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Family size and children quality: New evidence and new exogenous shocks in the case of Colombian Households *

Román David Zárate†

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Abstract

The interaction between family size and children quality has been a recurring topic in the economics of family. However, there is scarce evidence in Latin America, and the literature has not yet explored new mechanisms to explain either positive or null effects of an additional sibling found by different authors in the last ten years. This article addresses these two issues. On the one hand, I construct a simple theoretical model which rationalizes negative and postitive effects of an additional sibling due to family interactions. On the other hand, I estimate the effect of family size in Colombia on school lag, school attendance, school dropout and child labor. I use data from the Demographic and Health survey and construct a set of instruments based on the report of the ideal number of children. The novelty of the instruments lies in that unlike most articles which can only estimate the effect from two siblings onwards, I can estimate the effect of a first sibling. I find that for first (second) born children a first (second) sibling generates null or positive effects on the four outcomes but there are negative effects from two (three) siblings onwards on the four outcomes.

JEL codes: D10, D13, D31, J13

Keywords: Family size, nonlinear effects, children quality, educational outcomes, child labor.

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Tamaño de la familia y calidad de los niños: Nueva evidencia y nuevos choques exógenos en el caso de los hogares colombianos

Román David Zárate

February 2013

Resumen

La relación entre el tamaño de la familia y la calidad del hogar ha sido un tema recurrente en la literatura económica. Sin embargo, existe escasa evidencia para América Latina y no hay modelos teóricos que sustenten tanto los efectos positivos como nulos de un hermano adicional encontrados por diferentes autores en la última década. Este artículo aborda estos dos aspectos. Por una parte, se desarrolla un modelo teórico que racionaliza tanto efectos positivos como negativos de un hermano adicional a través de las interacciones dentro del hogar. Por otra parte, se estima para Colombia el efecto del tamaño de la familia sobre rezago escolar, asistencia escolar, deserción escolar y trabajo infantil. La fuente de información es la Encuesta Nacional de Demografía y Salud que permite construir un conjunto de instrumentos basado en el número ideal de hijos reportado. La novedad del instrumento radica en que a diferencia de otros artículos se puede estimar el efecto de un primer hermano. Los resultados muestran que para los primeros (segundos) nacidos un primer (segundo) hermano genera efectos positivos en las cuatro variables de resultado, pero de dos (tres) hermanos en adelante los resultados son negativos en las cuatro variables de resultado.

Códigos de clasificación JEL: D10, D13, D31, J13

Palabras clave: Tamaño de la familia, efectos no lineales, calidad de los niños, variables educativas, trabajo infantil.

1 Introduction

The seminal work by Becker and Lewis (1973) states that there is an inverse causality between the quantity and quality of children within the same household (QQ *trade-off*). This model reconciles the demand for children with the Malthusian theory about the relationship between economic development and population growth. Galor and Weil (1999) show that the QQ *trade-off* is one of the key mechanisms for the long run development, and Ashraf et al. (2011) show that programs designed to reduce the fertility rate would have positive impacts in the output per capita in a horizon between 20 and 50 years. Therefore, different countries around the world have sponsored family planning efforts to reduce the number of children within a household. The most extreme cases are the one child policy in China and the forced sterilization program in India.

Hence, empirical economics has tried to estimate the effect of family size on different quality outcomes, giving particular interest to educational ones. Most of these studies have estimated the effect of an additional child in developed countries and China, but the relationship between the quantity and quality of children remains an open question in developing countries.[1] Nevertheless, different countries in Latin America such as Colombia or Mexico have tried to design different policies to reduce the number of children within each household. In the case of Colombia, in March 2011 a law was submitted to the Congress to provide education, nutrition and housing subsidies only to families with two children or less. In the case of Mexico, the authorities designed an aggressive public promotion program of family planning that focused on the most vulnerable families.[2]

In the 1980's and 1990's different empirical articles found that there is an inverse causality between quantity and quality. However, during the last decade new evidence suggests that the QQ *trade-off* does not hold. In particular, an additional sibling has null effects on the quality of each child. These articles control for birth order and use sex compostition to solve the endogeneity of family size (Angrist and Evans (1998)). Most part of them specify a linear model and do not estimate the effect of an additional sibling for only children (i.e. increases in family size from 0 to 1 sibling). In this sense, the traditional instruments twins in higher births

[1] Specifically these articles have focused in the United States, Israel and Norway.

[2] Some episodes of the programs that different countries have designed to encourage family planning efforts are described in Weil (2005)(chapter 4).

and sex composition within the household only estimate the effect from two siblings onwards.

Furthermore, Qian (2009) finds new evidence of positive effects of an additional sibling in Rural China exploiting the fact that the one child policy was relaxed in some districts. The author attributes these positive effects on private school attendance to scale economies because the effect is greater when she compares only children with children in families where both are girls than in families where there is one girl and one boy. Mogstad and Wiswall (2010) find positive effects of an additional sibling on schooling attainment using a nonlinear specification in the case of Norway, particularly when the size of the family increases from 1 to 2 siblings. The authors find null effects when family size increases from 2 to 3 or more siblings. In spite of these facts, the literature has not yet constructed theoretical models which explore other mechanisms behind either null effects or positive effects of an additional sibling beyond scale economies and the traditional model of Becker and Lewis (1973).

Therefore, two questions remain open: 1) How is the interaction between the quantity and quality of children in developing countries? and 2) Which are the mechanisms behind either negative, positive or null effects of an additional sibling? This article addresses these two issues. First, I construct a simple theoretical model to rationalize negative and positive effects of an additional sibling through the interactions between siblings which are not internalized by their parents. The mechanism behind is that the child quality is a function of her parents education investment, the interactions within the household, and the effort of the child. In this way, an increase in family size changes the optimum level of these three inputs. Thus, under certain conditions of the parameters, the quality of the child improves or remains the same as the number of siblings increases.

Second, the study estimates the QQ *trade-off* for Colombia using a linear and a nonlinear specification for first and second born children. In this regard, the study does not consider the effects on the marginal child on educational outcomes and child labor. The source of data is the Demographic and Health Survey (DHS) for 2000, 2005, and 2010. The survey allows me to construct educational and labor market outcomes. The article focuses in four quality outcomes: 1) schooling attainment above or below the gender and age cohort's average; 2) school attendance at the time of the survey; 3) school dropout at the time of the survey; and 4) child labor at the time of the survey. I can identify maternal complete fertility history including twin births.

Moreover, the article proposes a new set of instruments to solve the endogeneity of children quantity based on the ideal number of children reported in the data by mothers. I compare the results with the traditional instrument of twins in higher births. Unlike the instruments used by different authors, this set of instruments allows to estimate the effect of an additional sibling in all the distribution, including the effect of a first sibling. Specifically the description of the question is: "'The ideal number of children that the respondent would have liked to have in her whole life, irrespecitve on the number she already has.'"

The empirical results show that under a linear specification, the QQ *trade-off* holds in Colombia. An additional child within the household increases the likelihood of lower years of education compared to the gender and age cohort between 4.1 and 4.9 percentage points. In the same way, it reduces the likelihood of school attendance between 1.3 and 1.5 percentage points, it increases the likelihood of school dropout between 1.1 and 1.3 percentage points, and it increases the likelihood of child labor between 0.7 and 2.0 percentage points. Nevertheless, under a nonlinear specification, a first sibling generates positive or null effects for first born children, but the QQ *trade-off* holds from two siblings onwards. For second born children, a second sibling generates ambigous effects, but the QQ *trade-off* holds from three siblings onwards. In particular an additional sibling generates negative effects in some parts of the sibling distribution.

Otherwise, in order to test the main conclusion of the theoretical model, I estimate the effect of family size on the four quality outcomes in heterogenous groups based on sex composition and the age gap between siblings. I find that the effect of an additional sibling changes as certain characteristics of the household vary. In particular, I focus on two categories. The first category corresponds to children with her different age gaps with their first sibling, in particular 0 to 3 years in a first group, and 4 to 6 years in a second group. And the second category corresponds to children who are of a different sex from all their siblings.

The rest of the article is organized as follows: section 2 describes the evidence available on the relationship between the quantity and quality of children in different countries. Section 3 constructs a simple theoretical model to show that interactions between siblings are a possible mechanism which explain the empirical results of the last decade. Section 4 describes the source of information for the empirical analysis. Section 5 explains the empirical strategy to estimate the effect of family size on the four outcomes under a linear and a nonlinear specification, section 6 shows the principal results for both models, and finally, section 7 concludes.

2 Evidence on the QQ *trade-off* of children

After the publication of the Becker and Lewis (1973) model, the relationship between the quantity and quality of children has been in the research agenda of empirical economics. In this sense, the main aim of the econometric excercise has been to find exogenous shocks to solve the endogeneity of family size. In the 1970's and 1980's Featherman and Hauser (1978), Rosenzweig and Wolpin (1980) and Blake (1989) found that increases in the family size reduced the quality of children. Rosenzweig and Wolpin (1980) were the first authors to use twins in higher births as a source of exogenous variation in family size. Similarly, during the 1990's and beginning of 2000's Powell and Steelman (1993) and Steelman et al. (2002) found that an additional sibling has negative effects on the quality of children specifically on educational attainment.

However two new factors changed the traditional results about the QQ *trade-off*. First, during the middle 1980's Behrman and Taubman (1986) developed a structural model to show the effect of birth order. The model was based in differences in ability between children within the same household, therefore the investment per child of the parents changes as the abilities between children differ. They found empirical evidence for negative birth-order effects on years of schooling and on earnings for the United States. Second, Angrist and Evans (1998) proposed a new instrumental variable in the economics of family defined as sex composition. The instrument is a dummy variable equal to one for whether the gender of the first two children in the family is the same and zero if the gender is different. The idea behind it is that when the first two children are of the same sex, the likelihood of having a third child increases, given the preferences of the parents to have children of both sexes. Hence, increases in family size from 2 to 3 children in cases where the first two children are of the same sex are exogenous, because the sex of the first two children was not determined by parents. However, many authors have criticized the sex composition instrument because it can generate scale economies within the household that affect directly children quality.

During the last ten years different articles have controlled for birth order and have used the sex composition instrument in order to evaluate the QQ *trade-off* in different countries. The new evidence suggests that the effect of family size on the quality of children is either too small or null (Angrist et al. (2010); Black et al. (2005); Conley and Glauber (2005); Booth and Kee (2009); Mogstad and Wiswall (2010); Iacovou (2001)). However, the different authors estimate the effect of an additional sibling from two siblings onwards because neither the sex composition nor the twin instrument can be used to estimate the impact from 0 to 1 sibling. The reasons for the former are obvious, the sex compostion instrument can only be constructed in households with two or more children. While the latter can not be used because the birthweight of twins is lower than the birthweight of singletons.

In this regard, Rosenzweig and Zhang (2009) are the first authors to evaluate the QQ *trade-off* controlling with the birthweight of twins in China. Unlike the previous empirical results, the authors find negative effects of family size on the average child quality, and show that the instrument of twins in higher births does not identify family size effects because these are confounded with a higher allocation of resources to singletons in detriment of twins. However, a linear specification can mask positive effects of siblings. Despite of this, both instruments, twins in higher birth order and sex composition can affect directly the child quality imposing an upper bound to the estimators, and will not find consistent estimators of the QQ *trade-off*. Aditionally, they can not estimate the effect from 0 to 1 sibling.

Furthermore, during the last years, new evidence also suggests that an additional sibling can generate positive effects. For example, Qian (2009) uses a relaxation in the one child policy in rural China as an exogenous shock to family size. The author finds that an only child has a disadvantage to attend private schools and that the positive effect is greater for families where both children are girls. The author shows that scale economies are a possible mechanism of this result under a similar framework to Becker and Lewis (1973). Similarly, Mogstad and Wiswall (2010) find positive effects on educational attainment when family size increases from 1 to 2 siblings in Norway. Nevertheless, other mechanisms behind the empirical results of the last ten years are unknown. In this regard, Price (2008) proposes in a pioneer work that the parent-child quality time is one of the factors behind birth order effects. The mechanism lies in the idea that the parent-child quality time is a decreasing function of the age of the child, and that parents have preferences for equality within the household.

To illustrate this, consider a very simple example in which the first born child is named A and the second born child is B, the age gap between the children is three years. On the one hand, if A is an only child then the parent-child quality time will decrease as A grows up. On the other hand, when B is born, the parents will spend the same parent-child quality time with both children A and B, then when A is 3 years old, she will spend the same parent-child quality time that she spent when she was 0 years old. Hence, an additional sibling increases the parent-child quality time for child A during all her childhood, and it will be more than the parent-child quality time the parents spend with the child B. Therefore, this mechanism explains the differences of birth order and positive or null effects of family size on the children quality. This is an example on how interactions between siblings can change the traditional result of the QQ *trade-off*. These interactions will be explored in the next section.

3 Theoretical Background

Consider a two period model where two types of agents interact. The first period is the traditional model of Becker and Lewis (1973) and Becker (1993) in which the parents decide the number of children within the household, and an investment (units of education) in the quality of each child. The parents are altruists towards their children and derive utility from the quality of each child, and the quantity of children. In the second period the children derive utility from their quality and from leisure. They decide the level of effort to increase their quality. In this sense, the quality is a function of the investment of the parents, the level of effort of the child, and the familiar environment within the household.

$$Q_i = I^{\gamma} + f(\theta, e_i)$$

Where I_i is the parental investment in education, e_i is the effort of the child i, and θ_i is a parameter that captures the family environment, which includes different elements of the household. In this sense, the parameter θ_i is a function of the characteristics of the child i and the characteristics of her siblings. Therefore as the number of siblings increases, the parameter θ_i changes. However, the parents do not take into account this environment. It is assumed that the investment and level of effort exhibit decreasing returns to scale and. And, for the three inputs $Q_1(\cdot) > 0$, where the subindex denotes the order of the derivative.

Problem of the parents

The problem of the parents is the same one as in the traditional model of Becker and Lewis (1973), however in this model parents decide a level of investment per child that will be one of the inputs in the child's Quality production function. The problem of the parents is:

$$\max_{\{N,I,Z\}} U^p(N, \bar{Q}, Z) = \bar{Q} + u(N) + u(Z) \quad \text{s.t} \quad P_I NI + P_z Z = M$$

Under this framework, each family maximizes a utility function where N is the number of children; I is the expenditure on each children in education; Z is a consumption good that aggregates all the commodities in the economy; P_I is the cost of each unit of education; P_z is the generalized price of the consumption good Z; and M is an exogenous level of income. The parents have preferences for equality within the household and don't take into account the initial endowment of their children.[3] This assumption is made because in the empirical excercise the variation of family size is between households and not within households. We assume that $U_1^p(\cdot) > 0$ and $U_2^p(\cdot) \leq 0$, where the subindex denotes the order of the derivative for the three parameters. The first order conditions implies that:

$$\frac{\partial U^p}{\partial I} = \frac{\gamma}{I^{1-\gamma}} - P_I n = 0$$

$$\frac{\partial U^p}{\partial N} = \frac{\partial Q}{\partial \theta}\frac{\partial \theta}{\partial N} + \frac{\partial Q}{\partial e_i}\frac{\partial e_i}{\partial N} + u'(N) - P_I I = 0$$

The optimal values are:

$$N^* = d_N(\pi_N, \pi_I, \pi_z, R)$$

$$I^* = d_I(\pi_N, \pi_I, \pi_z, R)$$

$$Z = d_z(\pi_N, \pi_I, \pi_z, R)$$

Where R is the sum of the *shadow* amounts spent on the three commodities (R=M+P$_I NI$),π_N is the shadow price of children quantity, π_I is the shadow price of the investment, and π_z is the shadow price of the consumption good. The main argument of Becker and Lewis (1973) is

[3] The problem of the parents can also include a decision in the time of child care. For example Bernal (2008) find evidence that when a mother works the full time the children's cognitive development is reduced

that:

$$\frac{dI^*}{dN} = \frac{\partial d_I}{\partial \pi_N} P_I < 0$$

Then an increase in the quantity of children will reduce the investment per child by a change in the shadow price of the investment, $\pi_I = P_I N$. However, the quality is not just a function of parent's investment, it also depends on the effort of the child and on the family environment.

Problem of the children

In the second period, the child obtains utility from her quality and from her leisure. She takes the number of children and the investment per child as given. The decision consists on the level of effort to increase their own quality and the time of leisure that is sacrificed. The problem of a representative child i consists of:

$$\max_{\{e_i, l_i\}} U(Q_i(I_i^*(N), e_i, \theta_i(N)), l_i) \quad \text{s.t} \quad e_i + l_i = 1$$

Where Q_i is the quality of the child i, e_i is the fraction of the time that the child efforts to increase her quality, and l_i is the time of leisure that she spends. We assume that $U_1(\cdot) > 0$ and $U_2(\cdot) \leq 0$, where the subindex denotes the order of the derivative for the two parameters. The first order condition of the associated problem is:

$$\underbrace{\frac{\partial U}{\partial Q_i}\frac{\partial Q_i}{\partial e_i}}_{\text{Marginal benefit of effort}} - \underbrace{\frac{\partial U}{\partial l_i}}_{\text{Marginal Benefit of leisure}} = 0$$

I denote the marginal benefit of one additional unit of effort as $B_{e_i} = \frac{\partial U}{\partial Q_i}\frac{\partial Q_i}{\partial e_i}$. In this sense, the derivative of B_{e_i} with respect to the number of children is ambigous. On the one hand, as the number of children increases the investment per child decreases, because the inputs are complementary, then B_{e_i} decreases. On the other hand, as N changes the interaction between siblings changes, this can have a positive effect in B_{e_i}. I define a complementary interaction as the one in which $\frac{\partial B_{e_i}}{\partial \theta_i} > 0$ and $\frac{\partial \theta_i}{\partial N} > 0$, and a substitutability interaction as the one in which $\frac{\partial B_{e_i}}{\partial \theta_i} < 0$ and $\frac{\partial \theta_i}{\partial N} < 0$. Under either the former or the latter the effect of an additional child is not necessarily negative. The optimal value of effort is:

$$e^*(N, \theta(N))$$

In this sense, if $\frac{dB_{e_i}}{dN} = \frac{\partial B_{e_i}}{\partial I^*}\frac{\partial I^*}{\partial N} + \frac{\partial B_{e_i}}{\partial \theta}\frac{\partial \theta}{\partial N} > 0$ then $\frac{de^*}{dN} > 0$. The main argument is that when family size increases, the family environment can compensate the reduction in the investment per child, and the effort of the child increases.[4] Henceforth, it is assumed that $\frac{de^*}{dN} > 0$. Thus, an exogenous shock to family size states conditions under which the effect of an additional sibling on quality is non negative:

Proposition P1. *Under the complementary interaction, if* $\frac{\partial Q}{\partial e_i^*}\frac{de_i^*}{dN} + \frac{\partial Q}{\partial \theta_i}\frac{\partial \theta_i}{\partial N} \geq |\frac{\partial Q}{\partial I^*}\frac{\partial d_I}{\partial \pi_n}P_I|$*, then the effect of an additional child is non negative.*

Proposition 1 establishes that when family size increases due to an exogenous shock, the change in the quality of each child depends on how much the investment in education units falls, the effort of the child increases, and the environment of the family improves. Therefore, when the effects of the effort of the child and the interaction between siblings compensate the reduction in the education investment, the quality of each child remains the same or increases.

Proposition P2. *Under the substitutability interaction if* $\frac{\partial Q}{\partial e_i^*}\frac{de_i^*}{dN} \geq |\frac{\partial Q}{\partial \theta_i}\frac{\partial \theta_i}{\partial N} + \frac{\partial Q}{\partial I^*}\frac{\partial d_I}{\partial \pi_n}P_I|$ *then the effect of an additional child is non negative.*

Proposition 2 establishes that when family size increases due to an exogenous shock, the change in the quality of each child depends on how much the investment in education units falls, the effort of the child increases, and the substitutability interactions in the family fall. Therefore, when the effect of the effort of the child compensates the reduction in the education investment and the interactions between siblings, the quality of each child remains the same or increases.

This model captures the fact that the family environment, which includes interactions between siblings can change the traditional results of the QQ *trade-off*. In particular, the model is the first one to include the decision of children, and how it changes as the number of siblings increases in a similar framework as the model of Becker and Lewis (1973). The idea behind is that the family environment generates externalities between siblings, such as cooperation or competition between them and may increase the effort of the children to increase their own quality and compensate the *trade-off*. The effect on quality is going to depend on: 1) The effect

[4]For example an additional sibling may increase competition within the household, thus the children are going to increase their effort in response to this competitive environment. Or in the case of our previous example, the sibling B increases the abilities of child A through an increase in parent child-quality time, this fact can rise the marginal benefit of one unit of effort, and compensate the fall in the level of the education investment.

of an additional sibling on the family environment, and 2) the degree of substitutability between the family environment and children effort. Intiutively, for example when an additional sibling improves the family environment and children cooperate more with each other (The older child can teach different things to the younger one) the effort of children may increase and compensate the reduction in the parental investment. In the same way, if an additional sibling reduces the family environment because children are going to fight more between them, the effort of the child may increase due to competition and this effect can compensate the effect of the reduction in parental investment.

This mechanism joins others in the literature such as scale economies and the substitution elasticity between quantity and quality in the parent's utility function. The three mechanisms can explain part of the empirical results of the last ten years. I evaluate how this type of interactions can change the traditional result of the QQ *trade-off*, estimating heterogenous effects in the empirical analysis depending on the sex composition and age gap between siblings.

4 Data

The source of data is the Demographic and Health Survey (DHS) in Colombia for 2000, 2005, and 2010. It is a nationally-representative household survey that provides information for different indicators in terms of health, nutrition, and education. The survey is collected every 5 years since 1990 by Profamilia and USAID, and corresponds to repeated cross sectional data. The relevant information to evaluate the QQ *trade-off* is available since of 2000. In this article the mother, household and children records are used in order to construct the relevant outcomes and individual characteristics.

The three waves in this study are representative of the 6 regions of the country.[5] The sample used for estimation correspond to the living first and second born children who lived in the same household with their mother and are older than 5 years old, twins are also excluded from the estimation following the idea of Rosenzweig and Zhang (2009) regarding the fact that the birth weight of twins is lower than the birth weight of singletons. The total number of

[5]The survey of 2000 was composed by 10,907 households; 11,585 women between 15 and 49 years old; and 21,267 children of which 20,302 were alive. The survey of 2005 was composed by 37,211 households; 41,344 women; and 71,278 children of which 68,164 were alive. Finally, the survey of 2010 interviewed 51,447 households; 53,521 women; and 91,399 children of which 87,949 were alive.

observations of first born children are 28,053, of which 3,249 were interviewed in 2000, 10,692 in 2005, and 14,112 in 2010. However, this number changes depending to the outcome. The total number of observations of second born children are 21,710 children of which 2,451 were interviewed in 2000, 8,261 in 2005, and 10,998 in 2010.

I construct 4 outcomes of interest from this survey: school lag, school attendance, school dropout and child labor. The variable *school lag* is a dummy variable equal to one for whether the years of education of the child i are lower than the median of the years of education of her sex and age cohort minus one year. The variable *school attendance* is a dummy variable equal to one if the child is between 6 and 18 years old and attends school. The variable *school dropout* is a dummy variable equal to one if the child dropped out from the school. And finally, *child labor* is a dummy variable equal to one for whether the child younger than 15 years old was working the last week prior to the interview.

Moreover, I construct two sets of instruments to solve the endogeneity of the quantity of children. The first set is composed by dummy variables equal to one for whether the mother had twins at the jth birth. These instruments are denoted $twin_j$ where $j = 2, 3, 4, 5$. The second set of instruments is composed by dummy variables equal to one for whether the ideal number of siblings that the mother reported is lower than i siblings, but the real number is equal to or greater than i siblings. These instruments are denoted $ideal_i$ where $i = 1, 2, 3, 4, 5$.

Table 2 presents summary statistics of the household and mother characteristics for first born and second born children interviewed in the DHS. On average for first born children, their mothers were 33 years old at the time of the survey, the mean of the ideal number of children that they reported was 1.97, the real number of children was 2.38, and 1% of the sample had twin siblings. And for second born children, their mothers were 36 years old, the mean of the ideal number of children that they reported was 2.18, the real number of children was 3, and 1% of the sample had twin siblings. [6]

Table 3 shows summary statistics on the individual characteristics of the children. On average, first born children were 11.8 years old at the time of the survey, 22% were only

[6] The average age of the mothers of first born children show that some of the women in the DHS survey have not finished their reproductive life. This fact will be corrected estimating a two stage Heckman in the empirical analysis.

children, 78% had at least one sibling, 38% had at least two siblings, 14% had at least three siblings, 5% had at least four siblings, and finally 1% had at least 5 siblings. In terms, of the outcomes 11% were lagged at school, the rate of school atendance is 90%, 7% have dropped out of school and 4% worked the week prior to the interview. Futhermore, only 2.1% of the sample had twin siblings, and nearly one third of the sample had more siblings than the mother's ideal. The table also shows that second born children were on average 11.7 years old, 61% had at least two siblings, 26% had at least three siblings, 10% had at least four siblings, and 3% had at least five siblings. In regard to the outcomes, 13% were in school lag, 90% attends school, 8% have dropped out from school, and 5% of the children younger than 15 years old worked the last week before the interview. In the same way, only 1.7% of the sample had twin siblings in a higher birth, and nearly 40% of the sample had more siblings than the mother's ideal.

5 Empirical Analysis

This section describes the linear and nonlinear specification for the OLS models and IV models. Specifically, for the IV model I construct a set of instruments based on the ideal number of children. Furthermore, I implement the methodology developed by Angrist et al. (2010) and Mogstad and Wiswall (2009) to correct the endogeneity and efficiency in a nonlinear specification. On the other hand, as our dependent and interest variables are binary , I follow Heckman and MaCurdy (1985) and estimate linear probability models in the first and in the second stage of the IV estimation.

5.1 OLS Specification

The traditional linear specification to estimate the effect of the quantity of children on quality is:

$$y_{ij} = \beta_0 + \delta siblings_{ij} + \gamma X_i + \gamma X_j + \epsilon_i + \epsilon_i \tag{1}$$

Where y_i is the dependent variable of the child i: school lag, school attendance, school dropout, and child labor; $siblings_i$ is the number of siblings of child i and X_i is a vector of covariates that includes household, mother and individual characterisics. The vector X is composed by the age and the sex of the household head, a wealth index of the household, a binary variable equal to 1 if the household was urban at the moment of the survey, the level of education of the mother, the level of education of the father, the relationship of the mother to the household head, the marital status of the mother, the age of the mother at first birth, the age of the mother at the moment of the survey, the age of the child, the sex of the child, and region and year fixed effects, the parameter ϵ_i is the error of the model.

For the nonlinear specification I exploit the fact that the number of siblings is a discrete variable to specify a model based on dummy variables. The model is:

$$y_i = \beta_0 + \delta_1 d_{1i} + \delta_2 d_{2i} + ... + \delta_{\hat{s}} d_{\hat{s}i} + \gamma X_i + \psi_i \quad (2)$$

Where s_i is the number of siblings and $d_{si} = 1[s_i \geq s]$, the vector X is composed by the covariates mentioned above. Note that the variable δ_s captures the effect of an additional child. In this regard, the dummy variables could also be constructed as $d_{si} = 1[s_i = s]$ and estimate the effect of children with s siblings in respect to children with 0 siblings. In the model I estimate $\hat{s} = 5$. Finally, the parameter ψ_i is the error of the regression. Thus, the model captures the fact that the effect of an additional sibling may be different depending on the number of siblings child i has.

5.2 IV strategy

Family size is an endogenous variable because parents choose the number of their children in a way that might be correlated with children's quality. This fact can yield to biased estimates if equation 1 is not appropriately estimated. For that reason, to find consistent estimators, I follow Rosenzweig and Wolpin (1980) for the linear specification and I implement the methodology developed by Angrist et al. (2010) and Mogstad and Wiswall (2010) to estimate nonlinear effects by using instrumental variables. In both models, the instruments included correspond to two sets of variables. The first set is composed by the standard instrument of twins in higher births used in empirical economics of family. The second set is based on the report of ideal number of children of mothers in the DHS sample. The latter allows to estimate the effect of an additional sibling in all the distribution including the effect from 0 to 1 sibling.

Firstly, the specification of the model for first born children using the twins instrument is:

$$y_i = \delta siblings_i + \gamma X_i + \nu_i \text{ (Second stage)} \tag{3}$$

$$siblings_i = \alpha twin_{2i} + \varphi dif_{ideali} + \lambda X_i + \mu_i \text{ (First stage)} \tag{4}$$

Where y_i and X_i are the same variables mentioned above, $twin_{2i}$ is a dummy variable equal to one for whether the second birth was a twin, and dif_{ideali} is the difference between the real number of children and the ideal number of children. We estimate the model using both sets of instruments in order to obtain an overidentified model that would allow for exogeneity tests. Notice than $twin_{2i}$ captures an exogenous increase from the second child onwards, but does not explain increases from 1 to 2 children, or equivalently from 0 to 1 sibling.

I can construct an additional instrument depending on the ideal number of children. The second stage remains the same, and the first stage is:

$$siblings_i = \theta ideal_{1i} + \varphi dif_{ideali} + \phi X_i + e_i \text{ (First stage)} \tag{5}$$

Where $ideal_{1i}$ is a dummy variable equal to 1 for whether the ideal number of siblings is lower than 1 sibling and the real number of siblings is greater than or equal to 1 sibling. This instrument captures an exogenous change from 0 to 1 sibling.

The specification of both models for second born children and rewritting the equations 4 and 5, is:

$$siblings_i = \alpha twin_{3i} + \varphi dif_{ideali} + \lambda X_i + \mu_i \tag{6}$$

$$siblings_i = \theta ideal_{2i} + \varphi dif_{ideali} + \phi X_i + e_i \tag{7}$$

Where $twin_{3i}$ is a dummy variable equal to 1 for whether the third birth was a twin, children with just one sibling will have missing values in this variable. Hence, equation 7 do not estimate the effect from 1 to 2 siblings. In the same way, $ideal_{2i}$ is a dummy variable for whether the ideal number of siblings of child's i mother is lower than 2 and the real number of siblings is greater or equal to 2. Model 7 also captures an exogenous increase from 1 to 2 siblings. In this regard, the main assumption that the instruments must meet to ensure their validity in the sample of children who have $\hat{c}$ or more siblings is:

$$E[\nu_i|X_i, c_i \geq \hat{c}] = E[\nu_i|c_i \geq \hat{c}] = 0$$

$$E[\nu_i|X_i, c_i \geq \hat{c}, Z_{ci}] = E[\nu_i|c_i \geq \hat{c}], \text{ for all } c_i \geq \hat{c}$$

Where Z_{ci} correspond to $twin_{ci}$ or $ideal_{(s+1)i}$, c is the number of children including child i and s is the number of siblings of child i.

For the nonlinear effects, I need at least the same number of instruments as endogenous variables. One possible set of instruments can be a set of dummy variables for whether the birth of order j was twin for $j = 2, 3, 4, 5$. Nonetheless, for families with just two children $twin_j$ will be missing for $j \geq 3$, and for families with three children, $twin_j$ will be missing for $j \geq 4$, given that the mothers of these children did not have a jth birth. This process will continue successively as j changes. Despite this fact, a possible instrument may be:

$$\bar{twin}_{ci} = \begin{cases} 0 & \text{if } c_i < c \\ twin_{ci} & \text{if } c_i \geq c \end{cases}$$

Where c_i denotes the number of children in the household including the child i. Nevertheless, these instruments would not produce consistent estimators. In regard to this fact, Mogstad and Wiswall (2010) point that:

> "... the constructed instruments are functions of the endogenous family size variables. To see this note that these instruments can be written as $z_{ci} = 1\{c_i \geq c\}twin_{ci}$ for $c = 3, 4, 5$."

Similarly, in the case of ideal children the set of instruments consists of $ideal_j$ for $j = 1, 2, 3, 4, 5$ for whether the number of ideal siblings is lower than j and the number of real siblings is greater than or equal to j. Households with just two children will have missing values in $ideal_j$ for $j \geq 3$, and in the same way as $twin_j$, this fact will continue successively as j changes. Therefore this set of instruments will produce inconsistent estimators. For that reason Angrist et al. (2010) implement a methodoloy discussed and used in Mogstad and Wiswall (2010) to correct this problem. Specifically, it consists of an instrument based on a conditional mean function of the different dummy variables: $twin_j$ and $ideal_j$ depending on nearly 200 covariates.[7] The instruments are defined as:

$$twin^*_{ci} = \begin{cases} 0 & \text{if} \quad c_i < c \\ twin_{ci} - \hat{E}[twin_{ci}|X_i, c_i \geq c] & \text{if} \quad c_i \geq c \end{cases}$$

$$ideal^*_{si} = \begin{cases} 0 & \text{if} \quad s_i < s \\ ideal_{si} - \hat{E}[ideal_{si}|X_i, s_i \geq s] & \text{if} \quad s_i \geq s \end{cases}$$

The function $\hat{E}[twin_{ci}|X_i, c_i \geq c]$ and $\hat{E}[ideal_{si}|X_i, s_i \geq s]$ is an unknown function that is estimated using nearly 200 covariates including the age of the mother, the age of the mother at the first birth, mother's level of education, child gender, father's level of education, a dummy variable indicating if the information of the father is missing, a dummy variable indicating if the household was urban at the moment of the survey, and region and wealth quintiles fixed effects. The model uses interactions between all the different variables. I include the age of the mother at first birth given that it is a great predictor of the probability of twinning.

In this sense, the first stage of the model for first born children consists of:

$$d_{si} = \alpha_{s2} twin_{2i} + \alpha_{s3} twin^*_{3i} + ... + \alpha_{s5} twin^*_{5i} + \varphi dif_{ideali} + \lambda X_i + \mu_{si}, \quad s = 2, 3, 4, 5 \qquad (8)$$

$$d_{si} = \theta_{s1} ideal_{1i} + \theta_{s2} ideal^*_{2i} + ... + \theta_{s5} ideal^*_{5i} + \varphi dif_{ideali} + \phi X_i + e_{si}, \quad s = 1, 2, 3, 4, 5 \qquad (9)$$

In the case of equation 8, the estimation sample will be first born children with at least one sibling, so that $twin_{2i}$ is not a missing variable for anyone, and the only children are not included. Similarly, the estimation sample of model 9 will be all first born children, including the only children, and the variable $ideal_{1i}$ will not be missing for any observation. For second born children the first stage is:

$$d_{si} = \alpha_{s3} twin_{3i} + \alpha_{s4} twin^*_{4i} + \alpha_{s5} twin^*_{5i} + \varphi dif_{ideali} + \lambda X_i + \mu_{si}, \quad s = 3, 4, 5 \qquad (10)$$

$$d_{si} = \theta_{s2} ideal_{2i} + ... + \theta_{s5} ideal^*_{5i} + \varphi dif_{ideali} + \phi X_i + e_{si}, \quad s = 2, 3, 4, 5 \qquad (11)$$

These two models have the same properties of the specifications of first born children applied

[7] Mogstad and Wiswall show that the instruments are valid under the same assumptions of the IV linear models.

to the second birth. I present Sargan's statistics to test the validity of the instrument, and Cragg-Donald's F statistic to test the weakness of the instrument in the first stage. Moreover, to study the effect in heterogenous groups depending on the siblings sex composition and age gap, I restrict the sample to these groups and apply the same methodology for this subsample.

5.3 IV efficient estimators

Despite the fact that the IV model allows estimation a nonlinear function, the fact that in the model I have to instrument different endogenous variables generates an increase in the imprecision of the estimators. Therefore, Mogstad and Wiswall (2010) construct more efficient IV estimators under the same assumptions of the linear model. They follow the non parametric estimators introduced by Newey (1990, 1993) imposing a particular functional form to construct them. Nevertheless, as they point out:

> "It is important, however, to emphasize that IV estimators using these efficient instruments will be robust to mis-specifications of the functional form (see e.g Newey (1990, 1993)). In particular, our approach is not a control function approach, like the Heckman two stage method. If the functional form is correct, our efficient instruments are the optimal instruments. And, if the functional form is misspecified, our efficient instruments are still consistent under IV assumptions."

The instruments they construct exploit two particular features of their model: a) twins increases the family size by at least one child, and b) the endogenous family size variables are binary in nature. In this sense, the dummy variables of ideal children have the property that if they are equal to 1 then the number of children in the family is at least 1 sibling greater than the ideal number of children reported by the mother. I can construct efficient instruments for both sets: twins, and ideal number of children. However, this process is only done for the ideal children instrument. In terms of notation, the efficient instruments of the ideal number of children dummy variables are going to be denoted by ξ. Wooldridge (2010) gives some examples of the application of this method by different authors.

In order to construct the instruments, consider the sample of first born children. The efficient instrument in terms of increases from 0 to 1 sibling is equal to:

$$\hat{\xi}_{1i} = \begin{cases} 1 & \text{if} \quad ideal_{1i} = 1 \\ f_1(X_i, \hat{\theta}_1) & \text{if} \quad ideal_{1i} = 0 \end{cases}$$

According to this funtional form, if the ideal number of children is lower than the real number of children, and the real number of children is equal to or greater than 2, then the probability of having at least one sibling is 1. In contrast, if the ideal number of children is not lower than the real number of siblings, the predicted probability of having an additional sibling is a nonlinear function of the included X_i, with a range restriction to the unit interval using a probit or logit model. Similarly, the definition of both efficient instruments from 1 to 2 siblings, 2 to 3 siblings, 3 to 4 siblings, and 4 to 5 siblings is:

$$\hat{\xi}_{2i} = \begin{cases} 1 & \text{if} \quad ideal_{2i} = 1 \\ f_2(X_i, ideal^*_{2i}, \hat{\theta}_2) & \text{if} \quad ideal_{2i} = 0 \end{cases}$$

$$\hat{\xi}_{3i} = f_3(X_i, ideal^*_{3i}, \hat{\theta}_3)$$

$$\hat{\xi}_{4i} = f_4(X_i, ideal^*_{4i}, \hat{\theta}_4)$$

$$\hat{\xi}_{5i} = f_5(X_i, ideal^*_{5i}, ideal_{1i}, \hat{\theta}_5)$$

The functions $f_s(\cdot)$ include the conditional mean functions constructed in the IV strategy for $s \geq 2$. The next step is to replace $\hat{\xi}_{si}$ for $ideal^*_{si}$ in the model 9 for first born children and in the model 11 for second born children. Hence, the first stage for first born children is:

$$d_{si} = \kappa_{s1}\hat{\xi}_{1i} + \kappa_{s2}\hat{\xi}_{2i} + ... + \kappa_{s5}\hat{\xi}_{5i} + \varphi dif_{ideali} + \phi X_i + e_{si}, \quad s = 1, 2, 3, 4, 5 \tag{12}$$

For second born children, the first stage is:

$$d_{si} = \kappa_{s2}\hat{\xi}_{2i} + ... + \kappa_{s5}\hat{\xi}_{5i} + \varphi dif_{ideali} + \phi X_i + e_{si}, \quad s = 2, 3, 4, 5 \tag{13}$$

The difference between the efficient estimators and the instruments used directly in the IV strategy is that the former has the advantage of using a nonlinear model to predict the endogenous family size variables in order to restrict the predicted range to the unit interval using probit or logit models. Aditionally, Mogstad and Wiswall (2010) take into account that the probability of an additional sibling is 1 when the *jth* birth are twins. Likewise, this article takes into account that the probability of an additional sibling is 1 when the ideal number of children is lower than the real number of children in the jth child. In this sense, the efficient instruments may be more strongly correlated with the endogenous variables of the quantity-quality model. I estimate the linear IV models with the efficient instruments in order to compare both of them. The specification for first born children is:

$$siblings_i = \theta\hat{\xi}_{1i} + \varphi dif_{ideali} + \phi X_i + e_i \quad (14)$$

In the case of second born children, I replace $\hat{\xi}_{1i}$ for $\hat{\xi}_{2i}$. The efficient instruments are constructed using probit models. I use a parsimonius specification in the vector of covariates which corresponds to: linear and quadratic child's age, child's sex, mother's age, mother's age at the first birth, 6 intercepts of mother's education, 6 intercepts of father's education, 1 intercept if the information of the father is missing, and 5 intercepts of the marital status of the mother.

5.4 Discussion of the ideal children instrument

One possible problem that the instrument of ideal children may present is that the report made by mothers is after they know the quality of their children, therefore the report may be correlated with the quality of children and the instrument will not hold exogeneity because it affects directly children quality.

To show that this is not the case. I take advantage that the quality outcomes are binary and take into account the fact that the ideal number of children affect children quality through the real number of children. I perform mean difference tests of the ideal number of children holding fixed the real number of children by the quality outcome. Table 1 shows the p-value of the ttest for each of the quality outcomes holding fixed the real number of children. There is not statistical evidence of differences in the ideal number of children reported by mothers given the quality of their children except for a few cases.

Table 1: **Mean difference test ideal children**

Panel A: First born children				
Real Children	School lag	School Attendance	School dropout	Child labor
1	0.19	0.97	0.77	0.04
2	0.52	0.11	0.38	0.12
3	0.04	0.29	0.13	0.65
4	0.81	0.03	0.07	0.54
5	0.08	0.37	0.69	0.64
Panel B: Second born children				
Real Children	School lag	School Attendance	School dropout	Child labor
2	0.04	0.18	0.28	0.67
3	0.13	0.12	0.41	0.15
4	0.37	0.64	0.94	0.02
5	0.47	0.78	0.91	0.04

This table shows mean difference tests holding fixed the real number of children. The dummy variables is the quality outcomes. Rows hold fixed the real number of children and columns denote the dummy variables that perform the test.

6 Empirical Results

6.1 Effects of family size on quality outcomes

This section describes the main results of the linear and nonlinear specifications for the four outcomes. The standard errors of the coefficients were computed using a bootstrap procedure with 100 repetitions. Unlike the evidence of the last ten years, I find negative effects of an additional sibling in different parts of the distribution. Table 4 shows the coefficients of family size on the variable *school lag*, table 5 on the variable *school attendance*, table 6 on the variable *school droput*, and table 7 on the variable *child labor*.[8] Columns 1 and 5 describe the OLS results for first and second born children respectively, columns 2 and 6 the IV twins strategy results, columns 3 and 7 the IV ideal children strategy results, and columns 4 and 8 the IV efficient ideal children strategy results.

Under a linear specification, an additional sibling has negative effects on the four outcomes. In particular, it increases the likelihood of *school lag* between 4.1 and 4.9 percentage points, it reduces the likelihood of *school attendance* between 1.3 and 1.5 percentage points, it increases the likelihood of school *dropout* between 1.0 and 2.0 percentage points, and it increases the likelihood of *child labor* between 0.8 and 2.0 percentage points.

[8]Each table contains a graphical representation of the coefficients. In this regard, figure 1 shows the parameters for *school lag*, figure 2 for *school attendance*, figure 3 for *school dropout*, and figure 4 for *child labor*.

Under a nonlinear specification, the results show that for first born children a first sibling generates positive or null effects in terms of *school lag*, *school attendance*, *school dropout*, and *child labor*. For example, it reduces the likelihood of *school lag* in 6.3 percentage points and it increases the likelihood of *school attendance* in 3.2 percentage points . However, there are negative effects from two siblings onwards. In particular, a second sibling generates negative effects on all the 4 outcomes, and a third sibling generates negative effects on the 3 educational outcomes. Finally, a fourth sibling has negative effects on *school lag* and *child labor*, and a fifth sibling has negative effects on *school lag* and *school dropout* and null effects in the remaining outcomes. For second born children, a second sibling generates positive effects on *school attendance*, *school dropout*, and *child labor*, and negative effects on *school lag*. A third and fourth sibling generate negative effects on the four outcomes, and a fifth sibling has negative effects on *school lag* and *child labor*.[9]

It is also important to test the exogeneity and relevance of the instruments. In terms of the exogeneity test, the three sets of instruments seem to comply with the exogeneity assumption at 1% for the 4 outcomes. However, for the variable *school lag* the p-value of some of the Sargan's test is lower than 0.1. For example, under the linear specification for first born children the p-value of twins in higher birth instrument is just 0.04. For the three remaining outcomes the p-value is greater than 0.1 for all the instruments except for the efficient ideal children instrument in the sample of second born children in the 3 educational outcomes. The Cragg-Donald's F statistic is greater than 12 in all the specifications except for the twins in higher births intruments for the variable *school lag*. In order to test the endogeneity of the OLS, table 8 shows the Hausman test for the 4 outcomes and the 3 sets of instruments. Under the linear specification, the variable *siblings* is only endogenous for *school lag*, but under a nonlinear specification family size is an endogenous variable for the 4 outcomes.

6.2 Heterogenous effects

This section explores how the QQ *trade-off* varies as certain household characteristics change to capture a proxy of interactions between siblings. In particular, I focus on two different categories. The first category captures differences in age gap cohorts. It corresponds of two

[9]For the variale *child labor*, I also estimate the effect of family size in the two lowest wealth quintiles, the effects are greater in magnitude. For example, for first born children a first sibling reduces the likelihood of *child labor* in 6.3 percentage points, and a second sibling increases the likelihood in 4.4 percentage points.

groups of first born children who have the following characteristics: 1) the difference in age with respect to her first sibling is lower than three years; and 2) the difference in age with respect to her first sibling is greater than three years and lower than six years. The second category corresponds to first born children who have a different sex from all her siblings, this category is also divided in two groups: boys and girls. In this empirical excercise, I restrict the sample only to first born children, and for the former category I exclude from the sample only children. Moreover, the IV strategy is just specified for the ideal children and efficient ideal children instruments.

Table 9 describes the results for the first sample: first born children who have an age gap lower than three years with her first sibling. Columns 1, 4, 7, and 10 describes the OLS regression for the 4 outcomes: *school lag*, *school attendance*, *school dropout*, and *child labor* respectively; while columns 2, 5, 8, and 12 show the results of the IV regression using the ideal children instruments for the four outcomes in the same order; and finally columns 3, 6, 9, and 12 display the results of the IV strategy using the efficient ideal children instruments.

The linear specification shows that the effect of an additional sibling is lower than the effect in the entire sample. In particular and consistent with the previous results an additional sibling increases the likelihood of *school lag*, reduces the likelihood of *school attendance*, increases the likelihood of *school dropout*, and has null effects on the likelihood of *child labor*, however the effects are lower. For the nonlinear specification a second sibling has no effect, a third and fourth sibling has negative effects on the three educational outcomes. And finally, when family size increases from 4 to 5 siblings only the likelihood of *school lag* increases.

One possible mechanism of this result is competition between siblings. In particular, when siblings are more similar, the competition between them is greater.[10] Hence, the competition can generate that the effect of an additional sibling is compensated by the effort of the child to be better than her first sibling. The result is that the effect of an additional sibling is lower or null in some parts of the distribution. For example when family size increases from 1 to 2 siblings.

Table 10 displays the results for the sample of first born children who have an age gap between 3 and 6 years with her first sibling. Under the linear specification, the effect of an

[10] For example Mejía and St-Pierre (2007) show that individuals with similar abilities exert higher levels of effort in tournaments system.

additional sibling is greater for *school lag* and *school attendance* and lower in terms of *school dropout* and *child labor*. For the nonlinear specification, a second sibling increases the likelihood of *school lag*, and reduces the likelihood of *school attendance*. However from 3 siblings onwards there is a small effect on *school lag*, and null effects in the remaining outcomes. One possible mechanism of this result, is that the age gap between first born child and last born child is too great, that the additional child is not going to generate any effect to the first born child when the number of siblings is greater than 3 siblings.[11]

Second, I consider the effect of an additional sibling in households where the sex of first born child is different from the sex of the rest of her siblings discriminating between boys and girls. I drop children who have 4 siblings or more from the sample, because the number of observations are only 53 and 62 for boys and girls, respectively. Table 11 displays the results for first born children who are boys and all his siblings are girls. In the linear specification, the QQ *trade-off* does not hold. In particular, an additional sibling has null efects in the 4 outcomes. This result can be attributed to the preferences of the parents towards the boy. However, under the nonlinear specification, there are positive effects of having a first sister on *school lag*, *school dropout* and *child labor*. Despite this fact, the coefficientes are lower than the estimators of the entire sample. Under the nonlinear specification a second sister increases the likelihood of *school lag*, and reduces the likelihood of *school attendance*, increases the likelihood of *school dropout* and the likelihood of *child labor*. Nevertheless, a third sibling has null efects on the four outcomes.

Table 12 describes the results for first born girls who have all their siblings boys. Under the linear specification, there are negative effects on *school attendance* and *school dropout*. This result can be explained by the preferences of the parents for the boys within the household. Under the nonlinear specification, a first sibling has positive effects on *school lag* and *child labor*, and negative effects in terms of *school attendance*. A second brother generates negative effects on *school lag* and *school attendance* and a third sibling has null effects on the 4 outcomes.

Hence, as certain characteristics within the household change, the effect of an additional

[11] I estimate the effect of family size on the four outcomes in an additional subsample, which consists of first born children with an age gap greater than 7 years. Under the linear specification the number of siblings has only an effect on *school lag*, and under a nonlinear specification there are no effects.

sibling varies also depending on the number of siblings the child i has. The results of the heterogenous effects show that in families where children are similar, the age gap between children varies, and the preferences of the parents change, the effect of an additional sibling is not the same as the effect of all sample. These results are consistent with the conclusions of the theoretical model.

6.3 Robustness check

This section explores the robustness of the empirical results. In this sense, one possible argument against the empirical strategy is that many mothers in the sample have not finished their reproductive life. Therefore, I specify another model to solve this problem and furthermore to check the robustness of my results. I restrict the sample to children who have mothers that reported a real number of children greater or equal to the ideal number of children, I assume that these women have finished their reproductive life [12].

Table 13 shows the results of this empirical excercise for first born children. Columns 1, 2 and 3 show the result for *school lag* using an OLS regression, the IV strategy using the ideal number of children instruments, and the IV strategy using the efficient ideal number of children instruments. Columns 4, 5, and 6 display the same results for *school attendance*, columns 7, 8, and 9 show the results for *school dropout*, and finally columns 10, 11, and 12 display the results for *child labor*.

Under a linear specification the QQ *trade-off* holds in Colombia. For example, an additional sibling increases the likelihood of *school lag* between 4.2 and 4.6 percentage points, reduces the likelihood of *school attendance* between 1.4 and 1.5 percentage points, increases the likelihood of *school dropout* in 1.1 percentage points, and increases the likelihood of *child labor* in 1.0 percentage points.

Similarly, under a nonlinear specification a first sibling generates null or positive effects. For example, a first sibling increases the likelihood of *school attendance* between 2.9 and 4.2 percentage points and reduces the likelihood of *school dropout* in 3.9 percentage points. However there are negative effects in some parts of the siblings distribution from two siblings onwards.

[12] An additional empirical excercise is carried out estimating the effect for children with mothers older than 40 years old. The results are weaker in all the outcomes. Nevertheless, for first born children a first sibling generates null or positive effects, but the QQ *trade-off* holds from two siblings onwards except for the variable *school lag*. However these mothers have different characteristics and children are older.

For example, a second sibling has negative effects on the 4 outcomes, and a third sibling on the 3 educational outcomes. Finally, a fourth sibling has negative effects on *school lag* and *child labor*.

Furthermore, for second born children the results are similar to the results show in the tables 4 to 7. Under a linear specification the QQ *trade-off* holds in Colombia. An additional sibling has negative effects on the four outcomes. And, under a nonlinear specification a second sibling generates null or positive effects, but the QQ *trade-off* holds from three siblings onwards. For example, a third sibling increases the likelihood of *school lag* between 4.3 and 4.9 percentage points, and reduces the likelihood of *school attendance* between 1.6 and 2.2 percentage points.

7 Conclusions

Since the seminal work of Becker and Lewis (1973) the relationship between family size and children quality has been in the research agenda of empirical economics. However, the majority of these studies have concentrated in developed countries. In spite of this fact, different countries around the world have sponsored family planning efforts to reduce the number of children within each household. In this sense, Colombia has not been the exception. In March 2011 a law was submitted in the Congress in order to encourage families of lower size restricting the subsidies of nutrition, education and housing only to households with two or less children.

This article has estimated the effect of an additional sibling on educational and labor market outcomes for the case of Colombia. Under a linear specification, the effect of an additional child is negative in terms of both outcomes. For example an additional sibling increases the likelihood of having lower years of education with respect to the gender and age cohort, reduces the likelihood of school attendance, increases the likelihood of schooling dropout, and increases the likelihood of child labor. The theoretical model shows that depending on the characteristics of the child and the family environment, an additional sibling can either have positive or null effects on those outcomes. These results were confirmed under a nonlinear specification and finding heterogenous effects in households with certain characteristics.

In particular, for first born children, a first sibling generates positive or null effects but there are negative or null effects from two siblings onwards. For second born children, a second sibling generates positive or null effects but there are negative effects from three siblings onwards. In the same way, depending on the age gap with her first sibling and the sex composition within the household the effect of an additional child varies. For example, in families where the age gap between the first two siblings is greater than three years and lower than six years the QQ *trade-off* does not hold from three siblings onwards. An additional sibling has null effects in the quality of first born children. Hence, the policies designed to encourage lower size families have to take into account the differences in age gap between siblings and the social programs have to focus in these effects. For example, when the family size increases from 2 to 3 siblings, the age gap between the first and third child has to be large enough to offset the effects of the QQ *trade-off* for first born children. But in the same way, the additional sibling may generate positive effects for second born children.

It is also important to consider the effects that such a policy may have in the long run. Authorities also have to focus in the existent relationship that exists between the elderly and working population in order to keep a healthy economic system. For example, Pezzin and Schone (1999) show that the children's provision of inkind services to the elderly affect the labor force participation of women, and Rainer and Siedler (2009) show that only children have a disadvantage to take economic opportunities due to parental care. In this sense, the bargaining process between siblings is easier when the family size is greater. Finally, it is also relevant that the literature in Colombia focuses in this type of relationship.

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A Tables and graphs

Table 2: **Summary Statistics DHS survey: Household and Mother Characteristics**

	First Born children					Second born children				
Variable	**Obs**	**Mean**	**SD**	**Min**	**Max**	**Obs**	**Mean**	**SD**	**Min**	**Max**
Panel A: Household Characteristics										
Household Head age	27,774	42.15	12.63	17.00	95.00	21,217	42.71	10.83	16.00	96.00
Household Head male	27,774	0.71	0.45	0.00	1.00	21,217	0.72	0.45	0.00	1.00
Urban	27,774	0.75	0.43	0.00	1.00	21,217	0.73	0.44	0.00	1.00
Prop kids 5	27,774	0.11	0.13	0.00	0.75	21,217	0.08	0.11	0.00	0.60
Panel B: Mother Characteristics										
Age of the mom	27,774	33.57	6.05	18.00	49.00	21,217	36.54	5.88	21.00	49.00
Mother's age at first birth	27,774	21.27	4.63	11.00	43.00	21,217	20.50	4.03	10.00	39.00
Ideal children	27,774	1.97	1.36	0.00	20.00	21,217	2.18	1.52	0.00	20.00
Real children	27,774	2.38	1.12	1.00	6.00	21,217	3.00	1.04	2.00	6.00
Twins at some birth	27,774	0.01	0.10	0.00	1.00	21,217	0.01	0.08	0.00	1.00
Educational Variables										
No education	27,774	0.02	0.14	0.00	1.00	21,217	0.03	0.17	0.00	1.00
Incomplete primary	27,774	0.15	0.35	0.00	1.00	21,217	0.19	0.39	0.00	1.00
Primary	27,774	0.16	0.37	0.00	1.00	21,217	0.20	0.40	0.00	1.00
Incomplete secondary	27,774	0.24	0.43	0.00	1.00	21,217	0.26	0.44	0.00	1.00
Secondary	27,774	0.25	0.44	0.00	1.00	21,217	0.21	0.40	0.00	1.00
Higher	27,774	0.18	0.38	0.00	1.00	21,217	0.13	0.33	0.00	1.00
Marital Status										
Single	27,774	0.07	0.25	0.00	1.00	21,217	0.02	0.16	0.00	1.00
Married	27,774	0.31	0.46	0.00	1.00	21,217	0.35	0.48	0.00	1.00
Living together	27,774	0.43	0.49	0.00	1.00	21,217	0.42	0.49	0.00	1.00
Widow	27,774	0.02	0.14	0.00	1.00	21,217	0.03	0.16	0.00	1.00
Not living together or divorced	27,774	0.18	0.38	0.00	1.00	21,217	0.00	0.06	0.00	1.00

Note: The units of observation are the first and second born children who lived with her mother in the same household at the moment of the survey. The surveys were carried out in 2000, 2005, and 2010.

Table 3: **Summary Statistics DHS survey: Individual Characteristics**

	First Born children					Second born children				
Variable	**Obs**	**Mean**	**SD**	**Min**	**Max**	**Obs**	**Mean**	**SD**	**Min**	**Max**
Individual Characteristics										
Age	27,774	11.81	3.93	5.00	24.00	21,217	11.73	3.90	5.00	24.00
Sex	27,774	0.52	0.50	0.00	1.00	21,217	0.50	0.50	0.00	1.00
Gender composition	27,774	0.51	0.50	0.00	1.00	21,217	0.39	0.49	0.00	1.00
No Siblings	27,774	0.22	0.41	0.00	1.00	21,217	0.00	0.00	0.00	0.00
Siblings ≥ 1	27,774	0.78	0.41	0.00	1.00	21,217	1.00	0.00	1.00	1.00
Siblings ≥ 2	27,774	0.38	0.49	0.00	1.00	21,217	0.61	0.49	0.00	1.00
Siblings ≥ 3	27,774	0.14	0.35	0.00	1.00	21,217	0.26	0.44	0.00	1.00
Siblings ≥ 4	27,774	0.05	0.22	0.00	1.00	21,217	0.10	0.30	0.00	1.00
Siblings ≥ 5	27,774	0.01	0.12	0.00	1.00	21,217	0.03	0.16	0.00	1.00
Relation househhold head										
Sons or daughters	27,774	0.78	0.41	0.00	1.00	21,217	0.87	0.33	0.00	1.00
Other	27,774	0.22	0.41	0.00	1.00	21,217	0.13	0.33	0.00	1.00
Dependent Variables										
School lag	23,583	0.11	0.31	0.00	1.00	17,965	0.13	0.33	0.00	1.00
School attendance	27,488	0.91	0.29	0.00	1.00	21,011	0.90	0.31	0.00	1.00
School dropout	23,749	0.07	0.26	0.00	1.00	18,050	0.08	0.27	0.00	1.00
Child labor	19,152	0.04	0.20	0.00	1.00	14,899	0.05	0.22	0.00	1.00
Instruments										
Twin at birth 2	21,649	0.007	0.083	0.00	1.00					
Twin at birth 3	10,682	0.006	0.078	0.00	1.00	13,037	0.006	0.079	0.00	1.00
Twin at birth 4	4,024	0.009	0.097	0.00	1.00	5,443	0.008	0.092	0.00	1.00
Twin at birth 5	1,448	0.002	0.045	0.00	1.00	2,079	0.003	0.054	0.00	1.00
Ideal 1	27,774	0.35	0.48	0.00	1.00	21,217	0.49	0.50	0.00	1.00
Ideal 2	21,649	0.32	0.47	0.00	1.00	21,217	0.40	0.49	0.00	1.00
Ideal 3	10,682	0.29	0.46	0.00	1.00	13,037	0.32	0.47	0.00	1.00
Ideal 4	4,024	0.31	0.46	0.00	1.00	5,443	0.33	0.47	0.00	1.00
Ideal 5	1,448	0.25	0.43	0.00	1.00	2,079	0.25	0.43	0.00	1.00

Note: The units of observation are the first and second born children who lived with her mother in the same household at the moment of the survey. The surveys were carried out in 2000, 2005, and 2010.

Table 4: **Results School lag**

	First Born children				Second born children			
Linear Results	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable	**OLS**	**Twins**	**Ideal**	**E.Ideal**	**OLS**	**Twins**	**Ideal**	**E.Ideal**
siblings	0.045***	0.049***	0.041***	0.041***	0.038***	0.046***	0.042***	0.049***
	(0.002)	(0.006)	(0.004)	(0.003)	(0.003)	(0.010)	(0.005)	(0.003)
R^2	0.14	0.16	0.16	0.16	0.13	0.14	0.14	0.14
Sargan pvalue		0.04	0.81	0.98		0.54	0.51	0.03
Cragg-Donald F		2421.64	5188.82	11586.15		1269.29	4720.62	12628.89
Nonlinear Results								
1 sibling	0.005		0.011	-0.063***				
	(0.005)		(0.010)	(0.017)				
2 siblings	0.024***	0.003	0.017***	0.057***	0.022***		0.023***	-0.005
	(0.005)	(0.034)	(0.006)	(0.011)	(0.005)		(0.008)	(0.007)
3 siblings	0.089***	0.093*	0.085***	0.089***	0.032***	-0.042	0.031***	0.067***
	(0.008)	(0.049)	(0.012)	(0.013)	(0.007)	(0.045)	(0.010)	(0.011)
4 siblings	0.095***	0.017	0.063***	0.099***	0.064***	-0.001	0.062***	0.069***
	(0.013)	(0.129)	(0.022)	(0.020)	(0.012)	(0.084)	(0.018)	(0.019)
5 siblings	0.146***	0.198	0.097**	0.117***	0.111***	0.327	0.089***	0.103***
	(0.022)	(0.410)	(0.039)	(0.040)	(0.019)	(0.324)	(0.025)	(0.029)
R^2	0.15	0.17	0.16	0.16	0.13	0.13	0.14	0.14
Sargan pvalue		0.09	0.51	0.09		0.75	0.07	0.01
Cragg-Donald F		24.33	988.32	336.04		20.62	2442.78	2001.88
Observations	23,583	18,103	23,583	23,583	17,965	10,716	17,965	17,965

Note: Each column is a separate regression. Columns 1 and 5 show the OLS results for the first and second born children respectively. Columns 2 and 6 show the IV strategy using the twin instruments; columns 3 and 7 show the IV strategy using the ideal children instruments; and columns 4 and 8 show the IV strategy using the efficient ideal children instruments. Standard errors are calculated using a bootstrap procedure with 100 repetitions and are in parenthesis.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 1: Dependent Variable: School lag

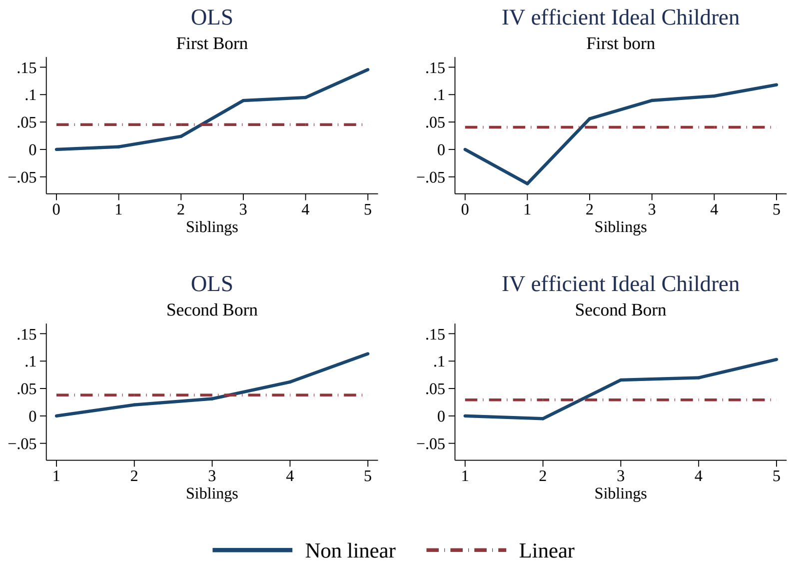

Table 5: **Results School Attendance**

	First Born children				Second born children			
Linear Results	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable	**OLS**	**Twins**	**Ideal**	**E.Ideal**	**OLS**	**Twins**	**Ideal**	**E.Ideal**
siblings	-0.015***	-0.015***	-0.013***	-0.015***	-0.018***	-0.014*	-0.015***	-0.022***
	(0.002)	(0.005)	(0.003)	(0.002)	(0.002)	(0.007)	(0.004)	(0.003)
R^2	0.24	0.25	0.25	0.25	0.26	0.27	0.26	0.26
Sargan pvalue		0.70	0.57	0.64		0.48	0.98	0.02
Cragg-Donald F		2868.04	5946.61	13089.36		1627.53	5528.19	14895.14
Nonlinear Results								
1 sibling	-0.000		-0.010	0.032***				
	(0.004)		(0.009)	(0.011)				
2 siblings	-0.020***	-0.051*	-0.015**	-0.034***	-0.006		-0.005	0.018***
	(0.004)	(0.028)	(0.006)	(0.008)	(0.004)		(0.008)	(0.006)
3 siblings	-0.017***	-0.057*	-0.010	-0.019*	-0.018***	-0.068**	-0.015	-0.044***
	(0.006)	(0.035)	(0.010)	(0.011)	(0.006)	(0.032)	(0.011)	(0.007)
4 siblings	-0.030***	0.057	-0.015	-0.015	-0.030***	-0.158***	-0.019*	-0.024**
	(0.010)	(0.098)	(0.016)	(0.016)	(0.009)	(0.060)	(0.012)	(0.011)
5 siblings	-0.005	0.216	-0.007	-0.029	-0.046***	0.513**	-0.013	-0.025
	(0.017)	(0.333)	(0.027)	(0.031)	(0.015)	(0.226)	(0.024)	(0.016)
R^2	0.24	0.23	0.25	0.24	0.26	0.19	0.26	0.26
Sargan pvalue		0.41	0.18	0.75		0.70	0.67	0.32
Cragg-Donald F		21.63	1143.64	370.22		16.06	2741.56	2188.79
Observations	27,488	21,432	27,488	27,488	21,011	12,897	21,011	21,011

Note: Each column is a separate regression. Columns 1 and 5 show the OLS results for the first and second born children respectively. Columns 2 and 6 show the IV strategy using the twin instruments; columns 3 and 7 show the IV strategy using the ideal children instruments; and columns 4 and 8 show the IV strategy using the efficient ideal children instruments. Standard errors are calculated using a bootstrap procedure with 100 repetitions and are in parenthesis.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 2: Dependent Variable: School Attendance

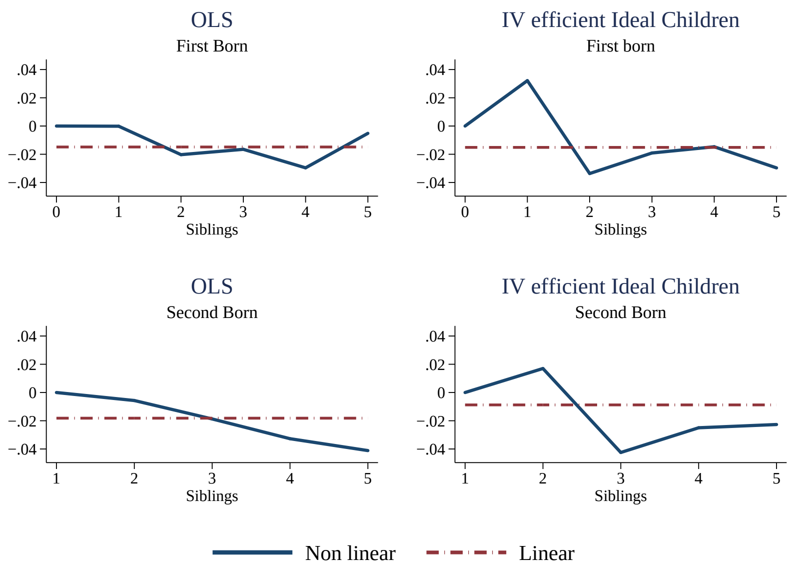

Table 6: **Results School Dropout**

	First Born children				Second born children			
Linear Results	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable	**OLS**	**Twins**	**Ideal**	**E.Ideal**	**OLS**	**Twins**	**Ideal**	**E.Ideal**
siblings	0.012***	0.011**	0.011***	0.013***	0.015***	0.010	0.014***	0.020***
	(0.002)	(0.005)	(0.003)	(0.002)	(0.002)	(0.007)	(0.003)	(0.003)
R^2	0.19	0.20	0.20	0.20	0.22	0.22	0.22	0.22
Sargan pvalue		0.54	0.48	0.70		0.21	0.19	0.01
Cragg-Donald F		2566.12	5252.12	11456.56		1398.97	4824.17	12889.28
Nonlinear Results								
1 sibling	-0.003		0.005	-0.056***				
	(0.004)		(0.008)	(0.013)				
2 siblings	0.014***	0.031	0.010*	0.041***	0.002		0.002	-0.018***
	(0.004)	(0.025)	(0.006)	(0.007)	(0.004)		(0.006)	(0.004)
3 siblings	0.018***	0.044*	0.011	0.012*	0.012**	0.078**	0.019**	0.039***
	(0.006)	(0.023)	(0.010)	(0.007)	(0.006)	(0.035)	(0.008)	(0.008)
4 siblings	0.023**	-0.042	0.010	0.011	0.036***	0.167***	0.019	0.028*
	(0.010)	(0.053)	(0.017)	(0.013)	(0.009)	(0.060)	(0.013)	(0.014)
5 siblings	0.010	-0.124**	0.024	0.037*	0.031**	-0.571**	0.003	0.014
	(0.017)	(0.059)	(0.021)	(0.020)	(0.015)	(0.242)	(0.018)	(0.024)
R^2	0.19	0.19	0.20	0.19	0.22	0.10	0.22	0.22
Sargan p-value		0.13	0.20	0.36		0.51	0.93	0.25
Cragg-Donald F		22.62	952.15	287.52		12.45	2348.14	1880.70
Observations	23,749	18,722	23,749	23,749	18,050	11,132	18,050	18,050

Note: Each column is a separate regression. Columns 1 and 5 show the OLS results for the first and second born children respectively. Columns 2 and 6 show the IV strategy using the twin instruments; columns 3 and 7 show the IV strategy using the ideal children instruments; and columns 4 and 8 show the IV strategy using the efficient ideal children instruments. Standard errors are calculated using a bootstrap procedure with 100 repetitions and are in parenthesis.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 3: Dependent Variable: School Dropout

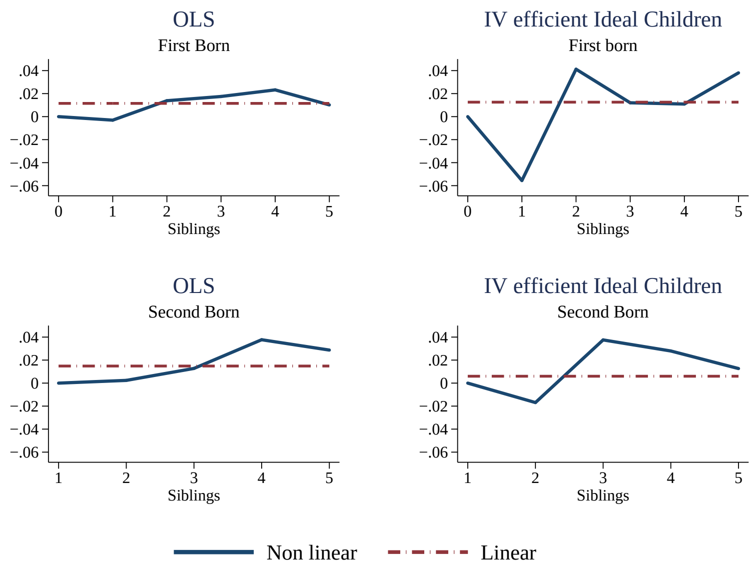

Table 7: **Results Child Labor**

	First Born children				Second born children			
Linear Results	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable	**OLS**	**Twins**	**Ideal**	**E.Ideal**	**OLS**	**Twins**	**Ideal**	**E.Ideal**
siblings	0.010***	0.011**	0.007**	0.008***	0.014***	0.017**	0.013***	0.014***
	(0.002)	(0.005)	(0.003)	(0.002)	(0.002)	(0.008)	(0.003)	(0.003)
R^2	0.07	0.07	0.06	0.06	0.08	0.08	0.07	0.07
Sargan pvalue		0.21	0.97	0.57		0.85	0.61	0.92
Cragg-Donald F		1888.43	4234.77	9326.63		985.28	3804.09	9965.96
Nonlinear Results								
1 sibling	0.005		0.007	-0.039***				
	(0.003)		(0.007)	(0.010)				
2 siblings	-0.001	0.013	0.002	0.027***	0.002		0.005	-0.004
	(0.004)	(0.053)	(0.006)	(0.007)	(0.004)		(0.006)	(0.005)
3 siblings	0.023***	-0.006	0.006	-0.003	0.019***	0.075	0.006	0.011*
	(0.006)	(0.055)	(0.009)	(0.008)	(0.005)	(0.060)	(0.008)	(0.006)
4 siblings	0.039***	0.124	0.030*	0.049***	0.025***	0.159	0.029**	0.042***
	(0.010)	(0.180)	(0.017)	(0.017)	(0.009)	(0.138)	(0.015)	(0.010)
5 siblings	0.024	-0.239	0.022	0.022	0.035**	-0.532	0.009	0.027
	(0.017)	(1.136)	(0.034)	(0.033)	(0.015)	(0.537)	(0.024)	(0.021)
R^2	0.07	0.06	0.07	0.06	0.08	-0.07	0.07	0.07
Sargan pvalue		0.15	0.27	0.70		0.87	0.26	0.83
Cragg-Donald F		18.08	792.97	280.82		4.89	2013.86	1695.43
Observations	19,152	14,362	19,152	19,152	14,899	8,652	14,899	14,899

Note: Each column is a separate regression. Columns 1 and 5 show the OLS results for the first and second born children respectively. Columns 2 and 6 show the IV strategy using the twin instruments; columns 3 and 7 show the IV strategy using the ideal children instruments; and columns 4 and 8 show the IV strategy using the efficient ideal children instruments. Standard errors are calculated using a bootstrap procedure with 100 repetitions and are in parenthesis.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 4: Dependent Variable: Child Labor

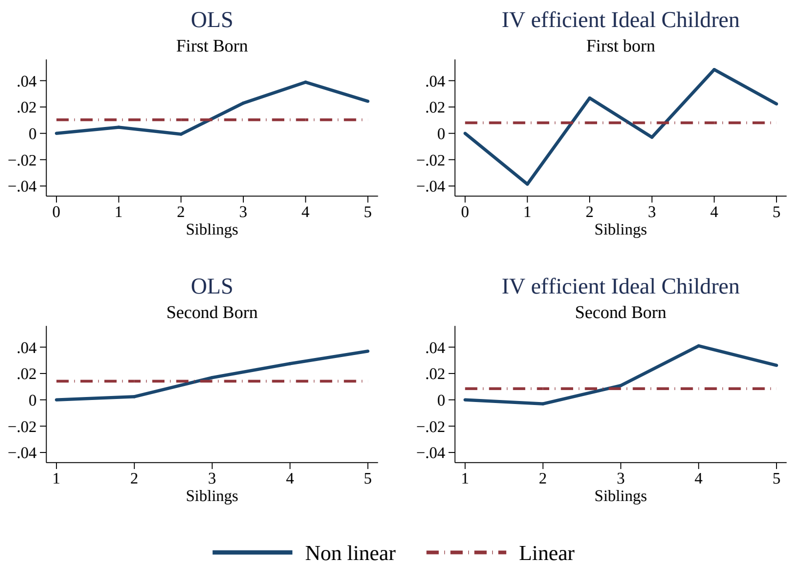

Table 8: Endogeneity Tests OLS

	First Born children			Second Born children		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	IV twins	IV ideal	IV E. ideal	IV twins	IV ideal	IV E. ideal
Linear						
School lag	0.02	0.00	0.00	0.05	0.05	0.43
School Attendance	0.95	0.88	0.65	0.20	0.63	0.04
School Dropout	0.99	0.64	0.97	0.23	0.69	0.01
Child Labor	0.60	0.01	0.03	0.33	0.11	0.38
Nonlinear						
School lag	0.00	0.00	0.00	0.02	0.01	0.00
School Attendance	0.03	0.02	0.01	0.00	0.00	0.00
School Dropout	0.05	0.31	0.00	0.00	0.00	0.00
Child Labor	0.04	0.00	0.00	0.06	0.00	0.00

Note: Columns 1 and 4 compare the OLS estimators vs the IV twins estimators for first and second born children; columns 2 and 5 compare the OLS estimators vs the IV ideal children estimators for first and second born children; and columns 3 and 6 compare the OLS estimators vs the IV efficient ideal children estimators.

Table 9: **Age gap between first born and second born child lower than 3 years**

	School lag			School Attendance			School Dropout			Child labor		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
siblings	0.061***	0.043***	0.043***	-0.018***	-0.013**	-0.014***	0.018***	0.013**	0.012**	0.013***	0.009	0.008
	(0.004)	(0.007)	(0.007)	(0.003)	(0.006)	(0.005)	(0.003)	(0.005)	(0.005)	(0.003)	(0.006)	(0.005)
R^2	0.17	0.18	0.18	0.25	0.26	0.26	0.20	0.21	0.21	0.09	0.08	0.08
Sargan pvalue		0.08	0.19		0.84	0.95		0.90	0.77		0.50	0.42
Cragg-Donald F		1755.80	2313.14		2048.78	2621.32		1785.31	2297.22		1388.24	1875.80
2 siblings	0.002	0.005	0.010	-0.018***	-0.011	-0.010	0.015**	0.010	0.004	-0.009	0.000	-0.002
	(0.008)	(0.015)	(0.014)	(0.007)	(0.008)	(0.007)	(0.007)	(0.011)	(0.007)	(0.006)	(0.011)	(0.007)
3 siblings	0.076***	0.055***	0.083***	-0.013	-0.007	-0.028***	0.014*	0.006	0.029**	0.023***	0.007	0.018*
	(0.010)	(0.018)	(0.023)	(0.008)	(0.012)	(0.010)	(0.008)	(0.013)	(0.012)	(0.008)	(0.012)	(0.009)
4 siblings	0.109***	0.142***	0.114***	-0.032**	-0.036**	-0.015	0.030**	0.037*	0.016	0.037***	0.047**	0.039*
	(0.016)	(0.024)	(0.022)	(0.013)	(0.017)	(0.016)	(0.012)	(0.021)	(0.016)	(0.013)	(0.020)	(0.020)
5 siblings	0.140***	0.100**	0.126**	-0.006	-0.010	-0.034	0.013	0.021	0.039	0.011	0.007	0.010
	(0.026)	(0.043)	(0.049)	(0.019)	(0.023)	(0.024)	(0.019)	(0.030)	(0.028)	(0.021)	(0.029)	(0.037)
R^2	0.18	0.19	0.19	0.25	0.26	0.26	0.20	0.21	0.21	0.10	0.09	0.09
Sargan pvalue		0.04	0.01		0.78	0.32		0.51	0.08		0.62	0.43
Cragg-Donald F		831.96	1194.08		953.48	1320.81		826.58	1134.28		666.40	954.44
Observations	8,705	8,705	8,705	10,329	10,329	10,329	8,888	8,888	8,888	6,868	6,868	6,868

Note: Each column is a separate regression. Columns 1, 4, 7, and 10 show the OLS; columns 2, 5, 8, and 11 show the IV strategy using the ideal children instruments; and columns 3, 6, 9, and 12 show the IV strategy using the efficient ideal children instruments. The units of observation are first born children who have an age gap lower than three years with her first sibling. Standard errors are reported in parenthesis.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 10: **Age gap between first born and second born child between 4 and 6 years**

	School lag			School Attendance			School Dropout			Child labor		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
siblings	0.058***	0.042***	0.046***	-0.026***	-0.024***	-0.022***	0.014***	0.010	0.012*	0.004	0.001	0.001
	(0.005)	(0.009)	(0.008)	(0.005)	(0.007)	(0.007)	(0.004)	(0.007)	(0.006)	(0.004)	(0.007)	(0.006)
R^2	0.12	0.14	0.14	0.24	0.25	0.25	0.21	0.21	0.21	0.07	0.06	0.06
Sargan pvalue		0.35	0.65		0.49	0.37		0.34	0.53		0.52	0.60
Cragg-Donald F		1648.13	2314.43		1794.70	2459.11		1567.44	2157.38		1384.81	1990.85
2 siblings	0.039***	0.026**	0.021*	-0.031***	-0.030***	-0.018	0.012*	0.011	0.008	-0.006	0.002	0.003
	(0.008)	(0.012)	(0.012)	(0.007)	(0.011)	(0.012)	(0.007)	(0.010)	(0.010)	(0.007)	(0.009)	(0.008)
3 siblings	0.107***	0.106***	0.142***	-0.021	-0.009	-0.030	0.027**	0.014	0.027	0.010	-0.020	-0.025
	(0.015)	(0.030)	(0.020)	(0.013)	(0.017)	(0.022)	(0.012)	(0.017)	(0.018)	(0.013)	(0.018)	(0.017)
4 siblings	0.029	-0.045	0.030	-0.029	-0.005	-0.014	0.013	-0.034	-0.015	0.038	0.036	0.061*
	(0.030)	(0.061)	(0.052)	(0.026)	(0.039)	(0.036)	(0.024)	(0.040)	(0.026)	(0.026)	(0.049)	(0.033)
5 siblings	0.066	0.093	-0.006	0.027	-0.018	0.004	-0.071	0.009	-0.019	0.086	0.116	0.094
	(0.066)	(0.118)	(0.089)	(0.050)	(0.071)	(0.052)	(0.050)	(0.088)	(0.078)	(0.059)	(0.101)	(0.123)
R^2	0.12	0.14	0.14	0.24	0.25	0.25	0.21	0.21	0.21	0.08	0.06	0.06
Sargan pvalue		0.52	0.44		0.22	0.35		0.17	0.45		0.65	0.84
Cragg-Donald F		739.76	1053.39		823.57	1183.54		702.18	986.70		585.15	927.02
Observations	6,011	6,011	6,011	7,086	7,086	7,086	6,116	6,116	6,116	4,820	4,820	4,820

Note: Each column is a separate regression. Columns 1, 4, 7, and 10 show the OLS; columns 2, 5, 8, and 11 show the IV strategy using the ideal children instruments; and columns 3, 6, 9, and 12 show the IV strategy using the efficient ideal children instruments. The units of observation are first born children who have an age gap greater than three years and lower than six years with her first sibling. Standard errors are reported in parenthesis.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 11: **Boys who have all his siblings girls**

Variable	School lag (1)	School lag (2)	School lag (3)	School Attendance (4)	School Attendance (5)	School Attendance (6)	School Dropout (7)	School Dropout (8)	School Dropout (9)	Child labor (10)	Child labor (11)	Child labor (12)
siblings	0.019***	0.014	0.007	-0.012***	-0.016**	-0.010	0.011***	0.013	0.005	0.018***	0.009	-0.000
	(0.004)	(0.009)	(0.009)	(0.004)	(0.008)	(0.009)	(0.004)	(0.008)	(0.008)	(0.004)	(0.008)	(0.008)
R^2	0.09	0.11	0.10	0.22	0.24	0.24	0.18	0.20	0.20	0.08	0.07	0.07
Sargan p-value		0.11	0.61		0.81	0.27		0.73	0.18		0.11	0.92
Cragg-Donald F		1056.02	884.07		1233.77	987.94		1012.60	820.07		876.49	741.33
1 sibling	0.008	0.014	-0.040*	0.002	0.007	0.035	-0.000	-0.003	-0.052**	0.010*	0.011	-0.050**
	(0.006)	(0.013)	(0.020)	(0.006)	(0.012)	(0.025)	(0.006)	(0.012)	(0.026)	(0.006)	(0.011)	(0.022)
2 siblings	0.015	0.010	0.073***	-0.033***	-0.051***	-0.078***	0.022**	0.035***	0.089***	0.019**	0.007	0.093***
	(0.010)	(0.013)	(0.027)	(0.009)	(0.012)	(0.026)	(0.009)	(0.011)	(0.027)	(0.009)	(0.012)	(0.023)
3 siblings	0.109***	0.028	0.114***	-0.008	0.013	-0.025	0.035*	-0.007	0.010	0.088***	0.000	-0.030
	(0.022)	(0.032)	(0.033)	(0.021)	(0.028)	(0.031)	(0.020)	(0.027)	(0.031)	(0.022)	(0.031)	(0.030)
R^2	0.09	0.11	0.10	0.22	0.24	0.23	0.18	0.20	0.19	0.08	0.07	0.05
Sargan p-value		0.10	0.08		0.92	0.90		0.94	0.68		0.11	0.72
Cragg-Donald F		485.42	100.53		567.63	104.46		464.93	77.23		401.42	94.19
Observations	6,207	6,207	6,207	7,090	7,090	7,090	6,022	6,022	6,022	5,223	5,223	5,223

Note: Each column is a separate regression. Columns 1, 4, 7, and 10 show the OLS; columns 2, 5, 8, and 11 show the IV strategy using the ideal children instruments; and columns 3, 6, 9, and 12 show the IV strategy using the efficient ideal children instruments. The units of observation are first born children who are boys and have all his siblings girls. Standard errors are reported in parenthesis.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 12: **Girls who have all her siblings boys**

Variable	School lag (1)	School lag (2)	School lag (3)	School Attendance (4)	School Attendance (5)	School Attendance (6)	School Dropout (7)	School Dropout (8)	School Dropout (9)	Child labor (10)	Child labor (11)	Child labor (12)
siblings	0.015***	-0.001	-0.010	-0.016***	-0.019***	-0.014*	0.012***	0.013*	0.010	0.003	-0.002	-0.009
	(0.005)	(0.009)	(0.010)	(0.004)	(0.007)	(0.008)	(0.004)	(0.007)	(0.008)	(0.003)	(0.006)	(0.006)
R^2	0.10	0.10	0.09	0.22	0.21	0.21	0.18	0.17	0.17	0.03	0.03	0.03
Sargan p-value		0.14	0.78		0.91	0.21		0.79	0.31		0.02	0.33
Cragg-Donald F		1053.79	826.42		1208.55	930.69		993.96	761.31		866.99	718.02
1 sibling	0.012	0.002	-0.071***	0.000	-0.018*	0.023	-0.001	0.014	-0.018	0.005	-0.002	-0.027*
	(0.008)	(0.013)	(0.027)	(0.006)	(0.011)	(0.022)	(0.006)	(0.011)	(0.022)	(0.004)	(0.008)	(0.015)
2 siblings	0.008	-0.001	0.096***	-0.043***	-0.036***	-0.076***	0.036***	0.021**	0.056**	0.001	0.001	0.028
	(0.011)	(0.014)	(0.029)	(0.009)	(0.011)	(0.023)	(0.009)	(0.011)	(0.023)	(0.007)	(0.009)	(0.020)
3 siblings	0.068***	-0.018	0.044	-0.003	0.041*	-0.000	-0.008	-0.033	-0.000	-0.005	-0.019	-0.001
	(0.025)	(0.033)	(0.034)	(0.020)	(0.025)	(0.027)	(0.019)	(0.024)	(0.027)	(0.015)	(0.022)	(0.021)
R^2	0.10	0.10	0.08	0.22	0.21	0.21	0.19	0.17	0.17	0.03	0.03	0.02
Sargan p-value		0.14	0.10		0.75	0.63		0.68	0.69		0.02	0.13
Cragg-Donald F		497.76	106.75		574.67	116.17		476.84	94.18		396.88	99.45
Observations	6,080	6,080	6,080	6,916	6,916	6,916	5,919	5,919	5,919	5,124	5,124	5,124

Note: Each column is a separate regression. Columns 1, 4, 7, and 10 show the OLS; columns 2, 5, 8, and 11 show the IV strategy using the ideal children instruments; and columns 3, 6, 9, and 12 show the IV strategy using the efficient ideal children instruments. The units of observation are first born children who are boys and have all his siblings girls. Standard errors are reported in parenthesis.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 13: **Robustness Results: First born children**

	School lag			School Attendance			School Dropout			Child labor		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
siblings	0.051***	0.046***	0.042***	-0.016***	-0.015***	-0.014***	0.013***	0.012***	0.011***	0.012***	0.010***	0.008***
	(0.003)	(0.004)	(0.004)	(0.002)	(0.004)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
R^2	0.15	0.17	0.17	0.24	0.25	0.25	0.20	0.20	0.20	0.08	0.07	0.07
Sargan pvalue		0.00	0.00		0.14	0.16		0.20	0.25		0.01	0.01
Cragg-Donald F		4158.00	7284.11		4775.58	8205.64		4228.46	7240.65		3258.34	5758.11
1 sibling	0.005	-0.009	-0.018	0.002	0.042**	0.029*	-0.002	-0.039**	-0.046***	0.006	-0.010	-0.035**
	(0.007)	(0.022)	(0.020)	(0.006)	(0.019)	(0.017)	(0.006)	(0.020)	(0.017)	(0.005)	(0.016)	(0.014)
2 siblings	0.021***	0.029***	0.025***	-0.020***	-0.028***	-0.020**	0.012**	0.022***	0.021***	-0.002	0.007	0.012*
	(0.006)	(0.008)	(0.009)	(0.005)	(0.007)	(0.008)	(0.005)	(0.007)	(0.008)	(0.004)	(0.006)	(0.007)
3 siblings	0.087***	0.090***	0.100***	-0.021***	-0.010	-0.024***	0.022***	0.013*	0.019**	0.024***	0.006	0.004
	(0.008)	(0.009)	(0.010)	(0.007)	(0.008)	(0.008)	(0.007)	(0.007)	(0.008)	(0.006)	(0.007)	(0.008)
4 siblings	0.095***	0.064***	0.097***	-0.021*	-0.010	-0.015	0.016	0.005	0.012	0.035***	0.032***	0.046***
	(0.014)	(0.014)	(0.014)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
5 siblings	0.161***	0.098***	0.115***	-0.010	-0.009	-0.025	0.015	0.022	0.035**	0.030	0.022	0.021
	(0.023)	(0.023)	(0.022)	(0.018)	(0.018)	(0.017)	(0.017)	(0.017)	(0.016)	(0.019)	(0.019)	(0.018)
R^2	0.16	0.17	0.17	0.24	0.25	0.25	0.20	0.20	0.20	0.08	0.07	0.07
Sargan pvalue		0.85	0.04		0.20	0.92		0.61	0.57		0.11	0.47
Cragg-Donald F		395.98	506.91		426.68	553.58		347.17	448.47		336.88	418.89
Observations	17,016	17,016	17,016	20,042	20,042	20,042	17,448	17,448	17,448	13,575	13,575	13,575

Note: Each column is a separate regression. Columns 1, 4, 7, and 10 show the OLS; columns 2, 5, 8, and 11 show the IV strategy using the ideal children instruments; and columns 3, 6, 9, and 12 show the IV strategy using the efficient ideal children instruments. The units of observation are first born children. The sample is restricted to children who have mothers that reported a real number of children greater or equal to the ideal number of children. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 14: **Robustness Results: Second born children**

	School lag			School Attendance			School Dropout			Child labor		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
siblings	0.038***	0.043***	0.049***	-0.019***	-0.016***	-0.022***	0.017***	0.015***	0.020***	0.013***	0.010***	0.013***
	(0.003)	(0.005)	(0.004)	(0.002)	(0.004)	(0.003)	(0.002)	(0.004)	(0.003)	(0.002)	(0.004)	(0.003)
R^2	0.13	0.15	0.15	0.26	0.26	0.26	0.21	0.21	0.21	0.08	0.08	0.08
Sargan pvalue		1.00	0.20		0.77	0.15		0.35	0.04		0.90	0.62
Cragg-Donald F		4434.38	10764.96		5194.30	12666.13		4503.18	10898.82		3527.91	8450.75
2 siblings	0.018***	0.004	-0.006	-0.004	0.008	0.017**	0.001	-0.011	-0.017**	0.002	-0.002	-0.004
	(0.006)	(0.009)	(0.009)	(0.005)	(0.007)	(0.008)	(0.005)	(0.007)	(0.008)	(0.004)	(0.006)	(0.007)
3 siblings	0.033***	0.034***	0.061***	-0.023***	-0.018***	-0.038***	0.018***	0.021***	0.035***	0.013**	0.004	0.008
	(0.008)	(0.009)	(0.009)	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)
4 siblings	0.059***	0.062***	0.071***	-0.029***	-0.016*	-0.029***	0.035***	0.016*	0.031***	0.028***	0.031***	0.041***
	(0.012)	(0.012)	(0.012)	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.009)
5 siblings	0.115***	0.094***	0.100***	-0.043***	-0.015	-0.021	0.031**	0.003	0.012	0.034**	0.005	0.025*
	(0.020)	(0.020)	(0.019)	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)	(0.015)
R^2	0.13	0.15	0.15	0.26	0.26	0.26	0.21	0.21	0.21	0.08	0.08	0.08
Sargan pvalue		0.18	0.46		0.03	0.78		0.21	0.34		0.52	0.47
Cragg-Donald F		2640.35	2457.64		2950.81	2719.85		2520.22	2330.76		2162.83	2059.09

Note: Each column is a separate regression. Columns 1, 4, 7, and 10 show the OLS; columns 2, 5, 8, and 11 show the IV strategy using the ideal children instruments; and columns 3, 6, 9, and 12 show the IV strategy using the efficient ideal children instruments. The units of observation are second born children. The sample is restricted to children who have mothers that reported a real number of children greater or equal to the ideal number of children. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 15: **First stage: Ideal number of children**

Variable	(1) Siblings	(2) 1 sibling	(3) 2 siblings	(4) 3 siblings	(5) 4 siblings	(6) 5 siblings
$ideal^*_1$	0.450***	0.444***	-0.076***	-0.084***	-0.044***	-0.017***
	[0.016]	[0.008]	[0.008]	[0.005]	[0.003]	[0.002]
$ideal^*_2$		-0.406***	0.749***	0.109***	0.013***	-0.002
		[0.008]	[0.007]	[0.005]	[0.003]	[0.001]
$ideal^*_3$		-0.084***	-0.389***	0.821***	0.196***	0.037***
		[0.008]	[0.008]	[0.005]	[0.003]	[0.002]
$ideal^*_4$		-0.056***	-0.170***	-0.320***	0.855***	0.181***
		[0.012]	[0.012]	[0.008]	[0.005]	[0.002]
$ideal^*_5$		-0.048**	-0.092***	-0.126***	-0.175***	0.922***
		[0.021]	[0.021]	[0.014]	[0.008]	[0.004]
dif_{ideal}	0.229***	0.034***	0.050***	0.041***	0.022***	0.009***
	[0.005]	[0.002]	[0.002]	[0.001]	[0.001]	[0.000]
R^2	0.519	0.372	0.563	0.641	0.688	0.712
$\hat{\xi}_1$	0.549***	0.681***	-0.138***	0.040***	0.006	-0.001
	[0.039]	[0.018]	[0.015]	[0.008]	[0.004]	[0.002]
$\hat{\xi}_2$		0.324***	0.919***	-0.072***	0.010***	0.001
		[0.009]	[0.007]	[0.004]	[0.002]	[0.001]
$\hat{\xi}_3$		-0.144***	0.164***	0.936***	-0.042***	0.000
		[0.010]	[0.009]	[0.005]	[0.002]	[0.001]
$\hat{\xi}_4$		0.001	-0.076***	0.042***	0.914***	-0.001
		[0.014]	[0.012]	[0.006]	[0.003]	[0.001]
$\hat{\xi}_5$		0.004	0.037**	0.029***	0.083***	0.902***
		[0.020]	[0.017]	[0.010]	[0.005]	[0.002]
dif_{ideal}	0.295***	0.004	-0.024***	-0.010***	-0.003***	-0.000
	[0.004]	[0.002]	[0.002]	[0.001]	[0.000]	[0.000]
R^2	0.509	0.371	0.667	0.808	0.892	0.920

This table shows the first stage for the ideal children instrument and the efficient ideal children instrument for first born children. Each column is a separate regression, column 1 shows the estimators for the variable siblings, column 2 for the variable 1 sibling, column 3 for the variable 2 siblings, column 4 for the variable 3 siblings, column 5 for the variable 4 siblings, and column 6 for the variable 5 siblings.

Table 16: **First stage: Twin births**

Variables	(1) Siblings	(2) 2 siblings	(3) 3 siblings	(4) 4 siblings	(5) 5 siblings
$twin^*_2$	0.555***	0.457***	0.109***	0.002	-0.008
	[0.061]	[0.035]	[0.027]	[0.018]	[0.011]
$twin^*_3$		-0.116**	0.521***	0.066**	0.002
		[0.053]	[0.040]	[0.027]	[0.016]
$twin^*_4$		-0.102	-0.067	0.605***	0.093***
		[0.070]	[0.053]	[0.036]	[0.021]
$twin^*_5$		-0.130	-0.317*	-0.433***	0.595***
		[0.243]	[0.187]	[0.127]	[0.074]
dif_{ideal}	0.282***	0.111***	0.096***	0.054***	0.020***
	[0.003]	[0.002]	[0.002]	[0.001]	[0.001]
R^2	0.421	0.287	0.304	0.216	0.094

This table shows the first stage for the twins instrument for first born children. Each column is a separate regression, column 1 shows the estimators for the variable siblings, column 2 for the variable 1 sibling, column 3 for the variable 2 siblings, column 4 for the variable 3 siblings, column 5 for the variable 4 siblings, and column 6 for the variable 5 siblings.