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The Quantity Quality Trade-off of Children and Quality of High School*

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Abstract

Using data from the Longitudinal Survey of Newborns in the 21st Century, we examine the effect of sibship size on high school standardized rank score in Japan. Using twin births as a control variable, the causal effect of sibling size on high school standardized *hensachi* scores is not found in the pooled sample across Japan, but emerges only when we divide the sample into urban and rural areas. We also find that when the number of children increases, parents and children in urban areas try to mitigate the adverse effects on *hensachi* by increasing the inputs of study time and conversations with parents. On the other hand, rural parents and their children reinforce the adverse effects by reducing their inputs.

1 Introduction

The trade-off between quantity and quality of children, i.e., sibling size negatively affects child outcomes, is one of the main economic theories of household fertility behavior (Becker

*We thank seminar participants at Kansai Labor Workshop, Empirical Moral Science Workshop, the Family Economics Workshop at Keio University for helpful comments. The data used in this paper come from the Japanese Ministry of Health, Labour and Welfare's Longitudinal Survey of Newborns in the 21st Century (21 seiki shusshoji judan chosa) and the Live Birth Form of Vital Statistics (Jinko dotai chosa shusseihyo).

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and Lewis (1973)), but previous studies that conduct empirical analysis using data from developed countries find that this theory does not necessarily hold. Using twin births as an instrumental variable, for example, Black et al. (2005) used a large Norwegian data set to measure the causal effect of an increase in the number of children and found that controlling for birth order effects, the impact on educational attainment was negligible. Similar conclusion is also reached in the Angrist et al. (2010) using Israeli data.[1] The prevailing view behind these studies is that schooling is publicly provided in many developed countries, with parents bearing little cost. In addition, regulations on child labor have kept the opportunity cost of children's time low, allowing parents to send their children to school even as the number of children increases (See Doepke (2015), Liu (2015) and Clarke (2018) for detailed surveys).

Unlike previous studies, as a measure of child quality, this study focuses on enrollment in selective high schools, where students are selected based on academic achievement and entrance examinations. We regard attending children in selective high schools because of their high performance in getting into top universities as a parental investment in their children to increase their children's chances of acceptance into post-secondary institutions. In the United States, given the intense competition for four-year colleges and universities, students prepare better academically by taking more challenging courses and participating in activities that are viewed favorably by admissions committees (Bound et al. (2009)) and well-educated parents increased their childcare time as an optimal response to increased competition for scarce university slots (Ramey and Ramey (2009).

In addition, East Asian countries, such as Japan, Korea, and China, students use private cram schools (which is called "shadow education") in addition to public educational institutions to prepare for higher education facilities after the compulsory education is completed (Bray and Lykins (2012), Entrich (2017)).

Our focus is that parents' motivations to provide their children with a higher quality

[1] However, studies using data from developing countries such as India and China provide evidence in support of the quantity-quality trade-off (Rosenzweig and Wolpin (1980), Rosenzweig and Zhang (2009)).

secondary education to prepare their children for the fierce competition of university entrance examinations may be placing financial and time burdens on families in developed countries. From this focus, we expect that, even in developed countries, there will be a trade-off between quantity and quality of children, where the quality of the high school education that parents provide for their children is adversely affected when the number of children/siblings increases.

Another focus is that the strength of this motivation differs between urban and rural areas. In the U.S., competition for high school graduates' college aspirations is most intense in the Northeast region and in California (Bound et al. (2009)), while in Japan, competition for entrance exams is more intense in the Tokyo metropolitan area and around Osaka (Tsuneyoshi (2013)). While 7.4% of all junior high school students attend private schools, the highest percentage is in Tokyo, where one out of every four junior high school students attends a private school. In urban prefectures such as Osaka, Kanagawa, and Kyoto, the percentages are higher than average, ranging from 10-13% (Japan Institute of Life Insurance[2]). Therefore, when attempting to estimate the trade-off between the quantity of children and the quality of secondary education, the sample needs to be divided between urban and rural areas, taking into account the severity of exam competition in urban areas.

This paper examines how the number of siblings affects the quality of high schools attended by children. We utilize long-term panel data from the Longitudinal Study of the Newborn in the 21st Century (NLS2001), which covers Japanese children born in 2001 and provides important information related to children's schooling, such as the name of the high school the child attended. The advantage of using this information is that the responses to the questions are convertible into the high school ranking score (*hensachi* score, see below). Since Japan's high school enrollment rate is close to 100%, it is possible to compare the quality of high schools for the majority of the children used in the analysis. Note that regarding the quality of the universities attended, the university enrollment rate is about 60%, so it is impossible to observe children who do not go to universities by using *hensachi*

[2]https://www.jili.or.jp/lifeplan/lifeevent/789.html

score. Furthermore, note that the information on years of education used in many studies does not identify quality within the same number of years of schooling.

Another unique feature of this survey compared to other nationally representative household surveys is that it asks a wide range of questions about parental investment and expenditures: spending on children (e.g., extracurricular activities and cram schools), time parents spend with their children, talking with their children, and children's study time. Mothers and fathers were asked about their employment status. These items can be considered inputs to the child's production function. Cáceres-Delpiano (2006) says that focusing on inputs rather than using outcomes is a more powerful test because inputs are one step closer to assessing the effect of family size in the causal chain. In addition, an increase in the number of children can reveal whether parents attempt to mitigate or enhance the adverse effects on child quality by reallocating these inputs.

Even though there is a rich variation in the *hensachi* score, there is an identification problem because the quality and quantity of children are determined jointly. Therefore, the observed correlations do not necessarily reflect causal relationships. One possibility is that, for example, unobserved factors may cause parents, especially mothers, to quit their jobs and join the household. This will lead to changes in household budgets and how they interact with their children. The housewife may then choose to have a small family and raise her children more generously. Another possibility is the bias from simultaneity. The high quality of the youngest child may make them feel that they do not need to have another child (Black et al. (2005) points out this possibility).

To address this identification problem, we adopt an instrumental variable method and use twin births as a source of exogenous variation in family size following Rosenzweig and Wolpin (1980). In the baseline specification, we add twins at the second birth as an instrumental variable to control the selection bias. In addition, given that indicators of maternal health and health-related behaviors and exposures are systematically positively correlated with the probability of twin births (Bhalotra and Clarke (2020)), we will control for child birth weight, gestational weeks, and maternal smoking. As an alternative specification, we also try to estimate using twins at the third birth as the instrumental variable with first-born and second-born sample and identify the effect of birth order (Black et al. (2005)).

The main empirical result is that the causal impacts of family size on the quality of high school, measured by the standardized *hensachi* score of the high school the child attends is not found in the pooled sample across Japan, but emerges only when we divide the sample into urban and rural areas. We find that each additional child is associated with 3.4 points decrease in *hensachi* score for first-born children with one or more siblings in the urban area and 3.3 points for first- and second-born children with two or more siblings in rural area, respectively. Our uniquely rich data set also allows us to explore the mechanisms behind the differences in trade-offs between urban and rural areas. We find contrasting reallocation behaviors in urban and rural households concerning household resources. In urban areas, households mitigate the adverse effects of having more children by substituting fewer extracurricular activities, such as piano and swimming, for more study time outside of school and more conversations with parents as the number of children increases. In rural areas, by contrast, households instead reinforce the harmful effects of an additional child by reducing their input into children's educational production, including spending on extracurricular activities and cram school, study time outside of school, and conversations with parents. The mitigating and reinforcing effects of the reallocation of resources within the household may exaggerate the trade-off between the number of siblings and the quality of the high school children attend, underestimating it (i.e., in the direction of no adverse effects) in urban areas and overestimating it (i.e., in the direction of adverse effects) in rural areas.

We conducte the estimation with several additional specifications. First, the sample is analyzed separately by parental education level, household income, and child gender. The results show a strong trade-off between the number of siblings and high school *hensachi* score for boys from highly educated households. We find that parents with higher socioeconomic status in urban areas are willing to invest in the education of their boys in high school. Our results are unaffected by the specific choice of child output variables, such as acceptance rate to a prominent university or the percentage of children who attend a middle or high school. Furthermore, the rate of children entering high school in rural areas also increases. Finally, the results were also robust when another instrumental variable, the combination of gender of the first and second child, was selected as the instrumental variable (Angrist and Evans (1998)).

The rest of this paper is organized as follows. In Section 2, we describe educational background in Japan. Section 3 explain the data we use. We explains our empirical strategy and then we show the descriptive statistics in Section 4. Section 5 reports the result. In Section 6, we discuss the mechanism behind our main results. Section 7 checks the robustness of our findings. Section 8 concludes the paper.

2 Education in Japan

This section outlines three aspects of Japanese education relevant to this study.

The first is the institutional background of education in Japan. The Fundamental Law of Education and the School Education Law in 1947 stipulated that the period of compulsory education is nine years, consisting of six years of elementary school and three years of junior high school and recently most children attend high school after graduating from junior high school. The percentage of students who go on to high school is now 98%. After graduating from high school, students who wish to enter a university, especially a difficult-to-enter university, must pass entrance exams, which are paper tests taken only once a year. In 2020, the university enrollment rate is 54.4 percent (according to the 2020 Basic School Survey).

The second is that how to measure the quality of schools in Japan. In Japan, a standardized score called the *hensachi* (deviation value, literally in Japanese) is often used to measure the quality of schools (Højlund Roesgaard (2006), Entrich (2017), p.133). Large private cram schools, called *juku*, conduct mock exams on a national scale and derive the relative position of each test taker with a standardized score, where the mean is 50 and the standard deviation is 10 (test taker's *hensachi* score). Then, by comparing the *hensachi* scores of past test takers with the actual pass/fail results, high school *hensachi* is calculated as a border or threshold value for the difficulty of each high school entrance exam (Goodman and Oka (2018)). It has been published as distribution tables by *juku* as an index of the difficulty level of the entrance exam for each school. Thus, *hensachi* score is an important indicator for junior high school students to determine the quality of high school. The relationship between school *hensachi* score and children's academic performance was examined by Kondo (2014), who indicated that the difference in school quality was reflected in the *hensachi* score of junior high schools.[3]

Third, we characterize Japan by a large education spending on their children. Japanese families try to increase their chances of being accepted into the desired university by enrolling their children in high schools with a high achievement rate in getting into difficult-to-enter universities. Japanese families also send their children to cram schools. According to the results of the National Survey of Academic Performance and Learning (2017) conducted by the Ministry of Education, Culture, Sports, Science and Technology, 46.3% of sixth-grade of elementary school students and 61.2% of third-grade of junior high school students attended cram school. Then, it is a considerable financial burden for parents to send their children to higher quality schools because high quality schools are not only in the public sector but also in the private sector. For example, according to the 2016 Household Survey on Educational Expenditures per Student, there is a significant difference between public and private schools in terms of cost. At the junior high school level, the cost of schooling is about 480,000 yen for public schools and about 1,330,000 yen for private schools. At the high school level, the cost is 450,000 yen for public schools and 1,040,000 yen for private schools, which is about

[3]Previous studies outside Japan that have examined whether going to a higher-ranked high school improves academic performance include Cullen et al. (2006), Clark (2010), and Pop-Eleches and Urquiola (2013).

2.3 to 2.8 times the cost of public schools. Note that whether a school is of good quality is not necessarily positively correlated with tuition.

3 Data

We use data from the Longitudinal Survey of Newborns in the 21st Century (LSN2001), a parent-child-level panel data set conducted by the Ministry of Health, Labour and Welfare (MHLW). LSN2001 has recorded all 53,575 babies (including multiple births) born in Japan on January 10-17 and July 10-17 in 2001. The first survey in 2001 collected 47,015 pairs of parents and children (collection rate: 87.8%). Since then, the collection rate for each year has been about 90%, and, when the children entered high school in the sixteenth survey in 2017, 26,900 parent-child pairs remained.[4] MHLW's website provides a summary of this survey in English,[5] and Sakata et al. (2015) provide a summary of this survey in Japanese.

This data set includes variables on schooling, household composition, education at home, monthly child-rearing expenses, parental employment status, and municipality-level residency. Using the information on sibling composition, we obtain the sibling size by counting the number of children in the household. If a parent works away from home alone and is absent for more than three months, he or she is not included in the same household, but if he or she returns home at least once every three months, he or she is included in the same household.

The dataset includes an identifier for whether the children surveyed are twins or not: 478 (1.78%) of the 26,900 are twins. We do not use these twins because they are more likely to be born prematurely, affecting their later life and biasing their scholarly output (Black et al. (2007)). Nevertheless, we use birth weight and gestational week as control variables in our estimation. This restriction leaves us with a total of 26,422 non-twin children. For their siblings, twin identifiers are not provided, thus, we define two siblings of a surveyed child in

[4]Since there was a change in the survey timing in the seventh survey, the survey was not conducted in 2007.

[5]https://www.mhlw.go.jp/english/database/db-hw/vs03.html

the same household as twins if they report being born in the same year and month.

Table 1 shows the distribution of sibship size for the 26,422 non-twin children included in LSN2001 in 2017. More than half of them have only one sibling (that is, two children in their household), and three or more siblings (four or more children) are quite rare. There are approximately 11-15 % of only children. In terms of birth order, more than half of the children are first-born, and slightly more than one-third are second-born. Over 10 percent are third and subsequent children.

	Urban Areas				Rural Areas			
Number of Siblings	1st-born Children	2nd-born Children	3rd or later-born Children	Total	1st-born Children	2nd-born Children	3rd or later-born Children	Total
0	1,576	-	-	1,576	1,767	-	-	1,767
	(28.69)	-	-	(14.74)	(23.26)	-	-	(11.23)
1	2,950	3,098	-	6,048	4,094	4,063	-	8,157
	(53.69)	(76.17)	-	(56.58)	(53.89)	(70.99)	-	(51.85)
2	829	841	885	2,555	1,469	1,405	1,797	4,671
	(15.09)	(20.68)	(78.46)	(23.9)	(19.34)	(24.55)	(74.47)	(29.69)
3	111	105	184	400	226	213	483	922
	(2.02)	(2.58)	(16.31)	(3.74)	(2.97)	(3.72)	(20.02)	(5.86)
4	20	14	40	74	32	27	94	153
	(0.36)	(0.34)	(3.55)	(0.69)	(0.42)	(0.47)	(3.9)	(0.97)
5+	8	9	19	36	9	15	39	63
	(0.15)	(0.22)	(1.68)	(0.34)	(0.12)	(0.26)	(1.62)	(0.40)
Total	5,494	4,067	1,128	10,689	7,597	5,723	2,413	15,733
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)

Table 1: Distribution of Number of Siblings by Birth Order. In 2017, of the 26,900 remaining children, 26,422 are non-twin.

One of the LSN2001 data advantages is that it asks children to name the high school they attend, allowing us to match that information with the high school's *hensachi* score, and, we use *hensachi* as an indicator variable to measure the selectivity of the high schools that the children attend for the analysis. We obtained the 2017 *hensachi* information for each high school from ReseMom[6], an educational information site that contains *hensachi* rankings for almost all high schools in Japan. The site notes that the *hensachi* information is provided

[6]https://resemom.jp/feature/hensachi/

by major cram schools. Out of the above 26,900 children, 26,625 are enrolled in higher educational institutions. There are 19 who are employed and 256 who are other/unknown. Since the *hensachi* score is not available for technical colleges, specialized training colleges, and special needs schools, we can assign the high school *hensachi* score to 24,287 children's high schools. Figure 1 shows the histograms of the *hensachi* scores, divided into urban areas and rural areas. The *hensachi* scores of the high schools the children attend are distributed between 33 and 86. The mean and standard deviation are 56.5 and 9.9 in urban areas and 52.9 and 9.3 in rural areas. The distributions are skewed to the right, with the degree being greater in rural areas (Skewness is 0.12 for urban and 0.39 for rural).

Several studies have examined the reliability of the *hensachi* scores as an indicator of school selectivity. Abe (2002) used school-level panel data and found a cross-sectional relationship between university entrance exam *hensachi* scores and labor market performance. Kondo (2014) found a strong correlation between the relationship between *hensachi* score at entrance to private girls' junior high schools in Tokyo and Kanagawa prefectures and university admission performance.

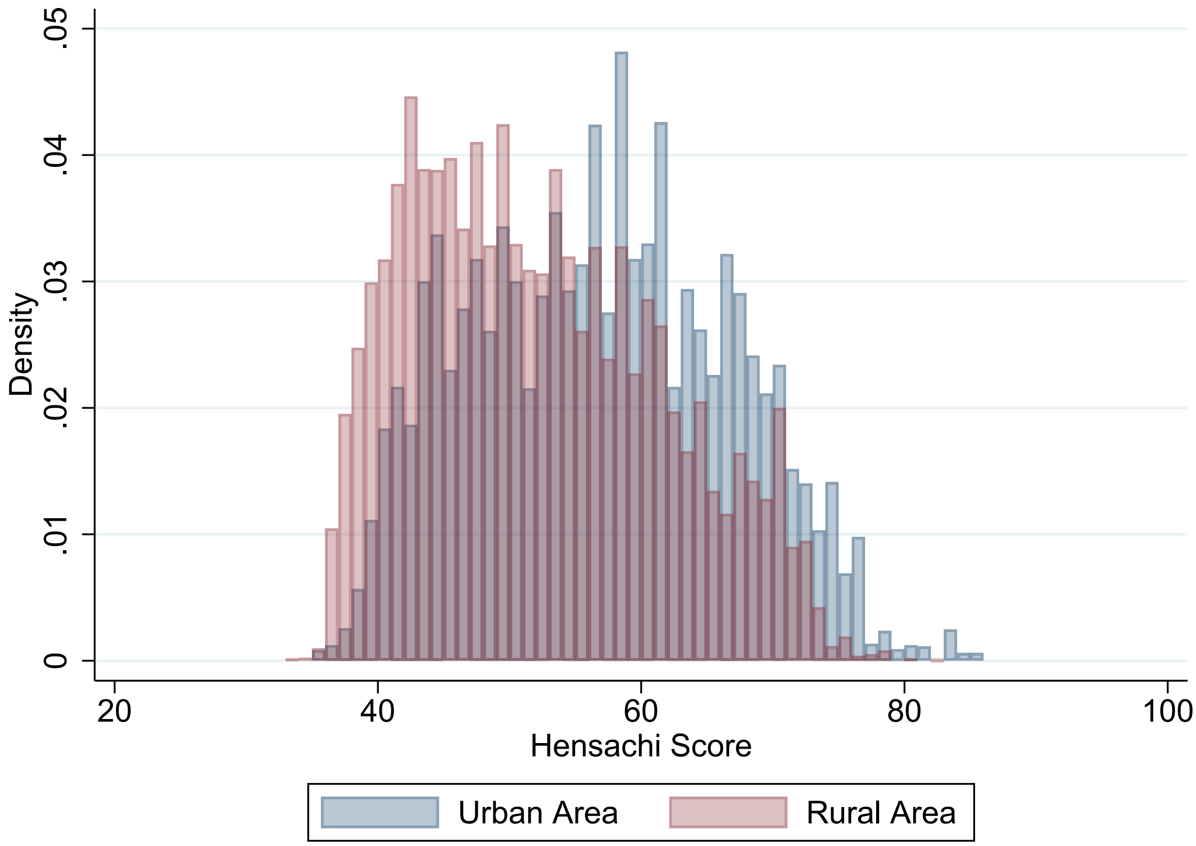
4 Empirical model

To identify the causal effect of the number of siblings on the quality of children, we consider the following equation (1), which states:

$$y_i = \beta_0 + \beta_1 size_i + \mathbf{X}_i\beta_2 + \mathbf{Z}_i\beta_3 + \varepsilon_i, \tag{1}$$

where the variable y_i on the left-hand side is the quality of the target child i, as measured by the *hensachi* score of the high school they attend. The right-hand side variable $size_i$ is the number of their siblings in the family. We focus on the coefficient β_1, which reveals the trade-off between quantity and quality. $\mathbf{X}_i$ is a vector of child characteristics, including the child's sex, the month of birth (representing birth in July) and birth order (if applicable). We

Figure 1: The Distributions of *Hensachi* Score. 9,694 children in urban areas and 17,203 children in rural areas whose *hensachi* scores for the high school they attend are known.



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add the child i's birth weight and gestational week to control for future adverse outcomes of premature babies (Black et al. (2007)). $\mathbf{Z}_i$ contains variables for parental attributes, including age and age squared of mother and father, university degree of mother and father, years living with grandparents, city size of residence, employment status of mothers and fathers before childbirth. In addition, to control for maternal health and maternal health-related behaviors and exposures, we add maternal smoking. Bhalotra and Clarke (2020) states that if unobserved maternal health is positively selected for twin births and positively correlated with children's educational output, then the estimate of β_1 with twins as IV tends to have an upward bias (toward no trade-off). They argue that addressing the omission of variables related to maternal health can adjust for the upward bias that IV estimates have.

The coefficients β_1 estimated by ordinary least squares (OLS) suggest correlation, not causation, as the number of siblings is likely endogenous. If unobserved aspects (e.g., unemployment or illness) result in fewer available resources, parents may seek to have larger families and invest less in their children. When adverse shocks occur, they may try to pursue economies of scale or receive child benefits by increasing family size and reducing spending on children. In addition, the high preference for full-time homemakers among women may lead parents to choose larger families and have more time to focus on their children's education. There is also the possibility of reverse causality. The child's outcome may influence whether the parents will try to have one more child. For example, a newborn child's low or high quality may influence parents to have additional children, either by complementing it or by being satisfied that it is adequate. Black et al. (2005) state that the effect of the last child follows the rule of optimal stopping.

Therefore, following Rosenzweig and Wolpin (1980) and Black et al. (2005), we use twin births as an instrumental variable for the number of siblings. If twin births are determined independently of parental characteristics, then we can use the births of twins as an instrumental variable for sibling size to remove bias arising from omitted variables and simultaneity. Then, the first stage of the two-stage least squares (2SLS) method is given as follows:

$$size_i = \alpha_0 + \alpha_1 twin_i + X_i\alpha_2 + Z_i\alpha_3 + \nu_i, \tag{2}$$

where $twin_i$ is a binary variable that takes the value one if there are twins at the n-th birth ($n = 2, 3$) and 0 if there are not. In order for this method of using twins as the instrumental variable to make sense, there must be a correlation between twin births and the number of siblings. In other words, the effect of twin births on the number of siblings, i.e., the first-stage regression of the 2SLS model, must have explanatory power. As Table 2 shows, the birth of twins at the second birth increases the number of siblings the firstborn children has by about 0.90 in the full sample. For the sample of children living in the urban area, the effect of twins is 0.92, which is higher than 0.87 in the rural area. The effect of twins at the third birth shows almost the same pattern. Looking at the F statistics corresponding to the null hypothesis that the coefficient of the instrumental variable in the first-stage regression is zero, they ranged from 24.8 to 174.4, well above the Staiger et al. (1997) guideline of 10, suggesting that there is no concern that the twin instrumental variable is weak. This suggests that there is no concern about the weak instrumental variable for twins.

	Sibling size		
	Full Sample	Urban	Rural
VARIABLES	(1)	(2)	(3)
(a) First-born Children with One or More Siblings			
Twin at Second Birth	0.898***	0.923***	0.871***
	(0.0484)	(0.0753)	(0.0624)
Cragg-Donald Wald F statistic	174.389	99.19	78.625
Observations	8,565	3,461	5,104
R-squared	0.080	0.088	0.076
	(4)	(5)	(6)
(b) First- and Second-born Children with Two or More Siblings			
Twin at Third Birth	0.892***	0.909***	0.876***
	(0.0491)	(0.0389)	(0.0732)
First Born	-0.0549***	-0.0551	-0.0512**
	(0.0196)	(0.0366)	(0.0224)
Cragg-Donald Wald F statistic	70.98	24.776	45.092
Observations	4,630	1,701	2,929
R-squared	0.055	0.065	0.058

Table 2: First Stage Estimates of Sibling Size. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Robust standard errors are reported in parentheses. The F-statistic corresponds to the null hypothesis that the coefficient on the instrument (twin births) is zero. The sample consisted of non-twin children. We include child characteristics (sex, birth month), parental attributes (age and age squared of mother and father, university degree of mother and father, years living with grandparents, and city size of residence, employment status of mothers and fathers before childbirth), maternal health (child's birth weight, gestational week, and maternal smoking), but we omit them in this Table.

Considering that the severity of competition in high school choice differs between metropolitan prefectures and other rural prefectures, the causal effect of family size will differ with the household's region of residence. Therefore, we conducted separate regressions for the two metropolitan areas (Tokyo and Saitama, Chiba, Kanagawa, Kyoto, Osaka, Hyogo) and the other 40 prefectures.

4.1 Sample Selection

As noted in the Data section, there are 24,287 children attending high schools for which *hensachi* information is available in 2017. We use the following two samples for our analysis. The first one consists of firstborn children with at least one sibling and is analyzed with the *hensachi* score of the first child as an output variable and twins at the second birth as the instrumental variable. If we restrict to children with all the necessary information for analysis, there remain 3,461 children in urban areas and 5,104 children in rural areas. The second sample consists of the first- and second-born children with at least two siblings. Using this sample, we analyze the *hensachi* scores of the first and second children with twins at the third birth as the instrumental variable. In this second sample, there are 1,701 children available in urban areas and 2,929 in rural areas.

Table 3 shows the descriptive statistics of the sample used in the analysis. The left two columns show the mean and standard deviation for the first-born children in families with two or more children, and the right two columns show those of first and second children with two or more siblings.

From these descriptive statistics, we note three things. First, the *hensachi* score for the high school attended by the first children with one or more siblings is statistically significantly higher in urban areas than in rural areas (57.03 vs. 53.53 (Panel (a)). The same is true for first and second children with two or more siblings (55.03 vs. 52.05 (Panel (b)), which means that the *hensachi* score is higher with fewer siblings and in urban living. Second, the size of siblings for the first child with one or more siblings is 1.29 in urban areas and 1.35 in rural areas, a statistically significant difference (Panel (a)), whereas that for the first and second child with two or more siblings is 2.16 in urban areas and 2.18 in rural areas, which is not a significant difference (Panel (b)). Third, compared to the rural areas, mothers and fathers are older and more educated in the urban areas. In addition, in rural areas, children live with their grandparents for longer years, and more mothers work before the birth of their children.

5 Main Results

We first present the correlation between the *hensachi* score of the high school attended and the number of siblings in the raw data. Figure 2 plots the average *hensachi* score of the high school children attended against the number of siblings, separately for the sample of firstborn children with one or more siblings (Panel (a)) and the sample of first- and second-born children with two or more siblings (Panel (b)). In both panels, all curves show a downward relationship. In other words, the more siblings a child has, the lower his or her *hensachi* scores are in the high school he or she attends. In addition, the urban graph (blue line) is higher than the rural graph (red line), indicating that children living in urban areas attend high schools with higher *hensachi* scores than children living in rural areas.

Table 4 is our main results showing the results for the full sample and for urban and rural samples separately. Panel (a) shows the results for the *hensachi* score of high school attended by the first-born children with at least one sibling, while Panel (b) shows the results for the first- and second-born children with at least two siblings. These estimations include all the control variables listed in Section 4, but for space considerations, coefficients other than the number of siblings are not shown (in Panel (b), a dummy variable for birth order is shown.)

Similar to the pattern observed in Figure 2, the OLS estimates consistently show a significant negative correlation between sibling size and the quality of the child's high school, regardless of regional separation or whether we include second-born children. In sum, the OLS coefficients suggest that, holding everything else constant, an additional sibling reduces the *hensachi* score of the high school children attend by about 0.71 to 1.28 points. However,

Variable	Urban Mean	Urban Std. dev.	Rural Mean	Rural Std. dev.
(a) First-born Children with One or More Siblings				
Hensachi Score	57.03	9.65	53.53	9.31 ***
Sibling Size	1.29	0.56	1.35	0.60 ***
Twin at Second Birth	0.01	0.099	0.007	0.084
Mother's Age	44.84	3.46	44.1	3.61 ***
Father's Age	46.88	4.56	45.91	4.58 ***
University Degree (Mother and Father)	0.18	0.38	0.11	0.31 ***
University Degree (Only Mother)	0.04	0.20	0.04	0.19
University Degree (Only Father)	0.32	0.47	0.24	0.43 ***
Living with Grandparents (Year)	1.96	4.22	3.69	5.48 ***
Gestational Period (Week)	39.6	1.38	39.57	1.43
Birth Weight (kg)	3.02	0.39	3.01	0.39
Mother's Smoking (Amount Per Day)	1.03	3.58	1.08	3.62
Ordinance-designated Cities	0.41	0.49	0.16	0.36 ***
Other Cities	0.56	0.50	0.72	0.45 ***
Employment Before Birth (Mother)	0.73	0.44	0.8	0.40 ***
Employment Before Birth (Father)	0.98	0.14	0.98	0.14
Annual Household Income Before Birth+	648.7	418.08	559.71	254.2 ***
Observations	3,461		5,104	
(b) First- and Second-born Children with Two or More Siblings				
Hensachi Score	55.03	9.49	52.05	9.08 ***
Sibling Size	2.16	0.49	2.18	0.51
First Born	0.50	0.50	0.51	0.50
Twin at Third Birth	0.004	0.064	0.005	0.071
Mother's Age	44.83	3.56	44.19	3.63 ***
Father's Age	46.9	4.53	46.17	4.61 ***
University Degree (Mother and Father)	0.16	0.36	0.11	0.31 ***
University Degree (Only Mother)	0.04	0.20	0.03	0.17 *
University Degree (Only Father)	0.29	0.45	0.23	0.42 ***
Living with Grandparents (Year)	2.17	4.38	4.09	5.69 ***
Gestational Period (Week)	39.5	1.31	39.45	1.47
Birth Weight (kg)	3.08	0.38	3.05	0.40 **
Mother's Smoking (Amount Per Day)	1.32	4.14	1.12	3.81 *
Ordinance-designated Cities	0.39	0.49	0.14	0.35 ***
Other Cities	0.57	0.50	0.73	0.44 ***
Employment Before Birth (Mother)	0.51	0.50	0.61	0.49 ***
Employment Before Birth (Father)	0.98	0.15	0.98	0.12
Annual Household Income Before Birth+	602.91	367.66	536.1	279.51 ***
Observations	1,701		2,929	

Table 3: Descriptive Statistics for the Samples We Use. Significance levels for t tests on the equality of means between urban and rural: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. +: Observations for Annual Household Income Before Birth is 3,298 for urban and 4,808 for rural in Panel (a) and 1,641 for urban and 2,763 for rural in Panel (b).

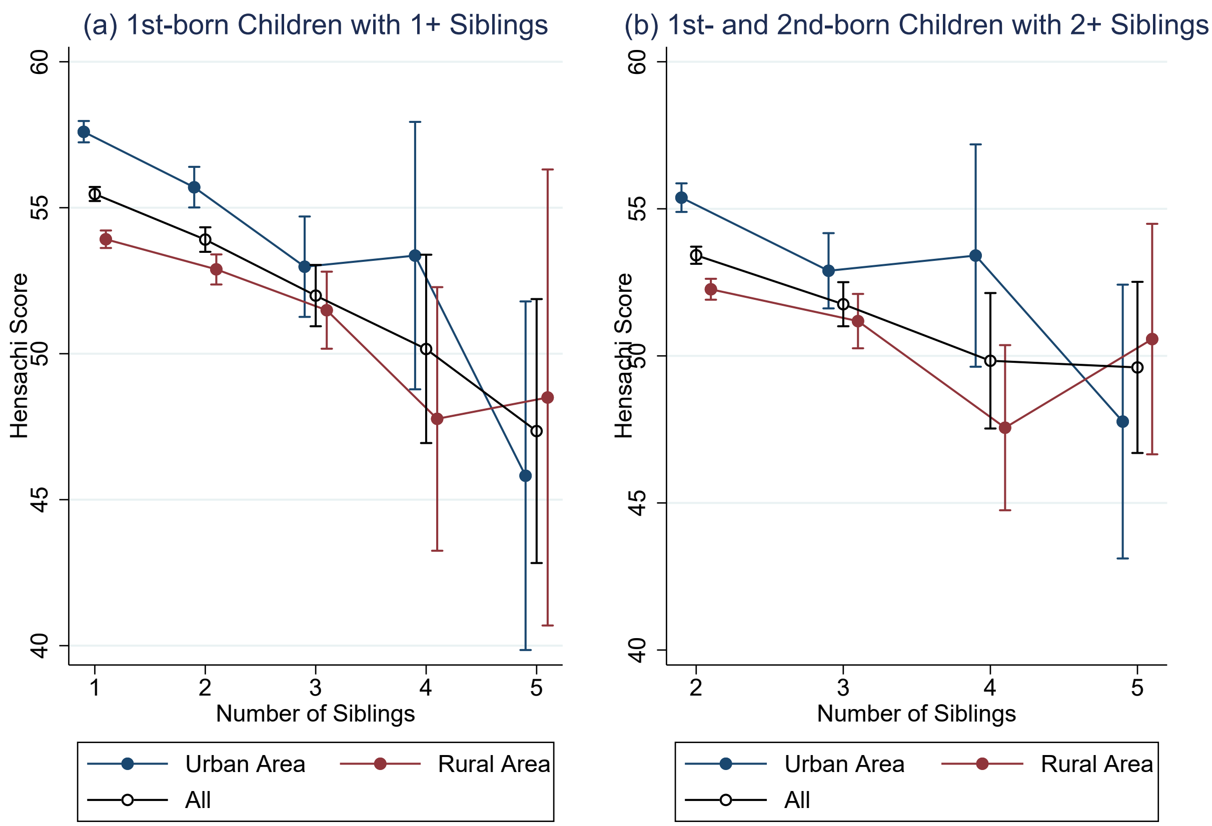

Figure 2: *Hensachi* Score across the Sibling Size. This figure plots the average *hensachi* score of high school students against the number of siblings, divided into urban and rural areas, and pooled for both regions. Panel (a) uses first-born children with one or more siblings in urban areas (3,461 children) and in rural area (5,104) and Panel (b) uses first- and second-born children with two or more siblings in urban area (1,701) and in rural area (2,929). Bars represent 95% confidence intervals. Number of siblings 5 indicates more than or equal to five siblings.

these results do not take into account the endogeneity between the number of siblings and the quality of children, and thus this shows only correlation, not causation.

When we conduct 2SLS estimations using twin instruments with the full sample of children, the coefficient on the number of siblings is negative but not statistically significant (columns (2) in Panel (a) and column (8) in Panel (b)). In Panel (b), we can observe the effect of birth order and find that the eldest children enter high school with a *hensachi* score 1.3 to 1.4 points higher than the second children.

We find that when the sample was pooled and analyzed, no trade-off was observed between quantity and quality for Japanese children, even when endogeneity is taken into account. Black et al. (2005), Angrist et al. (2010), and Doepke (2015) state that the trade-off between quality and quantity is absent or small if it exists, due to the prevalence of inexpensive and universal public education in developed countries. Japan has a school attendance obligation. The obligation to attend school places an obligation on parents to have their children receive six years of elementary school and three years of junior high school education. In such circumstances, the school attendance rate for elementary and junior high school is 100% and the tuition fee is free. In addition, the school environment in Japan is generally uniform and better than in other countries. The OECD's 2013 Teaching and Learning International Survey (TALIS) asked about discipline and learning atmosphere in elementary and junior high schools, and in every question item, Japanese elementary and junior high schools are more relaxed than in participating countries. The results of the survey suggest that the for example, 8.1% of teachers in Japanese junior high schools said that "a lot of time is lost because students interfere in class," compared to the average of 27.1% in the participating countries. Therefore, the result is that Japan also has no developed country-type trade-offs.

Next, we examine the results of splitting the sample into urban and rural areas, which yields statistically significant negative coefficients of sibling size. In columns (4) of Panel (a), we have the coefficient of sibling size turns to be negative and statistically significant for the first-born child with one or more siblings. This means that a one-child increase in the number of siblings is associated with decreases in the high school *hensachi* score by 3.1 points, but the coefficient on sibling size is still not significant in the case of first- and second-born children with two or more siblings (Panel (b)). In the rural area, the coefficient of sibling size is not significant for first-born children with one more siblings but becomes negative and significant in the case of first- and second-born children with two or more siblings. That is, a one-child increase in the number of siblings is associated with decreases in the high school *hensachi* score by 3.3 points.

These estimates implicate the most important claim of this study that the tradeoff between the number of siblings and the quality of the high schools attended by their children emerged only when urban and rural areas were analyzed separately. We interpret that this is due to the difference between urban and rural areas in the behavior of parents who send their children to high schools with high *hensachi* scores in order to take advantage of the fierce competition for the future college entrance exams. To explore the difference in parental behaviors, we need to identify potential mechanisms by which urban and rural households reallocate family resources in response to exogenous increases in children in the background of the tradeoff between the number of siblings and high school *hensachi* score.

6 Mechanisms

In this section, we explores how exogenous births due to twins affect spending on children, time allocation, and mothers' working patterns in urban and rural areas. These input variables in children's educational attainment are more closely tied to parental decision-making when the number of children increases, making them a more robust test than using educational attainment results when assessing the urban-rural difference in the effect of family size (Cáceres-Delpiano (2006)).

	Full Sample		Urban		Rural	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
(a) First-born Children with One or More Siblings						
Sibling Size	-0.936***	-1.378	-1.284***	-3.144**	-0.711***	0.530
	(0.155)	(1.158)	(0.256)	(1.573)	(0.196)	(1.693)
Observations	8,565	8,565	3,461	3,461	5,104	5,104
R-squared	0.245	0.244	0.250	0.239	0.202	0.196
	(7)	(8)	(9)	(10)	(11)	(12)
(b) First-born and Second-born Children with Two or More Siblings						
Sibling Size	-0.961***	-2.773	-1.131***	-1.473	-0.827***	-3.335*
	(0.228)	(1.856)	(0.372)	(4.014)	(0.289)	(1.802)
First Born	1.430***	1.329***	1.333***	1.315**	1.496***	1.359***
	(0.299)	(0.319)	(0.501)	(0.544)	(0.371)	(0.389)
Observations	4,630	4,630	1,701	1,701	2,929	2,929
R-squared	0.227	0.218	0.240	0.240	0.197	0.178

Table 4: Main Results: Sibling Size Effects on *Hensachi* Score. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. We use OLS and 2SLS estimations with high school *hensachi* score as the dependent variable. We include child characteristics (sex, birth month), parental attributes (age and age squared of mother and father, university degree of mother and father, years living with grandparents, and city size of residence, prefecture dummies, employment status of mothers and fathers before childbirth), maternal health (child's birth weight, gestational week, and maternal smoking), but we omit them in this Table. Robust standard errors are reported in parentheses.

6.1 Parental Investment on Children in Terms of Financial and Time

6.1.1 Expenditure on Children

The first group of input variables come from information on financial expenditures on children. The LSN2001 survey forms explicitly ask parents to answer the amount of money spent per month per surveyed child.

We would like to discuss by using the following three categories of expenditures: total expenditures (for example, school, extracurricular activities, cram school, childcare, medical care, food, clothing, and so on)[7], expenditure on extracurricular activities (piano lessons, swimming school, and so on), and cram school expenses. Then, for each of these three expenditure categories, we take the average for preschool (ages -5), elementary school (ages 7-12), and junior high school (ages 13-15). Note that the question about cram school expense has been asked since the seventh survey when the children entered elementary school.

Including these expenditures on the left-hand side of the equation (1), we perform the same 2SLS estimation with twin IV. The results are shown in Table 5. First, we find contrasts between urban and rural areas in the response of households to spending on cram schools when the number of siblings increases. The results of the 2SLS estimation show that in urban areas, the coefficient of the number of siblings on cram school expenditures is not statistically significant. In rural areas, it is negative and significant. Rural households reduce their cram school expenditures (per surveyed child) by 3,500 yen per month for junior high school students and 2,900 yen per month for elementary school students by adding one sibling. Descriptive statistics for these expenditure variables in Table 8 show that the average cost of cram school is higher in urban areas and lower in rural areas. Urban households spend about twice as much per child on cram school during the elementary school years as rural households. In junior high school, the figure is about 1.5 times higher. Thus, urban

[7] The items exemplified in the question on total expenditures vary by age.

households spend high amounts on cram school and do not try to reduce their spending when the number of children increases exogenously. Rural households spend only a small amount on cram school and reduce their spending when they have more children exogenously.

Second, commonly in urban and rural areas, when the sibling size increases from one to two (Panel (a)), we find negative and significant coefficients for the sibling size in extracurricular activity expenditures (such as piano lessons and swimming clubs) in the preschool and elementary school years. When the number of children increases by one, both urban and rural parents decrease their spending on extracurricular activities by 1,600 yen to 4,200 yen. Table 8 of the descriptive statistics shows that for extracurricular activities, there is no large difference between urban and rural areas, ranging from 7,700 yen to 10,700 yen in the elementary school period and from 5,700 yen to 6,500 yen in the junior high school periods.

Note we do not obtain significant coefficients for the total expenditures per child surveyed and, although not shown here, for the expenditures spent on school (educational materials, school lunches, and tuition).

6.1.2 Parental Time Investment and Child's Study Time.

The next group of variables relates to time inputs to a child's educational attainment. In fact, Guryan et al. (2008) shows, using data from 14 industrialized countries, that mothers have spent more time on child care in recent years. It is suggested that the time spent on children have become increasingly important.

In what follows, we use information from the following three questions in the LSN2001.

The first variable is the time parents spend with their children. The LSN 2001 asks how much time mothers and fathers spend together with their surveyed children, either by caring for them or eating with them on weekdays and weekends, intermittently up to and including the fourth grade. LSN2001 instructed respondents to omit time when the children were sleeping. We convert the time spent with the child into hours per day.

The second variable is the frequency of talks with parents. The survey asks children

VARIABLES	Preschool (1)	Urban E.S. (2)	J.H.S. (3)	Preschool (4)	Rural E.S. (5)	J.H.S. (6)
(a) First-born Children with One or More Siblings						
Total	0.622	-1.179	-2.094	-1.630	-2.263	10.15
	(5.196)	(4.004)	(9.969)	(5.494)	(2.799)	(9.391)
Lesson	-4.177***	-1.599**	-1.307	-2.248***	-2.214***	2.747
	(1.521)	(0.724)	(1.373)	(0.860)	(0.827)	(3.838)
Cram		-1.669	-2.259		1.564	-3.454*
		(1.785)	(3.182)		(1.864)	(1.784)
	(7)	(8)	(9)	(10)	(11)	(12)
(b) First-born and Second-born Children with Two or More Siblings						
Total	-0.505	3.604	4.888	25.15	-0.334	-1.943
	(10.12)	(6.925)	(22.95)	(30.35)	(3.717)	(7.165)
Lesson	7.530	1.864	-2.560	-3.010***	1.825	6.216
	(4.991)	(2.157)	(1.667)	(0.927)	(1.737)	(4.716)
Cram		0.453	6.375		-2.920***	-3.691
		(3.360)	(8.177)		(0.868)	(2.546)

Table 5: Family Size Effects on Expenditure on Children (a thousand yen). We use 2SLS estimations with expenditure on children (total expenditures (school expenses, lessons, child care, medical expenses, food, clothing, etc.), the expenses for lessons and sports clubs, and the expenses for cram schools as the dependent variable. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

whether they talk with their mothers and fathers about five different topics during their junior high school period, ranging from "not at all" to "often" on a four-point scale: school, friends, future/career path, studies/achievements, and the social issues. The variables are transformed to take values from 1 to 4 so that the more frequent the talks, the larger the value, and the average of the five topics is taken separately for mothers and fathers.

The third and final variable is the daily study time outside of school, which has been asked since the beginning of elementary school. During the elementary school years, homework and cram school time are answered by parents, while for junior high school students, time spent studying at home or at cram school, including preparation and review for regular classes and studying for exams, is answered by the children themselves on weekdays and weekends. We convert children's study time into hours per day for each elementary and junior high school period.

Similar to the earlier results on spending on children, there is a clear difference between urban and rural areas in the response of time inputs to children's educational attainment when the number of children increases due to twin births. Table 6 shows that in rural areas, the first children with one or more siblings spend less time with their fathers until children's fourth grade and talk less frequently with their mothers and fathers in junior high school age when adding one sibling (column (2)). The first and second children with two or more siblings spend less time studying during elementary school (0.177 hours = 11 minutes per day, column (4)). In urban areas, there are no negative and significant coefficients; instead, households increase these inputs when there are more children exogenously. Study time in junior high school increases by 24 minutes per day ($= 0.4 \times 60$) for the first child with one or more siblings in urban areas, and talk with the mother and father increases for the first and second children with two or more siblings. Note that the descriptive statistics in Table 8 do not show as large a difference in spending time with children and studying time between urban and rural areas as in the previous expenditure on children.

6.2 Mother's Working.

An increase in the number of exogenous siblings may lead to changes in mothers' employment status. A priori, it is ambiguous what effect an increase in the number of children has on mothers' labor force participation and full-time employment when such an increase harms children's scholarly output, and parents are concerned about this. This is because mothers may have more money to spend or invest in their children by working (financial incentives), or they may be able to spend more time with their children by working fewer hours (time incentives).

In Table 7, we report the results of the impact of an increase in the number of siblings on mothers' labor force participation, full-time employment, working hours (both mothers and fathers), and mothers' annual income as the dependent variables on the left-hand side of

	(1)	(2)	(3)	(4)
	(a) First-born Children with One or More Siblings		(b) First- and Second-born Children with Two or More Siblings	
VARIABLES	Urban	Rural	Urban	Rural
Time with Mother	-0.146	-0.0927	-0.0960	-0.281
	(0.184)	(0.162)	(0.359)	(0.284)
Time with Father	-0.124	-0.459**	-0.0217	-0.314
	(0.219)	(0.228)	(0.376)	(0.333)
Talk with Mother	0.117	-0.225**	0.635***	0.0481
	(0.108)	(0.106)	(0.132)	(0.148)
Talk with Father	0.120	-0.336***	0.404**	0.0118
	(0.126)	(0.120)	(0.182)	(0.187)
Study Time (E.S.)	-0.004	-0.122	-0.179	-0.177**
	(0.104)	(0.0760)	(0.184)	(0.0873)
Study Time (J.H.S.)	0.397*	-0.195	0.371	-0.108
	(0.213)	(0.161)	(0.397)	(0.206)

Table 6: Family Size Effects on Parental Time Investment and Child's Study Time. We use 2SLS estimations with time with mother and father (hours per day), talk with mother and father ("not at all (1)" to "often (4)", children's study time (hours per day) as the dependent variable. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

equation (1). Note that we average each of the variables for employment over the preschool, elementary school, and junior high school years.

Differences between urban and rural areas are also evident concerning mothers' employment. Statistically significant coefficients on the number of siblings are obtained mainly in the estimations with full-time employment and the mother's annual income as dependent variables. And it is concerning the magnitude of the coefficient that we find differences between urban and rural areas. On the one hand, in rural areas, the percentage of mothers working full-time declines by 12% to 24% points after one additional child is born. On the other hand, in urban areas, the percentage of mothers working full-time declines by 9% to 13% points drop, and it is not statistically significant for mothers of children with one or more siblings (columns (1) to (3)). The small or insignificant absolute value of the coefficients for urban areas may be because more urban mothers in the LSN2001 sample are non-working or working part-time, if at all, than rural mothers. More mothers in urban areas are likely to have a higher propensity to be housewives than those in rural areas. In fact, in Table 8, the labor force participation rate and the percentage of mothers working full-time are about ten percentage points higher in rural areas than in urban areas, with mothers working about 6 hours longer per week and earning about 250,000 more per year. In addition, for urban households with more children (column (7) in Panel (B)), we find a division of labor in which mothers work fewer hours and fathers work longer hours when their children are in preschool. We conducted similar estimations for fathers but obtained no significant results other than fathers' working hours significantly getting longer.

	Urban Area			Rural Area		
	Preschool	E.S.	J.H.S.	Preschool	E.S.	J.H.S.
	(1)	(2)	(3)	(4)	(5)	(6)
(a) First-born Children with One or More Siblings						
LFP	-0.0551	-0.0234	0.0313	-0.0939	0.0968	0.159***
	(0.0642)	(0.0663)	(0.0743)	(0.0663)	(0.0625)	(0.0432)
Fulltime	0.00439	-0.0231	0.0364	-0.136***	-0.175***	-0.122**
	(0.0583)	(0.0552)	(0.0672)	(0.0468)	(0.0433)	(0.0546)
Work Hour (Mother)	-2.686	-1.347		-3.687	-4.311	
	(1.652)	(2.628)		(2.381)	(3.523)	
Work Hour (Father)	0.692	2.055		1.014	2.004	
	(2.092)	(2.414)		(1.808)	(2.251)	
Annual Salary (Mother)	-12.83	-26.39	-17.62	-39.74***	-42.33***	-30.53*
	(21.69)	(24.85)	(26.65)	(12.91)	(14.18)	(16.32)
	(7)	(8)	(9)	(10)	(11)	(12)
(b) First-born and Second-born Children with Two or More Siblings						
LFP	-0.0644	-0.0281	0.0420	-0.0552	0.0863	-0.116
	(0.108)	(0.159)	(0.162)	(0.0971)	(0.111)	(0.103)
Fulltime	-0.0119	-0.0915**	-0.126***	-0.120**	-0.162***	-0.238***
	(0.0591)	(0.0406)	(0.0383)	(0.0598)	(0.0562)	(0.0640)
Work Hour (Mother)	-4.629**	-1.945		-3.167	-3.947	
	(2.202)	(2.465)		(2.979)	(3.928)	
Work Hour (Father)	8.028*	7.067		2.326	-1.957	
	(4.835)	(5.617)		(2.664)	(2.511)	
Annual Salary (Mother)	-21.21	-50.88*	-60.19**	-28.34*	-29.66	-51.13
	(15.95)	(26.48)	(27.13)	(15.16)	(28.43)	(32.79)

Table 7: (a) Family Size Effects on Mother's Working (Labor Market Participation). Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Finally, we summarize these results in this section and discuss how households respond to an exogenous increase in the number of children due to twin births in the background of its adverse effect on *hensachi* scores. The most apparent implication is that there are differences in the responses in reallocating household resources between urban and rural parents when they face a trade-off between the quantity and quality of their children. As the number of children increases in urban areas, substitution occurs in the inputs to children's educational production, from fewer extracurricular activities such as piano and swimming to more study time outside school and more conversations with parents. In the rural areas, however, as the number of children increases, parents reduce all of the inputs in their children's educational production: spending on cram school, study time outside of school, and conversations with parents, in addition to extracurricular activities as piano and swimming.

Our interpretation is that as the number of children increases in urban areas, parents and children try to mitigate the negative impact on hensachi by increasing study time and parental conversational input. Despite these attempts at mitigation, urban households still show a detrimental effect on the *hensachi* score when the number of siblings increased from two to three. Rural parents and children instead reinforce the adverse effects of additional childbearing by reducing their input into their children's educational production, which may have led to the observed negative effect on the *hensachi* score in the rural households when the number of siblings increased three to four. The above discussion confirms our claim that the incentives to send children to higher-quality high schools are more substantial in urban areas than in rural areas. This creates a trade-off between the quantity and quality of the children they attend, even in developed countries.

7 Robustness Checks

This section confirms the robustness of this study's claim that concerning Japanese children, the trade-off between the number of siblings and the quality of the high school their chil-

	Urban			Rural		
	Obs	Mean	S.D.	Obs	Mean	S.D.
(a) First-born Children with One or More Siblings						
(I) Expenditure on Children						
Total (E.S.) +	3,459	41.29	22.4	5,099	34.46	15.89 ***
Total (J.H.S.) +	3,451	78.76	63.88	5,095	61.25	44.13 ***
Cram (E.S.) +	3,398	8.52	11.83	4,887	4.34	6.73 ***
Cram (J.H.S.) +	3,456	27.44	28.95	5,102	18.25	22.81 ***
Lesson (E.S.) +	3,454	10.72	7.19	5,102	8.44	6.35 ***
Lesson (J.H.S.) +	3,459	6.48	16.50	5,104	5.71	12.96 **
(II) Parental Time Investment, Child's Study Time						
Time with Mother++	3,460	5.71	0.90	5,104	5.58	0.91 ***
Time with Father++	3,457	3.14	1.07	5,092	3.42	1.14 ***
Talk (Mother)	3,439	3.03	0.53	5,070	3.00	0.53 ***
Talk (Father)	3,308	2.51	0.64	4,850	2.50	0.63
Study Time (E.S.)++	3,461	1.10	0.60	5,104	1.02	0.46 ***
Study Time (J.H.S.)++	3,457	1.83	0.92	5,103	1.76	0.87 ***
(III) Mother's Working						
LFP (E.S.)	3,461	0.48	0.4	5,104	0.65	0.39 ***
LFP (J.H.S.)	3,459	0.73	0.4	5,104	0.81	0.35 ***
Fulltime (E.S.)	3,461	0.13	0.31	5,104	0.22	0.38 ***
Fulltime (J.H.S.)	3,459	0.17	0.35	5,104	0.27	0.42 ***
Work Hour (Mother)++	3,454	14.29	15.4	5,095	21.06	16.66 ***
Work Hour (Father)++	3,401	57.4	12.67	4,985	55.38	12.11 ***
Annual Salary (Mother, E.S.)+++	3,442	84.94	159.3	5,081	109.87	144.5 ***
Annual Salary (Mother, J.H.S.)+++	3,438	125.3	191.08	5,079	146.73	159 ***
(b) First- and Second-born Children with Two or More Siblings						
(I) Expenditure on Children						
Total (E.S.) +	1,701	36.95	20.64	2,927	32.47	17.11 ***
Total (J.H.S.) +	1,697	72.05	67.68	2,926	56.46	47.03 ***
Cram (E.S.) +	1,655	6.87	10.79	2,783	3.58	6.2 ***
Cram (J.H.S.) +	1,700	24.02	27.34	2,928	14.91	16.85 ***
Lesson (E.S.) +	1,694	9.28	6.13	2,927	7.76	5.93 ***
Lesson (J.H.S.) +	1,700	6.1	20.25	2,929	5.52	10.85
(II) Parental Time Investment, Child's Study Time						
Time with Mother++	1,701	5.60	0.95	2,929	5.47	9.97 ***
Time with Father++	1,697	3.09	1.10	2,926	3.38	1.19 ***
Talk (Mother)	1,688	2.96	0.53	2,904	2.94	0.54
Talk (Father)	1,623	2.41	0.64	2,806	2.43	0.63
Study Time (E.S.)++	1,701	0.98	0.54	2,929	0.96	0.43
Study Time (J.H.S.)++	1,700	1.65	0.93	2,929	1.62	0.85
(III) Mother's Working						
LFP (E.S.)	1,701	0.48	0.4	2,929	0.64	0.39 ***
LFP (J.H.S.)	1,700	0.71	0.4	2,929	0.81	0.35 ***
Fulltime (E.S.)	1,701	0.13	0.31	2,929	0.22	0.38 ***
Fulltime (J.H.S.)	1,700	0.17	0.36	2,929	0.27	0.42 ***
Work Hour (Mother)++	1,696	14.48	15.53	2,926	21.11	16.74 ***
Work Hour (Father)++	1,669	57.6	12.47	2,886	55.44	12.36 ***
Annual Salary (Mother, E.S.)+++	1,693	82.58	148.6	2,916	109.24	144.57 ***
Annual Salary (Mother, J.H.S.)+++	1,692	123.88	174.5	2,919	147.97	163.23 ***

Table 8: Descriptive Statistics for Expenditure on Children, Parental Time Investment, Child's Study Time and Mother's Working. +: a thousand yen. ++: hours per day. +++: 10 thousand yen. Significance levels for t tests on the equality of means between urban and rural: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

dren attend is driven by the motivation to provide children with a higher quality secondary education to prepare children for fierce competition in university admissions.

7.1 Socioeconomic Status: Gender and Parental Education

We have already observed that this motivation is stronger among urban parents, but it may be related to other socioeconomic attributes, such as child gender and parental education level. Given a wage gap between men and women, and the male-female ratio of students enrolled in universities is skewed toward boys (56.6% for boys and 50.7% for girls according to the 2020 Basic School Survey), parents of boys may be more likely to put their children through the exam competition than parents of girls. In addition, if the parents themselves are highly educated, their children may be more likely to commit to an entrance exam competition because the parents have the know-how, and the children use the parents as role models. Regardless of the number of children they have, only high-income households might be financially able to afford to provide their children with a higher-quality secondary education to prepare them for the fierce competition of college entrance exams. Nevertheless, we interpret parental education as a proxy variable for household income because of endogeneity issues in household income.

The results of the 2SLS estimation testing these robustness expectations are presented in Table 9. First, the coefficient on family size is negative and significant, especially when the children surveyed are boys (Panel (a)). The magnitude of the absolute values of the coefficients is larger than the estimates at baseline in Table 4. In contrast, the coefficients are insignificant or rather positive and significant for girls (Panel (b)). Second, we divide the sample by whether the mother or the father has a university degree. We find that the family size variable is negative and statistically significant for households with highly educated parents (Panel (c)) and insignificant for children with less-educated parents (Panel (d)).

We argue that these results, which show a similar trade-off pattern as in Section 5, suggesting that there is a stronger motivation among parents with boys and parents with higher education to provide their children with a higher quality secondary education to prepare them for the fierce competition of university entrance exams. And in those households, the *hensachi* score is adversely affected when the number of children increases exogenously.

7.2 Alternative Output Variables for *Hensachi* Score

We argue that the motivation to provide children with a higher quality secondary education to prepare them for the fierce competition of the university entrance exam creates a trade-off between the number of siblings and the *hensachi* score of the high school attended by the children in urban areas. We then test the robustness of this claim by using variables other than high school deviation as the left-hand side y_i of equation (1).

The first output variable is the percentage of high school students who go to Tokyo and Kyoto universities. This information is based on the annual report "2017 Complete Record of All University Entrance Examinations: High School Proficiency" (2017 nendo ban daigaku nyuushi zenkiroku: koukou no jitsuryoku, in Japanese). If the above claim is correct, parents would want their children to attend high schools with a high admission rate to prestigious universities. Table 10 shows the results of the 2SLS estimation. We find that the ratio of the number of students accepted to Tokyo and Kyoto Universities to graduates has a negative and significant impact from an increase in the size of siblings, in the estimations for both small and large urban households and for large rural households. This strengthens the existence of a trade-off between the number of children and the *hensachi* score, as negative coefficients are obtained for both small and large households in urban areas and only in the case of large households in rural areas.

Next, we use a dummy variable that takes the value of 1 if the student attends high school and 0 if the student does not attend high school. If the trade-off motivation is related to the quality of the high school, having more children exogenously will not affect the aspect of whether or not a child simply attends high school. In fact, the estimation with this dummy variable as the dependent variable does not yield a significant coefficient on the number of

VARIABLES	First-born Children with one or more Siblings Urban (1)	Rural (2)	First- and Second-born Children with Two or More Siblings Urban (3)	Rural (4)
(a) Boys				
Family Size	-4.250**	3.171	-7.562*	-4.840**
	(2.123)	(3.946)	(4.377)	(2.167)
First Born			0.777	1.285**
			(0.740)	(0.540)
Observations	1,723	2,514	909	1,466
R-squared	0.256	0.169	0.175	0.174

	(5)	(6)	(7)	(8)
(b) Girls				
Family Size	-1.703	-0.626	8.142***	-1.893
	(2.000)	(1.603)	(1.915)	(2.807)
First Born			1.981**	1.645***
			(0.851)	(0.576)
Observations	1,738	2,590	792	1,463
R-squared	0.237	0.202	0.104	0.205

	(9)	(10)	(11)	(12)
(c) High Education Parents				
Family Size	-5.345**	0.145	-9.018	-7.702***
	(2.275)	(2.349)	(5.486)	(2.680)
First Born			0.747	1.300*
			(0.785)	(0.756)
Observations	1,863	1,970	823	1,069
R-squared	0.072	0.130	0.019	0.035

	(13)	(14)	(15)	(16)
(d) Low Education Parents				
Family Size	-0.735	0.551	2.759	0.923
	(1.836)	(2.220)	(3.650)	(2.184)
First Born			1.811**	1.291***
			(0.765)	(0.447)
Observations	1,598	3,134	878	1,860
R-squared	0.081	0.061	0.044	0.072

Table 9: Family Size Effects on *Hensachi* Score Separately for Socio-Economic Status (Child Gender and Parental Education). We use 2SLS estimations with high school *hensachi* score as the dependent variable. The coefficients of *size* are presented. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

siblings in urban areas. Rather, we find that the number of siblings has a positive impact on the percentage of students who go on to high school for large households in rural areas. Qian (2009) is one of the few studies to show that the number of children has a positive effect on school enrollment, citing the economies of scale that the number of children possesses as the reason for this.

Finally, we turn our attention to integrated junior high school and high school, where there is no entrance examination or a simple examination to advance to high school. Parents and children choose integrated junior and senior high schools because many of them are attracted by the advantages of completing six years of classes by the second year of high school and preparing for college entrance exams in the third year of high school. According to the ”Survey on Junior High School Choice” conducted by Benesse Education Research Institute in 2007, 63.3% of respondents answered that they chose the junior high schools because many of them were accepted into famous universities (multiple answers). Oshio et al. (2009) states that since many students who attend national and private junior high schools go directly to attached high schools, the percentage of students who attend national and private junior high schools can be used to roughly capture the weight of integrated junior high and high schools. They state that 7.9% across Japan, and 14.9% and 10.0% in the Tokyo metropolitan area and Osaka metropolitan area, respectively, with more children attending integrated junior high and high schools in urban areas. We find that the variable for integrated junior high and high schools have a negative and significant impact from an increase in the size of siblings for small households in urban areas. Our finding of trade-offs in urban areas in enrolling children in combined junior high and high schools is consistent with the motivation to provide children with a higher quality education at the secondary level to prepare them for the university entrance examinations.

VARIABLES	First-born Children with one or more Siblings		First- and Second-born Children with Two or More Siblings	
	Urban	Rural	Urban	Rural
	(1)	(2)	(3)	(4)
Entrance Exam to Tokyo/Kyoto U	-0.671***	0.0528	-0.521*	-0.497**
	(0.167)	(0.340)	(0.291)	(0.225)
High School Attendance	-0.0226	-0.0202	0.000429	0.0117**
	(0.0297)	(0.0277)	(0.00582)	(0.00520)
Combined J.H.S. and H.S.	-0.0898**	0.0505	0.0178	-0.0473
	(0.0456)	(0.0672)	(0.132)	(0.0683)

Table 10: The Effects of *size* on Other Output Variables. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

8 Conclusion

Using data from the Longitudinal Survey of Newborns in the 21st Century, we examine the effect of sibship size on high school *hensachi* score in Japan. We use twin births as an instrumental variable and find that the causal impacts of family size on the standardized *hensachi* score of the high school the child attends is not found in the pooled sample across Japan, but emerges only when we divide the sample into urban and rural areas.

We also find that there are differences in the responses in reallocating household resources between urban and rural parents: As the number of children increases in urban areas, substitution occurs in the inputs to children's educational production, from fewer extracurricular activities such as piano and swimming to more study time outside school and more conversations with parents. In the rural areas, however, as the number of children increases, parents reduce spending on cram school, study time outside of school, and conversations with parents, in addition to extracurricular activities as piano and swimming. This implies that parents and children in urban areas try to mitigate the adverse effects on hensachi by increasing the inputs of study time and conversations with parents, while rural parents and their children reinforce the adverse effects by reducing their inputs.

Policy implications from this study include the following. Previous empirical findings that the number of children does not affect educational attainment in developed countries have led many to believe that policies aimed at increasing fertility are unlikely to impact child quality negatively. However, the results of this study prompt a reconsideration of this idea. The results suggest that policies that encourage couples to have more children, such as tax breaks or subsidies for families with more children, are likely to hurt the access of existing children to a high-quality, high school education. They may be at a disadvantage in the competition for their university entrance. As urban parents try to reallocate household resources in anticipation of such disadvantages, government policies should help facilitate such reallocation.

References

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

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

Joshua D Angrist and William N Evans. Children and their parents' labor supply: evidence from exogenous variation in family size. *The American Economic Review*, 88(3):450–477, 1998.

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

Sonia Bhalotra and Damian Clarke. The twin instrument: Fertility and human capital investment. *Journal of the European Economic Association*, 18(6):3090–3139, 2020.

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

Sandra E Black, Paul J Devereux, and Kjell G Salvanes. From the cradle to the labor market? the effect of birth weight on adult outcomes. *The Quarterly Journal of Economics*, 122 (1):409–439, 2007.

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

Mark Bray and Chad Lykins. *Shadow education: Private supplementary tutoring and its implications for policy makers in Asia*. Number 9. Asian Development Bank, 2012.

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

Damon Clark. Selective schools and academic achievement. *The BE Journal of Economic Analysis & Policy*, 10(1), 2010.

Damian Clarke. Children and their parents: a review of fertility and causality. *Journal of Economic Surveys*, 32(2):518–540, 2018.

Julie Berry Cullen, Brian A Jacob, and Steven Levitt. The effect of school choice on participants: Evidence from randomized lotteries. *Econometrica*, 74(5):1191–1230, 2006.

Matthias Doepke. Gary becker on the quantity and quality of children. *Journal of Demographic Economics*, 81(1):59–66, 2015.

Steve R Entrich. *Shadow education and social inequalities in Japan: Evolving patterns and conceptual implications*. Springer, 2017.

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

Jonathan Guryan, Erik Hurst, and Melissa Kearney. Parental education and parental time with children. *Journal of Economic perspectives*, 22(3):23–46, 2008.

Marie Højlund Roesgaard. *Japanese education and the cram school business: Functions, challenges and perspectives of the juku*. NIAS press, 2006.

Ayako Kondo. College entrance examinations and academic ability predetermined by middle school entrance : Evidence employing 'sunday shocks' to private middle school entrance exams as an instrumental variable. *JCER economic journal*, (70):60–81, 2014.

Haoming Liu. The quantity–quality fertility–education trade-off. *IZA World of Labor*, (143), 2015.

Takashi Oshio, Shimpei Sano, and Kaori Suetomi. Estimations of educational production functions: a case of six-year secondary schools in japan. *The Economic analysis*, (182): 48–69, 2009.

Cristian Pop-Eleches and Miguel Urquiola. Going to a better school: Effects and behavioral responses. *American Economic Review*, 103(4):1289–1324, 2013.

Nancy Qian. Quantity-quality and the one child policy: The only-child disadvantage in school enrollment in rural china. Technical report, National Bureau of Economic Research, 2009.

Garey Ramey and Valerie A Ramey. The rug rat race. Technical report, National Bureau of Economic Research, 2009.

Mark R Rosenzweig and Kenneth I Wolpin. Testing the quantity-quality fertility model: The use of twins as a natural experiment. *Econometrica: journal of the Econometric Society*, pages 227–240, 1980.

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

A Sakata, J Tano, and K Fuse. For ministry of health, labour and welfare longitudinal survey (development and challenges of the special panel survey). *Advances in Social Research*, 15:21–29, 2015.

Douglas Staiger, James H Stock, et al. Instrumental variables regression with weak instruments. *Econometrica*, 65(3):557–586, 1997.

Ryoko Tsuneyoshi. Junior high school entrance examinations in metropolitan tokyo. *Japanese education in an Era of globalization: Culture, politics, and equity*, page 164, 2013.

A Appendix A: Alternative Instrument for Sibling Size

We employ another identification strategy, using the mix of sibling gender as the instrumental variable to estimate the 2SLS (Angrist et al. (2010)). Results in Panel (a) of Table 11 show that the effect of sibship size is statistically significant when we use the first- and second-born children with one or more siblings and using the gender combination of the first- and second-born children as the instrumental variable, with a decrease in the *hensachi* score of 8.2 points per additional child in urban areas, but insignificant in rural areas, which is consistent with our main estimation results using twins as an instrumental variable. In Panel (b), estimations using the first through third-born children with two or more siblings and using the gender combination of the first through third-born children as the instrumental variable, did not yield statistically significant coefficients for sibling size. The Hansen J statistic, which tests for the exogeneity of the instrument, shows that the null hypothesis that the instrument is exogenous is not rejected, but that the Cragg-Donald Wald F statistic is quite small, ranging from 1.6 to 2.7, so we need to be careful about the exogeneity of the gender combination as an instrumental variable. In sum, in the analysis using gender combination as an instrumental variable, our result that family size has a negative effect on the *hensachi* score of the high school attended by the child is found in relatively small households with two or more children,

	Full Sample		Urban		Rural	
	First Stage	2SLS	First Stage	2SLS	First Stage	2SLS
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
(a) Gender Combination of First and Second Born Children						
Family Size		-2.279		-8.236**		1.974
		(2.354)		(3.817)		(3.010)
First Born	-0.106***	1.452***	-0.0945***	0.803*	-0.113***	1.996***
	(0.0115)	(0.298)	(0.0183)	(0.464)	(0.0147)	(0.398)
BoyBoy	0.0667***		0.0834***		0.0561***	
	(0.0127)		(0.0193)		(0.0168)	
GirlGirl	0.0447***		0.0248		0.0575***	
	(0.0128)		(0.0184)		(0.0174)	
Cragg-Donald Wald F statistic	20.05		10.84		11.02	
Hansen J statistic	0.459		0.000		0.055	
Chi-sq(1) P-val	0.4981		0.9903		0.8148	
Observations	16,181	16,181	6,627	6,627	9,554	9,554
R-squared	0.073	0.226	0.073	0.067	0.072	0.164
	(7)	(8)	(9)	(10)	(11)	(12)
(b) Gender Combination of First, Second, and Third Born Children						
Family Size		-0.851		1.531		-0.738
		(6.317)		(8.637)		(7.192)
First Born	-0.126***	2.929***	-0.155***	2.826*	-0.114***	3.176***
	(0.0265)	(0.878)	(0.0481)	(1.499)	(0.0315)	(0.933)
Second Born	-0.118***	1.224	-0.104***	1.707	-0.128***	1.068
	(0.0166)	(0.789)	(0.0276)	(1.046)	(0.0209)	(0.965)
BoyBoyBoy	0.0458**		0.0266		0.0538*	
	(0.0224)		(0.0363)		(0.0287)	
GirlGirlGirl	0.0278		0.0671		0.0126	
	(0.0271)		(0.0488)		(0.0326)	
Cragg-Donald Wald F statistic	2.65		1.552		1.83	
Hansen J statistic	1.72		1.294		0.745	
Chi-sq(1) P-val	0.1897		0.2553		0.388	
Observations	5,874	5,874	1,996	1,996	3,878	3,878
R-squared	0.061	0.224	0.062	0.204	0.063	0.205

Table 11: Alternative Specifications for Family Size Effects on *Hensachi* Score. We use 2SLS estimations with high school *hensachi* score as the dependent variable. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$