

**THE DISPERSION OF INTRA-HOUSEHOLD HUMAN CAPITAL ACROSS CHILDREN:  
A MEASUREMENT STRATEGY AND EVIDENCE**

by

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# The Dispersion of Intra-Household Human Capital Across Children: A Measurement Strategy and Evidence \*

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## **Abstract:**

Human capital accumulation has long been recognized as critical to economic growth and development. In recent years focus on the *intra-household* distribution of human capital has intensified both theoretically and empirically. However, connecting the theoretical and empirical literature has been impeded by the difficulty in measuring human intra-household 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*. 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

Synthesis of the seminal works of Schultz (1971) on human capital and Becker (1960) on the household has generated a vast literature on the household as a locus of human capital investment decisions. However, the distribution of human capital across children within the household has received relatively less attention. This distribution may reflect more than the innate heterogeneity of children due to the presence of borrowing constraints in human capital markets (for discussion see Keane and Wolpin 2001), among other things. Distortions in the distribution of intra-household human capital are therefore more likely to appear in poor households and in low income countries (LICs).

The conceptual and empirical challenges that accompany analysis of the distribution of children's human capital within the household 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 addresses the intra-household dispersion of observable human capital (OHK). While we believe there are a number of reasonable variables to capture this dispersion in both high and low income countries we focus in this paper on a large low (or middle) income country (Brazil) as the greater magnitude of intra-household specialization is useful for demonstration purposes. In particular, our OHK proxy— the rate of progress through the education system — emerges early in life in many lower income countries.

Our analysis reveals a previously unreported pattern of intra-household human capital dispersion across the income distribution. This relationship is strongly significant

and robust to the measure of dispersion after controlling for household demographic structure and other factors. Our findings are consistent with recent theoretical work that suggests distortions in the pattern of intra-household child specialization across education and labor market activities in poor LIC households.

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 describes 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*

Individual human capital levels are, in general, strongly affected by household level influences and decisions during childhood.<sup>1</sup> In particular, parental decisions regarding the time allocation of their children, as well as direct investment in human capital are of critical importance (see Behrman et al. 1995). This issue has received much attention in the LIC context, where poverty may cause some children to be selected by their parents as labor market specialists and others as human capital specialists at an early age. Though specialization across children also occurs in poor households in high-income-countries, its manifestation is typically not as stark or pervasive as in LICs.

The allocation of child-time has been a principal focus of the vast child-labor literature (see Basu, 1999 and 2003 for surveys). Baland and Robinson (2000) provide a 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.

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<sup>1</sup> The general efficiency properties of intra-household allocation have been explored by Browning and Chiappori (1998).

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. Cross-child specialization is addressed in a recent theoretical work by Horowitz and Wang (2004) who demonstrate that the pattern of specialization implied by comparative advantage does not typically hold for poor households facing imperfect human capital markets. This implies a relationship between income and the intra-household dispersion of human capital across children since the human capital investment decisions of the poor are more likely to be affected by capital markets imperfections.

#### *Household Education Progress Dispersion as a Proxy for Human Capital Dispersion*

The final dispersion of human capital across siblings 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 siblings could typically only be observed in reconstructed families, or in the atypical families that do not disperse. Though data that allows the reconstruction of households after dispersal could reveal siblings' education dispersion, 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 dispersion of intra-household 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 siblings' human capital is one of the principal innovations of this paper and we believe this technique may have wide-spread applicability.

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.

#### *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 and Byrnes and Yamamoto 1989). 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, 2001), 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.<sup>2</sup> This 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.<sup>3</sup> Returning to the sources of delay, though their aggregation is not ideal, it has economic rationale. Namely, in the

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<sup>2</sup> The precise test administered to children was the Peabody Picture Vocabulary Test (PPVT).

<sup>3</sup> 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.

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 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.

#### *Child Specialization and School Performance in LIC*

As noted, our data in this paper is from a LIC because there is strong prior evidence of child specialization in these settings. Incentives for child specialization include increasing returns to education, education capital market imperfections, and innate heterogeneity of children. Evidence of significant intra-household child specialization in either labor market or human capital activities can be found from Botswana (Chernichovsky's 1985) to Brazil (Emerson and Souza 2002) to Pakistan (Burki and Fasih 1998). 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 human capital activities such as homework, before school attendance directly. Such subtle effects of specialization would be captured by our proxy -- though not by a simple measure of school attendance.



Further discussion and numerous other references to specialization in child labor-education activities can be found in Grooaert and Patrinos (1999, eds.).

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 Buchman 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.

### *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).<sup>4</sup> In Brazil it is likely that the reverse is true – at least at the lower end of the school quality distribution.<sup>5</sup> 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

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4 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.

5 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.

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 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:

$$(1) \quad P_{ih} = K + \frac{\text{education}_{ih}}{\text{age}_{ih} - \text{entry}}, \quad K \geq 0 .$$

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  $K = 1$ , 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  $P_{ih} > 2$ . 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**

#### *Overview*

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 is highly sensitive to academic performance. In the U.S., for example, where grade repetition is less common, this proxy may have less power than in an environment where repetition is widespread.<sup>6</sup> 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.<sup>7</sup> The sample is based on a three-stage sampling design. With the exception of the first

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<sup>6</sup> In the US alternative measures of school performance, such as GPA, could be employed.

<sup>7</sup> The principal excluded area is the rural Amazon.

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. 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  $P_{ih} = 1 + \frac{education_{ih}}{age_{ih} - 6}$ .<sup>8</sup> 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 according to our measure.<sup>9</sup> 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.<sup>10</sup>

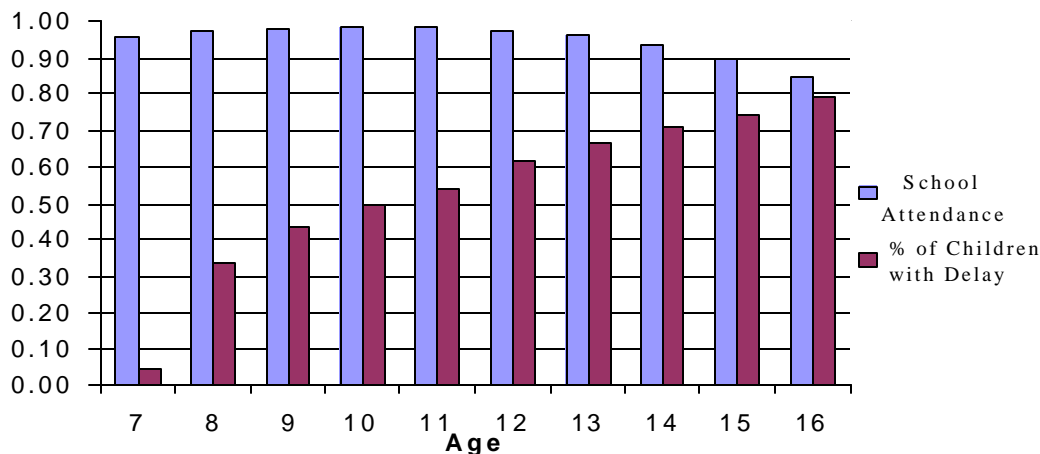
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8 For children not attending school we assign the highest completed years of schooling. For children attending school we assign the corresponding years of schooling for the grade the child is currently attending.

9 We define a child is delayed if  $P < 2$ .

10 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.

**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 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 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 (1994), 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

$$(2) \quad D_h = f(Y_h; X_h, \mathbf{e}_h)$$

where  $D_h$  is a measure of school-progression dispersion in household  $h$ ,  $Y_h$  is household income,  $X_h$  is a vector of other observable variables that affect dispersion, and  $\mathbf{e}_h$  represents unobservable factors (such as preferences). 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:

$$(3) \quad D_h = \mathbf{a} + \mathbf{b}_1 FE_h + \mathbf{b}_2 ME_h + \mathbf{d}' X_h + \mathbf{e}_h$$

where the instruments of household income are the father's and mother's education. We construct separate indicator variables 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 indicator variable, a metropolitan area indicator, and state indicators. 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  $\mathbf{a}$ ,  $\mathbf{b}$ 's, and  $\mathbf{d}$ . We assume the error term,  $\mathbf{e}_h$ , is i.i.d. normally distributed. We also run regressions with indicators for the decile of parents' income.<sup>11</sup>

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<sup>11</sup> Results are similar when year of schooling variables or indicator variables for each year of schooling are used. Similarly, indicator variables for income brackets or income values yield similar results..

*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 ( $P_h$ ) 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  $\left( \frac{1}{N_h} \sum_{i=1}^{N_h} \frac{P_{ih}}{P_h} \log \left( \frac{P_{ih}}{P_h} \right) \right)$ , Gini coefficient  $\frac{1}{N_h(N_h - 1)P_h} \sum_{i>j} \sum_j |P_{ih} - P_{jh}|$ ,

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  $h$ , 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.<sup>12</sup> The coefficient of variation 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.

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<sup>12</sup> Note that our since our measure of progress has a minimum value of one, the Gini upper bound is less than 1. This rescaling of the Gini does not affect any qualitative results and a similar procedure with  $K=0$ , which yields conventional Gini range of zero to one and identical qualitative patterns.

## 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.<sup>13</sup> 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 the parents' income deciles where parents' income is the sum of the father and mother's incomes. The graphs illustrate a robust pattern of monotonically decreasing delay dispersion as parental income increases.

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<sup>13</sup> 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.

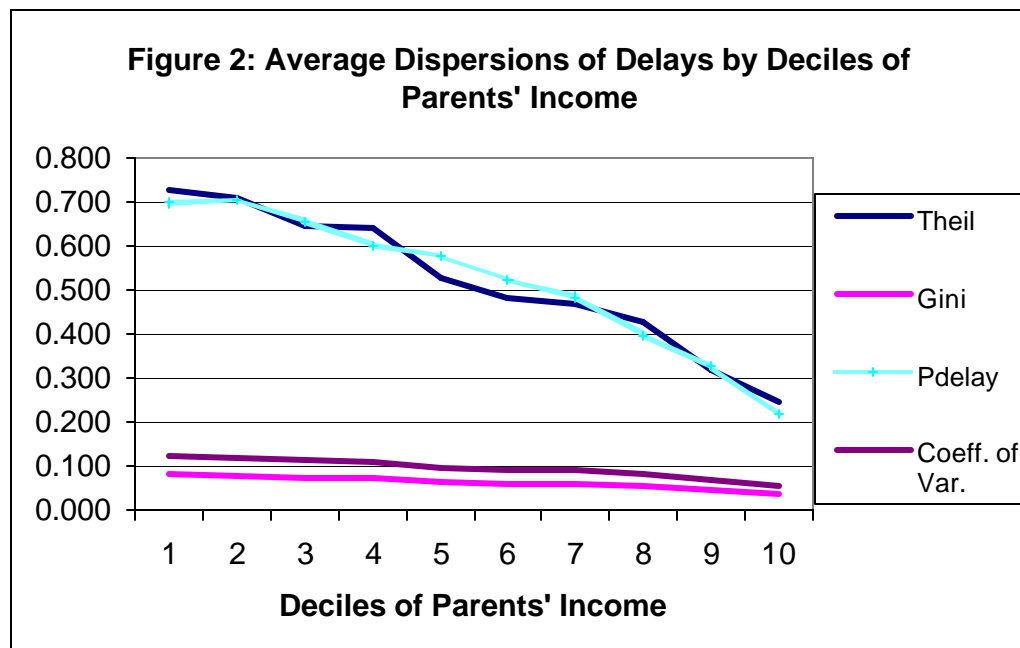
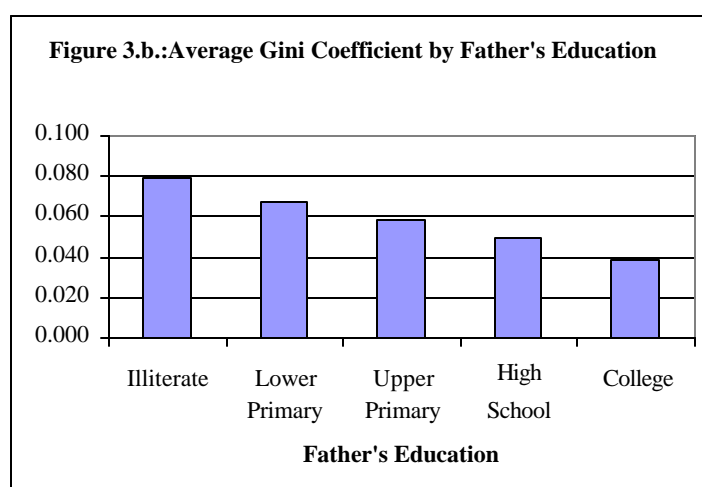
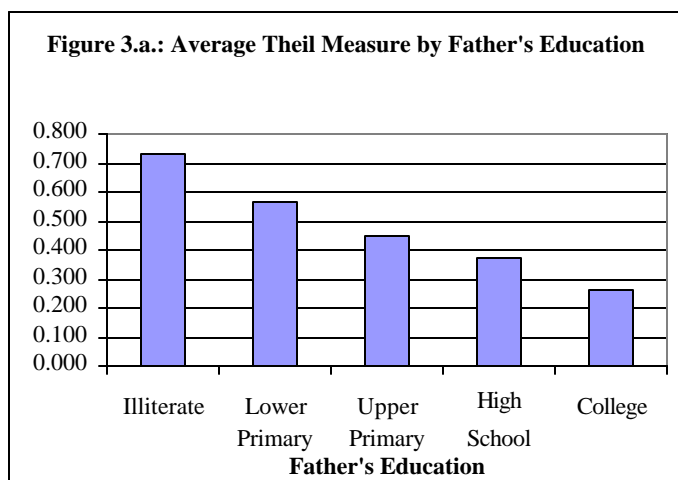
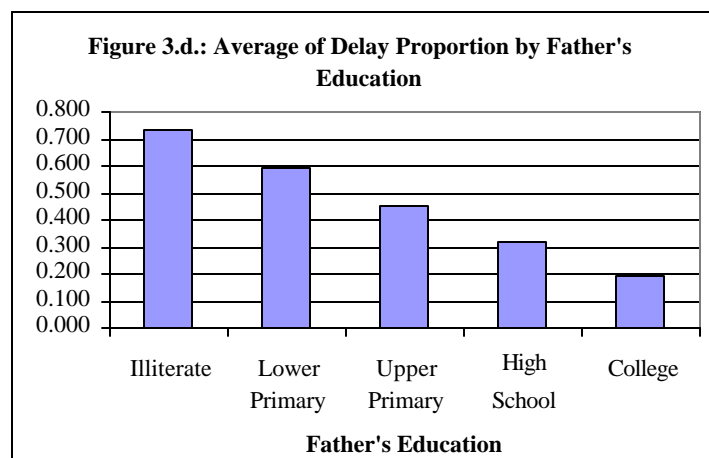
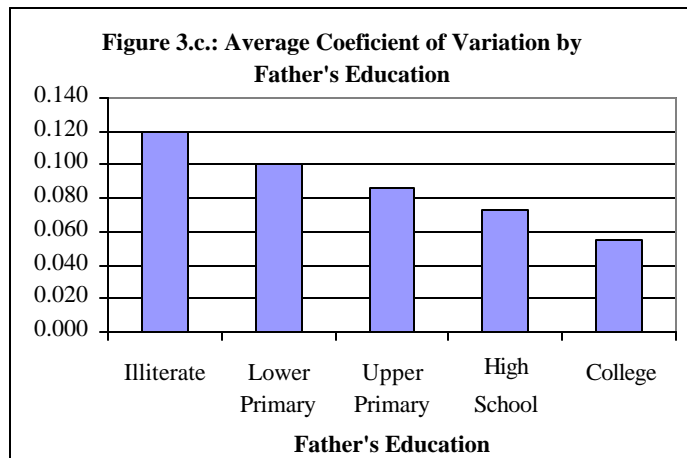
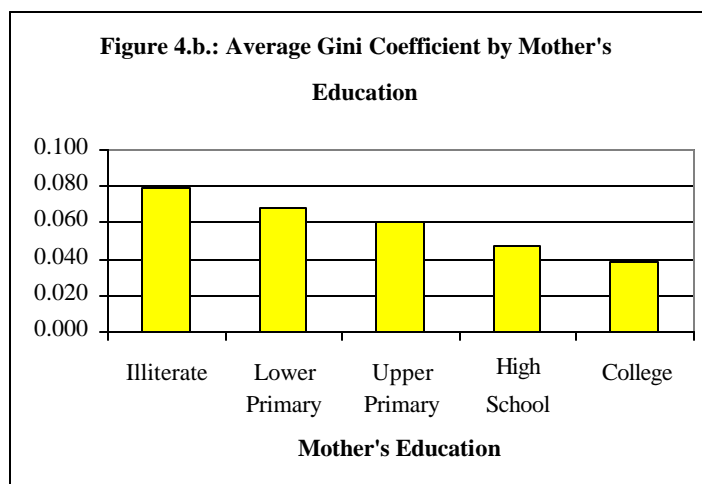
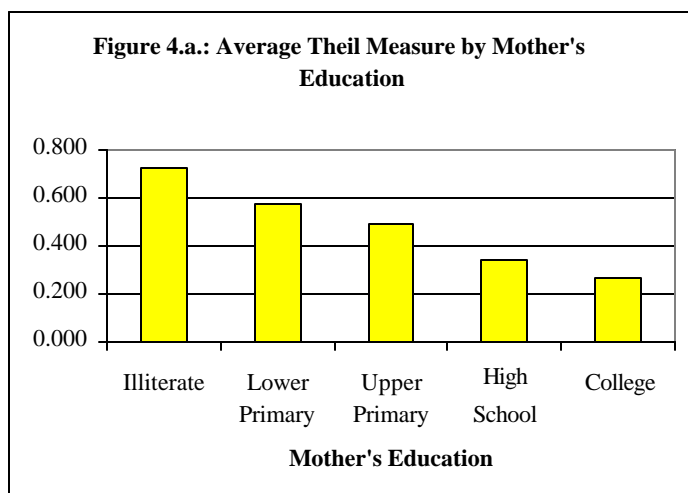


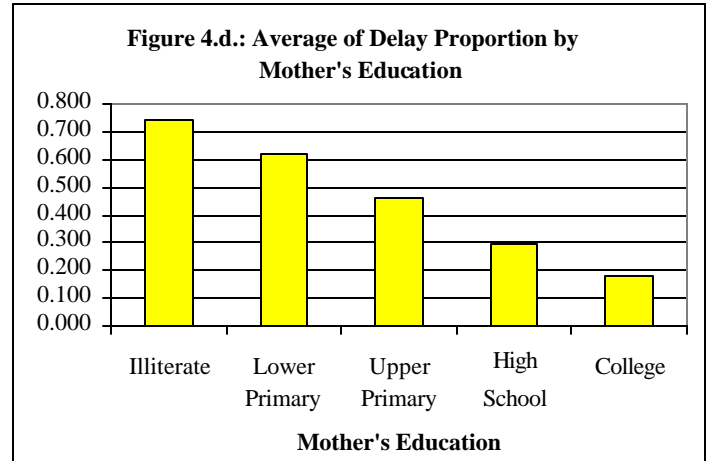
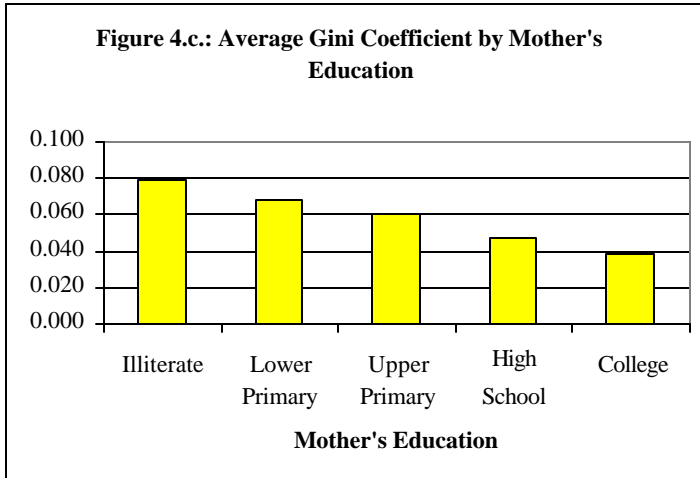
Figure 3.a. to 3.d. below present the unconditional mean of each of the four dispersion measures by the father's education category. There is clear consistent monotonic negative correlation between delay dispersion within households and the father's education level.





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





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. Moreover, since the Brazilian 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 indicator variables for the state, metropolitan, and rural-urban locality.

Table 1 presents regression results for the Gini Coefficient, Theil Measure, Coefficient of Variation, and Proportion of Delay measures of delay dispersion, where the right-hand side variables are a set of indicators 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 1-3, 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 indicators and reject the null hypothesis at 1% level.

The current income of fathers and mothers or their income deciles may not be an ideal predictor of the parents' permanent income due to its short-run variations or measurement error. For these reasons we instrument permanent income with father's and mother's education variables, a very good predictor of permanent income.

Table 2 presents the results of the four regressions for the Gini, Theil, Coefficient of Variation, and P-Delay measures, respectively. For each regression, the explanatory variables are the education category indicators of fathers and mothers, separately.<sup>14</sup> Examining the results reveals a robust pattern of a monotonic decrease of delay

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<sup>14</sup> The omitted education category is 0 years of schooling, the omitted locality categories are the urban non-metropolitan areas and the São Paulo state.

dispersion across the education distribution. The F-test for the joint equality of all the education category variables are computed for the father and mother 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, Table 3 presents results when parents' income decile indicator variables and education indicator variables are used along with the other controls. Again, the patterns obtained before remains. That is, controlling for each parent 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 in our analysis 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 across siblings 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 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 perspective, 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**

Variables	GINI		THEIL		CV		PDELAY	
	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: OLS Regressions of Delay Dispersion Measures on Parents' Education Levels**

Variables	GINI		THEIL		CV		PDELAY		28	
	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error		
<b>Father's Education</b>										
Illiterate	Omitted Category		Omitted Category		Omitted Category		Omitted Category			
Lower Primary	-0.005	*** 0.002	-0.079	*** 0.025	-0.008	*** 0.002	-0.050	*** 0.00777		
Upper Primary	-0.010	*** 0.002	-0.127	*** 0.029	-0.016	*** 0.003	-0.084	*** 0.00927		
High School	-0.013	*** 0.002	-0.130	*** 0.034	-0.018	*** 0.003	-0.158	*** 0.01073		
College	-0.018	*** 0.003	-0.191	*** 0.047	-0.026	*** 0.004	-0.181	*** 0.01481		
<b>Mother's Education</b>										
Illiterate	Omitted Category		Omitted Category		Omitted Category		Omitted Category			
Lower Primary	-0.005	*** 0.002	-0.064	*** 0.026	-0.007	*** 0.002	-0.052	*** 0.00828		
Upper Primary	-0.008	*** 0.002	-0.086	*** 0.030	-0.012	*** 0.003	-0.137	*** 0.00945		
High School	-0.016	*** 0.002	-0.155	*** 0.034	-0.023	*** 0.003	-0.253	*** 0.01087		
College	-0.019	*** 0.003	-0.166	*** 0.048	-0.028	*** 0.004	-0.292	*** 0.01524		
Father: F(3, 14236)	8.91	***	2.91	**	9.15	***	54.69	***		
Mother: F(3, 14236)	16.56	***	3.92	***	15.68	***	182.11	***		
R-squared	0.123		0.123		0.142		0.393			
# 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 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 3: OLS Regressions of Delay Dispersion Measures on Parents' Education Levels and Income Deciles

Variables	GINI		THEIL		CV		PDELAY					
	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error				
<b>Father's Education</b>												
Illiterate	Omitted Category		Omitted Category		Omitted Category		Omitted Category					
Lower Primary	-0.005	***	0.002	-0.071	***	0.025	-0.007	***	0.002	-0.043	***	0.008
Upper Primary	-0.009	***	0.002	-0.109	***	0.030	-0.013	***	0.003	-0.069	***	0.009
High School	-0.008	***	0.002	-0.090	**	0.035	-0.012	***	0.003	-0.126	***	0.011
College	-0.011	***	0.003	-0.129	***	0.050	-0.016	***	0.005	-0.142	***	0.016
<b>Mother's Education</b>												
Illiterate	Omitted Category		Omitted Category		Omitted Category		Omitted Category					
Lower Primary	-0.004	**	0.002	-0.060	**	0.026	-0.007	***	0.002	-0.049	***	0.008
Upper Primary	-0.007	***	0.002	-0.071	**	0.030	-0.010	***	0.003	-0.124	***	0.009
High School	-0.012	***	0.002	-0.118	***	0.035	-0.018	***	0.003	-0.224	***	0.011
College	-0.013	***	0.003	-0.106	**	0.051	-0.019	***	0.005	-0.255	***	0.016
<b>Income Deciles</b>												
Decile One	Omitted Category		Omitted Category		Omitted Category		Omitted Category					
Decile Two	-0.001		0.002	0.007		0.036	-0.002		0.003	0.003		0.011
Decile Three	-0.005	*	0.002	-0.058		0.037	-0.007	**	0.003	-0.014		0.012
Decile Four	-0.004		0.002	-0.022		0.037	-0.005		0.003	-0.042	***	0.012
Decile Five	-0.008	***	0.002	-0.083	**	0.037	-0.012	***	0.003	-0.054	***	0.012
Decile Six	-0.009	***	0.002	-0.082	**	0.038	-0.013	***	0.003	-0.075	***	0.012
Decile Seven	-0.007	***	0.002	-0.071	*	0.039	-0.011	***	0.004	-0.079	***	0.012
Decile Eight	-0.010	***	0.003	-0.082	**	0.039	-0.014	***	0.004	-0.121	***	0.012
Decile Nine	-0.015	***	0.003	-0.152	***	0.041	-0.022	***	0.004	-0.146	***	0.013
Decile Ten	-0.019	***	0.003	-0.171	***	0.047	-0.028	***	0.004	-0.167	***	0.015
Father: F(3, 14227)	2.96	**		1.15			3.18	**		29.40	***	
Mother: F(3, 14227)	6.75	***		1.36			6.24	***		132.07	***	
Deciles: (8, 14227)	6.26	***		2.84	***		6.23	***		27.64	***	
R-squared	0.126			0.124			0.145			0.400		
# 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 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. The third F-test tests the joint equality of the decile dummy coefficients.

**Table A.1: Unweighted Sample Statistics**

<b>Variables</b>	<b>N</b>	<b>Mean</b>	<b>Std Dev</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Age-Grade Distortion Measures</b>					
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
<b>Father's Characteristics</b>					
Age	14,315	41.811	8.098	23.000	98.000
Income	14,315	669.672	1299.960	0.000	50000.000
<i>Education Category</i>					
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
<b>Mother's Characteristics</b>					
Age	14,315	37.574	6.442	23.000	81.000
Income	14,315	206.466	644.977	0.000	40000.000
<i>Education Category</i>					
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
<b>Income Deciles</b>					
Decile One	14,315	0.100	0.300	0.000	1.000
Decile Two	14,315	0.108	0.311	0.000	1.000
Decile Three	14,315	0.090	0.286	0.000	1.000
Decile Four	14,315	0.099	0.299	0.000	1.000
Decile Five	14,315	0.103	0.304	0.000	1.000
Decile Six	14,315	0.100	0.300	0.000	1.000
Decile Seven	14,315	0.099	0.298	0.000	1.000
Decile Eight	14,315	0.101	0.301	0.000	1.000
Decile Nine	14,315	0.101	0.301	0.000	1.000
Decile Ten	14,315	0.100	0.300	0.000	1.000
<b>Number of Male Persons by Age</b>					
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 Contr ols**

Rural Area	14,315	0.192	0.394	0.000	1.000
Metropolitan Area	14,315	0.332	0.471	0.000	1.000

Rondônia	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
Piauí	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
Paraíba	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 Regressions of Delay Dispersion Measures on Parents' Income Deciles

Variables	GINI		THEIL		CV		PDELAY	
	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error
Intercept	0.040	0.005	-0.133	0.078	0.036	0.007	0.373	0.025
Father's Age	0.000	0.000	0.003	0.001	0.000	0.000	0.000	0.000
Mother's Age	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.001
<b>Income Deciles</b>								
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
<b>Number of Male Persons by Age</b>								
Zero Years Old	0.002	0.004	0.021	0.067	0.003	0.006	0.015	0.022
One Year Old	-0.001	0.004	0.023	0.058	-0.001	0.005	0.023	0.019
Two Years Old	0.001	0.003	0.034	0.053	0.001	0.005	0.040	0.017
Three Years Old	0.006	0.003	0.044	0.047	0.010	0.004	0.045	0.015
Four Years Old	0.005	0.003	0.051	0.044	0.007	0.004	0.057	0.014
Five Years Old	0.002	0.003	0.021	0.040	0.004	0.004	0.051	0.013
Six Years Old	0.009	0.002	0.157	0.038	0.013	0.004	0.064	0.012
Seven Years Old	0.030	0.002	0.666	0.027	0.055	0.003	-0.147	0.009
Eight Years Old	0.014	0.002	0.238	0.027	0.029	0.003	-0.042	0.009
Nine Years Old	0.001	0.002	0.075	0.027	0.011	0.003	0.006	0.009
Ten Years Old	0.000	0.002	0.059	0.025	0.009	0.002	0.037	0.008
Eleven Years Old	-0.001	0.002	0.084	0.025	0.007	0.002	0.056	0.008
Twelve Years Old	-0.001	0.002	0.095	0.025	0.008	0.002	0.105	0.008
Thirteen Years Old	-0.003	0.002	0.056	0.025	0.005	0.002	0.126	0.008
Fourteen Years Old	0.001	0.002	0.136	0.025	0.010	0.002	0.143	0.008
Fifteen Years Old	0.000	0.002	0.093	0.026	0.009	0.002	0.153	0.009
Sixteen Years Old	0.004	0.002	0.144	0.027	0.014	0.002	0.172	0.009
Seventeen Years Old	0.005	0.002	0.038	0.036	0.007	0.003	0.040	0.012
Eighteen Years Old	0.000	0.002	0.005	0.037	-0.001	0.003	0.051	0.012
Nineteen Years Old and Above	0.002	0.001	0.015	0.020	0.003	0.002	0.048	0.006
<b>Number of Female Persons by Age</b>								
Zero Years Old	0.004	0.004	0.051	0.061	0.005	0.006	0.042	0.020
One Year Old	0.004	0.004	0.060	0.058	0.006	0.005	0.049	0.019
Two Years Old	-0.001	0.003	-0.061	0.053	-0.002	0.005	0.021	0.017
Three Years Old	0.001	0.003	0.026	0.047	0.002	0.004	0.018	0.015
Four Years Old	0.006	0.003	0.089	0.045	0.009	0.004	0.050	0.015
Five Years Old	0.006	0.003	0.139	0.041	0.008	0.004	0.043	0.013
Six Years Old	0.008	0.003	0.147	0.040	0.012	0.004	0.028	0.013
Seven Years Old	0.038	0.002	0.833	0.028	0.067	0.003	-0.161	0.009
Eight Years Old	0.014	0.002	0.234	0.027	0.029	0.002	-0.055	0.009
Nine Years Old	0.005	0.002	0.148	0.027	0.016	0.003	-0.020	0.009
Ten Years Old	0.000	0.002	0.083	0.026	0.009	0.002	0.008	0.008

Eleven Years Old	-0.002	0.002	0.072	0.025	0.006	0.002	0.038	0.008
Twelve Years Old	-0.005	0.002	0.042	0.025	0.003	0.002	0.062	0.008
Thirteen Years Old	-0.005	0.002	0.043	0.025	0.001	0.002	0.073	0.008
Fourteen Years Old	-0.007	0.002	0.037	0.026	-0.001	0.002	0.085	0.008
Fifteen Years Old	-0.005	0.002	0.059	0.027	0.002	0.003	0.105	0.009
Sixteen Years Old	-0.001	0.002	0.102	0.028	0.008	0.003	0.114	0.009
Seventeen Years Old	-0.002	0.003	-0.051	0.041	-0.004	0.004	0.032	0.013
Eighteen Years Old	0.006	0.003	0.052	0.043	0.009	0.004	0.041	0.014
Nineteen Years Old and Above	0.000	0.002	-0.017	0.025	0.000	0.002	0.023	0.008
<b>Locality Controls</b>								
Rural Area	0.003	0.001	0.018	0.023	0.005	0.002	0.061	0.008
Metropolitan Area	0.001	0.001	0.001	0.022	0.001	0.002	0.014	0.007
Rondônia	0.014	0.005	0.200	0.073	0.021	0.007	0.127	0.024
Acre	0.026	0.006	0.320	0.093	0.037	0.009	0.119	0.030
Amazonas	0.022	0.004	0.226	0.061	0.031	0.006	0.169	0.020
Roraima	0.010	0.008	0.080	0.124	0.015	0.011	0.089	0.040
Pará	0.014	0.003	0.100	0.044	0.021	0.004	0.190	0.014
Amapá	0.004	0.010	0.004	0.160	0.007	0.015	0.073	0.052
Tocantins	0.012	0.004	0.112	0.064	0.018	0.006	0.137	0.021
Maranhão	0.018	0.004	0.173	0.059	0.025	0.005	0.166	0.019
Piauí	0.018	0.004	0.219	0.066	0.028	0.006	0.205	0.021
Ceará	0.014	0.003	0.131	0.040	0.020	0.004	0.086	0.013
Rio Grande do Norte	0.023	0.004	0.244	0.069	0.032	0.006	0.104	0.022
Paraíba	0.023	0.004	0.231	0.059	0.032	0.006	0.150	0.019
Pernambuco	0.020	0.003	0.223	0.041	0.030	0.004	0.123	0.013
Alagoas	0.024	0.004	0.253	0.066	0.035	0.006	0.180	0.021
Sergipe	0.026	0.004	0.330	0.068	0.039	0.006	0.233	0.022
Bahia	0.021	0.002	0.210	0.037	0.031	0.003	0.168	0.012
Minas Gerais	0.006	0.002	0.060	0.036	0.009	0.003	0.048	0.012
Espirito Santo	0.010	0.004	0.141	0.067	0.015	0.006	-0.016	0.022
Rio de Janeiro	0.017	0.003	0.178	0.043	0.025	0.004	0.177	0.014
Paraná	0.011	0.003	0.121	0.043	0.017	0.004	-0.017	0.014
Santa Catarina	0.007	0.004	0.033	0.058	0.009	0.005	0.008	0.019
Rio Grande do Sul	0.011	0.003	0.123	0.040	0.017	0.004	0.030	0.013
Mato Grosso do Sul	0.020	0.004	0.236	0.065	0.030	0.006	0.016	0.021
Mato Grosso	0.024	0.004	0.301	0.060	0.034	0.006	0.068	0.020
Goiás	0.011	0.003	0.091	0.046	0.016	0.004	0.105	0.015
Federal District	0.008	0.004	0.036	0.059	0.012	0.005	0.076	0.019
R-Squared	0.121		0.122		0.140		0.359	
Number of Observations	14,315		14,315		14,315		14,315	

Table A.3: OLS Regressions of Delay Dispersion Measures on Parents' Education Levels

Variables	GINI		THEIL		CV		PDELAY	
	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error
Intercept	0.050	0.005	0.004	0.083	0.051	0.008	0.507	0.026
Father's Age	0.000	0.000	0.002	0.001	0.000	0.000	-0.001	0.000
Mother's Age	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.001
<b>Father's Educational Controls</b>								
Primary Education	-0.005	0.002	-0.079	0.025	-0.008	0.002	-0.054	0.008
Secondary Education	-0.010	0.002	-0.127	0.029	-0.016	0.003	-0.091	0.009
High School	-0.013	0.002	-0.130	0.034	-0.018	0.003	-0.172	0.011
College/University	-0.018	0.003	-0.191	0.047	-0.026	0.004	-0.206	0.015
<b>Mother's Educational Controls</b>								
Primary Education	-0.005	0.002	-0.064	0.026	-0.007	0.002	-0.053	0.008
Secondary Education	-0.008	0.002	-0.086	0.030	-0.012	0.003	-0.142	0.009
High School	-0.016	0.002	-0.155	0.034	-0.023	0.003	-0.265	0.011
College/University	-0.019	0.003	-0.166	0.048	-0.028	0.004	-0.315	0.015
<b>Number of Male Persons by Age</b>								
Zero Years Old	0.002	0.004	0.016	0.067	0.003	0.006	0.012	0.021
One Year Old	-0.001	0.004	0.017	0.058	-0.002	0.005	0.019	0.018
Two Years Old	0.001	0.003	0.039	0.053	0.002	0.005	0.048	0.017
Three Years Old	0.006	0.003	0.042	0.047	0.009	0.004	0.037	0.015
Four Years Old	0.004	0.003	0.046	0.044	0.007	0.004	0.045	0.014
Five Years Old	0.002	0.003	0.017	0.040	0.003	0.004	0.042	0.013
Six Years Old	0.008	0.002	0.152	0.038	0.012	0.004	0.052	0.012
Seven Years Old	0.030	0.002	0.662	0.027	0.055	0.003	-0.156	0.009
Eight Years Old	0.014	0.002	0.234	0.027	0.029	0.003	-0.049	0.009
Nine Years Old	0.001	0.002	0.072	0.027	0.011	0.003	0.000	0.009
Ten Years Old	0.000	0.002	0.056	0.025	0.008	0.002	0.032	0.008
Eleven Years Old	-0.002	0.002	0.079	0.025	0.007	0.002	0.048	0.008
Twelve Years Old	-0.002	0.002	0.091	0.025	0.007	0.002	0.098	0.008
Thirteen Years Old	-0.003	0.002	0.051	0.025	0.004	0.002	0.115	0.008
Fourteen Years Old	0.000	0.002	0.132	0.025	0.010	0.002	0.135	0.008
Fifteen Years Old	-0.001	0.002	0.086	0.026	0.008	0.002	0.140	0.008
Sixteen Years Old	0.003	0.002	0.137	0.027	0.013	0.002	0.155	0.008
Seventeen Years Old	0.005	0.002	0.034	0.036	0.006	0.003	0.028	0.012
Eighteen Years Old	-0.001	0.002	-0.002	0.037	-0.002	0.003	0.034	0.012
Nineteen Years Old and Above	0.001	0.001	0.009	0.020	0.002	0.002	0.034	0.006
<b>Number of Female Persons by Age</b>								
Zero Years Old	0.004	0.004	0.052	0.061	0.005	0.006	0.040	0.019
One Year Old	0.004	0.004	0.060	0.057	0.006	0.005	0.050	0.018
Two Years Old	-0.001	0.003	-0.057	0.053	-0.002	0.005	0.025	0.017
Three Years Old	0.001	0.003	0.030	0.047	0.002	0.004	0.022	0.015
Four Years Old	0.006	0.003	0.086	0.045	0.009	0.004	0.039	0.014
Five Years Old	0.005	0.003	0.136	0.041	0.007	0.004	0.030	0.013
Six Years Old	0.008	0.003	0.148	0.040	0.012	0.004	0.025	0.013
Seven Years Old	0.038	0.002	0.830	0.028	0.066	0.003	-0.168	0.009
Eight Years Old	0.013	0.002	0.230	0.027	0.028	0.002	-0.062	0.009
Nine Years Old	0.005	0.002	0.145	0.027	0.016	0.003	-0.027	0.009
Ten Years Old	0.000	0.002	0.080	0.026	0.009	0.002	0.003	0.008

Eleven Years Old	-0.002	0.002	0.067	0.025	0.006	0.002	0.029	0.008
Twelve Years Old	-0.005	0.002	0.038	0.025	0.002	0.002	0.053	0.008
Thirteen Years Old	-0.006	0.002	0.039	0.025	0.000	0.002	0.062	0.008
Fourteen Years Old	-0.007	0.002	0.032	0.026	-0.002	0.002	0.075	0.008
Fifteen Years Old	-0.006	0.002	0.053	0.027	0.001	0.003	0.091	0.009
Sixteen Years Old	-0.002	0.002	0.094	0.028	0.007	0.003	0.098	0.009
Seventeen Years Old	-0.003	0.003	-0.058	0.041	-0.005	0.004	0.017	0.013
Eighteen Years Old	0.005	0.003	0.044	0.043	0.007	0.004	0.023	0.013
Nineteen Years Old and Above	0.000	0.002	-0.021	0.025	-0.001	0.002	0.011	0.008
<b>Locality Controls</b>								
Rural Area	0.002	0.001	0.007	0.023	0.003	0.002	0.037	0.007
Metropolitan Area	0.001	0.001	0.009	0.022	0.002	0.002	0.022	0.007
Rondônia	0.014	0.005	0.198	0.073	0.021	0.007	0.132	0.023
Acre	0.026	0.006	0.309	0.093	0.037	0.009	0.125	0.029
Amazonas	0.025	0.004	0.253	0.061	0.036	0.006	0.228	0.019
Roraima	0.009	0.008	0.066	0.124	0.013	0.011	0.082	0.039
Pará	0.017	0.003	0.122	0.044	0.025	0.004	0.237	0.014
Amapá	0.008	0.010	0.034	0.159	0.011	0.015	0.125	0.050
Tocantins	0.015	0.004	0.138	0.064	0.022	0.006	0.186	0.020
Maranhão	0.021	0.004	0.199	0.058	0.030	0.005	0.220	0.018
Piauí	0.021	0.004	0.240	0.065	0.032	0.006	0.251	0.021
Ceará	0.017	0.003	0.152	0.040	0.024	0.004	0.130	0.013
Rio Grande do Norte	0.027	0.004	0.276	0.069	0.038	0.006	0.164	0.022
Paraíba	0.026	0.004	0.254	0.059	0.037	0.005	0.199	0.019
Pernambuco	0.024	0.003	0.254	0.041	0.036	0.004	0.179	0.013
Alagoas	0.027	0.004	0.267	0.066	0.038	0.006	0.217	0.021
Sergipe	0.029	0.004	0.348	0.067	0.042	0.006	0.272	0.021
Bahia	0.024	0.002	0.227	0.037	0.034	0.003	0.208	0.012
Minas Gerais	0.008	0.002	0.076	0.036	0.011	0.003	0.070	0.011
Espirito Santo	0.013	0.004	0.172	0.067	0.019	0.006	0.033	0.021
Rio de Janeiro	0.019	0.003	0.195	0.043	0.028	0.004	0.209	0.014
Paraná	0.012	0.003	0.126	0.043	0.018	0.004	-0.009	0.014
Santa Catarina	0.007	0.004	0.038	0.058	0.010	0.005	0.007	0.018
Rio Grande do Sul	0.012	0.003	0.134	0.040	0.018	0.004	0.045	0.013
Mato Grosso do Sul	0.022	0.004	0.255	0.065	0.033	0.006	0.050	0.021
Mato Grosso	0.025	0.004	0.309	0.060	0.035	0.006	0.079	0.019
Goiás	0.012	0.003	0.104	0.046	0.018	0.004	0.132	0.015
Federal District	0.009	0.004	0.040	0.059	0.013	0.005	0.097	0.019
R-Squared	0.123		0.123	0.142		0.390		
Number of Observations	14,315		14,315	14,315		14,315		

Table A.4: OLS Regressions of Delay Dispersion Measures on Parents' Education Levels and Income Deciles

Variables	GINI		THEIL		CV		PDELAY	
	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error	Coeff.	Est. Error
Intercept	0.056	0.006	0.057	0.087	0.059	0.008	0.560	0.027
Father's Age	0.000	0.000	0.002	0.001	0.000	0.000	-0.001	0.000
Mother's Age	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.001
<b>Father's Educational Controls</b>								
Primary Education	-0.005	0.002	-0.071	0.025	-0.007	0.002	-0.043	0.008
Secondary Education	-0.009	0.002	-0.109	0.030	-0.013	0.003	-0.069	0.009
High School	-0.008	0.002	-0.090	0.035	-0.012	0.003	-0.126	0.011
College/University	-0.011	0.003	-0.129	0.050	-0.016	0.005	-0.142	0.016
<b>Mother's Educational Controls</b>								
Primary Education	-0.004	0.002	-0.060	0.026	-0.007	0.002	-0.049	0.008
Secondary Education	-0.007	0.002	-0.071	0.030	-0.010	0.003	-0.124	0.009
High School	-0.012	0.002	-0.118	0.035	-0.018	0.003	-0.224	0.011
College/University	-0.013	0.003	-0.106	0.051	-0.019	0.005	-0.255	0.016
<b>Income Deciles</b>								
Decile Two	-0.001	0.002	0.007	0.036	-0.002	0.003	0.003	0.011
Decile Three	-0.005	0.002	-0.058	0.037	-0.007	0.003	-0.014	0.012
Decile Four	-0.004	0.002	-0.022	0.037	-0.005	0.003	-0.042	0.012
Decile Five	-0.008	0.002	-0.083	0.037	-0.012	0.003	-0.054	0.012
Decile Six	-0.009	0.002	-0.082	0.038	-0.013	0.003	-0.075	0.012
Decile Seven	-0.007	0.002	-0.071	0.039	-0.011	0.004	-0.079	0.012
Decile Eight	-0.010	0.003	-0.082	0.039	-0.014	0.004	-0.121	0.012
Decile Nine	-0.015	0.003	-0.152	0.041	-0.022	0.004	-0.146	0.013
Decile Ten	-0.019	0.003	-0.171	0.047	-0.028	0.004	-0.167	0.015
<b>Number of Male Persons by Age</b>								
Zero Years Old	0.002	0.004	0.013	0.067	0.003	0.006	0.008	0.021
One Year Old	-0.001	0.004	0.018	0.058	-0.002	0.005	0.018	0.018
Two Years Old	0.001	0.003	0.033	0.053	0.001	0.005	0.041	0.017
Three Years Old	0.006	0.003	0.038	0.047	0.009	0.004	0.034	0.015
Four Years Old	0.004	0.003	0.042	0.043	0.006	0.004	0.042	0.014
Five Years Old	0.002	0.003	0.013	0.040	0.002	0.004	0.036	0.013
Six Years Old	0.008	0.002	0.148	0.038	0.011	0.004	0.049	0.012
Seven Years Old	0.029	0.002	0.658	0.027	0.054	0.003	-0.160	0.009
Eight Years Old	0.013	0.002	0.231	0.027	0.028	0.003	-0.052	0.009
Nine Years Old	0.001	0.002	0.067	0.027	0.010	0.003	-0.005	0.008
Ten Years Old	-0.001	0.002	0.053	0.025	0.008	0.002	0.028	0.008
Eleven Years Old	-0.002	0.002	0.078	0.025	0.006	0.002	0.046	0.008
Twelve Years Old	-0.002	0.002	0.089	0.025	0.007	0.002	0.096	0.008
Thirteen Years Old	-0.004	0.002	0.049	0.025	0.004	0.002	0.113	0.008
Fourteen Years Old	0.000	0.002	0.131	0.025	0.010	0.002	0.133	0.008
Fifteen Years Old	-0.001	0.002	0.086	0.026	0.008	0.002	0.140	0.008
Sixteen Years Old	0.003	0.002	0.138	0.027	0.013	0.002	0.156	0.008
Seventeen Years Old	0.004	0.002	0.032	0.036	0.006	0.003	0.028	0.011
Eighteen Years Old	-0.001	0.002	-0.003	0.037	-0.002	0.003	0.034	0.012
Nineteen Years Old and Above	0.001	0.001	0.008	0.020	0.001	0.002	0.033	0.006
<b>Number of Female Persons by Age</b>								
Zero Years Old	0.003	0.004	0.046	0.061	0.004	0.006	0.034	0.019

One Year Old	0.003	0.004	0.055	0.058	0.005	0.005	0.042	0.018
Two Years Old	-0.001	0.003	-0.065	0.053	-0.003	0.005	0.016	0.017
Three Years Old	0.001	0.003	0.024	0.047	0.001	0.004	0.013	0.015
Four Years Old	0.005	0.003	0.083	0.045	0.008	0.004	0.037	0.014
Five Years Old	0.005	0.003	0.131	0.041	0.007	0.004	0.027	0.013
Six Years Old	0.008	0.003	0.142	0.040	0.011	0.004	0.019	0.013
Seven Years Old	0.037	0.002	0.826	0.028	0.066	0.003	-0.173	0.009
Eight Years Old	0.013	0.002	0.227	0.027	0.028	0.002	-0.066	0.008
Nine Years Old	0.004	0.002	0.141	0.027	0.015	0.003	-0.031	0.008
Ten Years Old	-0.001	0.002	0.077	0.026	0.008	0.002	-0.001	0.008
Eleven Years Old	-0.003	0.002	0.064	0.025	0.005	0.002	0.026	0.008
Twelve Years Old	-0.005	0.002	0.036	0.025	0.002	0.002	0.051	0.008
Thirteen Years Old	-0.006	0.002	0.038	0.025	0.000	0.002	0.061	0.008
Fourteen Years Old	-0.008	0.002	0.031	0.026	-0.002	0.002	0.074	0.008
Fifteen Years Old	-0.006	0.002	0.052	0.027	0.001	0.002	0.092	0.008
Sixteen Years Old	-0.001	0.002	0.095	0.028	0.007	0.003	0.100	0.009
Seventeen Years Old	-0.003	0.003	-0.056	0.041	-0.005	0.004	0.020	0.013
Eighteen Years Old	0.005	0.003	0.046	0.043	0.008	0.004	0.024	0.013
Nineteen Years Old and Above	0.000	0.002	-0.021	0.025	-0.001	0.002	0.011	0.008
<b>Locality Controls</b>								
Rural Area	0.001	0.002	-0.003	0.024	0.002	0.002	0.026	0.007
Metropolitan Area	0.002	0.001	0.012	0.022	0.002	0.002	0.028	0.007
Rondonia	0.014	0.005	0.193	0.073	0.021	0.007	0.125	0.023
Acre	0.025	0.006	0.306	0.093	0.036	0.009	0.116	0.029
Amazonas	0.023	0.004	0.235	0.061	0.033	0.006	0.207	0.019
Roraima	0.009	0.008	0.064	0.124	0.013	0.011	0.079	0.039
Pará	0.015	0.003	0.101	0.045	0.022	0.004	0.213	0.014
Amapá	0.007	0.010	0.023	0.159	0.010	0.015	0.114	0.050
Tocantins	0.013	0.004	0.119	0.064	0.019	0.006	0.163	0.020
Maranhão	0.018	0.004	0.173	0.059	0.026	0.005	0.190	0.018
Piauí	0.019	0.004	0.215	0.066	0.028	0.006	0.222	0.021
Ceará	0.014	0.003	0.125	0.041	0.020	0.004	0.096	0.013
Rio Grande do Norte	0.024	0.004	0.252	0.069	0.034	0.006	0.134	0.022
Paraíba	0.023	0.004	0.228	0.060	0.033	0.006	0.167	0.019
Pernambuco	0.021	0.003	0.222	0.041	0.031	0.004	0.142	0.013
Alagoas	0.024	0.004	0.240	0.066	0.034	0.006	0.188	0.021
Sergipe	0.026	0.004	0.324	0.068	0.039	0.006	0.246	0.021
Bahia	0.021	0.002	0.202	0.037	0.031	0.003	0.179	0.012
Minas Gerais	0.006	0.002	0.064	0.036	0.009	0.003	0.056	0.011
Espirito Santo	0.011	0.004	0.156	0.067	0.017	0.006	0.012	0.021
Rio de Janeiro	0.018	0.003	0.185	0.043	0.026	0.004	0.195	0.014
Paraná	0.011	0.003	0.119	0.043	0.017	0.004	-0.018	0.014
Santa Catarina	0.007	0.004	0.041	0.058	0.010	0.005	0.011	0.018
Rio Grande do Sul	0.012	0.003	0.129	0.040	0.017	0.004	0.038	0.013
Mato Grosso do Sul	0.021	0.004	0.243	0.065	0.031	0.006	0.033	0.020
Mato Grosso	0.024	0.004	0.300	0.060	0.034	0.006	0.069	0.019
Goiás	0.011	0.003	0.094	0.046	0.016	0.004	0.118	0.015
Federal District	0.008	0.004	0.034	0.059	0.012	0.005	0.085	0.018
R-Squared	0.126		0.124		0.145		0.400	
Number of Observations	14,315		14,315		14,315		14,315	