HITOTSUBASHI UNIVERSITY

Global COE Hi-Stat Discussion Paper Series 271

Research Unit for Statistical
and Empirical Analysis in Social Sciences (Hi-Stat)

Fewer School Days, More Inequality

Daiji Kawaguchi

January 2013

Hi-Stat Discussion Paper

Hi-Stat
Institute of Economic Research
Hitotsubashi University
2-1 Naka, Kunitatchi Tokyo, 186-8601 Japan
http://gcoe.ier.hit-u.ac.jp

FEWER SCHOOL DAYS, MORE INEQUALITY[1]

Daiji Kawaguchi

Hitotsubashi University, RIETI, TCER, and IZA

January 11, 2013

Abstract

This paper examines how the intensity of compulsory education affects the time use and academic achievement of children with different socioeconomic backgrounds. The impact is identified off the school-day reduction of Japan in 2002 that resulted when all Saturdays were set as public-school holidays. An analysis of time diaries and test scores before and after the school-day reduction reveals that the socioeconomic gradient of 9th graders' study time becomes 80% steeper and the socioeconomic gradient of academic achievements of 8th and 10th graders becomes 20-30% steeper. Intensive compulsory education contributes to equalizing the academic performances of children with different socioeconomic backgrounds.

JEL Classification Code: I24, I28

Key Words: Compulsory Education, Inequality, Socioeconomic Gradient.

---

1 Financial support was provided by the Japan Society for Promotion of Science. Access to the survey of time use and leisure activities was granted by the Ministry of Internal Affairs and Communications. I am grateful to Yoichi Arai, Daniel Hamermesh, Hidehiko Ichimura, Edward Lazear, Patrick Puhani, Rebecca Ryan, Jay Stewart, Till von Wachter, Ken Yamada, and many seminar participants at Hitotsubashi University, University of Maryland, GRIPS, Singapore Management University, University of Tokyo, Academia Sinica, University of Hanover, and the East-West Center for comments.

I. Introduction

One purpose of compulsory education is to assure uniform educational opportunities for all children regardless of their socioeconomic backgrounds. Indeed, a few studies show that expanding the years of compulsory education reduces the dependence of children's educational attainment or risk attitudes on their parents' educational attainment (Meghir and Palme (2005), Aakvik et al. (2010), Hryshko et al. (2011), Brunello et al. (2012)). Then, how does the intensity of compulsory education affect the intergenerational dependence of educational attainment? Although this is an important question to address, since policymakers determine the national curriculum and choose the intensity of compulsory education, only a few studies examine the effect of the intensity of compulsory education on the intergenerational dependence of educational attainment.

This paper demonstrates that intensive compulsory education homogenizes children's time for studying and dampens the effect of parental socioeconomic background on their children's academic performance. This idea is related to previous research findings indicating that the socioeconomic gap of students' achievement widens after summer breaks, because the out-of-school environment is more heterogeneous by socioeconomic status than the in-school environment (Downey et al. (2004), Alexander et al. (2007)). Another strand of related literature examines the "incarceration" effects of schooling (other than cognitive ability) on youth behavior, such as the increase in property crimes committed by youth on off-session days (Jacob and Lefgren (2003)), or the reduction of teenage pregnancy resulting from more years of compulsory education (Black et al. (2008)).

To examine the effects of the intensity of compulsory education on children's time use and academic performance across socioeconomic classes, this study uses the school-day reduction in Japan that took place in 2002 for identification. For the purpose of reducing the time pressure on students and attaining 2 full days off per week for public-school teachers, the Japanese government set all Saturdays as holidays starting in April 2002, whereas half-day instruction had been given on the first, third, (and fifth) Saturdays of each month before the policy change. The change of time use of 9th graders who are subject to compulsory education is examined, based on the 1996, 2001, and 2006 waves of the Survey of Time Use and Leisure Activities (社会生活基本調査, JTUS), which includes the time diaries of the second and third weeks of October in each survey year, as well as background variables for all household members. In addition to the time-use survey, the 1999 and 2003 waves of the Trends in International Mathematics and Science Study (TIMSS), which targets 8th graders, and the 2000 and 2003 waves of the OECD Programme for International Student Assessment (PISA), which targets 10th graders, are used to assess the policy change's effect on students' academic performance.

The analysis of the JTUS data reveals that students' time for studying on Saturdays declined by one third from 2001 to 2006, on average, but the decrease of study time was more significant among children with less-educated parents, effectively making the socioeconomic gradient of study time 80% steeper. This increased socioeconomic gap of study time resulted in a widening gap in test scores: The socioeconomic gradients of test scores became 20-30% steeper after the policy change. These results imply that study time is a valuable input for the academic achievement of disadvantaged students and that time-intensive compulsory education contributes to reducing the gap of academic achievement between socioeconomic classes.

This paper also contributes to existing literature on the intergenerational dependence of socioeconomic status in Japan (Kariya (2001) and Tanaka (2008), Ueda (2009), Hojo and Oshio (2010) and Yamada (2011)). This paper demonstrates that study time is an important channel of this dependence and that the intensity of compulsory education determines the degree of the dependence.

II. Family Background, Students' Time Use, and Academic Performance

In this section, I lay out a simple model that conceptualizes the relationships among students' family background, time use, and academic performance to motivate the empirical analysis. I employ simple functional forms for the purpose of exposition, but it should be clear that the model's basic logic is robust to alternative assumptions.

I assume that a parent maximizes the utility function by choosing her child's time spent on studying, *t*, given the resources for her child’s education, *p*. The parental resource, *p*, refers to parental human capital that contributes to the production of a child’s human-capital production or a child’s innate ability inherited from the parent. The utility function consists of her child's test score, *y*, and her child's study time, *t*. I assume that the parent feels the pain of her child’s studying and that this is the only cost of letting her child study. By assuming that the marginal cost of studying does not depend on parental resources, I abstract away from the heterogeneity of the liquidity constraint. The child's test score, *y*, is determined through the production function *f(t, p)*, where f satisfies $f_t \geq 0, f_{tt} \leq 0, f_p \geq 0, f_{pp} \leq 0$. Assuming that the utility function is linear in the test score and time spent on studying, the utility function is given as:

$$\boldsymbol{u} = \boldsymbol{f}(\boldsymbol{t}, \boldsymbol{p}) - \boldsymbol{t}. \qquad (1)$$

Compulsory education sets the minimum amount of time that must be spent on studying, t_c. The optimal *t*, denoted as t^*, is determined to equate the marginal benefit and the marginal cost, so that $f_t(t^*, p) = 1$ in the case of an inner solution or $t^* = t_c$ in the case of a corner solution. The consequent test score is determined as $y^* = f(t^*, p)$.

It should be noted that the change of compulsory-education policy affects the time allocation of only those children who are at the corner solution. Then, who is at the corner solution? Are they children from wealthy families or poor families? The answer depends on whether time and parental resources are substitutes or complements in *f(t, p)*.

Let us first consider the case in which two inputs are perfect complements and the production function is

$$\boldsymbol{f(t,p) = a \min\{t, p\}, \quad a > 1.} \qquad (2)$$

The optimal study time is determined as $t^* = p$ if $p \geq t_c$ and $t^* = t_c$ if $p < t_c$. The test score is given as ap. This perfect complementarity represents the case when the child's effort is productive up to the parental resources, including the child's inherited ability. In this setting, a parent without sufficient resources faces zero marginal return to her child's study time exceeding *p*. Consequently, the parent lets her child study the minimum amount of time that is required by compulsory education. Thus, a reduction of hours of compulsory education reduces the study time of children from poor families, but it does not decrease their test scores, which is ap.

Another polar result is obtained when student's time and parental resources are perfect substitutes. Suppose that child study time and parental resources are perfect substitutes in the test-score production function, so that:

$$\boldsymbol{f(t,p) = \log(t+p)}. \qquad (3)$$

In this production technology, the higher the parental resources, the lower the marginal return to the child's study time. This functional form represents the case in which an inheritably smart child does not learn much from additional study time because the child already knows enough. Thus, the parent lets her child study fewer hours. In addition, the parent who endows her child with educational resources above the threshold lets her child study the minimum hours required by compulsory education. The solution to the problem is $t^* = 1 - p$ if $p \leq 1 - t_c$ and $t^* = t_c$ if $p > 1 - t_c$. The consequent test score is $y^* = \log(1) = 0$ if $p \leq 1 - t_c$ and $y^* = \log(t_c + p)$ if $p > 1 - t_c$. Therefore, a reduction of hours of compulsory education decreases the study time of children from affluent families and decreases their test scores.

As an additional example that lies between the two polar cases, let us consider the Cobb-Douglas production function, a functional form adopted by previous studies (Behrman et al. (1982) and Glomm (1997)):

$$\boldsymbol{f(t,p) = a\, t^{\theta} p^{1-\theta}}. \qquad (4)$$

Because the marginal productivity of study time positively depends on parental resources, parents with affluent resources let their children study more hours. In particular, the optimal study time is expressed as: $t^* = (a\theta)^{\frac{1}{1-\theta}} p$ if $p \geq (a\theta)^{\frac{-1}{1-\theta}} t_c$ or $t^* = t_c$ if $p < (a\theta)^{\frac{-1}{1-\theta}} t_c$. Thus, the reduction of hours of compulsory education reduces the study hours only of children with less parental resources. This reduction of study time causes a decline in test scores of children with less parental resources.

From this exercise, we learn that reducing compulsory education can affect study time and test scores heterogeneously, depending on family background, and the form of dependence is determined by whether study time and parental resource are complements or substitutes in the education production function. Thus, who is affected by the reduction of school days in terms of study time and how the effect translates into academic achievement are essentially empirical questions. The following empirical analysis examines the heterogeneous responses of study time and test scores to the reduction of school days by parental backgrounds.

III. Institutional Background

In Japan, parents are required to have their children receive nine years of general education (School Education Act (学校基本法) Article 16). The first six years of education are called primary school, and the ages of children attending such schools generally extends from 6 to 12 years old. The second three years of education consist of junior-high school, and its students range from 12 to 15 years old. The school year starts in April, and primary schools accept children who turn age 6 on April 1 or before. Since grade repetition and postponement of school entry are rare in Japan, most students graduate from junior-high school at age 15.

Historically, classes were given from Monday to Saturday in primary and junior-high schools, with half-day classes given on Saturday. There was criticism, however, that children were swamped with studying class materials and were being deprived of opportunities to spend time with their families or in local community activities. In addition, typical workers were starting to take Saturdays off by the mid-1990s, because the 1988 revision of the Labor Standard Act set the legal work hours at 40 per week (Kawaguchi et al. (2008) and Lee et al. (2012)). Motivated by this general trend of reduced work hours, pressure from teachers' unions to reduce class hours had grown steadily. In response to these demands, the government started a gradual process of setting all Saturdays as school holidays.

As the first step, the government set the second Saturday of each month to be a holiday, beginning on September 12, 1992. In the second step, the government added the fourth Saturday of each month as a holiday, starting from April 22, 1995. During this transition, however, the national curriculum guidelines (学習指導要領) were not revised. The guidelines required 5,785 class units for primary school and 3,150 class units for junior-high school. From April 2002, all Saturdays became school holidays, and this change was accompanied by a revision of the national curriculum guidelines, which require 5,367 class units (7.3% reduction) for primary school and 2,940 class units (7.7% reduction) for junior-high school.

The 2002 revision gives parents more discretion regarding their children's time use on the first, third, (and fifth) Saturdays. How did children of compulsory schooling age spend this extra time? Are there any differences in the responses by parental backgrounds? What are the consequences of the change of time use in terms of academic performance? The following empirical analysis addresses these questions.

IV. Analysis of Time-use Survey

A. Data and Descriptive Analysis

The Japanese Time Use Survey (JTUS) is conducted by the Bureau of Statistics every five years, starting from 1976. This study uses the 1996, 2001, and 2006 waves of the survey. All waves were fielded over nine-day periods, including the second and third weekends in October, targeting randomly sampled households. The survey covers all household members aged 10 or older, and each respondent fills out time diaries for two consecutive days, reporting their activities in 15-minute intervals. The number of pre-coded activities is 20 in all waves. These 20 activities are reclassified into three major categories of time use: study time, leisure time, and other time use.[2] The sample is nationally representative with individual survey weights, including about 175,000 persons in each wave.

In Japan, both private and public high schools admit students largely on the basis of their performance on the entrance examination and junior-high-school GPA, and, accordingly, most students take the entrance examination at the end of 9th grade. Because which high school a student attends significantly affects the life course, including college advancement probability, 9th graders generally spend a long time preparing for the entrance examination, and this study time is heterogeneous among students. Thus we restrict our analysis sample to 9th graders. To construct the analysis sample of 9th graders, children aged 15 who were born between April and October, as well as children aged 14 who were born between November and March, are included in the analysis sample.[3] About 7,600, 4,900, and 4,100 children are included in the analysis samples in 1996, 2001 and 2006, respectively.

Child's family-background variables are constructed from responses by other

---

[2] Study time includes “school work,” “commuting to/from school,” and “studying and researching.” Leisure time includes “TV, radio, reading,” “rest and relaxation,” “hobbies and amusements,” “sports,” “volunteer and social activities,” and “social life.” Other time use includes “housework,” “child care,” “shopping,” “sleep,” “personal care,” “meals,” and “medical examination or treatment.” The categories “travel other than commuting” and “other activities” are prorated to leisure and other activities.

[3] The month of birth is not recorded in 1996. Thus the birth month is randomly assigned based on a uniform distribution for the purpose of data construction.

household members. Educational attainment of the household head, identified by the household member's id, is a major variable that approximates a child’s socioeconomic background. Educational attainment is constructed as a continuous variable that takes 9 for junior-high-school graduates or less, 12 for high-school graduates, 14 for junior-college graduates, and 16 for 4-year-college graduates or more. Dummy variables indicating female-headed household, single parenthood, and mother's employment, as well as household annual income ranges, are also constructed.

The 2001 and 2006 surveys record the date of the survey so that we can distinguish the third Saturday, which is a holiday only in 2006, and the second Saturday, which is a holiday in both 2001 and 2006. The 1996 survey does not record the date of the survey, however, and therefore, we cannot distinguish between the second and third Saturdays. Thus, for the analysis that pools the 1996, 2001, and 2006 waves, the second and the third Saturdays are not distinguished, and the changes of time use on Saturdays are roughly considered to be one half the policy impact of setting a day as a holiday. In an additional analysis that focuses on time use on Saturdays in 2001 and 2006, the change of time use on the second Saturday is compared with the change of time use on the third Saturday.

Figure 1 illustrates the mean of students' study time by day of the week. On weekdays, the study time increases between 1996 and 2001. Between 2001 and 2006, it does not change much among children with a junior-high-school-graduate parent, but it increases by 17 minutes per day among children with a college-graduate parent. Although study time increases from 1996 to 2001 on Saturdays, the 2006 amount is little more than one half of the 2001 amount among children with a junior-high-school-graduate parent: 328 minutes in 2001 and 175 minutes in 2006. The study time of children with a college-graduate parent decreases from 405 minutes in 2001 to 299 minutes in 2006. In the case of children with a college-graduate parent, the reduction of study time on Saturdays between 2001 and 2006 is mostly made up for by an increase of study time on weekdays, because the 17-minute increase per weekday translates into a 85-minute increase per week. Study time on Sundays generally increases between 1996 and 2001 but not much change is observed between 2001 and 2006.

The sampling weights in the data, which are roughly 5 times larger for weekdays than for weekend days, allow us to calculate the daily average of time use over 7 days. All in all, from 2001 to 2006, the daily average of study time decreases from 435 minutes to 406 minutes among students with a junior-high-school-graduate parent, whereas it increases slightly from 498 minutes to 505 minutes among students with a college-graduate parent.

Table 1 tabulates the descriptive statistics of children's and their parents' characteristics. Study time increases from 1996 to 2001 but stays almost constant between 2001 and 2006, resulting from its increase on weekdays and its decrease on Saturday. The change of leisure time is almost the opposite of the change of study time. Time spent on other activities is almost unchanged during the sample period. About one half of the analysis sample consists of girls. In 2006, around 14 percent of household heads hold a junior-high-school degree or less. About 46 percent, 10 percent, and 31 percent of household heads have high-school, junior-college, and 4-year-college degrees, respectively. About 15 percent of households in the sample are headed by a female, and about 20 percent of children have only one parent. About 25 percent of mothers work. Annual-income categories are classified so that children are equally distributed across categories. A comparison of the 1996, 2001, and 2006 columns reveals that the distribution of children's household characteristics does not change significantly between 2001 and 2006.

B. Regression Analysis

Adding the third Saturday to school holidays for the nine-day survey period in 2002 decreases study time on Saturdays, but this decrease of study time on Saturdays is partly offset by an increase of study time on weekdays. This change of children’s study time, however, seems to depend on their parents' socioeconomic backgrounds, as approximated by the household head's educational attainment. To capture the heterogeneous change of time use across children with different backgrounds, the following regression model is estimated for each activity (A=study, leisure and other activities), using the pooled data of 1996, 2001, and 2006:

$$\boldsymbol{Time\ Use_{it}^{A} = \beta_0^{A} + \beta_1^{A} Head\ Educ_{it} + \beta_2^{A}(Head\ Educ_{it} - 12) \times Year2001 + \beta_3^{A}(Head\ Educ_{it} - 12) \times Year2006 + \beta_4^{A} Year2001 + \beta_5^{A} Year2006 + x_{it}\gamma^{A} + u_{it}^{A}.} \quad (5)$$

The dependent variable $Time\ Use_{it}^{A}$ is time use measured by minutes per day in activity A (study, leisure, and other activities) by individual *i* in year *t*. The vector of control variables, x_{it}, includes dummy variables for female-headed household, single parenthood, and 3 household annual income categories (4-5.99, 6-8.99, and 9 million yen).

The coefficient β_1^{A} captures the socioeconomic gradient of time use, and the coefficients β_2^{A} and β_3^{A} capture the changes of the socioeconomic gradient over time.

It should be noted that the coefficients β_4^A and β_5^A capture the average changes of time use between 1996 and 2001 and between 1996 and 2006, respectively, evaluated at $Head\ Educ = 12$.

The coefficients for other socioeconomic variables are assumed to be constant between 2001 and 2006, because allowing for a change of coefficients for other proxy variables for socioeconomic backgrounds tends to obscure the change of the socioeconomic gradient through the correlation between *Head Educ* and variables in *x*. By fixing the coefficients for *x* over time, the change of the socioeconomic gradient is efficiently captured by the change of β_2^A and β_3^A. Thus the change of β_2^A and β_3^A should not be interpreted as the change of the effect of household head's education *per se*; rather, it should be interpreted as the change of the effect of family socioeconomic background in general.

C. Basic Estimation Results

Table 2 lays out the results of the estimation of equation (5) for the study time of 9th graders. Column (1), reporting the results for weekdays, indicates that a one-year increase of the household head's educational attainment increases the child's study time by 3.7 minutes per day, though this result is not statistically significant. The coefficient for the interaction term of head's education and year 2001 implies that the socioeconomic gradient does not change between 1996 and 2001 in a statistically significant way. The interaction term of head's education and year 2006 implies that the socioeconomic gradient of study time becomes 65% (=(5.80+1.41)/(5.80-1.42)-1) steeper in 2006 compared with 2001, although the interaction term is not statistically significant.

Column (2) reports results for Saturday. An additional year of household head's education increases a child's study time by about 7 minutes in 1996, about 6 minutes per day in 2001, and 16 minutes per day in 2006. These estimates imply that the socioeconomic gradient of study time becomes twice as much in 2006 as it is in 2001. The large negative coefficient for the 2006 dummy implies a significant reduction in the study time of children with a high-school-graduate parent on Saturdays in 2006.

On Sundays, a child with a better-educated parent studies longer than a child with a less-educated parent, as implied by the estimates provided in Column (3). This gap grows both between 1996 and 2001 and between 1996 and 2006 in statistically significant ways.

Including the third Saturday as an additional school holiday during the sampling period increases the socioeconomic gradient of study time on weekdays and Saturdays between 2001 and 2006. What then is the average daily effect? To answer this question, we estimate equation (5) without specifying the day of the week. Weighted least-squares estimates, applying the sampling weight (roughly 5 times larger for weekdays than for weekend days), are reported in Column (4). These estimates reveal that the socioeconomic gradient of study time becomes steeper in 2006 than in 1996 or 2001, and the change is statistically significant at the 5% level. Between 2001 and 2006, the socioeconomic gradient of study time becomes 83% (=(5.34+7.00)/(5.34+1.39)-1) steeper. This steepening of socioeconomic gradient is not the result of a longer-term trend because the change of the socioeconomic gradient between 1996 and 2001 is not statistically significant.

Study time includes three subcategories of time use: school work, studying and researching and commuting. About 75% of study time consists of school work, about

15% consists of studying and researching, and the remaining 10% consists of commuting. Regression of each component on the same explanatory variables in Table 2 reveals that the socioeconomic gradient becomes steeper in a statistically significant way between 2001 and 2006 only for school work. Therefore, the increase of extra-curricular activities or distant commuting does not explain the increase of the socioeconomic gradient of study time.

The survey coverage of second and third Saturdays allows us to further examine whether the reduction of a school day is the cause for the steepening socioeconomic gradient of study time on Saturdays. Both 2001 and 2006 waves of the JTUS distinguish the second and third Saturdays as dates of the survey. Since the second Saturday was a school holiday before 2002, we should not observe a steepening of the socioeconomic gradient for the second Saturdays, but we should observe a steepening of the socioeconomic gradient for the third Saturdays because third Saturdays became a holiday from 2002. The regression result for second Saturdays, reported in Column (1) in Table 3, reveals that an additional year of parental education is associated with children studying 12 minutes more in 2001, and this relationship virtually does not change in 2006. In contrast, the study time on third Saturday is not correlated with parental education in 2001, but an additional year of parental education is correlated with children studying 17 minutes more in 2006, as reported in Column (2) in Table 3. The result implies that the socioeconomic gradient of study time is absent on school days but present on school holidays, pointing to the reduction of the school day as the reason for the steepening socioeconomic gradient of study time between 2001 and 2006.

The increase of the socioeconomic gradient after 2002 is arguably the result of an increase of parental discretion regarding their children’s time use. Parents who are well-off can afford to send their children to private schools, many of which continue to offer classes on Saturdays; 6.9% of junior-high-school students attended private schools in 2006 (School Basic Survey). Also, wealthy parents have the option to send their children to cram schools, which offer classroom teaching that focuses on problem solving in preparation for entrance examinations. Even without sending their children to a private school or a cram school on Saturdays, parents with higher socioeconomic status can help their children study by going over study materials together or preparing a good environment, such as an independent study room, for their children.

The additional school holidays on Saturdays in 2006 decrease the study time of children with weaker socioeconomic backgrounds. How then did children use this windfall of time? Changes of time spent on leisure and other activities reported in Table 5 answer this question. Column (1) implies that the greater the head's years of education, the shorter the leisure time on the daily mean. The size of this negative socioeconomic gradient of leisure time is comparable to the size of the positive socioeconomic gradient of study time. Children with a better-educated parent studied longer by reducing their time for playing. This negative socioeconomic gradient becomes even stronger in 2006. Again, this corresponds to the increase of the positive socioeconomic gradient of study time in 2006. Overall, the differences and changes of leisure time are almost a mirror image of the differences and changes of study time. Among the seven leisure-time activities, the socioeconomic gradients for sports and associating with friends increase between 1996 and 2006 in statistically significant ways. Column (2) reports the estimation results for other activities, such as sleep, personal care, and eating. The time spent on other activities does not depend on the parent’s educational background in 1996, 2001, and 2006.

In sum, adding Saturdays as school holidays reduced the average study time of only those 9th graders with weaker socioeconomic backgrounds, so that the socioeconomic gradient of study time became about 80% steeper between 2001 and 2006.

D. Estimation Results with Prefecture × Year Fixed Effects

The analysis heretofore found heterogeneous responses to the reduction of school days among children with different levels of parental educational attainment. One might argue, however, that these heterogeneous responses are largely caused by the heterogeneity of responses across regions. Since private schools and cram schools are more readily available in urban areas than in rural areas, the reduction of study time on Saturdays could presumably affect the study time of children living in rural areas because of the lack of alternative choices for educational opportunities. Since better-educated parents are more likely to live in urban areas, this potential heterogeneity could be captured by parental educational backgrounds. To address this concern, the following model allows for prefecture × year fixed effects.

$$\boldsymbol{Time\ Use_{it}^{A} = \beta_0^{A} + \beta_1^{A} Head\ Educ_{it} + \beta_2^{A}(Head\ Educ_{it} - 12) \times Year2001 + \beta_3^{A}(Head\ Educ_{it} - 12) \times Year2006 + \beta_4^{A} Year2001 + \beta_5^{A} Year2006 + x_{it}\gamma^{A} + c_{jt} + u_{ijt}^{A},} \quad (6)$$

where i, j, and t are indexes for individual, prefecture, and year, respectively. The fixed effects c_{jt} are the prefecture × year fixed effects that capture the heterogeneity of time use across 47 prefectures varying between 1996 and 2006. The fixed effects capture all the differences of availability of educational institutions across prefectures, including private and cram schools. All the coefficients are identified off the variation of family backgrounds across children within the same prefecture in the same year in the fixed-effects model.

Table 5 lays out the estimation results of the fixed-effects model. The estimated coefficients are quite similar to the estimated coefficients in Table 2, implying that allowing for the prefecture × year fixed effects virtually does not change the results.

The analysis of the time-use survey heretofore revealed that the reduction of school days made children's study time more dependent on their family background, as approximated by household heads' educational attainment. In relation to the theoretical discussion provided in the previous section, the fact that the reduction of school days reduced the study time of children with weaker socioeconomic backgrounds implies that study time and parental resources are not substitutes, but complements. This is because, if study time and parental resources were substitutes, children with stronger socioeconomic backgrounds should have reduced their study time more in response to the reduction of school days than children with weaker socioeconomic backgrounds.

Then how does this increased inequality of study time affect the distribution of test scores across children? Does the dispersion of study time by children's socioeconomic backgrounds make children's academic performances more dependent on socioeconomic background? The answers to these questions are not obvious, as suggested by the theoretical discussion, because studying longer may have zero marginal return for disadvantaged students. The empirical analysis in the next section addresses these questions by comparing the socioeconomic gradients of academic performance before and after the reduction of schooldays.

V. Analysis of Test Scores

A. Data

To examine the effect of additional school holidays from 2002 on the distribution of test scores across children with different socioeconomic backgrounds, the 1999 and 2003 waves of the Trends in Mathematics and Science Studies (TIMSS) and the 2000 and 2003 waves of the OECD Programme for International Student Assessment (PISA) are exploited.

The TIMSS, implemented by the International Association for the Evaluation of Educational Achievement, features the participation of 38 countries in 1999 and 49 countries in 2003, including Japan for both years. The TIMSS assesses students' academic achievements in mathematics and sciences, targeting 8th graders who belong to one or two classes of one of the 150 randomly sampled schools.[4] About 4,000 students in each wave took mathematics and science examinations, each lasting 90 minutes, based on different types of booklets.[5] To assure the comparability of achievements measured based on different booklets, standardized test scores using psychometric methods are recorded in the data sets. The standardized scores are normalized to have 50 as the mean value and 10 as the standard deviation. The surveys are accompanied by background questionnaires completed by students that ask about the number of books at home and the possession of a calculator, a computer, a desk, or a dictionary at home. In addition, the 2003 questionnaires ask about the father’s and mother’s educational attainments. Although the lack of parents’ educational attainment in 1999 is unfortunate, the 2003 data indicate that the number of books or computer

[4] TIMSS 2003 targeted 4th graders in addition to 8th graders. The 1999 and 2003 surveys for Japan were conducted between February and May of 1999 and between April and June of 2003, respectively.

[5] Eight booklets and 12 booklets were used for 1999 and 2003, respectively.

possession at home predicts parental educational background well. Thereby, further empirical analysis based on TIMSS utilizes the predicted highest years of parents' education. The analysis sample excludes observations who were born in a foreign country, who repeated a grade, and who have a missing value in test scores, sex, and books and other items possessed at home.

The PISA features participation by 32 countries in 2000 and 30 countries in 2003, including Japan for both years. The PISA tests mathematics, sciences, and reading comprehension and targets 15-year-olds. The 2000 sample includes about 5,300 10th-grade full-time students of 135 randomly sampled high-school classes. The 2003 sample includes about 4,700 full- and part-time students of 144 randomly sampled high-school classes.[6] Students in each wave took reading, mathematics, and science examinations, lasting 120 minutes and based on different types of booklets.[7] Standardized test scores using psychometric methods are normalized to have 50 as the mean value and 10 as the standard deviation. The accompanying survey for students asks about the number of books at home and the possession of own room, a computer, and access to the internet. Only the 2003 survey asks the father's and mother's educational attainments, and educational background of parent is predicted from the possession of books and the other mentioned items at home. The analysis sample excludes observations that have a missing value in test scores, sex, and books and other items possessed at home.

Table 6 reports the descriptive statistics of the analysis sample. Because of the sample construction, standardized test scores do not have exact mean values of 50.

---

6 High schools in 2003 include high school, secondary educational school (中等教育学校), and technical college (高等専門学校).

7 Nine booklets and 13 booklets were used for 2000 and 2003, respectively.

Average scores by parental educational backgrounds in the TIMSS for 2003 show that there is a 10-point (=1 standard deviation) difference in average mathematics test scores between children with a college-educated parent and children with a junior-high-school-educated parent. A similar test-score gap by parental education is found for science test scores in the TIMSS 2003. The PISA 2000 and 2003 also indicate similar gaps in average test scores by the educational backgrounds of parents in all three subjects.

About one half of the analysis sample consists of girls for both the TIMSS and the PISA. The distributions of the number of books at home are stable between 1999 and 2003 in the TIMSS and between 2000 and 2003 in the PISA. Since most students had a calculator, a desk, or a dictionary at home in 1999, the possession of these items did not change between 1999 and 2003 in the TIMSS. It is notable that according to this survey, possessing a computer at home increased from 52.5% in 1999 to 83.0% in 2003. This household information is used to predict the highest educational attainment of parents that is missing in the TIMSS 1999.

Parents' educational attainment is indicated by the mother's or father's attainment, whichever is higher, and it is transformed into a continuous variable that takes 16 if a parent is a 4-year-college graduate, 14 if a junior-college graduate, 12 if a high-school graduate, and 9 if a junior-high-school graduate.

This continuous variable is regressed on the possession of books and items at home using a sampling weight based on the TIMSS 2003. The estimation of a weighted least-squares model renders the following result:

$$\widehat{peduc} = \underset{(0.56)}{11.66} + \underset{(0.12)}{0.39}\, book_{11-25} + \underset{(0.12)}{0.69}\, book_{26-100} + \underset{(0.12)}{0.96}\, book_{101-200}$$
$$+ \underset{(0.12)}{1.45}\, book_{201-} - \underset{(0.36)}{0.25}\, calculator + \underset{(0.08)}{0.84}\, computer$$
$$+ \underset{(0.18)}{0.55}\, desk + \underset{(0.41)}{0.71}\, dictionary,\;\; R^2 = 0.095,\;\; N = 3{,}429.$$

The more books in the home, the higher is parental educational attainment. Possessing a computer at home is also positively associated with better parental educational background. Based on this regression model, the highest parental educational attainment is predicted for both 1999 and 2003 in the TIMSS. The distribution of predicted values is compressed, compared with the distribution of parents' actual educational attainment that is available for 2003. Moreover, reflecting the fact that students are asked to identify their parents' educational background, the distribution is upward biased compared with the distribution of educational background reported in the JTUS 2001. To maintain the comparability of variation of predicted and actual parental education and correct the upward bias, 16 years of education is assigned as the predicted parental education for the observations whose predicted value lies between 100 and the 75.85 percentile, because 24.15 percent of parents are 4-year college graduates in the JTUS 2001. Similarly, 14, 12, and 9 years of education are assigned based on the percentiles of the predicted value, $\widehat{peduc}$. The adjusted predicted parental education is denoted as $\widehat{\widehat{peduc}}$. For comparability across 1999 and 2003, predicted parental education is used for both 1999 and 2003.

Predicted parental education is similarly obtained using the PISA 2003. The continuous variable of parental education is regressed on the possession of books, computer, internet, and child's own room. The estimation result is:

$$\widehat{peduc} = \underset{(0.21)}{10.72} + \underset{(0.22)}{3.13}\, book_{1-10} + \underset{(0.22)}{3.42}\, book_{11-50} + \underset{(0.22)}{3.38}\, book_{51-100}$$
$$+ \underset{(0.22)}{3.73}\, book_{101-250} + \underset{(0.22)}{3.76}\, book_{251-500} + \underset{(0.22)}{3.77}\, book_{501-}$$
$$+ \underset{(0.07)}{0.26}\, ownroom - \underset{(0.05)}{0.03}\, computer + \underset{(0.05)}{0.65}\, internet,$$
$$R^2 = 0.135, \;\; N = 4{,}697.$$

Using this result, the adjusted predicted parental education $\widehat{\widehat{peduc}}$ is constructed for the PISA 2000 and 2003.

B. Socioeconomic gradients of test scores before and after 2002

Given predicted parental educational attainment as a proxy variable for a child's socioeconomic background in the TIMSS and PISA samples, the socioeconomic gradients of test scores in both 1999 and 2003 are estimated by following model:

$$Test\ Score_{it}^{S} = \beta_0^S + \beta_1^S \widehat{\widehat{peduc}}_{it} + \beta_2^S \left(\widehat{\widehat{peduc}}_{it} - 12\right) \times Year2003 + \beta_3^S Year2003$$
$$+ u_{it}^{s}\,, \qquad (7)$$

where $Test\ Score_{it}^{S}$ refers to the standardized test score in subject *s*, which refers to either the mathematics or science score of child *i* in year *t*, and $\widehat{\widehat{peduc}}_{it}$ is the parental education predicted from the number of books and possession of items at home. The coefficient β_1^S indicates the socioeconomic gradient in 1999, the coefficient β_2^S indicates the change of the socioeconomic gradient between 1999 and 2003, and the coefficient β_3^S indicates the change of the average test score of children with high-school-graduate parents. Since the independent variables include generate regressors, the standard errors of OLS estimators are invalid for inferences. To address this problem, the 95% confidence intervals are bootstrapped by a 500-times repetition.

Table 7 reports the regression results based on the TIMSS sample. Column (1) reports the results for mathematics test scores. In 1999, an additional year of predicted parental education increases the average test score by 0.99 point. Thus the average test-score difference between a child with a 4-year-college-graduate parent and a child with junior-high-school-graduate parents is about 7 points. In 2003, the coefficient for an additional year of predicted parental education increases up to 1.19 points. This coefficient turns into about an 8.3-point difference between a child with a college-graduate parent and a child with junior-high-school-graduate parents. This predicted gap is close to the actual gap, which is 10.1 points in 2003, as reported in Table 6. In this four-year period, the socioeconomic gradient increases by about 20%.

Column (2) reports the result for science test scores. An additional year of parental education increases the average science test score by 0.92 in 1999 and by 1.18 in 2003. The approximately 30% increase of the socioeconomic gradient for the science test score is more than its increase for the mathematics test score.

As a mechanism behind the increase of the socioeconomic gradient of test scores, one might argue that the change occurred through the choice of schools. In response to the reduction of school days, parents with more resources may well send their children to schools that do not reduce the amount of teaching, by giving supplementary classes or teaching more effectively in a limited amount of class time. If the correlation between unobserved school quality and parental socioeconomic background becomes stronger because of a more significant sorting of children into schools, the OLS estimates of socioeconomic gradients would become larger in 2003 than in 1999. To assess this possibility, the following school × year fixed-effects model is estimated to allow for the correlation between parental socioeconomic background and unobserved school quality:

$$Test\ Score_{ijt}^{S} = \beta_0^S + \beta_1^S \widehat{peduc}_{ijt} + \beta_2^S \left(\widehat{peduc}_{ijt} - 12\right) \times Year2003_t + \beta_3^S Year2003_t + c_{jt} + u_{ijt}^{s}\ , \qquad (8)$$

where c_{jt} refers to the unobserved determinant of test scores that is common in school *j* in year *t*. In this estimation, the coefficients β_1^S and β_2^S are identified off the variation of predicted parental background within a school in a specific year.

The estimation results of the school × year fixed-effects model are reported in Columns (3) and (4) in Table 7. All the estimated coefficients become slightly attenuated, suggesting that the effect of parental background on academic achievement is exercised through the choice of schools. The increase of the socioeconomic gradient of mathematics test scores is statistically significant, even after allowing for the school × year fixed effects. The difference between the socioeconomic gradients of 2003 and 1999 is still positive and statistically significant for mathematics test scores, but it is no longer statistically significant for science test scores.

Table 8 reports the estimation results based on the PISA. An additional year of education by either the mother or the father is associated with an increase of 10th graders' test scores by about 0.9 point in reading, mathematics, and science. The sizes of coefficients are comparable to the results based on the TIMSS. The estimated slopes in 2003 become 20-30% steeper compared with the slopes in 2000. The negative coefficient for 2003 implies that the test scores of students with high-school-graduate parents decrease by 4 points for reading and 5 points for mathematics and science in 2003. Girls score better in reading and score worse in mathematics than boys.

Allowing for school × year fixed effects attenuates the coefficient for parental education, as reported in Columns (4) to (6), implying that students with better-educated parents are selected in better schools. This attenuation is quite understandable because the PISA targets 10th graders who study at high schools, whereas the TIMSS targets 8th graders who study at junior-high schools. Only 6.9% of junior-high-school students attend private schools in 2006 (Basic School Survey), and the majority of junior-high-school students attends local public schools that are not academically segregated. In contrast, public and private high schools select their students based on academic performance measured by an entrance examination at the end of 9th grade and junior-high school GPA. Therefore, high-school students in Japan are sorted into schools based on their academic performance. This school sorting explains why a significant part of the socioeconomic gradient of test scores is explained by school × year fixed effects.

Overall, students' academic performances depend on parental socioeconomic backgrounds, as found in a previous study including Japan (Hojo and Oshio (2010)). Furthermore, the slope becomes steeper after all Saturdays become school holidays in 2002. Combined with the evidence found in the previous section, the widening gap of children’s study time by their socioeconomic background results in a widening inequality of test scores among students with different socioeconomic backgrounds.

VI. Local Average Treatment Effect of Study Time on Students' Achievement

The findings that the reduction of school days decreases the study time of children with weaker socioeconomic backgrounds and reduces their relative test scores implies that the time spent in a classroom has a positive effect on academic achievement among students with weaker socioeconomic backgrounds. Although previous studies point to the importance of the quality of school education as a determinant of academic achievement (Hanushek (2003) for example), there is limited evidence regarding the effect of study time on academic achievement.[8] This is presumably because of a serious endogeneity of time spent on studying in the educational production function. The reduction of school days creates an exogenous variation of study time and allows us to estimate the local average treatment effect of study time on academic achievement among students with weaker socioeconomic backgrounds.

Since neither the JTUS nor test-score data contain both study time and academic achievement in a sample, the idea of the two samples instrumental variable (TSIV) estimator by Angrist and Krueger (1992) needs to be applied.

An equation that expresses the causal impact of study time on a test score is expressed as:

$$y = x_1\beta_1 + x_2\beta_2 + u\,, \qquad (9)$$

where y is test score, x_1 is study time, and x_2 is a vector of explanatory variables that includes parental educational attainment, an indicator for girl, and an indicator for

[8] A notable exception is Stinebrickner and Stinebrickner (2008), who estimate the causal impact of study time on the academic achievement of liberal arts college students using the possession of a video game by a randomly assigned roommate.

school-day reduction. Even with a data set that contains all relevant variables, the causal effect β_1 cannot be consistently estimated because of a possible correlation between x_1 and u (i.e., students with higher ability study longer and score well). To deal with this endogeneity, the study time is instrumented with an exogenous policy change that affects students' study time, expressed by the following first-stage equation:

$$x_1 = z_1\gamma_1 + x_2\gamma_2 + v\,, \qquad (10)$$

where z_1 is the interaction of an indicator for school-day reduction and parental educational attainment. The key maintained assumption here is that z_1 is uncorrelated with *u* and *v*. Using the estimates $\widehat{\gamma_1}, \widehat{\gamma_2}$ and the TIMSS or PISA sample, the predicted study time $\widehat{x_1} = z_1\widehat{\gamma_1} + x_2\widehat{\gamma_2}$ is obtained. Note that the TIMSS or PISA sample is used to obtain the predicted value instead of the JTUS sample for the purpose of gaining efficiency in the estimation, as articulated by Inoue and Solon (2010). The estimated equation is:

$$y = \widehat{x_1}\beta_1 + x_2\beta_2 + e\,. \qquad (11)$$

This equation is estimated by OLS for the TIMSS sample and by IV for the PISA sample, using the number of books at home as the IV. The 95% confidence interval of the estimator is calculated by bootstrap with 500 repetitions, because the presence of a generated regressor makes usual standard errors inconsistent.[9]

The sample of 9th graders is used to estimate equation (10), because the study

9 Inoue and Solon (2010) note that Murphy and Topel's (1985) method is the correct method for obtaining standard errors, unless relying on the bootstrap.

time of 8th or 10th graders does not have sufficient variation so that the interaction term of parental education and after-policy change dummy is statistically significant. Eighth and 10th graders are used to estimate equation (11), however, because the test scores are available only among them. The change of the socioeconomic gradient of test scores after the school-day reduction is expected to be larger for 9th graders than for 8th and 10th graders, and thus the estimated β_1 is interpreted as the lower bound of the causal effect of study time on test scores.

Table 9 Column (1) reports the estimation result of equation (10) based on the JTUS, which is the first-stage equation. The estimated coefficient indicates that the socioeconomic gradient of study time becomes steeper by 6.76 minutes per day after 2002. This estimated coefficient is statistically significant with a p-value of 0.057. Columns (2) and (3) report the estimation results of equation (11) for mathematics and science scores based on 8th graders in the TIMSS. These estimation results indicate that if a student studies 1 hour more every day, the mathematics score increases by 9.6 points. Similarly, one additional hour of study increases the science score by 8.4 points. Considering the fact that the gap of mathematics test scores between students with junior-high-school-graduate parents and 4-year-college-graduate parents is 10.1 points, an additional one hour of study per day fills a significant amount of the gap between disadvantaged and advantaged students.

Columns (4) to (6) report the OLS estimates of study time on test scores based on the PISA. The coefficient in Column (4) implies that if a student studies 1 hour more every day, the reading score increases by 2.4 points. Similar results are obtained for the mathematics and science scores, as reported in Columns (5) and (6). One additional hour of study per day increases the mathematics test score by 2.4 points and the science score by 1.8 points, while the 95% confidence interval marginally crosses 0.

The effects of study time on test scores are identified off the reduction of study time of students with less-educated parents caused by the school-day reduction. Thus the estimates are interpreted as the local average treatment effects among students with less-educated parents. Therefore, the results imply that extending study time is productive even among students with weak socioeconomic backgrounds. Some may argue that letting socially disadvantaged students study longer is a waste of their time and public funds, but this argument is not supported by empirical findings.

VII. Conclusion

This paper examined the heterogeneous responses of students' time use and academic achievements to the increase of school holidays, using the all-Saturdays-off policy implemented from 2002 in the Japanese compulsory education system.

The theoretical discussion articulated that the reduction of compulsory education can affect study time and test scores heterogeneously, depending on family background. Who is affected by the policy change and how they are affected depend on the way study time and parental resources are combined in the production of students' achievement.

The analysis of the time-use survey of 9th graders revealed that setting a Saturday as an additional school holiday increases the socioeconomic gradient of study time by about 80%. This increase of the socioeconomic gradient of study time translates into an increase in the socioeconomic gradient of academic achievement of 8th and 10th graders. The analysis of the TIMSS and the PISA revealed that the socioeconomic gradient of test scores became 20-30% steeper in 2003 compared with 1999 or 2000 in reading, mathematics, and science.

The results reported in this paper directly indicate that time-intensive compulsory education suppresses the heterogeneity of children’s time use that depends heavily on parental socioeconomic background. The results also imply that study time is a valuable input for academic achievement, even among socioeconomically disadvantaged children. Therefore, time-intensive compulsory education contributes to homogenizing the academic achievement of children across the range of socioeconomic backgrounds. Consequently, reducing the intensity of compulsory education is likely to make the rich get richer and the poor get poorer through giving more discretion to parents on their children's time use. After all, schools are a leveling institution rather than a labeling institution.

References

Aakvik, Arild, Kjell G. Salvanes and Kjell Vaage. 2010. "Measuring Hetorogeneity in the Returns to Education Using an Educational Reform." *European Economic Review*, 54(4), 483-500.

Alexander, Karl L., Doris R. Entwisle and Linda S. Olson. 2007. "Lasting Consequences of the Summer Learning Gap." *American Sociological Review*, 72(2), 167-80.

Angrist, Joshua D. and Alan B. Krueger. 1992. "The Effect of Age at School Entry on Educational Attainment: An Application of Instrumental Variables with Moments from Two Samples." *Journal of the American Statistical Association*, 87(418), 328–36.

Behrman, Jere R., Robert Pollak and Paul Taubman. 1982. "Parental Preferences and Provision for Progeny." *Journal of Political Economy*, 90(1), 52-73.

Black, Sandra E., Paul J. Devereux and Kjell G. Salvanes. 2008. "Staying in the

Classroom and out of the Maternity Ward? The Effect of Compulsory Schooling Laws on Teenage Births." *The Economic Journal*, 118, 1025–54.

Brunello, Giorgio, Guglielmo Weber and Christoph T. Weiss. 2012. "Books Are Forever: Early Life Conditions, Education and Lifetime Income." University of Padua.

Downey, Douglas B., Paul T. von Hippel and Beckett Broh. 2004. "Are Schools the Great Equalizer? School and Non-School Sources of Inequality in Cognitive Skills." *American Sociological Review*, 69(5), 613-35.

Glomm, Gerhard. 1997. "Parental Choice of Human Capital Investment." *Journal of Development Economics*, 53(1), 99-114.

Hanushek, Eric A. 2003. "The Failure of Input-Based School Policies." *Economic Journal*, 113(485), F64–F98.

Hojo, Masakazu and Takashi Oshio. 2010. "What Factors Determine Student Performance in East Asia? New Evidence from Timss 2007." Institute of Economic Research, Hitotsubashi University.

Hryshko, Dmytro, María José Luengo-Prado and Bent E. Sørensen. 2011. "Childhood Determinants of Risk Aversion: The Long Shadow of Compulsory Education." *Quantitative Economics*, 2(1), 37-72.

Inoue, Atsushi and Gary Solon. 2010. "Two-Sample Instrumental Variables Estimators." *Review of Economics and Statistics*, 92(3), 557-61.

Jacob, Brian A. and Lars Lefgren. 2003. "Are Idle Hands the Devil's Workshop? Incapacitation, Concentration, and Juvenile Crime." *American Economic Review*, 93(5), 1560-77.

Kariya, Takehiko. 2001. *Kaisoka Nihon to Kyoiku Kiki*. Tokyo: Yushindo Koubunsha.

Kawaguchi, Daiji, Hisahiro Naito and Izumi Yokoyama. 2008. "Labor Market Responses to Legal Work Hour Reduction: Evidence from Japan." Cabinet Office, Japanese Government.

Lee, Jungmin, Daiji Kawaguchi and Daniel S. Hamermesh. 2012. "Aggregate Impacts of a Gift of Time." *American Economic Review*, 102(3), 612-16.

Meghir, Costas and Mårten Palme. 2005. "Educational Reform, Ability and Family Background." *The American Economic Review*, 95(1), 414-24.

Murphy, Kevin M. and Robert H. Topel. 1985. "Estimation and Inference in Two-Step Econometric Models." *Journal of Business & Economic Statistics*, 3(4), 370-79.

Stinebrickner, Ralph and Todd R. Stinebrickner. 2008. "The Causal Effect of Studying on Academic Performance." *The B.E. Journal of Economic Analysis & Policy*, 8(1).

Tanaka, Ryuichi. 2008. "The Gender-Asymmetric Effect of Working Mothers on Children's Education: Evidence from Japan." *Journal of the Japanese and International Economies*, 22(4), 586-604.

Ueda, Atuko. 2009. "Intergenerational Mobility of Earnings and Income in Japan." *B.E. Journal of Economic Analysis & Policy*, 9(1).

Yamada, Ken. 2011. "Family Background and Economic Outcomes in Japan," *SMU Economics & Statistics Working Paper Series.*

Table 1 **Descriptive Statistics of the Japan Time-use Survey Sample, 9th Graders**

	1996	2001	2006
Study (Minutes per Day)	434	463	458
Weekdays	517	540	556
Saturday	297	366	242
Sunday	148	190	192
Leisure (Minutes per Day)	254	228	220
Weekdays	196	174	156
Saturday	371	310	374
Sunday	435	403	388
Other activities (Minutes per Day)	752	750	761
Weekdays	728	726	728
Saturday	771	763	825
Sunday	856	847	860
Girl (%)	49	50	50
Head Education=9 (%)	24	16	14
Head Education=12 (%)	47	45	46
Head Education=14 (%)	5	8	10
Head Education=16 (%)	24	31	31
Female Headed (%)	10	11	15
Single Parenthood (%)	14	13	20
Mother's Employment (%)	28	29	25
Annual Income -39 (%)	18	20	25
Annual Income 40-59 (%)	23	21	22
Annual Income 60-89 (%)	33	32	32
Annual Income 90- (%)	25	25	18
Observations	7,645	4,852	4,140

Note: Household income is measured in 100,000 yen (approximately, $US1,000). Sampling weights are used. Study includes commute, study, and research. The commute time is included in study time because it is a fixed time cost for studying. The average commute time was 47, 38, and 34 minutes in 1996, 2001, and 2006, respectively. Leisure includes shopping, moving, watching TV and listening to the radio, hobbies, sports, social activities, and associations. Tertiary and other includes sleeping, personal care, eating, working, housekeeping, nursing, child rearing, rest, medical care, and other activities.

Table 2 **Changes of Child's Study Time by Head's Educational Attainment Before and After All Saturdays Became School Holidays in 2002, 9th Graders, Minutes Per Day**

	(1)	(2)	(3)	(4)
	Mon-Fri	**Sat**	**Sun**	**Daily Mean**
Head Education	5.80	6.63	4.84	5.34
	(2.18)	(2.38)	(2.38)	(1.90)
(Head Education -12) ×2001	-1.42	-0.44	5.63	1.39
	(3.59)	(3.58)	(3.61)	(3.08)
(Head Education -12) ×2006	1.41	9.85	8.31	7.00
	(4.06)	(5.04)	(3.82)	(3.53)
2001	21.44	67.28	34.78	24.24
	(7.85)	(9.04)	(8.42)	(7.33)
2006	35.74	-60.09	37.87	16.05
	(8.67)	(12.87)	(8.81)	(8.31)
Girl	28.31	16.42	30.74	25.76
	(7.09)	(9.06)	(7.14)	(6.23)
Female Headed	-1.59	-29.65	-6.15	7.13
	(20.88)	(36.73)	(22.84)	(18.51)
Single Parent	-8.89	-13.24	7.96	-8.31
	(18.48)	(34.15)	(21.17)	(16.40)
Mother Work	-8.94	-9.05	-11.50	-9.70
	(7.97)	(11.56)	(7.72)	(6.90)
Annual Income 40-59	-1.32	1.17	-5.03	6.32
	(10.74)	(12.02)	(10.17)	(9.75)
Annual Income 60-89	20.36	22.31	20.27	29.78
	(10.04)	(12.92)	(10.08)	(9.35)
Annual Income 90-	32.02	58.58	38.26	34.00
	(11.47)	(13.79)	(11.74)	(10.43)
Constant	421.01	191.03	59.74	338.93
	(27.79)	(29.77)	(29.04)	(24.04)
R^2	0.03	0.09	0.05	0.02
N	6,226	5,231	5,180	16,637

Note: Sample includes age 15 if born between April and September, or age 14 if born between October and March. All estimations are weighted by sampling weights. Standard errors are in parentheses. Household income is measured in 100,000 yen (approximately, $US1,000).

Table 3 **Changes of Child's Study Time on Saturday among 9th Graders, 2001 and 2006, 3rd Saturday Becomes Holiday from 2002.**

	(1)	(2)	(3)	(4)
	2nd Saturday	3rd Saturday	2nd Saturday	3rd Saturday
Head Education	12.39	0.24	11.17	0.44
	(5.20)	(3.01)	(4.59)	(2.95)
(Head Education -12) × 2006	1.38	16.65	-1.28	17.45
	(7.70)	(6.65)	(6.65)	(5.28)
2006	-38.60	-185.07	-	-
	(22.75)	(13.65)		
Prefecture × Year Fixed Effects	No	No	Yes	Yes
R^2	0.06	0.21	0.72	0.78
N	1,119	1,725	1,119	1,725

Note: Sample includes age 15 if born between April and September, or age 14 if born between October and March. All estimations are weighted by sampling weights. Standard errors are in parentheses. All specifications include a constant and dummy variables for girl, dummy variables for female-headed household and single parenthood, and 3 household annual income categories (4-5.99, 6-8.99, 9- million yen), but coefficients are not reported.

Table 4 **Changes of Child's Time Use by Head's Educational Attainment Before and After All Saturdays Became School Holidays in 2002, 9th Graders, Minutes Per Day**

	(1)	(2)
	Leisure	**Other activities**
Head Education	-4.26	-1.09
	(1.60)	(1.35)
(H Education -12) × 2001	-3.11	1.72
	(2.44)	(2.07)
(H Education -12) × 2006	-7.30	0.30
	(2.56)	(2.70)
2001	-20.91	-3.33
	(5.99)	(5.04)
2006	-24.73	8.67
	(6.69)	(5.69)
R^2	0.03	0.00
N	16,637	16,637

Note: The same note applies as in Table 3.

Table 5 Changes of Child's Time Use, Minutes Per Day, Daily Mean, Prefecture × Year Fixed Effects Included, 9th Graders

	(1)	(2)	(3)
Activity	**Study**	**Leisure**	**Other activities**
Head Education	5.78	-4.46	-1.32
	(1.84)	(1.59)	(1.38)
(Head Education -12) ×2001	1.60	-2.75	1.15
	(2.99)	(2.40)	(2.13)
(Head Education -12) ×2006	7.13	-7.31	0.18
	(3.39)	(2.61)	(2.58)
R^2	0.80	0.62	0.96
N	16,637	16,637	16,637

Note: The same note applies as in Table 3.

Table 6 **Descriptive Statistics of the TIMSS and the PISA**

	TIMSS, 8th Graders			PISA, 10th Graders	
	1999	2003		2000	2003
Standardized Math Score	50.2	50.7		49.6	50.1
Parent 4-year-college Graduate	-	53.7			
Parent junior-college Graduate	-	50.1			
Parent high-school Graduate	-	47.6			
Parent junior-high-school Graduate	-	43.6			
Standardized Science Score	50.2	50.7		49.6	50.1
Parent 4-year-college Graduate	-	53.2			
Parent junior-college-Graduate	-	50.5			
Parent high-school-Graduate	-	47.9			
Parent junior-high-school Graduate	-	45.8			
Standardized Reading Score	-	-		49.9	50.1
Parent 4-year-college Graduate	-	-			
Parent junior-college-Graduate	-	-			
Parent high-school-Graduate	-	-			
Parent junior-high-school Graduate	-	-			
Girl (%)	49.6	51.9		51.0	51.8
# of Books at Home (%)					
0-10	13.8	12.2	1-10	11.2	9.9
11-25	19.3	21.2	11-50	25.2	11.8
26-100	31.2	32.1	51-100	19.9	32.6
101-200	18.1	16.8	101-250	22.4	18.5
200-	17.5	17.6	251-500	12.3	17.4
			501-	8.9	9.7
Possession of Item at Home (%)					
Calculator	99.3	99.2	Computer	63.9	53.7
Computer	52.5	83.0	Internet	36.3	60.5
Desk	97.5	96.4	Child's room	83.2	88.9
Dictionary	99.4	99.5			
Head's Years of Education (%)					
4-year College	-	44.4		-	2.2
Junior College	-	17.6		-	9.3
High School	-	35.8		-	30.0

Junior-high School	-	2.2	-	58.4
N	4,542	3,429	4,505	4,641

Note: Mathematics and science scores in the 2000 PISA are available for 2,924 and 2,914 students, respectively. Computer possession in the 2000 PISA includes those who answered that they had two or more computers at home.

Table 7 Socioeconomic Gradient of TIMSS Scores in 1999 and 2003, 8th Graders, Standardized Mathematics and Science Scores, Mean = 50, Standard Deviation = 10

	(1)	(2)	(3)	(4)
Subject	Mathematics	Science	Mathematics	Science
Parent Education	0.99	0.92	0.88	0.84
	(0.77,1.11)	(0.75,1.05)	(0.66,1.00)	(0.67,0.98)
(Parent Education - 12)	0.20	0.26	0.13	0.18
× Year 2003	(0.03,0.42)	(0.08,0.46)	(-0.04,0.36)	(0.00,0.37)
Year 2003	0.08	-0.01	-	-
	(-0.52,0.48)	(-0.62,0.40)		
Girl	-0.39	-1.11	-0.48	-1.18
	(-0.79,-0.02)	(-1.48,-0.69)	(-0.87,-0.10)	(-1.57,-0.76)
Constant	38.13	39.38	-	-
	(36.51,41.09)	(37.66,41.84)		
School × year fixed effects	No	No	Yes	Yes
R^2	0.06	0.06	0.97	0.97
N	9,182	9,182	9,182	9,182

Note: Bootstrapped 95% confidence intervals with 500 repetitions are reported in parentheses. Parent education is higher educational attainment by either mother or father. Parental education is predicted by the number of books at home, as well as possession of a calculator, a computer, a desk, and a dictionary at home.

Table 8 Socioeconomic Gradient of PISA Scores in 2000 and 2003, 10th Graders, Standardized Reading, Mathematics and Science Scores, Mean = 50, Standard Deviation = 10

	(1)	(2)	(3)	(4)	(5)	(6)
	Reading	Math	Science	Reading	Math	Science
Parent Education	0.90	0.90	0.94	0.25	0.26	0.28
	(0.71,1.08)	(0.68,1.12)	(0.70,1.12)	(0.10,0.37)	(0.11,0.42)	(0.07,0.40)
Parent Education-12	0.26	0.25	0.20	0.23	0.05	0.11
× Year 2003	(0.02,0.47)	(-0.02,0.49)	(-0.02,0.47)	(0.05,0.40)	(-0.12,0.23)	(-0.04,0.34)
Year 2003	-0.38	-0.33	-0.31	-	-	-
	(-0.69,0.25)	(-0.67,0.38)	(-0.67,0.43)			
Girl	3.22	-0.47	0.39	2.12	-1.46	-0.82
	(2.83,3.62)	(-0.92,-0.01)	(-0.07,0.84)	(1.72,2.47)	(-1.89,-1.05)	(-1.26,-0.47)
Constant	37.33	39.30	38.24	-	-	-
	(35.11,39.58)	(36.44,41.91)	(36.08,41.10)			
School × year fixed effects	No	No	No	Yes	Yes	Yes
R^2	0.09	0.07	0.07	0.47	0.54	0.48
N	9,372	7,621	7,611	9,372	7,621	7,611

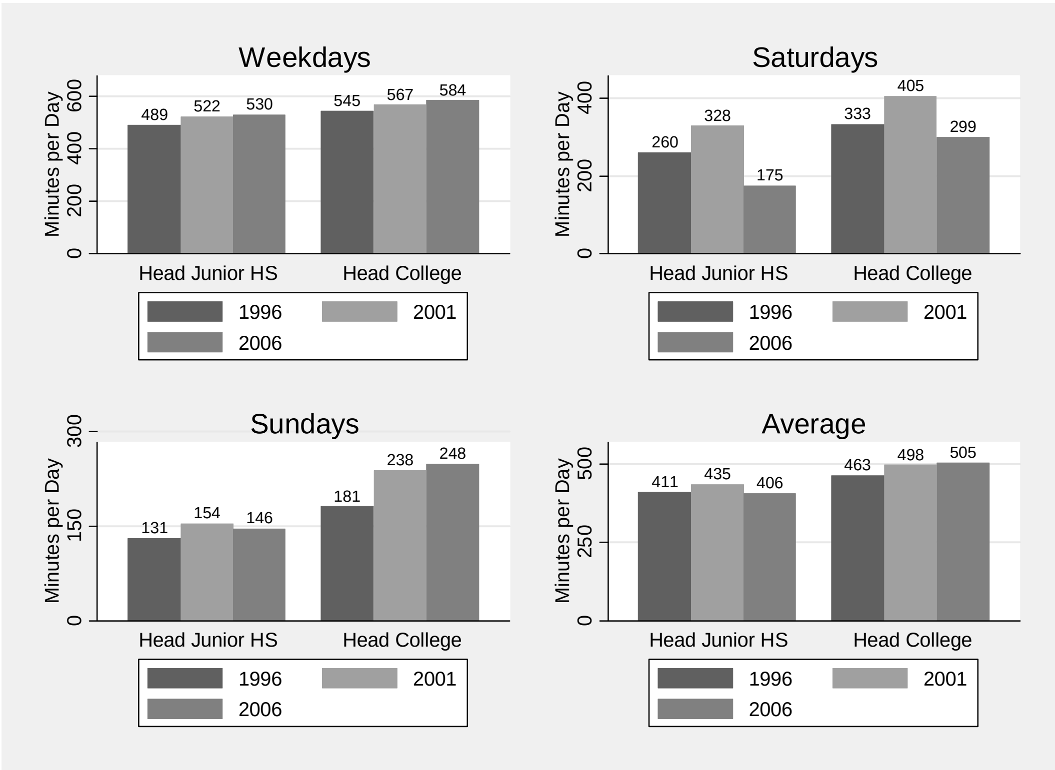
Note: Bootstrapped 95% confidence intervals with 500 repetitions are reported in parentheses. Parent education is higher educational attainment by either mother or father. Parental education is predicted by the number of books at home, possession of computer, internet, and child's own room.

Table 9 **Effects of Study Time on TIMSS and PISA Scores, Two Sample TSLS Estimation**

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	JTUS	TIMSS	TIMSS	PISA	PISA	PISA
Dependent Variable	Study Time	Math Score	Science Score	Reading Score	Math Score	Science Score
Study Time	-	0.16	0.14	0.04	0.04	0.03
(in minutes per day)		(0.04,0.70)	(0.03,0.60)	(0.00,0.07)	(-0.00,0.07)	(-0.00, 0.07)
Parent Education	7.38	2.17	2.21	0.55	0.56	0.68
	(1.89)	(-2.38,3.81)	(-2.23,3.68)	(0.13,1.01)	(0.07,1.10)	(0.12,1.11)
Year 2001	22.65	-	-	-	-	-
	(7.33)					
After 2002	12.55	-4.98	-4.62	-0.87	-0.80	-0.69
	(8.34)	(-13.64,-1.78)	(-12.56,-1.59)	(-1.36,-0.04)	(-1.37,0.16)	(-1.30,0.18)
(Parent Education - 12)	1.61	-	-	-	-	-
× 2001	(3.07)					
(Parent Education - 12)	6.76	-	-	-	-	-
× 2006	(3.56)					
Girl	26.63	-4.54	-4.83	2.18	-1.47	-0.41
	(6.27)	(-18.45,-1.13)	(-12.56,-1.59)	(1.26,3.12)	(-2.63,-0.36)	(-1.62,0.60)
R^2	0.02	0.06	0.06	0.09	0.07	0.07
N	16,637	9,182	9,182	9,372	7,621	7,611

Note: The 9th graders of the JTUS 1996, 2001, and 2006 are used to estimate Column (1). The 8th graders of the TIMSS 1999 and 2003 are used to estimate Columns (2) and (3). The 10th graders of the PISA 2000 and 2003 are used to estimate Columns (4) - (6). Standard Errors are reported in parentheses in Column (1). Bootstrapped 95% confidence intervals with 500 repetitions are reported in parentheses for Columns (2) and (3). Sampling weights are used for all regression models.

Figure 1 Students' Mean Study Time and Socioeconomic Background, 1996, 2001, 2006, 9th Graders



Note: All means are calculated using sampling weights. Study includes commute, study, and research. The commute time is included in study time because it is a fixed time cost for studying. The average commute time is 37, 38, and 34 minutes in 1996, 2001, and 2006, respectively.