World Development Vol. 36, No. 9, pp. 1647–1664, 2008

0305-750X/$ - see front matter
www.elsevier.com/locate/worlddev
doi:10.1016/j.worlddev.2007.09.004

Birth Order, Child Labor, and School Attendance in Brazil

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Summary. — This paper examines the effects of birth order on intra-household allocations as evidenced by the child labor incidence and school attendance of Brazilian children. Previous studies have found that earlier born children may have more intra-household resources directed to them, and better outcomes as adults. In the context of child labor, the effects of birth order can be confounded by the fact that earlier born children are able to command higher wages than their younger siblings. Empirical results show that, in fact, male and female first-born children are less likely to attend school than their later born siblings and male last-born children are less likely to work as child laborers than their earlier born siblings.

Key words — intra-household allocations, birth order, child labor, school attendance

1. INTRODUCTION

Economists have, for some time, been interested in the role that birth order plays in the intra-household investments in, and outcomes of, children. This interest was prompted by the findings of psychologists and sociologists (e.g., Zajonc, 1976; Zajonc & Markus, 1975) that suggest that birth order has significant impacts on children's measured abilities like standardized test performance and IQ. [1] Whether this empirical regularity is due to genetics, intellectual environment within the household, or resource dilution is an open debate in the psychological literature (Downey, 2001; Zajonc, 2001; Zajonc & Mullally, 1997), though a new study of Norwegian children dismisses the biological rationale (Kristensen & Bjerkedal, 2007). [2] Regardless of the mechanism through which this occurs, the consensus of this literature is that first-born children have higher measured IQs and cognitive abilities than their later born siblings controlling for family size. A number of previous economic studies have focused either on the outcomes of children as a function of birth order (e.g., Behrman & Taubman, 1986; Birdsall, 1991; Kessler, 1991) or on the intra-household allocation of resources to children as a function of birth order (e.g., Behrman, 1988; Horton, 1988; Price, forthcoming). In both the cases, the implication from the psychological and sociological literature is that outcomes and investments will be higher for earlier born children. This is because children with higher abilities should fare better in both school and adult labor market. Higher ability children may also have a greater amount of resources directed toward them by families who are inclined to invest in children with the

* For helpful comments and advice, we thank Elaine Toldo Pazello, Katheryn Anderson, Laura Argys, Brian Duncan, Naci Mocan, three anonymous referees of this journal, and seminar participants at Vanderbilt University, the University of Colorado at Denver, and the 2002 NEUDC, LACEA, and LAMES Conferences. Final revision accepted: September 6, 2007.

highest potential return or simply due to the fact that parents have more time to invest in earlier born children due to the fact that that time is not shared by other siblings. [3] The bulk of the evidence from the received literature points to significant birth order effects in both outcomes and allocations that favor earlier born children, although a few studies have failed to find significant effects (e.g., Kessler, 1991). The outcome studies have focused mainly on the United States, while the allocation studies have focused mainly on developing countries. What this paper argues is that it is reasonable to expect birth order effects to be opposite (i.e., more favorable treatment of later born children) when families are forced by poverty and/or capital constraints to send some or all of their children to work in the labor market.

The proposition that birth order effects may be different in the child labor context stems from the recent child labor literature, starting with Basu and Van (1998), which emphasizes the fact that child labor is most frequently a result of familial poverty that forces parents to send their children to the labor market. [4] If this is an accurate description, then there may be a number of factors that determine which children a family chooses to send to the labor market and which children they choose to keep in school. Birth order is potentially one of these factors. The fact that earlier born children may have higher abilities may mean that their return to education is greater than that of later born children which might lead to the decision to withhold them from the labor market. This would be consistent with the previous literature on birth order effects. On the other hand, the same abilities may mean that they are able to command higher wages as children on the labor market than their later born siblings and thus are more likely to be sent to work as children. Also, if older children can command higher wages than younger children, this also could lead to earlier born children being sent to work rather than their later born siblings. Finally, if households are capitally constrained, the income an older sibling earns might be used to finance the education of younger siblings. As working as a child laborer has a negative effect on educational achievement and adult wages (see Emerson & Souza, 2003, 2007a,b), these last three implications are in contrast to the earlier work in birth order that suggests that earlier born children are likely to have better outcomes than later born children. [5] Thus, when examined in a developing country context, where child labor is widespread, the effects of birth order may be distinctly different than has been previously shown.

One of the challenges to all the studies of birth order, including the present study, is disentangling the effects of family size. Family size has been found to have negative developmental effects likely due to the fact that family resources are spread more thinly the larger the family is (see, e.g., Becker & Lewis, 1973; Becker & Tomes, 1976; Hanushek, 1992). The size of the family may also be an important factor in the labor force participation and school attendance of children. It may be that larger families increase the likelihood of the household being impoverished and thus large families are more likely to need the additional income a child who works in the labor market can provide. Or it may be that families increase the number of children they bear as a response to poverty so that the family's income may be supplemented by sending some children to work or having them provide labor within the household (or family farm). Either way, the additional income brought in by their offspring may allow families to invest in select children's education. This selection may depend on both the size of the family and the birth order of the child.

This paper begins by considering the theoretical link between birth order and child labor and then examines the theoretical implications empirically by using household survey data from Brazil. [6] In the child labor context, where older children generally command higher wages, it is shown that it is just as reasonable to expect that earlier born children are more likely to work (and less likely to go to school) than are later born children as it is to expect the opposite. Thus, how birth order affects the child labor incidence and schooling of children in developing countries is an empirical issue.

The empirical findings show that sons who are the first-born in their families are more likely to work and less likely to go to school than later born sons, while daughters who are the first-born are less likely to go to school than later born daughters. These results hold when controlling for family size, looking only at completed families and looking only at completed families of a certain size. These results suggest that in economies where child labor is widespread, as in many developing countries, birth order effects on children's outcomes may actually serve to favor later born children. These results contrast with findings from some developed countries where birth order effects have been shown to favor earlier born children.

The paper proceeds as follows. The theoretical link between birth order and child labor is discussed in Section 2. The data used in the empirical investigation are discussed in Section 3. The results of the empirical investigation are presented in Section 4. A discussion of the results and their implications is presented in the concluding section, Section 5.

2. BIRTH ORDER AND CHILD LABOR

Incentives to specialize across children within households in the child labor context have been explored theoretically (see, e.g., Horowitz & Wang, 2004) and empirically (e.g., Horowitz & Souza, 2004). It is also well established in the child labor literature that wages increase with the age of child workers. [7] Older children are presumably more productive, more reliable, and better able to perform more complex tasks. If earlier born children also have systematically higher abilities, this could also lead to higher wages for older, earlier born, children. The fact that a child laborer's wage in the labor market is positively related to the child's birth order is an important factor in the effects of birth order on the child labor and schooling decisions of a family. Specifically, if families send their children to work for subsistence reasons, they may choose to send their older children to the labor market first, where they can command relatively higher wages than their younger siblings. There are other factors that can influence a family's decision to send a child to work that could be correlated with birth order, perhaps the most obvious being credit constraints and the sequence of births.

To fix ideas, consider first the decision to send any child to the labor market and its consequences. [8] If adults in a household value the family's current consumption, each child's human capital attainment, and each child's consumption of leisure time, then there are competing incentives for the child's time allocation. The children in the household can go to school and increase their human capital accumulation. They can go to work in the labor market and increase the current consumption of the household. And they can engage in leisure activities which may contribute to the happiness of the child and of the family. These three activities are not mutually exclusive, but children who work may not be able to attain as much education—or, more generally, the adult human capital attainment—as those who do not. [9] Since the education a child receives determines the amount of adult human capital they acquire, this will in turn determine his or her wage as an adult. Familial poverty in this framework increases the emphasis on current consumption and can thus draw children away from school and leisure and into work. The consequences of a child working can linger through generations, because the amount of labor income the adults bring into the household depends on how much schooling they received as children. Thus, parents who were child laborers command lower wages and are more likely to demand their children work to supplement the family income. [10] Efficient credit markets could solve this problem by allowing families to borrow against the future earnings of their children, but credit markets are generally either non existent or not well developed in low income countries. [11, 12]

Now consider the effect of birth order on child time allocation decisions within a family. The relative amount of schooling and/or child labor the family will allocate for each child will be determined, in part, by the marginal effect of schooling on the human capital accumulation of the child, how additional human capital affects the adult's utility function, and the returns each child receives for his or her labor. Depending on how birth order affects these marginal returns, older children may be more or less likely to work in the labor market. Since these marginal returns may also be a function of the child's age, the age difference between siblings may matter as well.

For example, consider a two child family. If both children have the same ability to generate human capital for all the levels of schooling, then the family may allocate relatively more child labor and less schooling to the older child (due to higher wages). On the other hand, if the older child has higher ability such that the marginal returns on an extra unit of education are higher for all the levels of education, it may be the case that the family will invest relatively more schooling to the oldest child and allocate relatively more child labor to the younger one. In other words, the birth order effect will depend on parental preferences, the children's human capital accumulation technology, and the difference in the wage rate. Capital markets, or lack thereof, may also play a critical role in the determination of work and school based on birth order for the children in the household. If this household is too poor to send a child to school, then it may be forced to send its first-born child to work. However, with the additional income generated by the first-born child, it may be possible to invest in the education of the second-born child. Thus, it may simply be a poverty and timing story that drives any systematic differences in the work and schooling of children based on their birth order. [13]

In summary, if the gain from the higher wages commanded by older children outweigh the potentially relatively higher returns to schooling due to higher abilities, or if poverty and lack of access to capital force earlier born children to work first, then we should expect that earlier born children are more likely to work as child laborers and less likely to attend school than later born children. On the other hand, if the gain from the higher wages commanded by older children does not outweigh the potentially relatively higher returns to schooling due to higher abilities (and if timing and access to capital are not important) then we should expect that later born children are more likely to work as child laborers and less likely to attend school than earlier born children. The net effect then is an empirical issue.

We search for empirical regularities of birth order effects on child labor and school attendance in Section 4. First, however, we describe the data used in our analysis and our sample selection criteria in the next section.

3. DATA SET AND SAMPLE SELECTION

The data used in the empirical analysis come from the 1998 *Pesquisa Nacional por Amostragem a Domicílio* (PNAD) from *Instituto Brasileiro de Geografia e Estatística* (IBGE), the Brazilian census bureau. The PNAD is a yearly and nationally representative household survey similar to the Current Population Survey in the United States. It covers close to one hundred thousand households and includes information on the demographic and labor market characteristics of the households. Unlike most other years, the 1998 PNAD includes information on the labor market activities of all children in a household who are at least five years of age.

Our sample consists of all sons and daughters who are between seven and 16 years of age and live in a two-parent family. [14] Therefore, we exclude all children younger than seven and older than 16 as well as all children from single head families. [15] We exclude younger children because compulsory schooling begins at seven years old in Brazil and older children because Brazilian legislation allows them to participate in the labor market but precludes 15-year-old children or younger to work in the labor market. Moreover, we exclude single head families since the decision to send children to the labor market may be fundamentally different for single head households than two-parent households. [16]

The child labor variables for the children are constructed as follows. A child is considered working if he or she worked any strictly positive hours per week. [17] Another child labor indicator variable was constructed that equals one if the child worked 20 h or more per week. This second (alternate) definition of child labor was used to check the robustness of the main results and all the qualitative results remained the same (the results are not presented here but are available upon request). For each child, we also obtained his or her school attendance status, age, gender, race, whether they live in a metropolitan area, the number of siblings, whether they were a first-born or a last-born child, the age difference between them and the first-born or the last-born, the average spacing of children in the family, and the age and years of schooling of each parent. [18, 19] Our final sample consists of 26,930 sons and 25,435 daughters. The basic statistics are presented in Table A1 of the Appendix.

We will also use three alternative samples to check the robustness of the results. As the potential endogeneity of fertility decisions (family size) may bias the estimation of the birth order effects, we check the robustness of the results by first comparing children living in completed families only. For this purpose, we use a sub-sample of all children belonging to families where their mothers are 40 years old or older who are unlikely to still be making fertility decisions. However, past fertility decisions are related to current family size and may, in turn, be correlated with the time allocation decisions for the children. For this reason, we also construct another sub-sample of all children from families where there are exactly three siblings. We choose three children families to provide an adequate sample size as the mean number of children in the data set is three, as well as to make the analysis of the first- and last-born coefficients relative to second-born children. Finally, as parents from completed families with the same number of siblings are more likely to have faced similar constraints and/or have had a similar set of preferences, we construct a sub-sample that includes all children from families where their mothers are 40 years old or older and where there are exactly three siblings.

4. EMPIRICAL RESULTS

A child in our sample is assumed to allocate his or her time among many activities. Chief among these activities are working as child laborer in the labor market (including work done on the family farm) and attending school. As stated in the previous section, a child is defined to be a laborer if he or she works strictly positive hours in the labor market. Table 1 presents the time allocation figures under this definition of child labor for male and female children, separately. Most of the children in the sample attend school and there is not much gender difference. More than 95% of male and female children attend school. However, a greater proportion of male children work in the labor market. Specifically, more than 17% of male children work in the labor market, whereas less than 9% of female children participate in the labor market. For both males and females that are child laborers, more than 81% attend school as well.

In order to capture the birth order effect on the time allocation of the children, we estimate a series of bivariate probit models of the child labor and school attendance decisions of households with at least one child in the age range of 7–16 years old. We start by using an unrestricted sample of all households with a child in this age range. Because fertility is likely an endogenous regressor, however, we then perform a series of robustness checks of the results that attempt to confirm that the results from the unrestricted sample are not an artifact of bias. There are two ways in which the family size variable from the basic model estimation can be endogenous. First, it could be that it is correlated with the error term because it is measuring two different things, completed fertility for some families, and current children for families that have not yet finished having kids. Including the second type of family in the sample causes error in the measurement of fertility. As a first robustness check then, we restrict the sample to include only those households where the mother is 40 years or over in an attempt to look at only completed families, or those families who are no longer making fertility decisions. The second way fertility could be correlated with the error term is due to the fact that investment in children and number of children could be jointly determined. In order to control for this potential source of bias, we construct another sub-sample, this time of families that have the same number of children—in this case three. The estimates from this sub-sample are therefore unbiased for the sub-sample population, but may be biased if three child families are systematically different than other families when inference is made to the entire population. Finally, to deal with both sources of endogeneity at once, we restrict the sample further to include only those families with

Table 1. *Child labor and school attendance*

Child labor		Male child School attendance			Female child School attendance		
		No	Yes	Total	No	Yes	Total
Families with at least one child aged 7–16 years old							
No	Number	1,075	21,117	22,192	1,053	22,162	23,215
	Row %	4.84	95.16	100	4.54	95.46	100
	Column %	55.02	84.55	82.41	75.27	92.2	91.27
Yes	Number	879	3,859	4,738	346	1,874	2,220
	Row %	18.55	81.45	100	15.59	84.41	100
	Column %	44.98	15.45	17.59	24.73	7.8	8.73
Total	Number	1,954	24,976	26,930	1,399	24,036	25,435
	Row %	7.26	92.74	100	5.5	94.5	100
	Column %	100	100	100	100	100	100

mothers 40 years or over *and* with exactly three children.

Another approach to dealing with an endogenous regressor is to identify a set of instrumental variables. However, data limitations in this case prevent the identification of a set of valid exogenous instruments, and therefore IV regressions could not be relied upon to provide unbiased estimates. An alternate strategy, suggested by Rosenzweig and Schultz (1987), and used again in Foster and Roy (1997), is to use residuals from a fertility regression as an (noisy) estimate of the unexplained component of fertility as these residuals can be expected to be correlated with realized fertility but not with unexplained component of time allocation choices (i.e., net of explanatory variables). In other words, the residuals from the fertility regression can be thought of as a measure of natural fecundity, or the unplanned/uncontrolled part of the fertility of the couple. This is likely correlated with realized fertility, but not with the residuals of the child labor and schooling regressions. Thus, these residuals can be used in place of the fertility variable in the child labor and schooling regressions. Though a second-best alternative, we employ this strategy as yet another check of the robustness of the main results.

The dependent variables in all regressions are a child labor indicator variable that equals one if a child works strictly positive hours in the labor market and a school attendance indicator variable that equals one if a child goes to school. We construct two birth order variables: The first is an indicator variable that equals one if the child is the first-born child in the family. The second is an indicator variable that equals one if the child is the last-born child in the family. [20] We also construct a variable that equals the age difference between the observed child and the first-born in the family, and another that equals the age difference between the observed child and the last-born in the family, as age difference is likely a factor in the child labor decision of the household. [21] Additional controls included are the child's age, the child's race, the father's and the mother's schooling, the father's and the mother's age, and an indicator variable that equals one if the household is in a rural area. For the first three estimations, we include a variable that equals the number of children in the family. Finally, we estimate the birth order effects for sons and daughters separately as the work that male and female children are expected to do, as well as their duties within the household (which are not included in the child labor variable), may be quite different and therefore time allocation decisions for boys and girls can be reasonably expected to come from different decision making processes. [22]

Tables 2–6 present the birth order results for the unrestricted sample (both excluding and including controls for first- and last-born children), the sample with only those households where the mother is 40 years and over, the sample with all families with exactly three children, and the sample for those households where the mother is 40 years and over and that have exactly three children, respectively. In each table, the first and third columns present the coefficients for child labor and school attendance for male children, and the fifth and seventh columns show the results for child labor and school attendance for female children.

Tables 2 and 3 present the coefficient estimates for the unrestricted sample. Table 2 presents results for a base regression that includes child's age but excludes the indicator variables that account for the child being a first- or last-born child. In this regression, the coefficient estimates of age are positive and significant for both males and females when the dependant variable is the working in the labor market indicator, and negative and significant for both males and females when the dependant variable is the attending school indicator. This reflects the increased likelihood of participating in the labor market as children of both genders get older, and the natural attrition from school that occurs as children grow-up in Brazil. The fathers and mothers schooling variables are negative and significant for the work regressions and positive and significant for the school regressions reflecting the role that household wealth and educational status play in the work and school decisions for the children. These results confirm some of the basic assumptions of the theoretical model: that parental human capital is important in the determination of the time spent at work and at school of children, that as children age, they are more likely to be at work and less likely to be in school.

Table 3 presents the regression results when the unrestricted sample is used, and controls for the child being a first- or last-born are included. For male children, those that were born last are less likely to work, and those that were born first are less likely to go to school. For females, first-born children are less likely to attend school, but no more or less

Table 2. *Bivariate probit of child labor and school attendance*

Independent variables	Male child				Female child			
	Work		School		Work		School	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Families with at least one child aged 7–16 years old								
Child's age	0.293**	0.005	−0.105**	0.006	0.224**	0.005	−0.068**	0.006
Non-white child	−0.053*	0.023	−0.024	0.027	−0.065*	0.027	0.001	0.030
Father's schooling	−0.060**	0.004	0.059**	0.005	−0.030**	0.005	0.035**	0.006
Mother's schooling	−0.024**	0.004	0.061**	0.005	−0.032**	0.005	0.078**	0.006
Father's age	0.001	0.002	−0.001	0.002	−0.001	0.002	−0.002	0.002
Mother's age	−0.005*	0.002	0.003	0.002	−0.005*	0.002	0.001	0.003
Rural	0.888**	0.025	−0.099**	0.029	0.627**	0.029	−0.190**	0.031
Number of children	0.043**	0.006	−0.056**	0.007	0.040**	0.007	−0.044**	0.008
Constant	−4.473**	0.083	2.435**	0.098	−3.993**	0.094	2.242**	0.107
Rho	−0.155**	0.018			−0.155**	0.022		
Log-likelihood	−14,453				−10,591			
Sample size	26,717				25,223			

White's heteroskedastic consistent errors used in all regressions.
* Statistically significant at 5% level.
** Statistically significant at 1% level.

Table 3. *Bivariate probit of child labor and school attendance*

Independent variables	Male child				Female child			
	Work		School		Work		School	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Families with at least one child aged 7–16 years old								
First-born child	−0.023	0.028	−0.091**	0.032	−0.042	0.033	−0.149**	0.036
Last-born child	−0.080**	0.030	−0.040	0.035	−0.059	0.035	−0.021	0.039
Child's age	0.291**	0.005	−0.103**	0.006	0.224**	0.006	−0.064**	0.006
Non-white child	−0.055*	0.023	−0.025	0.027	−0.065*	0.027	0.003	0.030
Father's schooling	−0.060**	0.004	0.059**	0.005	−0.030**	0.005	0.035**	0.006
Mother's schooling	−0.024**	0.004	0.060**	0.005	−0.032**	0.005	0.078**	0.006
Father's age	0.001	0.002	−0.001	0.002	0.000	0.002	−0.003	0.002
Mother's age	−0.004	0.002	0.002	0.003	−0.004	0.003	−0.001	0.003
Rural	0.886**	0.026	−0.097**	0.029	0.627**	0.029	−0.188**	0.031
Number of children	0.032**	0.008	−0.068**	0.009	0.030**	0.009	−0.060**	0.009
Constant	−4.431**	0.090	2.545**	0.104	−3.935**	0.102	2.418**	0.114
Rho	−0.157**	0.019			−0.155**	0.023		
Log-likelihood	−14,454				−10,596			
Sample size	26,717				25,223			

White's heteroskedastic consistent errors used in all regressions.
* Statistically significant at 5% level.
** Statistically significant at 1% level.

likely to work than their middle-born counterparts. Note that we are controlling for the age of the child so it is not age difference *between observations* that is driving these results. The coefficients on child's age and the education of the father and mother are all still significant

Table 4. *Bivariate probit of child labor and school attendance*

Independent variables	Male child				Female child			
	Work		School		Work		School	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Families with at least one child aged 7–16 years old and mothers aged at least 40 years old								
First-born child	−0.028	0.043	−0.118*	0.050	−0.090	0.051	−0.112**	0.058
Last-born child	−0.166**	0.040	−0.001	0.048	−0.094*	0.046	0.047	0.053
Child's age	0.270**	0.007	−0.118**	0.009	0.202**	0.008	−0.087**	0.010
Non-white child	−0.077*	0.033	−0.028	0.039	−0.113**	0.038	0.004	0.044
Father's schooling	−0.066**	0.006	0.056**	0.008	−0.031**	0.007	0.040**	0.009
Mother's schooling	−0.030**	0.006	0.062**	0.008	−0.038**	0.007	0.066**	0.009
Father's age	0.000	0.002	0.000	0.003	−0.003	0.003	−0.003	0.003
Mother's age	−0.002	0.004	0.002	0.004	−0.008	0.004	−0.009	0.005
Rural	0.923**	0.037	−0.131**	0.042	0.659**	0.042	−0.278**	0.047
Number of children	0.006	0.011	−0.051**	0.012	0.007	0.012	−0.038**	0.013
Constant	−4.023**	0.179	2.644**	0.223	−3.230**	0.208	3.048**	0.233
Rho	−0.182**	0.026			−0.151**	0.031		
Log-likelihood	−6931				−5143			
Sample size	10,471				9,994			

White's heteroskedastic consistent errors used in all regressions.
** Statistically significant at 1% level.
* Statistically significant at 5% level.

Table 5. *Bivariate probit of child labor and school attendance*

Independent variables	Male child				Female child			
	Work		School		Work		School	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Three children families with at least one child aged 7–16 years old								
First-born child	−0.076	0.051	−0.058	0.062	0.004	0.061	−0.160*	0.075
Last-born child	−0.117*	0.056	0.062	0.072	−0.014	0.069	0.112	0.084
Child age	0.294**	0.010	−0.098**	0.013	0.235**	0.011	−0.044**	0.014
Non-white child	−0.041	0.044	−0.034	0.053	−0.005	0.052	−0.060	0.064
Father's schooling	−0.062**	0.008	0.060**	0.010	−0.030**	0.009	0.027*	0.011
Mother's schooling	−0.023**	0.008	0.054**	0.010	−0.031**	0.009	0.080**	0.011
Father's age	0.000	0.003	−0.005	0.004	0.001	0.004	−0.002	0.005
Mother's age	−0.001	0.005	0.006	0.006	−0.010	0.005	−0.011	0.006
Rural	0.842**	0.051	−0.110	0.060	0.565**	0.060	−0.199**	0.070
Constant	−4.428**	0.164	2.295**	0.200	−3.917**	0.190	2.493**	0.226
Rho	−0.084	0.039			−0.201	0.050		
Log-likelihood	−3641				−2389			
Sample size	7,379				6,840			

White's heteroskedastic consistent errors used in all regressions.
** Statistically significant at 1% level.
* Statistically significant at 5% level.

as are the rural coefficients and the coefficients on the non-white indicator variables for the work equations. The age of the father and mother has no effect on any of the categories. Note that the family size variable is highly significant for all categories and the results are consistent: a larger family means a higher probability to work and lower probability to go to school for both male and female children.

Table 6. *Bivariate probit of child labor and school attendance*

Independent variables	Male child				Female child			
	Work		School		Work		School	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Three children families with at least one child aged 7–16 years old and mothers aged 40 years or above								
First-born child	−0.094	0.090	0.004	0.114	−0.068	0.109	−0.049	0.136
Last-born child	−0.210**	0.075	0.012	0.099	−0.007	0.090	0.104	0.114
Child's age	0.283**	0.016	−0.150**	0.023	0.239**	0.019	−0.120**	0.026
Non-white child	−0.053	0.067	−0.136	0.086	−0.015	0.080	−0.048	0.099
Father's schooling	−0.073**	0.011	0.048**	0.016	−0.035**	0.013	0.044*	0.018
Mother's schooling	−0.020	0.011	0.055**	0.015	−0.039**	0.014	0.069**	0.018
Father's age	0.002	0.005	−0.003	0.006	−0.002	0.006	0.000	0.007
Mother's age	0.005	0.008	0.004	0.010	−0.027**	0.010	−0.016	0.010
Rural	0.885**	0.081	−0.253**	0.097	0.684**	0.096	−0.395**	0.108
Constant	−4.566**	0.370	3.146**	0.489	−2.961**	0.457	3.624**	0.479
Rho	−0.147**	0.056			−0.223**	0.068		
Log-likelihood	−1536				−1016			
Sample size	2626				2384			

White's heteroskedastic consistent errors used in all regressions.
* Statistically significant at 5% level.
** Statistically significant at 1% level.

When the sample is restricted to include only those with mothers who are 40 years old or older, the main results, presented in Table 4, are unchanged except that now last-born female children are less likely to work as well. Another interesting difference is that the family size variable is no longer significant for the male and female work equations.

When the sample is restricted to include only those families with exactly three children, the main results, presented in Table 5, are similar to Table 4, except for the coefficient on first-born male's school attendance, which is still negative but no longer significant at the 5% level, and the coefficient on the last-born female in the work equation is again not significant. Additionally, the coefficient on non-white child is now no longer significant in any category and the coefficient estimate on the rural indicator variable is no longer significant in the male school equation.

Finally, Table 6 presents the coefficient estimates for the sample restricted to just those families where the mother is 40 years old or older and who have exactly three children. This last restriction is, again, to minimize possible bias due to the potential endogeneity of the family size variable in the previous two regression estimations. In this case, last-born male children are still less likely to work than are their first- and middle-born siblings, but first-born females are now no less likely to attend school, although the coefficient is still negative. The loss of the significance in the estimation of the first-born female coefficient is not surprising considering the way the sample is restricted, this leaves us with very few first-born children that we observe (i.e., in the 7–16 age range) that are wage workers. In other words, by restricting the age of mothers to 40 years old and older, most first-borns in these families are older than 16 and thus do not enter the sample. Together, Tables 3–6 present a set of consistent results that birth order effects on time allocation decisions in Brazil favor later born children.

Tables 7 and 8 present the results of the estimation where the residuals of an estimated fertility equation are used in place of the realized fertility variable. Table 7 shows the results of the bivariate probit model with the residuals of the fertility model (Table 8) included in place of the number of children on the full sample. The main pattern of results remain the same: last-born male children are less likely to go to work, first-born male children are less likely to go to school, and first-born female children are less likely to go to school.

The next two tables, Tables 9 and 10, present the estimation results of two more models in an attempt to capture the effect of age difference. In the first estimation, we include the two age difference variables and drop the

Table 7. *Bivariate probit of child labor and school attendance*

Independent variables	Male child				Female child			
	Work		School		Work		School	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Families with at least one child aged 7–16 years old								
First-born child	−0.023	0.028	−0.091**	0.032	−0.042	0.033	−0.149**	0.036
Last-born child	−0.080**	0.030	−0.040	0.035	−0.059	0.035	−0.021	0.039
Child's age	0.291**	0.005	−0.103**	0.006	0.224**	0.006	−0.064**	0.006
Non-white child	−0.041	0.023	−0.053*	0.027	−0.052*	0.027	−0.022	0.029
Father's schooling	−0.062**	0.004	0.062**	0.005	−0.031**	0.005	0.038**	0.006
Mother's schooling	−0.027**	0.004	0.066**	0.005	−0.034**	0.005	0.082**	0.006
Father's age	0.002	0.002	−0.002	0.002	0.000	0.002	−0.003	0.002
Mother's age	−0.004	0.002	0.002	0.003	−0.004	0.003	−0.001	0.003
Rural	0.900**	0.026	−0.127**	0.029	0.640**	0.029	−0.214**	0.031
Residual number of children	0.032**	0.008	−0.068**	0.009	0.030**	0.009	−0.060**	0.009
Constant	−4.335**	0.083	2.340**	0.098	−3.847**	0.094	2.238**	0.107
Rho	−0.156**	0.019			−0.154**	0.022		
Log-likelihood	−14,455				−10,596			
Sample size	26,717				25,223			

White's heteroskedastic consistent errors used in all regressions.
* Statistically significant at 5% level.
** Statistically significant at 1% level.

Table 8. *OLS of number of children on parent's characteristics*

Independent variables	Coeff.	Std. error
Families with at least one child aged 7–16 years old		
Father's schooling	−0.043**	0.002
Mother's schooling	−0.076**	0.002
Father's age	0.009**	0.001
Mother's age	0.005**	0.001
Non-white child	0.418**	0.014
Rural	0.437**	0.020
Constant	2.989**	0.043
R^2	0.165	
Sample size	51,942	

White's heteroskedastic consistent errors used in this regression.
** Statistically significant at 1% level.

first- and last-born child indicators. In the second, we include the average spacing among children in a family instead of the age difference variables. We do the first estimation without first- and last-born indicator variables as there is, by construction, a direct correlation with the age difference variables. In both the cases, we present the results using the full sample, but sub-sample results that are consistent with those presented in Tables 4–6 were obtained as well and are available upon request.

Table 9 presents the coefficient estimates for the model with only the age difference variables. Here, the coefficients on the age difference with the first-born child and the age difference last-born child are negative and significant and positive and significant, respectively, for males but not for females in the work equation. The coefficient estimate on the age difference with the last-born child is negative and significant for the male and female school equations. This means that for male children, the greater the age difference with

Table 9. *Bivariate probit of child labor and school attendance on age difference*

Independent variables	Male child				Female child			
	Work		School		Work		School	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Families with at least one child aged 7–16 years old								
Age diff. w/first-born	−0.008*	0.004	0.006	0.005	−0.005	0.005	0.007	0.005
Age diff. w/last-born	0.008*	0.004	−0.016**	0.004	0.006	0.004	−0.028**	0.005
Child's age	0.284**	0.005	−0.093**	0.006	0.218**	0.006	−0.050**	0.007
Non-white child	−0.054*	0.023	−0.025	0.027	−0.066*	0.027	0.002	0.030
Father's schooling	−0.060**	0.004	0.059**	0.005	−0.030**	0.005	0.035**	0.006
Mother's schooling	−0.024**	0.004	0.060**	0.005	−0.031**	0.005	0.077**	0.006
Father's age	0.002	0.002	−0.002	0.002	0.000	0.002	−0.004	0.002
Mother's age	−0.002	0.002	−0.002	0.003	−0.002	0.003	−0.006*	0.003
Rural	0.882**	0.026	−0.091**	0.029	0.624**	0.029	−0.181**	0.031
Number of children	0.040**	0.009	−0.042**	0.010	0.037**	0.010	−0.020	0.011
Constant	−4.537**	0.085	2.509**	0.100	−4.045**	0.097	2.371**	0.111
Rho	−0.152**	0.018		−0.149**	0.022			
Log-likelihood	−14,444			−10,580				
Sample size	26,717			25,223				

White's heteroskedastic consistent errors used in all regressions.
** Statistically significant at 1% level.
* Statistically significant at 5% level.

Table 10. *Bivariate probit of child labor and school attendance*

Independent variables	Male child				Female child			
	Work		School		Work		School	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Families with at least one child aged 7–16 years old								
First-born child	−0.025	0.028	−0.096**	0.033	−0.046	0.033	−0.171**	0.037
Last-born child	−0.082**	0.032	−0.047	0.036	−0.065	0.037	−0.048	0.040
Average spacing	−0.002	0.009	−0.007	0.011	−0.006	0.011	−0.027*	0.012
Child age	0.291**	0.005	−0.103**	0.006	0.224**	0.006	−0.065**	0.006
Non-white child	−0.055*	0.023	−0.026	0.027	−0.066*	0.027	0.000	0.030
Father's schooling	−0.060**	0.004	0.059**	0.005	−0.030**	0.005	0.035**	0.006
Mother's schooling	−0.024**	0.004	0.060**	0.005	−0.032**	0.005	0.078**	0.006
Father's age	0.001	0.002	−0.001	0.002	0.000	0.002	−0.003	0.002
Mother's age	−0.004	0.002	0.002	0.003	−0.004	0.003	0.000	0.003
Rural	0.886**	0.026	−0.097**	0.029	0.627**	0.029	−0.190**	0.031
Number of children	0.032**	0.008	−0.069**	0.009	0.029**	0.009	−0.063**	0.009
Constant	−4.427**	0.092	2.559**	0.107	−3.923**	0.104	2.472**	0.117
Rho	−0.156	0.018			−0.154	0.022		
Log-likelihood	−14454				−10592			
Sample size	26,717				25,223			

White's heteroskedastic consistent errors used in all regressions.
* Statistically significant at 5% level.
** Statistically significant at 1% level.

the last-born, the more likely to work he is and the less likely to go to school. Also, the greater the age difference with the first-born, the less likely to go to work he is. For females, the greater the age difference with the last-born, the less likely to go to school she is. Both of these results are consistent with the results in Table 3. The rest of the results are similar to those in Table 3 as well.

In order to estimate birth order effects while taking into account the average time between sibling births, one last model is estimated. In this case the unrestricted sample is used, and both the birth order indicator variables are included, along with a variable, average spacing, that is the average number of years between siblings. This variable is included as an attempt to control for age difference as distinct from birth order. The results are presented in Table 10. The average spacing variable is significant in only the female schooling equation where the coefficient estimate suggests that the greater the spacing of births in a family, the less likely to attend schools are the female children of that family. More importantly, including the average spacing variable does not change the qualitative results presented in Table 3: first-born children are less likely to attend school and male last-born children are less likely to work.

We also estimated a model where the two age difference variables *and* the first- and last-born variables are included. However, due to the way the variables are constructed we cannot interpret the coefficients using the *ceteris paribus* assumption. Evaluating these results involves obtaining the predicted probability for representative children. We refer the reader to the Appendix for a discussion of the methodology and the results of this examination. Also presented in the Appendix are the results of the estimation of a linear probability model on the pooled sample where controls for the female children are included. Results from this estimation are consistent with the results from the bivariate probit models.

5. CONCLUSION

The one result that is robust throughout is that male last-born children are less likely to work than their first- and middle-born siblings. This is consistent with the model of birth order and child labor where, *ceteris paribus*, older children are sent to the labor market because they can command higher wages and younger children, who cannot command as high wages, are sent to school. This is true, apparently, even though earlier born children tend to have higher measured abilities on aptitude and IQ tests. This explanation is consistent with the complementary results that, in the first two regressions, male children who are first-borns are less likely to attend school.

As for female children, it appears that females who are first-borns are less likely to attend school and no more or less likely to work than their middle- or last-born siblings. This result is consistent with the explanation given above, and also with the common practice in Brazil, as in other developing countries, of keeping the oldest female children out of school and, instead, assisting the mother with housework and childcare (which is not considered working in the labor force in the PNAD).

These results suggest that there may be fundamental differences in the effects of birth order on children's outcomes depending on whether widespread child labor exists in a country, or at least if a family is forced to send one or more children to the labor market. Thus, it may be reasonable to expect that the effects of birth order have an opposite effect on children in the developed world than on children from developing countries, especially those from poorer households.

NOTES

1. More recent studies have found similar pattern both between and within families (Armor, 2001; Zajonc, 2001).

2. There is also an open debate among psychologists about whether these empirical findings are all attributable to across family variation and not to within family variation. However, because within families earlier born children are necessarily older (an issue we discuss in our empirical section), disentangling birth order effects from age effects has been problematic and has led to broad disagreement in the field about the validity of within family studies (e.g., Armor, 2001; Rodgers, 2001; Rodgers, Cleveland, van den Oord, & Rowe, 2000).

3. Some evidence of reinforcing investments is presented in Behrman, Rosenzweig, and Taubman (1994), and in Rosenzweig and Schultz (1982) for low income countries. In a recent study, Price (forthcoming) has found that first-born children receive more quality interactive time with parents than do second-born children of similar ages and from similar families.

4. See also Baland and Robinson (2000), Basu (1999, 2006), and Emerson and Souza (2007b).

5. Edmonds (2005) examines family composition and child labor in Nepal, but does not examine school attendance.

6. Empirical studies of child labor have emphasized distinct dimensions of child labor such as poverty, family size, parent's bargaining power, or social norms on the child's time allocation decisions (e.g., Emerson & Souza, 2003, 2007b; Freije & Lopez-Calva, 2001; Grotaert & Patrinos, 1999; Lopez-Calva, 2002). However, the empirical relation between birth order, child labor, and school attendance has not been explored.

7. This is true of the children in our data set as well as others, see, for example, Freije and Lopez-Calva (2001).

8. Formal models of household decision making are myriad, starting with the unitary family model *a là* Becker (1982). The most closely related to this discussion perhaps are the models presented in Behrman, Pollack, and Taubman (1995).

9. This is found to be true empirically in terms of adult earnings in Brazil, see Emerson and Souza (2007a).

10. This is similar to the child labor trap model in Emerson and Souza (2003).

11. Severely limited access to credit for poor families in developing countries is well established (see, e.g., Rose, 2000; Rosenzweig & Wolpin, 1993; Swain, 2002; and the review of micro evidence on credit markets in developing countries in Banerjee, 2001).

12. For dynamic models of child labor and credit constraints, see Emerson and Knabb (2005, 2006, 2007).

13. Adverse shocks to the household income may also drive some children to work in the absence of credit and insurance markets, see de Janvry, Finan, Sadoulet, and Vakis (2006).

14. We are able to distinguish between families and households in the data, and we consider children to be siblings only if they are in the same family. Additionally, PNAD classifies children as sons and daughters if they are the son or daughter of the head of the household or the spouse. This classification of the children means that we classify as siblings children that may be related only legally (and not biologically) to each other and the parents, but that are living as one family. Finally, we call the head of the household the father if the head is male and the spouse (if listed as the opposite sex) the mother, and if the head of the household is female, we call the head the mother and the spouse (if listed as the opposite sex) the father.

15. We also excluded families where the age difference between the oldest sibling and the youngest parent is 14 or below.

16. Not just in terms of poverty and capital constraints, but in the intra-household time allocation decisions in general as well as factors that may have led to the single-parent household. By including single-headed households, then, we would run the risk of identifying an affect of some unobservable difference in these two types of households.

17. PNAD asks the usual hours worked per week for each individual that responded that they worked during the survey week. This is followed by a question about the occupation and job status and thus generally understood to be exclusive of household chores.

18. The number of siblings, average spacing and birth order status are relative to the children observed in the family at the time of the survey, thus some measurement error is introduced leading to possible attenuation bias.

19. Male and female children in this sample do not have significantly different number of siblings. For females, the average number of children in the family is 3.21 and for males it is 3.17.

20. To be precise, the first-born and last-born indicator variables refer to the oldest and youngest children living in the same family at the time of the survey since the information in the PNAD on family composition are obtained from those living in the same household.

21. One of these will equal zero if the child happens to be the first- or last-born child in the family.

22. Table A3 of the Appendix, however, presents results from a linear probability model run on pooled sample with controls for female children.

23. It should be noted, however, that age difference may well be an endogenous regressor in this estimation so the results should be viewed with a modicum of caution.

24. Based on unreported *F*-tests of the joint significance of the first- and last-born indicator variables with their interactive counterparts.

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APPENDIX

Table A1 presents the basic statistics of the variables used. Table A2 presents the coefficient estimates of the regression where both the birth order indicator variables and the age difference variables are included.[23] At first glance it may seem that some of the results in Table A2 are inconsistent with the results presented above; however, we can no longer interpret the coefficients on the birth

Table A1. *Unweighted basic statistics*

Variables	Obs	Mean	Std. error	Min	Max
Male children					
Child's age	26,930	11.517	2.851	7	16
Non-white child	26,927	0.519	0.500	0	1
School	26,930	0.927	0.259	0	1
Work	26,930	0.176	0.381	0	1
Rural	26,930	0.235	0.424	0	1
Number of siblings	26,930	3.229	1.674	1	13
First-born child	26,930	0.403	0.491	0	1
Last-born child	26,930	0.368	0.482	0	1
Age diff. w/first-born	26,930	3.239	3.993	0	40
Age diff. w/last-born	26,930	3.598	3.813	0	16
Father's age	26,930	42.596	8.824	22	94
Father's schooling	26,830	5.164	4.404	0	15
Mother's age	26,930	38.287	7.328	22	97
Mother's schooling	26,805	5.386	4.243	0	15
Average spacing	26,930	2.017	1.266	0	14
			Female children		
Child's age	25,437	11.459	2.840	7	16
Non-white child	25,436	0.506	0.500	0	1
School	25,436	0.945	0.228	0	1
Work	25,436	0.087	0.282	0	1
Rural	25,437	0.228	0.420	0	1
Number of siblings	25,437	3.253	1.720	1	13
First-born child	25,437	0.399	0.490	0	1
Last-born child	25,437	0.373	0.484	0	1
Age diff. w/first-born	25,437	3.329	4.077	0	35
Age diff. w/last-born	25,437	3.536	3.770	0	16
Father's age	25,437	42.551	8.819	22	101
Father's schooling	25,345	5.195	4.378	0	15
Mother's age	25,437	38.320	7.351	22	92
Mother's schooling	25,297	5.407	4.223	0	15
Average spacing	25,437	2.012	1.279	0	16

Table A2. *Bivariate probit of child labor and school attendance on birth order and age difference*

Independent variables	Male child				Female child			
	Work		School		Work		School	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Families with at least one child aged 7–16 years old								
First-born child	−0.078**	0.031	−0.030	0.036	−0.086*	0.037	−0.072	0.040
Last-born child	−0.030	0.034	−0.140**	0.041	−0.013	0.040	−0.185**	0.046
Age diff. w/first-born	−0.012**	0.005	0.006	0.005	−0.010*	0.005	0.006	0.005
Age diff. w/last-born	0.009*	0.004	−0.023**	0.005	0.008	0.005	−0.037**	0.006
Child's age	0.284**	0.005	−0.093**	0.006	0.218**	0.006	−0.050**	0.007
Non-white child	−0.055*	0.023	−0.030	0.027	−0.066*	0.027	−0.001	0.030
Father's schooling	−0.060**	0.004	0.059**	0.005	−0.030**	0.005	0.035**	0.006
Mother's schooling	−0.024**	0.004	0.060**	0.005	−0.031**	0.005	0.077**	0.006
Father's age	0.002	0.002	−0.002	0.002	0.000	0.002	−0.004	0.002
Mother's age	−0.001	0.002	−0.001	0.003	−0.002	0.003	−0.005	0.003
Rural	0.882**	0.026	−0.093**	0.029	0.624**	0.029	−0.184**	0.032
Number of children	0.031**	0.010	−0.051**	0.011	0.030**	0.011	−0.034**	0.011
Constant	−4.466**	0.090	2.591**	0.105	−3.977**	0.102	2.504**	0.116
Rho	−0.153**	0.018			−0.150**	0.022		
Log-likelihood	−14,435				−10,567			
Sample size	26,717				25,223			

White's heteroskedastic consistent errors used in all regressions.
* Statistically significant at 5% level.
** Statistically significant at 1% level.

order indicator variables and the age difference variables in isolation. Due to the way the variables are constructed, the *ceteris paribus* assumption does not hold. For instance, a first-born child will always have a zero value for the age difference with respect to the oldest, whereas a non-first-born child will always have strictly positive values. So, in order to interpret these results we obtained a series of predicted probabilities for two representative families: one with only sons and one with only daughters. In both the cases the families are white, urban, have three children, and the mother and father are both 40 years and have five years of schooling. We then varied the age difference between the first-born and last-born from 3 to 9 years in three-year increments. In Figures 1–4, we plot the predicted probabilities of working and attending school for first and last-born children, first for the family with only sons (Figures 1 and 2) and next for family with only daughters

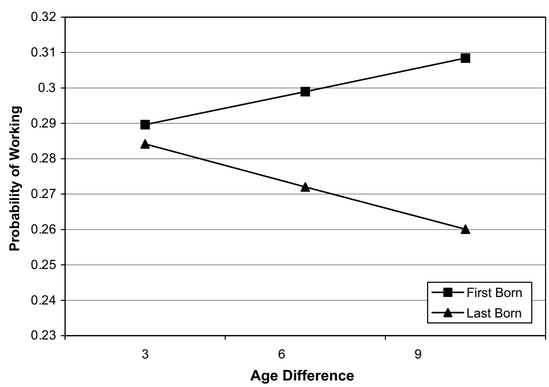

Figure 1. *Predicted probability of working for 15-year-old males from all-male three children families.*

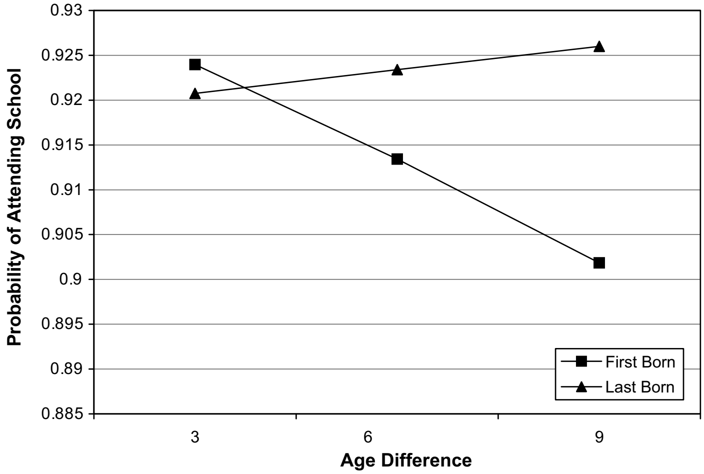

Figure 2. *Predicted probability of attending school for 15-year-old males from all-male three children families.*

(Figures 3 and 4). Both sets of charts reveal the same basic pattern: that there appears to be no real birth order effect when age difference is 3 years, but there appears to be a large birth order effect for age differences of 6 and 9 years, and that the effect increases with age difference. These results are consistent with our model. As for the direction of the effect of birth order, it is as expected: first-borns are more likely to work and less likely to attend school than are last-born children.

Table A3 presents results of a linear probability model estimated using the pooled sample and including controls for female children. In this regression, the coefficient estimates suggest that, in general, last-born male children are less likely to work than their earlier born siblings, and first-born male children are less likely to go to school. For female children, the coefficient estimates suggest that first- and last-born females are more likely to work and less likely to go to school than their middle-born counterparts. [24] The results for female children are somewhat different from the estimated bivariate probit models, which may reflect misspecification from the imposition of a linear model on dichotomous variables.

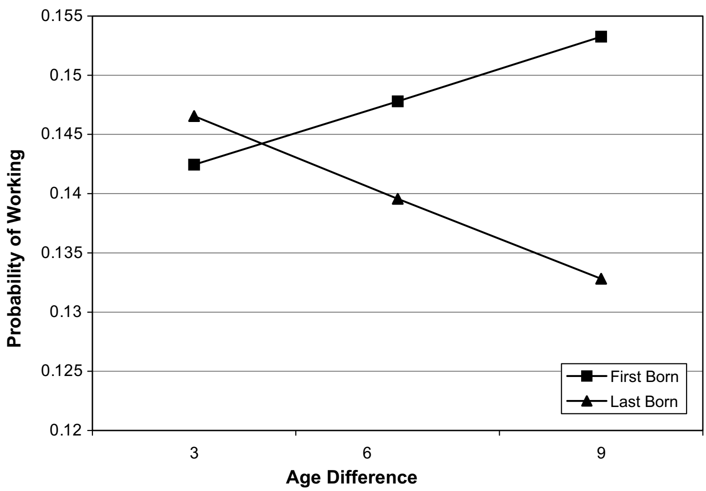

Figure 3. *Predicted probability of working for 15-year-old females from all-female three children families.*

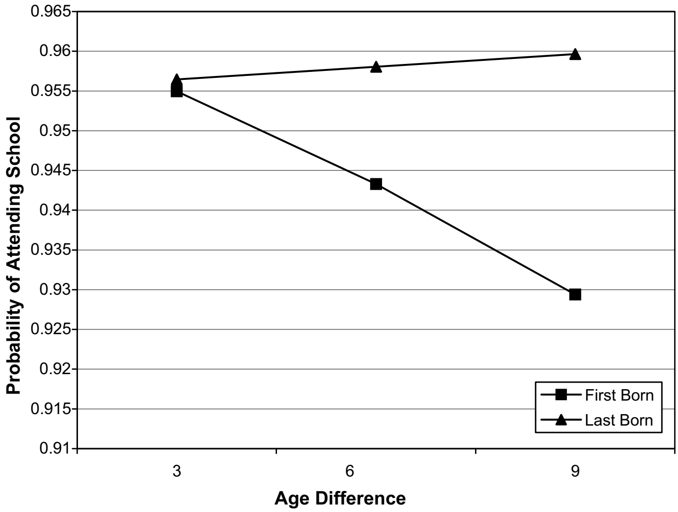

Figure 4. *Predicted probability of attending school for 15-year-old females from all-female three children families.*

Table A3. *OLS of child labor and school attendance on birth order and female indicator variable with pooled sample of families*

Independent variables	Work		School	
	Coeff.	Std. error	Coeff.	Std. error
Families with at least one child aged 7–16 years old				
First-born child	0.000	0.005	−0.017**	0.004
Last-born child	−0.025**	0.005	−0.004	0.004
First-born*Female	0.014*	0.006	−0.008	0.005
Last-born*Female	0.042**	0.006	−0.010*	0.004
Female	−0.106**	0.005	0.024**	0.004
Child's age	0.038**	0.001	−0.009**	0.000
Non-white child	−0.011**	0.003	−0.001	0.002
Father's schooling	−0.006**	0.000	0.003**	0.000
Mother's schooling	−0.003**	0.000	0.005**	0.000
Father's age	0.000	0.000	0.000*	0.000
Mother's age	0.000	0.000	0.000	0.000
Rural	0.164**	0.004	−0.028**	0.003
Number of children	0.008**	0.001	−0.012**	0.001
Constant	−0.262**	0.010	1.073**	0.009
R^2	0.202		0.058	
Sample size	51,941		51,941	

White's heteroskedastic consistent errors used in all regressions.
* Statistically significant at 5% level.
** Statistically significant at 1% level.