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An Empirical Study of the Quantity-Quality Fertility Model

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Abstract

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Gary S. Becker's Quantity-Quality Fertility Model states that there is a tradeoff between the number of children in the family and the quality of children. This is because as the number of children in the family increases, each child receives a smaller share of the parents' investment and becomes worse off. This paper tries to confirm the quantity-quality tradeoff by using twins as a natural experiment to mimic an exogenous increase in the number of children in the family. In this paper, quality of children is measured by educational attainment. Our econometrics analyses did not yield convincing evidence that having younger twin siblings in the household decreases the quality of the older children. Also, we did not find substantial evidence that parental investment in children is significantly compromised in the presence of younger twin siblings.

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Figures and Tables

Introduction

A family can be viewed as a firm that uses various inputs to produce an output. We can imagine the input to be the parents' time, money, and emotional investments. The output is the children that the parents produce. Time, money, and emotional investments can be bundled into a blanket term parental investment in children because these resources go into the children that will grow up and give returns to their parents. Returns can be in the form of emotional satisfaction, spiritual satisfaction, or monetary gains.

This framework of thinking is how Becker (1991) puts family and fertility into an economic framework in his Quantity-Quality Fertility Model (QQ). The model develops an economic framework to analyze and predict family size. The QQ model is a model of investment where parents decide the level of resources that they wish to invest in each child. The model assumes that similarly to financial investments, parental investments lead to higher levels of child quality, which is usually measured by educational attainment. A direct implication of the model is that there will be a tradeoff between child investment, which is channeled through child quality, and the number of children in the family.

This paper will attempt to do three things. Firstly, this paper will attempt to find the determinants of child quality. Child quality in this paper is measured by educational attainment, which is broken down into grade point average in middle and high school and grades in English, mathematics, social studies, and science. We would like to see what major factors regarding the child's personal characteristics and family have significant effects on the child's performance in school. Secondly, we will try to find the determinants of child quantity or the number of children in the household. We would like to know which variables are significant factors that affect parents' decision to have more or fewer children. Thirdly, we will try to find the major factors that determine the probability that a mother will give

birth to twins. The third item contributes to the literature in this topic because previous studies such as Rosenzweig and Wolpin (1980) and Caceres-Delpiano (2006) assume that twin births occur randomly. Knowing the factors that determine the probability of twin births will help us test the QQ model.

To test the QQ model, this paper will use twins as a natural experiment that mimics an exogenous increase in the number of children in the family. Theory suggests that an exogenous increase in the number of children from causes such as multiple births should decrease the quality of each child in the household. This is because it is likely that parents only planned for one child and will be caught by surprise when they have twins. Ultimately, the parents will not have time to get enough resources to raise one additional child and so the quality of each child is likely to decrease.

The empirical analyses that this paper will perform will be to examine the tradeoff between the quality of the older children in the household who are not twins and who have younger twin siblings and the quantity of children in the household. We chose to look at just the older children because we want to eliminate the effects from being part of a twin pair so that we can investigate the tradeoff between the quantity and quality of children as purely as possible. Specifically, rates of low birth weight and infant mortality in multiple births are 4 to 33 times higher than those in singleton births. Furthermore, twins and other higher order multiple births are more likely to suffer from life-long disabilities when they survive (Caceres-Delpiano, 2006).

In light of the framework that parents use inputs to produce children as output, this paper will also explore the effect of an exogenous increase in the number of children on the parental children investment behavior. Our econometric analyses will try to determine how parents change their investment in their older children when they have younger twin siblings.

We would also like to see whether the parents try to compensate for this unexpected increase in the number of children in the household. The variables that we use in these input regressions try to capture the parents' ability to spend time with their children. Time is one of the most important resources that are used in raising children and time is strictly limited. So if there were a tradeoff between quantity and quality of children, then the time that parents are willing to invest in each child should be affected.

Literature Review

Becker and Barro (1988) reformulate the economic theory of fertility by assuming that parents derive utility from their own consumption, the number of children that they have, and the utility of their children. This theory assumes that parents are altruistic towards their children and will invest human capital and monetary capital into their children. Parents will weigh the costs and benefits of having children to determine how many children to have. Furthermore, Becker and Barro (1988) assume that children are normal consumption goods to their parents so wealthier parents will have more children than less wealthy parents. An exogenous increase in come will increase the amount of consumption goods that the individual will consume.

To determine specifically how and what parents invest in their children, economists have done much empirical work on the behavior of parental investment in children. Guryan et al. (2008) assume that parent invest both material resources and time in their children in order to indentify factors that affect how much time parents choose to invest in their children. The study breaks child care activities into four categories: basic, education, recreational, and travel. Guryan et al. (2008) find that college educated parents spend more time with their children than parents who do not have a high school degree. College educated men spend 105 percent more time with their children than men who did not finish high school and college

educated women spend 70 percent more time with their children than women who did not finish high school.

Omori (2010) investigates the determinant of parental monetary investment in children. The studies look at household expenditures on children. Expenditure is broken down into four categories: education, entertainment, subscriptions, and apparel. Omori (2010) suggests that previous research shows that children in single-parent households are deprived economically and socially. Furthermore, differences in children's well-being are often attributed to differences in household income. Results from the study shows that married couples do not spend more on their children than singe-parents. Over an 18-year period, higher income households spend more than twice the amount that lower income households spend on their children. Furthermore, college educated parents spend more on their children in all four categories than parents who did not finish high school. Lastly, in higher income households, Asians spend the most on their children's education and whites spend the least. In lower income households, whites spend the most on their children's education.

Parental investment in children is often thought to be reflected in the quality of their children. Similarly to financial investment, higher parental investment should lead to higher quality children. The concept of child quality is difficult to measure but a common measure of child quality that economists use is the child's educational attainment. Haile and Nguyen (2008) use test scores in reading, mathematics, and sciences of 8th graders in the United States as measures of child quality. Their study uses quartile regressions to indentify determinants of child quality. The results show that race, parental education, and parental occupation type are major factors that affect a child's test scores. For both males and females, Asians tend have the highest test scores and blacks tend to have the lowest. Furthermore, children with parents who have a college education or more tend to have higher scores.

To study the interaction between the quantity and quality of children, economists also need to identify the determinants of family size and fertility. Narayan and Peng (2006) conduct a study on the determinants of fertility in China. Their study finds that mother's education, labor force participation, age, and income are major factors that determine the number of children that she has. Furthermore, the child's life expectancy and infant mortality rates are also important factors that affect fertility.

Becker (1991) stimulated much research on the tradeoff between the quantity and quality of children. Rosenzweig and Wolpin (1980) use data from farm households in India to test the effect of an exogenous increase in the number of children through multiple births on the quality of children in the household. They use educational attainment as the main measure of child quality. They look at how the presence of multiple births within a family affects the educational attainment of children within the household and compare these results to children in households that do not have multiple births. Rosenzweig and Wolpin (1980) find that an exogenous increase in family size reduces both the average educational attainment of twin children and non-twin children in the household. The effect on twin children is stronger than that on non-twin children. This result indicates that parents do not fully compensate for the exogenous change in the number of children within the household.

Caceres-Delpiano (2006) also tests the QQ model by using multiple births as a natural experiment of an exogenous increase in the number of children within a household and sees how this affects the parental investment in children and the quality of children within the household. Instead of examining the effect on both twin children and non-twin children, Caceres-Delpiano (2006) looks only at the effect that multiple births have on the quality of the oldest non-twin child. To account for the nonrandom occurrence of multiple births, Caceres-Delpiano (2006) includes variables such as age of the mother, race, and mother's

education in his regressions. The study uses the 1980 US Census Five-Percent Public Use Micro Sample dataset.

The parental children investment or input variables that Caceres-Delpiano (2006) uses are the dummy variable for private school attendance, the mother's labor force participation, the mother's weekly usual hours of work, and the dummy variable for divorce. The quality of children or output variable that the paper examines is the dummy variable for whether children are progressing in school with their cohort. Caceres-Delpiano (2006) suspects that there is a missing variable bias in the QQ model so the paper uses the two-staged least squared method to account for the bias. The instruments used are dummy variables for the second and third multiple births within the family. Caceres-Delpiano (2006) concludes that parents reallocate different types of investment in children in order to minimize the impact on child wellbeing. The negative impact of greater number of children in the family on the quality variable such as educational attainment is not supported by the regression analyses. Caceres-Delpiano (2006) also finds that an additional child from multiple births increases the probability of divorce. The study suspects that family size impacts child well-being through family structure because previous studies show that children with divorced parents have lower achievements than children who live in traditional nuclear families.

Data

The National Longitudinal Study of Adolescent Health or Add Health is a panel dataset of a nationally representative example of adolescent in grades 7 to 12 in the United States during the 1994 and 1995 school year. The survey follows the sample up to 2008, which was when the sample was aged 24 to 32. The dataset combines longitudinal survey data on respondents' social, economic, psychological and physical well-being with contextual

data on the family, neighborhood, community, school, friendships, peer groups, and romantic relationships. There are a total of four waves of interviews.

This paper uses data from the restricted version of the Add Health dataset. Compared to the 1980 US Census Five-Percent Public Use Micro Sample, the Add Health dataset has a larger sample size. Hence, we hope obtain better estimations by using a larger dataset. We employ the first wave of surveys to perform cross sectional analyses. The wave one data is broken into many smaller datasets that are linked by AID codes, which are unique codes given to each adolescent that was surveyed in the dataset. The dataset that this study uses was constructed by merging four smaller datasets from the wave one survey.

The first dataset lists every sibling that the respondent has and indicates the relationship that each sibling has to the respondent. These relationships are full brother/sister, half brother/sister, non-related brother/sister, identical twin brother/sister, and paternal twin brother/sister. The second dataset gives data on the respondent's performance in school and characteristics of the school that he or she attends. The third dataset includes data on the respondent's characteristics, interaction with his or her parents, parents, and household. Finally, the last dataset links each respondent with his or her sibling by a matching pair code that indicates the type of relationship, the gender of the pair, and the family code that indicates that the pair lives in the same household.

The data set used in this study is a result of merging these four datasets at the individual level. The final dataset lists of all of the desired variables from the four smaller datasets for each individual that was surveyed and these individuals are organized by their AID codes. Since the focus of this paper is on the effect of having younger twin siblings in the household on child quality of the older children, the main variable of interest is the dummy variable Twins in Household, which indicates the presence of twins in the household.

Twins in Household was constructed using the household roster, which lists the respondent's siblings in the household and their ages. Then the variable was made to take the value of one when any two of the ages of the siblings in the household match. Twins in Household will also take a value of one if the respondent is a twin. This method of construction assumes that the two siblings that have the same age are twins and not step siblings or adopted siblings. Similarly, the number of sibling variable was constructed by counting the siblings that are listed on the household roster.

Another important variable is the dummy variable Younger. This variable indicates whether the respondent is younger than the twin siblings in his or her household or not. The Younger variable was constructed from the Twins in Household variable. Younger was made to take the value of one when the age of the respondent is less than the age of the twins, which are the two ages that match on the sibling household roster.

Empirical Methodology

Every regression in this study uses the basic Ordinary Least Squares Model (OLS). We also use the OLS model for regressions that have a dummy variable as the dependent variable. This is because the interpretation of the regression coefficients is simpler than that of the Probit or Logit model. Secondly, the problem that the OLS model violates the basic property of probability in which the probability of an event occurring has to be between zero and one is not severe in our models. We test the robustness of the regressions in Tables 3, 4, and 6 by adding sets of variables that are associated with the respondent's personal characteristics, and family. Personal characteristics include age, gender, race, and performance in school. Family-related variables are household income, activities that the respondent participates with his or her parents, parent's age, and parent's education. These

regressions are run at the household level so the sample size is limited to the first child from each household.

This study uses grade point average and grades in English, mathematics, social studies, and science as measures of child quality. The goal of the regressions in Tables 3 and 4 is to identify the determinants of child quality. First of all, we control for basic factors such as the respondent's age, gender, and race. We included the dummy variable for adoption because adoption often causes difficulties in childhood and household dynamics for the reason that adopted children often feel emotional distress when they find out that they are adopted. Also, parents' interaction with an adopted child may be different from that with biological children. Number of siblings also needs to be included in the regressions because the QQ model suggests that there is a tradeoff between the quantity and quality of children.

Factors related to the respondent's performance in school also need to be included. Logically, if a child puts more effort in school work, then he or she will have higher grades. Furthermore, if a child repeats a grade, then it follows that his or her grades will be lower because a student needs to fail several classes in order to repeat a grade. Lastly, the number of extracurricular activities that a student engages in will affect his or her performance in school. Greater number of extracurricular activities can mean higher grades or lower grades because extracurricular activities can take up time from school work or act as indicators of productive students who tend to get higher grades.

On the household level, household income needs to be included in the regressions because children with access to more financial resources are more likely to do better in school. Becker and Barro (1988) theorize that wealthier families will invest more in both the quantity and quality of children. Omori (2010) suggests that differences in children's well-being or quality are often related to differences in household income. Next, parental

education is also an important possible determinant of child quality. Haile and Nguyen (2008) find that children with highly educated parents tend to get higher test scores than children with parents who did not finish high school. Furthermore, Omori (2010) says that children in single-parent households are economically and socially deprived so family structure needs to be included in the regression. Finally, economic theory from Guryan et al. (2008) suggests that parental investment in children occur in the form of money and time so activities that the respondent participates in with his or her parents should be important determinants of child quality.

To identify the determinants of number of siblings in the household, we follow the empirical methodology from Narayan and Peng (2006). Like before, we include basic characteristics variables such as the respondent's age, gender, and race in the regressions in Table 5. Here, the respondent's race is acting as a proxy for the parents' race since the race of the children and the parents should be the same for most households. Becker and Barro (1988) conclude that parents with higher income will have more children. Results from Narayan and Peng (2006) show that mothers who finished college and mothers who participate in the labor force will have fewer children. Mothers who have more years of education will have better understanding of fertility control and mothers who participate in the labor force will delay their reproductive age. The inclusion of the parents' marital status follows the logic that a married couple has more resources to raise children than a single-parent so married couples should have more children.

To address the suspicion from the work of Caceres-Delpiano (2006) that multiple births may not be random as his paper assumes, we seek to find the determinants of the probability that a household will have twin children. Following the list of variables that Caceres-Delpiano (2006) uses to control for the nonrandom characteristic of multiple births, we include mother's education and mother's age. We included household income because

household with high income have the option to use reproductive technologies, which increases the probability of multiple births. The probability of twining is also known to be affected by genes for twining that run in the family. Specifically, if there is history of twins in the family, then it is more likely that subsequent generations will give births to twins. (Ecker, 2004) Unfortunately, this variable cannot be included in the regression because the Add Health dataset does not contain this information. It is worth noting that if these same genes also affect the parents' decision to invest in their children, then the use of twins to study the tradeoff between the quantity and quality of children will become problematic. Finally, since twining is a surprise to parents, some parents may choose to abort the pregnancy when they find out that they are having twins. Ideally, abortion should be controlled for because the parents' choice to abort the pregnancy will certainly affect the regression but this information is also absent from the dataset.

The main goal of our study is to test the QQ model by investigating the effect of having twins in the household on the quality of the children older than the twin pair. We choose to use the occurrence of multiple births to test the model because it mimics an exogenous increase in the number of children in the household. We cannot get the same effect by just looking at the number of siblings in the household because parents can easily adjust their investment behavior as they plan to have one more child. However, when parents are surprised with a pair of twins, their ability to adjust their resources is compromised. In this study, quality is defined as the child's educational attainment, which is measured by his or her grade point average and grade in various subjects. We choose to look at the older children because we want to exclude the effects of being part of a twin pair and observe the effect of an exogenous increase in the number of children on the quality of children as purely as possible. The effects of being part of a twin pair are lower birth weights, higher infant mortality rate, and higher probability of having long-term disabilities.

The fact that twins tend to have lower birth weights, higher infant mortality rate, and higher chances of having long-term complications raises an issue regarding the use of twin births to test the QQ model. Changes in child quality and parental children investment behavior in the presence of twins in the household may be the result of an exogenous increase in the number of children in the household and the twins' disadvantages. It is likely that parents will divert more resources to the twins to compensate for their advantages and this decreases the quality of the older children. If this is the case, then changes in child quality of the older children does not indicate a clear tradeoff between the quantity and quality of children in the household. This problem makes the presence of twins in the household a flawed tool to test the QQ model. Luckily, low birth weight, high infant mortality rate, and long-term complications from twin births are rare in the United States so our dataset and econometrics analyses should not have this problem.

The main variable of interest is Twins in Household. It indicates the presence of a pair of twins in the household. Twins in Household is a dummy variable that takes the value of one when the age of two siblings in the household roster match and takes the value of zero otherwise. The variable that is used to eliminate individuals that are not the first children of the family from the sample is the variable Younger. The variable is a dummy variable that takes the value of one when the respondent's age is less than the age of the twin pair in the household and takes the value of zero otherwise. Lastly, the variable Twins is used to indicate whether the respondent is part of a twin pair or not. The variable takes the value of one if the respondent is a twin and takes the value of zero otherwise.

Each regression that seeks to capture the interaction between the number of children and the quality of children within the household is run on individuals with the variables younger and twins equal to zero. These restrictions ensure that the sample of the regressions includes only the children in the household who are not twins themselves and are older than

the twin pair in the same family. There are two sides of the interaction between quantity and quality of children, the output side and the input side. The output regressions aim to capture the effect of twins on the older children's quality or performance in school. The input regressions aim to capture the changes in the parents' children investment behavior in response to the presence of twins in the household.

In Table 7, to explore the interaction between the quantity and quality of children on the output side, we use modified versions of the models from Tables 3 and 4. Firstly, we include the dummy variable, which indicates the presence of twins in the household, in the model. This is to see the effect of an exogenous increase in the quantity of children on the quality of children measured by educational attainment. Secondly, we combine the various activities that the respondent participates with his or her parents into the variables that capture the number of activities that the respondent participates with his or her father and mother.

In column 6 of Table 7, we use the dummy variable that takes a value of one if the respondent has repeated a grade level and zero otherwise. Repetition of a grade level can be used as another measure of scholastic success and child quality because higher probability of repeating a grade level can indicate low child quality. The model of grade level repetition is similar to the models for GPA except that GPA is included as an explanatory variable. The results from Rosenzweig and Wolpin (1980) indicate that the presence of younger twin siblings in the household should hinder the older children's scholastic performance.

Lastly, this study wishes to study the input side of the interaction between the quantity and quality of children. Table 8 aims to capture the effect of having younger twin siblings in the household on the parents' children investment behavior. Parental investment in children is captured by how much the parents appear to care about their children, how many activities do the parents participate with their children, how often the mother takes her children to a

religious service, and how often the father talks to his children about their personal problems. The reasoning behind using these variables as dependent variables follows that of Guryan et al. (2008) that parents invest both time and money in their children. Changes in these variables due to the presence of younger twin siblings can indicate a tradeoff between the quantity and quality of children.

The models in Table 8 control for basic characteristics of the respondent such as his or her age, gender, and race. We decide to include variables associated with the respondent's performance in school such as GPA and the amount of effort that he or she puts into schoolwork because parental investment can be related to how well the child is performing in school, which can proxy for possible future return on investment. In other words, we are trying to control for child quality. Next, economic theory from Becker and Barro (1988) suggests that wealthier households tend to invest more in their children. This is also supported by the results from Omori (2008) and so we wish to control for income by including household income and welfare payments that the parents receive. Furthermore, results from Guryan et al. (2008) show that nonworking parents and married parents spend more time with their children than working parents and unmarried parents do. So to control for these factors, we included parents' marital status and parents' weekly hours of work. Finally, Guryan et al. (2008) suggests that college educated parents spend more time with their children than parents who did not finish high school. Highly educated parents gain higher return on investment from their children because they value their children's quality more than parents who did not finish high school. Therefore parental education also needs to be controlled for.

Results

Determinants of Child Quality Measured by GPA

An important part of understanding the tradeoff between the quantity and quality of children is to understand the determinants of child quality. This study measures child quality with educational attainment, specifically, grade point average and grades in English, mathematics, social studies, and science. Our regression in Table 3 shows that gender, race, adoption, effort, grade repetition, extracurricular activity, household income, mother's education, and parents' time investment are significant determinants of a child's grade point average.

Firstly, we find that males tend to have lower GPAs than females. This agrees with what we observe today. Males tend to do worse than females in grade school and so more females end up going to college than males. Secondly, Asians tend to do better than their whites counterparts and blacks tend to do worse than their white counterparts. Also, respondents who are not Asian, black, or Native American tend to do worse than their white counterparts. This group includes Hispanics. This finding regarding the respondent's race agrees with that of Haile and Nguyen (2008). Thirdly, we find that the respondent's effort in school is positively correlated with his or her GPA. This is expected because more effort should lead to better results. Furthermore, if the respondent repeated a grade level, then his or her GPA is lower. Again, this is expected because a student needs to do very poorly in school in order to be forced to repeat a grade. Finally, we find that holding everything else constant, if a student participates in one more extracurricular activity, then his or her GPA will increase by about 0.03. Mean GPA is 2.747 and mean number of extracurricular activities is 2.323. So a significant increase in extracurricular activity leads to a relatively small increase in GPA. Nonetheless, this shows that the more appropriate interpretation of the effect that more

extracurricular activity has on GPA is that students who participate in more extracurricular activities tend to be better students.

On the household level, we find that an increase in household income increases the respondent's GPA. One possible interpretation is that students with higher household income tend to have more resources at their disposal. This includes things such as tutors and better school supplies. Furthermore, the students are likely to not have to worry about their family's financial status and so are able to focus more on school work. This result supports the theory from Becker and Barro (1988), which says that wealthier families will invest more in their children because an increase in the utility or happiness of each child increases the utility of the parents. Furthermore, this result seems to support the idea from Guryan et al. (2008) that return on investment in children for higher income and education parents is higher because they value education and want their children to get what they have.

Next, we find that the respondent's GPA is positively correlated with his or her mother's level of education. We only use the mother's education as explanatory variables because it tends to be highly correlated with that of the father so using both sets of variables will cause a problem of multicollinearity. The regression indicates that the respondent tends to have a lower GPA if his or her mother did not finish high school. This means that the mother does not value education and so she will not greatly encourage her children to work as hard in school. As the mother's education increases beyond high school, the marginal increase in the child's GPA is greater. This may suggest that a mother who went to college is likely to value education more than a mother who went to vocational school after she finished high school. And a mother who attended professional school also attended college, so the effect on GPA should be greater than if she only attended college. Another possible interpretation is that mothers who received higher levels of education have more human capital than those with less education. Therefore highly educated mothers are able to invest

more human capital into their children and so their children tend to perform better in school than children with less educated mothers. Again, these results agree with those of Haile and Nguyen (2008).

The interaction variables that are positive and significant are the variables that indicate that the parents took their children to a shopping mall, religious service, and sporting event in the past 4 weeks. The relationship between participating in these activities with their parents and GPA is unclear. But a plausible story is that these variables indicate that the respondent has a good relationship with his or her parents and so his or her parents are willing to spend more time or invest more into him or her. These interactions foster a higher quality student by giving them better emotional and spiritual wellbeing. This finding supports the conjecture from Guryan et al. (2008) that parental investment in children comes in the forms of money and time.

The interaction variables that are negative and significant are variables that indicate that the parents have argued with respondent about his or her behavior and that the parents have talked to the respondent about his or grades in the past 4 weeks. This result could suggest that if the respondent argues with his or her parents about his or her behavior, then it is likely that he or she is a lower quality child and so it is not surprising that he or she will do worse in school. It also follows that if the respondent talked about his or her grades with his or her mother, then it is likely his or her grades are lower than a certain desired level. On the other hand, a talk would be unnecessary if the child is doing well in school. Also, the talk about grades can be highly positive or highly negative and so there may be other possible interpretations for the regression result.

Determinants of Child Quality Measured by Subject

When we look at the determinants of child quality by subject, we find that our regression result for subject is similar to that of GPA. This is expected because GPA is the average of these four grades. It should be noted that different parent interaction variables are significant for different subjects. For example, Father Activity is positive and significant for grade in science but not for grades in other subjects. This means that students who talk about school activities with their fathers tend to do better in science classes. Again, the relationship between the two variables is unclear but it can be generally concluded that parents invest their time into their children through different types of activity and more investment leads to higher child quality and better performance in school.

An interesting result from Table 4 is that males tend to do as well as females in mathematics. Another interesting result is that the respondent's age is insignificant in the GPA model, but it is significant and negative for grades in mathematics, and science. And it is significant and positive for grades in English and social studies. A possible interpretation is that technical subjects such as mathematics and the sciences become significantly more difficult as a student progresses to a higher grade level so the average student tends to do worse as he or she gets older. On the other hand, humanities subjects such as English and social studies require students to be more mature and to have acquired substantial life experiences to be able to relate to and analyze what they learn in class well. Furthermore, the level of difficulty in these subjects does not increase substantially with each grade level. Hence, it is possible that students do better in these subjects as they grow older.

Determinants of Number of Siblings

Now that we have investigated the determinants of child quality, we have to find the determinants of child quantity. This study measures child quantity with the number of siblings that the respondent has. We find that the significant determinants of family size are the parents' race, age, marital status, labor force participation, and education.

Firstly, we find that Asians, blacks, Native American, and other races tend to have more children than their white counterparts. Secondly, the age of the parent is negatively correlated with number of siblings. A logical conclusion is that as the gap of the parents' age and that of their first child gets wider, then it is less likely that the parents will have more children because they have less time and less effective reproductive systems. Thirdly, married parents tend to have more children than single-parents. This result supports the theory from Omori (2010), which says that married parents can offer more economic and social resources to their children than single-parents so married couples are more likely to have more children. Lastly, we find that mothers who work tend to have fewer children and mothers who did not finish high school tend to have more children than mothers who finished high school. These two findings agree with the results from Narayan and Peng (2006). Possible interpretations are that mothers who work delay their reproductive age so they end up having less children. And mothers who are less educated do not have a good understanding of fertility technologies and they end up having more children.

Determinants of Having Twin Siblings in the Household

As we have mentioned earlier, this study uses twins as a natural experiment to study the effect of an exogenous increase in quantity of children on the quality of children. Caceres-Delpiano (2006) thinks that multiple births are not random. Hence, our study wants to find the determinants of twin births so that we can control for its nonrandom nature in our

interaction regressions. Our regression analyses show that the significant determinants of twin births are the respondent's gender, the mother's race, and the mother's education. Firstly, if the respondent is male, then the probability of him having younger twin siblings in the household is higher is puzzling because there is no obvious explanation. Secondly, Asians are less likely to have twin siblings and blacks and Native Americans are more likely to have twin siblings. Finally, it appears that it is more likely for the respondent to have twin siblings if his or her mother did not finish high school. Again, the relationship between the mother's education and the probability of her having twin children is unclear. However, this result is only significant at the 10 percent level so it is not very convincing. We also expected household income to be significant and positive because mothers who use birth technologies, which are expensive, are more likely to conceive twins than mothers who conceive naturally. But we did not see this in our regressions.

Multiple Births' Effect on Child Quality

Now that we have found the determinants of child quality, family size, and twin births, we are ready to investigate the tradeoff between the quantity of children and quality of children. We start off by looking at child quality. Becker (1991) suggests that child quality reflects parental investment in children. Therefore if the educational attainment of the older children is compromised by the presence of younger twin siblings, then it is likely that there is a tradeoff between parental investment in children and quantity of children in the household.

We find that having younger twin siblings in the household does not significantly affect the older children's performance in school. Hence, our results do not support the QQ model. When quality is measured by performance in school, there seems to be no interaction between the quantity and quality of children in the same household. It is worth noticing that

number of sibling is significant and negative in the fifth regression, which is the grade in science regression. We can interpret that this result is showing a tradeoff between quantity and quality of children because the regression says that holding other things constant, an increase in the number of siblings in the household decreases the older children's grade in science. Although this result appears to support the QQ model, the interpretation should be made with caution because there may not be a direct causal effect between number of siblings and the older children's grade in science. The reasoning is that parents usually plan to have one child at a time. Sensible parents will make sure that they have enough resources to support the additional child so that the quality of the existing children will be unaffected by the new child.

These results agree with those of Caceres-Delpiano (2006) but disagree with those of Rosenzweig and Wolpin (1980). A possible explanation is that the Becker QQ model does not apply to the United States of America because income of the average American has risen beyond the point that parents need to make a decision on which children to invest in. In other words, parents are wealthy enough that their ability to invest in each child is not compromised by an exogenous increase in the number of children. Rosenzweig and Wolpin (1980) use data on Indian farm households from 1969 to 1971 and found that there is a tradeoff between the quantity and quality of children when there is an exogenous increase in the number of children. India in the 1970s' was a significantly poorer country than the United States of America in 1994 so the change in income may have eliminated the mechanisms of the QQ model. Furthermore, Rosenzweig and Wolpin (1980) specifically look at poor families that have many children.

To explore the speculation above, we ran the regressions in Tables 7 and 8 on households with income in the lowest 25 percent of the dataset. This is to see if the QQ model holds true for low income families because the relatively large number of wealthy

families in the dataset may have clouded the tradeoff between the quantity and quality of children. These regressions did not yield any results because the scholastic performance of the older children remains unaffected by the presence of younger twin siblings in the household.

An interesting result from Table 7 is that having younger twin siblings in the household increases the probability that the older children will repeat a grade level in school. This seems to be an indication that the presence of multiple births in the household lowers the quality of the children in it. This result supports the hypothesis that there is a tradeoff between quantity and quality of children in the same household. Although this result is significant at the 1 percent level, it is not very convincing because results from the grade regressions indicate that having younger twin siblings in the household does not decrease the older children's scholastic performance. It is unlikely that there is a direct causal effect between having younger twin siblings and the older children repeating a grade level because a student must do very poorly in many classes before he or she is forced to repeat a grade level. Since there is no evidence that children with younger twin siblings do worse in school than those who do not, it does not make sense to conclude that having younger twin siblings is the main factor that causes students to repeat a grade level.

This result on the repetition of grade level disagrees with that of Caceres-Delpiano (2006). Using OLS estimation, the study finds that having younger twin siblings increases the probability that the oldest child will repeat a grade level. But using Two-Stage Least Squares (2SLS) estimation, the study finds that the effect disappears. This indicates that we may need to use 2SLS to estimate our grade level repetition model so that every regression in Table 6 points to the same conclusion.

Multiple Births' Effect on Parents' Children Investment Behavior

As the final part of the study, we investigate the effect of having younger twin siblings on parental investment behavior towards the older children. We would like to see if parental investment is compromised by an exogenous increase in the number of children in the household. Again, we find that having younger twin siblings in the household does not make the parents invest less time into their older children. It also does not make the older children think that their fathers care less about them. So the parents' investment behavior seems to be unaffected by the presence of twin siblings in the household or the parents effectively compensate for the increase in the number of children. This finding seems to agree with what we find in Table 7 and the results from Caceres-Delpiano (2006).

An interesting result is that the older children seem to think that their mothers care less about them when they have younger twin siblings. The regression may suggest that the parents' resources are compromised because maternal care tends to be less for each child in the household. This finding appears to contradict with the result of the fourth regression in the same table because the perceived paternal care appears to be unaffected by the presence of younger twin siblings. A possible explanation is that the father works for pay in most households so his behavior seems to be independent of the presence of younger twin siblings. His children also have fewer opportunities to observe his behavior so changes due to the presence of twins may not be obvious to them. On the other hand, the mother takes care of each child in the household all day and so her behavior heavily depends on the number of children that she has. And changes in her behavior are also more obvious to her children.

The third regression says that mothers who have twin children tend to take their older children to religious services less often than mothers who do not have twin children do. A possible interpretation for the third regression result is that the mother's main resource, time,

is spread out too thinly when her family is surprised by a pair of twins and so she no longer has the time to take her older children to religious services. This can be seen as a compromise in the parental investment in children.

Another interesting result is that holding other things constant, if the older children in the household have younger twin siblings, then it is more likely that their father will have talked to them about their personal problems in the past four weeks. This result yields two possible implications. The first implication is that the father tries to compensate for the fact that he has one more children than he expected so he tries to invest more in each child by talking to them more often. The second implication is that with twins in the household, the older children's quality decreases and so their father has to talk to them about their personal problems more often. The second implication can be used to support the hypothesis of the QQ model that there is a tradeoff between the quantity and quality of children in the same household. But the significance of the variable is only at the 10 percent level so this evidence is not very strong.

Finally, we find that holding other things constant, if the older children in the family have younger twin siblings in the household, then the probability that their parents will be married decreases. A possible interpretation is having twin children increases the probability that their parents will get a divorce. This interpretation should be made with caution because the Parents Married variable takes a value of one if the parents are married and takes a value of zero otherwise. This means that divorce is not the only possible interpretation. Another possible interpretation is holding other things constant, single parents are more likely to adopt twins. Hence, the first implication, which is having twin children in the family puts stress on the marriage because the parents' resources suddenly become insufficient for each child and so the marriage is more likely to fail becomes less plausible. This finding regarding probability of divorce agrees with that from Caceres-Delpiano (2006). The study concludes

that having twin siblings increases the probability of divorce and households with divorced parents tend to produce children with lower well-being. With this logic in mind, this result may suggest that there is a tradeoff between the quantity and quality of children.

Conclusion

The first goal of this paper to find the determinants of child quality measured by educational attainment, the determinants of number of siblings, and the determinants of the probability of having twin children. The second goal of this paper is to test the Becker QQ model by indentifying the tradeoff between the quantity and quality of children in the same household. This paper looks at both the output side, child quality, and the input side, parental investment in children, of the QQ model.

We found that the main determinants of child quality are the respondent's race, gender, mother's education, interaction with his or her mother, household income, effort in school, repetition of a grade level, and participation in extracurricular activities. For number of siblings in the household, the main determinants are the mother's race, education, labor force participation, and marital status. Finally, the determinants of the probability of having twin children are the respondent's race, gender, and the mother's education.

For the interaction between the quantity and quality of children, our regressions on the output side show that having younger twin siblings in the household does not significantly affect the quality of the older children in the household. On the input side, there are some indications that the presence of younger twin siblings changes the parents' ability to invest in their older children. Some examples are the perceived maternal care seems to be lower and the mother tends to decrease the frequency that she takes her older children to religious services. Regressions on the father's children investment behavior did not yield any

significant result. We also find that having twin siblings decreases the probability that the parents will stay or be married but the implication of this finding on the QQ model is unclear.

A possible explanation for the results of our regressions is that parents in the modern era think that investing in the quality of children gives higher return on investment than investing in the quantity of children. In the past, investing in the quantity of children may have paid more than investing in the quality of children because children are additional sources of income for the family. In the modern era when children no longer work for pay, quality of children measured by educational attainment yields a higher return on investment because highly educated children can obtain high-paying jobs. Having children with high-paying jobs can benefit parents in many ways. The benefits include monetary benefit, emotional benefit, etc. Hence, on average, parents intentionally choose to have a few high quality children and so the mechanism of the QQ model does not take place in the household. This speculation implies that the QQ model may hold for households with larger number of children. Therefore a possible further research project on this topic can be to conduct econometrics analyses on families with larger number of children such as four or greater children to see if the presence of younger twin siblings lower the quality of the older children.

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Table 1
Variable Description

Variable Name	Description
Age	Age of the respondent in years
Male	Gender of the respondent with 0 being female and 1 being male
White	Takes the value of 1 if the respondent is white and takes the value of 0 if the respondent is not white.
Black	Takes the value of 1 if the respondent is black and takes the value of 0 if the respondent is not black.
Asian	Takes the value of 1 if the respondent is Asian and takes the value of 0 if the respondent is not Asian.
Native American	Takes the value of 1 if the respondent is Native American and takes the value of 0 if the respondent is not Native American.
Other Race	Takes the value of 1 if the respondent is of other races not included above and takes the value of 0 if the respondent is not of other races not included above.
Twins	Takes the value of 1 if the respondent if the respondent is a twin and takes the value of 0 if the respondent is not.
Twins in Household	Takes the value of 1 if the respondent is a twin and/or has siblings that are twins in the household and take the value of 0 otherwise.
Birth Order	The order of the respondent as one of the children in the household.
Adopt	Takes the value of 1 if the respondent is adopted and takes the value of 0 otherwise.
Younger Sibling	Takes the value of 1 if the respondent lives with an older pair of twins in the household.
Number of Siblings	The number of siblings that the respondent has in the household.
Labor Mother/Father	Takes the value of 1 if the mother/father works for pay and takes the value of 0 if the mother/father is unemployed.
Labor Hours Mother/Father	Number of hours the mother/father works in one week
Welfare Mother/Father	Takes the value of 1 if the mother/father receives welfare payments from the government and takes the value of 0 otherwise.
Mother/Father Care	A score from 1 to 5 of how much the respondent thinks his or her mother/father cares about him or her. (1) Means that the parent cares very little and (5) means that the parent cares very much.
Mother/Father Interaction Count	A score from 1 to 10 of how much interaction the respondent has with his or her mother/father. (1) Means that the parent interacts very little with the respondent and (10) means that the parent interacts with the respondent a lot.
Mother/Father Shopping	Takes the value of 1 if the respondent went shopping with his or her mother/father in past 4 weeks.
Mother/Father Sport	Takes the value of 1 if the respondent played sport with his or her mother/father in past 4 weeks.

Mother/Father Religion	Takes the value of 1 if the respondent went to a religious service with his or her mother/father in past 4 weeks.
Mother/Father Talk	Takes the value of 1 if the respondent talked about relationships with his or her mother/father in past 4 weeks.
Mother/Father Movie	Takes the value of 1 if the respondent went to the movies, a play, a concert, or a museum with his or her mother/father in past 4 weeks.
Mother/Father Personal	Takes the value of 1 if the respondent talked about personal problems with his or her mother/father in past 4 weeks.
Mother/Father Argument	Takes the value of 1 if the respondent argued about his or her behavior with his or her mother/father in past 4 weeks.
Mother/Father Grades	Takes the value of 1 if the respondent talked about his or her grades with his or her mother/father in past 4 weeks.
Mother/Father Project	Takes the value of 1 if the respondent worked on a school project with his or her mother/father in past 4 weeks.
Mother/Father Activity	Takes the value of 1 if the respondent talked about his or her extracurricular activities with his or her mother/father in past 4 weeks.
Mother/Father No HS	Takes the value of 1 if the mother/father did not finish high school and takes the value of 0 otherwise.
Mother/Father Vocational	Takes the value of 1 if the mother/father went to vocational school after high school and takes the value of 0 otherwise.
Mother/Father College	Takes the value of 1 if the mother/father finished college and takes the value of 0 otherwise.
Mother/Father Professional	Takes the value of 1 if the mother/father went to professional school after college and takes the value of 0 otherwise.
Parents Married	Takes the value of 1 if the respondent's parents are still married and takes the value of 0 otherwise.
Parents' Age	The parent's age in years
Household Income	Annual income of the respondent's household in 10,000 USD
Both Parents Work	Takes the value of 1 if the both parents work for pay.
Grade in English	The respondent's grade in English on the 4.0 grading scale with 1 being the lowest grade.
Grade in Math	The respondent's grade in mathematics on the 4.0 grading scale with 1 being the lowest grade.
Grade in Social Studies	The respondent's grade in social studies on the 4.0 grading scale with 1 being the lowest grade.
Grade in Science	The respondent's grade in science on the 4.0 grading scale with 1 being the lowest grade.
GPA	The respondent's grade point average on the 4.0 grading scale with 1 being the lowest grade.
Repeat a Grade	Takes the value of 1 if the respondent repeated a grade and takes the value of 0 otherwise.

Effort in School	A score of 1 to 4 of how much effort the respondent puts into his or her school work. (1) Means that the respondent tries very little in school and (4) means that the respondent tries very hard in school.
Activity Count	The number of extracurricular clubs or teams that the respondent participates in.

Table 2
Summary Statistics

Variable Name	Sample Size	Mean	Standard Deviation
Age	21251	16.149	1.742
Male	21266	0.495	0.499
White	21227	0.612	0.487
Black	21227	0.234	0.423
Asian	21227	0.0778	0.268
Native American	21227	0. 0357	0.186
Other Race	21227	0.0949	0.293
Twins	15471	0.117	0.322
Twins in Household	21310	0.112	0.316
Adopt	15253	0.0593	0.236
Younger Sibling	21310	0.00502	0.0707
Number of Siblings	21310	1.479	1.253
Labor Mother	16842	0.908	0.289
Labor Hours Mother	21310	47.488	17.76
Welfare Mother	19712	0.111	0.314
Mother Care	19946	4.847	0.50037
Mother Interaction Count	19943	3.935	1.999
Mother Shopping	19943	0.724	0.447
Mother Sport	19943	0.0857	0.279
Mother Religion	19943	0.377	0.485
Mother Talk	19943	0.469	0.499
Mother Movie	19943	0.254	0.435
Mother Personal	19943	0.389	0.488
Mother Argument	19943	0.333	0.471
Mother Talk Grades	19943	0.633	0.482
Mother Project	19943	0.132	0.339
Mother Activity	19554	0.538	0.499
Mother No HS	19554	0.197	0.397
Mother Vocational	19554	0.193	0.394
Mother College	19554	0.191	0.393
Mother Professional	19554	0.0763	0.265
Labor Father	13960	0.969	0.172
Labor Hours Father	21310	54.392	14.97
Welfare Father	14681	0.0356	0.185
Father Care	14775	4.734	0.646
Father Interaction Count	14770	2.918	1.988
Father Shopping	14770	0.269	0.444
Father Sport	14770	0.283	0.451
Father Religion	14770	0.297	0.457
Father Talk	14770	0.281	0.449
Father Movie	14770	0.237	0.425
Father Personal	14770	0.205	0.4036
Father Argument	14770	0.261	0.439
Father Grades	14770	0.526	0.499
Father Project	14770	0.109	0.311
Father Activity	14770	0.449	0.497
Father No HS	14403	0.197	0.398

Father Vocational	14403	0.176	0.381
Father College	14403	0.199	0.399
Father Professional	14403	0.108	0.3109
Parents Married	21310	0.591	0.492
Parents' Age	17964	41.924	6.782
Household Income	21310	7.091	5.367
Grade in English	20256	2.798	0.959
Grade in Math	19316	2.636	1.0432
Grade in Social Studies	18234	2.826	1.0089
Grade in Science	18182	2.772	1.0175
GPA	20534	2.747	0.772
Repeat a Grade	21221	.226	0.418
Effort in School	15011	3.255	0.697
Activity Count	15678	2.323	2.787

Table 3
Determinants of Child Quality Measured by GPA

	Grade Point Average		
Variable	(1)	(2)	(3)
Male	-0.121	-0.139	-0.139
	(0.0119)***	(0.0159)***	(0.0159)***
Age	0.00215	0.00249	0.00232
	(0.0036)	(0.00485)	(0.00486)
Asian	0.113	0.07064	0.0722
	(0.0218) ***	(0.0262)***	(0.0262)***
Black	-0.226	-0.285	-0.284
	(0.0144) ***	(0.02104)***	(0.02104)***
Native American	-0.134	-0.0665	-0.06509
	(0.0326) ***	(0.0434)	(0.0434)
Other Races	-0.181	-0.159	-0.158
	(0.0212) ***	(0.0278)***	(0.0279)***
Adopt	-0.128	-0.175	-0.177
	(0.0251) ***	(0.0312)***	(0.0312)***
Effort in School	0.255	0.234	0.234
	(0.00869) ***	(0.0112)***	(0.0112)***
Repeat a Grade	-0.397	-0.367	-0.366
	(0.0154) ***	(0.0215)***	(0.0215)***
Activity Count	0.0436	0.03085	0.03091
	(0.00214) ***	(0.00264)***	(0.00264)***
Household Income		0.004059	0.004015
		(0.00175)**	(0.00176)**
Parents Married		0.0294	0.0288
		(0.0231)	(0.02309)
Labor Mother		-0.0291	-0.03093
		(0.0243)	(0.0244)
Mother No HS		-0.0655	-0.0639
		(0.0237)***	(0.0238)***
Mother Vocational		0.0799	0.080043
		(0.02069)***	(0.02069)***
Mother College		0.169	0.169
		(0.02035)***	(0.02035)***
Mother Professional		0.312	0.311
		(0.0269)***	(0.02701)***
Mother Shopping		0.0429	0.0421
		(0.01804)**	(0.0181)**
Mother Sport		0.0328	0.0325
		(0.027002)	(0.027003)
Mother Religion		0.0841	0.0852
		(0.02092)***	(0.02094)***
Mother Talk		0.0161	0.0155
		(0.0173)	(0.0174)
Mother Movie		-0.00275	-0.00278
		(0.0198)	(0.0198)
Mother Personal		0.000313	-0.0000265
		(0.0174)	(0.0174)

Mother Argument		-0.0742	-0.0739
		(0.0179)***	(0.0179)***
Mother Grades		-0.0332	-0.033
		(0.0191)*	(0.0191)*
Mother Project		0.0179	0.0177
		(0.0249)	(0.0249)
Mother Activity		0.0333	0.0329
		(0.0196)*	(0.0197)*
Father Shopping		0.00793	0.00762
		(0.0176)	(0.0176)
Father Sport		0.0396	0.04024
		(0.0178)**	(0.0177)**
Father Religion		0.0689	0.0697
		(0.02207)***	(0.02208)***
Father Talk		0.029004	0.0287
		(0.0189)	(0.0189)
Father Movie		0.02203	0.0218
		(0.0205008)	(0.020501)
Father Personal		-0.0334	-0.0334
		(0.02094)	(0.02094)
Father Argument		-0.0716	-0.0713
		(0.01909)***	(0.01909)***
Father Grades		0.0294	0.0298
		(0.0186)	(0.0186)
Father Project		0.0142	0.0139
		(0.0262)	(0.0262)
Father Activity		0.0447	0.0448
		(0.0197)**	(0.0197)**
Number of Siblings			-0.00744
			(0.006601)
Sample Size	13898	8122	8122
R-squared	0.173	0.227	0.227

Standard errors are reported in parentheses below the estimated coefficients. Individual coefficients are statistically significant at the *10% or **5% or ***1% significance level.

Table 4
Determinants of Child Quality Measured by Subject

Variable	Grade in English	Grade in Mathematics	Grade in Social Science	Grade in Science
Male	-0.272	-0.0281	-0.115	-0.1202
	(0.02081)***	(0.0241)	(0.0229)***	(0.0236)***
Age	0.0125	-0.0139	0.0256	-0.0179
	(0.00631)**	(0.007401)*	(0.00691)***	(0.00727)**
Asian	0.0829	0.0969	0.0779	0.0721
	(0.03405)**	(0.0392)**	(0.0384)**	(0.0389)*
Black	-0.2604	-0.311	-0.291	-0.276
	(0.0274)***	(0.0315)***	(0.030098)***	(0.03088)***
Native American	-0.0523	0.01077	-0.112	-0.0854
	(0.0565)	(0.0649)	(0.0622)*	(0.06403)
Other Races	-0.08011	-0.194	-0.153	-0.168
	(0.0363)**	(0.0425)***	(0.0411)***	(0.0419)***
Adopt	-0.219	-0.142	-0.2103	-0.149
	(0.04064)***	(0.0467)***	(0.0448)***	(0.0463)***
Effort in School	0.227	0.246	0.218	0.252
	(0.0145)***	(0.0169)***	(0.0161)***	(0.0166)***
Repeat a Grade	-0.423	-0.348	-0.393	-0.322
	(0.0281)***	(0.0325)***	(0.0311)***	(0.03201)***
Activity Count	0.03601	0.0268	0.0322	0.0284
	(0.00343)***	(0.00397)***	(0.00383)***	(0.00381)***
Household Income	0.00441	0.00554	0.00436	0.00447
	(0.00228)*	(0.00264)**	(0.00252)*	(0.00258)*
Parents Married	0.0259	0.0214	0.07092	0.0287
	(0.030047)	(0.0348)	(0.0334)**	(0.0342)
Labor Mother	-0.0499	-0.0281	-0.0261	-0.0175
	(0.0317)	(0.0367)	(0.0352)	(0.0358)
Mother No HS	-0.0978	-0.0495	-0.0493	-0.07086
	(0.03098)***	(0.03603)	(0.0344)	(0.0356)**
Mother Vocational	0.0616	0.05502	0.0921	0.10079
	(0.0269)**	(0.0313)*	(0.0295)***	(0.03055)***
Mother College	0.154	0.159	0.181	0.182
	(0.0264)***	(0.0304)***	(0.0292)***	(0.0298)***
Mother Professional	0.254	0.319	0.295	0.397
	(0.0351)***	(0.04041)***	(0.03904)***	(0.0396)***
Mother Shopping	0.0542	0.0289	0.0349	0.0145
	(0.0235)**	(0.0272)	(0.02603)	(0.0268)
Mother Sport	0.0109	0.0579	0.0138	0.0677
	(0.0351)	(0.04029)	(0.0385)	(0.0391)*
Mother Religion	0.0616	0.112	0.0945	0.0794
	(0.0272)**	(0.0314)***	(0.0299)***	(0.03067)***
Mother Talk	0.0147	0.02068	0.00664	0.0278
	(0.0226)	(0.02609)	(0.0251)*	(0.0255)
Mother Movie	0.0292	-0.00395	-0.0192	-0.00123
	(0.0257)	(0.0296)	(0.0283)	(0.0289)
Mother Personal	0.0155	-0.00736	0.0438	-0.0358
	(0.0226)	(0.0263)	(0.0252)*	(0.0258)

Mother Argument	-0.0835	-0.0689	-0.0658	-0.04048
	(0.0234)***	(0.0271)**	(0.02602)**	(0.0266)
Mother Grades	-0.0255	-0.0799	-0.000701	0.00292
	(0.0248)	(0.0287)***	(0.0274)	(0.0281)
Mother Project	-0.0187	0.0473	-0.0274	0.0385
	(0.0323)*	(0.03702)	(0.0352)	(0.0361)
Mother Activity	0.04209	0.0175	0.0457	-0.00251
	(0.0255)	(0.0295)	(0.0282)	(0.0291)
Father Shopping	0.0187	-0.00291	-0.00937	0.0334
	(0.0228)	(0.0263)	(0.0251)	(0.0257)
Father Sport	0.0345	0.0614	0.0618	0.00416
	(0.0231)	(0.0264)**	(0.0254)**	(0.0259)
Father Religion	0.09048	0.03017	0.0672	0.0782
	(0.0286)***	(0.0331)	(0.0315)**	(0.0322)**
Father Talk	0.0184	0.0314	0.00817	0.0369
	(0.0245)	(0.0285)	(0.0272)	(0.02803)
Father Movie	-0.0185	0.0312	0.0663	0.00288
	(0.0266)	(0.03064)	(0.0294)**	(0.0299)
Father Personal	-0.02303	-0.06072	-0.002048	-0.0192
	(0.0272)	(0.0317)*	(0.03025)	(0.03101)
Father Argument	-0.0595	-0.0936	-0.0489	-0.0917
	(0.0248)**	(0.0288)***	(0.0275)*	(0.0282)***
Father Grades	0.0214	0.0531	-0.00453	0.0263
	(0.0241)	(0.0279)*	(0.0267)	(0.0275)
Father Project	0.02404	0.0647	0.01058	-0.0241
	(0.03407)	(0.03902)*	(0.0372)	(0.03803)
Father Activity	0.0319	0.0461	0.04043	0.07501
	(0.0256)	(0.0296)	(0.0284)	(0.0291)***
Number of Siblings	-0.0000973	-0.00353	-0.01039	-0.0136
	(0.00858)	(0.00995)	(0.00945)	(0.00972)
Sample Size	8049	7703	7225	7317
R-squared	0.169	0.121	0.134	0.136

Standard errors are reported in parentheses below the estimated coefficients. Individual coefficients are statistically significant at the *10% or **5% or ***1% significance level.

Table 5
Determinants of Number of Siblings

	Number of Siblings	
Variable	(1)	(2)
Male	0.0141	0.0147
	(0.0169)	(0.0188)
Age	-0.0519	-0.00581
	(0.00489)***	(0.00567)
Asian	0.2901	0.3103
	(0.0325)***	(0.0395)***
Black	0.0893	0.167
	(0.02056)***	(0.02404)***
Native American	0.165	0.169
	(0.0456)***	(0.0521)***
Other Races	0.447	0.271
	(0.0295)***	(0.0352)***
Household Income		-0.00315
		(0.00227)
Parents' Age		-0.03204
		(0.0016003)***
Parents Married		0.289
		(0.0226)***
Mother Works		-0.3036
		(0.0325)***
Mother No HS		0.231
		(0.0294)***
Mother Vocational		-0.0000824
		(0.0261)
Mother College		0.0127
		(0.0265)
Mother Professional		0.01095
		(0.0366)
Sample Size	20454	13712
R-squared	0.0186	0.0615

Standard errors are reported in parentheses below the estimated coefficients. Individual coefficients are statistically significant at the *10% or **5% or ***1% significance level.

Table 6
Determinants of Having Twin Siblings in the Household

	Twins in Household	
Variable	(1)	(2)
Male	0.0335	0.0347
	(0.00418)***	(0.00468)***
Age	-0.00161	-0.00122
	(0.00121)	(0.00141)
Asian	-0.0287	-0.0278
	(0.0080088)***	(0.010027)***
Black	0.0433	0.0452
	(0.0050703)***	(0.00572)***
Native American	0.0257	0.0345
	(0.0113)**	(0.0125)***
Other Races	0.00431	-0.005054
	(0.00726)	(0.00846)
Parents' Age		-0.0000155
		(0.000371)
Household Income		-0.000817
		(0.000528)
Mother No HS		0.0123
		(0.00681)*
Mother Vocational		0.00492
		(0.00656)
Mother College		-0.00719
		(0.00675)
Mother Professional		-0.00594
		(0.00952)
Sample Size	20454	16138
R-squared	0.0081	0.0093

Standard errors are reported in parentheses below the estimated coefficients. Individual coefficients are statistically significant at the *10% or **5% or ***1% significance level.

Table 7
Multiple Births' Effect on Child Quality

Variable	GPA	Grade in English	Grade in Mathematics	Grade in Social Studies	Grade in Science	Repeat a Grade
Twins in Household	0.0986	0.10021	0.06043	0.05801	0.146	0.1074
	(0.0653)	(0.0849)	(0.0974)	(0.0905)	(0.095)	(0.0326)***
Male	-0.113	-0.265	0.00164	-0.0825	-0.0899	0.06014
	(0.0161)***	(0.02095)***	(0.0244)	(0.0231)***	(0.0238)***	(0.008087)***
Age	-0.00112	0.0126	-0.02068	0.0208	-0.0241	0.03504
	(0.00478)	(0.00618)**	(0.00731)***	(0.00673)***	(0.00717)***	(0.00235)***
Asian	0.0621	0.0825	0.0881	0.0577	0.05602	-0.0632
	(0.0263)**	(0.0341)**	(0.0395)**	(0.0385)	(0.0391)	(0.0131)***
Black	-0.277	-0.252	-0.294	-0.282	-0.287	0.00392
	(0.0218)***	(0.0283)***	(0.0328)***	(0.0312)***	(0.0319)***	(0.0111)
Native American	-0.0728	-0.0428	0.0191	-0.135	-0.112	0.0537
	(0.0467)	(0.06066)	(0.07037)	(0.0668)**	(0.0686)	(0.0233)**
Other Races	-0.147	-0.0665	-0.181	-0.145	-0.144	0.0154
	(0.0292)***	(0.0379)*	(0.0447)***	(0.0431)***	(0.0439)***	(0.0146)
Adopt	-0.186	-0.235	-0.123	-0.225	-0.1701	0.0485
	(0.0341)***	(0.0443)***	(0.0512)**	(0.0488)***	(0.05081)***	(0.0171)***
Effort in School	0.257	0.256	0.271	0.231	0.273	0.0235
	(0.0121)***	(0.0156)***	(0.0182)***	(0.0172)***	(0.0178)***	(0.00621)***
Repeat a Grade	-0.399	-0.459	-0.366	-0.436	-0.345	
	(0.0228)***	(0.0296)***	(0.0345)***	(0.0328)***	(0.0337)***	
Activity Count	0.0476	0.0514	0.0455	0.05045	0.0393	-0.00149
	(0.00332)***	(0.00429)***	(0.005012)***	(0.00471)***	(0.00478)***	(0.00168)
Household Income	0.00321	0.00349	0.00576	0.00263	0.00376	-0.00526
	(0.00183)*	(0.00237)	(0.00277)**	(0.00263)	(0.00269)	(0.000916)***
Parents Married	0.0292	0.0182	0.0275	0.0827	0.00973	-0.0663
	(0.0242)	(0.0313)	(0.0366)	(0.03502)**	(0.0359)	(0.0121)***
Mother Works	-0.0292	-0.0539	-0.0216	-0.0276	-0.00946	-0.0222
	(0.0257)	(0.0333)	(0.0387)	(0.0371)	(0.0376)	(0.0128)*

Mother No HS	-0.0621	-0.0971	-0.0339	-0.0571	-0.0715	0.0633
	(0.0248)**	(0.0322)***	(0.0377)	(0.0359)	(0.0371)*	(0.0124)***
Mother Vocational	0.0616	0.04074	0.0367	0.0732	0.0861	-0.0311
	(0.0217)***	(0.0281)	(0.03302)	(0.03096)**	(0.0319)***	(0.01086)***
Mother College	0.1601	0.1403	0.1502	0.169	0.188	-0.0391
	(0.0213)***	(0.0275)***	(0.0319)***	(0.03052)***	(0.0312)***	(0.01068)***
Mother Professional	0.298	0.255	0.30604	0.282	0.387	-0.0393
	(0.0282)***	(0.0365)***	(0.0423)***	(0.04059)***	(0.0413)***	(0.0142)***
Mother Interaction Count	0.00597	0.00648	0.00283	0.0156	0.005052	-0.00375
	(0.00494)	(0.00641)	(0.00745)	(0.007068)**	(0.00724)	(0.00247)
Father Interaction Count	0.02044	0.0181	0.02302	0.0192	0.0221	0.000172
	(0.00487)***	(0.00632)***	(0.00734)***	(0.00695)***	(0.00713)***	(0.00244)
Number of Siblings	-0.0115	-0.00439	-0.00471	-0.00878	-0.0226	0.00397
	(0.00711)	(0.00919)	(0.01072)	(0.01015)	(0.01041)**	(0.00355)
GPA						-0.0998
						(0.00571)***
Sample Size	7400	7336	7015	6568	6656	7400
R-squared	0.2202	0.169	0.112	0.133	0.131	0.129

Standard errors are reported in parentheses below the estimated coefficients. Individual coefficients are statistically significant at the *10% or **5% or ***1% significance level.

Table 8
Multiple Births' Effect on Parental Children Investment Behavior

Variable	Mother Care	Mother Interaction Count	Mother Religion	Father Care	Father Interaction Count	Father Personal Problems	Parents Married
Twins in Household	-0.10023	-0.0826	-0.0643	0.00275	-0.00835	0.0537	-0.0839
	(0.0341)***	(0.145)	(0.0362)*	(0.0498)	(0.169)	(0.0326)*	(0.03084)***
Male	0.0383	-0.611	-0.00141	0.0612	0.359	0.0351	0.0425
	(0.009014)***	(0.0361)***	(0.00896)	(0.0131)***	(0.0415)***	(0.00864)***	(0.00819)***
Age	-0.00351	-0.00389	-0.00815	-0.0159	-0.0336	0.0186	-0.00983
	(0.00272)	(0.01093)	(0.00271)***	(0.004035)***	(0.0127)***	(0.00264)***	(0.00245)***
Asian	-0.0458	-0.383	0.009201	-0.0425	-0.344	-0.0486	-0.124
	(0.0162)**	(0.0652)***	(0.0162)	(0.0221)*	(0.070021)***	(0.0145)***	(0.0147)***
Black	0.00471	-0.0427	0.191	-0.00719	-0.1027	0.0254	-0.255
	(0.0114)	(0.0458)	(0.0113)***	(0.0185)	(0.0585)*	(0.0121)**	(0.010033)***
Native American	-0.0296	-0.00959	-0.0481	-0.0332	-0.0285	0.0338	0.01084
	(0.0254)	(0.1015)	(0.0252)*	(0.0379)	(0.119)	(0.0249)	(0.0232)
Other Races	-0.00668	0.0813	0.0396	0.01021	-0.131	-0.0181	-0.0529
	(0.0163)	(0.0653)	(0.0162)**	(0.0236)	(0.0744)*	(0.0155)	(0.0148)***
Adopt	-0.0631	0.141	0.0823	-0.0172	0.223	0.0583	0.0693
	(0.02018)***	(0.08054)*	(0.0200058)***	(0.0287)	(0.09017)**	(0.0188)***	(0.0183)***
Effort in School	0.0394	0.0545	0.0138	0.0642	0.1082	-0.0003802	
	(0.00697)***	(0.0279)*	(0.00693)**	(0.01034)***	(0.0325)***	(0.00678)	
Repeat a Grade	-0.0196	-0.0934	-0.0285	-0.0491	-0.0963	0.0181	-0.0747
	(0.0123)	(0.0495)*	(0.0123)**	(0.0188)***	(0.0593)	(0.0123)	(0.0111)***
GPA	0.0154	0.137	0.0684	0.0547	0.174	-0.00498	0.0354
	(0.00655)	(0.0262)***	(0.00652)***	(0.00975)***	(0.03074)***	(0.00639)	(0.00571)***
Activity Count	0.002043	0.111	0.0131	0.00355	0.1082	0.00654	
	(0.00194)	(0.00781)***	(0.00193)***	(0.00282)	(0.0325)	(0.00185)***	
Number of Siblings	-0.0169	-0.0366	0.0314	-0.00674	0.00556	-0.00559	0.0369
	(0.00396)***	(0.0158)**	(0.00394)***	(0.00576)	(0.0181)	(0.00378)	(0.00359)***

Household Income	0.000917	-0.0137	-0.0000557	0.000824	-0.00968	-0.00173	-0.0178
	(0.000885)	(0.00354)***	(0.000881)	(0.00147)	(0.00464)**	(0.000968)*	(0.00079)***
Parents Married	0.0274	-0.167	0.0786	0.0415	-0.144	-0.0678	
	(0.00991)***	(0.0397)***	(0.00986)***	(0.0183)*	(0.0579)**	(0.0121)***	
Welfare Mother	-0.010034	-0.123	-0.0523				-0.334
	(0.0165)	(0.0663)*	(0.0164)***				(0.0146)***
Labor Hours Mother	-0.000222	-0.00118	-0.000125				0.000152
	(0.000265)***	(0.001064)	(0.000264)				(0.000242)
Mother No HS	-0.0364	-0.271	-0.0334				-0.0275
	(0.0134)	(0.0536)***	(0.0133)**				(0.0122)**
Mother Vocational	0.00894	0.300031	0.0536				-0.00857
	(0.0123)	(0.0496)***	(0.0123)***				(0.0113)
Mother College	0.00961	0.254	0.0852				0.0544
	(0.0126)	(0.05058)***	(0.0125)***				(0.0115)***
Mother Professional	0.00265	0.411	0.0999				0.0521
	(0.0171)	(0.0687)***	(0.0171)***				(0.0157)***
Welfare Father				0.00546	0.1033	0.0488	
				(0.03801)	(0.1203)	(0.0249)*	
Labor Hours Father				-0.0009704	-0.00563	-0.000142	
				(0.000513)**	(0.00161)***	(0.000336)	
Father No HS				-0.0387	-0.164	0.0132	
				(0.0194)**	(0.0612)***	(0.0127)	
Father Vocational				0.01093	0.321	0.0334	
				(0.01903)	(0.0599)***	(0.0124)***	
Father College				0.00686	0.462	0.0284	
				(0.0186)	(0.0586)***	(0.0122)**	
Father Professional				0.0178	0.5902	0.0314	
				(0.0228)	(0.0719)***	(0.0149)**	
Sample Size	11790	11689	11689	8915	8837	8912	12176
R-Squared	0.0148	0.0803	0.0762	0.0231	0.0702	0.0193	0.154

Standard errors are reported in parentheses below the estimated coefficients. Individual coefficients are statistically significant at the *10% or **5% or ***1% significance level.