000
Amazonas	14,315	0.022	0.146	0.000	1.000
Roraima	14,315	0.004	0.067	0.000	1.000
Pará	14,315	0.049	0.216	0.000	1.000
Amapá	14,315	0.003	0.051	0.000	1.000
Tocantins	14,315	0.020	0.139	0.000	1.000

Maranhão	14,315	0.025	0.155	0.000	1.000
Piaui	14,315	0.019	0.135	0.000	1.000
Ceará	14,315	0.070	0.255	0.000	1.000
Rio Grande do Norte	14,315	0.016	0.127	0.000	1.000
Paraiba	14,315	0.024	0.152	0.000	1.000
Pernambuco	14,315	0.066	0.248	0.000	1.000
Alagoas	14,315	0.018	0.134	0.000	1.000
Sergipe	14,315	0.017	0.129	0.000	1.000
Bahia	14,315	0.097	0.296	0.000	1.000
Minas Gerais	14,315	0.098	0.298	0.000	1.000
Espirito Santo	14,315	0.017	0.129	0.000	1.000
Rio de Janeiro	14,315	0.053	0.224	0.000	1.000
São Paulo	14,315	0.109	0.312	0.000	1.000
Paraná	14,315	0.051	0.221	0.000	1.000
Santa Catarina	14,315	0.024	0.154	0.000	1.000
Rio Grande do Sul	14,315	0.065	0.247	0.000	1.000
Mato Grosso do Sul	14,315	0.018	0.134	0.000	1.000
Mato Grosso	14,315	0.022	0.147	0.000	1.000
Goiás	14,315	0.045	0.208	0.000	1.000
Federal District	14,315	0.024	0.154	0.000	1.000

Table A.2: OLS Regression
Dependent Variable: Gini Coeficient of Age-Grade Distortion

Variable	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Intercept	0.0453	0.0050	0.0497	0.0053	0.0586	0.0056
Log of Father's Income	-0.0029	0.0003			-0.0015	0.0003
Log of Mother's Income	-0.0010	0.0002			-0.0003	0.0002
Father's Age	0.000124	0.000083	0.000000	0.000084	0.000014	0.000084
Mother's Age	0.000048	0.000114	0.000078	0.000115	0.000063	0.000115
Father's Educational Controls						
Lower Primary Education			-0.005	0.002	-0.005	0.002
Upper Primary Education			-0.010	0.002	-0.010	0.002
High School			-0.013	0.002	-0.011	0.002
College/University			-0.018	0.003	-0.015	0.003
Mother's Educational Controls						
Lower Primary Education			-0.005	0.002	-0.004	0.002
Upper Primary Education			-0.008	0.002	-0.008	0.002
High School			-0.016	0.002	-0.015	0.002
College/University			-0.019	0.003	-0.017	0.003
Number of Male Persons by Age						
Zero Years Old	0.003	0.004	0.002	0.004	0.002	0.004
One Year Old	-0.001	0.004	-0.001	0.004	-0.001	0.004
Two Years Old	0.001	0.003	0.001	0.003	0.001	0.003
Three Years Old	0.007	0.003	0.006	0.003	0.006	0.003
Four Years Old	0.006	0.003	0.004	0.003	0.004	0.003
Five Years Old	0.004	0.003	0.002	0.003	0.002	0.003
Six Years Old	0.010	0.002	0.008	0.002	0.008	0.002
Seven Years Old	0.031	0.002	0.030	0.002	0.030	0.002
Eight Years Old	0.015	0.002	0.014	0.002	0.014	0.002
Nine Years Old	0.002	0.002	0.001	0.002	0.001	0.002
Ten Years Old	0.000	0.002	0.000	0.002	-0.001	0.002
Eleven Years Old	-0.001	0.002	-0.002	0.002	-0.002	0.002
Twelve Years Old	-0.001	0.002	-0.002	0.002	-0.002	0.002
Thirteen Years Old	-0.002	0.002	-0.003	0.002	-0.004	0.002
Fourteen Years Old	0.001	0.002	0.000	0.002	0.000	0.002
Fifteen Years Old	0.001	0.002	-0.001	0.002	-0.001	0.002
Sixteen Years Old	0.004	0.002	0.003	0.002	0.003	0.002
Seventeen Years Old	0.006	0.002	0.005	0.002	0.005	0.002
Eighteen Years Old	0.000	0.002	-0.001	0.002	-0.001	0.002
Nineteen Years Old and Above	0.003	0.001	0.001	0.001	0.001	0.001
Number of Female Persons by Age						
Zero Years Old	0.004	0.004	0.004	0.004	0.003	0.004
One Year Old	0.004	0.004	0.004	0.004	0.003	0.004
Two Years Old	0.000	0.003	-0.001	0.003	-0.001	0.003
Three Years Old	0.002	0.003	0.001	0.003	0.001	0.003
Four Years Old	0.007	0.003	0.006	0.003	0.006	0.003
Five Years Old	0.006	0.003	0.005	0.003	0.005	0.003
Six Years Old	0.009	0.003	0.008	0.003	0.008	0.003
Seven Years Old	0.039	0.002	0.038	0.002	0.038	0.002

Eight Years Old	0.015	0.002	0.013	0.002	0.013	0.002
Nine Years Old	0.006	0.002	0.005	0.002	0.004	0.002
Ten Years Old	0.001	0.002	0.000	0.002	-0.001	0.002
Eleven Years Old	-0.001	0.002	-0.002	0.002	-0.002	0.002
Twelve Years Old	-0.004	0.002	-0.005	0.002	-0.005	0.002
Thirteen Years Old	-0.005	0.002	-0.006	0.002	-0.006	0.002
Fourteen Years Old	-0.006	0.002	-0.007	0.002	-0.007	0.002
Fifteen Years Old	-0.005	0.002	-0.006	0.002	-0.006	0.002
Sixteen Years Old	0.000	0.002	-0.002	0.002	-0.001	0.002
Seventeen Years Old	-0.002	0.003	-0.003	0.003	-0.003	0.003
Eighteen Years Old	0.007	0.003	0.005	0.003	0.005	0.003
Nineteen Years Old and Above	0.001	0.002	0.000	0.002	0.000	0.002
Locality Controls						
Rural Dummy	0.006	0.001	0.002	0.001	0.002	0.001
Metropolitan Area Dummy	-0.001	0.001	0.001	0.001	0.001	0.001
Rondónia	0.016	0.005	0.014	0.005	0.014	0.005
Acre	0.027	0.006	0.026	0.006	0.025	0.006
Amazonas	0.023	0.004	0.025	0.004	0.025	0.004
Roraima	0.012	0.008	0.009	0.008	0.009	0.008
Pará	0.018	0.003	0.017	0.003	0.017	0.003
Amapá	0.004	0.010	0.008	0.010	0.007	0.010
Tocantins	0.015	0.004	0.015	0.004	0.014	0.004
Maranhão	0.021	0.004	0.021	0.004	0.020	0.004
Piaui	0.022	0.004	0.021	0.004	0.021	0.004
Ceará	0.019	0.003	0.017	0.003	0.016	0.003
Rio Grande do Norte	0.025	0.004	0.027	0.004	0.026	0.004
Paraiba	0.027	0.004	0.026	0.004	0.025	0.004
Pernambuco	0.025	0.003	0.024	0.003	0.023	0.003
Alagoas	0.028	0.004	0.027	0.004	0.026	0.004
Sergipe	0.029	0.004	0.029	0.004	0.028	0.004
Bahia	0.025	0.002	0.024	0.002	0.023	0.002
Minas Gerais	0.008	0.002	0.008	0.002	0.007	0.002
Espirito Santo	0.011	0.004	0.013	0.004	0.012	0.004
Rio de Janeiro	0.019	0.003	0.019	0.003	0.019	0.003
Paraná	0.013	0.003	0.012	0.003	0.012	0.003
Santa Catarina	0.007	0.004	0.007	0.004	0.007	0.004
Rio Grande do Sul	0.013	0.003	0.012	0.003	0.013	0.003
Mato Grosso do Sul	0.022	0.004	0.022	0.004	0.022	0.004
Mato Grosso	0.025	0.004	0.025	0.004	0.024	0.004
Goiás	0.013	0.003	0.012	0.003	0.012	0.003
Federal District	0.008	0.004	0.009	0.004	0.008	0.004
R-Squared	0.114		0.123		0.124	
Number of Observations	14,315		14,315		14,315	

Table A.3: OLS Regression
Dependent Variable: Theil Measure of Age-Grade Distortion

Variable	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Intercept	-0.096	0.078	0.0043	0.083	0.088	0.088
Log of Father's Income	-0.025	0.005			-0.013	0.005
Log of Mother's Income	-0.010	0.003			-0.005	0.003
Father's Age	0.003	0.001	0.002	0.001	0.002	0.001
Mother's Age	0.002	0.002	0.002	0.002	0.002	0.002
Father's Educational Controls						
Lower Primary Education			-0.079	0.025	-0.075	0.025
Upper Primary Education			-0.127	0.029	-0.120	0.029
High School			-0.130	0.034	-0.116	0.034
College/University			-0.191	0.047	-0.168	0.048
Mother's Educational Controls						
Lower Primary Education			-0.064	0.026	-0.062	0.026
Upper Primary Education			-0.086	0.030	-0.081	0.030
High School			-0.155	0.034	-0.140	0.035
College/University			-0.166	0.048	-0.136	0.050
Number of Male Persons by Age						
Zero Years Old	0.026	0.068	0.016	0.067	0.014	0.067
One Year Old	0.020	0.058	0.017	0.058	0.016	0.058
Two Years Old	0.035	0.053	0.039	0.053	0.034	0.053
Three Years Old	0.051	0.047	0.042	0.047	0.040	0.047
Four Years Old	0.059	0.044	0.046	0.044	0.044	0.043
Five Years Old	0.031	0.040	0.017	0.040	0.016	0.040
Six Years Old	0.165	0.038	0.152	0.038	0.150	0.038
Seven Years Old	0.673	0.027	0.662	0.027	0.660	0.027
Eight Years Old	0.245	0.027	0.234	0.027	0.233	0.027
Nine Years Old	0.081	0.027	0.072	0.027	0.069	0.027
Ten Years Old	0.065	0.025	0.056	0.025	0.054	0.025
Eleven Years Old	0.091	0.025	0.079	0.025	0.079	0.025
Twelve Years Old	0.100	0.025	0.091	0.025	0.090	0.025
Thirteen Years Old	0.061	0.025	0.051	0.025	0.050	0.025
Fourteen Years Old	0.142	0.025	0.132	0.025	0.132	0.025
Fifteen Years Old	0.098	0.026	0.086	0.026	0.086	0.026
Sixteen Years Old	0.150	0.027	0.137	0.027	0.138	0.027
Seventeen Years Old	0.045	0.037	0.034	0.036	0.034	0.036
Eighteen Years Old	0.012	0.037	-0.002	0.037	-0.002	0.037
Nineteen Years Old and Above	0.020	0.020	0.009	0.020	0.007	0.020
Number of Female Persons by Age						
Zero Years Old	0.055	0.062	0.052	0.061	0.047	0.061
One Year Old	0.061	0.058	0.060	0.057	0.054	0.058
Two Years Old	-0.052	0.053	-0.057	0.053	-0.061	0.053
Three Years Old	0.035	0.047	0.030	0.047	0.027	0.047
Four Years Old	0.098	0.045	0.086	0.045	0.085	0.045
Five Years Old	0.148	0.041	0.136	0.041	0.135	0.041
Six Years Old	0.156	0.040	0.148	0.040	0.146	0.040
Seven Years Old	0.842	0.028	0.830	0.028	0.829	0.028

Eight Years Old	0.242	0.027	0.230	0.027	0.230	0.027
Nine Years Old	0.156	0.027	0.145	0.027	0.143	0.027
Ten Years Old	0.089	0.026	0.080	0.026	0.078	0.026
Eleven Years Old	0.079	0.025	0.067	0.025	0.065	0.025
Twelve Years Old	0.048	0.025	0.038	0.025	0.037	0.025
Thirteen Years Old	0.048	0.025	0.039	0.025	0.039	0.025
Fourteen Years Old	0.045	0.026	0.032	0.026	0.033	0.026
Fifteen Years Old	0.063	0.027	0.053	0.027	0.053	0.027
Sixteen Years Old	0.106	0.028	0.094	0.028	0.095	0.028
Seventeen Years Old	-0.046	0.041	-0.058	0.041	-0.056	0.041
Eighteen Years Old	0.055	0.043	0.044	0.043	0.044	0.043
Nineteen Years Old and Above	-0.013	0.025	-0.021	0.025	-0.021	0.025
Locality Controls						
Rural Dummy	0.044	0.023	0.007	0.023	0.005	0.023
Metropolitan Area Dummy	-0.011	0.021	0.009	0.022	0.009	0.022
Rondónia	0.215	0.073	0.198	0.073	0.199	0.073
Acre	0.331	0.093	0.309	0.093	0.310	0.093
Amazonas	0.240	0.061	0.253	0.061	0.247	0.061
Roraima	0.092	0.124	0.066	0.124	0.068	0.124
Pará	0.130	0.044	0.122	0.044	0.119	0.044
Amapá	-0.001	0.160	0.034	0.159	0.026	0.159
Tocantins	0.137	0.064	0.138	0.064	0.133	0.064
Maranhão	0.204	0.058	0.199	0.058	0.192	0.059
Piaui	0.252	0.065	0.240	0.065	0.235	0.065
Ceará	0.171	0.040	0.152	0.040	0.146	0.040
Rio Grande do Norte	0.271	0.069	0.276	0.069	0.269	0.069
Paraiba	0.271	0.059	0.254	0.059	0.250	0.059
Pernambuco	0.262	0.041	0.254	0.041	0.245	0.041
Alagoas	0.288	0.066	0.267	0.066	0.260	0.066
Sergipe	0.356	0.067	0.348	0.067	0.341	0.067
Bahia	0.243	0.036	0.227	0.037	0.221	0.037
Minas Gerais	0.079	0.036	0.076	0.036	0.073	0.036
Espirito Santo	0.154	0.067	0.172	0.067	0.165	0.067
Rio de Janeiro	0.190	0.043	0.195	0.043	0.193	0.043
Paraná	0.134	0.043	0.126	0.043	0.125	0.043
Santa Catarina	0.035	0.058	0.038	0.058	0.041	0.058
Rio Grande do Sul	0.138	0.040	0.134	0.040	0.136	0.040
Mato Grosso do Sul	0.248	0.065	0.255	0.065	0.250	0.065
Mato Grosso	0.312	0.060	0.309	0.060	0.306	0.060
Goiás	0.108	0.046	0.104	0.046	0.102	0.046
Federal District	0.041	0.059	0.040	0.059	0.038	0.059
R-Squared	0.119		0.123		0.123	
Number of Observations	14,315		14,315		14,315	

Table A.4: OLS Regression
Dependent Variable: Coefficient of Variation of Age-Grade Distortion

Variable	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Intercept	0.044	0.007	0.0505	0.0077	0.0636	0.0082
Log of Father's Income	-0.004	0.000			-0.0022	0.0005
Log of Mother's Income	-0.001	0.000			-0.0005	0.0003
Father's Age	0.00018	0.00012	0.00000	0.00012	0.00002	0.00012
Mother's Age	0.00012	0.00017	0.00016	0.00017	0.00014	0.00017
Father's Educational Controls						
Lower Primary Education			-0.008	0.002	-0.008	0.002
Upper Primary Education			-0.016	0.003	-0.014	0.003
High School			-0.018	0.003	-0.016	0.003
College/University			-0.026	0.004	-0.022	0.004
Mother's Educational Controls						
Lower Primary Education			-0.007	0.002	-0.007	0.002
Upper Primary Education			-0.012	0.003	-0.011	0.003
High School			-0.023	0.003	-0.022	0.003
College/University			-0.028	0.004	-0.025	0.005
Number of Male Persons by Age						
Zero Years Old	0.004	0.006	0.003	0.006	0.003	0.006
One Year Old	-0.002	0.005	-0.002	0.005	-0.002	0.005
Two Years Old	0.002	0.005	0.002	0.005	0.002	0.005
Three Years Old	0.011	0.004	0.009	0.004	0.009	0.004
Four Years Old	0.008	0.004	0.007	0.004	0.006	0.004
Five Years Old	0.005	0.004	0.003	0.004	0.003	0.004
Six Years Old	0.014	0.004	0.012	0.004	0.012	0.004
Seven Years Old	0.057	0.003	0.055	0.003	0.055	0.003
Eight Years Old	0.030	0.003	0.029	0.003	0.029	0.003
Nine Years Old	0.012	0.003	0.011	0.003	0.011	0.003
Ten Years Old	0.010	0.002	0.008	0.002	0.008	0.002
Eleven Years Old	0.008	0.002	0.007	0.002	0.007	0.002
Twelve Years Old	0.008	0.002	0.007	0.002	0.007	0.002
Thirteen Years Old	0.006	0.002	0.004	0.002	0.004	0.002
Fourteen Years Old	0.011	0.002	0.010	0.002	0.010	0.002
Fifteen Years Old	0.010	0.002	0.008	0.002	0.008	0.002
Sixteen Years Old	0.015	0.002	0.013	0.002	0.013	0.002
Seventeen Years Old	0.008	0.003	0.006	0.003	0.006	0.003
Eighteen Years Old	0.001	0.003	-0.002	0.003	-0.002	0.003
Nineteen Years Old and Above	0.003	0.002	0.002	0.002	0.001	0.002
Number of Female Persons by Age						
Zero Years Old	0.006	0.006	0.005	0.006	0.004	0.006
One Year Old	0.006	0.005	0.006	0.005	0.005	0.005
Two Years Old	-0.001	0.005	-0.002	0.005	-0.002	0.005
Three Years Old	0.003	0.004	0.002	0.004	0.002	0.004
Four Years Old	0.011	0.004	0.009	0.004	0.009	0.004
Five Years Old	0.009	0.004	0.007	0.004	0.007	0.004
Six Years Old	0.013	0.004	0.012	0.004	0.012	0.004
Seven Years Old	0.068	0.003	0.066	0.003	0.066	0.003

Eight Years Old	0.030	0.003	0.028	0.002	0.028	0.002
Nine Years Old	0.017	0.003	0.016	0.003	0.015	0.003
Ten Years Old	0.010	0.002	0.009	0.002	0.008	0.002
Eleven Years Old	0.008	0.002	0.006	0.002	0.005	0.002
Twelve Years Old	0.004	0.002	0.002	0.002	0.002	0.002
Thirteen Years Old	0.002	0.002	0.000	0.002	0.000	0.002
Fourteen Years Old	0.000	0.002	-0.002	0.002	-0.002	0.002
Fifteen Years Old	0.002	0.003	0.001	0.003	0.001	0.003
Sixteen Years Old	0.009	0.003	0.007	0.003	0.007	0.003
Seventeen Years Old	-0.003	0.004	-0.005	0.004	-0.005	0.004
Eighteen Years Old	0.009	0.004	0.007	0.004	0.007	0.004
Nineteen Years Old and Above	0.001	0.002	-0.001	0.002	-0.001	0.002
Locality Controls						
Rural Dummy	0.009	0.002	0.003	0.002	0.003	0.002
Metropolitan Area Dummy	-0.001	0.002	0.002	0.002	0.002	0.002
Rondónia	0.024	0.007	0.021	0.007	0.021	0.007
Acre	0.039	0.009	0.037	0.009	0.037	0.009
Amazonas	0.033	0.006	0.036	0.006	0.035	0.006
Roraima	0.016	0.012	0.013	0.011	0.013	0.011
Pará	0.026	0.004	0.025	0.004	0.024	0.004
Amapá	0.006	0.015	0.011	0.015	0.010	0.015
Tocantins	0.022	0.006	0.022	0.006	0.021	0.006
Maranhão	0.030	0.005	0.030	0.005	0.029	0.005
Piaui	0.033	0.006	0.032	0.006	0.031	0.006
Ceará	0.027	0.004	0.024	0.004	0.023	0.004
Rio Grande do Norte	0.037	0.006	0.038	0.006	0.037	0.006
Paraiba	0.038	0.006	0.037	0.005	0.036	0.005
Pernambuco	0.036	0.004	0.036	0.004	0.034	0.004
Alagoas	0.040	0.006	0.038	0.006	0.037	0.006
Sergipe	0.043	0.006	0.042	0.006	0.041	0.006
Bahia	0.036	0.003	0.034	0.003	0.033	0.003
Minas Gerais	0.012	0.003	0.011	0.003	0.011	0.003
Espirito Santo	0.017	0.006	0.019	0.006	0.018	0.006
Rio de Janeiro	0.027	0.004	0.028	0.004	0.027	0.004
Paraná	0.019	0.004	0.018	0.004	0.018	0.004
Santa Catarina	0.010	0.005	0.010	0.005	0.010	0.005
Rio Grande do Sul	0.019	0.004	0.018	0.004	0.019	0.004
Mato Grosso do Sul	0.032	0.006	0.033	0.006	0.032	0.006
Mato Grosso	0.036	0.006	0.035	0.006	0.035	0.006
Goiás	0.019	0.004	0.018	0.004	0.018	0.004
Federal District	0.012	0.005	0.013	0.005	0.012	0.005
R-Squared	0.133		0.142		0.143	
Number of Observations	14,315		14,315		14,315	

Table A.5: OLS Regression
Dependent Variable: Proportion of Delay of Age-Grade Distortion

Variable	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Intercept	0.438	0.026	0.5073	0.0264	0.5888	0.0278
Log of Father's Income	-0.037	0.002			-0.0140	0.0016
Log of Mother's Income	-0.014	0.001			-0.0029	0.0010
Father's Age	0.00014	0.00044	-0.00142	0.00042	-0.00129	0.00042
Mother's Age	-0.00025	0.00060	0.00035	0.00057	0.00021	0.00057
Father's Educational Controls						
Lower Primary Education			-0.054	0.008	-0.050	0.008
Upper Primary Education			-0.091	0.009	-0.084	0.009
High School			-0.172	0.011	-0.158	0.011
College/University			-0.206	0.015	-0.181	0.015
Mother's Educational Controls						
Lower Primary Education			-0.053	0.008	-0.052	0.008
Upper Primary Education			-0.142	0.009	-0.137	0.009
High School			-0.265	0.011	-0.253	0.011
College/University			-0.315	0.015	-0.292	0.016
Number of Male Persons by Age						
Zero Years Old	0.024	0.023	0.012	0.021	0.011	0.021
One Year Old	0.020	0.019	0.019	0.018	0.018	0.018
Two Years Old	0.045	0.018	0.048	0.017	0.044	0.017
Three Years Old	0.056	0.016	0.037	0.015	0.036	0.015
Four Years Old	0.068	0.015	0.045	0.014	0.043	0.014
Five Years Old	0.068	0.013	0.042	0.013	0.040	0.013
Six Years Old	0.076	0.013	0.052	0.012	0.050	0.012
Seven Years Old	-0.136	0.009	-0.156	0.009	-0.157	0.009
Eight Years Old	-0.032	0.009	-0.049	0.009	-0.050	0.009
Nine Years Old	0.016	0.009	0.000	0.009	-0.003	0.009
Ten Years Old	0.048	0.008	0.032	0.008	0.030	0.008
Eleven Years Old	0.066	0.009	0.048	0.008	0.047	0.008
Twelve Years Old	0.111	0.008	0.098	0.008	0.097	0.008
Thirteen Years Old	0.134	0.008	0.115	0.008	0.114	0.008
Fourteen Years Old	0.153	0.008	0.135	0.008	0.134	0.008
Fifteen Years Old	0.160	0.009	0.140	0.008	0.140	0.008
Sixteen Years Old	0.181	0.009	0.155	0.008	0.155	0.008
Seventeen Years Old	0.052	0.012	0.028	0.012	0.029	0.012
Eighteen Years Old	0.063	0.012	0.034	0.012	0.034	0.012
Nineteen Years Old and Above	0.056	0.007	0.034	0.006	0.033	0.006
Number of Female Persons by Age						
Zero Years Old	0.048	0.021	0.040	0.019	0.037	0.019
One Year Old	0.053	0.019	0.050	0.018	0.045	0.018
Two Years Old	0.036	0.018	0.025	0.017	0.023	0.017
Three Years Old	0.033	0.016	0.022	0.015	0.018	0.015
Four Years Old	0.063	0.015	0.039	0.014	0.039	0.014
Five Years Old	0.054	0.014	0.030	0.013	0.029	0.013
Six Years Old	0.040	0.013	0.025	0.013	0.022	0.013
Seven Years Old	-0.147	0.009	-0.168	0.009	-0.169	0.009

Eight Years Old	-0.042	0.009	-0.062	0.009	-0.063	0.008
Nine Years Old	-0.009	0.009	-0.027	0.009	-0.029	0.009
Ten Years Old	0.019	0.009	0.003	0.008	0.002	0.008
Eleven Years Old	0.049	0.008	0.029	0.008	0.027	0.008
Twelve Years Old	0.072	0.008	0.053	0.008	0.052	0.008
Thirteen Years Old	0.080	0.008	0.062	0.008	0.061	0.008
Fourteen Years Old	0.096	0.009	0.075	0.008	0.075	0.008
Fifteen Years Old	0.111	0.009	0.091	0.009	0.091	0.009
Sixteen Years Old	0.120	0.009	0.098	0.009	0.099	0.009
Seventeen Years Old	0.038	0.014	0.017	0.013	0.018	0.013
Eighteen Years Old	0.046	0.014	0.023	0.013	0.022	0.013
Nineteen Years Old and Above	0.030	0.008	0.011	0.008	0.011	0.008
Locality Controls						
Rural Dummy	0.100	0.008	0.037	0.007	0.036	0.007
Metropolitan Area Dummy	-0.006	0.007	0.022	0.007	0.022	0.007
Rondónia	0.154	0.024	0.132	0.023	0.133	0.023
Acre	0.142	0.031	0.125	0.029	0.124	0.029
Amazonas	0.194	0.020	0.228	0.019	0.223	0.019
Roraima	0.107	0.041	0.082	0.039	0.081	0.039
Pará	0.239	0.015	0.237	0.014	0.234	0.014
Amapá	0.067	0.053	0.125	0.050	0.118	0.050
Tocantins	0.180	0.021	0.186	0.020	0.180	0.020
Maranhão	0.213	0.020	0.220	0.018	0.213	0.018
Piaui	0.255	0.022	0.251	0.021	0.245	0.021
Ceará	0.150	0.013	0.130	0.013	0.123	0.013
Rio Grande do Norte	0.147	0.023	0.164	0.022	0.156	0.022
Paraiba	0.214	0.020	0.199	0.019	0.193	0.019
Pernambuco	0.185	0.014	0.179	0.013	0.170	0.013
Alagoas	0.231	0.022	0.217	0.021	0.210	0.021
Sergipe	0.272	0.023	0.272	0.021	0.265	0.021
Bahia	0.222	0.012	0.208	0.012	0.202	0.012
Minas Gerais	0.078	0.012	0.070	0.011	0.067	0.011
Espirito Santo	0.010	0.023	0.033	0.021	0.028	0.021
Rio de Janeiro	0.200	0.014	0.209	0.014	0.206	0.014
Paraná	0.005	0.015	-0.009	0.014	-0.010	0.014
Santa Catarina	0.011	0.019	0.007	0.018	0.010	0.018
Rio Grande do Sul	0.054	0.013	0.045	0.013	0.046	0.013
Mato Grosso do Sul	0.039	0.022	0.050	0.021	0.044	0.021
Mato Grosso	0.087	0.020	0.079	0.019	0.076	0.019
Goiás	0.136	0.015	0.132	0.015	0.130	0.015
Federal District	0.086	0.020	0.097	0.019	0.094	0.018
R-Squared	0.316		0.390		0.393	
Number of Observations	14,315		14,315		14,315	