Panel Data Research Center, Keio University

PDRC Discussion Paper Series

子どもの数と質（QQ）のトレードオフは母の教育水準に依存するか

暮石渉、若林緑、マッケンジー　コリン、坂田圭

2025 年 10 月 20 日

DP2025-004
https://www.pdrc.keio.ac.jp/publications/dp/10000/

Panel Data Research Center, Keio University
2-15-45 Mita, Minato-ku, Tokyo 108-8345, Japan
info@pdrc.keio.ac.jp
20 October, 2025

子どもの数と質（QQ）のトレードオフは母の教育水準に依存するか
暮石渉、若林緑、マッケンジー　コリン、坂田圭
PDRC Keio DP2025-004
2025 年 10 月 20 日
JEL Classification: I21; J13; J62
キーワード: 子どもの数と質のトレードオフ; 教育競争; 高校の偏差値

【要旨】

本研究は、日本における子どもの質と量に関するトレードオフ仮説（すなわち quantity-quality（QQ）仮説）を検証し、特に母親の教育水準が家庭内の教育資源配分と第 1 子の教育成果に果たす役割を明らかにすることを目的とする。分析には、厚生労働省および文部科学省が提供する「21 世紀出生児縦断調査（2001 年出生児、2001～2017 年）（LSN21）」を用い、第 2 子出産時の双子発生を家族規模の外生的変動として利用した 2 段階最小二乗法（2SLS）により推定を行った。　分析結果によれば、QQ トレードオフの大きさは母親の教育水準および世帯所得によって異なる。特に、高学歴の母親をもつ低所得世帯では、きょうだい数の増加が第 1 子の「質」（高校偏差値スコアで測定）を有意に低下させることが明らかとなった。この低下は、塾など学校外教育への支出の顕著な減少を伴っている。一方、母親が大学教育を受けていない世帯や高所得世帯では、有意な低下は確認されなかった。

暮石渉
東京都立大学 経済経営学部
〒192-0397
東京都八王子市南大沢1-1
wataru.kureishi@gmail.com

若林緑
東北大学 大学院経済学研究科
〒980-8576
宮城県仙台市青葉区川内27-1
midori.wakabayashi.d3@tohoku.ac.jp

マッケンジー　コリン
慶應義塾大学
〒108-0072
東京都港区白金1-25-11-910
mckenzie@keio.jp

坂田圭
オーストラリア家族問題研究所
〒3006
Level 4, 40 City Rd, Southbank, Victoria, Australia
kei.sakata@aifs.gov.au

謝辞：本研究に対して、Daniel Halim氏、田中隆一氏、ならびに以下の場でのセミナー参加者の皆様から貴重なご助言とご示唆をいただいた：2022年Society of Economics of the Household（SEHO）年次大会、2022年日本経済学会春季大会、第17回および第19回東アジア経済学会国際大会、関西労働ワークショップ、RoMacS Workshop VIII、Empirical Moral Science Workshop、東北大学でのセミナー、ならびに慶應義塾大学でのEconomics of the Family Workshop。また、本研究で用いたデータの提供を受けた厚生労働省に感謝する。特に、『21世紀出生児縦断調査（2001年出生児）』および『人口動態調査出生票』の利用を許可いただいた。さらに、高等学校名とその偏差値スコアの収集および照合に協力してくれた若林ゼミナールの学部生諸氏に深く感謝する。本研究は、日本学術振興会（JSPS）科学研究費補助金（基盤研究（B）[23K20151, 21H00721]）の支援を受けている。
また、第3著者は、日本学術振興会特別推進研究費による旅費助成 [22H04911] の支援を受けたことを付記して感謝する。

Does the Quantity–Quality Trade-off Depend on Maternal Education Levels?*

Wataru Kureishi[†] Midori Wakabayashi[‡] Colin McKenzie[§] Kei Sakata[¶]

17 October 2025

Abstract

This study examines the quantity–quality (QQ) trade-off hypothesis in Japan, focusing on how maternal education influences the allocation of educational resources and the educational outcomes of first-born children. Using data from the *Longitudinal Survey of Newborns in the 21st Century* (2001 Birth Cohort, 2001–2017) (LSN2001), we estimate a two-stage least squares (2SLS) model that exploits the occurrence of twin births at second parity as an exogenous variation in family size.

Our results indicate that the QQ trade-off varies by maternal education and household income. Among low-income households with highly educated mothers, an increase in sibling size significantly reduces the quality of the first-born child, as measured by the senior high school ranking score (*hensachi*). This decline is accompanied by a marked decrease in out-of-school educational expenditures. In contrast, no significant effects are observed among households with less-educated mothers or among high-income households.

JEL codes: I21, J13, J62

Keywords: quantity–quality trade-off; educational competition; senior high school ranking score (*hensachi*)

*We are grateful to Daniel Halim, Ryuichi Tanaka, and seminar participants at the 2022 Annual Meeting of the Society of Economics of the Household (SEHO), the 2022 Spring Meeting of the Japanese Economic Association, the 17th and 19th International Conventions of the East Asia Economic Association, the Kansai Labor Workshop, RoMacS Workshop VIII, the Empirical Moral Science Workshop, a seminar at Tohoku University, and the Economics of the Family Workshop at Keio University for their valuable comments and suggestions. We also thank the Japanese Ministry of Health, Labour and Welfare for providing the data used in this study, specifically the *Longitudinal Survey of Newborns in the 21st Century (2001 Births)* and the *Live Birth Form of Vital Statistics*. Special thanks are extended to members of the Wakabayashi undergraduate seminar for their assistance in collecting and matching senior high school names with their ranking scores. This research was supported by the Japan Society for the Promotion of Science (JSPS) Grants-in-Aid for Scientific Research (B) [23K20151, 21H00721]. The third author also acknowledges support from a JSPS Special Promotion Research Grant [22H04911].

[†]Tokyo Metropolitan University, Email: `wataru.kureishi@gmail.com` (Corresponding Author)

[‡]Tohoku University

[§]Keio University

[¶]Australian Institute of Family Studies

1 Introduction

The quantity–quality (QQ) trade-off in children is a key economic issue that examines how families balance the number of children they have with the resources allocated to each child to maximize their well-being (Becker, 1960; Becker and Lewis, 1973). Another important reason to study the QQ trade-off is the argument by Doepke and Tertilt (2016) that how much parents value the quality versus the quantity of their children can determine the long-run rate of economic growth. Empirical evidence shows that the QQ trade-off significantly affects educational attainment and economic outcomes in developing countries such as India (Rosenzweig and Wolpin, 1980) and China (Rosenzweig and Zhang, 2009), where limited household resources and insufficient public provision of education constrain opportunities.

In developed countries, understanding the QQ trade-off is also critical, particularly in light of declining birth rates and the role of pro-natalist policies aimed at influencing children's human capital. While many studies validate the QQ trade-off in developing countries, evidence supporting it in developed countries is scarcer (Devereux et al., 2005; Angrist et al., 2010). Three key differences between developed and developing countries may explain these divergent outcomes: the universal provision of public education in developed countries; the presence of child labor laws; and lower average incomes in developing countries, which likely make credit or liquidity constraints binding for a larger share of the population.

An increase in family size raises demands on both parental time and financial resources, potentially leading to a QQ trade-off. In theoretical models of the QQ trade-off, as households are allowed to engage in activities such as saving or adjusting their labor supply, the range of options available to mitigate the trade-off expands. One way to relax financial constraints (though not time constraints) is for either the husband or wife to increase labor supply in response to a larger family. However, using a compiled dataset covering 441 data sets from 1787 to 2015, Aaronson et al. (2021) find that the impact of fertility on mothers' labor supply is negligible in low-income countries but becomes significantly negative in more developed economies. This suggests that, in wealthier settings, increased fertility further constrains the resources available for children. This pattern is consistent with mothers in developing countries responding to an increase in family size by minimizing adjustments to their working hours in order to stabilize household finances. An alternative interpretation is that, given tight budget constraints, mothers in developing countries cannot afford to withdraw from the labor market because the opportunity cost is too high.

Taken at face value, this evidence implies that—within the standard QQ framework assuming identical quality levels across children (Becker and Lewis, 1973)—the trade-off embedded in a household's budget constraint may actually be steeper in developed countries. Given the substantial income differences between developing and developed economies, the average household budget constraint in developed countries will lie much farther from the origin.

Among studies focusing on developed countries, Mogstad and Wiswall (2016) emphasize the nonlinearity of the QQ relationship and highlight heterogeneity in its effects. Using administrative data covering the entire Norwegian population, they find that the QQ trade-off becomes apparent only at relatively high levels of fertility. Building on this line of inquiry into the sources of heterogeneity, our study explicitly examines two related but distinct dimensions of heterogeneity in the QQ trade-off: maternal education—a factor that has received limited empirical attention—and household income. Ignoring such heterogeneity in estimation generally leads to biased estimators and invalid inference. Our research hypothesis is that the QQ trade-off varies with maternal education levels and is stronger among low-income households. We also focus on a different aspect of child quality by using children's ranking scores on their senior high school entrance examinations in Japan, thereby providing new evidence on post-compulsory educational outcomes.

Private expenditure on education ("shadow education") and parental time investments can significantly shape children's educational outcomes. The growing importance of private educational services[1] underscores the need to consider both financial and time-related inputs. As competition for university admission intensifies, socio-economic disparities—particularly those associated with maternal education—play an increasingly important role in determining levels of educational preparation. This raises the question of how an increase in the number of children affects families differently depending on the mother's level of education. Our paper examines the extent to which the QQ trade-off is influenced by maternal education and explores the role of budget constraints in shaping educational investments. The existence of a QQ trade-off that depends on maternal education (and household income) suggests that such heterogeneity may be an important source of inequality among children.

In Japan, gaining admission to a prestigious university is widely regarded as a prerequisite for obtaining high-income employment and social success, leading to intense competition in university entrance examinations (Dore, 1976). In recent years, this competition has begun even earlier, with many students attending private cram and preparatory schools from as early as age 13 to prepare for admission to highly selective schools (Tsuneyoshi, 2013). This preparatory process places immense pressure on students and imposes substantial financial and time burdens on parents (Entrich, 2018).

In Japan, mothers are often expected to bear the primary responsibility for their children's education and care, investing considerable time and effort in these activities. This expectation frequently restricts mothers' labor market participation and career advancement. Japanese households also shoulder a large share of education costs—particularly at the preschool and tertiary levels—covering 55.0% and 64.8% of total expenditures, compared with the respective OECD averages of 18.3% and 30.0% (see Tables B3.2a and B3.2b in OECD (2012)). These figures exclude substantial out-of-school expenditures, such as cram school fees, which average 360,000 yen (approximately $2,400) per year for third-year junior high school students.[2]

Although universal education is provided up to grade 9 (around age 15), the substantial private outlays for out-of-school education make Japanese households a compelling context for examining the QQ trade-off in a developed country setting. This study focuses on heterogeneity in the QQ trade-off by maternal education level. Previous research may have found limited evidence of a QQ trade-off in developed countries partly because it did not explicitly account for heterogeneity in parental education

[1]In Japan, the *Nihon Keizai Shimbun* (16 August 2025) reports record-high per capita spending on cram schools for children in primary and junior high school. See also Ministry of Education, Culture, Sports, Science and Technology (MEXT) (Japan) (2010).

[2]All yen amounts are converted to U.S. dollars using a fixed exchange rate of 150 yen per dollar.

or household resources (cf. Mogstad and Wiswall (2016)).

Building on this insight, we hypothesize that the QQ trade-off is more pronounced among children of highly educated mothers. These mothers typically have greater access to educational resources and opportunities, enabling their children to attend high-quality cram schools and elite private institutions. In contrast, children of less-educated mothers often face restricted access to such opportunities (Kariya, 2011). There are also large differences in educational aspirations across Japanese households depending on maternal education. Using data from the *Longitudinal Survey of Newborns in the 21st Century (2001 Births)* conducted by the Ministry of Health, Labour and Welfare (MHLW), we examine parental expectations when children are in the third year of junior high school (just before high school entry). Among college-educated mothers, 70% (8,763 out of 17,203) aspire for their children to obtain a college degree, whereas only 41% (3,296 out of 8,084) of non-college-educated mothers report the same aspiration. A two-sample t-test indicates that this difference is highly significant ($t = 43.82$, $p < 0.001$). These findings underscore the sharp divide in parental expectations for their children's educational attainment by maternal education level.

Using data from the LSN2001 and a two-stage least squares (2SLS) estimator with twin births at the second parity as an instrument for the number of siblings, we estimate the causal effect of family size on the educational outcomes and resource allocations for first-born children. By focusing on first-borns, we exploit the exogenous variation generated by the subsequent birth of twins. Our analysis examines how an increase in sibling size affects outcomes such as out-of-school education expenditures for the first child, total child-related expenses, study time, and the amount of time the child spends with parents.

This study contributes to the literature in three main ways. First, it challenges the prevailing view that the QQ trade-off is primarily a phenomenon of developing countries by providing evidence that it also exists in Japan. Second, it uses a high-quality, objective measure of educational attainment—the senior high school ranking score (*SHSRS*)—to capture heterogeneity among children with similar years of schooling. Third, it investigates how maternal education influences the magnitude and dynamics of the trade-off.

We find that in households with highly educated mothers, the addition of another sibling results in a 3.0-point decline in the *SHSRS* for the first child, equivalent to 0.3 standard deviations, whereas no significant change is observed for first-borns in households with less-educated mothers. Moreover, among college-educated mothers, adding one sibling reduces monthly out-of-school education expenditures by approximately 3,000 yen (roughly $20), representing 23% of the average out-of-school spending (13,000 yen). It also decreases total child-related expenses by about 5,200 yen ($34), equivalent to around 10% of these expenses (50,000 yen). For mothers without college degrees, this effect is evident only for out-of-school education expenditures. These results confirm that the QQ trade-off depends on maternal education, with stronger effects observed among households in which mothers have higher education levels.

Our findings, consistent with our research hypothesis, indicate that the QQ trade-off is most pronounced in households where the mother has a college degree but faces tight budget constraints. Among college-educated mothers, an increase in sibling size reduces educational investments and school selectivity for the first child when household income is relatively low (below the median level). However, this effect is mitigated in households with relatively high (above-median) income, suggesting disparities in educational opportunities shaped jointly by income and education.

The implications of our findings extend beyond the Japanese context. In the United States and the United Kingdom, highly educated parents spend more time with their children (Guryan et al., 2008; Kalil et al., 2024) and possess greater financial resources for education (Kornrich and Furstenberg, 2013). Competition for educational advantages is also intense among parents with higher academic qualifications (Bound et al., 2009; Ramey and Ramey, 2009; Borra and Sevilla, 2019). These patterns suggest that the QQ trade-off is likely relevant in other developed countries, where parental education and economic status significantly influence children's educational opportunities and investments.

The remainder of this paper is organized as follows. Section 2 provides an overview of the Japanese education system and explains the construction of the senior high school ranking score used as a measure of child quality. Section 3 presents the theoretical framework linking parental education, household income, and the quantity–quality (QQ) trade-off, and describes the empirical strategy. Section 4 introduces the data, variable definitions, and sample selection procedures, and reports descriptive statistics. Section 5 discusses the main empirical findings, including heterogeneity by maternal education and income level. Finally, Section 6 summarizes the results and offers concluding remarks.

2 Education System in Japan

2.1 School Entrance Examinations and High School Selectivity

For most students in Japan, the schooling system follows a 6–3–3–4 structure: six years in primary school, three years in junior high school, three years in senior high school, and four years in university.[3]

In Japan, children must begin primary school in the academic year starting after their sixth birthday and must remain enrolled until the end of the academic year in which they turn fifteen. All children thus receive nine years of compulsory education—six years of primary school and three years of junior high school. Attendance in post-compulsory education is exceptionally high: approximately 97% of junior high school graduates continue to some form of senior high school.

The extent to which Japanese students are free to attend the senior high school of their choice depends on several factors. For private schools, students are free to apply anywhere, provided they can gain admission. For public schools, however, eligibility often depends on the student's prefecture of residence, as some prefectures still apply school zoning policies that restrict school choices to specific geographic areas within the prefecture. The decision to maintain or abolish school zoning is left to

[3] When the junior and senior high schools form an integrated high school, the system becomes a 6-6-4 system. There are integrated high schools where there is either no entrance examination or only a simple examination to advance from grade 9 to grade 10, and integrated schools that implement entrance exams for students who wish to join the senior high school portion from outside, even if many integrated junior and senior high schools require entrance examinations at grade 7 (the beginning of junior high school). Parents and children often choose integrated high schools because they are attracted to the advantage of completing six years of education without the need to prepare for an entrance exam in year 9. According to the School Basic Survey conducted by the MEXT, there were 604 integrated junior and senior high schools in Japan in 2016, accounting for approximately 5.4% of all 11,252 junior high schools nationwide. In our analysis, integrated junior and senior high schools are excluded from the sample.

the discretion of each prefectural government.

As shown in Figure 1 of Ogawa et al. (2024), between 2003 and 2017 roughly half of Japan's 47 prefectures completely abolished school zoning, allowing students in those prefectures to attend any public senior high school within the prefecture, provided they pass the school's entrance examination. Even in prefectures where zoning remains, students can usually choose among multiple schools within their designated zone.

2.2 The Senior High School Ranking Score (*SHSRS*)

The key variable used in this paper to measure the quality of a child's education is the Senior High School Ranking Score (*SHSRS*) of the school the child attends. The *SHSRS* reflects both the difficulty of gaining admission to a senior high school and its level of academic selectivity. In Japan, major private cram schools administer nationwide and regional mock entrance examinations to calculate *SHSRS*—commonly known as the *hensachi*, or "deviation score"—for each examinee (mean = 50, standard deviation = 10). Each high school's ranking score is then determined based on the aggregate of individual students' scores (Goodman and Oka, 2018).

In principle, *SHSRS* scores are available for both schools and individual students who have taken these mock examinations. However, because we do not have access to individual-level *SHSRS* data, we use the *SHSRS* of the senior high school the student actually attends as a proxy for the student's own *SHSRS*. This measure can be interpreted as a lower bound of the student's true score.[4] A *SHSRS* of 50 represents a school of average difficulty, while scores above 60 indicate a highly selective school that is substantially more difficult to enter.

Empirical evidence shows that attending a high school with a high *SHSRS* is associated with a greater likelihood of university admission (Oshio et al., 2010), and that attending a university with a high ranking score improves subsequent employment opportunities (Abe, 2002). The *SHSRS* provides a reliable measure of academic achievement, as it contains less measurement error than self-reported performance indicators. It offers an objective and standardized assessment of a high school's academic rigor and selectivity. Moreover, its widespread recognition and use in Japan's education system enhance its credibility as a measure of educational quality. Using the *SHSRS* also helps mitigate potential biases that may arise when using less standardized indicators of school quality.

2.3 The Role of Out-of-School Education and Parental Involvement

2.3.1 Out-of-school Education (Shadow Education) Expenditure

Investment in out-of-school (shadow) education is perceived as critical for academic success among Japanese parents. Out-of-school education includes activities outside formal schooling aimed at enhancing academic progress, such as mock exams, correspondence courses, and attendance at cram schools, which complement formal education to improve university admission success rates. According to a survey by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) conducted

[4] One possible way to address this discrepancy would be to follow the stochastic frontier literature and incorporate a one-sided error term. The challenge lies in addressing the endogeneity of sibling size.

in 2008, out-of-school educational spending accounts for more than 60% of the average annual total spending on education-related items for public primary and junior high school students, 307,000 yen ($2,050) and 480,000 yen ($3,200), respectively. For private school students, the share is lower due to higher tuition fees, yet remains approximately 40% for primary and 25% for junior high school students, out of total education-related expenses of 1.39 million yen ($9,270) and 1.24 million yen ($8,270), respectively. Additionally, 25.9% of primary and 53.5% of junior high school students attend cram schools (Ministry of Education (Japan) (2008)), highlighting the widespread reliance on shadow education. Therefore, this study also focuses on out-of-school education expenditure and the time spent studying outside school, such as at cram schools or home study, as key variables to measure educational investment in children.

2.3.2 Parental Involvement

Parents' enthusiasm plays a key role in their children's education, particularly through mothers' active support and engagement in their academic progress (Sakaguchi, 2010). The term "education mama," or *kyoiku mama* in Japanese, has been used for many years to describe such mothers in Japan (Holloway et al., 2010).

Analyzing data from the Japanese General Social Survey (JGSS), Tanaka and Yamamoto (2009) find a negative impact of maternal employment on a child's years of education in Japan, with variations depending on the mother's employment type (full-time, part-time, or self-employment) and the child's gender. Among the three mechanisms connecting maternal employment and children's educational outcomes—the income effect, the role model effect, and the reduced care effect—the evidence presented by Tanaka and Yamamoto (2009) supports the role model effect.

Therefore, this study includes information about a mother's employment status when explaining educational outcomes. It also analyzes the time parents spend with their children as a measure of educational investment.

3 Theoretical Framework and Empirical Model

3.1 Mother's Education Level and the QQ Trade-off

We build on Becker and Lewis (1973), who suggest that increased parental education can reduce the "price" of quality, leading to a steeper trade-off between the quality and quantity of children. Although not directly addressing parental education levels, the model of the QQ trade-off developed by Rosenzweig and Zhang (2009) provides five channels through which parental education might influence this trade-off: (a) differences in the price of quality for the first child, as described by Becker and Lewis (1973); (b) differences in the price of quality for subsequent children (including twins); (c) economies of scale in producing quality for subsequent children; (d) differences in the production function linking child quality to resources and endowments; and (e) differences in parental preferences for educational quality.

Another possible channel is variation in beliefs about the returns to education—that is, differences in beliefs about the production function linking child quality to resources and endowments (see Delavande 2022). In Rosenzweig and Zhang (2009)'s model, where family utility depends separately on the quality of the first and subsequent children, it can be shown that (a) leads to a shallower trade-off, whereas (b) and (c) lead to a steeper trade-off. For (d) and (e), the trade-off varies with parental education levels, but it is ambiguous whether the trade-off will be steeper or shallower. We speculate that (c)–(e) are the main sources of the observed heterogeneity in QQ outcomes in Japan.

For the QQ trade-off, measuring a child's "quality" is a crucial issue. One of the quality production functions assumed by Rosenzweig and Zhang (2009) takes the form:

$$h = h(Z, e), \tag{1}$$

where h is the quality of the child, Z is the amount of resources devoted to the child, and e is the child's endowment. It is assumed that $\partial h/\partial Z > 0$ and $\partial h/\partial e > 0$. The quantity or quality of human capital is often used as a measure of the "quality" of a child; for example, the years of schooling are the most commonly used indicator of a child's (and an adult's) human capital.

The number of years of schooling is easy to quantify, as it reflects participation in formal education, but it often clusters around milestones such as high school and university graduation. These graduations are significant markers of formal educational attainment, as explored by Rosenzweig and Wolpin (1980), Devereux et al. (2005), and Black et al. (2010). However, these indicators may not fully capture the quality of education or the skills acquired through the process of being educated.

For the sample analyzed in this paper, in which all children were born in 2001 (either in January or July), using the years of schooling to measure "quality" would imply there is no variation in child quality at the end of compulsory education. This study therefore uses the *SHSRS* of the senior high school attended by each student to measure educational quality.

Conley and Glauber (2006) and Cáceres-Delpiano (2006) use a binary variable (0–1) to indicate the quality of education, based on the choice of attending a private school in the United States. However, a comparison of the distributions of the *SHSRS* for private and public schools in our sample suggests that it is inappropriate to say that the quality of private schools is higher than that of public schools in Japan.[5] Unlike this binary variable, our *SHSRS* indicator, which measures the selectivity and difficulty of schools, is continuous and can therefore better capture variation in the educational environment.[6]

One measure of Z in Equation 1 that we can use is parents' spending on their children's education (educational expenditure). As Equation 1 indicates, this provides an indirect indicator of child quality.

[5] The distributions of *SHSRS* for public and private schools are presented in Figure OSM1 in the Online Supplementary Material, and some basic descriptive statistics for both types of schools are contained in Table OSM5.

[6] Children's human capital also encompasses additional dimensions, such as health status and cognitive/non-cognitive abilities. Physical health indicators, such as body mass index (BMI) relative to age and height, also reflect children's human capital, influencing their learning and productivity. However, these indicators are subject to external factors such as genetics and socioeconomic status (Millimet and Wang, 2011). Cognitive abilities (e.g., IQ or test scores) provide insights into intellectual development, and non-cognitive abilities (e.g., social behavior, emotional regulation) are crucial for long-term success (Aizer and Cunha, 2012), though these are harder to measure consistently across contexts. Appendix E of the Online Supplementary Material presents evidence that there is no significant impact of sibling size on two health measures—the number of outpatient and inpatient visits by the first child—regardless of the mother's education level.

If a QQ trade-off exists, it is expected that as the number of children in a family increases, the amount spent on each child's education decreases. This is particularly due to the fact that parents' ability to invest in education—including spending on informal learning and shadow education (such as tutoring and cram schools)—is limited by their available financial resources.

For example, Lee (2008) show that an increase in the number of children in a family leads to a decrease in educational expenditures in South Korea.

In addition, inputs such as educational expenditures are directly related to parental decision-making, which is useful in measuring the impact of families on child quality. This is because inputs, rather than outcomes, are located at a more direct stage in the causal relationship (Cáceres-Delpiano, 2006).

Besides expenditures on out-of-school education for children, three other possible variables that could be included in Z are: (1) total spending on the child, (2) the amount of time the child spends studying outside of school, either at home or at a cram school, and (3) the amount of time parents spend with the child (see, for example, Guryan et al. 2008).

3.2 Empirical Model

This study analyzes how the number of children affects specific outcomes for the first child, including the *SHSRS*, out-of-school education expenditures, total child-related expenses, study time, and parental time investment. Specifically, we compare first-born children of college-educated mothers with those whose mothers lack a college degree. This approach allows us to explicitly investigate how the QQ trade-off depends on maternal education levels. We also employ different estimation methods for school selectivity and for the other variables, depending on the nature of the available data.

3.2.1 School Selectivity (Academic Achievement)

We use the *SHSRS* to measure the difficulty of entering the high school attended by the child. Because it is available only in Wave 16 of the survey, we assume the following cross-sectional model for the *SHSRS*:

$$academic\_score_i = \beta_{10} + \beta_{11} size_i + \mathbf{X}_i \beta_{12} + \varepsilon_{1i}, \tag{2}$$

where $academic\_score_i$ denotes the selectivity level of the high school attended by the first child in family i, as measured by the *SHSRS*. $size_i$ denotes the number of siblings of the first child in family i, defined as the maximum number of younger siblings born between 2001 and 2016. $\mathbf{X}_i$ is a vector of control variables, including the characteristics of the first child (gender, birth month, length of pregnancy in weeks, and birth weight in kilograms), maternal characteristics (mother's age when the child is around age 15 and its square, the number of cigarettes the mother smoked just after the birth and its square, and the mother's labor force participation before the birth), and other household characteristics (father's age when the child is around age 15 and its square, the father's education level, single-mother status, co-residence with grandparents, and municipality size[7]), as well

[7]Municipality is used to cover the Japanese term *shichōson*, which directly translates to "city," "town," or "village."

as prefecture dummies.

Variables such as the characteristics of the first child are considered to be direct determinants of the outcome variables. ε_{1i} is an error term.[8]

This study focuses on estimating the coefficient of $size_i$, β_{11}, which reflects the average treatment effect of having additional siblings on the selectivity level of the high school attended. Standard errors are clustered at the municipality level to account for possible correlations in the error term within municipalities, due to the critical role that geographic access and municipality-specific institutional features play in the context of high school choice in Japan.

3.2.2 Household Investments

Next, we investigate household investments in children using a panel framework to take advantage of the longitudinal data available. This approach allows us to capture temporal changes and account for unobserved heterogeneity in household behavior. To do so, we assume the following panel data model:

$$y_{it} = \beta_{20} + \beta_{21} size_{it} + \mathbf{X}_{it}\beta_{22} + \eta_i + \varepsilon_{2it}, \tag{3}$$

where y_{it} represents various out-of-school educational inputs for child i at time t: (i) total expenditure on child i; (ii) expenditures on out-of-school education for child i; (iii) child i's out-of-school study time; and (iv) child i's time spent with their parents (measured separately for the father and mother, on weekdays and weekends, respectively). $size_{it}$ denotes the number of siblings that child i has at time t, capturing how the number of siblings changes over time. η_i represents time-invariant random individual effects, reflecting unobserved individual-specific attributes that influence educational inputs, and ε_{2it} denotes the idiosyncratic error term.

In this equation, the variables in $\mathbf{X}_{it}$ in Equation (3) are the panel equivalents of those in $\mathbf{X}_i$ in Equation (2). When the dependent variable is an expenditure variable, we also include household income prior to the child's birth as an explanatory variable. In earlier research examining the effects of birth order and gender on parental financial allocations to a child, we used current income as an explanatory variable (Sakata et al., 2022). Here, since current income is potentially a "bad control" because it may change as a result of changes in family size, we instead use pre-natal income—that is, the household's income level in the year prior to the birth of the first child (Angrist and Pischke, 2009).[9]

[8] It might appear incongruent to include a single-mother dummy, the father's age and its square, and information about the father's education level. Information on the father's age is available in Wave 1 (2002), and information on the father's education level is available in Wave 2 (2003), so even if the father is not present after Wave 2, this information remains available. The single-mother dummy is computed using the information in each wave on whether the father is living with the family and, if not, whether he is living away from home for work reasons. A household is deemed to be a single-mother household if the father is not living with the family and is not living away from home for work reasons.

[9] In Equation (3), we include parental age (both the father's and mother's age) as control variables to capture life-cycle effects, whereby the number of siblings tends to increase over time as part of the family formation process. Parental age directly reflects the family's life stage and is highly correlated with year dummy variables, raising concerns about multicollinearity. The estimates using parental age are nearly identical to those using year dummies in our data. For robustness, we adopt the specification that includes parental age.

3.3 Instrumental Variable Estimation

Becker and Lewis (1973)'s model of the QQ trade-off assumes that both the number of children and the average quality of the children are household choice variables. Therefore, an endogeneity issue is expected when estimating a QQ-related model. As a result, the variables $size_i$ and $size_{it}$ in Equations (2) and (3), respectively, may be correlated with the error terms ε_{1i} and ε_{2it}, leading to biased and inconsistent estimates. For instance, parents who highly value their children's education may prefer to invest significant time and resources in each child. To enhance their children's educational quality, such parents might opt to have fewer children. This behavior creates a reverse causal relationship: the desire to invest in education influences the decision to limit family size, rather than family size independently affecting educational investment.

To address this endogeneity issue, we employ an instrumental variable (IV) estimator, using twins at the second birth as the instrument for sibling size: $twin_i$ in the cross-sectional regressions and $twin_{it}$ in the panel models. Our choice of an instrument for the number of siblings aligns with the existing literature on the effects of fertility and family size, particularly the use of twins as an instrumental variable (e.g., Rosenzweig and Wolpin, 1980; Angrist et al., 2010). For the cross-sectional analysis, the first-stage regression for child i is specified as:

$$size_i = \alpha_{30} + \alpha_{31} twin_i + \mathbf{X}_i \alpha_{32} + \varepsilon_{3i}, \tag{4}$$

where $twin_i$ is a dummy variable that equals 1 if the second birth is a twin or higher-order multiple, and 0 if it is a single birth. The combination of Equations (2) and (4) enables us to estimate Equation (2) using a two-stage least squares (2SLS) estimator.

For the panel analysis, the first-stage regression equation is:

$$size_{it} = \alpha_{40} + \alpha_{41} twin_{it} + \mathbf{X}_{it} \alpha_{42} + \eta_{4i} + \varepsilon_{4it}, \tag{5}$$

where $twin_{it}$ is a dummy variable that equals 1 if the second birth that occurs up to and including time t is a twin or higher-order multiple, and 0 otherwise. Once the variable becomes 1, it remains constant for the rest of the sample. η_{4i} and ε_{4it} denote a time-invariant individual random effect and an idiosyncratic error term, respectively. The combination of Equations (3) and (5) enables us to estimate Equation (3) using a random effects instrumental variable (REIV) estimator.[10]

One of the conditions for an instrument to be valid is that it must be uncorrelated with the error term in the outcome equation, that is, ε_{1i} in Equation (2) and ε_{2it} in Equation (3), respectively. In past studies, twins born at the second birth have been treated as an unexpected addition, potentially serving as a quasi-natural experiment (Rosenzweig and Wolpin, 1980), which allows us to use twins as an instrumental variable to estimate the average treatment effect of sibling size on educational investment. Technological innovation in assisted reproductive technology (ART) since Rosenzweig and Wolpin (1980)'s study has significantly increased the number of ART-related births in Japan.

In our sample of first-born children with siblings born in 2001, 79% (nearly 100%) of these children

[10] In theory, it would be possible to estimate Equation (3) using a fixed effects instrumental variable (FEIV) estimator. However, the small number of non-zero observations for $twin_{it}$ makes it difficult to obtain robust estimates.

have a sibling within 3 (5) years. In Japan, ART was not common in the early 2000s. For example, in 2001, there were only 13,158 births from ART, including in-vitro fertilization (IVF), representing only 1.1% of the 1,170,662 births in that year (Ishihara et al., 2021). Since then, the number has sharply increased, reaching 8.6% in 2021 (69,797 out of 811,604 births). The probability of multiple births with ART is significantly higher than with natural conception. For example, using the available data for 2019 published in Katagiri et al. (2022), the probability of an ART treatment leading to multiple births is estimated to be around 2.7%. Another concern is that twin births induced by infertility treatments, such as IVF, may be correlated with the socioeconomic characteristics of mothers (Farbmacher et al., 2018). However, the use of ART soon after first births in 2001 is unlikely to have significantly affected the number of twins.

Recent studies have raised additional concerns about the validity of the twin instrument. For example, Bhalotra and Clarke (2019) argue that even if twinning at conception is random, the likelihood of live twin births may be associated with positive maternal health behaviors, which are in turn correlated with maternal education and other socioeconomic factors. There are three variables that may affect both the probability of having twins at the *second birth* and child outcomes: the mother's college-degree dummy, the mother's smoking behavior prior to the *first* birth, and the mother's age at the time of the *first* birth. The mother's college-degree dummy directly incorporates maternal education. However, the only information we have on children in the family who are not the subject of the survey is their gender, birth month, and birth year. Smoking behavior prior to the *first* birth and the mother's age when the child is around 15 are used as proxy variables for the mother's health behavior prior to the *second* birth and her age at the time of the *second* birth, respectively.[11] Since 79% of our sample of first-born children have siblings within 3 years of their birth, the observed variables for the first birth are likely to be correlated with the unobserved variables for the second birth.

We follow the approach of previous influential studies (e.g., Angrist et al., 2010; Aaronson et al., 2021) and emphasize that our results should be interpreted as *Local Average Treatment Effects* (LATE), identifying the causal effect of an exogenous increase in family size specifically for families whose fertility was affected by the birth of twins at the second parity.

A further requirement for instrumental variable estimation is that the instrument be correlated with the endogenous variable of interest, which in this study is the number of siblings. Limiting the sample to second births guarantees that twins at the second birth lead to a family size of at least three. The expected magnitudes of α_{31} in Equation (4) and α_{41} in Equation (5) depend on whether the desired number of children is two, or three or more. If the desired family size is two, the twin coefficient is expected to be close to one, whereas if the desired number is three or more, the expected twin coefficient is considerably smaller and closer to zero.

According to the National Institute of Population and Social Security Research,[12] the average number of children born to Japanese couples married for 15–19 years was 2.09, with three-quarters of

[11] It should be remembered that all the children are born in the same year, so measuring the mother's age when they are 15 is basically equivalent to measuring it at age 3, with only a slight difference in the intercept.

[12] National Institute of Population and Social Security Research (2015). *The 15th Japanese National Fertility Survey (Dai 15 kai shussei doko chosa)* (in Japanese). Accessed 7 December 2024. Available at: `https://www.ipss.go.jp/ps-doukou/j/doukou15/gaiyou15html/NFS15G_html07.html`.

couples having two or fewer children. Therefore, if the actual number of children proxies well for the desired number, our estimates of α_{31} in Equation (4) and α_{41} in Equation (5) are expected to be close to one. That is, twins at the second birth are likely to lead to an increase in family size beyond the desired level.[13]

4 Data

4.1 The Longitudinal Survey of Newborns in the 21st Century (2001 Births)

This study uses data from the first 16 waves (2001–2017) of the Longitudinal Survey of Newborns in the 21st Century (2001 Births) (LSN2001), which tracks all 53,575 babies (including multiple births) born in Japan during the periods 10–17 January and 10–17 July 2001. Wave 1 had an initial response rate of 87.7%, yielding 47,015 respondents. By the sixteenth wave, however, the number of respondents had declined to 28,810, representing 53.8% of the original cohort.

Information on birth weight, the length of pregnancy, and the occurrence of multiple births is obtained from the Live Birth Form of Vital Statistics, which is merged with the LSN2001 dataset by the Ministry of Health, Labour and Welfare (MHLW). Initially, the questionnaires were administered only to the parents of the surveyed child, but from Wave 13 (2014) onward, separate questionnaires were administered to both the child and their parents.

The LSN2001 collects basic family information, including siblings' birth records, allowing for the identification of twins and the determination of the number of siblings. It also contains detailed information on variables critical for analyzing out-of-school educational investments, such as children's study hours, providing insights into their academic activities. For each surveyed child, data on hours spent studying outside school per day, along with out-of-school education expenses, were collected over multiple years, albeit not annually (see Table OSM3).

In 2017 (Wave 16), when all children reached high school age, the name of the senior high school each child attended was recorded, allowing the LSN2001 data to be matched to a database containing the *SHSRS* of their respective senior high schools.

4.2 Sample Selection

Four key rules are applied in selecting the sample used in our analysis.

First, the sample is restricted to singleton children, excluding twins. This selection criterion aims to minimize biases arising from adverse postnatal conditions and differential parental responses, as twins often have lower birth weights, which can affect developmental and educational outcomes (Almond and Currie, 2011).

[13]We do not employ sibling sex composition as an instrument (e.g., Rosenzweig and Wolpin, 2000; Angrist et al., 2010). Postnatal gender preferences may violate the exclusion restriction if parents systematically invest more in sons, implying that the sex of earlier-born children could directly affect later-born children's outcomes (see Sakata et al., 2022). Empirically, for this sibling-sex-composition instrument, the first-stage relationship is rather weak in our data: the Kleibergen–Paap rk Wald F statistic is only 6.3 in the full sample, 5.7 among highly educated mothers, and 1.6 among less-educated mothers, suggesting underidentification.

Second, the sample is further narrowed to include only first-born children who have at least one sibling. This criterion is applied because the study uses twins born at the second birth as an instrumental variable to estimate the impact of family size on first-borns' educational outcomes. By focusing on first-born children, the analysis can exploit the natural variation provided by the subsequent birth of twins, thereby isolating the effect of increased family size from other potential confounding factors.

Using the 2017 cross-sectional data, we identify 28,358 non-twin children who meet the first selection criterion (17,018 with mothers holding a college degree and 11,340 without). Descriptive statistics on the number of siblings and birth order are provided in Online Supplementary Table S1.

Third, there is some data loss associated with matching the names of senior high schools in the LSN2001 survey with those in the *SHSRS* database, because: (a) the senior high school is part of an integrated junior/senior high school;[14] (b) the senior high school is a vocational school or a special support school; (c) the information provided by the student is insufficient to identify the senior high school; or (d) the student refused to answer the question regarding the name of their senior high school. In these cases, the *SHSRS* are either unavailable or not appropriate for use.

Fourth, complete data must be available for all variables included in the regression model.

After applying these restrictions, the final 2017 cross-sectional sample consists of 7,421 children: 4,738 children with college-educated mothers in 2,306 senior high schools, and 2,683 children with non-college-educated mothers in 1,875 senior high schools. The panel analysis, which uses information up to 2016 (Wave 15), applies the same selection criteria but does not require information on *SHSRS*.

4.3 Key Variables and Descriptive Statistics

This subsection defines the dependent variables used in our analysis: the senior high school ranking score (*SHSRS*), educational investments, study habits, and parental time spent with the first child.

The first dependent variable used in Equation (2) is the *SHSRS* of the senior high school attended by the first child. This variable is analyzed using a cross-sectional specification. It is constructed based on information from the 16th wave (2017) of the LSN2001 survey, which records the name of the senior high school attended by the surveyed student. This school-name data is then merged with *SHSRS* data for 2018 obtained from the Japanese education portal ReseMom,[15] which provides *SHSRS* scores for all senior high schools in Japan.

It is worth noting that the students in LSN2001 were born in either January or July 2001 (see Section 4). The rule determining the academic year in which a child starts primary school (discussed in Section 2) means that children born in January and July of the same year enter different grades. Children born in January 2001 entered primary school in April 2007 and senior high school in April 2016, while those born in July 2001 entered primary school in April 2008 and senior high school in April 2017. We matched all students' schools with the *SHSRS* using the 2018 ReseMom data.

In our panel-data analysis, we estimate Equation (3) using four key outcome variables measured annually for the first child: (1) total expenditures, (2) out-of-school education expenditures, (3) child

[14] Integrated schools that allow students to enter in year 10 appear in the ReseMom database we use. Since, in Wave 16, parents are asked to provide the name of the junior high school their child attended, we can match the names of these junior and senior high schools and eliminate most of these integrated high schools from the dataset.

[15] This portal can be accessed at `https://resemom.jp/pages/hensachi/index.html`.

study time, and (4) parental time spent with the child. These variables capture both monetary and time investments in child development and are observed at multiple points between 2005 and 2016. All variables are treated as dependent variables in the panel regression framework of Equation (3), and their availability by year is summarized in Table OSM3.

Total Expenditures. This variable includes school fees, extracurricular activities, cram school costs, childcare, medical care, food, and clothing for the first child. The survey specifies age-relevant items depending on the child's age. Data are available annually from 2005 to 2016.

Cost of Out-of-school Education. This variable measures monthly expenditures on tutoring, private lessons, and correspondence courses. Respondents are instructed to report child-specific costs. Data are available annually from 2009 to 2016.

Child Study Time. This variable records the total number of hours the first child spends studying outside regular school hours, either at home or in cram schools. It is available annually from 2008 to 2016.

Parental Time Spent with the Child. This variable measures the amount of time each parent spends with the child, reported separately for weekdays and holidays. It is available for 2005, 2008, and 2009–2011.

The key explanatory variables are $size_i$ in Equations (2) and (4), and $size_{it}$ in Equations (3) and (5), representing the number of siblings the first child of family i has in 2017 and at time t, respectively. When defining $size_{it}$, we do not use the sibling numbers reported in each survey, denoted as $sizea_{it}$, but instead define $size_{it}$ as the maximum number of siblings observed up to that point in time:

$$size_{it} = \max(sizea_{i1}, \ldots, sizea_{it}). \tag{6}$$

This definition addresses the issue of undercounting younger siblings who are not living at home. For example, in the 16th survey conducted in 2017, respondents are asked to report the number of siblings *living with the respondent*, so siblings who, for specific reasons, are not living in the same household are not counted.[16] To address this issue, $size_i$ is defined as the maximum number of younger siblings born to the first child's mother between 2001 and 2017, that is, $size_i = size_{i2017}$.

Descriptive statistics for the dependent variables and selected control variables used in the cross-sectional and panel models are provided in the Online Supplementary Materials (Tables OSM2 and OSM3).

[16] Respondents are explicitly instructed not to count siblings who have been living away from home for three months or more. Alternatively, the respondents themselves may reside in a student dormitory attached to their school. In such cases, they may not count their siblings living at home or elsewhere.

5 Main Results

In this section, we first present the first-stage results of our 2SLS estimation (Section 5.1). We then apply the empirical strategy outlined in Section 3.2 to examine the causal effects of an increase in family size on (i) the selectivity of the senior high school attended by the child (Section 5.2), and (ii) household investments, including out-of-school education expenditures, study time, and parental time with the child (Section 5.3).[17]

5.1 First-Stage Results for Sibling Size

The first-stage estimation results for Equation (4) are presented in panel (a) of Table 1. The Wald F-test statistics (weak instrument tests), as well as the Cragg–Donald and Kleibergen–Paap Wald F-statistics, are all well above the conventional threshold values, indicating that the twins instrument is sufficiently strong in all specifications. The estimates of α_{31} in Equation (4), presented in Table 1, show that the birth of twins as the second child significantly increases the average number of siblings, with estimated coefficients of 0.87 for children of college-educated mothers and 0.90 for those whose mothers lack a college degree, both statistically significant at the 1% level. Because this specification is just identified, the LIML and Fuller estimators coincide with the 2SLS results and are therefore omitted from the table.

These results suggest that Japanese families, who typically desire two children, often expand their family size from two to three following the birth of twins. This finding differs from Angrist et al. (2010) for Israel, where the twin coefficient is around 0.3, highlighting cultural and contextual variations in family planning responses to twin births. The results implicitly underscore the significant role of cultural norms and educational background in shaping family size decisions following the birth of twins. The estimated coefficient of the gender dummy is positive and significant for children with college-educated mothers, indicating that in this group, having a male firstborn increases the likelihood of having another child by nearly 4%. This result may reflect a preference for daughters in Japan (Kureishi and Wakabayashi (2011)).

5.2 The Impact of Sibling Size on Senior High School Ranking Scores (*SHSRS*)

Panel (b) of Table 1, Columns (1b.1)–(1b.3), presents the 2SLS estimates of Equation (2), using twins at the second birth as an instrument for three different samples: all first-born children, first-born children with mothers who have a college degree, and first-born children with mothers who do not have a college degree, respectively.

In the pooled estimation (Column 1b.1), which includes both children with college-educated and non-college-educated mothers, the estimated coefficient on the number of siblings is negative (-2.044) and statistically significant. This suggests that, overall, an increase in the number of siblings signif-

[17] Analyses of gender differences across outcomes, as well as the effects of sibling size on mothers' employment and household income, were also conducted. The results of these additional analyses are provided in the Online Supplementary Materials due to space limitations.

icantly reduces child quality as measured by *SHSRS*, after controlling for child and parental characteristics, indicating the presence of a QQ trade-off in Japan.

For children with college-educated mothers (Column 1b.2), the estimated coefficient on the number of siblings is also negative and statistically significant, indicating that an additional sibling decreases the eldest child's *SHSRS* by about 2.9 points. In contrast, for children with mothers without a college degree (Column 1b.3), the estimated coefficient is insignificant, indicating that the number of siblings does not have a discernible effect on child quality in these households. Taken together, the findings in Columns (1b.1)–(1b.3) suggest that the overall effect observed in Column (1b.1) is primarily driven by children of college-educated mothers. Boys attend high schools with *SHSRS* scores 0.5 to 0.8 points lower than girls on average.

The results for the control variables that are not reported in Panel (b) of Table 1, but are presented in full in Table OSM5, generally align with expectations. The estimated coefficients on the July dummy indicate that children born in July attend high schools with higher *SHSRS* scores than those born in January. Children born in July are six months older than those born in January at the time of their senior high school entrance exams, consistent with evidence that relatively older students in a cohort tend to have better academic performance and higher incomes, especially among males (Kawaguchi (2011)). Although not reported in Panel (b) of Table 1, Table OSM2 in the Online Supplementary Material shows a positive effect of birth weight, and that factors such as single motherhood, co-residence with grandparents, and postnatal maternal health (e.g., smoking) affect a child's academic achievement as measured by *SHSRS*.

Nonetheless, several limitations of this measure should be noted. First, the *SHSRS* is a school-level variable, not an individual score, introducing potential measurement error by ignoring within-school variation in student ability. Second, the *SHSRS* may not only reflect academic merit but may also be influenced by family financial constraints, particularly when the number of children increases. Although public high schools in Japan are now generally tuition-free under recent reforms, some high-ranked private schools require substantial entrance or tuition fees. Even if students could pass the entrance exams for such schools, some families may exclude them from consideration due to their high cost. This raises the possibility that reduced educational expenditures in larger families could affect school choice for financial reasons, rather than academic ability.

To address this concern, we conducted an additional analysis using high school entrance and tuition fees as outcome variables. The results, presented in Table OSM13 of the Online Supplementary Materials, show no statistically significant relationship between sibling size and these school-related costs. This provides evidence that financial barriers are unlikely to be the primary channel through which sibling size affects school selectivity, supporting the interpretation of *SHSRS* as a proxy for academic placement rather than family financial resources.

5.3 The Impact of Sibling Size on Household Investments

Table 2 presents the REIV estimates of Equation (3), which examine the effect of sibling size on household investments in the first child, using twins at the second birth as an instrumental variable. We investigate whether households with college-educated mothers invest more in their children's education through external resources such as cram schools and private tutors.

In Panel (a) of Table 2, Columns (2a.1) and (2a.2) use as dependent variables the total amount spent on the child and the monthly expenditures on out-of-school education, respectively. An additional sibling decreases total expenditures by about 5,200 yen ($32) and monthly out-of-school education spending by approximately 3,000 yen ($20) for the eldest child. Given that the average total expenditure and monthly out-of-school spending are approximately 51,000 yen ($340) and 13,000 yen ($87), respectively, these reductions represent decreases of about 10% and 23%. Column (2a.3) examines changes in the first child's out-of-school study time (including cram school and home study). Each additional sibling reduces the first child's *daily* study time in college-educated households by about 0.15 hours (9 minutes). The number of siblings also negatively affects the amount of time fathers spend with their children on weekends (Column (2a.7)).

In contrast, for mothers without college degrees (Panel (b) of Table 2), the number of siblings primarily reduces spending on out-of-school education by about 3,000 yen, while showing insignificant effects on all other dependent variables.

These findings suggest that an increase in family size has differential impacts depending on the mother's education level. For mothers with college degrees, an increase in the number of siblings is associated with the first child attending a less selective high school, reduced spending on out-of-school education, and a decrease in overall child-related expenditures. Conversely, for mothers without college degrees, the negative impact of an increase in the number of siblings is observed primarily in out-of-school education costs, with no significant effects on other educational investments or time use. These results imply that mothers without college degrees are less able to manage the financial and time demands of education and exam preparation as family size grows. In contrast, college-educated mothers tend to be more intensively involved in their children's education and exam competition, leading to reductions in educational expenditures and preparation time when the number of siblings increases.

5.4 Income-Constrained Disadvantaged Groups

As shown in the previous subsection, households in which the mother holds a college degree exhibit a more pronounced QQ trade-off. Evidence from developing countries suggests that resource, liquidity, and credit constraints play a critical role in shaping the QQ trade-off. It is therefore important to examine whether budget constraints impose a particularly restrictive influence on such families. Understanding the impact of financial limitations on educational investments is crucial for analyzing how the trade-off varies across different family backgrounds. To explore this mechanism, we analyze heterogeneity in the QQ trade-off among high-income and low-income households. Based on prenatal household income in 2000, we divide the sample of college-educated mothers into two groups: high-income households (upper 50% of the income distribution) and low-income households (lower 50%). We expect the negative QQ trade-off to be more pronounced among low-income households headed by college-educated mothers.

Table 3 presents the results using children of college-educated mothers, with twins at the second birth serving as the instrumental variable for the number of siblings. Columns (3a.1)–(3a.3) show that sibling size has no significant effect on school selectivity or educational spending in high-income households. However, Columns (3b.1)–(3b.3) reveal that in low-income households, the number of siblings has a statistically significant negative impact: each additional sibling reduces the *SHSRS* by 3.5 points, monthly total expenditure on the first child by 5,900 yen ($39), and monthly out-of-school education spending by 3,700 yen ($24).

In summary, these findings indicate that the impact of an increase in sibling size on the educational quality of the first child among college-educated mothers varies by household income. Specifically, the negative effects are observed only in the low-income group, with no significant impacts in high-income families. This pattern may reflect that college-educated parents are more responsive to educational incentives and competition, possibly due to differences in information access, expectations, or familiarity with the education system. Low-income, well-educated households are more financially constrained, limiting their ability to provide enhanced educational opportunities when faced with additional children. In contrast, higher-income, well-educated households possess the financial capacity to offset the effects of an unexpected increase in sibling size. Consequently, the QQ trade-off is more pronounced among low-income parents with college degrees.

6 Conclusion

This study examined the quantity–quality (QQ) trade-off in children using Japanese data, focusing on heterogeneity in maternal education and household income. Exploiting the birth of twins at the second birth as a source of exogenous variation in family size, the analysis provides evidence that an increase in sibling size reduces per-child educational investments and access to selective senior high schools, particularly in low-income households with highly educated mothers. In contrast, in households with mothers who only graduated from high school or with higher income, sibling size has little to no effect on educational investments. It should be noted that our findings focus exclusively on the first-born child and do not directly address whether the trade-off exists for later-born children.

From a policy perspective, these results suggest that current government policies in Japan aimed at promoting higher fertility rates may unintentionally compromise child quality, especially among households where mothers are highly educated but financially constrained. To mitigate such unintended consequences, targeted policy interventions are essential—such as financial support for educational expenses and programs designed to alleviate the burden of private education costs.

Bibliography

D. Aaronson, R. Dehejia, A. Jordan, C. Pop-Eleches, C. Samii, and K. Schulze. The effect of fertility on mothers' labor supply over the last two centuries. *Economic Journal*, 131(633):1–32, 2021.

Y. Abe. Universities and the entry-level job market: Evidence from Japanese panel data. *Labour Economics*, 9(6):699–715, 2002.

A. Aizer and F. Cunha. The production of human capital: Endowments, investments and fertility. Technical report, NBER Working Paper no. 18429, National Bureau for Economic Research (NBER), 2012.

D. Almond and J. Currie. Killing me softly: The fetal origins hypothesis. *Journal of Economic Perspectives*, 25(3):153–172, 2011.

J. Angrist, V. Lavy, and A. Schlosser. Multiple experiments for the causal link between the quantity and quality of children. *Journal of Labor Economics*, 28(4):773–824, 2010.

J. D. Angrist and J.-S. Pischke. *Mostly Harmless Econometrics: An Economist's Companion*. Princeton University Press, 2009.

G. Becker. An economic analysis of fertility. In R. Roberts, editor, *Demographic and Economic Change in Developed Countries*, pages 209–240. Columbia University Press, 1960.

G. S. Becker and H. G. Lewis. On the interaction between the quantity and quality of children. *Journal of Political Economy*, 81(2)(Part 2):S279–S288, 1973.

S. Bhalotra and D. Clarke. Twin birth and maternal condition. *Review of Economics and Statistics*, 101(5):853–864, 2019.

S. E. Black, P. J. Devereux, and K. G. Salvanes. Small family, smart family? Family size and the IQ scores of young men. *Journal of Human Resources*, 45(1):33–58, 2010.

C. Borra and A. Sevilla. Competition for university places and parental time investments: Evidence from the United Kingdom. *Economic Inquiry*, 57(3):1460–1479, 2019.

J. Bound, B. Hershbein, and B. T. Long. Playing the admissions game: Student reactions to increasing college competition. *Journal of Economic Perspectives*, 23(4):119–46, 2009.

J. Cáceres-Delpiano. The impacts of family size on investment in child quality. *Journal of Human Resources*, 41(4):738–754, 2006.

E. J. Choi and J. Hwang. Child gender and parental inputs: No more son preference in Korea? *American Economic Review*, 105(5):638–643, 2015.

D. Conley and R. Glauber. Parental educational investment and children's academic risk: Estimates of the impact of sibship size and birth order from exogenous variation in fertility. *Journal of Human Resources*, 41(4):722–737, 2006.

J. Cragg and S. Donald. Testing identifiability and specification in instrumental variable models. *Econometric Theory*, 9:222–240, 1993.

A. Delavande. Expectations in Development Economics. In R. Bachmann, G. Topa, and W. van der Klaauw, editors, *Handbook of Economic Expectations*, chapter 9, pages 261–291. Academic Press, 2022.

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

M. Doepke and M. Tertilt. Families in macroeconomics. In J. B. Taylor and H. Uhlig, editors, *Handbook of Macroeconomics: Volume 2B*, pages 1789–1891. Elsevier, 2016.

R. Dore. *The Diploma Disease: Education, Qualification, and Development*. University of California Press, 1976.

S. R. Entrich. *Shadow Education and Social Inequalities in Japan: Evolving Patterns and Conceptual Implications*. Springer, 2018.

H. Farbmacher, R. Guber, and J. Vikström. Increasing the credibility of the twin birth instrument. *Journal of Applied Econometrics*, 33(3):457–472, 2018.

R. Goodman and C. Oka. The invention, gaming, and persistence of the hensachi ('standardised rank score') in Japanese education. *Oxford Review of Education*, 44(5):581–598, 2018.

J. Guryan, E. Hurst, and M. Kearney. Parental education and parental time with children. *Journal of Economic Perspectives*, 22(3):23–46, 2008.

C. Ho. Child's gender, parental monetary investments and care of elderly parents in China. *Review of Economics of the Household*, 17:741–774, 2019.

S. D. Holloway, S. Suzuki, and Y. Yamamoto. From kyôiku mama to monster parent: Changing images of Japanese mothers and their involvement in children's schooling. Child Research Net, 2010. URL `https://www.childresearch.net/papers/parenting/2010_04.html`.

O. Ishihara, S. C. Jwa, A. Kuwahara, and et al. Assisted reproductive technology in Japan: A summary report for 2018 by the Ethics Committee of the Japan Society of Obstetrics and Gynecology. *Reproductive Medicine and Biology*, 20(1):3–12, 2021.

A. Kalil, S. E. Mayer, W. Delgado, and L. A. Gennetian. Education gradients in parental time investment and subjective well-being. *Review of Economics of the Household*, 2024. doi: 10.1007/s11150-024-09734-5.

T. Kariya. Japanese solutions to the equity and efficiency dilemma? Secondary schools, inequity and the arrival of 'universal' higher education. *Oxford Review of Education*, 37(2):241–266, 2011.

Y. Katagiri, S. C. Jwa, A. Kuwahara, and et al. Assisted reproductive technology in Japan: A summary report for 2019 by the Ethics Committee of the Japan Society of Obstetrics and Gynecology. *Reproductive Medicine and Biology*, 21(1):e12434, 2022.

D. Kawaguchi. Actual age at school entry, educational outcomes, and earnings. *Journal of the Japanese and International Economies*, 25(2):64–80, 2011.

S. Kornrich and F. Furstenberg. Investing in children: Changes in parental spending on children, 1972–2007. *Demography*, 50(1):1–23, 2013.

W. Kureishi and M. Wakabayashi. Son preference in Japan. *Journal of Population Economics*, 24: 873–893, 2011.

J. Lee. Sibling size and investment in children's education: An Asian instrument. *Journal of Population Economics*, 21(4):855–875, 2008.

D. L. Millimet and L. Wang. Is the quantity-quality trade-off a trade-off for all, none, or some? *Economic Development and Cultural Change*, 60(1):155–195, 2011.

Ministry of Education, Culture, Sports, Science and Technology (MEXT) (Japan). Releasing the results of the 2023 fiscal year survey of educational costs for children (reiwa 5 nendo kodomo no gakushuhi chosa no kekka ni tsuite) (in japanese). `https://www.mext.go.jp/content/20241225-mxt_chousa01_000039333_1.pdf`, 2010. Press release dated 25 December. Accessed 22 August 2025.

Ministry of Education (Japan). Survey on children's learning activities outside school (kodomo no gakugai de no gakushu katsudo ni kan suru jittai chosa hokoku) (in japanese). `https://www.mext.go.jp/b_menu/houdou/20/08/08080710/001.pdf`, 2008. Accessed 12 November 2024.

M. Mogstad and M. Wiswall. Testing the quantity–quality model of fertility: Estimation using unrestricted family size models. *Quantitative Economics*, 7(1):157–192, 2016.

OECD. *Education at a Glance 2012: OECD Indicators*. OECD, 2012.

R. Ogawa, R. Okazawa, and S. Sano. Does competition among schools benefit students? Evidence from Japan's school zone reform. mimeo, 2024.

T. Oshio, S. Sano, and K. Suetomi. Estimate of the production function of education: Combined junior/senior high schools. *Japanese Economy*, 37(2):83–119, 2010.

G. Ramey and V. A. Ramey. The rug rate race. Technical report, National Bureau of Economic Research, 2009.

M. R. Rosenzweig and K. I. Wolpin. Testing the quantity-quality fertility model: The use of twins as a natural experiment. *Econometrica*, 48(1):227–240, 1980.

M. R. Rosenzweig and K. I. Wolpin. Natural "natural experiments" in economics. *Journal of Economic Literature*, 38(4):827–874, 2000.

M. R. Rosenzweig and J. Zhang. Do population control policies induce more human capital investment? twins, birth rate and china's "one-child" policy. *Review of Economic Studies*, 76(3):1149–1174, 2009.

N. Sakaguchi. Mothers' educational expectations and their changes (Hahaoya no kyouiku kitai to sono suii, in Japanese). *Japanese Journal of Research on Household Economics*, 88:17–27, 2010.

K. Sakata, C. McKenzie, W. Kureishi, and M. Wakabayashi. Birth order, gender and the parental investment gap among children. *Singapore Economic Review*, pages 1–25, 2022.

R. Tanaka and Y. Yamamoto. Does maternal employment in early childhood matter for educational outcomes? Discussion Paper no. DP2010-2, Tokyo Institute of Technology, 2009.

R. Tsuneyoshi. Junior high school entrance examinations in Metropolitan Tokyo. The advantages and costs of privilege. In G. DeCoker and C. Bjork, editors, *Japanese Education in an Era of Globalization: Culture, Politics, and Equity*, pages 164–182. Teachers College Press, 2013.

Table 1: Two-Stage Least Squares Estimates of Models for *SHSRS*

Sample Selection Rule	All Mothers	Mothers w/ College Degrees	Mothers w/o College Degrees
	(1a.1)	(1a.2)	(1a.3)
(a) First-Stage Estimates of Equation (4)			
Dependent Variable: *Sibling Size*			
Twin at Second Birth Dummy	0.882***	0.869***	0.904***
	(0.052)	(0.068)	(0.092)
Gender Dummy (Boy)	0.029**	0.037**	0.007
	(0.014)	(0.016)	(0.023)
Prefectural Dummies	YES	YES	YES
City Size Dummies	YES	YES	YES
Other Controls	YES	YES	YES
Cragg–Donald Wald F-statistic	281.159	169.853	97.590
Kleibergen–Paap rk Wald F-statistic	284.625	164.161	96.518
Sample Size	7,421	4,738	2,683
	(1b.1)	(1b.2)	(1b.3)
(b) Second-Stage Estimates of Equation (2)			
Dependent Variable: *SHSRS*			
Sibling Size	-2.044*	-2.924*	-0.457
	(1.229)	(1.754)	(1.566)
Gender Dummy (Boy)	-0.592***	-0.463*	-0.758**
	(0.201)	(0.243)	(0.327)
Prefectural Dummies	YES	YES	YES
City Size Dummies	YES	YES	YES
Other Controls	YES	YES	YES
Sample Size	7,421	4,738	2,683
R-squared	0.082	0.084	0.102

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) "Other Controls" include mother's and father's age and their squares (see Footnote 9). Additional controls (not shown) include dummies for father's education level, pregnancy length (weeks), birth weight (kg), number of cigarettes smoked by mother post-birth and its square, grandparent cohabitation dummy, mother's prenatal work status, single-mother dummy, and prenatal household income.
(4) The regression for "All Mothers" also includes a dummy for whether the mother holds a college degree.
(5) Full results for Panels (a) and (b) are reported in Tables OSM1 and OSM2 in the Online Supplementary Materials.
(6) Weak instrument tests use the Wald F-statistic proposed by Cragg and Donald (1993).
Source: Longitudinal Survey of Newborns in the 21st Century (2001 Births): Wave 1 (2002), Wave 2 (2003), and Wave 16 (2017).

Table 2: Estimates Related to Expenditures, Study Time, and Parental Time (Selective Results)

Dependent Variable	Total Exp. on Child (1,000 yen)	Out-of-School Education Exp. (1,000 yen)	Child Study Time (hrs/day)	Time with Mother (Weekday)	Time with Mother (Weekend)	Time with Father (Weekday)	Time with Father (Weekend)
(a) Mothers with College Degrees							
	(2a.1)	(2a.2)	(2a.3)	(2a.4)	(2a.5)	(2a.6)	(2a.7)
Sibling Size	-5.224*	-2.990**	-0.145*	-0.165	-0.295	0.114	-0.717**
	(2.983)	(1.477)	(0.085)	(0.113)	(0.222)	(0.162)	(0.349)
Gender Dummy (Boy)	-0.175	0.899***	-0.090***	-0.081***	-0.260***	-0.005	0.014
	(0.703)	(0.278)	(0.014)	(0.025)	(0.037)	(0.025)	(0.053)
Prefectural Dummies	YES	YES	YES	YES	YES	YES	YES
City Dummies	YES	YES	YES	YES	YES	YES	YES
Other Controls	YES	YES	YES	YES	YES	YES	YES
Sample Size	73,027	51,184	59,841	33,623	33,486	32,686	32,522
Number of IDs	8,209	7,654	7,822	8,078	8,077	8,022	8,014
(b) Mothers without College Degrees							
	(2b.1)	(2b.2)	(2b.3)	(2b.4)	(2b.5)	(2b.6)	(2b.7)
Sibling Size	-4.759	-2.803*	-0.055	-0.073	-0.013	0.231	-0.114
	(4.295)	(1.551)	(0.113)	(0.169)	(0.217)	(0.193)	(0.309)
Gender Dummy (Boy)	-0.579	0.417	-0.123***	-0.091***	-0.197***	0.009	-0.055
	(0.718)	(0.364)	(0.016)	(0.031)	(0.043)	(0.035)	(0.067)
Prefectural Dummies	YES	YES	YES	YES	YES	YES	YES
City Dummies	YES	YES	YES	YES	YES	YES	YES
Other Controls	YES	YES	YES	YES	YES	YES	YES
Sample Size	40,715	26,411	33,053	19,062	18,994	18,319	18,254
Number of IDs	4,926	4,318	4,548	4,795	4,795	4,749	4,742

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) All regressions are estimated using the Random Effects Instrumental Variables (REIV) estimator. The instrument for sibling size is the presence of twins at the second birth. First-stage estimates are not reported.
(4) In addition to the variables described in Table 1, prenatal household income is also included.
(5) Full estimation results are provided in Table OSM3 in the Online Supplementary Materials.

Table 3: Selectivity and Spending on Out-of-School Education by Household Income Level for Mothers with College Degrees (Selective Results)

Sample Selection Rule	High Income			Low Income		
Dependent Variables	*SHSRS*	Total Exp. on Child (1,000 yen)	Out-of-School Exp. (1,000 yen)	*SHSRS*	Total Exp. on Child (1,000 yen)	Out-of-School Exp. (1,000 yen)
Explanatory Variables	(3a.1)	(3a.2)	(3a.3)	(3b.1)	(3b.2)	(3b.3)
Sibling Size	-1.895	-3.064	-2.145	-3.506*	-5.921**	-3.701*
	(3.374)	(6.083)	(2.226)	(2.000)	(2.987)	(1.904)
Gender Dummy (Boy)	-0.294	0.662	1.221***	-0.511	-1.047	0.552
	(0.334)	(1.195)	(0.479)	(0.356)	(0.802)	(0.362)
July Dummy	0.457	-8.812***	-6.555***	0.618*	-5.385***	-4.503***
	(0.323)	(1.091)	(0.462)	(0.335)	(0.769)	(0.355)
Prefectural Dummies	YES	YES	YES	YES	YES	YES
City Dummies	YES	YES	YES	YES	YES	YES
Parental Age Controls	YES	YES	YES	YES	YES	YES
Estimator	2SLS	REIV	REIV	2SLS	REIV	REIV
Sample Size	2,373	36,376	26,066	2,365	36,651	25,118
Number of IDs	2,373	4,022	3,801	2,365	4,187	3,853

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) 2SLS and REIV denote two-stage least squares and random effects instrumental variables estimators, respectively. The instrument is the occurrence of twins at the second birth. First-stage estimates are not reported.
(4) *SHSRS* stands for senior high school ranking score. The estimates in columns (3a.1) and (3b.1) are based on the cross-sectional model in Equation (2), while those in columns (3a.2), (3a.3), (3b.2), and (3b.3) are based on the random effects panel model in Equation (3).
(5) "Parental Age Controls" refer to the inclusion of the mother's and father's age and their squares (see Footnote 9), as well as additional controls: dummies for the father's education level, pregnancy length (weeks), birth weight (kg), number of cigarettes smoked by the mother post-birth and its square, grandparent cohabitation dummy, mother's prenatal work status, single-mother dummy, and prenatal household income.
(6) The model for "All Mothers" also includes a dummy for whether the mother holds a college degree. Full results are provided in the Online Supplementary Materials (see Table OSM7).

Online Supplementary Material

A Distribution of the Number of Siblings by Birth Order in 2017

As shown in Table OSM1, using cross-sectional data for 2017, we identify 28,358 non-twin children who meet the first selection criterion (17,018 with college-educated mothers and 11,340 with mothers without a college degree). More than half of the surveyed children have only one sibling, approximately 30% come from families with two or more siblings, and around 12% are only children with no siblings.

Regarding birth order, nearly half of the children are first-borns (=13,822/28,358), about 37% are second-borns (=10,606/28,358), and 14% are third-born or later-born children (=3,930/28,358). In our analytical sample, there are 6,645 eldest non-twin children with one or more siblings in households where the mother has a college degree (=4,847+1,573+190+35), and 3,700 such children in households where the mother does not have a college degree (=2,645+890+140+25).

B Complete Set of Regression Results

Tables OSM4–OSM7 provide the complete set of regression results corresponding to Tables 1–3 in the main text.

C Quality Differences Across School Types

As shown in Table OSM8, of the 4,517 senior high schools in our sample, 3,311 (73.3%) are public[18] and 1,206 (26.7%) are private schools. According to MEXT's *Basic School Statistics* (*Gakkō Kihon Chōsa*) for 2017, there were a total of 4,907 senior high schools in Japan, of which 3,586 (73.1%) were public and 1,321 (26.9%) were private. Thus, although our sample does not cover all senior high schools in Japan, the proportions of public and private schools are broadly consistent with the national distribution.

While the average *SHSRS* is higher for private senior high schools than for public ones (see Table OSM8), the distribution of *SHSRS* between the two groups is not clearly distinct (see Figure OSM1). The quality of private senior high schools, as measured by their *SHSRS*, is therefore not evidently superior to that of public senior high schools.

D Gender Differences Across Outcomes

In East Asia, including Japan, it is well documented that parental investments in children vary by the child's gender (Ho (2019) for China; Choi and Hwang (2015) for South Korea). For Japan, Sakata et al. (2022), using data from Waves 1–13 of the *Longitudinal Survey of Newborns in the 21st Century* (2001 births)—the same dataset used in this study—find that Japanese parents tend to spend more on their daughters than on their sons.

[18] A "public" school denotes any school administered by a city, prefectural, or national government.

Following this literature, we divide the sample into two groups based on the gender of the first child (male and female) and conduct instrumental variable analyses for each subsample (see Panels (a) and (b) in Table OSM9). When the first child is male (Panel a), the effect of an increase in the number of siblings is negative and significant only in the regression for total expenditure on that child (a decrease of 4,800 yen). Similarly, when the first child is female (Panel b), the effect of the number of siblings is also negative and significant for total child-related expenditure (a decrease of 3,200 yen). Moreover, as the number of siblings increases, both mothers and fathers tend to spend less time with their daughters on weekdays and weekends.

Overall, the impacts of an increase in the number of siblings on *SHSRS* and out-of-school education expenditures for the first child are not statistically significant. This may reflect the fact that, in Japan, access to education is largely gender-neutral, and educational opportunities are provided equally to boys and girls. However, regarding parental time inputs, girls may be more adversely affected. Given the relatively low female labor force participation rate and cultural norms surrounding early marriage for women, there remain household expectations, values, and social stereotypes that prioritize boys' education over girls'. Accordingly, the results of this study suggest that an increase in the number of siblings has a significant adverse effect on parental investment in daughters' education, reflecting persistent gender norms in Japanese families.

E Impacts of Sibling Size on Mothers' Employment and Household Income

Two main channels through which parents may attempt to relax tightened budget constraints resulting from the addition of another child are: (a) mothers who were previously not working may enter the labor force; and (b) mothers who were working part-time may increase their working hours or shift to full-time employment. The addition of a child can thus influence parental employment and earnings—particularly for mothers—beyond their investments in children's education. However, the direction of the effect remains theoretically and empirically ambiguous. On the one hand, mothers may increase their labor market participation to alleviate household budget constraints; on the other hand, they may experience employment or wage penalties due to their primary role in childbirth and child-rearing.

We use information on mothers' labor force participation and annual earned income to examine the impact of additional children on mothers' employment and income outcomes. Income is measured as the mother's total annual income in the previous year. Descriptive statistics are presented in Table OSM10, and the regression results are reported in Table OSM11. The results show that an increase in the number of children has no statistically significant effect on mothers' employment status or income, regardless of whether the mother's education level is high (Columns OSM11.1–OSM11.3) or low (Columns OSM11.4–OSM11.6).

F Child Health Outcomes

Table OSM12 examines the effect of sibling size on two binary health indicators: (1) whether the child had at least one outpatient visit in the previous year (Outpatient Visit; Columns OSM12.1 and OSM12.3), and (2) whether the child had at least one inpatient stay in the previous year (Inpatient Visit; Columns OSM12.2 and OSM12.4). The data used for Table OSM12 cover the period 2007–2012, when the children were in primary school. No significant effects of sibling size are observed in any of the four regressions. However, we find that boys tend to have both more outpatient and inpatient visits than girls.

G Educational Expenditure Outcomes

Table OSM13 investigates whether household economic constraints systematically affect high school choice—particularly attendance at more selective schools as measured by the *SHSRS*. This analysis is motivated by the hypothesis that families with more children may reduce per-child educational expenditures, potentially limiting access to higher-ranked schools for financial rather than academic reasons.

To examine this, we estimate the effect of sibling size (instrumented by twinning at the second birth) on several educational expenditure items related to the first-born child: tuition, facility fees, entrance fees, scholarships received, the total of the three major cost components, and the total net of scholarships. The estimation follows the same 2SLS approach used in the main analysis and stratifies the sample by maternal education level.

Across all specifications, we find no statistically significant effect of sibling size on any category of educational spending. These results suggest that access to selective high schools is unlikely to be constrained by household financial capacity resulting from larger family size. This reinforces the interpretation of the *SHSRS* as an outcome that primarily reflects children's academic placement rather than household budget limitations.

H Alternative Specification: Instrument for Sibling Size

We employ an alternative identification strategy, using the mix of siblings' genders as an instrumental variable to estimate the 2SLS model (Angrist et al. (2010)). The results, reported in Table OSM14, indicate that when the gender combination of the first and second children is used as the instrument (Panel a), the estimated coefficient on sibling size is negative in urban areas, but statistically insignificant (-5.2, p-value $= 0.196$). In rural areas, the coefficient is smaller in magnitude and also statistically insignificant, with a much larger p-value.

When the gender combination of the first through third children is used as the instrument (Panel b), the estimated coefficient for urban areas remains negative but statistically insignificant (p-value $=$ 0.35). Moreover, the Cragg–Donald Wald F-statistic is below 10 in all specifications except for the rural sample in Panel (a), where the gender combination of the first and second children serves as the instrument. This suggests the presence of a weak-instrument problem.

Table OSM1: Distribution of the Number of Siblings by Birth Order in 2017

Number of Siblings	**Total**		**First-born**		**Second-born**		**Later-born**	
	Freq.	(%)	Freq.	(%)	Freq.	(%)	Freq.	(%)
(a) All Parents								
0	3,477	12.26	3,477	25.16				
1	15,253	53.79	7,492	54.20	7,761	73.18		
2	7,887	27.81	2,463	17.82	2,449	23.09	2,975	75.70
3	1,419	5.00	330	2.39	338	3.19	751	19.11
4+	322	1.14	60	0.43	58	0.55	204	5.19
Total	28,358	100.00	13,822	100.00	10,606	100.00	3,930	100.00
(b) Mothers with College Degrees								
0	2,049	12.04	2,049	23.57				
1	9,423	55.37	4,847	55.75	4,576	73.29		
2	4,651	27.33	1,573	18.09	1,445	23.14	1,633	78.51
3	746	4.38	190	2.19	194	3.11	362	17.40
4+	149	0.88	35	0.40	29	0.46	85	4.09
Total	17,018	100.00	8,694	100.00	6,244	100.00	2,080	100.00
(c) Mothers without College Degrees								
0	1,428	12.59	1,428	27.85				
1	5,830	51.41	2,645	51.58	3,185	73.02		
2	3,236	28.54	890	17.36	1,004	23.02	1,342	72.54
3	673	5.93	140	2.73	144	3.30	389	21.03
4+	173	1.53	25	0.49	29	0.66	119	6.43
Total	11,340	100.00	5,128	100.00	4,362	100.00	1,850	100.00

Note: "Mothers with college degrees" include those with a vocational, junior college, or higher degree. "Mothers without college degrees" include those with a high school diploma or less. Data for multiple births are excluded. In 2017, among the 28,810 children remaining in the sample, 28,358 (=17,018 + 11,340) were singletons, while 452 (1.6% of the sample) were from multiple births.

Source: Authors' calculations based on data from Wave 16 (2017) of the *Longitudinal Survey of Newborns in the 21st Century (2001 births)* conducted by the Japanese Ministry of Health, Labour and Welfare.

Table OSM2: Descriptive Statistics for the Cross-Section Model for *SHSRS* in 2017

Sample Selection Rule	**Mothers with College Degrees**			**Mothers without College Degrees**		
Variable	Obs.	Mean	SD	Obs.	Mean	SD
Variables in 2017						
SHSRS (High School Ranking Score)	4,738	56.14	9.21	2,683	50.97	8.45
Sibling Size (excluding surveyed child)	4,738	1.27	0.59	2,683	1.27	0.64
Maximum Number of Siblings (excluding surveyed child)	4,738	1.32	0.56	2,683	1.33	0.61
Gender Dummy (Boy = 1)	4,738	0.49	0.50	2,683	0.48	0.50
Twin at Second Birth Dummy	4,738	0.01	0.09	2,683	0.01	0.10
Mother's Age (years)	4,738	44.73	3.26	2,683	43.72	3.95
Father's Age (years)	4,738	46.50	4.27	2,683	45.74	4.89
Grandparents Cohabiting Dummy	4,738	0.17	0.38	2,683	0.22	0.42
Variables Related to and Prior to Pregnancy						
Length of Pregnancy (weeks)	4,738	39.57	1.44	2,683	39.61	1.37
Birth Weight (kg)	4,738	3.01	0.39	2,683	3.02	0.39
Mother's Smoking (amount)	4,738	0.63	2.77	2,683	1.86	4.68
Mother's Prenatal Employment Status (1 = employed)	4,738	0.77	0.42	2,683	0.77	0.42
Prenatal Household Income (10,000 yen)	4,738	613.17	269.80	2,683	511.60	240.27

Note: "Mothers with college degrees" include those with vocational, junior college, or higher degrees. "Mothers without college degrees" include those with a high school diploma or less. *SHSRS* denotes the Senior High School Ranking Score. Household income refers to annual pre-tax labor income in 2000, the year before the birth of the first child.

Source: Authors' calculations based on data from Waves 1 (2002) and 16 (2017) of the *Longitudinal Survey of Newborns in the 21st Century (2001 Births)* conducted by the Ministry of Health, Labour and Welfare.

Table OSM3: Descriptive Statistics for Variables Related to Models for Child Investments (Panel Analysis)

Sample Selection Rule		**Mothers with College Degrees**			**Mothers without College Degrees**		
Variable	**Data Availability**	Obs.	Mean	SD	Obs.	Mean	SD
Total Expenditure (per month, 1,000 yen)	2005–2016	73,027	50.75	66.61	40,715	42.67	55.98
Out-of-school Education Expenditure (per month, 1,000 yen)	2009–2016	51,184	12.92	26.06	26,411	9.51	24.81
Child Study Time (hours per day)	2008–2016	59,841	1.32	1.06	33,053	1.15	0.92
Time with Mother (Weekday, hours per day)	2005, 2008, 2009–2011	33,623	4.55	1.50	19,062	4.59	1.49
Time with Mother (Weekend, hours per day)	2005, 2008, 2009–2011	33,486	8.28	2.24	18,994	8.24	2.26
Time with Father (Weekday, hours per day)	2005, 2008, 2009–2011	32,686	1.64	1.43	18,319	2.00	1.53
Time with Father (Weekend, hours per day)	2005, 2008, 2009–2011	32,522	7.27	2.85	18,254	7.18	2.87

Note:
(1) "Mothers with college degrees" refer to households where the mother has a vocational, junior college, or higher degree, while "mothers without college degrees" refer to households where the mother has a high school diploma or less. "Total Expenditure" and "Out-of-school Education Expenditure" are monthly amounts measured in 1,000 yen.
(2) Observations with zero expenditures or zero study times are included in the statistics. Zero expenditure on out-of-school education is reported for 36.3% and 48.0% of children in households where the mother has and does not have a college degree, respectively. Zero study times are reported for 3.0% and 4.5% of children in households where the mother has and does not have a college degree, respectively.

Table OSM4: First-Stage Estimates of Sibling Size (Estimation of School Selectivity)

[Full set of estimates for Equation (5) corresponding to Panel (a) of Table 1]

Sample Selection Rule **Explanatory Variables**	**All Households** (OSM4.1)	**Mothers with College Degrees** (OSM4.2)	**Mothers without College Degrees** (OSM4.3)
Twin at Second Birth Dummy	0.882***	0.869***	0.904***
	(0.052)	(0.068)	(0.092)
Gender Dummy (Boy)	0.029**	0.037**	0.007
	(0.014)	(0.016)	(0.023)
July Dummy	0.002	-0.015	0.037
	(0.013)	(0.015)	(0.023)
Mother's Age	-0.125***	-0.099**	-0.179***
	(0.035)	(0.049)	(0.051)
Father's Age	-0.050**	-0.051*	-0.041
	(0.022)	(0.027)	(0.032)
Mother's Age Squared	0.001***	0.001	0.002***
	(0.000)	(0.001)	(0.001)
Father's Age Squared	0.000**	0.000	0.000
	(0.000)	(0.000)	(0.000)
Grandparents Cohabiting Dummy	0.020	0.025	0.017
	(0.016)	(0.020)	(0.027)
Length of Pregnancy (weeks)	0.005	0.005	0.005
	(0.005)	(0.006)	(0.010)
Birth Weight (kg)	-0.019	-0.013	-0.027
	(0.019)	(0.022)	(0.034)
Mother's Smoking (amount)	-0.016***	-0.016**	-0.016**
	(0.005)	(0.006)	(0.007)
Mother's Smoking $(\text{amount})^2$	0.001**	0.001*	0.001*
	(0.000)	(0.000)	(0.000)
Mother's Prenatal Work Status	0.027*	0.027	0.024
	(0.016)	(0.020)	(0.028)
Single Mother Dummy	-0.046**	-0.057**	-0.025
	(0.021)	(0.026)	(0.033)
Prenatal Household Income	0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)
Mother's College Degree Dummy	0.025*		
	(0.015)		
Father's Education Level			
Technical or Specialized Training	0.025	0.044	0.012
	(0.078)	(0.118)	(0.103)
Senior High School (SHS) Graduate	-0.104**	-0.116	-0.082*
	(0.042)	(0.073)	(0.052)

Table OSM4: First-Stage Estimates of Sibling Size (Estimation of School Selectivity) (Continued)

Sample Selection Rule **Explanatory Variables**	**All Households** (OSM4.1)	**Mothers with College Degrees** (OSM4.2)	**Mothers without College Degrees** (OSM4.3)
Technical or Specialized Training	-0.108**	-0.120	-0.087*
	(0.042)	(0.073)	(0.052)
Junior College	-0.011	-0.027	0.009
	(0.068)	(0.090)	(0.131)
University Graduate	-0.108**	-0.123*	-0.081
	(0.042)	(0.073)	(0.049)
Graduate School Graduate	-0.089*	-0.111	0.054
	(0.052)	(0.078)	(0.129)
Constant	5.928***	5.470***	6.838***
	(0.743)	(1.043)	(1.075)
Prefectural Dummies	YES	YES	YES
City Dummies	YES	YES	YES
Parental Age Controls	YES	YES	YES
Weak Instrument Test (Wald F)	281.159	169.853	97.590
Sample Size	7,421	4,738	2,683
R-squared	0.082	0.084	0.102

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) The dependent variable is sibling size.
(4) Data are from Waves 1 (2002), 2 (2003), and 16 (2017) of the *Longitudinal Survey of Newborns in the 21st Century (2001 Births)* conducted by the Ministry of Health, Labour and Welfare.
(5) "Father's Education Level" dummies are relative to the omitted category "University Graduate."
(6) Weak instrument test reports the Wald F-statistic proposed by Cragg and Donald (1993).

Table OSM5: Models for *SHSRS* by Mother's Education Level (Full set of estimates for Equation (2) corresponding to Panel (b) of Table 1)

Explanatory Variables	**All Households** (OSM5.1)	**Mothers with College Degrees** (OSM5.2)	**Mothers without College Degrees** (OSM5.3)
Sibling Size	-2.044*	-2.924*	-0.457
	(1.229)	(1.754)	(1.566)
Gender Dummy (Boy)	-0.592***	-0.463*	-0.758**
	(0.201)	(0.243)	(0.327)
July Dummy	0.748***	0.566**	0.969***
	(0.186)	(0.243)	(0.320)
Mother's Age	0.191	1.123	-0.391
	(0.544)	(0.823)	(0.787)
Father's Age	0.108	0.248	0.010
	(0.294)	(0.457)	(0.400)
Mother's Age^2	-0.002	-0.013	0.005
	(0.006)	(0.009)	(0.009)
Father's Age^2	-0.002	-0.003	-0.001
	(0.003)	(0.005)	(0.004)
Grandparents Cohabiting Dummy	-0.970***	-0.962***	-0.909**
	(0.242)	(0.314)	(0.373)
Length of Pregnancy (weeks)	-0.080	-0.066	-0.094
	(0.079)	(0.101)	(0.130)
Birth Weight (kg)	0.788***	0.732**	0.796*
	(0.297)	(0.357)	(0.482)
Mother's Smoking (amount)	-0.240***	-0.254***	-0.206**
	(0.065)	(0.088)	(0.094)
Mother's Smoking (amount)^2	0.007**	0.007	0.006
	(0.004)	(0.005)	(0.005)
Mother's Prenatal Work Status	-0.217	-0.238	-0.202
	(0.236)	(0.317)	(0.361)
Single Mother Dummy	-2.173***	-2.291***	-2.067***
	(0.330)	(0.436)	(0.456)
Prenatal Household Income	0.003***	0.003***	0.004***
	(0.001)	(0.001)	(0.001)
Mother's College Degree Dummy	2.616***	–	–
	(0.214)	–	–

Table OSM5: Models for *SHSRS* by Mother's Education Level (Continued)

Explanatory Variables	**All Households** (OSM5.1)	**Mothers with College Degrees** (OSM5.2)	**Mothers without College Degrees** (OSM5.3)
Father's Education Level			
Technical or Specialized Training	0.358	0.469	0.322
	(0.948)	(1.436)	(1.182)
Senior High School (SHS) Graduate	0.755*	0.839	0.908
	(0.440)	(0.760)	(0.558)
Technical or Specialized Training (Post-SHS)	2.196***	1.942**	3.085***
	(0.502)	(0.787)	(0.679)
Junior College or Specialized Training	3.170***	3.065***	4.007***
	(0.676)	(0.972)	(1.102)
University Graduate	6.098***	6.399***	5.360***
	(0.478)	(0.766)	(0.641)
Graduate School Graduate	9.484***	9.852***	6.798***
	(0.650)	(0.935)	(1.499)
Constant	43.690***	22.250	56.830***
	(13.690)	(20.410)	(18.58)
Prefectural Dummies	YES	YES	YES
City Size Dummies	YES	YES	YES
Parental Age Controls	YES	YES	YES
Sample Size	7,421	4,738	2,683
R-squared	0.244	0.203	0.154

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) The dependent variable is the high school ranking score (*SHSRS*).
(4) All regressions are estimated using a 2SLS estimator with twins at the second birth as the instrument for sibling size.
(5) "Mothers with college degrees" refers to households where the mother has a vocational, junior college, or higher degree; "Mothers without college degrees" refers to those with a high school diploma or less.
(6) Data are drawn from Waves 1 (2002), 2 (2003), and 16 (2017) of the *Longitudinal Survey of Newborns in the 21st Century (2001 Births)* conducted by the Ministry of Health, Labour and Welfare.

Table OSM6: Estimates Related to Expenditures, Study Time, and Parental Time (Full set of estimates for Equation (3) corresponding to Table 3)

(a) Mothers with College Degrees

Dependent Variable / **Explanatory Variables**	Total Exp. on the Child (1,000 yen) (OSM6a.1)	Out-of-School Education Exp. (1,000 yen) (OSM6a.2)	Child Study Time (hours/day) (OSM6a.3)	Time with Mother (Weekday) (hours/day) (OSM6a.4)	Time with Mother (Weekend) (hours/day) (OSM6a.5)	Time with Father (Weekday) (hours/day) (OSM6a.6)	Time with Father (Weekend) (hours/day) (OSM6a.7)
Sibling Size	-5.224*	-2.990**	-0.145*	-0.165	-0.295	0.114	-0.717**
	(2.983)	(1.477)	(0.085)	(0.154)	(0.222)	(0.162)	(0.349)
Gender Dummy (Boy)	-0.175	0.899***	-0.090***	-0.082***	-0.260***	-0.005	0.014
	(0.703)	(0.278)	(0.014)	(0.025)	(0.037)	(0.025)	(0.053)
July Dummy	-7.113***	-5.668***	-0.107***	-0.028	0.060*	-0.038	-0.045
	(0.663)	(0.309)	(0.013)	(0.025)	(0.036)	(0.026)	(0.048)
Mother's Age	-11.000***	-0.074	-0.000	-0.272***	1.346***	-0.148***	1.351***
	(1.140)	(0.691)	(0.026)	(0.043)	(0.065)	(0.047)	(0.088)
Father's Age	-0.373	1.040***	0.083***	-0.047*	0.336***	-0.089***	0.254***
	(0.729)	(0.379)	(0.017)	(0.026)	(0.040)	(0.028)	(0.049)
Mother's Age^2	0.159***	0.015*	0.001*	0.002***	-0.016***	0.002**	-0.016***
	(0.015)	(0.009)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Father's Age^2	0.012	-0.008*	-0.001***	0.000	-0.004***	0.001***	-0.003***
	(0.009)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Birth Weight (kg)	0.734	0.056	-0.012	0.013	0.087	-0.029	-0.008
	(1.082)	(0.446)	(0.020)	(0.036)	(0.054)	(0.038)	(0.079)
Length of Pregnancy (weeks)	-0.204	-0.028	0.002	-0.013	-0.008	-0.007	0.011
	(0.283)	(0.113)	(0.005)	(0.011)	(0.015)	(0.011)	(0.020)
Mother's Smoking (amount)	0.219	0.192*	0.001	-0.016	0.073***	0.005	0.048*
	(0.241)	(0.113)	(0.005)	(0.011)	(0.025)	(0.012)	(0.026)
Mother's Smoking (amount)^2	-0.007	-0.007	-0.000	0.000	-0.004**	-0.000	-0.002
	(0.013)	(0.006)	(0.000)	(0.001)	(0.002)	(0.001)	(0.002)
Grandparents Cohabiting Dummy	-1.888***	-0.333	-0.034**	-0.215***	-0.018	-0.025	-0.187***
	(0.704)	(0.349)	(0.017)	(0.033)	(0.043)	(0.030)	(0.061)
Single Mother Dummy	-1.910	-0.083	0.005	-0.831***	0.073	-1.074***	-3.644***
	(1.599)	(0.682)	(0.037)	(0.073)	(0.115)	(0.131)	(0.367)

Table OSM6: Estimates Related to Expenditures, Study Time, and Parental Time (Continued)

(a) Mothers with College Degrees (Continued)

Dependent Variable / **Explanatory Variables**	Total Exp. on the Child (1,000 yen) (OSM6a.1)	Out-of-School Education Exp. (1,000 yen) (OSM6a.2)	Child Study Time (hours/day) (OSM6a.3)	Time with Mother (Weekday) (hours/day) (OSM6a.4)	Time with Mother (Weekend) (hours/day) (OSM6a.5)	Time with Father (Weekday) (hours/day) (OSM6a.6)	Time with Father (Weekend) (hours/day) (OSM6a.7)
Mother's Prenatal Work Status	-0.128	0.256	-0.017	-0.353***	0.001	0.038	-0.032
	(0.854)	(0.394)	(0.016)	(0.029)	(0.047)	(0.031)	(0.059)
Prenatal Household Income	0.009***	0.002*	-0.000	0.000**	-0.001***	0.000**	-0.000***
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Father's Education Level							
(Junior High School (JHS) graduation = base)							
Technical or Specialized Training	-0.724	-2.279*	0.082	0.063	-0.630**	-0.305	-0.328
	(4.532)	(1.189)	(0.072)	(0.170)	(0.291)	(0.189)	(0.393)
College Graduate (Post-JHS)	0.616	0.106	0.080*	0.141*	-0.194	-0.181*	0.136
	(1.727)	(0.803)	(0.042)	(0.076)	(0.119)	(0.095)	(0.177)
Senior High School (SHS) Graduate	1.609	1.114	0.119***	0.105	-0.220*	-0.252***	0.044
	(1.856)	(0.851)	(0.042)	(0.081)	(0.125)	(0.097)	(0.183)
Technical or Specialized Training (Post-SHS)	2.455	0.873	0.109**	0.164	-0.299**	-0.269**	0.107
	(2.236)	(1.014)	(0.052)	(0.100)	(0.151)	(0.117)	(0.221)
University Graduate	5.417***	1.330	0.166***	0.297***	-0.451***	-0.584***	-0.018
	(1.800)	(0.849)	(0.043)	(0.076)	(0.121)	(0.095)	(0.178)
Graduate School Graduate	13.930***	2.578**	0.305***	0.372***	-0.431***	-0.654***	0.074
	(2.716)	(1.019)	(0.052)	(0.090)	(0.135)	(0.106)	(0.200)
Prefectural Dummies	YES	YES	YES	YES	YES	YES	YES
City Dummies	YES	YES	YES	YES	YES	YES	YES
Parental Age Controls	YES	YES	YES	YES	YES	YES	YES
Sample Size	73,027	51,184	59,841	33,623	33,486	32,686	32,522
Number of IDs	8,209	7,654	7,822	8,078	8,077	8,022	8,014

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) Dependent variables are described in the column headers.
(4) All regressions use the Random Effects Instrumental Variable (REIV) estimator with twins at the second birth as the instrument for sibling size.
(5) Data are drawn from the *Longitudinal Survey of Newborns in the 21st Century (2001 Births)*, Waves 1–16 (2002–2017).

Table OSM7: Estimates Related to Expenditures, Study Time, and Parental Time
(b) Mothers without College Degrees

Dependent Variable / **Explanatory Variables**	Total Exp. on the Child (1,000 yen) (OSM6b.1)	Out-of-School Education Exp. (1,000 yen) (OSM6b.2)	Child Study Time (hours/day) (OSM6b.3)	Time with Mother (Weekday) (hours/day) (OSM6b.4)	Time with Mother (Weekend) (hours/day) (OSM6b.5)	Time with Father (Weekday) (hours/day) (OSM6b.6)	Time with Father (Weekend) (hours/day) (OSM6b.7)
Sibling Size	-4.759	-2.803*	-0.055	-0.073	-0.013	0.231	-0.114
	(4.295)	(1.551)	(0.113)	(0.169)	(0.217)	(0.193)	(0.309)
Gender Dummy (Boy)	-0.579	0.417	-0.123***	-0.091***	-0.197***	0.009	-0.055
	(0.718)	(0.364)	(0.016)	(0.031)	(0.043)	(0.035)	(0.067)
July Dummy	-5.915***	-4.211***	-0.090***	-0.039	-0.047	-0.056	-0.082
	(0.692)	(0.355)	(0.016)	(0.031)	(0.044)	(0.036)	(0.064)
Mother's Age	-9.411***	-3.572***	-0.166***	-0.057	0.608***	-0.128***	0.520***
	(1.083)	(0.574)	(0.023)	(0.040)	(0.058)	(0.044)	(0.086)
Father's Age	0.723	1.249***	0.063***	-0.046*	0.189***	-0.011	0.201***
	(0.786)	(0.412)	(0.014)	(0.025)	(0.037)	(0.028)	(0.063)
Mother's Age^2	0.140***	0.057***	0.003***	0.000	-0.008***	0.001**	-0.007***
	(0.014)	(0.008)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Father's Age^2	-0.004	-0.010**	-0.001***	0.000	-0.002***	0.000	-0.002***
	(0.009)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Birth Weight (kg)	-0.867	-0.356	0.008	0.064	0.122**	0.008	0.162*
	(1.107)	(0.563)	(0.025)	(0.045)	(0.060)	(0.053)	(0.090)
Length of Pregnancy (weeks)	0.515*	0.175	0.008	-0.021*	0.005	-0.014	0.012
	(0.280)	(0.140)	(0.007)	(0.012)	(0.018)	(0.015)	(0.025)
Mother's Smoking (amount)	-0.015	0.069	-0.001	-0.002	0.001	0.002	-0.004
	(0.200)	(0.129)	(0.004)	(0.007)	(0.010)	(0.011)	(0.015)
Mother's Smoking (amount)^2	0.009	-0.002	-0.000	0.000	0.000	0.000	0.000
	(0.013)	(0.007)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Grandparents Cohabiting Dummy	-0.954	-0.243	-0.001	-0.233***	-0.036	0.026	-0.120
	(0.710)	(0.418)	(0.017)	(0.039)	(0.052)	(0.040)	(0.074)
Single Mother Dummy	-2.480**	-0.703	-0.029	-0.761***	0.022	-1.642***	-4.797***
	(1.240)	(0.626)	(0.034)	(0.079)	(0.111)	(0.126)	(0.390)

Table OSM7: Estimates Related to Expenditures, Study Time, and Parental Time
(b) Mothers without College Degrees (Continued)

Dependent Variable / **Explanatory Variables**	Total Exp. on the Child (1,000 yen) (OSM6b.1)	Out-of-School Education Exp. (1,000 yen) (OSM6b.2)	Child Study Time (hours/day) (OSM6b.3)	Time with Mother (Weekday) (hours/day) (OSM6b.4)	Time with Mother (Weekend) (hours/day) (OSM6b.5)	Time with Father (Weekday) (hours/day) (OSM6b.6)	Time with Father (Weekend) (hours/day) (OSM6b.7)
Mother's Prenatal Work Status	1.080	0.944**	0.062***	-0.196***	0.083	0.024	0.063
	(0.901)	(0.450)	(0.021)	(0.036)	(0.053)	(0.045)	(0.076)
Prenatal Household Income	0.006***	-0.002**	-0.000***	0.000	-0.001***	-0.000**	-0.000
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Father's Education Level							
(Junior High School (JHS) graduation = base)							
Technical or Specialized Training	-4.105	-0.543	-0.111*	0.195	-0.022	-0.235	-0.285
	(2.558)	(1.480)	(0.066)	(0.124)	(0.157)	(0.166)	(0.272)
College Graduate (Post-JHS)	-1.914	-0.178	-0.034	0.074	-0.083	-0.233***	-0.068
	(1.477)	(0.616)	(0.029)	(0.063)	(0.080)	(0.068)	(0.117)
Senior High School (SHS) Graduate	-3.166**	-0.949	-0.037	0.125*	-0.148	-0.318***	-0.149
	(1.537)	(0.707)	(0.035)	(0.074)	(0.096)	(0.085)	(0.141)
Technical or Specialized Training (Post-SHS)	0.071	-0.828	-0.005	0.144	-0.139	-0.433***	-0.209
	(2.763)	(0.975)	(0.057)	(0.122)	(0.153)	(0.119)	(0.227)
University Graduate	1.119	0.126	-0.018	0.238***	-0.184**	-0.695***	-0.164
	(1.798)	(0.842)	(0.034)	(0.070)	(0.091)	(0.078)	(0.136)
Graduate School Graduate	-0.292	1.745	0.055	-0.091	-0.974***	-0.938***	-0.585
	(4.581)	(1.938)	(0.097)	(0.223)	(0.305)	(0.160)	(0.399)
Prefectural Dummies	YES	YES	YES	YES	YES	YES	YES
City Size Dummies	YES	YES	YES	YES	YES	YES	YES
Parental Age Controls	YES	YES	YES	YES	YES	YES	YES
Sample Size	40,715	26,411	33,053	19,062	18,994	18,319	18,254
Number of IDs	4,926	4,318	4,548	4,795	4,795	4,749	4,742

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) Dependent variables are listed in the column headers.
(4) All regressions use the Random Effects Instrumental Variable (REIV) estimator with twins at the second birth as the instrument for sibling size.
(5) First-stage estimation results are not reported.
(6) Data are drawn from the *Longitudinal Survey of Newborns in the 21st Century (2001 Births)*, Waves 1–16 (2002–2017).

Table OSM8: Selectivity and Spending on Out-of-School Education, by Household Income Level for Mothers with College Degrees (Full Estimates)

Sample Selection Rule		High Income			Low Income	
Dependent Variables	*SHSRS*	Total Exp. on the Child (1,000 yen)	Out-of-School Education Exp. (1,000 yen)	*SHSRS*	Total Exp. on the Child (1,000 yen)	Out-of-School Education Exp. (1,000 yen)
Explanatory Variables	(OSM7.1)	(OSM7.2)	(OSM7.3)	(OSM7.4)	(OSM7.5)	(OSM7.6)
Sibling Size	-1.895	-3.064	-2.145	-3.506*	-5.921**	-3.701*
	(3.374)	(6.083)	(2.226)	(2.000)	(2.987)	(1.904)
Gender Dummy (Boy)	-0.294	0.662	1.221***	-0.511	-1.047	0.552
	(0.334)	(1.195)	(0.479)	(0.356)	(0.802)	(0.362)
July Dummy	0.457	-8.812***	-6.555***	0.618*	-5.385***	-4.503***
	(0.323)	(1.091)	(0.462)	(0.335)	(0.769)	(0.355)
Mother's Age	0.682	-14.880***	0.677	0.721	-9.011***	-0.040
	(1.194)	(1.998)	(1.185)	(1.179)	(1.344)	(0.791)
Father's Age	1.072	-1.013	1.473**	-0.446	-0.019	1.565***
	(0.840)	(1.175)	(0.622)	(0.554)	(0.962)	(0.454)
Mother's Age^2	-0.008	0.208***	0.011	-0.008	0.136***	0.013
	(0.013)	(0.025)	(0.015)	(0.013)	(0.017)	(0.010)
Father's Age^2	-0.012	0.021	-0.011	0.005	0.005	-0.014***
	(0.008)	(0.014)	(0.007)	(0.006)	(0.012)	(0.005)
Birth Weight (kg)	0.716	-0.655	-0.619	0.799	2.257*	0.990*
	(0.514)	(1.745)	(0.733)	(0.506)	(1.250)	(0.534)
Length of Pregnancy (weeks)	-0.030	0.086	0.038	-0.094	-0.448	-0.117
	(0.140)	(0.460)	(0.204)	(0.145)	(0.313)	(0.144)
Mother's Smoking (amount)	-0.273	0.319	0.060	-0.248**	0.167	0.257**
	(0.198)	(0.558)	(0.235)	(0.108)	(0.270)	(0.125)
Mother's Smoking (amount)^2	0.006	-0.023	-0.005	0.007	0.001	-0.008
	(0.012)	(0.030)	(0.013)	(0.005)	(0.015)	(0.007)
Mother's Prenatal Work Status	-0.484	-1.929	0.489	-0.091	0.888	0.795*
	(0.513)	(1.736)	(0.752)	(0.396)	(0.904)	(0.415)
Grandparents Cohabiting Dummy	-0.601	-2.184*	-0.272	-1.355***	-1.665*	-0.507
	(0.433)	(1.173)	(0.583)	(0.449)	(0.908)	(0.457)
Single Mother Dummy	-1.630**	-1.959	0.186	-2.952***	-2.480	-0.499
	(0.682)	(2.484)	(1.311)	(0.557)	(2.151)	(0.818)
Prenatal Household Income	0.003**	0.009***	0.002	0.001	0.000	-0.004**
	(0.001)	(0.002)	(0.001)	(0.002)	(0.004)	(0.002)

Table OSM8: Selectivity and Spending on Out-of-School Education, by Household Income Level for Mothers with College Degrees (Full Estimates) (Continued)

Sample Selection Rule	High Income			Low Income		
Dependent Variables	*SHSRS*	Total Exp. on the Child (1,000 yen)	Out-of-School Education Exp. (1,000 yen)	*SHSRS*	Total Exp. on the Child (1,000 yen)	Out-of-School Education Exp. (1,000 yen)
Explanatory Variables	(OSM7.1)	(OSM7.2)	(OSM7.3)	(OSM7.4)	(OSM7.5)	(OSM7.6)
Father's Education Level						
(Junior High School (JHS) graduation = base)						
Technical or Specialized Training	2.245	-8.809*	-4.358	-0.442	2.318	-1.895
	(2.349)	(4.937)	(2.770)	(1.667)	(6.130)	(1.350)
College Graduate (Post-JHS)	2.207	-2.519	-0.810	0.242	2.162	0.621
	(1.362)	(3.870)	(1.590)	(0.923)	(1.826)	(0.936)
Senior High School (SHS) Graduate	3.595**	-1.478	0.954	1.161	3.433*	1.427
	(1.431)	(4.049)	(1.707)	(0.977)	(1.967)	(0.978)
Technical or Specialized Training (Post-SHS)	6.199***	-0.330	0.459	1.214	4.330	1.679
	(1.612)	(4.326)	(1.937)	(1.227)	(2.679)	(1.118)
University Graduate	7.572***	4.237	0.549	6.118***	5.247***	1.829*
	(1.402)	(3.933)	(1.629)	(0.964)	(1.873)	(0.961)
Graduate School Graduate	10.810***	13.060***	1.724	10.000***	12.060***	3.078**
	(1.591)	(4.670)	(1.830)	(1.304)	(3.435)	(1.339)
Prefectural Dummies	YES	YES	YES	YES	YES	YES
City Dummies	YES	YES	YES	YES	YES	YES
Parental Age Controls	YES	YES	YES	YES	YES	YES
Estimator	2SLS	REIV	REIV	2SLS	REIV	REIV
Observations	2,373	36,376	26,066	2,365	36,651	25,118
Number of IDs	–	4,022	3,801	–	4,187	3,853

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) 2SLS and REIV denote the two-stage least squares and random effects instrumental variable estimators, respectively.
(4) The instrument for sibling size is the occurrence of twins at the second birth.
(5) *SHSRS* represents the senior high school ranking score.
(6) For the models estimating *SHSRS* (columns OSM7.1 and OSM7.4), estimation is based on the cross-sectional model in Equation (2).
(7) The models for total and out-of-school education expenditures (columns OSM7.2, OSM7.3, OSM7.5, and OSM7.6) are based on the random effects panel model in Equation (3).
(8) First-stage estimation results are not reported.
(9) Data are drawn from the *Longitudinal Survey of Newborns in the 21st Century (2001 Births)*, Waves 1–16 (2002–2017).

Table OSM9: Descriptive Statistics for *SHSRS* by School Type

School Type	**Obs.**	**Mean**	**SD**	**Min**	**Max**
All Schools	4,517	51.36	9.84	33	80
Public Schools	3,311	49.71	9.35	34	77
Private Schools	1,206	55.87	9.75	33	80

Source: Data obtained by merging senior high school names from Wave 16 (2017) of the *Longitudinal Survey of Newborns in the 21st Century (2001 Births)* conducted by the Ministry of Health, Labour and Welfare with *SHSRS* data from the educational portal ReseMom. Integrated (combined junior and senior high) schools were excluded by cross-checking the names of junior and senior high schools attended by each student.

Table OSM10: Gender Differences in Outcomes

Dependent Variables	*SHSRS* (1,000 yen)	Total Exp. on Children (1,000 yen)	Cram School Exp.	Child Study Time (hours/day)	Time with Mother (Weekday) (hours/day)	Time with Mother (Weekend) (hours/day)	Time with Father (Weekday) (hours/day)	Time with Father (Weekend) (hours/day)
Panel (a): Males								
Explanatory Variables	(OSM9a.1)	(OSM9a.2)	(OSM9a.3)	(OSM9a.4)	(OSM9a.5)	(OSM9a.6)	(OSM9a.7)	(OSM9a.8)
Sibling Size	-2.045	-4.891*	-1.561	-0.011	-0.011	0.052	0.142	0.052
	(2.181)	(2.817)	(1.157)	(0.065)	(0.119)	(0.169)	(0.136)	(0.217)
Sample Size	4,195	167,299	107,938	132,815	79,376	78,926	75,447	75,077
R-squared	0.312	–	–	–	–	–	–	–
Panel (b): Females								
Explanatory Variables	(OSM9b.1)	(OSM9b.2)	(OSM9b.3)	(OSM9b.4)	(OSM9b.5)	(OSM9b.6)	(OSM9b.7)	(OSM9b.8)
Sibling Size	-1.562	-3.255**	-0.112	-0.034	-0.355***	-0.406***	-0.101	-0.586***
	(1.205)	(1.685)	(0.762)	(0.041)	(0.102)	(0.161)	(0.095)	(0.225)
Observations	4,306	155,801	102,291	124,009	73,281	72,919	69,182	68,826
R-squared	0.274	–	–	–	–	–	–	–

Notes: Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses. All regressions reported in this Table are estimated using a random effect instrumental variable estimator with twins on the second birth as the instrument. The results of the first stage estimates are not reported. The estimates are based on the random effects model in equation (3). Additional variables included in the regressions but not reported in this Table are: dummies for the father's educational level, the mother's age and its square, the father's age and its square, the length of the pregnancy in weeks, baby's birth weight (Kg), the number of cigarettes smoked by the mother just after the birth and its square, a grandparent's cohabiting dummy, mother's prenatal work status, single mother dummy, prenatal household income, prefectural dummies, and city size dummies.

Table OSM11: Descriptive Statistics for Variables Related to Models on Mothers' Employment (Panel Analysis)

Sample Selection Rule	**Data Availability**	**Mothers with College Degrees**			**Mothers without College Degrees**		
Variable		Obs.	Mean	SD	Obs.	Mean	SD
Mother Employment Status	2005–2016	73,657	0.58	0.49	41,161	0.59	0.49
Mother Full-time Worker	2005–2016	73,657	0.21	0.41	41,161	0.15	0.36
Mother's Income (10,000 yen)	2005, 2008, 2011, 2013–2016	43,907	124.22	195.42	24,397	83.33	123.66

Notes:
(1) Mothers with college degrees refer to households where the wife has a vocational or junior college degree or higher, while mothers without college degrees refer to households where the wife has a high school degree or lower.
(2) The unit of measurement for mother's income is 10,000 yen.
(3) Income refers to the total annual income from employment for the mother in each corresponding survey year.

Table OSM12: The Effect of Sibling Size on Mothers' Employment

Sample Selection Rule	**Mothers w/ College Degrees**			**Mothers w/o College Degrees**		
Dependent Variables	Mother Employment Status (OSM11.1)	Mother Full-time Status (OSM11.2)	Mother Annual Income (10,000 yen) (OSM11.3)	Mother Employment Status (OSM11.4)	Mother Full-time Status (OSM11.5)	Mother Annual Income (10,000 yen) (OSM11.6)
Sibling Size	0.019	-0.014	-5.163	0.046	0.000	-7.947
	(0.046)	(0.047)	(18.150)	(0.060)	(0.043)	(16.070)
Gender Dummy (Boy)	0.002	-0.014*	-5.928*	0.015	0.007	3.095
	(0.008)	(0.008)	(3.575)	(0.010)	(0.009)	(2.947)
Observations	73,657	73,657	43,907	41,161	41,161	24,397
Number of IDs	8,216	8,216	8,088	4,936	4,936	4,834

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) All regressions are estimated using the random effects instrumental variable (REIV) estimator, with the occurrence of twins at the second birth as the instrument for sibling size.
(4) First-stage estimation results are not reported.
(5) The estimations are based on the random effects model in Equation (3).
(6) Additional control variables (not reported) include: dummies for the father's educational level, the mother's and father's ages and their squares, length of pregnancy (weeks), birth weight (kg), mother's smoking amount just after birth and its square, grandparent cohabitation dummy, mother's prenatal work status, single mother dummy, prenatal household income, and prefectural and city size dummies.

Table OSM13: Children's Health Outcomes

Sample Selection Rule	**Mothers with College Degrees**		**Mothers without College Degrees**	
Dependent Variables	Outpatient Visit	Inpatient Stay	Outpatient Visit	Inpatient Stay
	(OSM12.1)	(OSM12.2)	(OSM12.3)	(OSM12.4)
Sibling Size	-0.016	0.001	-0.012	-0.006
	(0.030)	(0.010)	(0.035)	(0.013)
Gender Dummy (Boy)	0.021***	0.006***	0.019***	-0.010***
	(0.004)	(0.002)	(0.005)	(0.002)
Observations	40,075	41,281	22,249	23,111
Number of IDs	7,800	7,805	4,518	4,528

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) All regressions are estimated using the random effects instrumental variable (REIV) estimator, with the occurrence of twins at the second birth as the instrument for sibling size.
(4) First-stage estimation results are not reported.
(5) Outpatient (inpatient) visit is a 0–1 dummy variable taking the value 1 if the child had at least one outpatient (inpatient) visit in the relevant year.
(6) All estimations are based on the random effects model in Equation (3).
(7) Additional control variables (not reported) include: dummies for the father's educational level, the mother's and father's ages and their squares, length of pregnancy (weeks), birth weight (kg), mother's smoking amount just after birth and its square, grandparent cohabitation dummy, mother's prenatal work status, single mother dummy, prenatal household income, and prefectural and city size dummies.

Table OSM14: Effect of Number of Siblings on Educational Expenses (by Maternal Education)

(a) Mothers with College Degrees						
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Tuition	Facility Fees	Entrance Fees	Scholarships	Total (1+2+3)	Total – Scholarships
Explanatory Variables	(OSM13a.1)	(OSM13a.2)	(OSM13a.3)	(OSM13a.4)	(OSM13a.5)	(OSM13a.6)
Sibling Size	-0.080	0.070	-0.238	0.055	-0.098	-0.036
	(0.279)	(0.241)	(0.300)	(0.204)	(0.265)	(0.254)
Observations	5,032	4,323	3,398	5,226	5,270	4,952
Number of IDs	0.091	0.035	0.145	0.035	0.058	0.062
(b) Mothers without College Degrees						
	(7)	(8)	(9)	(10)	(11)	(12)
Dependent Variable	Tuition	Facility Fees	Entrance Fees	Scholarships	Total (7+8+9)	Total – Scholarships
Explanatory Variables	(OSM13b.1)	(OSM13b.2)	(OSM13b.3)	(OSM13b.4)	(OSM13b.5)	(OSM13b.6)
Sibling Size	-0.350	-0.096	0.040	-0.256	-0.034	0.040
	(0.264)	(0.298)	(0.295)	(0.278)	(0.262)	(0.270)
Observations	2,807	2,336	1,938	2,822	2,970	2,712
Number of IDs	0.066	0.055	0.099	0.015	0.061	0.063

Notes:
(1) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) All regressions are estimated using the two-stage least squares (2SLS) estimator, with the occurrence of twins at the second birth as the instrument for sibling size.
(4) The dependent variables represent various educational expenses for the first-born child, including tuition, facility fees, entrance fees, scholarships received, and their combinations.
(5) The sample is stratified by the mother's education level (college degree or not).
(6) Additional control variables include dummies for the father's educational level, the mother's and father's ages and their squares, length of pregnancy (weeks), birth weight (kg), mother's smoking amount just after birth and its square, grandparent cohabitation dummy, mother's prenatal work status, single mother dummy, prenatal household income, and prefectural and city size dummies.
(7) First-stage estimation results are omitted for brevity.

Table OSM15: Alternative Specifications for Family Size Effects on *Hensachi* Score

	Full Sample		**Urban**		**Rural**	
	First Stage	2SLS	First Stage	2SLS	First Stage	2SLS
Variables	(OSM14a.1)	(OSM14a.2)	(OSM14a.3)	(OSM14a.4)	(OSM14a.5)	(OSM14a.6)
(a) Gender Combination of First and Second Born Children						
Family Size		-2.279		-5.227		-0.430
		(2.354)		(4.039)		(2.796)
First Born	-0.106***	1.452***	-0.0886***	0.850*	-0.115***	1.832***
	(0.0115)	(0.298)	(0.0190)	(0.469)	(0.0143)	(0.372)
BoyBoy	-0.002	-0.138	0.003	0.200	-0.005	-0.256
	(0.0124)	(0.136)	(0.0199)	(0.279)	(0.0158)	(0.161)
GirlGirl	-0.005	1.013***	0.019	1.389***	-0.017	0.896***
	(0.0090)	(0.133)	(0.0148)	(0.252)	(0.0114)	(0.166)
Cragg–Donald Wald F	20.05		8.83		12.74	
Hansen J statistic		0.459		0.010		0.506
Chi-sq(1) p-val		0.4981		0.9190		0.4769
Observations	16,181	16,181	5,374	5,374	10,807	10,807
R-squared	0.073	0.226	0.075	0.180	0.073	0.218
	(7)	(8)	(9)	(10)	(11)	(12)
(b) Gender Combination of First, Second, and Third Born Children						
Variables	(OSM14b.1)	(OSM14b.2)	(OSM14b.3)	(OSM14b.4)	(OSM14b.5)	(OSM14b.6)
Family Size		-0.851		-12.43		5.569
		(6.317)		(13.30)		(9.020)
First Born	-0.126***	2.929***	-0.0854*	1.465	-0.144***	4.057***
	(0.0265)	(0.878)	(0.0511)	(1.458)	(0.0312)	(1.363)
Second Born	-0.118***	1.224	-0.0849***	0.273	-0.133***	2.059*
	(0.0166)	(0.789)	(0.0315)	(1.279)	(0.0195)	(1.227)
BoyBoyBoy	0.0458**		0.0475		0.0414	
	(0.0224)		(0.0434)		(0.0260)	
GirlGirlGirl	0.0278		0.0426		0.0235	
	(0.0271)		(0.0486)		(0.0324)	
Cragg–Donald Wald F	2.65		1.11		1.44	
Hansen J statistic		1.720		0.168		1.207
Chi-sq(1) p-val		0.1897		0.6819		0.2719
Observations	5,874	5,874	1,652	1,652	4,222	4,222
R-squared	0.061	0.224	0.068	-0.239	0.063	0.056

Notes:
(1) All estimations use two-stage least squares (2SLS) with the high school *hensachi* score as the dependent variable.
(2) Standard errors, clustered at the municipality level and robust to heteroskedasticity, are reported in parentheses.
(3) Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
(4) Cragg–Donald Wald F statistics indicate the strength of the instruments. Hansen's J and Chi-squared tests report overidentification results.

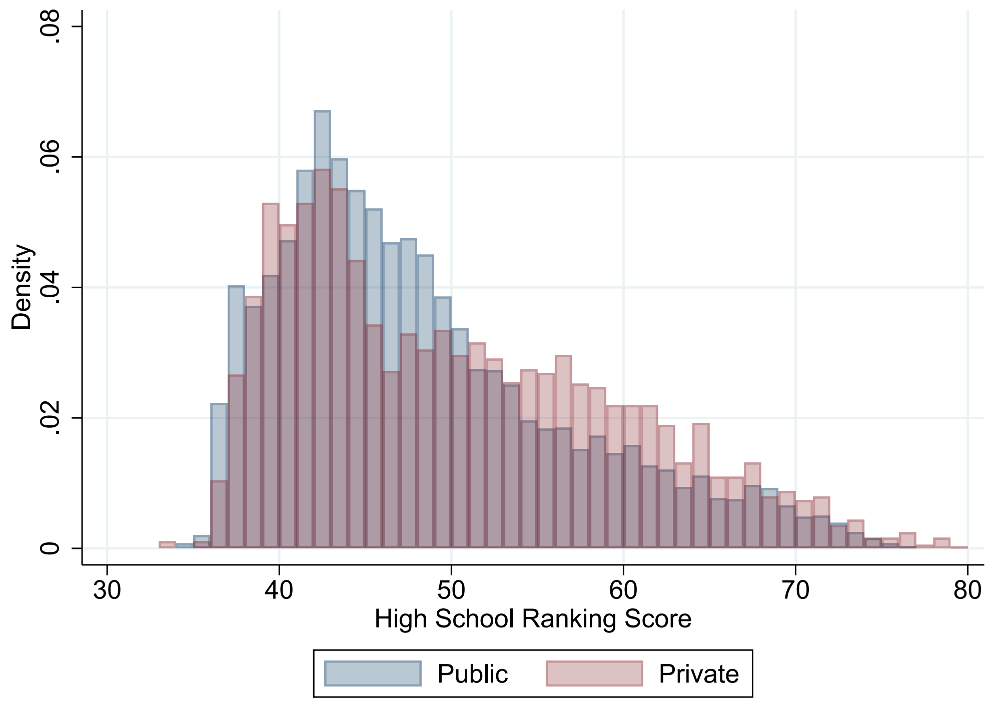

Figure OSM1: Distributions of Senior High School Ranking Scores (*SHSRS*) for Private and Public Schools

Note: This figure presents the distributions of senior high school ranking scores (*SHSRS*) for private and public schools, as used in the samples for Tables 4 and 5. *SHSRS* data were obtained by merging senior high school names from Wave 16 (2017) of the Longitudinal Survey of Newborns in the 21st Century (2001 births), conducted by the Ministry of Health, Labour and Welfare, with *SHSRS* data from the educational portal ReseMom. Integrated schools were excluded by cross-checking the junior and senior high school names attended by each student.

Source: Data obtained by merging the senior high school names from Wave 16 (2017) of the Longitudinal Survey of Newborns in the 21st Century (2001 births) conducted by the Ministry of Health, Labour and Welfare with *SHSRS* data from the educational portal ReseMom.