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Family Size, Gender, and Birth Order in Brazil

The Implications of Family Size for Adolescents' Education and Work in Brazil: Gender and Birth Order Differences

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Numerous studies have found a negative association between family size and children's outcomes, particularly education. The main theoretical frameworks that explain these negative associations posit that family resources mediate the relationship between family size and children's outcomes, and children are resource receivers only. However, societies in which adolescents often work inside and outside the household and family resources are transferred unequally undermine these assumptions. We implement a twin birth instrumental variable approach and use the nationally representative 1997–2009 PNAD data to examine the impact of family size on school enrollment, labor force, and household work in Brazil. We propose a framework for understanding the implications of family size when adolescents both receive and provide resources in the family unit and these resources may be provided and/or received unequally depending on gender and birth order. While we find no evidence of gender or birth order differences in the effects of family size on education, the results indicate strong gender and birth order differences in adolescents' contributions to their family units. We discuss the implications of our findings for the life course of adolescents.

Introduction

Researchers have long been interested in the influence of family size[1] on children's education. Simply put, the classical dilution of resources model theorizes that family resources (social, cultural, and financial) are diluted within

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families that have more children, and therefore the larger the family, the fewer the resources available per child and the worse the outcomes for each child (Blake 1981). In such a framework, family resources are key for understanding the relationship between family size and children's outcomes such that larger families imply fewer resources per child. The dilution of resources model and most research examining the influence of family size on children's outcomes assume that children only receive resources; however, children and adolescents are resource providers in many parts of the world. Whether adolescents work inside or outside the household likely varies by family size. In developing countries, combining school and work is often the norm for adolescents (Orazem, Glewwe, and Patrinos 2009), and the provision of resources is part of a dynamic process of intra-family transfers. While there are reports that children receive unequal resources based on gender (Parish and Willis 1993; Yu and Su 2006) and birth order (Black, Devereux, and Salvanes 2005; Conley and Glauber 2006; Chu, Xie, and Yu 2007), research has for the most part overlooked differences in the impact of family size on adolescents' provision of resources to the family.

The first goal of this paper is therefore to examine whether there is a *causal* effect of family size on adolescent work in Brazil, in addition to education. To more broadly encompass the reality of adolescents' welfare in Brazil and most developing countries, we move beyond the more common educational outcomes to include economic and household work performed during adolescence. By doing so, we propose a broader conceptualization of the intra-family transfer of resources than suggested by the dilution of resources framework—including economic and household work—that can be applied to the study of the implications of family size for adolescents' welfare. Although Brazil has experienced recent increases in adolescent school enrollment levels, a large proportion of adolescents still drop out of school—a life stage with long-range impacts for social stratification later in life—and work. Importantly, examining educational and work outcomes will also provide a more detailed picture of adolescents' welfare in Brazil and most developing countries, an important counterpoint to the current literature that focuses primarily on the United States or other developed countries.

The second goal of this paper is to examine whether the *causal* effect of family size on adolescent welfare depends on birth order and gender. Are resources distributed equally among siblings? Do siblings provide resources equally to the family? Importantly, we address methodological concerns about the joint determination of children's outcomes and family size. We implement a twin instrumental variable approach and use nationally representative data from the Pesquisa Nacional por Amostra de Domicílio (PNAD) from 1997 to 2009 to measure the effect of family size on the welfare of Brazilian adolescents. While scholars have long recognized that parental predisposition likely shapes family size and children's outcomes simultaneously, researchers have only recently begun to address the issue methodologically. Parents who place a high value on children's *quality* may decide to have fewer children, which could explain the association found in past studies. To explore the issue, researchers have examined children's educational outcomes using the arguably exogenous variation in family size induced by twins (Angrist, Lavy, and Schlosser 2010; Black, Devereux, and Salvanes 2005, 2010; Cáceres-Delpiano 2006; Li, Zhang, and Zhu 2008; Rosenzweig and Wolpin 1980) or by sibling sex composition (Conley and Glauber 2006; Black, Devereux, and Salvanes 2010). The idea is that the birth of twins is out of parents' control and results in an unexpected increase in family size of two rather than one, arguably providing a source of random variation that is not associated with any measurable family background characteristics. This new wave of research has reported findings that differ sharply from earlier results, with studies documenting no significant effects of family size on children's education.

The significance of this work is both conceptual and methodological. First, the analysis uses recent data from Brazil and expands the outcomes assessed to include work performed during adolescence. In addition to examining school enrollment, we also examine enrollment in private school, labor force participation, and household work. By considering that adolescents often provide resources to the family, this research goes beyond previous conceptualizations of family dynamics in studies of the implications of family size for children and adolescents that have principally examined educational outcomes. Thus, a key contribution of this study is the incorporation of theoretically informed variation into the effects of family size on adolescent welfare—variation that depends on the nature of the outcomes examined and on adolescent *gender* and *birth order*. The second contribution is related to the implications of unequal understandings of adolescence. We examine the hypothesis that gender and birth order moderate the ways in which parents invest resources in and receive resources from their children. For example, parents may provide resources in an equitable manner but receive resources in an unequal manner depending on children's gender and birth order, or vice versa. Finally, while previous research has examined the association between family size and children's education, only a few studies have addressed the simultaneous impact of parental predisposition on family size and children's well-being, and therefore have not appropriately assessed the *causal* implications of family size for adolescents. We use the exogenous variation in family size resulting from twins to assess the causal effect of family size on adolescent education and work. In summary, the research questions we address in this paper are: Is there a *causal* effect of family size on work and school enrollment of Brazilian adolescents? Does the effect of family size depend on adolescent birth order or gender?

Family Size, Birth Order, and Gender

The three main explanations for the association between family size and children's outcomes are that: (1) parents in larger families provide fewer resources per child, resulting in lower educational levels (Blake 1981); (2) larger families have a lower average intellectual environment (Zajonc and Markus 1975); and (3) parents who value high "quality" children do not choose to have large families, and therefore the association reflects a spurious rather than causal effect. According to the dilution of resources framework, parental resources constitute the main mechanism connecting family size and children's education: parents in larger families provide fewer resources per child, resulting in lower educational levels (Blake 1981). The confluence model also assumes that resources—in the form of intellectual quality—are key for understanding the association between family size and children's outcomes (Zajonc and Markus 1975). According to Zajonc and Markus, the intellectual quality of parents is higher than that of children, and therefore the average family intellectual quality decreases with each additional child (1975). Both frameworks assume a composition and allocation of family resources in which the flow of resources is almost entirely from parents to children. While these assumptions may be valid in industrialized contexts, in developing countries the allocation of family resources may entail alternative flows of support coming from the extended family, siblings, or the state, therefore mediating the influence of family size on children's well-being (Buchman and Hannum 2001; Powell, Werum, and Steelman 2004). Support from kin networks can even reverse the potentially negative role of family size, leading to advantages for certain children (Lloyd and Blanc 1996; Shavit and Pierce 1991). Siblings may also be resource providers in the family by working or taking care of younger children. In fact, a number of studies have found gender and birth order differences in the associations between family size and education (Black, Devereux, and Salvanes 2005; Conley and Glauber 2006; Chu, Xie, and Yu 2007). While most of the research on these birth order and gender differences speculates that they occur because some children work so that others can gain education (Chu, Xie, and Yu 2007), most studies have overlooked the direct implications of family size on economic and household work *during* adolescence.

Whether birth order and gender are important components in the process of receiving and distributing resources within families depends on whether parents perceive children equally. If parents invest equally in their children, each child in larger families can potentially combine work and school and still provide resources to the family more easily than in smaller families (Mueller 1984). On the other hand, parents may embrace a strategy of diversifying risk based on their children's characteristics; specifically, parents may have some children work while keeping others in school to gain enough education to secure better jobs and support their parents as they age. In this scenario, where some children may depend on labor support from siblings to attend school, we might find that birth order and gender play important roles in the effects of family size on adolescents' outcomes.

Birth Order

Until recently studies have concluded that birth order had a smaller influence on education than family size (Steelman et al. 2002). While firstborn children experience higher levels of parental time and engagement than later-born children, later-born children are more likely to receive financial assistance from parents because older parents are generally in a better financial position than younger parents (Steelman and Powell 1991). More recently, a series of studies using the exogenous variation produced by twin births and sibling sex composition as instrumental variables have challenged the idea that the effects of family size on children's outcomes are larger than those of birth order (Angrist, Lavy, and Schlosser 2010; Black, Devereux, and Salvanes 2005; Conley and Glauber 2006). These studies report large birth order differences, with large negative effects of family size on the education of first- (Black, Devereux, and Salvanes 2005) and second-born children (Conley and Glauber 2006). These results cast doubt on the negligible effects of birth order found in previous studies.

Research from developing countries also casts doubt on the birth order effects found in early studies in developed countries. A tendency of parents to invest in earlier-born children has been documented in Asian societies (Yu and Su 2006). Parents receive faster returns on their investments in earlier-born children than their investments in later-born children, which shapes their strategies for family well-being. In fact, a "chain arrangement," in which the oldest child is educated at the parents' expense and is then obliged to contribute to the education of younger children, has been reported in Asia and Africa (Mueller 1984). This theorized strategy is in line with reports that early birth order is associated with higher use of prenatal care and a higher incidence of doctor presence at delivery in Brazil, which could have long-lasting consequences for children's well-being (Burgard 2004). Although this explanation meshes nicely with the confluence model in which earlier-born children benefit from mentoring younger siblings (Zajonc and Marcus 1975), it stands in contrast to reports from developed countries in which later-born children are better off because of parents' stage in the life course (Steelman and Powell 1991). The idea that parents invest more in earlier-born children also conflicts with evidence that earlier-born girls do particularly poorly in Taiwan (Parish and Willis 1993; Chu, Xie, and Yu 2007) and Mexico (Post 2000), and earlier-born boys spend more time working than their later-born peers in Nicaragua and Guatemala (Dammert 2010). Using 1998 data from Brazil, Emerson and Souza (2008) reported that firstborn children are at an educational disadvantage compared to their later-born peers. On the other hand, birth order was found to be an insignificant predictor of health outcomes for Brazilian children (Sastry and Burgard 2011). It remains unclear whether the combination of birth order and gender mediates the effect of family size on adolescent welfare for recent cohorts of Brazilian adolescents.

Gender

While the dilution of resources framework has assumed gender symmetry in the influence of family size on children's outcomes, there are reasons to believe that this is not the case in most contexts. Gender is a key factor for understanding the consequences of the interaction between receiving and providing resources within the family. The consequences of larger family sizes for adolescents might differ for boys and girls because of the different nature of parental investments; gender may also moderate how adolescents provide resources to the family.

There are three broad conceptual explanations for gender differences in parental investments in children based on family resource allocation. Rational-choice theory predicts that parents invest in their children in order to maximize family well-being (Becker 1981). Parents base their investments in children on their expectations of future returns for the whole family, and therefore reinforce rather than compensate for differences in their children's endowments. Sex differences in the long-term returns to education would therefore explain the higher parental investments in sons over daughters found in some developing countries (Buchmann 2000; Parish and Willis 1993). One study reports that Kenyan parents point to sex differences in wages as a reason for investing more in sons rather than daughters (Buchmann 2000). The family-economy model distinguishes between short- and long-term returns to education, and suggests that families cannot base their investing decisions on long-term returns to education if doing so puts them at risk in the short term. This framework explains why some Brazilian parents pull children out of school and place them in the labor market in response to unemployment shocks (Duryea, Lam, and Levison 2007). The framework can also explain the tendency of Filipino parents to invest more in daughters than in sons, because daughters provide greater financial support to parents (DeGraff, Bilsborrow, and Herrin 1996).

In addition to gender differences in parental investments in their children, adolescent boys and girls might also provide resources to the family differently. The literature on gender and adolescent work in developing countries shows that there are significant gender differences in the nature of adolescent work—boys spend more time working for pay, while girls spend more time on housework (Lloyd, Grant, and Richie 2008). While Brazilian society is not organized around explicit son-preference cultural norms as are some Asian societies, gender is understood through the lens of a patriarchal culture, and thus has important implications for the intra-family allocation of resources. In Latin American societies, the traditional domestic role of women implies that adolescent girls are often expected to perform household chores and care for siblings, a type of work that is significantly more demanding in larger families (Stromquist 1997). Daughters have been traditionally expected to perform domestic chores on a routine basis (Stromquist 1997), while sons work in the informal sector to secure additional income (Orazem, Glewwe, and Patrinos 2009; Post 2000). While the participation of women in the labor market has increased significantly in Brazil (Wajnman and Rios-Neto 1999), the sexual division of household labor is still based on traditional gender roles (Goldani 2002). If the resources granted to and obligations placed on adolescents vary by gender and birth order, then family size may affect the amount of family resources distributed (via education) and provided (via economic work and household work) differently for girls vis-à-vis boys and earlier-born vis-à-vis later-born children. We investigate whether the influence of family size on a series of adolescents' education and work outcomes differ by gender and birth order.

School Enrollment, Economic Work, and Household Work in Brazil

The Brazilian educational system has traditionally exhibited low educational coverage, a high incidence of grade repetition, and low attainment; these outcomes have been associated with high fertility levels, economic problems, and lack of access to schools (Birdsall and Sabot 1996). Smaller cohorts of school-age children (Lam and Marteleto 2006) and educational policies implemented since the mid-1990 s have contributed to recent improvements (Veloso 2009). Despite significant improvements in the 2000 s, a large proportion of Brazilian adolescents still drop out of school during the secondary level (Néri 2009). For example, in 2009, 35.04 percent of 17- and 18-year-olds were out of school. Another noteworthy problem with Brazil's educational system is the large quality divide between public and private schools (Carnoy, Gove, and Marshall 2003). The private-school advantage in test scores was 119.13 points in math and 114.41 points in reading, for example (INEP 2008). Public schools tend to be of worse quality, and access by low-income pupils is highly limited. Importantly, recent research has shown a strengthening of the inequality in private-school access (Marteleto et al. 2012). We therefore examine access to private schools, an important aspect of inequality in adolescents' lives that most studies have neglected.

Concomitant with improvements in adolescent school enrollment rates, child and adolescent labor[2] levels have been declining since the 1990 s (Hoek et al. 2009), although rates remain high (Kassouf 2007). According to our data, nearly a fifth of those age 12 to 16 were working in 2009, for example. Adolescent and child employment rates for males in Brazil are typically about twice as high as those for females (Hoek et al. 2009), with the exception of child domestic servants (Levison and Langer 2010). Child labor rates are higher in rural than in urban areas mainly because of the higher concentration of poor families in rural areas, as well as the low quality of schools and the ease with which children can be incorporated into agricultural work (Kassouf 2007). Employment rates are also highest in the most-developed Southern regions (Levison et al. 2007). As socioeconomic conditions have improved, adolescents have been pushed into the labor market, often combining school and work (Manacorda and Rosati 2010). For example, in 2009, 22.0 percent of the adolescents in our sample were working; 14.4 percent of them combined school and work for more than ten hours a week. This proportion reaches 26.2 percent among males age 15 and 16.

For the most part, child and adolescent household work has been neglected by studies examining paid labor in Brazil. The few studies that have examined household work have reported that girls are more likely to work in the household than boys, and that the likelihood of performing housework increases for girls with working mothers (Connelly, DeGraff, and Levison 1996). Some studies have suggested that housework may be as strong a deterrent to schooling as paid labor (Kruger, Berthelon, and Soares 2010), and in the case of behavioral problems may be even more harmful than paid labor (Benvegnú et al. 2005). Examining the effects of family size on these outcomes provides a more thorough picture of adolescents' welfare in Brazil.

Data and Methods

Data

We use data from the 1997–2009 PNAD (Pesquisa Nacional por Amostra de Domicílio), a nationally representative survey collected annually by the Brazilian Census Bureau (IBGE). The PNAD is a probability-based, stratified, multistage household survey. The sampling design follows a three-step probabilistic procedure based first on municipalities, then census tracts within municipalities, and finally households within sectors. The PNAD contains information on every household and family member, and is therefore a rich source of social, economic, and demographic data, including information on schooling, labor force participation, and hours of household work for all family members older than 10.

Analytical Sample

We use an analytic sample of adolescents from age 12 through 16 to explore whether gender and birth order drives the effect of family size on adolescents' work and education. For the years we examine, the total sample size of the PNAD is 4,601,701; the sample size of adolescents age 12 to 16 is 175,233. The choice to include individuals age 12 to 16 is both theoretical and practical. Theoretically, in Brazil, while primary school enrollment has recently reached universal levels, secondary school enrollment levels are far from ideal. Adolescents are at the most vulnerable age for dropping out of school. In practical terms, because the PNAD is a household survey, the data do not allow a count of the total number of siblings for those who do not live with their parents. Because our focus is family size and in Brazil most adolescents age 12 to 16 live with at least one parent, this sample permits analyses of adolescent outcomes that account for sibship size. To accurately include family size in the models, we restrict the sample to children of the family head. We tested for differences in the samples of children and non-children of the family head and did not find significant differences between the two groups. Despite this restriction, we may be missing children living outside the household, an issue also faced by previous research (e.g., Càceres-Delpiano 2006; Conley and Glauber 2006; Li, Zhang, and Zhu 2008; Lu and Treiman 2008). A few years of PNAD data offer reports on women's number of living children, which provide a direct way to test the reliability of our count measure, an improvement over these past studies; however, the benefits are limited because there is no information on birth order, a necessary variable for our analysis. Nonetheless, to verify the reliability of our measure, we compared these reports with the count of the number of children of the family head in the household: we found a 94-percent concordance for our analytical sample of children of mothers younger than 40. We therefore restrict our analyses to children of mothers younger than age 40 to ensure that this is a young sample of mothers who are not likely to have older children outside the household. Each of our analytical samples is larger than 21,000 cases, most reaching 40,000.

Analytical Strategy

The statistical literature proposes the use of linear probability models as an appropriate approach for estimating models when both the dependent variable and the instrument are dichotomous (Cameron and Trivedi 2009; Heckman and Macurdy 1985; Wooldridge 2013). The standard practice is to estimate family size coefficients through OLS models (*naïve* or spurious model) and then attempt to establish the *causal* effect of family size through 2SLS models.[3] We also compare marginal effects of family size estimated through logistic regression models (evaluated at the sample mean for all variables) with OLS coefficients of family size. We first used ordinary least squares (OLS) and logistic regression models to examine the relationship between family size and each of the six outcomes of adolescent welfare: school enrollment, private-school enrollment, labor force participation, working for pay more than ten hours a week, household work participation, and working in the household more than ten hours a week. We then used a twin approach to attempt to establish the causal effect of family size on each outcome. We estimated two-stage least squares (2SLS) models. In the first stage of the models, the presence of twins (in addition to the vector of control variables X described below) predicts the number of siblings:

$$\text{NSIB} = \alpha_0 + \alpha_1 \text{TWIN} + \alpha_2 \text{X} + \text{d} \tag{1}$$

We estimate the following equation in the second stage:

$$\text{OUTCOME} = \beta_0 + \beta_1 \widehat{\text{NSIB}} + \beta_2 X + \varepsilon \tag{2}$$

where OUTCOME refers to each of six outcomes reflecting adolescents' welfare. Each outcome we examine—school enrollment, private-school enrollment, labor force participation, labor force participation for more than ten hours a week, housework, and housework for more than ten hours a week—is coded as a dummy variable where 1 means participating in the corresponding activity. The control measures represented by vector X are included in both equations 1 and 2. The models include controls for the ages of the adolescent, the mother, and the father, each of which is coded as a continuous variable. Mother's and father's schooling are also coded as continuous variables. Three dummy variables define skin color: black, *pardo* (mixed race), and Asian; white is the omitted category. We also controlled for family income (in 2001 *Reais*).[4] We also included a dummy variable for urban versus rural residence; rural is the omitted category. Because of Brazil's significant geographic diversity, we also included a variable indicating Brazil's five main regions; Southeast is the omitted category.[5] Importantly, we included dummy variables for year.[6] We estimated the models separately by gender to examine whether the differences between coefficients were statistically significant. All of our specifications are estimated with the robust standard error procedure in STATA. It is worth noting that our large sample sizes ensure efficient robust standard errors for all specifications, which are unbiased with respect to heteroskedasticity and autocorrelation.[7]

The validity and limitations of using twins as an instrumental variable

The argument for using twins as an instrumental variable is that the birth of twins implies an increase in family size that is not a result of the parents' desired family size, which therefore removes the endogeneity between family size and children's outcomes. The use of twins to handle endogeneity bias was first implemented by Rosenzweig and Wolpin (1980). Recent research has proposed examining the outcomes of nth order children in families of $n + 1$ or more children, using the birth of twins at the nth + 1 order as an instrumental variable (Angrist, Lavy, and Schlosser 2010; Black, Devereux, and Salvanes 2005, 2010). There are two main reasons for examining children born prior to the nth birth separately by family size. First, family preferences with regard to having an additional child (therefore increasing family size) differ significantly by family size. That is, by restricting the sample to families with at least n births, we make sure that, on average, preferences over family size are the same in the families with twins at the nth birth and those with singleton births. Second, selecting a sample of children at a birth order lower than that of the twins avoids selection problems that arise because families who choose to have another child after a twin birth likely differ from families who choose to have another child after a singleton birth. We follow this approach to construct our instrumental variables and to implement the 2SLS models. We first restrict the sample to families with at least two children and examine firstborn adolescents (twin at second pregnancy as the instrumental variable). Next, we restrict the sample to families with at least three children and examine first- and second-born children (twin at third birth as the instrumental variable). Finally, we restrict the sample to families with at least four children to examine first-, second-, and third-borns (twin at fourth birth as the instrumental variable).

To adequately address our research questions, a good instrument should be correlated with our outcomes only through family size; the occurrence of twins must be a random event in the population at large. A possible threat to this assumption is the use of new reproductive techniques such as fertility drugs and in vitro fertilization (IVF). The issue arises because parents who make use of IVF and fertility drugs—and therefore are more likely to have twins—are potentially different than parents who do not use these treatments. While we cannot control for unobserved family characteristics such as opting and not opting for IVF, we can control for observable differences such as parents' education and income. Following past research (Black, Devereux, and Salvanes 2005, 2010), we examine whether the occurrence of twins is associated with observable family characteristics. We find that the probability of having twins is uncorrelated with parents' education and family income.

Results

Descriptive Results

Table 1 provides summary statistics for our analytic samples. Schooling decreases for adolescents in larger families; for example, first-, second-, and third-order girls in families of four or more children had on average almost one less year of schooling (0.94) than their peers in families of two or more children. We also find a gender difference favoring girls that increases in larger families—while firstborn girls in families of two or more children have 0.47 years more schooling than boys, this difference reaches 0.59 years for adolescents in families of four or more children. Table 1 also shows that a similar proportion of firstborn adolescent boys and girls are enrolled in school in all subsamples.

The descriptive statistics for work offer a different story: they show large differences associated with both gender and birth order. For example, among firstborn adolescents in families with two or more children, 27 percent of boys but only 15 percent of girls were in the labor force. There are also large gender differences in the proportions of boys and girls performing household work. Only 51 percent of firstborn boys reported doing housework, compared to 84 percent of firstborn girls. The gender differences in housework are large in all samples.

Table 1 also shows that the mothers of the adolescents in our samples have higher levels of education than fathers; mothers' education ranges from 4.06 to 6.47 years of schooling, depending on the sample, while fathers' education ranges from 3.80 to 6.13. About half of the sample is non-white and, not surprisingly, this proportion increases among larger families. Brazil is overwhelmingly urban, and our samples reflect that: more than 69 percent live in urban areas, with 82 percent of firstborn adolescent girls in families of two or more children residing in urban areas.

Table 2 provides the proportions of adolescents enrolled in school, enrolled in private school, participating in the labor market, and performing household work by family size. As expected, school enrollment levels are lower among adolescents in larger families compared to those in smaller families—95.32 percent of only-child adolescents were enrolled in school, while only 86.11 percent of their counterparts in families of six or more children were enrolled. Enrollment levels are lower among boys vis-à-vis girls, and the gap favoring girls increases in larger families. The larger the family, the smaller the proportion of adolescents enrolled in private school.

Considering the work variables, table 2 shows that the larger the family, the greater the percentage of adolescents in the labor force; only 15.97 percent of only children are in the labor force, compared to 35.21 percent of those in families of six or more children. The trend is similar for working more than ten hours a week, but the gender difference increases with family size—in families with six or more children, 37.61 percent of boys but only 16.91 percent of girls worked for more than ten hours a week. As expected, there are also gender differences in the proportions doing household work. For example, 81.23 percent of only-child girls performed household work, compared to only 48.52 percent of only-child boys. This gender difference remains in larger families. Overall, girls are overrepresented in performing household work, while boys participate in the labor force at higher rates. Notably, whereas the percentage of boys doing housework hardly varies as family size increases, the percentage of girls working in the household—which is already high—increases significantly as family size increases.

Table 1. Summary Statistics of Adolescents (ages 12–16): Brazil, 1997 to 2009

	Firstborn in families 2 +		First- and second-born in families 3 +		First-, second-, and third-born in families 4 +	
Variable	Girl	Boy	Girl	Boy	Girl	Boy
Years of schooling	5.78 (2.00)	5.31 (2.09)	5.39 (2.06)	4.86 (2.14)	4.84 (2.08)	4.25 (2.15)
School enrollment	0.96 (0.20)	0.94 (0.24)	0.94 (0.23)	0.92 (0.28)	0.92 (0.27)	0.88 (0.32)
Enrolled in private school[a]	0.12 (0.33)	0.12 (0.32)	0.06 (0.25)	0.06 (0.24)	0.02 (0.14)	0.02 (0.14)
Labor force participation	0.15 (0.36)	0.27 (0.44)	0.18 (0.39)	0.32 (0.47)	0.21 (0.41)	0.37 (0.48)
Worked more than 10 hours per week[a]	0.09 (0.29)	0.20 (0.40)	0.12 (0.32)	0.24 (0.43)	0.14 (0.35)	0.29 (0.46)
Household work	0.84 (0.36)	0.51 (0.50)	0.87 (0.34)	0.51 (0.50)	0.88 (0.32)	0.50 (0.50)
Worked in household more than 10 hours per week	0.45 (0.50)	0.10 (0.30)	0.49 (0.50)	0.11 (0.31)	0.50 (0.50)	0.10 (0.30)
Age	13.88 (1.39)	13.93 (1.40)	13.86 (1.39)	13.92 (1.40)	13.83 (1.38)	13.90 (1.39)
Mother's education	6.47 (4.00)	6.39 (4.01)	5.38 (3.80)	5.34 (3.82)	4.13 (3.33)	4.06 (3.33)
Father's education	6.13 (4.18)	6.02 (4.20)	5.10 (4.01)	5.05 (4.05)	3.88 (3.56)	3.80 (3.56)
Race	0.52 (0.50)	0.55 (0.50)	0.59 (0.49)	0.62 (0.49)	0.67 (0.47)	0.69 (0.46)
Number of siblings	1.85 (1.13)	1.86 (1.15)	2.76 (2.76)	2.78 (1.18)	3.86 (1.21)	3.89 (1.23)
Twins in the family	0.01 (0.12)	0.01 (0.11)	0.02 (0.14)	0.02 (0.14)	0.03 (0.18)	0.04 (0.19)
Twins at second birth	0.01 (0.08)	0.01 (0.08)	0.01 (0.09)	0.01 (0.08)	0.00 (0.06)	0.00 (0.07)
Twins at third birth	0.00 (0.06)	0.00 (0.06)	0.01 (0.08)	0.01 (0.09)	0.01 (0.11)	0.01 (0.12)
Twins at fourth birth	0.00 (0.04)	0.00 (0.04)	0.00 (0.06)	0.00 (0.06)	0.01 (0.09)	0.01 (0.09)
Urban	0.82 (0.39)	0.81 (0.39)	0.77 (0.42)	0.76 (0.43)	0.69 (0.46)	0.69 (0.46)
North	0.13 (0.33)	0.13 (0.33)	0.15 (0.36)	0.15 (0.36)	0.18 (0.38)	0.18 (0.38)

Northwest	0.30 (0.46)	0.31 (0.46)	0.34 (0.47)	0.35 (0.48)	0.40 (0.49)	0.40 (0.49)
South	0.16 (0.37)	0.16 (0.37)	0.14 (0.34)	0.13 (0.34)	0.12 (0.32)	0.11 (0.31)
Southwest	0.29 (0.45)	0.28 (0.45)	0.26 (0.44)	0.26 (0.44)	0.23 (0.42)	0.22 (0.42)
Center-West	0.12 (0.33)	0.12 (0.33)	0.11 (0.32)	0.11 (0.32)	0.08 (0.28)	0.08 (0.28)
[N]	40,843	44,656	37,571	40,574	21,008	22,615

Source: 1997–2009 PNAD data. IBGE (National Household Sample Survey).
Note: Standard deviations in parentheses.
[a] Only available from 2001 to 2009.

Multivariate Results

Table 3 shows results for the first-stage 2SLS models. The results are interesting in that they show the influence of a multiple birth on the increase in family size. The first-stage estimates are strong and suggest that a multiple birth increases family sizes by about 0.6 to 0.9. This is in line with findings from past research in other countries (Black, Devereux, and Salvanes 2010; Angrist, Lavy, and Schlosser 2010; Li, Zhang, and Zhu 2008). The *F*-statistics for the first stage are generally above 60, indicating that there are no concerns with weak instruments in the use of twins for the analyses.

Tables 4, 5, and 6 show results for the models implemented for both sexes (columns 1–3) and for females (columns 4–6) and males (columns 7–9) separately. Regression models are presented separately by subsamples. As explained above, we use different samples of adolescents corresponding to a birth order lower than that of the twins (the instrumental variable) to avoid selection problems: subsample 1 is composed of firstborn adolescents in families with at least two children; subsample 2 is composed of first- and second-borns in families with at least three children; and subsample 3 is composed of first-, second-, and third-born children in families with at least four children. The tables report coefficients for family size and coefficients for the dummy variables representing birth order for samples 2 and 3, which include more than one birth order.

Table 4 shows results for the models of school enrollment (panel A) and enrollment in private school (panel B). Results from logistic regression models (in columns 1, 4, and 7) and OLS regression models (columns 2, 4, and 8) confirm that the higher the number of siblings, the lower the probability of school enrollment. All OLS coefficients and logistic regression marginal effects representing family size in panel A are negative and statistically significant at the 0.01 level. While we do not report results for additional controls due to space limitations, the control variables have the expected signs. In general, rural children have worse educational outcomes than their urban peers, as do those with lower-educated parents and lower levels of family

Table 2. Adolescents' Outcome Variables According to Family Size (Ages 12–16): Brazil, 1997 to 2009 Proportions of Adolescents Who…

Family Size	… were enrolled in school			… were enrolled in private school[a]			… worked in the labor market			… worked more than 10 hours per week[a]			… performed household work			… worked in household more than 10 hours per week			[N]
	All	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All	Girls	Boys	
1	95.32	96.30	94.43	0.19	0.20	0.19	15.97	11.76	19.80	10.62	6.61	14.27	64.11	81.23	48.52	0.23	0.39	0.10	14,129
	(21.12)	(18.87)	(22.94)	(0.40)	(0.40)	(0.39)	(36.63)	(32.22)	(39.85)	(30.81)	(24.84)	(34.98)	(47.97)	(39.05)	(49.98)	(0.42)	(0.49)	(0.29)	
2	96.75	97.43	96.13	0.16	0.17	0.16	16.76	11.90	21.26	11.16	6.90	15.10	64.89	82.06	48.98	0.24	0.40	0.10	60,143
	(17.73)	(15.83)	(19.30)	(0.37)	(0.37)	(0.36)	(37.35)	(32.38)	(40.91)	(31.49)	(25.35)	(35.81)	(47.73)	(38.37)	(49.99)	(0.43)	(0.49)	(0.29)	
3	95.51	96.57	94.54	0.09	0.09	0.09	20.57	14.84	25.88	14.39	9.38	19.03	67.17	85.47	50.20	0.26	0.46	0.10	51,859
	(20.70)	(18.20)	(22.73)	(0.29)	(0.29)	(0.29)	(40.42)	(35.55)	(43.80)	(35.10)	(29.16)	(39.25)	(46.96)	(35.24)	(50.00)	(0.44)	(0.50)	(0.30)	
4	92.93	94.33	91.62	0.03	0.03	0.03	24.74	17.89	31.22	17.96	11.78	23.81	68.20	87.59	49.85	0.27	0.48	0.10	24,609
	(25.63)	(23.14)	(27.72)	(0.17)	(0.17)	(0.18)	(43.15)	(38.33)	(46.34)	(38.39)	(32.23)	(42.60)	(46.57)	(32.97)	(50.00)	(0.45)	(0.50)	(0.30)	
5	90.70	92.24	89.24	0.01	0.02	0.01	28.69	20.27	36.73	21.32	13.64	28.66	68.61	87.82	50.27	0.28	0.50	0.10	11,983
	(29.04)	(26.75)	(31.00)	(0.12)	(0.12)	(0.12)	(45.23)	(40.20)	(48.21)	(40.96)	(34.32)	(45.22)	(46.41)	(32.71)	(50.00)	(0.45)	(0.50)	(0.30)	
6 +	86.11	89.17	83.34	0.01	0.01	0.01	35.21	24.06	45.32	27.77	16.91	37.61	66.81	88.56	47.10	0.28	0.52	0.10	12,504
	(34.59)	(31.08)	(37.27)	(0.08)	(0.08)	(0.08)	(47.77)	(42.75)	(49.78)	(44.79)	(37.49)	(48.44)	(47.09)	(31.83)	(49.92)	(0.45)	(0.50)	(0.29)	

Source: 1997–2009 PNAD data. IBGE (National Household Sample Survey).
Note: Standard deviations in parentheses.
[a] Only available from 2001 to 2009.

Table 3. First Stage of Two-Stage Least Squares (2SLS) Estimates of the Effect of a Twin Birth on Family Size (Ages 12–16): Brazil, 1997 to 2009

Birth Order and Gender	All		Girls		Boys	
	Coefficient	[*N*]	Coefficient	[*N*]	Coefficient	[*N*]
Sample: First child in families of 2+ children	0.693**	85,499	0.634**	40,843	0.751**	44,656
(Instrument: twin at second order)	(0.034)		(0.047)		(0.048)	
Sample: First and second children in families 3 +	0.852**	78,145	0.869**	37,571	0.837**	40,574
(Instrument: twin at third order)	(0.043)		(0.062)		(0.060)	
Sample: First, second, and third children in families 4 +	0.794**	43,623	0.819**	21,008	0.775**	22,615
(Instrument: twin at fourth order)	(0.056)		(0.073)		(0.084)	

Source: 1997–2009 PNAD data. IBGE (National Household Sample Survey).
Note: Robust standard errors in parentheses.
** $p < 0.01$

income. Non-white adolescents are less likely to be enrolled in school than their white peers; girls have higher chances of school enrollment. Importantly, the results for the control variables are similar across all models.

The 2SLS estimates reported in column 3 reflect the effects of an additional sibling on school enrollment for adolescents who experienced an unexpected increase in family size caused by a multiple rather than a singleton birth. Contrary to the results from logistic and OLS regression models, the results from the 2SLS models show no strong adverse effects of family size on school enrollment. The coefficients are small, and only one is marginally significant (0.10 level). Analyses by gender (shown in column 6 for girls and column 9 for boys) confirm that there is no large negative effect of family size on enrollment when we estimate models that attempt to purge the endogeneity between family size and adolescent education. However, the results in column 6 indicate that first- and second-born girls with an additional sibling have higher probabilities of school enrollment than their counterparts with one fewer sibling, though the coefficients are only marginally significant at the 0.10 level. Examining the birth order coefficients, we find additional important patterns. The coefficient representing third-order adolescents is positive for girls (0.025) and statistically significant at the 0.05 level, which suggests that later-born girls have an educational advantage over firstborn girls, although this advantage is not related to family size.

Panel B of table 4 shows results from models similar to the ones discussed above but for private-school enrollment. Column 3 of panel B shows that an addi-

Table 4. Logistic (MFX), Ordinary Least Square (OLS), and Two-Stage Least Squares (2SLS) Estimates of the Effect of Family Size on Adolescents' Educational Outcomes (Ages 12–16): Brazil, 1997 to 2009

	All			Girls			Boys		
	MFX	OLS	2SLS	MFX	OLS	2SLS	MFX	OLS	2SLS
Birth Order and Sex	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: School Enrollment									
Sample: 1st child in families of 2 + children									
Family size coefficient	–0.006**	–0.018 **	0.013	–0.005**	–0.016**	0.025 +	–0.007**	–0.020**	0.003
(Instrument: twin at 2nd)	(0.000)	(0.001)	(0.011)	(0.000)	(0.001)	(0.014)	(0.001)	(0.001)	(0.017)
		[–.009 .035]			[–.003 .052]			[–.030 .036]	
Sample: 1st & 2nd children in families of 3 + children									
Family size coefficient	–0.008**	–0.021**	0.019 +	–0.007**	–0.019**	0.024 +	–0.009**	–0.023**	0.014
(Instrument: twin at 3rd)	(0.000)	(0.001)	(0.011)	(0.001)	(0.001)	(0.013)	(0.001)	(0.002)	(0.017)
Controlling for:		[–.002 .041]			[–.001 .050]			[–.020 .047]	
Second birth order	0.002	0.004*	–0.004	0.004*	0.007**	0.000	0.000	0.000	–0.007
(omitted: 1st order)	(0.001)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)
Sample: 1st, 2nd, and 3rd children in families of 4 + children									
Family size coefficient	–0.011**	–0.019**	–0.020	–0.009**	–0.017**	–0.014	–0.012**	–0.021**	–0.024
(Instrument: twin at 4th)	(0.001)	(0.001)	(0.020)	(0.001)	(0.002)	(0.027)	(0.001)	(0.002)	(0.030)
Controlling for:		[–.060 .019]			[–.067 .039]			[–.083 .034]	
Second birth order	0.004	0.005	0.005	0.008*	0.011**	0.011 +	0.000	–0.001	0.000
(omitted: 1st order)	(0.002)	(0.003)	(0.005)	(0.003)	(0.004)	(0.006)	(0.004)	(0.005)	(0.007)
Third birth order	0.016**	0.020**	0.021*	0.019**	0.026**	0.025*	0.012**	0.015**	0.016
(omitted: 1st order)	(0.003)	(0.003)	(0.009)	(0.003)	(0.005)	(0.012)	(0.004)	(0.005)	(0.013)

Panel B: Enrollment in Private School[a]									
	Sample: 1st child in families of 2+ children								
Family size coefficient	−0.013**	−0.006**	−0.067**	−0.014**	−0.007**	−0.047	−0.011**	−0.005**	−0.083**
(*Instrument: twin at 2nd*)	(0.001)	(0.001)	(0.017)	(0.001)	(0.001)	(0.030)	(0.001)	(0.001)	(0.020)
	[−.101 −.033]			[−.106 .012]			[−.122 −.044]		
	Sample: 1st and 2nd children in families of 3+ children								
Family size coefficient	−0.004**	−0.002**	0.022	−0.005**	−0.003**	0.016	−0.003	−0.001	0.028
(*Instrument: twin at 3rd*)	(0.000)	(0.001)	(0.015)	(0.001)	(0.001)	(0.019)	(0.001)	(0.001)	(0.023)
Controlling for:		[−.007 .051]			[−.021 .054]			[−.016 .072]	
Second birth order	−0.002**	0.000	−0.004	−0.002*	−0.012**	−0.003	−0.002**	0.000	−0.005
(omitted: 1st order)	(0.001)	(0.002)	(0.003)	(0.001)	(0.003)	(0.004)	(0.001)	(0.003)	(0.005)
	Sample: 1st, 2nd, and 3rd children in families of 4+ children								
Family size coefficient	−0.001**	−0.001*	−0.001	−0.001	−0.001	−0.008	−0.001*	−0.001*	0.006
(*Instrument: twin at 4th*)	(0.000)	(0.001)	(0.010)	(0.000)	(0.001)	(0.011)	(0.000)	(0.001)	(0.015)
Controlling for:		[−.020 .019]			[−.030 .014]			[−.024 .037]	
Second birth order	0.000	0.004 +	0.004	0.000	0.003	0.004	0.000	0.004	0.003
(omitted: 1st order)	(0.001)	(0.002)	(0.003)	(0.001)	(0.003)	(0.003)	(0.001)	(0.003)	(0.004)
Third birth order	−0.001 +	0.003	0.003	0.000	0.006 +	0.009	−0.002*	0.001	−0.002
(omitted: 1st order)	(0.001)	(0.002)	(0.004)	(0.001)	(0.003)	(0.005)	(0.001)	(0.003)	(0.006)

Source: 1997–2009 PNAD data. IBGE (National Household Sample Survey).

Note: Robust standard errors in parentheses. 2SLS coefficient 95% confidence interval in brackets. Marginal effects from logistic regression models evaluated at the sample mean for all variables. All models include controls for adolescents' age and mother's and father's age, mother's and father's schooling, race dummies, family income, area and region of residence.

[a] Only available for 2001–2009 PNAD.

** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table 5. Logistic (MFX), Ordinary Least Square (OLS) and Two-Stage Least Squares (2SLS) Estimates of the Effect of Family Size on Adolescents' Work (Ages 12–16): Brazil, 1997 to 2009

	All			Girls			Boys		
	MFX	OLS	2SLS	MFX	OLS	2SLS	MFX	OLS	2SLS
Birth Order and Sex	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Labor force participation									
Sample: 1st child in families of 2+ children									
Family size coefficient	0.015**	0.019**	0.059**	0.011**	0.016**	0.058 +	0.019**	0.022**	0.064*
(Instrument: twin at 2nd)	(0.001)	(0.001)	(0.023)	`	(0.002)	(0.034)	(0.002)	(0.002)	(0.030)
		[.015 .104]			[–.008 .125]			[.005 .122]	
Sample: 1st and 2nd children in families of 3+ children									
Family size coefficient	0.015**	0.017**	0.000	0.008**	0.011**	0.032	0.023**	0.023**	–0.030
(Instrument: twin at 3rd)	(0.001)	(0.001)	(0.020)	(0.002)	(0.002)	(0.027)	(0.002)	(0.002)	(0.028)
Controlling for:		[–.039 .038]			[–.021 .085]			[–.084 .025]	
Second birth order	0.003	0.006*	0.009*	0.003	0.006 +	0.003	0.004	0.006	0.017*
(omitted: 1st order)	(0.003)	(0.003)	(0.005)	(0.004)	(0.004)	(0.006)	(0.005)	(0.004)	(0.007)
Sample: 1st, 2nd, and 3rd children in families of 4+ children									
Family size coefficient	0.018**	0.018**	0.005	0.010**	0.011**	–0.032	0.026**	0.023**	0.049
(*Instrument: twin at 4th*)	(0.002)	(0.002)	(0.028)	(0.002)	(0.002)	(0.034)	(0.003)	(0.003)	(0.046)
Controlling for:		[–.050 .061]			[–.098 .034]			[–.042 .139]	
Second birth order	0.004	0.007	0.009	0.003	0.007	0.014 +	0.007	0.009	0.004
(omitted: 1st order)	(0.005)	(0.005)	(0.007)	(0.006)	(0.006)	(0.008)	(0.008)	(0.007)	(0.011)
Third birth order	–0.031**	–0.022**	–0.017	–0.017*	–0.008	0.010	–0.046**	–0.033**	–0.043*
(omitted: 1st order)	(0.006)	(0.005)	(0.013)	(0.007)	(0.007)	(0.016)	(0.009)	(0.008)	(0.019)

Sample: 1st child in families of 2+ children									
Family size coefficient	0.011**	0.017**	0.047*	0.008**	0.013**	0.052 +	0.015**	0.021**	0.048 +
(*Instrument: twin at 2nd)*	(0.001)	(0.001)	(0.020)	(0.001)	(0.002)	(0.029)	(0.001)	(0.002)	(0.028)
		[.008 .087]			[–.005 .108]			[–.007 .103]	
Sample: 1st and 2nd children in families of 3+ children									
Family size coefficient	0.012**	0.016**	0.029	0.006**	0.008**	0.034	0.019**	0.023**	0.024
(*Instrument: twin at 3rd)*	(0.001)	(0.001)	(0.018)	(0.001)	(0.002)	(0.024)	(0.002)	(0.002)	(0.027)
Controlling for:		[–.007 .064]			[–.013 .081]			[–.029 .076]	
Second birth order	0.005*	0.010**	0.008 +	0.005	0.009**	0.005	0.007	0.012**	0.012 +
(omitted: 1st order)	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)	(0.005)	(0.004)	(0.004)	(0.007)
Sample: 1st, 2nd, and 3rd children in families of 4+ children									
Family size coefficient	0.015**	0.017**	–0.008	0.008**	0.009**	–0.011	0.023**	0.022**	0.002
(*Instrument: twin at 4th)*	(0.001)	(0.002)	(0.026)	(0.002)	(0.002)	(0.031)	(0.003)	(0.003)	(0.042)
Controlling for:		[–.059 .044]			[–.071 .049]			[–.081 .084]	
Second birth order	0.005	0.009*	0.014*	0.006	0.011*	0.015*	0.005	0.010	0.014
(omitted: 1st order)	(0.004)	(0.004)	(0.006)	(0.005)	(0.005)	(0.007)	(0.007)	(0.006)	(0.010)
Third birth order	–0.026**	–0.016**	–0.007	–0.010 +	0.000	0.008	–0.044**	–0.030**	–0.022
(omitted: 1st order)	(0.005)	(0.005)	(0.012)	(0.006)	(0.006)	(0.014)	(0.008)	(0.007)	(0.018)

Source: 1997–2009 PNAD data. IBGE (National Household Sample Survey).

Note: Robust standard errors in parentheses. 2SLS coefficient 95% confidence interval in brackets. Marginal effects from logistic regression models evaluated at the sample mean for all variables. All models include controls for adolescents' age and mother's and father's age, mother's and father's schooling, race dummies, family income, area and region of residence.

** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

Table 6. Logistic (MFX), Ordinary Least Square (OLS) and Two-Stage Least Squares (2SLS) Estimates of the Effect of Family Size on Adolescents' Household Work (Ages 12–16): Brazil, 1997 to 2009

	All			Girls			Boys		
	MFX	OLS	2SLS	MFX	OLS	2SLS	MFX	OLS	2SLS
Birth Order and Sex	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Household work									
Sample: 1st child in families of 2+ children									
Family size coefficient (Instrument: twin at 2nd)	0.003 +	0.003*	0.030	0.001	0.000	0.004	0.004 +	0.006*	0.052
	(0.002)	(0.001)	(0.026)	(0.002)	(0.002)	(0.033)	(0.002)	(0.002)	(0.039)
		[–.021 .081]			[–.062 .069]			[–.023 .128]	
Sample: 1st & 2nd children in families of 3+ children									
Family size coefficient	–0.004*	–0.002	0.045*	–0.003	–0.002	0.020	–0.003	–0.001	0.062 +
(Instrument: twin at 3rd)	(0.002)	(0.001)	(0.021)	(0.002)	(0.001)	(0.023)	(0.002)	(0.002)	(0.034)
Controlling for:		[.005 .086]			[–.025 .065]			[–.004 .128]	
Second birth order	–0.011**	–0.015**	–0.024**	0.005	0.001	–0.003	–0.026**	–0.030**	–0.043**
(omitted: 1st order)	(0.004)	(0.003)	(0.005)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.008)
Sample: 1st, 2nd, and 3rd children in families of 4+ children									
Family size coefficient (*Instrument: twin at 4th*)	–0.002	–0.001	–0.024	0.000	0.001	0.018	–0.004	–0.003	–0.060
	(0.002)	(0.002)	(0.029)	(0.002)	(0.002)	(0.029)	(0.003)	(0.003)	(0.050)
Controlling for:		[–.080 .032]			[–.040 .075]			[–.158 .037]	
Second birth order	–0.027**	–0.026**	–0.022**	–0.006	–0.007	–0.009	–0.043**	–0.045**	–0.035**
(omitted: 1st order)	(0.005)	(0.005)	(0.007)	(0.005)	(0.005)	(0.007)	(0.008)	(0.008)	(0.012)

Third birth order	−0.056**	−0.055**	−0.046**	−0.019**	−0.025**	−0.032*	−0.078**	−0.084**	−0.062**
(omitted: 1st order)	(0.007)	(0.005)	(0.013)	(0.006)	(0.006)	(0.014)	(0.009)	(0.009)	(0.021)
Panel B: Worked in household more than 10 hours a week									
Sample: 1st child in families of 2+ children									
Family size coefficient	0.005**	0.007**	0.031	0.011**	0.013**	0.029	0.002 +	0.003*	0.031
Instrument: twin at 2nd)	(0.001)	(0.001)	(0.027)	(0.003)	(0.003)	(0.050)	(0.001)	(0.002)	(0.028)
		[−.023 .084]			[−.069 .127]			[−.023 .086]	
Sample: 1st and 2nd children in families of 3+ children									
Family size coefficient	0.004**	0.005**	0.047*	0.009**	0.009**	0.084*	0.002	0.002	0.011
(Instrument: twin at 3rd)	(0.002)	(0.002)	(0.023)	(0.003)	(0.003)	(0.041)	(0.001)	(0.002)	(0.024)
Controlling for:		[.002 .091]			[.004 .164]			[−.036 .058]	
Second birth order	−0.009*	−0.010**	−0.018**	−0.006	−0.009	−0.021*	−0.009**	−0.010**	−0.012*
(omitted: 1st order)	(0.004)	(0.003)	(0.005)	(0.006)	(0.006)	(0.009)	(0.003)	(0.003)	(0.006)
Sample: 1st, 2nd, and 3rd children in families of 4+ children									
Family size coefficient	0.006**	0.006**	0.027	0.010**	0.010**	0.030	0.003 +	0.003 +	0.023
(Instrument: twin at 4th)	(0.002)	(0.002)	(0.032)	(0.004)	(0.004)	(0.057)	(0.002)	(0.002)	(0.035)
Controlling for:		[−.036 .089]			[−.081 .141]			[−.045 .092]	
Second birth order	−0.017**	−0.017**	−0.020**	−0.023*	−0.023*	−0.026*	−0.011*	−0.013*	−0.017*
(omitted: 1st order)	(0.005)	(0.005)	(0.007)	(0.010)	(0.009)	(0.012)	(0.005)	(0.005)	(0.008)
Third birth order	−0.067**	−0.063**	−0.072**	−0.096**	−0.094**	−0.102**	−0.036**	−0.041**	−0.048**
(omitted: 1st order)	(0.006)	(0.006)	(0.014)	(0.011)	(0.011)	(0.026)	(0.005)	(0.006)	(0.015)

Source: 1997–2009 PNAD data. IBGE (National Household Sample Survey).

Note: Robust standard errors in parentheses. 2SLS coefficient 95% confidence interval in brackets. Marginal effects from logistic regression models evaluated at the sample mean for all variables. All models include controls for adolescents' age and mother's and father's age, mother's and father's schooling, race dummies, family income, area and region of residence.

** $p < 0.01$, * $p < 0.05$, + $p < 0.1$

tional sibling is related to a 6.7-percent lower chance of private-school enrollment (significant at the 0.01 level). The entire 95-percent confidence interval is negative, indicating that the effect is indeed negative; however, the coefficients for the two additional subsamples are not statistically significant. The 2SLS gender analyses (columns 6 and 9) show that the finding of firstborn adolescents in larger families having a lower chance of private-school enrollment than their peers in smaller families reflects boys' disadvantages (–0.083, significant at the 0.01 level).

Taken as a whole, the results for education show that most of the estimates of family size lost significance when estimated through 2SLS models.[8] With one exception, our findings suggest no large adverse effects of family size on adolescents' education, a result that is in line with past studies that used a twin strategy to estimate the causal effect of family size on education (Angrist, Lavy, and Schlosser 2010; Black, Devereux, and Salvanes 2005; Cáceres-Delpiano 2006). While it does not seem that parents invest differently in boys' and girls' education, boys in larger families have lower chances of private-school enrollment than their peers in smaller families, a finding that does not hold for girls.

We next examine a series of adolescents' work outcomes. In table 5, panel A shows results for labor force participation, while panel B shows results for working more than ten hours a week. All marginal effects from logistic regressions (column 1) and OLS coefficients (column 2) representing family size are positive and statistically significant at the 0.01 level, suggesting that an additional sibling is associated with higher levels of labor force participation. The 2SLS estimates are reported in column 3. The estimate for the sample of firstborn adolescents in families of two or more is positive and statistically significant at the 0.01 level (0.059), indicating that an additional sibling leads to a higher chance of working for firstborn children. The 95-percent confidence interval ranges from 0.015 to 0.104, ruling out a negative effect.

The 2SLS estimates for models stratified by gender are reported in column 6 for girls and column 9 for boys. The 2SLS estimates shown in column 6 indicate that for girls, an additional sibling does not imply a significantly higher chance of participation in the labor market: the estimate for firstborns is only marginally significant, and the estimates for later-born samples are not statistically significant. The results show a different pattern for boys, with the family size coefficient (0.064) for firstborn boys significant at the 0.05 level—an additional sibling is strongly associated with pushing firstborn adolescent boys into the labor market. The lower bound of the 95-percent confidence interval approaches zero, suggesting a precisely estimated positive effect. The two additional subsamples generate estimates that are not statistically significant. However, two coefficients representing birth order are statistically significant. The coefficient representing third-born boys in families with four or more children is –0.043 and significant at the 0.05 level, showing that third-born boys have a smaller chance of working vis-à-vis their firstborn siblings. The coefficient representing second-born boys in families with three or more children is 0.017 and also significant at the 0.05 level, suggesting that second-born boys are more likely to work than firstborn boys. Because the second-order coefficient is small and approaches zero, these findings suggest that higher-parity boys seem to have lower chances of working than lower-parity boys. More importantly, combined, these coefficients reinforce the significance of birth order for boys' labor market participation. The findings for working more than ten hours a week outside the home (in panel B of table 5) are very similar to the findings discussed above, though estimated with less precision.

Table 6 shows results for models of both performing any household work and working in the household for more than ten hours a week. Column 1 of panel A shows marginal effects of family size from logistic regression models, while Column 2 of panel A shows the OLS coefficients of family size. Column 3 in panel A shows estimates from the 2SLS models. When we used multiple births as an exogenous source of variation in family size, we found that an additional sibling increases the probability of household work by a precisely estimated coefficient of 0.045 for the sample of first- and second-born adolescents. The lower bound of the 95-percent confidence interval is 0.005, suggesting that the effect is indeed positive; additional siblings increase the chances of earlier-born adolescents performing household work. Although the estimates for the additional subsamples are not statistically significant, the birth order coefficient representing second- versus first-order children is –0.024 and statistically significant at the 0.01 level, suggesting that firstborn adolescents have higher chances of performing household work than their second-born siblings, independent of family size. The coefficients representing second-order versus first-order adolescents (–0.022) and third-order versus first-order adolescents (–0.046) in families of four or more children confirm this birth order effect, suggesting that firstborn children have higher chances of household work than their second- and third-born peers. Results of the 2SLS gender-stratified analyses are reported in columns 6 and 9. Only one coefficient representing family size is marginally significant, and not surprisingly the 95-percent confidence intervals are wider than the non-stratified analyses because of smaller sample sizes.

We next show results of models of working more than ten hours a week in the household (panel B). In comparison to the previous analysis of whether adolescents do any household work, these models reflect a higher level of commitment to housework, which may become increasingly incompatible with school. Both the marginal effects in columns 1, 4, and 7 of panel B and the OLS estimates in columns 2, 5, and 8 of panel B show a positive association between an additional sibling and the probability of working more than ten hours a week in the household, although the estimates are very small. Column 3 of panel B shows estimates from the 2SLS models that suggest a higher probability of performing more than ten hours of domestic tasks a week due to an additional sibling. The coefficient was precisely estimated for the sample of first- and second-born adolescents with two or more siblings (0.047). The estimates for the additional subsamples are not statistically significant. At the same time, both the coefficient representing second- versus firstborn children in families of three or more (–0.020) and the coefficient representing second- and third-born adolescents in families of four or more (–0.072) are statistically significant at the 0.01 level;

these results suggest that firstborn adolescents have a higher chance of working longer hours in the household than their later-born peers.

The 2SLS estimates of the gender-stratified analysis are reported in column 6 for girls and column 9 for boys. The family size coefficient in column 6 shows that first- and second-born girls have a higher probability of performing more than ten hours a week of domestic tasks due to an additional sibling. This coefficient was precisely estimated (0.084), with the lower bound of the 95-percent confidence interval at 0.004. The coefficients representing second-born (–0.026) and third-born (–0.102) are negative and statistically significant, suggesting that firstborn girls are more likely to perform more than ten hours of household tasks than their later-born counterparts.

Overall, the results suggest that—with the exception of firstborn boys enrolling in private school—contrary to the *naïve* models estimated through logistic regression and OLS, an additional sibling does not adversely affect the school participation and private-school enrollment of Brazilian adolescents. However, the findings indicate that an additional sibling is associated with a higher chance of adolescents providing resources to the family via work inside or outside the home.[9] Adolescents in larger families are more likely to participate in the labor force, and this is particularly true for firstborn boys. Girls in larger families have a higher chance of performing household work, a result that is stronger for earlier-born girls.

Conclusions and Discussion

This research uses recent nationally representative data from Brazil and a twin instrumental variable approach to examine the effects of family size on adolescents' reception of resources from and provision of resources to the family. The first set of outcomes includes educational indicators—school enrollment and enrollment in private school—and reflects the influence of an additional sibling on parental investments in their children. The second set of outcomes—labor force participation and household work—reflects resources flowing from adolescents to the family. This paper expands previous analyses of the implications of family size for children's welfare by considering that (1) adolescents both receive resources from and provide resources to the family; and (2) birth order and gender are key factors moderating the association between family size and these processes. To address concerns about the joint determination of children's outcomes and family size, we use the exogenous variation produced by a twin birth to examine the effects of family size.

Our results show no strong adverse effects of family size on the educational outcomes for young cohorts of adolescents in Brazil. The findings also suggest that, in general, Brazilian families do not seem to distribute resources unequally between boys and girls and across birth orders. One exception is that firstborn boys are adversely affected in their chances of private-school enrollment—a measure of the quality of the education received—by the presence of an additional sibling. To some extent, our results reinforce findings from a body of research that reported no adverse effects of family size on children's educational outcomes once birth order and the endogeneity of family size and children's outcomes were considered (Black, Devereux, and Salvanes 2005; Cáceres-Delpiano 2006).

The results for economic and household work, which focus on adolescents providing resources to the family, offer a different story. While we found a strong tendency for firstborn boys to become more likely to work outside the home with each additional sibling, the results also show that larger families are associated with a higher chance of household work for girls, particularly earlier-born girls. Although an additional sibling entails a higher tendency for girls to perform more than ten hours of household work, this is not true of boys. In this sense, our findings suggest the presence of significant gender and birth order differences in adolescents' provision of resources to the family. Our results indicate that adolescents provide resources to the family in different ways and to a different extent depending on birth order and gender; an additional sibling has significantly different implications for boys vis-à-vis girls. Eradicating child and adolescent work requires comprehensive social policies that focus on multiple dimensions of their lives; our paper focuses on an important aspect of adolescent family life, that is, family size. Our findings underscore the importance of targeting larger families—while at the same time considering gender and birth order—for policies aimed at improving adolescent welfare through diminishing their participation in the labor force and commitment to household work.

That we found significant birth order and gender differences in the effect of family size on the provision of resources to the family but not in the reception of resources from the family confirms that family resource transfer is a dynamic process that is heavily dependent on the nature of the outcome examined. Our broad conceptualization of intra-family resource transfers has proven to be a fruitful framework for the study of the influence of family size on adolescent outcomes.

The traditional gendered allocation of work in larger families that we found in this study reflects gendered stereotypes and norms that prescribe social control and responsibilities for daughters and more independence for sons. Adolescents' perceptions of their abilities and the differential socialization of girls and boys in their families through gendered role assignments in the provision of resources to the family place boys and girls on very different pathways that set the stage for their life course trajectories. The time spent by girls in household work and the time spent by boys in economic work produces and reinforces gender roles early in the life course of Brazilian adolescents; these gender roles have direct consequences for adolescents' subsequent trajectories and adult lives, which should be the subject of further research and policies aimed at improving adolescent welfare.

Notes

1. We use the terms "family size" and "number of siblings" interchangeably.
2. An amendment to the 1988 Brazilian constitution established 16 as the minimum age for work. For an excellent discussion on the meanings of child and adolescent work, see Bourdillon et al. (2010).

3. Linear probability models are "computationally tractable and easily interpretable simultaneous equations model for dummy endogenous variables" (Heckman and Macurdy 1985, 28). An additional advantage of the 2SLS linear probability estimator is its ability to use tests of validity for over-identifying instruments and diagnostics for weak instruments (Cameron and Trivedi 2009, 471–72). This analytical approach was used in most past studies focusing on the causal effects of family size on children's outcomes with dichotomous dependent variable and instrument (e.g., Angrist, Lavy, and Schlosser 2010; Black, Devereux, and Salvanes 2005; Càceres-Delpiano 2006; Li, Zhang, and Zhu 2008).
4. Because most studies in this area examine outcomes during adulthood (e.g., complete education; see Black, Devereux, and Salvanes [2005]), family income at the time these adults were growing up is impossible to measure accurately because of recollection. Because our study focuses on adolescents, our family income measure is current and does not suffer from the same recollection issues. Importantly, we calculated family income excluding adolescents' income because it is endogenous to decisions of education and work.
5. Region and urbanicity are important determinants of employment opportunities; although we implemented models with state dummy variables, we opted to leave region and urbanicity because they consume fewer degrees of freedom and results were substantially similar.
6. To rule out concerns regarding changing variance of unobservable factors in pooled models across time, we compared the variance of the residuals in single-year models. We do not find significant changes in the variance of the residuals over time; the pooled model is preferable because it yields higher-precision estimates.
7. Robust standard errors deal with concerns about failure of estimations to meet assumptions, such as lack of normality, autocorrelation, and heteroskedasticity. Although the coefficient estimates remain the same, the test statistics will give accurate *p*-values.
8. We also examined years of schooling; results also show insignificant effects of family size.
9. We tested the sensitivity of the estimates to other specifications by estimating models for additional age groups and single ages. The results are qualitatively similar, but the smaller sample sizes for models estimated for single ages led to imprecise estimates.

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