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Research Article

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The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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The authors report generative AI was not used in their research or preparation of this manuscript).

DATA AVAILABILITY

The data necessary to reproduce the analyses presented here are publicly accessible at https://osf.io/gt37f/overview?view_only=4cf153e3ef3e4a1d88cb14d2660a8aa8

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Abstract: By exploiting the fact that all firstborn children are reared as only children prior to the birth of their young sibling, only children are compared with firstborn children to identify the only-child effect. Only children exhibit inferior labor market outcomes to firstborns, with the extent of this disparity contingent upon the birth intervals between the firstborn and the secondborn. This interval-specific negative only-child effect is examined using a conceptual framework that delineates the trade-off between parent-child and inter-sibling relationships. The benefits of enjoying an exclusive parent-child relationship improve with increased child spacing—such as reduced competition for parental resources and a higher level of intellectual maturity—yet this also increases the cost of lacking a sibling relationship, which results from the forgone sibling resources and scale economies. The combined marginal benefit and loss regarding birth interval produces a hump-shaped pattern of the sibling premium curve: The relative advantage of having a younger sibling increases when the birth interval is under one year but declines when child spacing extends to six or seven years, making firstborn children indistinguishable from only children. Utilizing multiple births as an instrument for child spacing, only children earn, on average, sixty percent less than firstborn children.

Keywords: Only-child effect, child spacing, sibling interactions, parent-child relationships

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INTRODUCTION

One of the most significant and long-lasting influences on a person's development is their relationship with their siblings (Brody, 1998; Conger & Little, 2010; Howe et al., 2023). The effects of sibling size, birth order, child spacing, and gender composition on personal development have been the subject of numerous studies (Ejrnaes & Pörter, 2004; Black et al., 2005; Price, 2008; Booth & Kee, 2009; De Haan, 2010; Buckles & Munnich, 2012; Campbell et al., 2019). These studies typically focus on children who have at least one sibling. In contrast, the experiences of only children, those without siblings, remain relatively under-explored. But, due to the continuous drop in birth rates and the rise in single-child households, only children have attracted a lot more scholarly attention over the past ten years. Two hundreds and three research papers published between 1971 and 2026 where found on Google Scholar, focusing on quantitative analyses of only children (where the term "only child" appears in the title or abstract). Of these, 128 papers (63%) were published after 2014. The average number of yearly publications surged from 3.02 before 2014 to 14.4 afterward (see Figure 1).

[Figure 1 about here]

Out of these 128 papers published after 2014, the majority are published in journals related to medicine and psychology journals (72%), with the remaining 16 percent and 12 percent appearing in social science and economic journals, respectively. Most of this research (75%) looks at non-cognitive aspects of only children, like personality, behaviors, psychological well-being, and physical development. Only seven papers (5%) look at economic outcomes like earned income (Skog, 2019; Wen, 2023), career life (Xian et al., 2022; Chen et al., 2023; Chen & Cheng, 2024), and entrepreneurial activities (Yang et al., 2023; Yue et al., 2025). The remaining 19 percent focus on academic and cognitive performance. Furthermore, these studies focus more

on the traits of kids or teenagers (77%) rather than long-term adult outcomes (23%). Evaluation of adult outcomes should receive more attention because any differences – positive or negative – between only children and their peers during childhood or adolescence may lose their policy significance if they become less pronounced as childen get older. Furthermore, economic outcomes are as important as cognitive and non-cognitive factors because career success is a major component of individual well-being and plays a crucial role in modern life (Howell and Howell, 2008; Abele-Brehm, 2014). Besides, job market performance results from the cognitive and non-cognitive abilities that are developed during childhood or adolescence, at least to some extent.

Another noteworthy feature of these publications is the extensive use of Asian data – 70 percent of the studies rely on data collected in China, while 10 percent utilize data from other Asian countries. Publications focusing on the U.S. (8%) and Europe (12%) are notably underrepresented. Findings from different countries can be highly contextual, influenced by particular socioeconomic and cultural contexts. For example, compared to Western parents, Asian parents typically show stronger son preferences (Das Gupta et al., 2003) and adopt a more authoritative parenting style (Pinquart & Kauser, 2018). While fertility decisions in the West are usually based on personal factors, the one-child policy in China plays a major role in the decision to have a single child. Children's development may be impacted in different ways by these diverse backgrounds. Therefore, inferences made from the Asian sample might not provide non-Asian samples with comparable insights. In conclusion, a research gap in the studies of only children is highlighted by this succinct review of the literature. This study close that gap by using a U.S. dataset to investigate the effects of being an only child on lifetime income in adulthood.

The primary challenge in this field of study is the potential endogeneity in parents'

fertility decisions. When the choice to have an only child is correlated with unobserved characteristics of the parents that also influence the child's outcomes, the estimated effect of being an only child may be biased. For instance, studies have shown that wealthier parents are more likely to opt for having an only child, and their considerable financial resources can positively affect their child's outcomes (Veenhoven and Verkuyten, 1989). The estimated benefits of being an only child may therefore be overstated. However, this issue of endogeneity was only addressed in three studies (8%) that were published before 2014. Recently, this issue has garnered more attention, particularly in journals related to economics, sociology, and medicine. Since 2014, 26 studies (20%) have tackled the endogeneity problem, utilizing techniques such as propensity score matching (10), instrumental variables (14), and fixed effects models (2). Still, each of these approaches has its own strengths and limitations (Martens et al., 2006).

The propensity score matching method aims to eliminate observable differences between families with only children and those with non-only children (Skog, 2019; Song & Wang, 2019; Jia et al., 2022; and Zhao et al., 2022). A limitation of this method is the trade-off between inexact matching and incomplete matching; inexact matching results in residual confounding, while incomplete matching leads to a lack of generalizability and a loss of statistical power (Sainani, 2012). The instrumental variable method and the fixed effect model, on the other hand, seek to eliminate the impact of unmeasured confounders. Finding a valid instrumental variable is difficult, though, because it needs to be exogenous to the outcome variables of children and powerful enough to influence parents' fertility decisions. While a strong instrument usually fails the endogeneity condition, a variable that satisfies the exogeneity requirement is frequently a weak instrument (Murray, 2006).

Out of the 14 papers using the instrumental variable method, 13 of them use datasets from China, with the only exception being conducted for Denmark (Ilciukas et al., 2025). The papers conducted for China mostly (10 papers) exploit the one child policy (Qian, 2009; Cameron et al., 2013). Specifically, they make use of regional and temporal variations in policy's implementation intensity, such as local birth quotas and penalty rates (Li & Qiu, 2021; Zeng et al., 2020). As long as these regional and temporal variances don't directly affect the children's results, the only child policy functions as a quasi-natural experiment. The fact that this instrumental variable is only applicable in the Chinese context and cannot be used in other nations is one of its main problems. Another less common choice of instrumental variable (3 papers) exploits the son preference in Asian culture, which uses the gender of the firstborn to induce exogenous change (Tian & von Cramon-Taubadel, 2020; Shi et al., 2021; Lao and Lin, 2022). The primary issue of this instrument is the potential violation of the exogeneity condition, as prior research has demonstrated that gender composition significantly influences children's development. In the context of Denmark, Ilciukas et al. (2025) employ a novel instrument: the in vitro fertilization success rate. Unfortunately, this instrument is often not available in the commonly used survey data.

Endogeneity can be handled more effectively with the fixed effect model, as it does not require an instrument. Its application in detecting the only-child effect is difficult, though, as it can only detect within-group effects. For example, Keenan et al. (2023) investigate the health outcomes of only children by removing the common unobserved endogeneity between them and their cousins, assuming that they share similar genetic backgrounds. The differences between only children and their cousins are interpreted as the only-child effect. One drawback of this strategy is its ignorance of possible heterogeneity unique to children and their parents that might

not be related to their cousins. To address the heterogeneity unique to individual children, Lo (2023) employs a difference-in-difference methodology. He compares the age trends of outcomes for only children with those of firstborns before and after the birth of a younger sibling. However, the results depend significantly on particular parametric assumptions related to the non-linear age trend of children's outcomes, which undermines the robustness of the findings.

In this paper, we use multiple births occurring at the first birth as an instrument. Multiple births are a standard instrumental variable in studying the effect of sibling size in families with at least two children (Angrist et al., 2010); however, to the best of our knowledge, this approach has not been applied to the study focusing on the only-child effect. The fact that only child status and multiple birth are binary variables could be one explanation for this circumstance. Since it is commonly known that a binary instrument used for a binary treatment variable frequently produces low predictive power, this could result in the issue of a weak instrument (Xu, 2021). In order to solve this problem, we redefine the binary treatment variable – whether a child is an only child – as a continuous variable, the birth interval between firstborns and their younger sibling. Our hypothesis posits that every firstborn child is raised as an only child until the mother becomes pregnant again or, at the latest, until the second child is born. From that point onward, firstborns and only children are raised in different environments. The time interval between these two births determines the difference between firstborns and only children. The firstborn is treated as an only child for a longer period of time the wider this gap is. Consequently, the observed outcomes for firstborn children with sufficiently large gaps serve as an estimator of the counterfactual outcome had these firstborn children been only children. According to this framework, the only-child effect does not stem from a simple binary transition between having a

younger sibling and not having one. Instead, it reflects a continuum that depends on the spacing between children. We use multiple births at first birth as an instrument to remove endogeneity in child spacing. The problem of weak instruments is avoided because child spacing is a continuous variable as opposed to the binary only child status.

The remainder of this paper is structured as follows: Section 2 defines the only-child effect and sibling premium. Section 3 presents the dataset we use in this study. Section 4 presents the estimation methods and results. We discuss and conclude our results in the last section.

SIBLING PREMIUM AND ONLY-CHILD EFFECT

The only-child effect is defined in this paper as the disparities in outcomes between firstborn children who have one younger sibling and those who are only children. This definition excludes any effects related to having more than one sibling. In this case, the sibling effect – which pertains to the consequences of having a younger sibling – is the exact opposite of the only-child effect. Previous research indicates that the impact of having a younger sibling is influenced by the age gap between them (Black et al., 2005). Therefore, it is appropriate to consider the only-child effect as a function of child spacing. The gap-specific only-child effect is found by comparing the results of firstborn children with varying age gaps between them and their siblings with those of only children. A positive sibling effect at a specific gap corresponds to a negative only-child effect at that same gap, and vice versa.

Existing theories do not reach a consensus on the gap-specific only-child effect. Several proposals have been discussed in the literature. The most prominent is the resource dilution hypothesis (Blake, 1981). This hypothesis posits that siblings compete for scare parental resources - both monetary and time. Children who receive a larger proportion of financial

resources gain access to products and services that support their personal growth. In a similar vein, children who receive a greater proportion of time resources gain from more parental attention, which also benefits their development. The dilution effect is more pronounced when children are closer together and becomes negligible when they are farther apart (Powell & Steelman, 1995). According to this theory, the outcome of firstborn children is a positive function of child spacing. The scale effect hypothesis, on the other hand, postulates that parents are more likely to devote time and money to raising children when they are closer in proximity, under the assumption that these inputs benefit from economies of scale (Cicirelli, 1973). Conversely, firstborn children with wider gaps are disadvantaged and receive less parental input. As a result, the outcome of firstborn children is a negative function of child spacing. These two contrasting theories produces ambiguous predictions regarding the results of only children.

According to earlier sociological and psychological research, firstborn children can gain from having a younger sibling in a number of ways (for a review, see Kitzmann et al., 2002). The social learning theory, which considers siblings as a valuable resource, is linked to these advantages (Bandura, 1977). For example, through their interactions with their siblings, firstborn children learn social skills like sharing and resolving conflicts. When the siblings are close in age, these benefits are more noticeable; however, they lessen as the age difference widens (Whiteman et al., 2011). Accordingly, the firstborn's result is a decreasing function in child spacing. On the other hand, the confluence model (Zajonc, 1976) states that a child's development is influenced by the level of intellectual maturity in their surrounding. Only children are able to access a higher level of maturity through their interactions with adult parents. For example, parents boost their confidence by providing them with cognitive stimulation and a sense of security. Conversely, firstborns are brought up with younger siblings, which can lower

the average maturity level and lead to less favorable outcomes. The disadvantages of having younger siblings decrease as the age gap grows. Children's performance therefore is an increasing function in child spacing. Once more, these conflicting theories do not lead to a consensus.

We use a framework to conceptualize the various effects discussed above into two categories of relationships. The first category examines the benefits of inter-sibling relationships, which include access to sibling resources and economies of scale. The second category focuses on parent-child relationships, highlighting the advantages of obtaining parental resources and the benefits of enhanced intellectual maturity. We evaluate the positive effect of these two types of relationships over a timeline of child spacing. When child spacing decreases to zero, the outcomes for firstborn children resemble those of twins. Twins gain from inter-sibling relationships from birth. However, they experience smaller benefits from parent-child relationships, as they must compete for parental attention with their siblings from the outset. Conversely, as child spacing expands indefinitely, the outcomes for firstborn children become similar to those of only children. Only children reap the full benefits of parent-child relationships but miss out on the experiences that come with inter-sibling relationships. The outcomes of first-born children with varying age gaps form a continuum between the two extreme cases mentioned above, which we refer to as the sibling premium curve. This curve measures the advantages of having siblings compared to being an only child at each specific age gap. By tracking how the outcomes of first-born children alter as child spacing increases, we can learn about how the net effects of these two distinct relationships evolve. Specifically, first-born children with a one-month longer age gap benefit from the marginal gain of an extended parent-child relationship. However, they face a disadvantage due to the marginal loss associated with a shorter inter-

sibling relationship. The marginal net effect is positive when the marginal benefits surpass the marginal loss. In this instance, the children's results would show an increasing slope along the child spacing continuum. Conversely, a decreasing slope is anticipated when the opposite is true.

The sibling premium is regarded as the causal sibling effect, arising from the dynamics of parent-child relationships and interactions between siblings. However, there are other factors that simultaneously influence child spacing and children's outcomes. One of those is the heterogeneity among parents, which impacts their prenatal fertility decisions regarding child spacing and their postnatal nurturing approaches. We use instrumental variable method to deal with this issue. Nonetheless, it is essential to recognize that differential parental styles not related to prenatal fertility preferences should not be viewed as confounding effects. For example, parents typically dedicate more time to childcare when the birth interval is shorter, regardless of their specific prenatal preferences concerning child spacing. The occurrence of multiple births falls into this category. This variation in parental style, which directly responds to child spacing, should be considered as an integral part of the causal sibling effect. This can be understood through the lens of the scale economies effect within our framework, suggesting that parents allocate more resources to raising children when they are spaced closer together.

Lastly, child spacing can be influenced by events such as abortions, miscarriages, preterm or post-term deliveries during the second birth. These occurrences may impact the mother's emotional state, which can subsequently affect the firstborn (Bennett et al., 2005). We include these variables in the regression model to account for their effects on the firstborn's outcomes.

DATA

We extracted data from the National Longitudinal Survey of Youth 1979 Child and Young Adult

(NLSCYA). This dataset includes 5,094 mothers with at least one child, born between 1979 and 2011. When the first interviews were conducted in 1986, the children were aged from zero to 16 years. Additionally, the National Longitudinal Survey 1979 (NLSY) provides detailed demographic information about mothers born between 1957 and 1964. These mothers were first interviewed in 1979, when they were between 14 and 21 years old. As of 2020, the last year included in our data sample, the NLSY women are between 56 and 63 years old, while the NLSCYA children are aged 9 to 52 years. Our sample includes firstborn children with either no siblings or one sibling. The final sample comprises 2,024 family units, of which 608 (30%) are families with only one child.

We examine the wage outcomes of firstborn and only children aged 21 to 49. This analysis measures the only-child effect as these children transition into adulthood. We calculate lifetime income based on the average log real income. Aside from gender, race, and child spacing, we do not incorporate other covariates related to children, as factors like education level are integral to the only-child effects and may influence wage outcomes. Including these variables could obscure the only-child effects we seek to identify. Nevertheless, we account for potential endogeneity in child spacing by including various maternal characteristics. These variables are computed as the average value over the sample period. Descriptive statistics for the variables included in this study can be found in Table 1.

[Table 1 about here]

RESULTS

Sibling premium curve

We utilize multiple births as an instrument for child spacing (measured in months) and derive the predicted exogenous child spacing from the following first stage regression:

$$gap_i = \alpha_0 + \alpha_1 twin_i + \alpha_2 x_i + v_i \quad \text{(first stage equation)}, \tag{1}$$

where gap_i represents the child spacing, $twin_i$ is the dummy variable for twins, and x_i is a vector of covariates list in Table 1. The F-value of $twin_i$ is 13.80. Detail results are given in Table 2, which will be discussed in the next section. We then compute the predicted child spacings using (1) and discretize them into monthly intervals. We calculate the average income of firstborn children who have the same age gap to create income data specific to that gap. To reduce noise in our results, we apply a smoothing technique by computing the moving average of the gap-specific wages over a three-month. It results in the sibling premium curve, as displayed in Figure 2(a). In this figure, the horizontal dashed line represents the average lifetime income of only children, while the average lifetime income of older twins is indicated by the observation at a zero age gap.

[Table 2 about here]

[Figure 1 about here]

Several observations are found in Figure 2(a). Firstborn children earn higher income than only children for almost all gaps less than 84 months (7 years). After this point, the differences are less pronounced. To check whether the observed income discrepancies between firstborn and only children are statistically significant, we employ the method of seemingly unrelated regression to jointly estimate the average incomes of only children and firstborn children across different gaps. We utilize the Hausman test to assess the significance of the differences. The p-values for each gap are displayed in Figure 2(b). The differences are generally significant at the 5% level (indicated by the horizontal dashed line) when the gap ranges from 15 to 58 months. In contrast, the sibling premium are mostly insignificant for gaps shorter or longer than that range. These findings suggest that the disparity between only children and firstborn children diminishes

when birth intervals are sufficiently large.

Next, we compute the running sum of the sibling premium along the gap line and divide it by the number of gaps. This running sum is referred to as the cumulative sibling premium curve, as illustrated in Figure 2(c). The cumulative sibling premium curve increases steadily and rather smoothly from a 12-month gap until 84 months. It confirms that the sibling premium for firstborn children is closed to a continuous function in age gaps. Beyond this point, the cumulative sibling premium shows no noticeable rising or falling trends, confirming that there is no longer any difference between firstborn children and only children. The cumulative sibling premium, by construction, is an integrand that measures the area between the income of firstborns (represented by the sibling premium curve) and the income of only children (depicted by the horizontal line in Figure 2(a)). The right limit of the cumulative sibling premium is interpreted as the average sibling premium taken over birth intervals. This value is 0.52, indicating that firstborn children earn, on average, 68% more than only children, calculated as $(= \exp(0.52) - 1)$. To examine in which way endogeneity understates the sibling effect, we add the estimated cumulative sibling curve when child spacing is not instrumented in Figure 2(c). The non-instrumented cumulative sibling premium curves are positioned below those from the instrumented results across all age gaps. Sibling premium is undervalued when endogeneity is ignored.

Figure 2(a) suggests a hump shaped sibling premium curve, with income increases initially and drops later. We demonstrate this pattern in Figure 3. To help us better understand the gap pattern of this total effect, two theoretical curves that illustrate the benefits of parent-child and child-child relationships, respectively, have been included in this figure. We assume that the advantages of parent-child and sibling relationships are continuous and monotonic

functions of birth intervals. Specifically, the benefits derived from parent-child relationships, denoted as y_{pc}, are a strictly increasing function of child spacing. Thus, $y_{pc} = f_1(gap)$, where $f_1 > 0$, $f_1' > 0$ and $f_1'' < 0$. In contrast, the benefits from the child-child relationship, denoted as y_{cc}, are a strictly decreasing function of child spacing. That is, $y_{cc} = f_2(gap)$, where $f_2 > 0$, $f_2' < 0$ and $f_2'' > 0$. These assumptions are justified by the notion that as the time between births increases, firstborn children benefit from spending more time in an exclusive parent-child relationship, which enhances their outcomes ($f_1' > 0$). However, this improvement experiences diminishing returns as child spacing increases ($f_1'' < 0$). On the other hand, firstborn children spend more time with their younger siblings and benefit from these sibling interactions when the birth interval is shorter. This benefit diminishes with greater child spacing ($f_2' < 0$) and becomes negligible when the spacing is infinitely long ($f_2'' > 0$).

Although having siblings can sometimes bring disadvantages, such as rivalry for parental resources (Whiteman et al., 2011), we attribute these negative sibling effects to the loss of exclusive access to parental resources following the birth of a second child, which is captured by y_{pc}. Specifically, firstborn children who experience more intense sibling rivalry due to shorter sibling gaps benefit less from parent-child relationships. Conversely, firstborn children face less intense sibling rivalry and benefit more from parent-child relationships, which is consistent with the increasing function of y_{pc}. Both y_{pc} and y_{cc} are regarded as non-negative functions ($f_1 > 0$ and $f_2 > 0$) in this framework.

In Figure 3, the elder twin with a zero gap benefits most from inter-sibling relationships because they are born together. However, they benefit the least from parent-child relationships due to the strongest resource dilution effect. As child spacing increases from zero to about two years, the negative resource dilution effect diminishes quickly, allowing firstborn children with a

gap as short as two years to enjoy most of the benefits of the parent-child relationship. Increasing the gap further yields minimal improvement in the benefits of the parent-child relationship. Conversely, the advantages of inter-sibling relationships gradually decrease for all gaps and disappear when the gap reaches about ten years.

[Figure 3 about here]

Due to these disparate elasticities of the effects of parent-child and inter-sibling relationships with regard to child spacing, the marginal gains from increased parent-child interactions during the first two years of life more than offset the marginal losses from fewer inter-sibling interactions. This leads to better results for the firstborn as the gap widens, peaking at around one to two years. Beyond this point, there is no obvious marginal improvement from a more intense child-parent relationship, while the marginal losses from weaker sibling interactions become more pronounced. Consequently, the total effect declines as the gap widens, and the sibling premium vanishes at about ten years. We will provide an estimation of this theoretical model in the following section.

Controlling for covariates

The exercises above calculate the mean income for firstborn children with the same gap, without accounting for the influence of other covariates. To remove these potential confounding factors, we estimate a regression model that incorporates a list of these characteristics, summarized in Table 1. For clarity, we categorize the predicted child spacing derived from the first-stage equation (1), measured in months, into year dummies for child spacing. We define child spacing of less than 12 months as zero years, primarily including twins and a few cases with gaps of 11 months. The incomes of children are then regressed against these categorical child spacings,

along with the other regressors. Specifically, we fit the following models in the second stage:

$$w_i = \beta_0 + \sum_{t=0}^{T} \beta_{1t} \ \hat{g}ap_{ti} + \beta_2 x_i + u_i \quad \text{(Second stage equation)}, \tag{2}$$

where w_i represents the income of children and $\hat{g}ap_{ti}$ denotes the dummy for the predicted gap at year t obtained from the first stage estimation. The coefficient β_{1t} indicates the effect of the gap at year t on children's income.

Table 2 presents the results for both the first and second stage equations. The impact of child spacing in the second-stage equation is detailed separately in Table 3. The results from the first stage indicate that child spacing is significantly influenced by various characteristics of mothers, such as education level, cognitive ability, attachment to the labor market, marital status, expected fertility, the age at which the firstborn is delivered, and the duration between marriage and the first birth. Generally, mothers with higher grade completed, greater AFQT, and longer work weeks tend to have their second child sooner, which aligns with previous findings (Buckles & Munnich, 2012; Pörtner, 2016). For instance, it has been suggested that mothers with higher incomes often reduce child spacing to minimize maternity duration and the subsequent loss of human capital. Since these characteristics typically enhance their child's income, as indicated by the second stage results, these confounding effects are likely to overstate the sibling premium for shorter gaps and understate it for longer gaps. Consequently, the observed declining trend in gap-specific sibling premiums may be exaggerated. By addressing the effect of these confounding factors, we anticipate that the estimated sibling premium curve will show a smaller negative slope.

[Table 3 about here]

Another source of confounding factors arises from mothers' attitudes toward family and child-rearing. The first stage results indicate that married mothers who wish to have more children and have their first child at younger ages tend to have their second child sooner. If these mothers devote more time to child-rearing, leading to better outcomes for their children (as confirmed by the second stage results), the negative slope of the estimated sibling premium will again be biased upward. Notably, abortions between the first and second births have a significant effect on child spacing; mothers who have had previous abortions delay their second birth by 2.7 years. It is reasonable to assume that abortion reflects a lower preference for forming a family, which may adversely affect the outcomes for their children (as seen in the second stage results). The effect of miscarriage between the first and second births shows a similar magnitude, increasing child spacing by 2.2 years. If a miscarriage reflects the mother's poorer physical condition and adversely affects her psychological well-being, it could negatively impact her children (as confirmed by the second stage results). These will, again, overstate the slope of the sibling premium.

The estimated effects of child spacing are presented in Table 3. We consider year gaps up to 9 years (108 months) and use the final years as the benchmark. Since the wage outcome of firstborn children at 9 years gap is similar to that of only children, the estimated coefficient at a specific gap is interpreted as the additional wage earned by firstborn children with this gap relative to the only children (sibling premium).

The results without adding covariates are first reported, which should reflect similar patterns to the estimated sibling premium shown in Figure 2. Notably, elder twins (with a zero gap) earn more income than only children. Subsequently, sibling premiums exhibit a consistent

decreasing trend, declining from 1.51 for a one-year gap to 0.17 for an eight-year gap. As previously discussed, confounding observable covariates may overstate the sibling premium for shorter gaps and exaggerate the negative slope of the sibling premium curve. As anticipated, the sibling premium at shorter gaps decreases significantly when endogeneity is accounted for. The premium for a one-year gap falls from 1.51 to 1.29, and the sibling premium becomes insignificant for gaps longer than seven years. To assess the impact on the cumulative sibling premium, we sum up the coefficients across different gaps. The cumulative effect decreases from 7.61 (without covariates) to 5.92 (with covariates). Nonetheless, the finding that sibling premiums for short to medium gaps (less than five years) remain positive and significant holds true. The hump-shaped pattern of the premiums depicted in Figure 3 is also reaffirmed.

To investigate the different contributions of parent-child relationship (y_{pc}) and inter-sibling relationship (y_{cc}) to the hump shape pattern of the sibling premium curve, we employ the following parametric models:

$$y_{pc} = \gamma_1(1 - \exp(-\gamma_2 \ gap)), \tag{3}$$

$$y_{cc} = \gamma_3 \exp(-\gamma_4 \ gap). \tag{4}$$

In these models, $\gamma_1(> 0)$ is the income of only children and $\gamma_3(> 0)$ is the income of elder twins. $\gamma_2(> 0)$ measures the curvature of y_{pc} contributed by the parent-child relationship. The larger its value, the faster y_{pc} reaches its maximum value at γ_1. It implies that the gain in the benefits accrued from parent-child relationship is very sensitive to child spacing when the gap is very small, but is almost invariant to child spacing when the gap widens. Similarly, $\gamma_4(> 0)$ measures the curvature of y_{cc} contributed by the inter-sibling relationship. The smaller its value the slower y_{cc} drops to its minimum value at zero. It implies that the loss of inter-sibling

relationship due to large gap dissipates slowly with gap.

Using equations (3) and (4) to capture the gap effect, the second stage wage equation in (2) becomes

$$w_i = \gamma_1(1 - \exp(-\gamma_2 \ \hat{g}ap_{ti})) + \gamma_3 \exp(-\gamma_4 \ \hat{g}ap_{ti}) + \beta_2 x_i + u_i. \quad (5)$$

This model is estimated by non-linear least square regression. Results are reported in Table 4. They confirm that elder twin earns (γ_3) more than the only children (γ_1). Besides, the curvature of parent-child relationship (γ_2) is nearly double that of the inter-sibling relationship (γ_4).

[Table 4 about here]

In Figure 4, we display the estimated curves for y_{pc} and y_{cc}, along with their sum, which represents the total effect. To facilitate comparison, we include the estimated income of firstborn after adjusting for the impact of covariates. The actual incomes align well with the fitted total effect. At zero gap, the parent-child relationship contributes only 8.4% to the income of the elder twin (0.58 out of 6.85). This indicates a significant adverse resource dilution effect, which nearly eliminates the benefits of the parent-child relationship. However, the contribution of the parent-child relationship increases sharply with child spacing. Firstborn children with a one-year gap can already obtain two-thirds of the full benefit of the parent-child relationship (3.9 out of 6.14). In contrast, the curvature of the inter-sibling relationship is flatter; firstborn children with a one-year gap lose only about one-third in the benefit of the inter-sibling relationship (5.3 out of 6.85). Since the marginal gain in the parent-child relationship more than offsets the marginal loss in the inter-sibling relationship, firstborn children with a one-year gap have the highest income. The subsequent decline in the outcomes for firstborn children is primarily driven by the diminishing benefits of the inter-sibling relationship.

[Figure 4 about here]

Lastly, we calculate the average sibling premium by integrating the fitted parametric model of income across the gap. The average sibling premium is found to be 0.49, which suggests that having a younger sibling increases average income by 63% (= exp(0.49) - 1).

DISCUSSIONS AND CONCLUSIONS

We discuss how our proposed framework enhances research on the only-child effect. Previous studies on this topic typically focus on the impact of sibling size rather than child spacing. The treatment variable employed is the only-child dummy. We estimate this model using our dataset. The OLS result for this regression model is -0.59, with a standard error of 0.03 and a t-value of -20.2. This suggests that being an only child is associated with a 45% decrease in income compared to firstborn children ($= 1 - \exp(-0.59)$). We use multiple births (twins) to instrument this treatment variable. Unfortunately, multiple births becomes a weak instrument in this context. The F-statistic drops from 13.8, the value obtained when instrumenting for child spacing, to 7.09. The standard error increases dramatically from 0.03 in the OLS to 0.49, resulting in an insignificant t-value of -1.01. This scenario highlights the prevalent issue of weak instruments, when a binary instrument is used for a binary treatment variable.

In summary, this study calculates a gap-specific only-child effect, demonstrating that firstborn children whose younger siblings are born six years or less apart earn higher lifetime income than only children. When the child spacing exceeds six years, there is no more notable difference between firstborn and only children. Having a younger sibling improves wage outcomes by an average of 63%. We explain this positive sibling premium using a conceptual framework that outlines the trade-off between parent-child and inter-sibling relationships. While

the benefits of the parent-child bond increase with child spacing – such as less competition for parental resources and a higher level of intellectual maturity – so does the loss in the sibling relationship, which results from the forgone sibling resources and scale economies. The hump shape of the sibling premium curve is determined by the combined marginal gain and loss from these two factors.

This study uses lifetime earnings as the outcome variable to examine the only-child effect. It is interesting to know in which way the cognitive and noncognitive performances of the only child during childhood and adolescence are linked to this long-term outcome as measured in adulthood. For this purpose, we investigate the literature of only children that was mentioned in the introduction. Only children perform worse than firstborns in many ways. For example, 43% of the research papers that measure personality reported negative results from only children, while only 17% of them found positive results (the remaining 40% found no significant effect). Results are even worse for psychological well-being, problematic behaviors, and social skills (see Table 5). The only exception is academic performance and cognitive ability, where over half of the research finds a positive only-child effect. Papers addressing endogeneity particularly follow a similar pattern, except a lower proportion of insignificant results. This finding suggests that, even though only children perform better academically and cognitively, their lower earnings are mostly due to their worse non-cognitive skills. It would be beneficial to investigate the role of these mediators in future research.

[Table 5 about here]

REFERENCES

Abele-Brehm, A. E. (2014). The influence of career success on subjective well-being. In Psychological, educational, and sociological perspectives on success and well-being in career development (pp. 7-18). Dordrecht: Springer Netherlands.

Bandura, A. (1977). Social learning theory. Engle-wood Cliffs, NJ: Prentice Hall.

Bennett, S. M., Litz, B. T., Lee, B. S., & Maguen, S. (2005). The scope and impact of perinatal loss: Current status and future directions. Professional Psychology: Research and Practice, 36(2), 180.

Black, S., Devereux, P., & Salvanes, K. (2005). The more the merrier: The effect of family size and birth order on children's education. The Quarterly Journal of Economics, 120(2), 669-700.

Blake, J. (1981). Family size and the quality of children. Demography, 18, 421-442.

Booth, A. L., & Kee, H. J. (2009). Birth order matters: the effect of family size and birth order on educational attainment. Journal of population economics, 22(2), 367-397.

Brody, G. H. (1998). Sibling relationship quality: Its causes and consequences. Annual review of psychology, 49(1), 1-24.

Buckles, K., & Munnich, E. (2012). Birth spacing and sibling outcomes. Journal of Human Resources, 47(3), 613-64

Cameron, L., Erkal, N., Gangadharan, L., & Meng, X. (2013). Little emperors: behavioral impacts of China's One-Child Policy. Science, 339(6122), 953-957.

Campbell, R. J., Jeong, S. H., & Graffin, S. D. (2019). Born to take risk? The effect of CEO birth order on strategic risk taking. Academy of Management Journal, 62(4), 1278-1306.

Chen, S., & Cheng, M. I. (2024). The Experience of Work–Family Conflict: Does Being the

Only Child Matter?. Journal of Family Issues, 45(12), 2966-2984.

Chen, Y., Swee, E. L., & Wang, H. (2023). Little emperors in the workplace: Labor market consequences of China's one-child policy. China Economic Review, 80, 101985.

Conger, K. J., & Little, W. M. (2010). Sibling relationships during the transition to adulthood. Child development perspectives, 4(2), 87-94.

Das Gupta, M., Zhenghua, J., Bohua, L., Zhenming, X., Chung, W., & Hwa-Ok, B. (2003). Why is son preference so persistent in East and South Asia? A cross-country study of China, India and the Republic of Korea. The Journal of Development Studies, 40(2), 153-187.

De Haan, M. (2010). Birth order, family size and educational attainment. Economics of

Ejrnaes, M., & Pörtner, C. C. (2004). Birth order and the intrahousehold allocation of time and education. Review of Economics and Statistics, 86(4), 1008-1019.

Howe, N., Recchia, H., & Kinsley, C. (2023). Sibling Relations and Their Impact on Children's Development.

Howell, R. T., & Howell, C. J. (2008). The relation of economic status to subjective well-being in developing countries: a meta-analysis. Psychological bulletin, 134(4), 536.

Ilciukas, J., Lundborg, P., Plug, E., & Rasmussen, A. W. (2025). The Only Child (No. 17641). IZA Discussion Papers.

Jia, C., Yang, Z., Xin, T., Li, Y., Wang, Y., & Yang, T. (2022). Differences in school performance between only children and non-only children: evidence From China. Frontiers in Psychology, 12, 608704.

Keenan, K., Barclay, K., & Goisis, A. (2023). Health outcomes of only children across the life course: An investigation using Swedish register data. Population studies, 77(1), 71-90.

Kitzmann, K. M., Cohen, R., & Lockwood, R. L. (2002). Are only children missing out?

Comparison of the peer-related social competence of only children and siblings. Journal of Social and Personal Relationships, 19(3), 299-316.

Lao, Y., & Lin, S. (2022). Comparison of educational performance between the only children and children in two-child families. Scientific Reports, 12(1), 15355.

Li, X., & Qiu, Y. (2021). Are more children better than one? Evidence from a lab experiment of decision making. China Economic Review, 69, 101653.

Lo, S. (2023). Do only children have lower quality? A study of the only-child effect on children's human and social capital development. Unpublished manuscript. DOI: 10.13140/RG.2.2.12524.33925.

Martens, E. P., Pestman, W. R., de Boer, A., Belitser, S. V., & Klungel, O. H. (2006). Instrumental variables: application and limitations. Epidemiology, 17(3), 260-267.

Murray, M. P. (2006). The bad, the weak, and the ugly: Avoiding the pitfalls of instrumental variables estimation. Available at SSRN 843185.

Pinquart, M., & Kauser, R. (2018). Do the associations of parenting styles with behavior problems and academic achievement vary by culture? Results from a meta-analysis. Cultural diversity & ethnic minority psychology, 24(1), 75.

Pörtner, C.C. (2016). Sex Selective Abortions, Fertility, and Birth Spacing. Fertility, and Birth Spacing (March 1, 2016).

Price, J. (2008). Parent-child quality time: Does birth order matter?. Journal of human resources, 43(1), 240-265.

Qian, N. (2009). Quantity-quality and the one child policy: The only-child disadvantage in school enrollment in rural China (No. w14973). National Bureau of Economic Research.

Sainani, K. L. (2012). Propensity scores: uses and limitations. PM&R, 4(9), 693-697.

Shi, J., Li, L., Wu, D., & Li, H. (2021). Are only children always better? Testing the sibling effects on academic performance in rural Chinese adolescents. Children and Youth Services Review, 131, 106291.

Skog, F. (2019). Sibling effects on adult earnings among poor and wealthy children evidence from Sweden. Child Indicators Research, 12(3), 917-942.

Song, S., & Wang, W. (2019). Testing the only-child advantage in cognitive development in the context of China's one-child policy. Population Research and Policy Review, 38(6), 841-867.

Tian, X., & von Cramon-Taubadel, S. (2020). Are only children in China more likely to be obese/overweight than their counterparts with siblings?. Economics & Human Biology, 37, 100847.

Wen, F. (2023). Assortative mating on only-child status and accumulation of economic advantages in contemporary China. Available at SSRN 4519501.

Whiteman, S.D., McHale, S. M., & Soli, A. (2011). Theoretical Perspectives on Sibling Relationships. Journal of Family Theory & Review, 3(2):124–139.

Xian, H., Atkinson, C., & Meng-Lewis, Y. (2022). How work–life conflict affects employee outcomes of Chinese only-children academics: the moderating roles of gender and family structure. Personnel Review, 51(2), 731-749.

Xu, R. (2021). On the instrument functional form with a binary endogenous explanatory variable. Economics Letters, 206, 109993.

Veenhoven, R., & Verkuyten, M. (1989). The well-being of only children. Adolescence: an international quarterly devoted to the physiological, psychological, psychiatric, sociological, and educational aspects of the second decade of human life, 24(93), 155-

166.

Yang, X., Hong, X., & Li, W. (2023). “Only children” and entrepreneurship in China: Spillover effects and mechanisms. Pacific-Basin Finance Journal, 79, 101994.

Yue, G., Chen, H., & Zeng, S. (2025). Imprint from early-life family environment: how do CEOs’ only-child backgrounds impact product innovation. Technology Analysis & Strategic Management, 37(11), 1541-1556.

Zajonc, R. (1976). Family configuration and intelligence. Science, 192:227-36.

Zeng, S., Li, F., & Ding, P. (2020). Is being an only child harmful to psychological health?: evidence from an instrumental variable analysis of China’s one-child policy. Journal of the Royal Statistical Society Series A: Statistics in Society, 183(4), 1615-1635.

Table 1: Descriptive summary of the variables.

Variable	mean	s.d.	min	max
Children's variables [a]:				
Log income	7.01	2.97	-2.49	11.3
Child spacing (month)b	56.2	43.3	0	325
Mothers' variables:				
Log family income	9.66	0.92	3.47	11.8
Working weeks per year	35.3	12.2	0	52
Highest grade completed	13.6	2.45	0	20
AFQT	39.3	26.2	1	99
Married (dummy)	0.46	0.30	0	1
Divorced (dummy)	0.17	0.23	0	1
Ideal number of children	2.87	1.27	0	15
Months between marriage and first birth	52.4	57.1	0	518
Age at first birth	23.5	5.81	14	62
Second birth's variables:				
Miscarriage between the first and second birth dummy)[b]	0.09	0.29	0	1
Abortion between the first and second birth (dummy)[b]	0.07	0.26	0	1
Second birth delivered within expected week (dummy)[b,c]	0.67	0.47	0	1

Notes: [a] There are 608 only children and 1416 firstborn with one sibling. [b] Variables not available for only children. [c] It is zero when the delivery is one week within the expected date and one otherwise.

Table 2: Two stage least square regression on child spacing (years) using multiple birth as instrument.

	First stage		Second stage	
Dependent variable [a]	Child spacing		Children's income	
Variable:	coeff.[b]	t-value	coeff.	t-value
Instrument:				
Twin (dummy)	-3.61 **	-3.71		
Mothers' variables:				
Highest grade completed	-0.10 *	-2.22	0.01	1.53
AFQT	-0.01 *	-2.15	0.003 **	4.63
Log income	-0.18	-1.14	0.05 *	2.27
Working weeks per year	0.02 **	2.71	-0.004	-2.95
Married (dummy)[c]	-1.32 **	-2.79	0.34 **	4.99
Divorced (dummy)[c]	-0.28	-0.55	0.13 *	2.07
Ideal number of children	-0.16 *	-2.12	0.03 *	3.36
Age at first birth	-0.05 *	-2.29	0.01 *	2.36
Months between marriage and first birth	0.01 **	3.88	-0.002 **	-5.48
Second birth:				
Miscarriage between 1st and 2nd birth (dummy)	2.20 **	7.17	-0.37 **	-5.42
Abortion between 1st and 2nd birth (dummy)	2.74 **	7.94	-0.56 **	-6.21
2nd birth delivered in expected week (dummy)	0.42 *	2.18	-0.03	-1.14
Other children's variable:				
Child spacing [d]			yes	
Gender	yes		yes	
Race	yes		yes	

Notes: [a] There are 1416 firstborn with sibling. [b] ** significant at 1% level, * significant at 5% level.

[c] The benchmark group is never married. [d] Results are provided in Table 3.

Table 3: Effect of child spacing on children income estimated by 2SLS.

	Without covariates [a]		With covariates	
Spacing: [b]	coeff. [c]	t-value	coeff.	t-value
0 year	1.02 **	5.48	0.80 **	4.12
1 year	1.51 **	5.65	1.29 **	4.75
2 year	1.47 **	10.1	1.18 **	7.24
3 year	1.31 **	11.6	1.05 **	8.21
4 year	0.88 **	7.87	0.65 **	5.43
5 year	0.42 **	3.75	0.26 **	2.27
6 year	0.53 **	4.67	0.43 **	3.78
7 year	0.31 **	2.62	0.18	1.46
8 year	0.17	1.33	0.08	0.64
Cumulative effect [d]	7.61 **	7.36	5.92 **	5.42

Notes: [a] There are 1416 firstborn with sibling. [b] The benchmark group is 9 - year gap. [c] ** significant at 1% level, * significant at 5% level. [d] The coefficient for all years are summed up to compute the cumulative effect.

Table 4: Nonlinear regression for the parametric effect of parent-child and inter-sibling relationships.

Dependent variable: [a]	Firstborn's income	
Parameters [b]:	coeff. [c]	t-value
Parent-child relationship:		
γ_1 (level)	6.14 **	133.23
γ_2 (curvature)	1.00 **	10.39
Inter-sibling relationship:		
γ_3 (level)	6.85 **	45.3
γ_4 (curvature)	0.57 **	17.8

Note: [a] There are 1416 firstborn with sibling. [b] The parameters are estimated using model (5). [c] ** Significant at 1% level.

Table 5: Meta analysis of only child literature.

Abilities [a]	Personality	Social skills	Problematic behaviour	Psychological wellbeing	Physical strength	Cognitive & academic performance
Number of papers [b]	30	21	12	44	20	24
Negative [c]	43%	33%	75%	50%	60%	25%
No effect [c]	40%	43%	8%	25%	30%	21%
Positive [c]	17%	24%	17%	25%	10%	54%

Note: [a] We include 128 papers published after 2014 in our sample. [b] Since some papers assessed more than one type of abilities, the sum of this row is 151, which is more than the number of papers. [c] These rows illustrate the percentage of papers that find positive, insignificant, or negative only-child effect.

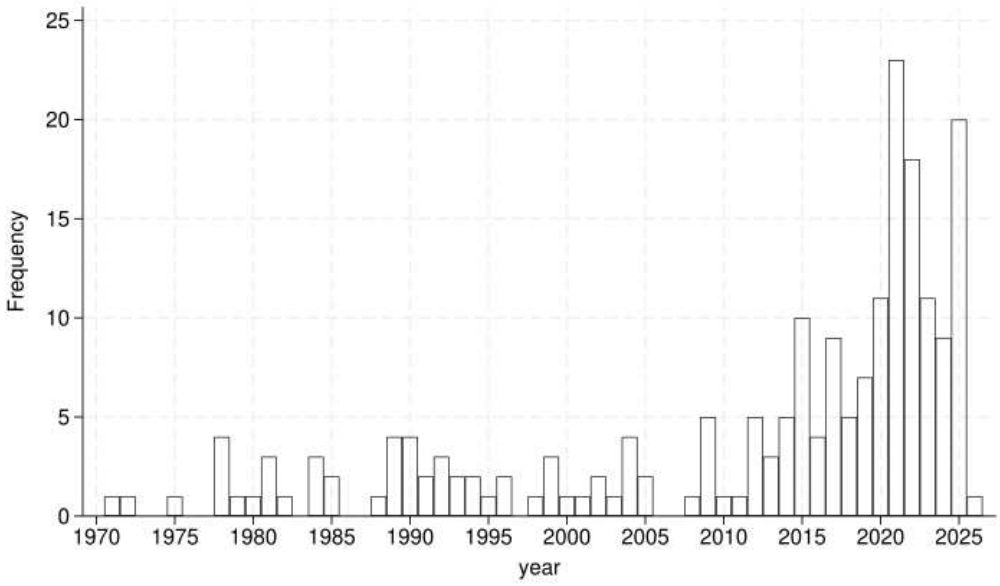
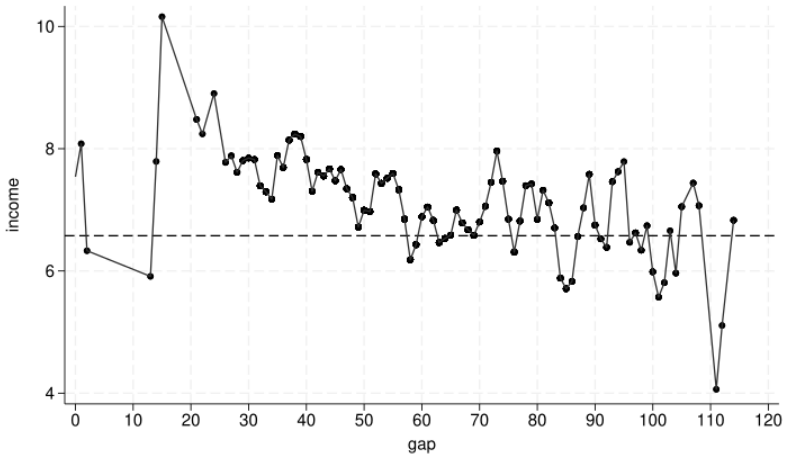
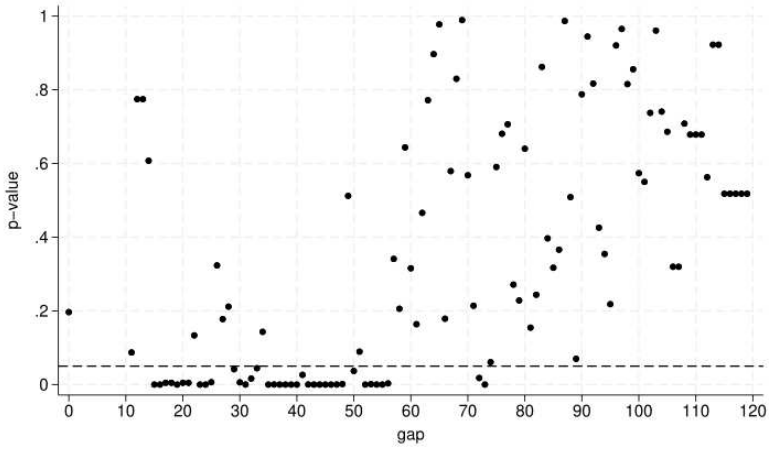


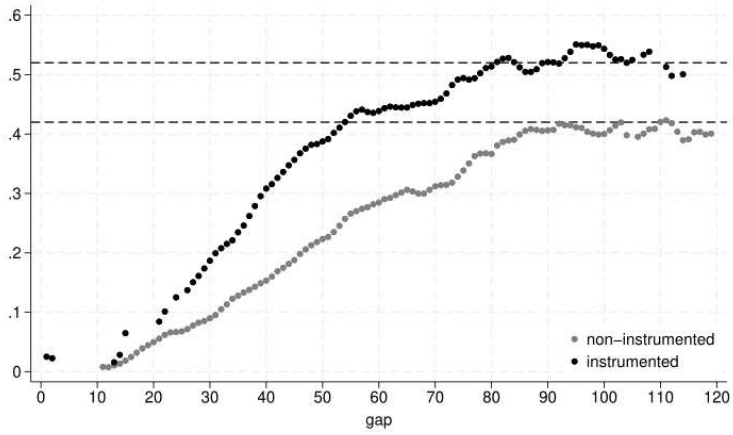
Figure 1: Number of published papers addressing only children.



(a) Sibling premium curve



(b) P-value for the difference between firstborn and only children.



(c) Cumulative sibling curve.

Figure 2: The estimated sibling premium curve.

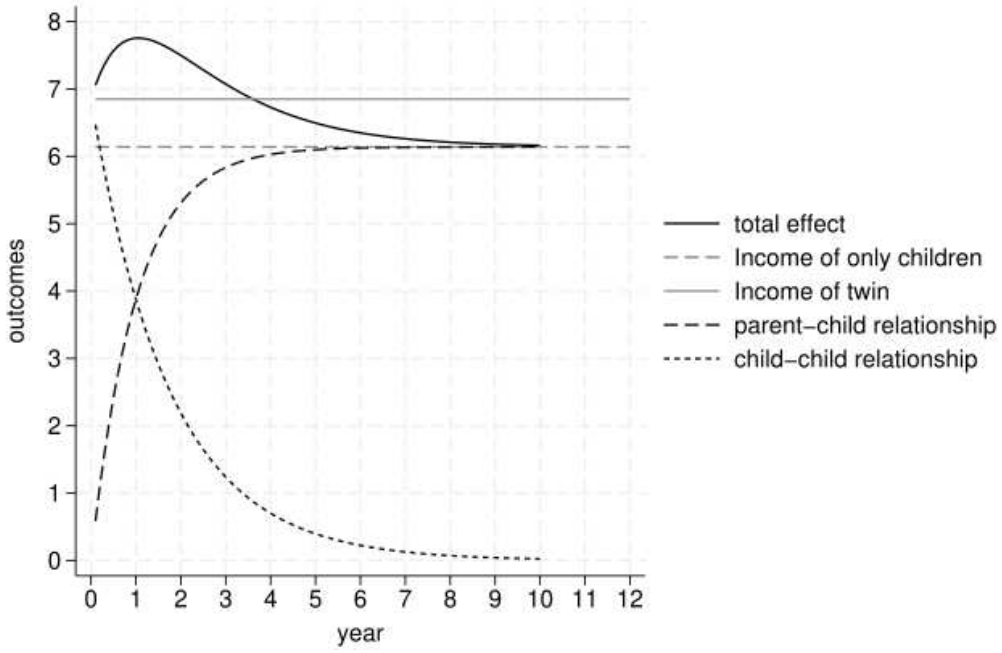


Figure 3: Theoretical effects of parent-child and intersibling relationships.

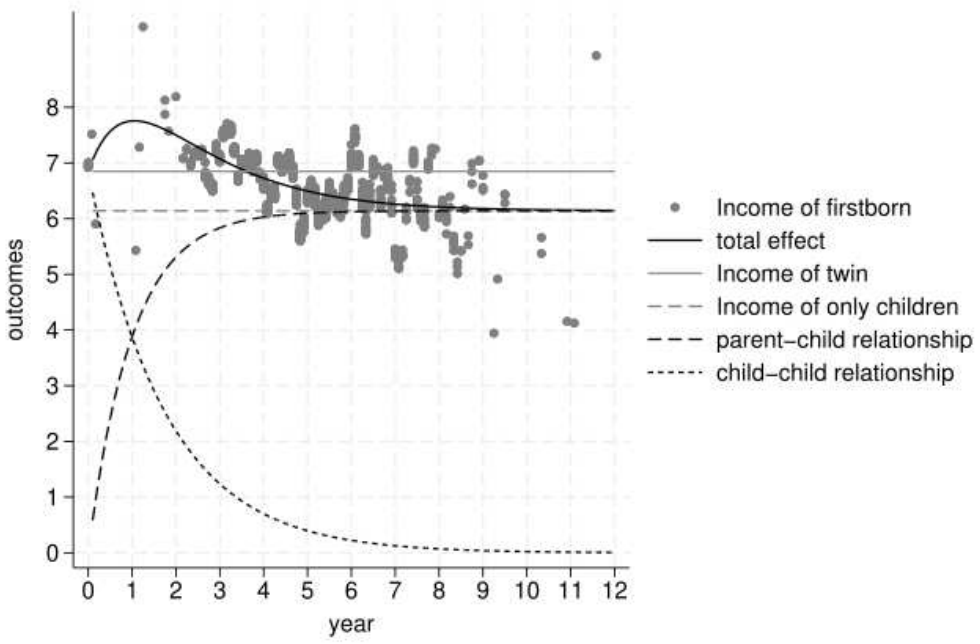


Figure 4: Estimated effects of parent-child and inter-sibling relationships.