Time vs. Money: Which Resources Matter for Children?*

Joseph Price

Department of Economics
Brigham Young University

Abstract

Parents face a number of decisions that involve a trade-off between the amount of time and money they can provide their children. This paper estimates the relative impact of parental time and family income on child outcomes. Parents generally allocate resources equally among their children at each point in time but the amount of resources available to distribute changes over time. As a result the first-born child gets more parental time while the second child experiences a higher level of family income at each age. Using this within-family variation in resources received by each child, I find that for the average family an hour of quality parent-child quality interaction produces the same amount of reading achievement as $172 of additional family income. Parental time inputs also decrease measures of behavior problems but neither time nor family income appear to influence math achievement.

* Author contact: joseph_price@byu.edu. This paper has benefited from helpful comments from Jessica Bean, Fran Blau, Julio Caceres, Thomas DeLeire, Lisa Dragoset, Ron Ehrenberg, Gary Fields, George Jakubson, Baran Han, Liz Peters, Robert Pollack, Dan Rees and participants at the SOLE conference. Any comments are extremely welcome.

Introduction

Family income is possibly the most well established predictor of child outcomes. Children from families with more income have higher test scores, fewer behavioral problems, are less likely to have a teenage pregnancy, are more likely to go to college, and end up with higher earnings themselves. In fact, one of the primary motivations behind efforts to provide income to support families is the negative effect that poverty has on child outcomes. One such policy, the earned income tax credit, has been shown to be particularly effective in raising achievement. Dahl and Lochner (2005) exploit changes in the EITC and find that an additional $1,000 in family income raises math and reading test scores by about 2–3 percent of a standard deviation, with a larger impact on more disadvantaged families.

While these results provide policy-relevant insight for government income transfer programs, most families cannot simply choose to have access to additional income. Instead parents generally face the difficult tradeoff between the amount of time and money they can to provide their children. These tradeoffs take the form of deciding whether or not both parents will work or whether they should take on extra hours. Parents often have some idea of how much their extra time is worth in the marketplace. For hourly workers, the exchange rate is generally their wage. For salaried workers, the exchange rate is less certain, but just as real, with the extra hours of work often resulting in promotion and higher future salaries.

What is much less certain to parents is how much additional income is required to make up for the drop in parent-child time. Understanding the rate of technical substitution between time and money in the production of child outcomes can help guide parents as they chose the ideal mix of time and money resources to provide their children much in the same way that firms make decisions about the optimal mix of labor and capital. These estimates will also provide insight into the possible consequences of public policies (such as welfare reform, subsidized child care, or other tax credits) which encourage parents to exchange their time for additional income. They also provide some insight into the possible benefits of institutional changes that make it easier for workers to chose hours that deviate from the traditional 40-hour week in the U.S.

A few studies include both measures of parent time and money when estimating the determinants of the child outcomes. Hill and O'Neill (1994) find that both family income and number of days per week the mother reads to the children have a positive impact on child achievement and the coefficients indicate that an extra day each week of reading to your child has about the same impact as an additional $5,000 in annual family income. Most of the research, though, has focused on maternal employment which is generally viewed as a debate about whether the additional income can compensate for the decrease in time the mother has available for her children.[1] However, Bianchi (2000) notes that working women are able to minimize the change in quality mother-child time by rearranging other aspects of their lives. The results in this paper thus extend beyond the debate about the consequences of a mother's working and focuses specifically on the degree to which additional income can compensate for fewer hours of parent-child interaction for both fathers and mothers.

Past studies have used various shocks to family resources such as the death of a parent (Gertler, Levine, and Ames 2004; Case and Ardington 2006), the absence of a

---

[1] For example, Blau and Grossberg (1992) comment that the positive impact of maternal employment that they find for children after the first year of life may reflect the increase in family income that accompanies the additional hours of work.

parent due to war (Angrist and Johnson 2000), or a layoff due to a plant closing (Shea 2006). In most of these cases, there is a psychological shock that accompanies the change in time and money resources, making extrapolation of the results to other settings problematic. For example, Elder et al. (1985) finds that economic strain reduces a father's involvement, indicating that a temporary layoff may provide more potential father-child time but the stress that accompanies the abrupt change may actually reduce both time and money inputs.

In this paper I exploits a common pattern of how parents allocate resources to their children. In the U.S., parents spend more time with the first-born child at each age and this birth order gap is larger when children are spaced further apart. However, because family income generally increases over time due to wages increasing with experience or a second earner (re)entering the workforce, the second child will experience a higher level of family income than the first-born child did at the same age. This gap is wider when birth spacing is larger or when the family income increases a greater rate. Thus two children in the same family will experience very different bundles of time and money inputs over their childhood based solely on their birth order and birth spacing. I use these within-family differences to estimate of the relative benefit of time and money on child outcomes.

I. Child Outcomes Production Function

The empirical work in this paper is founded in the household production framework originally developed by Becker (1965; 1991). Parents receive satisfaction from raising happy, healthy, well-behaved, and high-achieving children. Parents allocate time and money to their children so as to maximize child outcomes subject to the constraints of income, time, and technology (Zick, Bryan, and Osterbacka 2001).

While the exact nature of the production function for child outcomes is far from clear, Todd and Wolpin (2003) describe the assumptions underlying the most commonly used estimation strategies. Their general production function takes the following form:

$$Y_{ija} = Y_a[F_{ij}(a), S_{ij}(a), \mu_{ij0}, \varepsilon_{ija}]$$

Y_{ija} is a measure of achievement for child i, from family j, at age a. F represents the set of inputs received at each age (a), S represents school inputs at each age, and μ represents the child's endowed mental capacity (i.e. ability).

The framework provided by Todd and Wolpin connects the research on the educational production function and the family-based determinants of child outcomes (a connection rarely discussed in the literature, likely due to data limitations). The NLSY data used in this paper does not provide information on important school inputs (such as teacher salaries, school quality, or class size) but the analysis will be based on sibling comparisons which require the assumption that children from the same family receive roughly similar schooling inputs once we control for family income.

The simplest form of the production function in equation (1) is to use a contemporaneous specification:

$$Y_{ija} = Y_a[F_{ij}, S_{ij}] + \varepsilon_{ija}$$

This approach relies on two assumptions. First, contemporaneous inputs are the only relevant determinant of the outcome of interest, or inputs are unchanging over time (so that measurements today capture the entire history of inputs). Second, the amount of contemporaneous inputs is unrelated to the child's endowment.

The contemporaneous model can be extended to take into account the full history of inputs where family inputs as consistof two components: time and money. Assuming an additive version of the accumulation of child inputs, I obtain the following estimating model:

$$Y_{ija} = \sum_{t=1}^{a}(\alpha_t \cdot T_{ijt} + \beta_t \cdot M_{ijt}) + \mu_{ij0} + \nu_{j0} + \varepsilon_{ij}(a)$$

The individual endowment is now separated into the component that is common to all children in the family (ν) and the child's individual deviation (μ) from the family's baseline. I use sibling-fixed effect models to deal with the factors that will influence all children in the same household, which requires assuming that the inputs a child receives is not correlated with the degree to which his endowment varies from his or her sibling. Sibling comparisons can be made at either the same age or at the same point in time. I use comparisons at the same age, which requires the additional assumption that the outcomes of older siblings do not influence the inputs allocated to younger siblings.

I average the time and money inputs for each child over the first ten years of life and then look at outcomes measures while the child is between the ages of 11 and 13:

$$Y_{ij} = \alpha \cdot \overline{T} + \beta \cdot \overline{M} + \mu_{ij} + \nu_j + \varepsilon_{ij}$$

The advantage of this approach is that it provides a single measure of the rate of technical substitution between time and money inputs and report the results over different outcomes and a wider set of specifications than if I were to report the RTS at each age. By using average input amounts, I also avoid some of the problems associated with missing data. I average family income over all available data for the child's first ten years (thus assuming that the average of the missing years is the same the non-missing years—a common practice in the literature) rather than imputing data for a particular year.

II. Data

The analysis in this paper draws on three data sources: the American Time Use Survey (ATUS), the 2000 Census 1% public use micro-sample, and the National Longitudinal Survey of Youth (NLSY). All three datasets contain information on how parents allocate resources among their children who still live at the home and the NLSY provides information on family income and child outcomes.

The ATUS data is based on a time diary completed by one adult from a random sample of households from the outgoing group of the CPS. This person reports all of their activities for one day along with the start and end time and who else was present for the activity. I use this information to construct a measure of how much time the parent spends with each of his or her children. I focus specifically on parent-child activities that involve a high degree of interaction and are thought to have the greatest impact on child development such as reading, talking, and helping with homework.

Many time-use researchers have lamented the fact that the ATUS does not contain any measures of child outcomes. Even if the ATUS included measures of child outcomes, the measurement error involved in inferring someone's typical time use from one day would not provide any meaningful analysis. The power of the time use data comes when aggregating the information over many individuals with similar characteristics.

Since the ATUS respondents are drawn from the outgoing rotation group of the CPS, there is a large set of characteristics about the respondent and other household characteristics including the age, gender, birth order, and birth spacing of the children and the age, education, work status, and marital status of the parents. I use these measures to impute information from the ATUS onto the NLSY.

The NLSY provides a long-run history of the family income of each child born to the original female respondents as well as measures of various child outcomes reported at different points in the child's life. I use three of these outcomes: the raw scores of Peabody Individual Achievement Tests (PIAT) of reading and math and the Behavior Problems Index (BPI). The PIAT test instruments are the same for all children and so the test score increases as children age.[2]

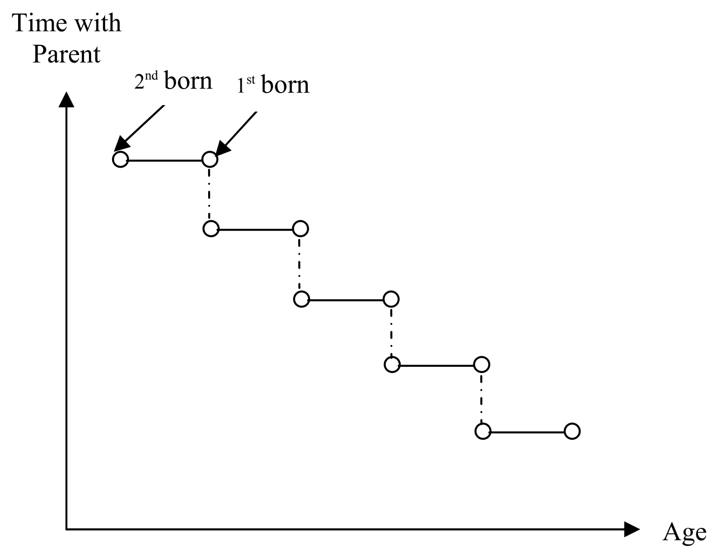
Finally, the 2000 Census 5% Public Use Micro-sample (PUMS) provides information on household composition, parent and child characteristics, and several measures of material resources such as household income, number of bedrooms, type of home, whether the child is enrolled in a private school, number of vehicles, and the labor status of both parents. Each of these datasets are described in more detail in the next two sections.

III. Birth Order, Birth Spacing, and Child Inputs

The empirical strategy of this paper relies on three patterns related to intra-household allocation of resources. First, parents divide available resources equally among their children at each point in time (as long as the children are not spaced too far apart and both children are biologically related to the parent). Second, the amount of resources available to distribute varies over time. Third, the degree to which parents inter-temporally substitute time and money resources is limited.

[2] Joyce, Kaestner, and Korenman (2000) use these same outcomes in their analysis of the impact of an unintended pregnancy on the child's outcomes.

One way to illustrate the result of these patterns is with a simple diagram:



The vertical axis is the amount of resources (in this case time) allocated to each child. The horizontal axis is the age of the child. The solid lines indicate that at each point in time the two children (who are different ages) receive the same amount of parental time input. As children age, they receive less parental time. The birth order differences arise when comparing children at the same age (but at different points in time), as indicated by the dotted lines. The difference in the integrals between the time paths followed by the two children would provide the aggregate birth order difference in parental time inputs. The diagram for material inputs would be upward sloping for most families causing the second-born child to experience a higher level of material well-being at each age. The next sections provide evidence for each of the three patterns.

Equal Division of Resources at Each Point in Time

The first pattern is that parents split resources available at a point in time equally among their children. Hertwig, Davis, and Sulloway (2002) refer to this decision rule as the "equity heuristic." They cite several studies supporting this view and note that the desire for equity at a point in time can lead to inequities over time.[3] There are three stages in which parent-child transfers occur: while the children are still living at home, while the children are living away from home, and when the parents die and leave an inheritance. Most past research has examines the equal division of resources in terms of bequests and transfers to older non-resident children with much less attention given to the equal allocation of resources among children still living at home.

In terms of bequests, Wilheim (1996) uses a sample of wealthy families and finds that for families with two or more children, 68.6 percent provided equal bequests across all their children and 76.6 percent had the bequests fall within 2 percent of each other. Light and McGarry (2004) use information on intended bequests from individuals in the NLS Mature Women sample and finds that 92.1 percent of the sample reported that they intended to divide their estate equally among their children[4].

A number of U.S. datasets include questions about the amount of financial transfers made to each child over a certain period of time (usually over the preceding 12 months). These datasets include the PSID (1988 supplement), the Wisconsin Longitudinal Survey (1992 wave), and the Health and Retirement Study. Using data from the Health and Retirement Study, McGarry and Schoeni (1995) find unequal treatment in

---

[3] Hertwig, Davis, and Sulloway (2002) assume that family resources are constant over time and that birth order inequities arise because the number of children in the home changes over time. Their model follows the same logic as Hanushek (1992) and leads them to the prediction that child outcomes will follow a U-shaped pattern—a pattern that has not born out in more recent research on birth order differences which finds a monotonic decrease in outcomes as you move further out in the birth order (Black, Devereux, and Salvanes 2005).

[4] Additional studies include McGarry (1999) and Menchik (1988).

inter-vivo transfers to children living outside the home. This unequal treatment at a point in time may arise for two reasons. First, financial transfers to children outside the home are generally tied-transfers associated with the costs of education or purchasing a home (Brown, Mazzocco, Scholz, and Seshadri 2005), so that the timing of these transfers won't often occur at the same time for each child especially if they are spaced further apart. Second, financial transfers to children outside the household are not as observable as bequests or transfers within the home, allowing parents to avoid the stigma that accompanies appearing to favor one child (Lundholm and Ohlsson 2000).

Studies on inter-vivo transfers generally exclude children still living at home because of the difficulty in assigning monetary values to food, lodging, or other items purchased for each child. Data on expenditures in the U.S. are collected at the household level and surveys that include information on household possessions (i.e. number of books, computer, etc.) do not generally ask who the items belong to. The same problem is faced by researchers looking at bargaining between spouses. These studies have one advantage in that they can characterize some types of spending as having a large gender-specific aspect (e.g. Lundberg, Pollak, and Wales 1997). However, this approach does not help in distinguishing which child receives the resources.

One type of material input that cannot be shared by siblings and is observable in many datasets is whether the child is enrolled in a private school. Caceres (2006) uses private school enrollment information from the Census as one of the child inputs in his research on the impact of family size on the investments that children receive. The first panel in Table 1 uses information from the 2000 Census for families in which the first and second-born children are both between the ages of 6 and 17. For this group, the probability that both of the first two children are enrolled in private school (given that at least one is enrolled) is about 64 percent. The unequal allocation of private school enrollment is most likely to occur when children are spaced further apart in age or when one is enrolled in high school while the other is at a lower grade level.[5]

Data on equality of parental time transfers are much easier to measure since the ATUS reports the amount of time that an individual spends with each member of the family and the NLSY reports how often the mother reads to each of the children. The second panel in Table 1 provides information from the ATUS on differences between siblings in the amount quality parent time they receive. The ATUS only samples one parent from each household, so the results are shown separately for fathers and mothers. The average absolute difference in reported time spent with the first and second-born child by fathers is about 5 minutes (or about 6 percent of the average quality time of 79 minutes) and 80–90 percent of the families had a difference in time received between the two children of less than 10 minutes. For mothers the absolute gaps are slightly larger (10–13 minutes) or 9 percent of the average quality time of 110 minutes, with about 70 percent of mothers having a difference between siblings of 10 minutes or fewer.

The third panel presents results based on a mother-reported question that was asked in each wave after 1986 in the NLSY about how often the mother reads to each child who is between the ages of 0–9. The measure is based on a six-point scale that range from never (0) to daily (6). Again the comparisons are between the first and second-born children in families with 2, 3, or 4 children. The average response of 4.32

---

[5] The regression coefficients using the subset of families with at least one child enrolled in private school: *P(only one child enrolled) = .768 + .030*spacing + .214*(only one enrolled in high school) - .057*ln(income) - .0076*(both children same gender) + .023 * (number of children).* All of the coefficients, except same gender, are significant at the 1% level.

corresponds to a frequency of about 3 times each week. The absolute difference in the unit score between siblings is about .4, with about 70 percent of siblings having the exact same reported frequency and about 90 percent within 1 unit of each other.

One reason that parents may adopt an equity heuristic is to reduce the unhappiness and inter-sibling quarrels that often accompany inequities. There is growing evidence that happiness might be influenced not only by what individuals have but also how much they have in relation to those around them (Frank 2005; Luttmer 2005). Given the close proximity of siblings and the ease with which they can observe the inputs received by each other, it is likely that positional externalities (the effect of our relative standing among those around us on our utility) play an even greater role among siblings.

Variation over Time in Family Resources

Variation over time in available family resources comes from three main sources: changes in the number of parents present in the home (due to death or divorce), the earning potential of the parents (due to increases in work experience), and changes in the number of parents working and their work hours.

I create a single measure of changes in family income by estimating a family specific time trend using measures of family income after the first child is born:

$$Income_t = \beta_0 + \beta_1 \cdot time_t + \varepsilon_t$$

The average slope of income in our sample is \$1,066 per year (the median is \$686). However, there is a great deal of variation, with families at the 25th percentile experiencing an average drop in real income of \$464 and families at the 75th percentile experiencing an average growth of \$3,892 per year.

Doing the same analysis for parent-child quality time reveals an annual drop of about 9 minutes per day (dropping from 170 minutes at age 1 to 35 minutes at age 17). This drop in parent-child quality time occurs because as children age, parents and children spend more time watching television together (replacing the interactive activities that constitute quality time) and children become more involved in activities outside the home.

Inter-temporal Substitution of Family Resources

There is considerable debate over the degree to which families inter-temporally substitute resources. The permanent income hypothesis, in its most extreme form, would imply that the timing of family income would have no impact on child outcomes. That is while income may matter for child outcomes, if parents are not credit constrained they can smooth consumption such that income when the children are young will have the same impact as income when the children are older. Several recent papers present evidence that this may not be the case.

In their analysis of years of completed schooling and graduation rates using the PSID data, Duncan and Brooks-Gunn (1997) find that family income at younger ages (0–5) had a larger impact than income when the child is older. In addition, the work by Dahl and Lochner (2005) that exploit year-to-year variation EITC finds that changes in income for a particular year influence child outcomes that year. In contrast, Carneiro and Heckman (2003) argue that once permanent income is controlled for using proper discounting that the timing of income has little impact.

Other evidence against the permanent income hypothesis comes from work by Carroll (1994) who finds that predictions of future income (based on one's age, education, and occupation) do not influence current consumption as would be predicted by the permanent income hypothesis. In addition, Hall and Mishkin (1982) find that year-to-year consumption is highly correlated with income and Gruber (1997) exploits changes in the replacement rates of unemployment insurance benefits and finds that a 10% decrease in benefits leads to a 2.5% decrease in food expenditures. Gruber's simulations indicate that in the absence of a unemployment insurance program, food expenditures would drop by about 22%.[6]

Differences in Aggregate Inputs

Combining these three patterns leads to the prediction that a first-born child will receive a higher level of overall time inputs (especially if the children are spaced further apart in age) while the second-born child will generally experience a higher level of family income. I test for these differences in inputs using the following regression equation:

$$T_i=\beta_0 + \beta_1 \cdot second_i + \beta_2 \cdot second_i \cdot spacing_i + \beta_3 \cdot spacing_i + \gamma \cdot Z_i + \varepsilon_i$$

T represents the input of interest and includes parental time, family income, number of bedrooms, whether the child is enrolled in private school, and whether the family lives in a house (that is separated from any other living space). Z is a set of control variables that includes the child's age and gender, and the parent's age, education, marital status, and

[6] Additional reviews on the issues related to testing the permanent income hypothesis are found in Thaler (1990) and Browning and Crossley (2001). While the review in this section omits a lot of the research, the basic point is clear that income received in a particular year is an important determinant of the amount of resources available to children that year.

work status. In the ATUS data, the parental information refers to the responding parent, while the Census data refers to the mother's information and single fathers are excluded from the analysis. Both samples are restricted to children ages 4–13. Twins are excluded from the analysis.

The coefficients of interest in Table 2 are those on the interaction between second child and birth spacing. The coefficient on the main effect of birth order represents the hypothetical difference between siblings with birth spacing equal to zero, so it is not surprising that it is often insignificant. The results in Table 2 show that time resources favor the firstborn child especially when the children are spaced far apart, while just the opposite is true in terms of material resources.

In two-child families, the birth order gap in quality time spent with the father increases by 5.5 minutes per day (over a baseline of 8 minutes) for each year the children are spaced apart, such that children spaced three years apart receive a difference of 23 minutes each day. Time spent with mothers increases by about 9 minutes per day for each year apart the children are spaced, leading to an overall birth order difference of 30 minutes each day when children are spaced three years apart.

In terms of material resources, second-born children experience a family income that is $1,700 per year greater for each additional year of birth spacing. Second-born children also experience a higher probability of living in a home that is detached from any other or having more bedrooms (both possible proxies of neighborhood quality) and are also more likely to attend a private school.

For three-child families, the point estimates for the birth order gap between first and second-born children are nearly all the same. The time use differences are no longer significant but still suggest the same pattern.[7]

IV. Time, Money, and Child Outcomes

The results in the previous section indicate that children receive different amounts of time and material resources based on their birth order and birth spacing, but do these differences in inputs translate into differences in outputs? The research about birth order differences goes back to Galton (1874), who found that firstborn children were over-represented as members of the Royal Society. Recently there has been a surge of research on birth order differences in a number of settings, with nearly all of the recent research documenting that first-born children have better outcomes.

The most convincing recent studies are those that credibly separate birth order effects from the effects of family size (since higher birth order children have to come from larger families) and address unobserved family differences by using sibling-fixed effects. These two requirements severely limit the type of datasets that can be used to test for birth order effects. The best data for this purpose is that used by Black, Devereux, and Salvanes (2005) who have longitudinal data on everyone in Norway who were between the ages of 16 and 74 at some point between 1986 and 2000. This data allows them to have enough sibling sets for each family size group to carry out their analysis. Using family-fixed effects, they find that a second-born child in a two-child family achieved .415 fewer years of schooling (the same gap in three-child families was .315 years).

---

[7] The sample sizes for three-child families are about a third of those of two-child families and the corresponding standard errors on the estimates for parental time are about three times as large.

Kantarevic and Mechoulan (2006) carry out a similar analysis using information from the PSID. Their sample includes 1,422 individuals from two-child families and 1,743 from three-child families. In their family-fixed effect specifications they control for the child's birth order, the mother's age when the child was born and the child's gender. They find that in two-child families the gap in the number of years of schooling completed between the first and second-born child was .216 years (though not significant). For three-child families, the gap is .437 years. They find similar gaps in the high school graduation rate (.033 percentage points for two-child families and .089 percentage points in three-child families).

Table 3 summarizes these studies and several others that have employed family-fixed effect models to examine the determinants of child and youth outcomes. The majority of studies draw on data from either the NLSY or PSID. Most of the studies use years of schooling as one of their outcomes; three studies use the child's birth weight and two use the PIAT test scores and behavior problem index used in this study.

One aspect of the birth order gap not explored in these previous studies is the degree to which it differs based on the birth spacing between the children as well as the degree to which family income changes over time. To test this, I use the following empirical model:

$$Y_{ij} = \beta_0 + \beta_1 \cdot second + \beta_2 \cdot second \cdot spacing + \beta_3 \cdot second \cdot slope \\ + \beta_4 \cdot second \cdot spacing \cdot slope + \mu_j + \varepsilon_{ij}$$

If parental time matters, then $\beta_2>0$. If family income matters, then some of the birth order difference will offset in families with a steeper income slope, such that $\beta_4<0$.

Table 4 provides results for each of the three measures of child outcomes. The first column under each outcome show the aggregate birth order differences, displaying that firstborn children score 1.2 points higher on the PIAT reading test and have a behavior problem index that is 14.4 points lower with no significant difference in math scores. The second column of the panels looking at reading scores and BPI indicate that these birth order gaps favoring the firstborn are even larger when the children are spaced further apart, providing evidence that parent time inputs do influence these outcomes. The third column under each outcome includes the interactions with the family income slope. For reading and math the relative impact of family income is insignificant and for BPI it has a different sign than would be expected, indicating that children that experience higher levels of family income have more behavioral problems (something that emerges again in the next section).

Imputation Approach

Estimating the rate of technical substitution between time and money requires including both inputs in a single estimation. However, Haveman and Wolfe (1995) point out that a major deficiency of current datasets is an accurate measure of parental time inputs. The PSID addresses part of this deficiency with the child development supplements that contain a time diary component in 1996 and 2002. However, the two days of observation of an individual child's time use is likely a noisy proxy for the actual level of parent-child interaction.[8] The real strength of time diary data comes from aggregating the information over groups with similar characteristics.

To incorporate parent time inputs into the analysis, I estimate a model predicting the amount of quality time a child receives with her parents based on the child's age,

[8] This is similar to the small window problem discussed by Wolfe et al. (1996) to illustrate that single year measures of family income or family structure may be a poor proxy for the types of inputs that a child has received.

gender, birth order, birth spacing; and mother's education, race, marital status, and work status. I use the coefficients from this model to impute a predicted value of parent-child quality time for each person-year observation in the NLSY using the same set of covariates.[9]

Since the ATUS does not collect time diaries for both parents, I estimate parent time inputs separately for fathers and mothers but use the mother's information about age, education, and employment in both cases. In families where a father is present (married or cohabiting), I sum the predicted values of mother and father time. Otherwise, I just use the predicted value of mother time, thus assuming that children only receive father time inputs when there is a residential father. Argys et al. (2006) discuss many of the challenges involved in accurately measuring the amount of contact between children and their non-residential fathers. Using data from the 1998 wave of the NLSY data, they find that most children (60-90% depending on the subgroup) report contact with their non-residential father with the typical amount of contact being 2-5 times a week. Future research might test whether the amount of contact with one's non-residential father varies by birth order or spacing (the sources of variation I am exploiting in this paper).

In summing the parent's time inputs, I also assume that father and mother time inputs are both additive and perfect substitutes. Pollak (2007) discusses issues of combining parental inputs into a single production functions and notes that Becker's (1991) work on household production often makes the assumption of perfect substitutes. Pollak suggests a number of ways in which these assumptions may be unreasonable and

[9] This is similar to the approach of Carroll (1994) who uses information from the PSID to calculate predicted values of income for individuals in the consumer expenditure survey. Also, Gruber and Mullainathan (2005) use information on individual characteristics to estimate the degree to which someone is likely to be a current or former smoker and Björklund and Jäntti (1997) obtain predicted values of an income of the individual's father.

some directions that might be used to provide a more realistic picture of household production.

A related issue is dealing with parent-child interaction in which both parents are present. In this paper, I sum the amount of time the child spends with both her mother and father regardless of whether one or both are present (so that an hour with both parents present is counted double). Folbre et al. (2005) discuss some of the issues involved in measuring parental overlap time and note that children may benefit from having two adults present because the adults will experience less stress and the children are able to observe the adults interacting. Price (2007) finds that about 58% of parent-child quality interaction in the ATUS involves both parents. If instead the appropriate metric of parent time inputs is the amount of time that one parent is present then the coefficients on parental time in the empirical work that follows should be scaled upwards by the reciprocal of .58.

I use the imputed parental time measures (*T*) from the ATUS, and the outcomes (*Y*) and measures of family income (*M*) from the NLSY to estimate the following regression:

$$Y_{ij} = \alpha \cdot \overline{T} + \beta \cdot \overline{M} + \gamma \cdot X_{ij} + \mu_{ij} + \nu_j + \varepsilon_{ij}$$

The measures of parent time and family income are averaged over the first ten years of life and outcomes are measured for when the child is between ages 11 and 13. The rate of technical substitution comes by dividing α by β and adjusting by the appropriate units (since parental time is measured in hours per day and family income is measured in \$1,000's per year).

The results in Panel A of Table 5 show that parent-child time has a positive impact on reading scores, especially among families in the lower quartile of the income distribution. While the effect of income does not have an aggregate positive impact on reading scores, I do find a positive and significant impact when using log income, a spline function of income (for the bottom quartile), and when restricting the sample to the bottom quartile of income. For this subset of families in the bottom quartile of income, the implied rate of technical substitution is $9.25 per hour.[10] Neither parental time nor family income appear to have any major effect on math scores. For BPI, parental time has a positive impact while additional family income has a negative impact (i.e. a higher BPI).[11]

Of the parents who report positive wages among the families in the bottom quartile of family income, 15% of the mothers and 17.5% of the fathers report wages greater than $9.25. This indicates that even for the sample of families for which the additional income matters the most, only a small fraction of these families could improve child outcomes by trading one hour of parent-child quality time for one more hour of work.

Alternative Specifications

This last section addresses two additional specification issues. First, I have specified the production function of child outcomes as linear in both time and money

[10] The RTS comes from: $\frac{1.661}{356} \Big/ \frac{.504}{1000}$. This estimate of $9.25 is very similar to research by Moore and Driscoll (1997) about how the impacts of maternal employment among single mothers receiving welfare differs based on their wage level. In their most basic estimates, they find that for mother's earning $7.50 per hour (or $9.45 in year 2000 dollars), that maternal employment is associated with higher reading scores.

[11] While the negative impact of income on BPI seems unexpected, Blau (1999) finds a very small and insignificant negative impact of income on BPI in his mother-fixed effect models.

inputs (thus assuming constant returns to scale in both inputs and perfect substitution between them). An alternative specification would be to adopt a Cobb-Douglas production function:

$$Y = A \cdot T^{\alpha} \cdot M^{\beta} \qquad \text{with } A = e^{\gamma \cdot X + \mu + \nu + \varepsilon}$$

This approach allows for decreasing returns to scale in both inputs and recognizes the fact that even large amounts of additional income can not compensate for a complete lack of parental time inputs (or vice versa). Taking logs of both sides leads to the following estimation equation:

$$\ln(Y_{ij}) = \alpha \cdot \ln(\overline{T}) + \beta \cdot \ln(\overline{M}) + \gamma \cdot X_{ij} + \mu_{ij} + \nu_j + \varepsilon_{ij}$$

The results in panel A of table 6 show that a 10% increase in the amount of parent-child time leads to a 1.23% increase in reading scores, while a 10% increase in family income leads to only .38% increase in reading scores. The last row of the first column shows that these two coefficients are significantly different from each other at the 1% level (F-stat of 11.61), suggesting that if a parent could obtain a 10% increase in parent-child time in exchange for 10% less income, their children's reading scores would increase by about 1%.

For families in the bottom quartile the impact of parental time inputs are slightly smaller in magnitude while the impacts of family income are slightly larger. The difference in the coefficients on time and money inputs is no longer significant, suggesting that the ability of lower income families to improve child outcomes by exchanging time for money is less certain. For both the full sample and the low income sample, a 10% increase in parent-child interaction leads to a 3.8% decrease in the behavior problem index, while additional income actually leads to an increase.

The average income for the full sample is $46,000 compared to the $10,000 per year for the families in the bottom quartile, while quality time inputs are 866 hours per year for the full sample and 824 hours for the low income group. Thus the implied marginal rate of technical substitution at the sample means ($46,000 p/year for the full sample and $10,000 for the low income sample) is $172 per hour of quality parent time for the full sample and $24 for the low income sample.

To put this estimate into the context of past studies, Hill and O'Neil (1994) find that an extra day each week of reading to your child is equivalent to about $5,000 extra family income. On days that parents read to their children, they read on average for about 30 minutes (Price 2007). Thus the Hill and O'Neil estimates imply an rate of technical stubstitution of $192 per hour between family income and time spent reading.

A second issue is that I have treated family income as a purely public good, subject to no resource dilution. Researchers and government agencies have developed a number of methods for adjusting family income to address this issue. Buhmann et al. (1988) adopt a simple framework in which family income is divided by S^e, where S is the number of people in the home and e is some number between 0 to 1 (with a larger e indicating smaller economies of scale). Using data from a number of countries and adopting different scales, they provide a range of estimates for e with those estimates of the US based on statistical measures of poverty being about .7 (i.e. Lazear and Michael 1980), those based on program eligibility of about .5 to .6, and those based on consumption being about .4 to .5. (i.e. Van der Gaag and Smolensky 1982).

Subsequent research has expanded the basic concept above to adjust for differential costs of adults and children. Cutler and Katz adopt the following equivalence scale: $(A + cK)^e$, where A is the number of adults, K the number of children, and c is the relative consumption of children compared to adults. They adopt a value of c of .4 based on work by Deaton and Muellabauer (1986) and Lazear and Michael (1988) and pick an intermediate value of .5 for e based on the range of estimates from Buhmann et al. (1988).

I adjust family income in each year by the equivalence factor of Cutler and Katz (1992) using the number of parents and children present in the home at the time. The results using this alternative measure of material well-being are presented in panel B of table 6. Comparing these results with the first columns of each panel in table 5 shows that adjusting family income for household size has almost no effect on the size of the coefficients. However, for the low-income family sample, the household size adjustment shifts the coefficients in the direction of more positive outcomes (reading and math score coefficients increase and BPI coefficient decreases). Part of this shift comes from the fact that the income measures of have all been rescaled downward (since the adjustment factors is always greater than 1). Adjusting the income coefficients by the average rescaling (1.64) leads to a coefficient on income of .422 and an implied RTS for reading scores of $9.61 per hour.

V. Conclusion

The results in this paper show that parents allocate time resources equally among their children at each point in time. For example, I find that of families that enroll at least one of their two oldest children in private school, the majority enroll both children (about 64 percent). Similarly I find that most parents spend equal amounts of quality time on a particular day and read about as frequently to each of their children. Future research could examine the reasons that lead some parents to deviate from the equity heuristic and compare it to the explanations for unequal bequest intentions examined by Light and McGarry (2004).

I also find large variation in the amount of resources available over time. Family income generally increases by about $1000 per year, though this amount varies widely, with many families experiencing drops in real income over time (over 25 percent of families experience an annual drop in real income of over $400). I find that firstborn children receive more time inputs especially if the children are spaced further apart. Just the opposite is true in terms of family income and other measures of material well-being (owning a home, number of bedrooms, private school enrollment).

These patterns lead to two predictions. First, if parental time matters then, all else equal, a firstborn will have better outcomes and this birth order gap will be larger when the children are spaced further apart in age. Second, if family income matters then the birth order difference will be offset in families that have a steeper income profile. The results in this paper indicate that parental time does matter and that for the average family the impact of less parental time is not offset by experiencing a higher level of family income.

I extend this analysis to estimate the rate of technical substitution between parental time and family income in the production of child outcomes. The results indicate that the rate of technical substitution in terms of reading scores for low income families between parent time and family income is about $9.25 per hour. Just as this type of estimate could help guide a firm about whether to shift to more capital or more labor, estimating the rate of technical substitution in this context would give some indication of whether families in the U.S. are currently spending too much or too little time with their children. One caveat of such a result is that parents derive utility from many things besides their children's well-being and so may provide less time than this analysis might suggest is optimal because of the other ways that they can use their additional income. However, it is still a beneficial and useful result for the "benevolent social planner" who might at sometime want to improve child outcomes and want to create incentives to change the division of time between work and family.

References

Aaronson, Daniel. “Using Sibling Data to Estimate the Impact of Neighborhoods on Children’s Educational Outcomes.” *The Journal of Human Resources*, 33, 915–946, 1998.

Altonji, Joseph and Thomas Dunn. “Using Siblings to Estimate the Effect of School Quality on Wages.” *The Review of Economics and Statistics*, 78, 665–671, 1996.

An, Chong-Bum; Donna Ginther, Robert Haveman, Barbara Wolfe. “The “Window Problem” in Studies of Children’s Attainments: A Methodological Exploration” *Journal of the American Statistical Association*, 91, 435, 970–982, 1996.

Angrist, Angrist and John Johnson. “Effects of Work-Related Absences on Families: Evidence from the Gulf War.” *Industrial and Labor Relations Review*, 54, 41–58, 2000.

Argys, Laura; H. Elizabeth Peters; Steven Cook; Steven Garasky; Lenna Nepomnyaschy; and Elaine Sorensen. "Measuring Contact between Children and Nonresident Fathers" in *Handbook of Measurement Issues in Family Research* edited by Sandra Hofferth, and Lynne Casper, Mahwah, N.J.: Lawrence Erlbaum & Associates, 2006.

Becker, Gary. *A Treatise on the Family*, Cambridge, MA: Harvard University Press, 1991.

Becker, Gary. “A Theory of the Allocation of Time.” *The Economic Journal*, 75, 493–517, 1965.

Bianchi, Suzanne. “Maternal Employment and Time with Children: Dramatic Change or Surprising Continuity?” *Demography* , vol. 37, no. 4, 139–154, 2000.

Black, Sandra; Paul Devereux, and Kjell Salvanes “The Effect of Family Size and Birth Order on Children’s Education.” *Quarterly Journal of Economics*, 2005.

Björklund, Anders; Markus Jäntti. “Intergenerational Income Mobility in Sweden Compared to the United States.” *The American Economic Review,* 87, 5, 1009–1018, 1997.

Blau, David. “The Effect of Income on Child Development.” *The Review of Economics and Statistics*, 81, 2, 261–276, 1999

Blau, Francine and Adam Grossberg. “Maternal Labor Supply and Children’s Cognitive Development,” *The Review of Economics and Statistics*, vol. 74, no. 3, 474–81, 1992

Brooks-Gunn, Jeanne; Greg J. Duncan “The Effects of Poverty on Children.” *The Future of Children*, 7, 2, 55–71, 1997

Brown, Meta; Maurizio Mazzocco, John Karl Scholz, and Anath Seshadri. “Tied Transfers.” University of Wisconsin-Madison Working Paper, 2005.

Browning, Martin and Thomas Crossley. “The Life-Cycle Model of Consumption and Saving.” *The Journal of Economic Perspectives*, 15, 3, 3-22, 2001

Buhmann Brigitte; Lee Rainwater, Guenther Schmaus, and Timothy Smeeding. “Equivalence Scales, Well-being, Inequality, and Poverty: Sensitivity Estimates Across Ten Countries Using the Luxembourg Income Study.” *Review of Income and Wealth*, 34, 2, 115-142, 1988.

Caceres, Julio. “Impact of Family Size on Investment in Child Quality. Multiple Births as Natural Experiment.” *Journal of Human Resources*, 41, 2006, forthcoming.

Carneiro, Pedro; James J. Heckman “Human Capital Policy” *IZA Discussion Paper No. 821*, 2003.

Carroll, Christopher. “How Does Future Income Affect Current Consumption?” *The Quarterly Journal of Economics*, 109, 1, 111–147, 1994.

Case, Anne and Cally Ardington. “The Impact of Parental Death on School Outcomes: Longitudinal Evidence From South Africa.” *Demography*, 43, 401–420, 2006.

Conley, Dalton and Neil Bennett. “Is Biology Destiny? Birth Weight and Life Chances.” *American Sociological Review*, 65, 458–467, 2000.

Currie, Janet; Nancy Cole. “Welfare and Child Health: The Link Between AFDC Participation and Birth Weight.” *The American Economic Review*, 83, 4, 971–985, 1993.

Cutler, David and Lawrence Katz. “Rising Inequality? Changes in the Distribution of Income and Consumption in the 1980’s.” *The American Economic Review*, 82, 2, 546-551, 1992.

Dahl, Gordon and Lance Lochner. “The Impact of Family Income on Child Achievement.” *IRP Discussion Paper No. 1305–05*, 2005.

Deaton, Angus and John Muellbauer. “On Measuring Child Costs: With Applications to Poor Countries.” *Journal of Political Economy*, 94, 720-44, 1986.

Duncan, Greg; W. Jean Yeung, Jeanne Brooks-Gunn, and Judith Smith. “How Much Does Childhood Poverty Affect the Life Chances of Children?”*American Sociological Review*, 63, 406–423, 1998.

Elder, Glen; Tri van Nguyen, and Avshalom Caspi. “Linking Family Hardship to Children’s Lives.” *Child Development*, 56, 361–375, 1985.

Folbre, Nancy; Jayoung Yoon, Kade Finnoff, and Allison Sidle Fuligni. "By What Measures? Family Time Devoted to Children in the United States. *Demography*, 42, 373-390, 2005.

Frank, Robert. "Positive Externalities Cause Large and Preventable Welfare Losses." *American Economic Review*, 95, 2, 137–141, 2005

Galton, Francis. "English men of science: Their nature and nurture" *New York: D. Appleton and Company.* 1874.

Garces, Eliana; Duncan Thomas; Janet Currie "Longer-Term Effects of Head Start" *The American Economic Review*, 92, 4, 999–1012, 2002.

Geronimus, Arline; Sanders Korenman "The Socioeconomic Consequences of Teen Childbearing Reconsidered" *The Quarterly Journal of Economics*, 107, 4, 1187–1214, 1992.

Gertler, Paul; David Levine, and Minnie Ames. "Schooling and Parental Death." *Review of Economics and Statistics*, 86, 211–225, 2006.

Gruber, Jonathan. "The Consumption Smoothing Benefits of Unemployment Insurance." *The American Economic Review*, 87, 1, 192-205, 1997.

Gruber, Jonathan and Sendhil Mullainathan. "Do Cigarette Taxes Make Smokers Happier?" *Advances in Economic Analysis & Policy*, 5, 1, 2005.

Hall, Robert and Frederic Mishkin. "The Sensitivity of Consumption to Transitory Income: Estimates from Panel Data on Households." *Econometrica*, 50, 2, 461-481, 1982.

Hanushek, Eric. "The Trade-off between Child Quantity and Quality" *The Journal of Political Economy*, 100, 1, 84–117, 1992.

Haveman, Robet and Barbara Wolfe. "The Determinants of Children's Attainments: A Review of Methods and Findings" *Journal of Economic Literature*, 33, 1829–1878, 1995.

Hertwig, Ralph; Jennifer Davis, and Frank Sulloway. Parental investment: How an equity motive can produce inequality. *Psychological Bulletin*, 128, 5, 728–745, 2002.

Hill, Anne and June O'Neill. "Family Endowments and the Achievement of Young Children with Special Reference to the Underclass." *The Journal of Human Resources*, 29, 4, 1064–1100, 1994.

Joyce, Theodore; Robert Kaestner; Sanders Korenman "The Effect of Pregnancy Intention on Child Development" *Demography*, 37, 1, 83–94, 2000.

Kantarevic, Jasmin; Mechoulan, Stéphane "Birth Order, Educational Attainment, and Earnings: An Investigation Using the PSID" *Journal of Human Resources*, 41, 4, 755–777, 2006.

Kim, Hisam. "Parental Investments Between Children with Different Abilities." University of Wisconsin, Madison Working Paper, February 2005.

Lazear, Edward and Robert Michael. "Family Size and the Distribution of Real Per Capita Income." *American Economic Review*, 70, 1, 91-107, 1980.

Lazear, Edward and Robert Michael. *Allocation of Income Within the Household*, Chicago: University of Chicago Press, 1988.

Light, Audrey and Kathleen McGarry. "Why Parents Play Favorites: Explanations for Unequal Bequests." *American Economic Review*, 94, 1669–1681, 2004.

Lundberg, Shelly; Robert Pollak and Terence Wales. "Do Husbands and Wives Pool Their Resources? Evidence from the United Kingdom Child Benefit." *The Journal of Human Resources*, 32, 3, 463–480, 1997.

Luttmer, Erzo. "Neighbors as Negatives: Relative Earnings and Well-Being." *The Quarterly Journal of* Economics, 120, 3, 963–1002, 2005.

Mayer, Susan. "What Money Can't Buy: Family Income and Children's Life Chances" *Harvard University Press*, 1997.

McGarry, Kathleen,. "Inter vivos Transfers and Intended Bequests*," Journal of Public Economic,* 73, 3, 321–351, 1999.

McGarry, Kathleen and Robert F. Schoeni "Transfer Behavior in the Health and Retirement Study: Measurement and the Redistribution of Resources within the Family" *The Journal of Human Resources*, 30, 0, 184–226, 1995.

Menchik, Paul. "Unequal Estate Division: Is it Altruism, Reverse Bequests, or Simply Noise?" in Denis Kessler and Andre Masson (eds) *Modeling the accumulation and Distribution of Wealth*, NewYork: Oxford University Press, 105–116, 1988.

Ohlsson, Henry and Lundholm, Michael. "Post Mortem Reputation, Compensatory Gifts and Equal Bequests." *Economics Letters* , vol. 68, 165–171, 2000.

Pollak, Robert. "Allocating Time: Individuals' Technologies and Household Technology." Paper presented at Society of Labor Economics, May 2007.

Powell, Brian and Lala Steelman. "Feeling the Pinch: Child Spacing and Constraints on Parental Economic Investments in Children." *Social Forces*, 73, 1465–1486, 1995.

Price, Joseph. “Quality Time: The Effect of Birth Order.” *Journal of Human Resources*, forthcoming. Current version, working paper, Cornel University, 2006.

Rosenzweig, Mark and Kenneth Wolpin “Sisters, Siblings, and Mothers: The Effect of Teen-Age Childbearing on Birth Outcomes in a Dynamic Family Context.” *Econometrica*, 63, 2, 303–326, 1995.

Ruhm, Christopher. “Maternal Employment and Adolescent Development“, University of North Carolina-GreensboroWorking Paper, March 2006.

Shea, John. “Does Parents’ Money Matter?” *Journal of Public Economics*, 77, 155–184, 2000.

Solon, Gary “Intergenerational Income Mobility in the United States” *The American Economic Review*, 82, 3, 393–408, 1992.

Thaler, Richard. “Anomalies: Saving, Fungibility, and Mental Accounts .” *The Journal of Economic Perspectives*, 4, 1, 193-205, 1990.

Todd, Petra and Kenneth Wolpin. “On the Specification and Estimation of the Production Function for Cognitive Achievement.” *The Economic Journal*, 113, 3–33, 2003.

Van der Gaag, Jacques and Eugene Smolensky. “True Household Equivalence Scales and Characteristics of the Poor in the United States.” *Review of Income and Wealth*, 28, 17-28, 1982.

Wilhelm, Mark. “Bequest Behavior and the Effect of Heirs’ Earnings: Testing the Altruistic Model of Bequests” *The American Economic Review*, 86, 4, 874–892, 1996.

Zick, Cathleen D., W. Keith Bryant, and Eva Osterbacka. “Mother’s Employment, Parental Involvement, and the Implications for Children’s Behavior.” *Social Science Research,* vol. 30, 25–49, 2001.

Table 1. Evidence of the Equal Treatment of Children at a Point in Time

A. Private School Enrollment (2000 Census PUMS, Ages 6–17)

	Family Size		
	2	3	4
P(first two children are both enrolled | at least one is enrolled)	63.7%	63.4%	64.8%
N	10,329	4,151	1,051

B. Parent-Child Quality Time (ATUS, Ages 4–13)

		Family Size		
		2	3	4
Father Time	abs(diff)	5.71	4.70	4.24
[mean=79 min]	% ≤10min	84%	87%	93%
Mother Time	abs(diff)	10.41	13.04	10.25
[mean = 110 min]	% ≤10min	75%	72%	73%
N		3,623	1,200	328

C. Frequency of Reading to Each child (NLSY, Mother Report, Ages 1–9)

	Family Size		
	2	3	4
Average Absolute Difference [mean= 4.32]	0.381	0.412	0.398
% Same	73.1%	71.6%	73.8%
% within 1 unit	92.9%	91.0%	90.6%
N	2,110	1,414	480

Notes: Frequency of reading is based on a 6-point scale ranging from never (1) to daily (6).

Table 2. Differences in Inputs by Birth Order and Birth Spacing

A. Two-child Families

	ATUS (2003–2005)		Census PUMS (2000)			
	Father Time	Mother Time	Family Income	# Bedrooms	Private School	House
second · spacing	-5.55**	-8.88**	1,711.524**	0.023**	0.008**	0.010**
	[1.40]	[1.38]	[154.367]	[0.003]	[0.001]	[0.001]
second child	-6.99	-3.24	171.348	-0.014*	-0.007**	-0.007**
	[3.95]	[3.74]	[321.535]	[0.005]	[0.003]	[0.003]
spacing	0.58	2.21	-516.399**	-0.022**	0.001	-0.007**
	[1.61]	[1.54]	[91.611]	[0.002]	[0.001]	[0.001]
Observations	3,254	4,674	146523	146523	146523	146523
R-squared	0.15	0.17	0.23	0.18	0.07	0.16
Mean	80.9	109.5	64,709	2.99	0.143	0.727
N	3,254	4,674	146,523			

B. Three-child Families

	ATUS (2003–2005)		Census PUMS (2000)			
	Father Time	Mother Time	Family Income	# Bedrooms	Private School	House
second · spacing	-5.09	-5.21	1,492.426**	0.025**	0.008**	0.008**
	[3.33]	[3.53]	[304.979]	[0.005]	[0.002]	[0.002]
second child	-3.79	-13.58	-448.727	-0.004	-0.008*	0.003
	[7.22]	[8.14]	[476.438]	[0.008]	[0.003]	[0.004]
spacing	5.15	2.45	-306.134	-0.026**	-0.000	-0.004**
	[2.95]	[2.67]	[206.656]	[0.004]	[0.001]	[0.002]
Observations	1138	1614	64371	64371	64371	64371
R-squared	0.11	0.14	0.24	0.19	0.08	0.17
Mean	78.7	110.7	59,875	3.08	0.122	0.705
N	1,138	1,614	64,371			

Notes: Both samples are restricted to children ages 4–13 who are either the oldest or second oldest child in the household. * significant at 5%; ** significant at 1%. Each regression includes controls for the child's age and gender, and the parent's age, education, marital status, and work status. The ATUS regression includes a control for weekend/weekday and the Census regression includes parental measures on just the mother. Both regressions exclude single father families.

Table 3. Studies Using Sibling-fixed Effects to Estimate Determinants of Child Outcomes

Study	Data	Outcome(s)	Birth Order Effect
Black, Devereux, and Salvanes (2005)	Norway	Years of School	2nd child: .415** 3rd child: .314**
Kantarevic and Mechoulan (2006)	PSID	Years of School/HS grad	2nd child: .216/.033 3rd child: .427*/.089*
Kim (2005)	WLS	Years of schooling	Oldest child: .199** Youngest child: -.043
Conley and Bennett (2000)	PSID	Low birth weight; HS grad by age 19	Firstborn: .174/.112
Currie and Cole (1993)	NLSY	Birth weight (ounces)	Firstborn: -.149
Garces, Thomas, and Currie (2002)	PSID	HS grad, college attendance, ln(earnings at 23–25), booked or charged with a crime	Included but not reported
Joyce, Kaestner, and Korenman (2000)	NLSY	PIAT, PPVT, BPI	Included but not reported
Blau (1999)	NLSY	PIAT, PPVT, BPI, verbal memory, motor and social development	Similar measures (# sibs, # younger sibs) but not reported
Geronimus and Korenman (1992)	NLSYW, PSID, NLSY	Income measures, HS grade, some college, currently married, ever married, currently employed	Not included (uses sisters)
Aaronson (1998)	PSID	Years of completed schooling, HS grad, college attendance	Not included
Altonji and Dunn (1996)	PSID and NLS	Return to education	Not included
Rosenzweig and Wolpin (1995)	NLSY	Birth weight	Not included
Duncan et al. (1998)	PSID	Years of schooling	Not included

Notes: Excludes studies such as Ashenfelter and Krueger (1994) that only look at twins. ** indicates that the estimated difference in significant at the 1% level and * at the 5% level.

Table 4. Differences in Child Outcomes by Birth Order, Spacing, and Income Slope Using Family-Fixed Effects

A. PIAT (Ages 5–13)

	Reading [mean=40.1]			Math [mean=36.9]		
	(1)	(2)	(3)	(1)	(2)	(3)
second	-1.214***	-0.678**	-0.681**	-0.021	0.183	0.203
	[0.143]	[0.316]	[0.322]	[0.128]	[0.282]	[0.287]
second·space		-0.194*	-0.186*		-0.074	-0.068
		[0.102]	[0.104]		[0.091]	[0.093]
second·slope			-0.018			-0.004
			[0.050]			[0.045]
second·slope·space			-0.002			-0.010
			[0.019]			[0.017]
Observations	16,450	16,450	16,252	16,529	16,529	16,330
# families	2,694	2,694	2,634	2,698	2,698	2,637
R-squared	0.78	0.78	0.78	0.79	0.79	0.79

B. BPI (Ages 4–13) [mean=59.3]

	(1)	(2)	(3)
second	14.459***	4.793***	5.333***
	[0.721]	[1.609]	[1.639]
second·space		3.458***	3.267***
		[0.514]	[0.527]
second·slope			-0.404*
			[0.244]
second·slope·space			0.177*
			[0.091]
Observations	18,717	18,717	18,457
# families	2,840	2,840	2,764
R-squared	0.12	0.12	0.13

Notes: All models include mother-fixed ages and variables indicating the child's age in months. * significant at 5%; ** significant at 1%. The standard deviation of each of the measures is 18.6 for reading, 16.7 for math and 59.3 for BPI.

Table 5. Difference in child outcomes based on average family income and parent-child time across the ages of 0-10.

A. PIAT-Reading (ages 11-13)

		Full Sample		Family Income in bottom quartile
Parent-child time	1.474***	1.621***	1.624***	1.661*
hrs/day	[0.310]	[0.317]	[0.317]	[0.875]
Income	-0.005			0.504**
$1,000/year	[0.006]			[0.216]
Ln(Income)		1.696**		
		[0.820]		
Spline1			0.350**	
			[0.161]	
Spline2			0.070	
			[0.092]	
Spline3			0.044	
			[0.063]	
Spline4			-0.009	
			[0.006]	
Observations	6,630	6,612	6,630	1,660
R-squared	0.74	0.74	0.74	0.72

B. PIAT-Math (ages 11-13)

		Full Sample		Family Income in bottom quartile
Parent-child time	0.099	0.163	0.168	-0.069
hrs/day	[0.242]	[0.245]	[0.244]	[0.594]
Income	-0.001			0.311*
$1,000/year	[0.006]			[0.169]
Ln(Income)		0.681		
		[0.565]		
Spline1			0.210*	
			[0.112]	
Spline2			-0.005	
			[0.061]	
Spline3			0.026	
			[0.053]	
Spline4			-0.002	
			[0.007]	
Observations	6,662	6,644	6,662	1,634
R-squared	0.70	0.70	0.70	0.63

C. BPI (ages 11-13)

		Full Sample		Family Income in bottom quartile
Parent-child time	-3.323**	-2.830*	-2.837*	-2.273
hrs/day	[1.480]	[1.495]	[1.482]	[3.795]
Income	0.055*			2.311**
$1,000/year	[0.028]			[0.986]
Ln(Income)		8.011**		
		[3.243]		
Spline1			0.985	
			[0.763]	
Spline2			-0.198	
			[0.443]	
Spline3			0.645**	
			[0.319]	
Spline4			0.039	
			[0.030]	
Observations	6,820	6,802	6,820	1,662
R-squared	0.61	0.61	0.61	0.64

Notes: All income is based on year 2000 dollars. Income refers to the average income across all years which family income was available for the child between ages 0-10.

Table 6. Alternative Specifications

A. Cobb-Douglas Model

	Full-sample			Family Income in Bottom Quartile		
	ln(read)	ln(math)	ln(bpi)	ln(read)	ln(math)	ln(bpi)
ln(parental time)	0.123***	0.031	-0.384***	0.113*	0.031	-0.381*
	[0.023]	[0.021]	[0.085]	[0.067]	[0.056]	[0.205]
ln(income)	0.038**	0.017	0.123**	0.056*	0.020	0.103
	[0.017]	[0.013]	[0.054]	[0.032]	[0.023]	[0.068]
Observations	6,611	6,611	6,802	1,642	1,638	1,644
R-squared	0.73	0.66	0.61	0.71	0.58	0.65
Test: ln(T)= ln(M)	11.61***	0.45	29.25***	0.71	0.04	5.15**

B. Adjust income by number of parents and children in the household

	Full-sample			Family Income in Bottom Quartile		
	read	math	bpi	read	math	bpi
parental time	1.478***	0.090	-3.358**	1.445*	-0.192	-3.262
	[0.309]	[0.241]	[1.477]	[0.858]	[0.586]	[3.787]
income	-0.008	-0.005	0.099**	0.693**	0.476*	3.289**
	[0.011]	[0.011]	[0.050]	[0.323]	[0.248]	[1.506]
Observations	6630	6634	6820	1660	1658	1662
R-squared	0.74	0.70	0.61	0.72	0.63	0.64

Notes: Panel B is the same as the first and last columns of table 5 except that family income is divided by the family equivalence scale used by Cutler and Katz (1992): $(\text{adults} + .4\cdot\text{kids})^{.5}$.