School Cutoff Dates, the Timing of Births, and Heterogeneous Responses

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Abstract

This is the first paper that documents that school entrance cut-off date affects the timing of births. Many countries require children to reach a certain age by a specified date in the calendar year in order to start primary school. There is a clear tradeoff for parents to time a birth either before or after the school entrance cut-off date; births just *before* cut-off date benefit parents by avoiding a year of child care costs through sending their children to school at a relatively young age, while births just *after* cut-off date may benefit children by being in the oldest among the school cohort, which is shown to provide the children with academic advantage (relative age effects). Using the universe of birth during 1974–2010 in Japan with single school entrance cut-off date of April 2, I reach three findings. First, I find that more than 1,800 births are shifted roughly a week before the cut-off date to a week following the cut-off date. My finding suggests that relative age effects may dominate at least in Japanese setting. Second, I find that non-working mothers are more likely to delay births, which is consistent with lower opportunity cost of non-working mothers. However, interestingly among those working, mothers with low skilled jobs are more likely to shift births *before* the school entrance cut-off dates. This result implies that financial burden of child cares may force mothers to time delivers earlier to avoid the additional one year of child care cost. Also I find that delay of births is much more drastic for male births than female births, which may be one form of son-preference. Finally, I examine the health outcomes of births. While birth after the cut-off date was slightly heavier, I do not find any change in infant mortality, which is plausible since hospitals anticipate the surge in the births. This study may have implications for growing literature that assumes births around the school entrance cut-off dates are random. In fact, ongoing work uses the publically available Trends in International Mathematics and Science Study (TIMSS) 1995 and 1999, which report both test scores and exact date of births, to examine whether there is academic advantage among those born after the cut-off date in Japan in a regression discontinuity framework and if so, whether such advantage is robust to controlling for mother's observable characteristics.

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1. Introduction

There is a small but growing literature which examines the impact of the incentives created by birth-related cut-off dates on the timing of births. Past studies have analyzed the timing of births in very different settings and institutions that rely on cut-off dates that were known to parents before delivery. For example, evidence suggests that parents have manipulated birth dates in order to avoid taxes in the US (Dickert-Conlin and Chandra, 1999) and obtain monetary bonuses in Australia (Gans and Leigh, 2009).[2]

In this paper, I analyze one of such cut-offs: school entrance date. Many countries require children to reach a certain age by a specified date in the calendar year in order to start primary school. Parents who plan to have children face a trade-off to time a birth before and after the school entrance cut-off dates. The benefit of shifting birth *before* the school entrance cut-off date is that parents can send their children to school at a relatively young age, and thus avoid a year of child care costs.[3] The benefit of shifting birth *after* the school entrance cut-off date is that academic performance, and later labor outcome, is shown to be better for the older children within an academic cohort (relative age effects).[4] Whether parents react to the incentives, and if so which incentive dominates is an empirical question.

There are a few papers which examined this question: Dickert-Conlin and Elder (2010) in the US, McCrary and Royer (2010) in Texas and California in the US, McEwan and Shapiro (2008) in Chile, and Berlinski et al. (2011) in Argentine. However, no paper so far finds evidence of sorting around school entrance cut-off dates.

There are two key institutional features that make Japan a unique setting where the timing of birth is very important for parents. First, the delay of the entry into primary school is very rare in Japan. In fact, Kawaguchi (2012) documents that only 0.03% of primary school age children are exempted from the mandatory starting age in Japan. Therefore the timing of births indeed decides when the children start primary schools later. This setting is in contrast to the case in the US where significant fraction of children defer school entry by a year, making them the oldest students (Datar, 2006). Second, there is only one single school entrance cut-off date that applies to all children in Japan, so it is impossible for parents to move to other prefectures which have different school entrance cut-off dates unlike the US

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[2] Tax incentives in the US (Dickert-Conlin and Chandra, 1999; Maghakian and Schulkind, 2012; LaLumia, Sallee, and Turner, 2013); tax incentives in Japan (Kurenishi and Wakabayashi, 2008); bonus payment in Australia (Gans and Leigh, 2009); parental leave benefit reform in Germany (Tamm, 2012); expansion of job-protection leave in Germany (Dustmann and Schonberg, 2012); extending the leave duration in Austria (Lalive and Zweimuller, 2009). Some papers find the evidence on shift in the timing of births, while others do not.

[3] There is some convincing evidence that availability of kindergarten affects mother's labor supply (e.g., Berlinski and Galiani, 2007; Cascio, 2009; Gelbach, 2002; Schlosser, 2011). These findings suggest that kindergarten implicitly serve as a child care center.

[4] There is solid evidence that the older children perform better in school than younger children within an academic cohort (e.g., Bedard and Dhuey, 2006; Dobkin and Ferreira, 2010).

where each state has different school entrance cut-off dates.[5]

I use universe of birth certificate records 1974 – 2010 which reports exact date of births to assess whether parents systematically time childbirth before or after this eligibility cut-off date. I also examine the heterogeneous responses of shifts in the timing of birth by mother's observable characteristics. Finally, I examine the effect of the shift on child outcomes. I find three main results.

First, I find that more than 1,800 births are shifted roughly a week before the cut-off date to a week following the cut-off date. Since I observe a gradual decline and a gradual increase in the number of births roughly within a week of the cut-off date, this shift of births is more consistent with real shift instead of pure manipulation. This finding of delaying births suggests that the relative age effect dominates at least in Japanese setting. Also this result contrast with the findings from other papers that parents do react to incentives if the financial reward is immediate but do not or are less likely to do so if it only affects the outcomes at some future point in time (in this case children's academic performance). This is the first paper that documents the solid evidence that school entrance cut-off date affects the timing of births.

Second, I examine the characteristics of mothers who shift the births, and find that those mothers who are not working are more likely to delay births, which is consistent with the notion that opportunity cost of non-working mothers is smaller than those of working mothers. However, interestingly among those working, mothers with low skilled jobs are more likely to shift births *before* the school entrance cut-off dates. This result imply that contemporaneous financial burden of additional one year of child care cost outweigh the importance of future academic advantage of children for those mothers.

Third, I examine the characteristics of child including gender of births, birth weight, and infant mortality. The most interesting result is that male births are much more likely to be delayed than female births. This finding is striking since Japan is known to show little son preference in the prenatal stage, and therefore have normal sex ratio at births unlike many of Asian countries that show elevated sex ratio at births in favor of male births (Sen, 1990, 1991). This result may imply a different form of son preference at postnatal stage instead of prenatal stage such as sex-selective abortion. Also consistent with the real shifts in timing of births instead of pure manipulation, I find the birth weight of children born after the school entrance cut-off date is slightly heavier, and the probability of overweight (>4000 grams) is also slightly higher. Finally, I also examine the infant mortality. If the surge in the number of births right after the school entrance cut-off date creates the congestion or overcrowding in hospitals, it could potentially harm the health of newborns. But it may not affect the infant health since

[5] For example, school entrance cut-off date for California is December 1, and that for Texas is September 1. These cut-offs are exploited in McCrary and Royer (2010) and Dobkin and Ferreira (2010). For school entrance cut-off dates in each state in the US, see Dickert-Conlin and Elder (2010). For international school entrance cut-off dates, see Bedard and Dhuey (2006).

hospitals can anticipate such a surge, and thus they are well prepared. Consistent with the latter view, I do not find that births born right after the school entrance cut-off date show the excess infant mortality.

This paper is related to several strands of literature. First, this result provides evidence on the power that parents have on the timing of birth. Overall there is ample evidence that a certain number of births are timed. For example, using our data from birth certificates I observe that the number of births taking place on weekends or holidays is lower by around 18% than on weekdays. Yet, it is generally not clear whether this timing is due to doctors and hospitals or due to parents.[6] Since doctors/hospitals certainly prefer not to have congestions, this surge in the number of births right after the school entrance cut-off dates suggest that parents has some power vis-`a-vis doctors/hospitals on the timing of the delivery.

Second, in addition to the literature on strategic timing of birth, this paper also contributes to the growing literature that relies on the identification strategy that assumes that births around the school entrance cut-off dates are random.[7] Since a seminal paper by Angrist and Krueger (1991), many studies combine this fact with the compulsory school law to instrument for educational outcome. This paper adds to the literature that cast doubt on the validity of such instruments in some occasions (e.g., Buckles and Hungerman, forthcoming).[8]

Also this paper is closely linked to the literature that argues the underlying assumption of a regression discontinuity (RD) design. For example, Verhoogen and Urquiola (2009) show that schools in Chile at the class-size cap precisely control enrollments to avoid adding an additional classroom, which generates discontinuities in the relationship between enrollment and household characteristics, violating the underlying assumptions of RD designs. I also find that age and working status of mothers, and type of mother's job discretely change right after the school entrance cut-off dates.[9]

The remainder of this paper is organized as follows. Section 2 provides background information on the school system. Section 3 describes the data used herein, and the identification strategy. Section 4 shows the main results and section 5 discusses the implications of the findings. Section 6 concludes.

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[6] Chandra et al. (2008) documents that more births in the weekends than weekdays, but also notes that it is not clear whether they are driven by hospitals/doctors or patients.

[7] For example, see Bedard and Dhuey (2006), Cascio and Schanzenbach (2007), Dobkin and Ferreira (2007), Elder and Lubotsky (2009), McCrary and Royer (2011), and Black, Devereux, and Salvanes (2011).

[8] For the instruments to be valid, instruments have to satisfy two conditions: exclusion restrictions and relevance. Most of past literature questions the relevance, i.e., weak instrument, such as Bound, Jaeger, and Baker (1995). Here the issue is about exclusion restrictions.

[9] In fact, Bedard and Dhuey (2006) exploit this school cutoff date among OECD countries, which *does* include data from Japan, and show that younger cohorts within the academic cohort do perform worse than older children.

2. Background

In this section, I briefly describe the school system. This school entrance cut-off dates in Japan has been April 2 since 1947, and it has not changed since then. The school system in Japan is legally defined in the School Education Law (SEL) enacted in 1947. SEL article 22 mandates parents to send their children to primary schools as soon as their children turn age six before the school starting day, which is April 1 in Japan. However, according to Japanese law, people reach the additional age a day before their birthday. This means that actual school cut-off date is April 2 instead of April 1; children born on April 1 enter primary schools on their 6th birthday, while those born on April 2 enter primary schools on the day before their 7th birthday. So there is about a 1-year age difference at the maximum among primary school students in the first grade.

This rule is strongly enforced and thus students rarely delay or start primary school earlier than scheduled date in Japan. Japan employs social promotion system, where automatic promotion occurs from one grade to the next. Indeed, SEL Article 23 allows a delay in school entry due to a child's illness or underdevelopment, but this exception is rarely applied. According to Kawaguchi (2010), the percentage of exemption is 0.03%.[10] Also the SEL Article 23 does not prohibit students from learning in the grade above the scheduled grade, but the advancement is also very rare. The fact that almost all children start attending school without delay or advancement contrasts with the situation in the US, where postponing school attendance has become popular among educated parents (Datar, 2006; Elder and Lubotsky, 2009; Cascio and Schanzenbach, 2012; Dobkin and Ferreira, 2010).

Also unlike the US, compulsory schooling is not defined by the age when students can leave, but by the length of the years; 9 years of education (6 year in primary school and 3 year in junior high school) is uniformly required for all children. Therefore there is no systematic variation in years of schooling based on the timing of births. This means parent in Japan do not face a well-known tradeoff in the US where though students who are the youngest in their school cohort typically have poorer academic performance, on average, they have slightly higher educational attainment. In Japan, latter effect is not mechanical as in the US. That is, the Japanese institutional setting does not create a variation in the number of completed years of schooling by quarter of birth or birth date unlike the case in Angrist and Kruger (1992) or McCrary and Royer (2011). Therefore, if there is a variation in the years of schooling depending on the birth date in Japan, the variation is induced by individual choice (Kagaguchi, 2010).

[10] In 2004, 7,200,933 children at the primary school age (ages 6–12) attended primary schools, while 2261 did not (Kagaguchi, 2010).

3. Data and Identification Strategy

3.1 Data

The primary data for this analysis are the universe of birth record that covers all births occurred in Japan during 1974-2010 compiled by Ministry of Health, Labour and Welfare. I drop those born outside of Japan, missing birth dates information. Combining the 1974-2010 birth data provides me with information on over 50 million births. Our main interest of outcome is the mean daily number of births. Also I examine the heterogeneous responses to shift in the timing of births by mothers' characteristics.[11] I also examine the child characteristics to investigate whether the shits in the timing of births are indeed real shift in timing instead of pure manipulation by looking at the birth weight of children. I also examine a gender of child, and a parity of child.[12]

For every five years, the birth certificates in Japan collect information on working status of mothers at the time of delivery, and roughly 10 categories of mother's job types for working mothers. I divide the 10 categories of job types into high skilled jobs, medium skilled jobs and low skilled jobs. Appendix Table 1 summarizes the occupational categories.

I also use the death certificates to examine the infant mortality. The death certificates contain a unique record of each death occurring in the Japan, which includes information about the decedent's exact date of death, exact date of birth, gender, and cause of death (ICD8-10). I can simply count the number of deaths within certain days from births by combining the exact date of death, and exact date of birth.While the birth and death data are not linked in Japan, I merge the number of deaths for birth born each birth date from death data (the numerator) to the number of birth for each birth date from birth data (the denominator), and calculate the infant mortality rate on each birth date.

3.2 Identification Strategy

Let $birth_{dy}$ be counts of deaths for day *d* in year *y*. Days are organized in relation to the April 2. Given this structure for the data, the econometric model I estimate is:

$$birth_{dy} = \alpha + \beta After_{dy} + \sum_{j=1}^{6} DOW(j)_{dy}\gamma_j + \sum_{k=1}^{N} Holiday(k)_{dy}\delta_k + \theta_y + \varepsilon_{dy} \quad (1)$$

$$\ln(birth_{dy}) = \alpha + \beta After_{dy} + \sum_{j=1}^{6} DOW(j)_{dy}\gamma_j + \sum_{k=1}^{N} Holiday(k)_{dy}\delta_k + \theta_y + \varepsilon_{dy} \quad (2)$$

[11] Unfortunately, the information on mother's socioeconomics (SES) characteristics is limited in the birth certificates in Japan. They do not collect education of mothers/fathers, number of prenatal checkups, delivery method (such as C-section and inducement), and complications of births.

[12] Also since 1992, mothers' exact date of birth is reported. Setting aside the selection issue, I examine whether mothers' date of birth show the same patterns as I see in the birth data. In fact, I also find that mothers' birth date is also concentrated right after the school entrance cut-off date (not shown).

where $After_{dy}$ takes one if the birth day *d* is after April 2 in each year *y*. *DOW(j)* is one of six dummy variables for the different weekdays, and $Holiday(k)$ of *K* dummy variables for holidays throughout the year. The coefficient of interest is β. The variable θ_y captures year effects, and ε_{dy} is an idiosyncratic error term. The year indicators are included to account for time trends in the overall number of births.[13] I change the windows around the April 2, from 7 days to 28 days following Gan sand Leigh (2008).[14] Using the log number of births in equation (2) provides a measure of the proportion of births shifted.

I also examine the child characteristics around the school entrance cut-off date. Here I use the individual birth data instead of number of counts at each birth date. The equation I estimate is:

$$Y_{idy} = \alpha + \beta After_{idy} + \sum_{j=1}^{6} DOW(j)_{idy}\gamma_j + \sum_{k=1}^{N} Holiday(k)_{idy}\delta_k + \theta_y + \varepsilon_{idy} \quad (3)$$

for each outcome *Y* for individual birth *i* born in year *y*, and day *d*. To account for common characteristics within the same birth date cells, the standard errors are clustered at the birth date, following Lee and Card (2008).

4. Results

4.1 Shift in the Timing of Births

Before running formal statistical analysis, the simple histogram of mean daily number of births reveals the striking pattern. Figure 1 shows the birth distribution throughout the year using the pooled 1974-2010 birth data. The markers with cross sign correspond to the holidays. Note once again that school entrance cut-off date is April 2 instead of April 1. To my knowledge, nothing other than school entrance cut-off dates lies on this specific day.

Figure 1 shows that there is clearly a heaping on April 2, and relatively high number of births on subsequent days. In fact, April 2 is the day with the highest number of births throughout the year, and April 1, a day before the cut-off date, is the third lowest in number of births. Table 1 reports the top 5 and bottom 5 of the day of the year in terms of mean daily number of births, and the relative number of births, computed as the average births on a given day divided by the average birth across all days. Thus, a value of 1.1 represents a 10 percent increase in the daily births compared to the average in the year. April 2, and April 3 are 20 and

[13] I also tried to include day of week*year fixed effect to allow each week day to have differential impact by each year. The results are very similar.

[14] Widening the window has two purposes. First, it allows for births to have been moved by more than one week even though as I show later, birth shifting is concentrated within a week from the cut-off date. Second, it accounts for the possibility of 'unsuccessful moves', where some parents may have attempted to delay their child's birth until April 2, but instead only moved the birth date from mid-March to late-March. Such moves attenuate the estimates derived from focusing on a narrow window.

10 percent more births than average, while April 1, a day before the cut-off date, is 15 percent less than average. This graph also shows the importance of controlling for holidays in the estimation. There is also variation in the weekdays vs. weekends, but pooling many years of data smooth out such an effect. In the regression, I include the day of the week fixed effects to control for the within week fluctuations.[15]

In Figure 2, I graph the mean daily number of births around April 2 using pooled 1974-2010 birth data. To provide symmetry, I report the 28 days prior to the April 2 (March 4 −April 1), and the 28 days after April 2 (April 2−April 29). Again, the markers with cross sign correspond to the holidays.[16] Panel A simply plots the mean daily number of births. Starting about 10 days before April 2, daily number of births gradually declines, and falls to roughly 2800 per day on April 1, a day before the school entrance cut-off date. The number of births then sharply increases to roughly 4,500 on April 2. The difference between a day before and after the school entrance cut-off date is as much as 1700 births with an average of 3,711 births per day throughout the year. Note that other dips around March 20 and April 29 are the result of holiday, Spring Equinox Day (either March 20 or 21), and Greenery day (April 29), respectively. Panel B accounts for weekend, and holidays by plotting the residual of regressions of number of births on weekday and holiday fixed effects. This graph shows the similar patterns as Panel A.

Table 2 summarizes the results from formal statistical test of estimating equation (1) and (2). First row in Panel A restricts the sample to the last 7 days and first 7 days around April 2, and it shows that roughly 1,835 births are shifted within 7 days from April 2. In the remaining columns, I progressively widen the window of analysis. As I widen the window, the number of births shifted does not substantially change in 14 and 21 days around the cut-offs. This result implies that most of the shift in the timing of births is concentrated within the first and last 7 days from the school entrance cut-off date. Panel B now use natural log of the mean daily birth as an outcome. The first column shows that roughly 7.0 percent of births are shifted from a week before to a week after April 2. This pattern is not just limited to a certain period. Appendix Figure A1 shows the mean daily number of birth around April 2 by different time period. While the magnitude of the abrupt change is larger in the early years, I still find the large shift in the timing of births in the most recent decade as well.

Since I observe the gradual decline before April 2, it seems unlikely that manipulation of reported birth date can account for all the birth shifts. This result cannot be entirely driven by the manipulation of birth date among births delivered at homes since 99 % of birth occurs

[15] Some holidays do not fall on the same day. Holidays in Japan are: Jan 1, Jan 15 (till 1999), Feb 11, March 20 or Mach 21 (during 1974-2010, 14 years on Mach 20, and 23 years on March 21), April 29, May 3, May 4, May 5, July 29 (till 2002), Sep 15 (till 2002), Sep 23 (Sep22 for 1975, and 1979), Oct 10 (till 1999), Nov 3, Nov 23, and Dec 23.

[16] The holidays included in this graph is Spring Equinox Day or *shubun-no-hi* (March 20 or Mach 21), and Greenery Day or *midori-no-hi* (April 29).

either at hospitals or clinics during 1974-2010.[17] [18] Further evidence against pure manipulation story is shown later when I examine the birth weight of children, and gestational length of mothers. This delaying of births is pretty surprising since medical literature documents that it is more difficult to delay the births than bring forward through C-sections o inducement.

4.2 Heterogeneous Responses by Mothers' Characteristics

Exploiting the characteristics of mother and children, I shed the light on the incentive behind the shift of the timing of births. Figure 3-6 plots the mean daily number of births by a parity of child, by mother's age, by mother's working status, and a gender of child within 28 days before and after the school entrance cut-off date. Table 3 and 4 summarizes the results from estimating equation (3) where outcome is log of the mean daily number of births separately for each sub-groups.

Figure 3A show that births at higher parity is more likely to fall behind the school entrance cut-off date. This is apparent in Figure 3B which plot the share of high parity birth (2^{nd} and above) among all births around April 2. The figure shows that share of high parity birth increase right after April 2. Panel C in Table 3 shows while 8.6 percent of birth at high parity are delayed within 7 day window, that for 1^{st} birth is 5.3 percent, implying that mothers may learn from the previous experience of first child that it is probably beneficial for forthcoming children to fall behind the school entrance cut-off date to make sure that children are older within the grade.

Figure 4A show that relatively younger mothers less than 30 years old show a larger delay of births around April 2, compared to mothers more than 30 years old. Because of this differential pattern by mother's age group, Figure 4B shows a decline in mean mother's age at birth right after the school entrance cut-off date. The more delay of birth among younger mothers may contradict with the learning story, however, since the delay of births can be potentially harmful to the mother's health, the delays of births for older mothers may be difficult, and physicians/hospital may not agree on the mother's request to delay births.

[17]The birth certificates include information in which type of institution the birth has happened: either hospitals or clinics or home. In Japan, roughly 99 % of births occur either hospitals or clinics, where hospitals are those with more than 20 beds, and clinics are those with less than 20 beds or no bed. I find that births are more likely to shifter at clinics than hospitals, consistent with the view that smaller hospitals has more scope for physician's discretion. Also if some of the births shifts reflect the pure manipulation of reported birth date, it may be easier to manipulate in clinics than hospitals, where there are more stuffs, and thus more difficult to coordinate.

[18]Once the child is born in either hospitals or clinics, the basic characteristics of infants such as birth weight are collected at the hospitals or clinics, and the doctors write down the confirmation form of the births. In case of deliveries at home, midwives take care of it. Then the parents bring the form to the near-by public health center (hokenjyo), and register the birth. Therefore if the manipulation of reported birth date happens, it may be more likely to happen at the delivery stage at medical institutions or home rather than reporting stage at the public health center.

The arguably most interesting results are the responses by the gender of births. Figure 5A clearly shows that male births are more likely to be shifted than female births. Figure 5B plot the male/female ratio on each day, and the share of male birth is substantially larger after the school entrance cut-off date. Panel D in Table 3 shows while 8.0 percent of male births are delayed within 7 day window, 6.1 percent of female births are delayed.

This finding is striking since Japan is known to show little son preference in the prenatal stage, and therefore have normal sex ratio at births unlike many of Asian countries that show elevated sex ratio at births (Sen, 1990, 1991). This result may imply a different form of son preference at postnatal stage instead of prenatal stage such as sex-selective abortion. Appendix Figure A2 shows the ratio of male/female births by each period. The figure suggests that the son preference is persistent across different periods.

4.3 Working Status of Mothers

In addition to the mothers' characteristics examined above, here I examine the differential responses by mothers' working status and type of jobs. Since the opportunity cost of working mothers is higher than that of non-working mothers, working mothers may be less likely to delay the births to avoid one additional year of child care. To examine this hypothesis, I divide the sample into working and non-working mothers. Mother's working status is only collected every five years ending with last digit of 0 and 5.

Figure 5A clearly shows that non-working mothers are more likely to shift the timing of births than working mothers. Panel A in Table 4 shows that while non-working mothers shifts 11.3 percent of births within 7 days of school entrance cut-off date, the number is only 3.5 percent for working mothers.

However, the results for working mothers may mask the heterogeneous responses by the different job type of mothers. Figure 5B shows the mean daily number of birth by mothers' job type among those working. Interestingly, mothers with low skilled jobs are more likely to shift births *before* the school entrance cut-off dates. This result imply that financial burden of child cares outweigh the opportunity cost for these mothers, and hence time births earlier than school-cut off dates to avoid the additional one year of child care cost. In fact, Panel B in Table 4 shows that while roughly 20 % of births are shifted backward among mothers with high and medium skilled jobs, the mothers with low skilled jobs (and hence arguably low income) shifts birth forward by roughly 18 percent of births within 7 days of school entrance cut-off date.

Appendix Figure A3 shows the same graphs as Figure 5A and Figure 5B, by the different periods.[19] Panel B in Appendix Figure A3 shows that the shifts in the timing of birth forward among mothers with low skilled jobs became obvious in late 1990s, and it gets much more

[19] Here I combine the medium and high skilled jobs into one category since they shows very similar trend.

accelerated in the most recent year of 2005. While speculative, this result may be the result of the fact the wage disparity became more severe in Japan in later period.

4.4 Child Outcomes

Since I observe the gradual decline before April 2, it seems unlikely that manipulation of reported birth date account for the entire shift in the timing of births. Here I show further evidence against pure manipulation by examining the birth weight of children, and gestational length of mothers. Birth weight is of particular importance as there is ample evidence that health at birth has consequences for medium and long-term outcomes of children (e.g. Black, Devereux, and Salvanes, 2007; Oreopoulos et al., 2008; Royer, 2009; Johnson and Schoeni, 2011). I am aware of only two previous papers by Gans and Leigh (2009) and Tamm (2012) that analyze the impact of cut-off induced birth timing on infant health.

Figure 7A plot the mean birth weight around April 2.[20] The graph clearly shows that birth after the school entrance cut-off dates are heavier than those before April 2. Figure 7B plots the probability of birth more than 4,000 grams, and show similar patterns as mean birth weight. Table 5 presents the results of estimating equation (3) using the individual birth as a unit of observation. Panel A in Table 5 shows that birth weight is roughly 2.3 gram heavier for those born after school entrance cut-off date. Since 7.0 present of births are shifted backward, this would imply that births that are actually delayed are heavier by around 33 grams. Panel B shows that birth after school entrance cut-off date is 0.05 percent more likely to be over 4000 grams. Figure 7C instead plots the probability of birth delivered after more than 42 weeks of gestation. The figure shows the same pattern as mean birth weight.[21]

After having shown that there were sizeable shifts in deliveries, I now analyze health outcomes. One the one hand, if the surge in the number of births right after the school entrance cut-off date creates the congestion or overcrowding in hospitals, it could potentially harm the health of infants. On the other hand, it may not affect the infant health since hospitals can anticipate such a surge, and thus they are well prepared. Consistent with the latter view, Figure 7D shows that there is no change in infant mortality. Panel D in Table 5 confirms that births born right after the school entrance cut-off date do not show the excess mortality.

[20] The birth weight is collected with 100 grams interval till 1995, and therefore I stick with this measure and divide the birth weight collected in grams after 1995 by 100.

[21] I am also currently collecting the health insurance claim data which report the delivery method of birth. Planned C-sections and inducement of births may increase after the school cut-off date. This is the same data used for Shigeoka and Fushimi (2012) that examines the NICU utilization in Japan except that both data covers different period.

5. Discussion

This paper so far shows that school entrance cut-off date affect the timing of births. Since birth shifts gradually from a week before the cut-off date, and also birth weight as well as gestational length of mothers increases after the school entrance cut-off date, the pure manipulation cannot fully account for this shift.

The results have implication for the growing literature that relies on the identification strategy that assumes that births around the school entrance cut-off dates are random. A seminal paper by Angrist and Krueger (1991) showed that individuals born in the 1st quarter of the year have lower education attainment than individuals born in the 4th quarter of the previous year. Such difference was arguably due to the interaction of compulsory schooling laws with school entry laws, which makes individuals born in the first quarter more likely to start school later and therefore more likely to quit formal education before completing a high school degree. Since then quarter of birth is used as instrument for education in many papers, and recent papers use more precise data on the day of the births, and use the day of birthd to instrument for education (e.g., McCrary and Royer, 2011).

However the underlying assumption for this instrument to be valid is that the birth at different quarters or neighborhood of school entrance cut-off dates are random. Indeed, recent studies question the validity of such assumption. Notably, the recent paper by Buckles and Hungerman (forthcoming) shows that birth date may not be random.[22] But no paper has showed that birth around the school entrance cut-off dates is not random.

Furthermore, Bedard and Dhuey (2006) show that using Trends in International Mathematics and Science Study (TIMSS) data among OECD countries *including* Japan the youngest members of fourth and eighth grade classes have standardized test scores that are 2–12 percentiles lower than the oldest students in the same cohort, exploiting the single school entrance cut-off date together with the assumption of the randomness of the births around the cui-off date. Similarly, Kawaguchi (2010) uses TIMSS 2003, and leads to similar conclusion.[23] However, both use the month of births instead of day of birth as their running variable, which could potentially mask the change in characteristics of children and mothers around the school entrance cut-off date.

In ongoing work, I examine whether relative age effects in Japan shown by Bedard and Dhuey (2006) and Kawaguchi (2010) which relies on the month of birth variation instead using the exact date of birth information is still valid if I carry out the same analysis at the day

[22] See also Bound and Jaeger (2000), Dobkin and Ferreira (2010), Cascio and Lewis (2006), and Carlsson et al. (2012) on nonrandomness of birthdate.

[23] These papers cannot distinguish whether the cause of this academic disadvantage for young kids is due to their relative age to peers or due to their absolute age at which they are exposed to a material for the first time, or simply age at the test taking date (Stipek, 2002). Since age at the time of the test, school start date, and birthdate are often perfectly collinear, it is difficult to separately estimate these three effects in conventional empirical framework. See Carlsson et al. (2012) that deal with this issue.

of birth level instead of birth month level. Also since I see the mother's characteristics as well as child characteristics discreetly changes around the school entrance cut-off date, I will examine whether the estimates are robust to controlling for mother and children's observable characteristics. If the estimate differs significantly among those with controls and without controls, this study may caution against assuming the birth around the school entrance cut-off is random. I use the publically available TIMSS data, which report both exact date of births, and test scores for 4^{th} and 8^{th} grade. This is the same dataset used in Bedard and Dhuey (2006) for 1995, and 1999 and Kawaguchi (2010) for 2003. This paper speaks to the importance of checking the distribution of observations around the threshold (McCrary, 2008), and also smoothness of the observable characteristics around the threshold (Lee, 2008; Imbens and Lemiux, 2008; Lee and Lemieux, 2010).

6. Conclusion

Parents are known to time birth in response to various incentives. Some papers has documents that parents do react to incentives if the financial reward is immediate such as tax benefits in the US and Japan, monetary bonuses in Australia, parental leave benefit reform in Germany, while other study find no shifts in the timing of births in response to expansion of job-protection leave in Germany, extending the leave duration in Austria. This paper is distinct from these studies since the delay in the timing of births documented in this paper is mother's response to more long term consequences, that is, children's academic performance at some future point in time.

The question still remains as to why I find the shifts of births in response to school entrance cut-off date in Japan, while other attempts in US, Chile and Argentine do not find such behavioral responses of mothers. Even though speculative, the strict enforcement of entry age in Japan, and social promotion education system without delays, and advancement, suggest that the stake of birth timing is much high in Japan since it determines when the child start schools later in their life compared to other countries where school entry can be easily delayed. Investigating this question in detail using other source of data that include information that influences the incentive structure, for example, wages of mothers, availability of the child care center, is the scope for the future research.

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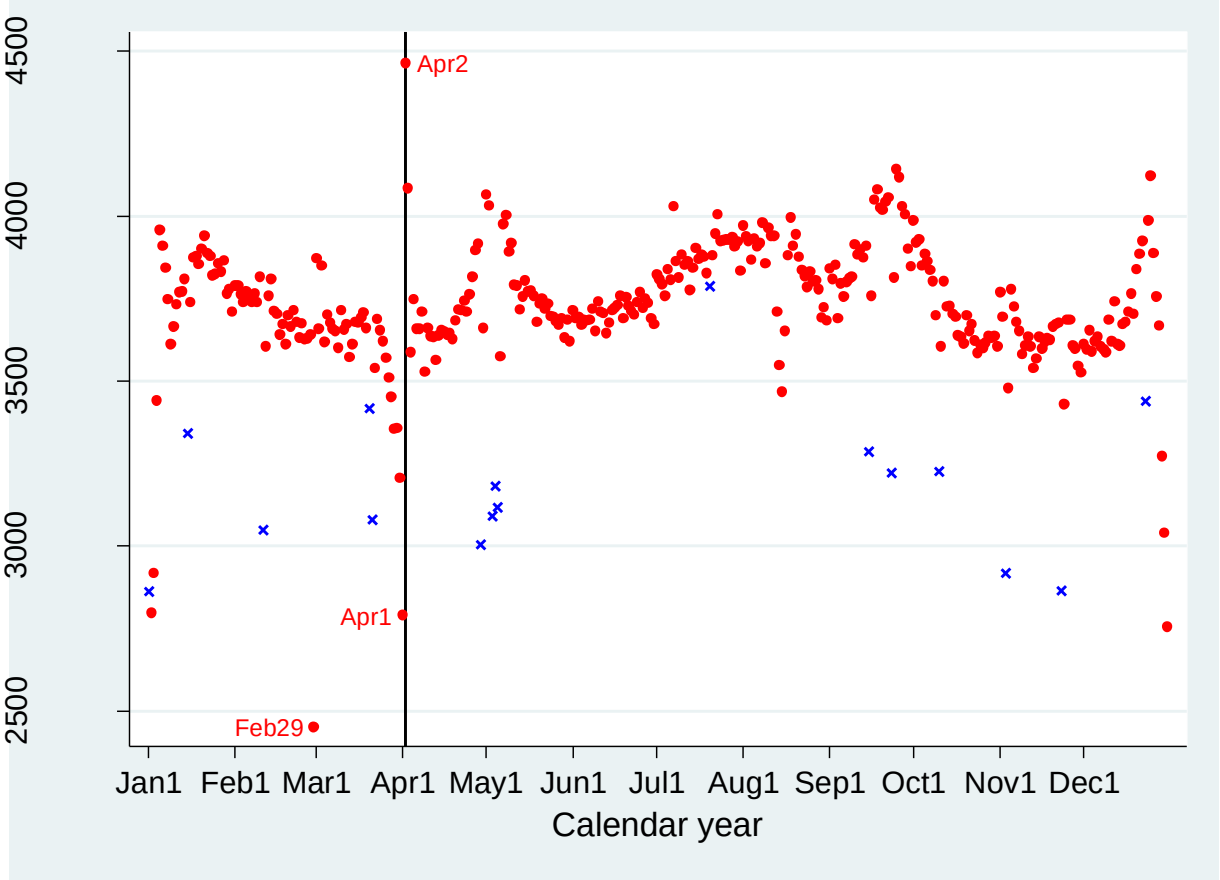
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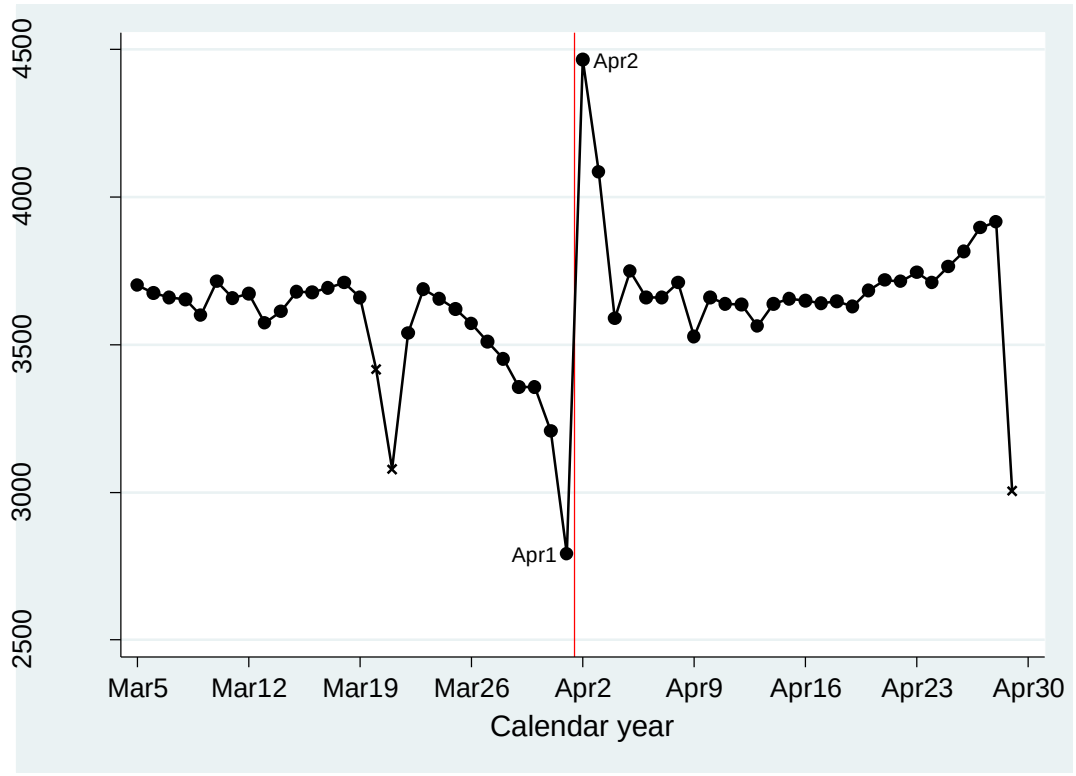
Figure 1: Mean daily number of births through the year



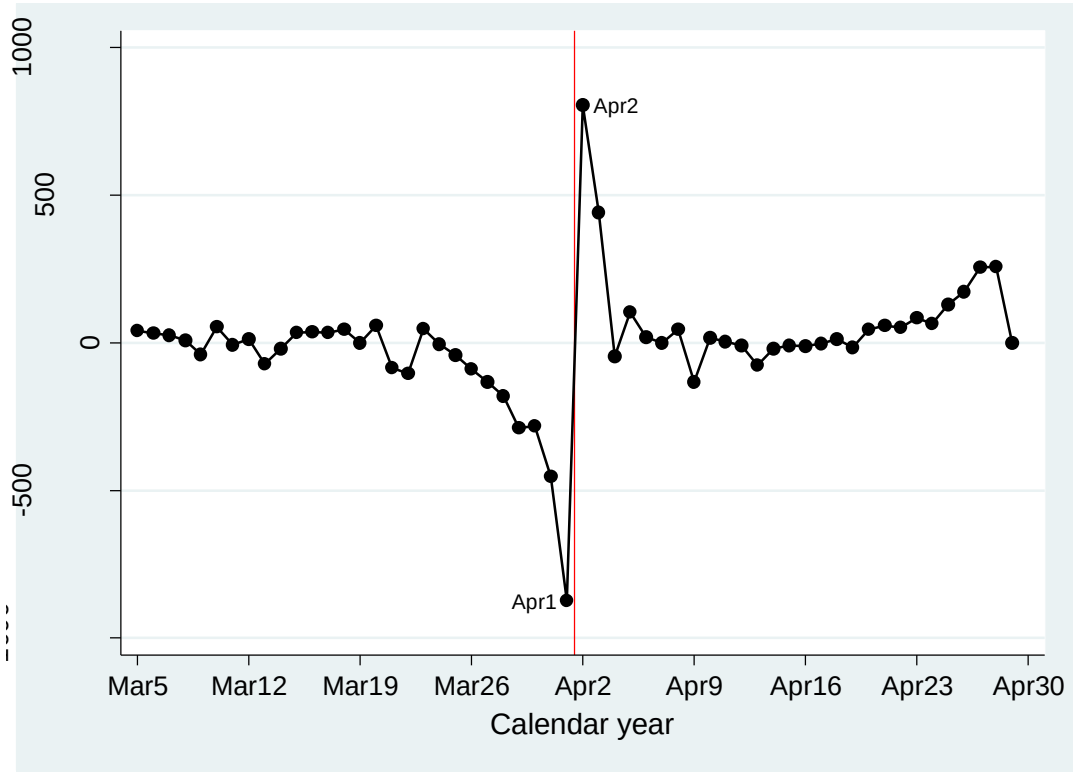
Note: The vertical line corresponds to April 2, which is the school entrance cut-off day in Japan. The data come from pooled 1974-2010 birth data. The markers with cross sign are holidays (see text for all the holidays in Japan).

Figure 2: Mean daily number of births around April 2

A. Raw



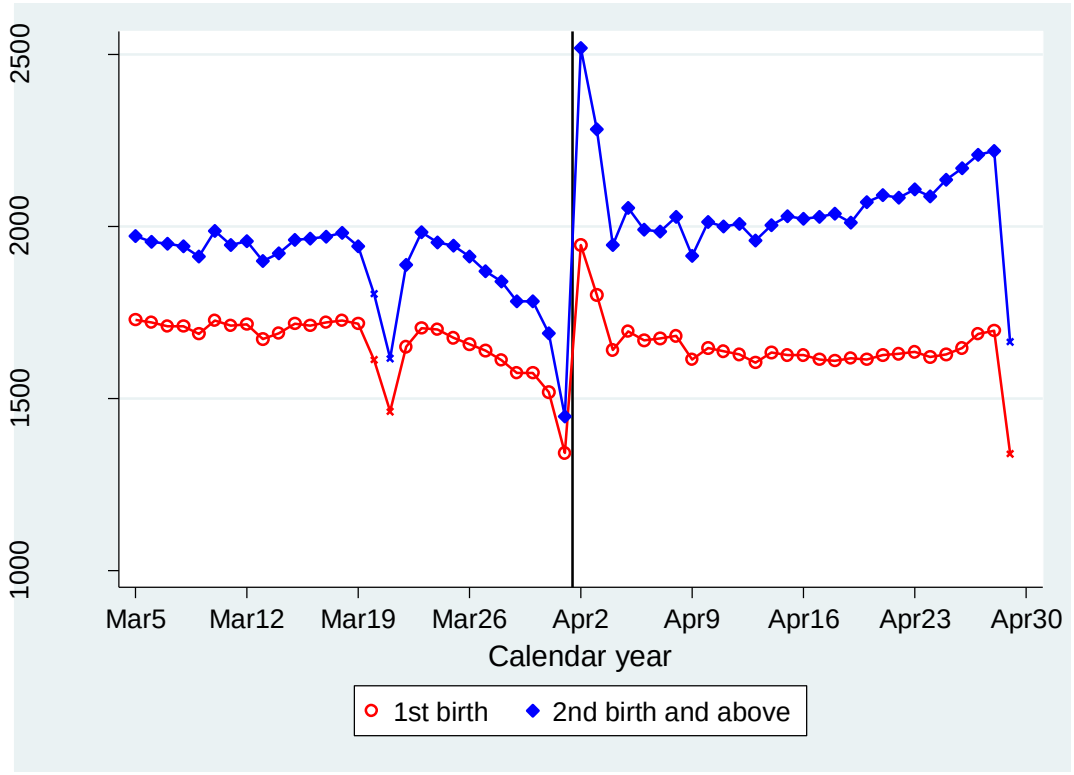
B. Adjusted



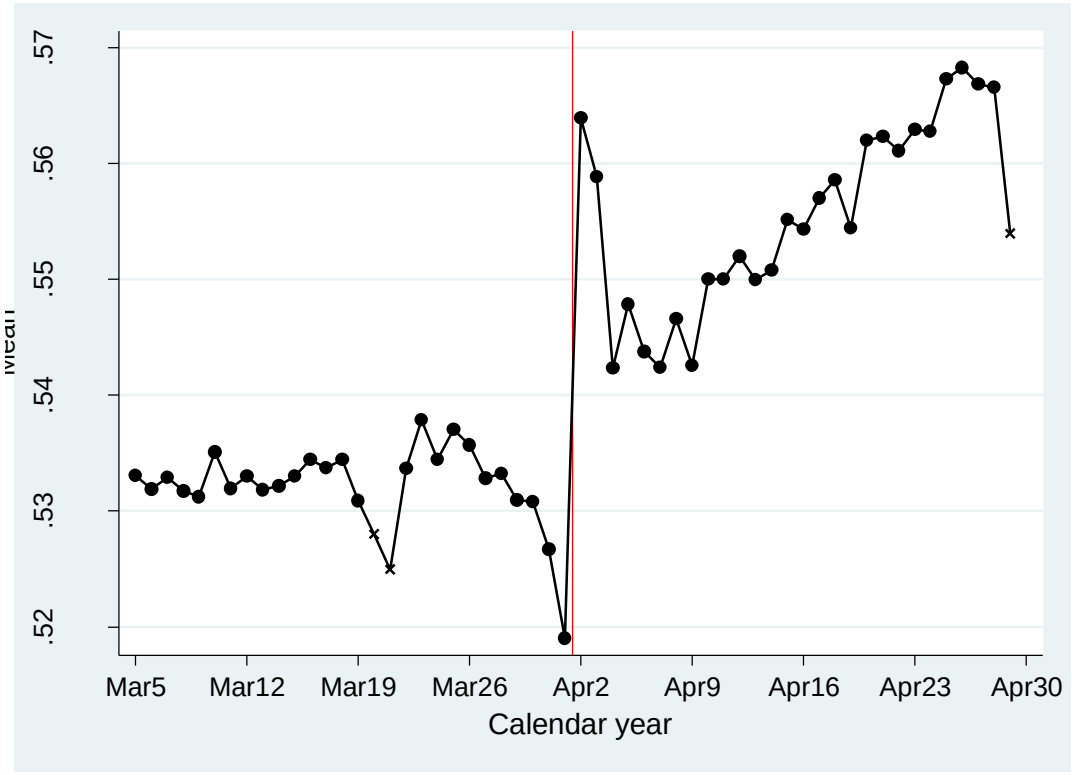
Note: The vertical line corresponds to April 2, which is the school entrance cut-off day in Japan. The data come from pooled 1974-2010 birth data. Each plot is the mean daily number of birth. The markers with cross sign in Panel A are holidays (either March 20 or March 21 depending on the year, and April 29). Panel B adjusts for holidays, year and day of week fixed effects.

Figure 3: Heterogeneous responses, by parity

A. Number of births by parity



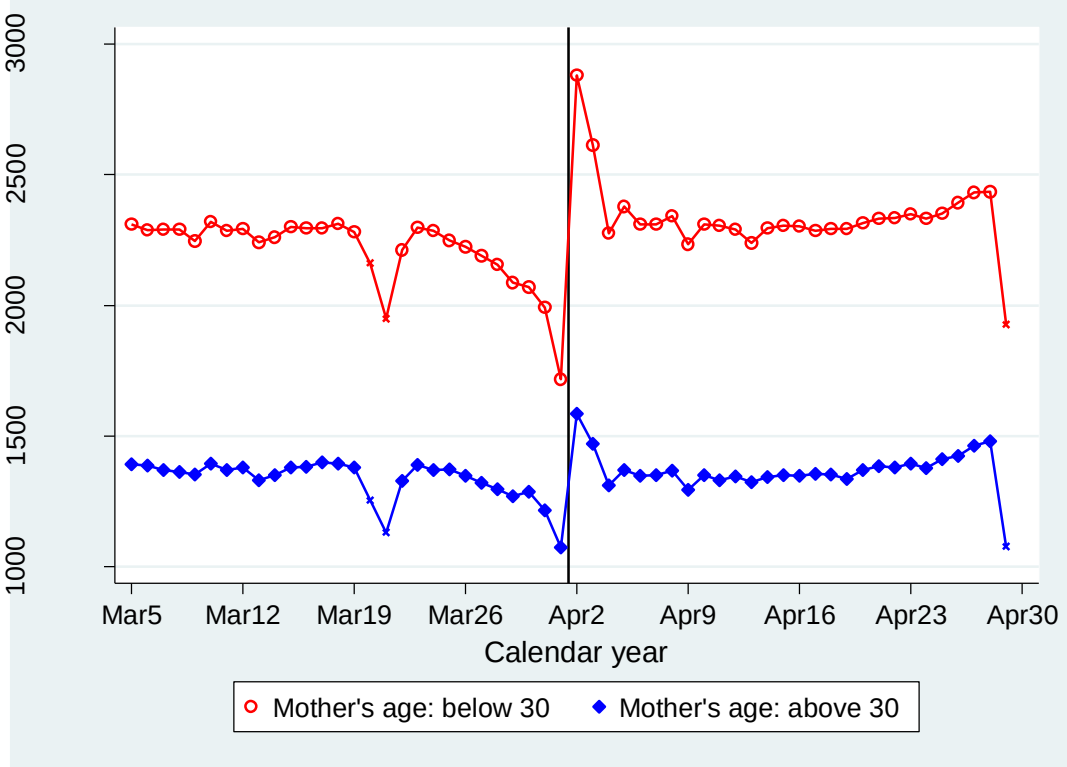
B. Ratio of 2nd+ births among all births



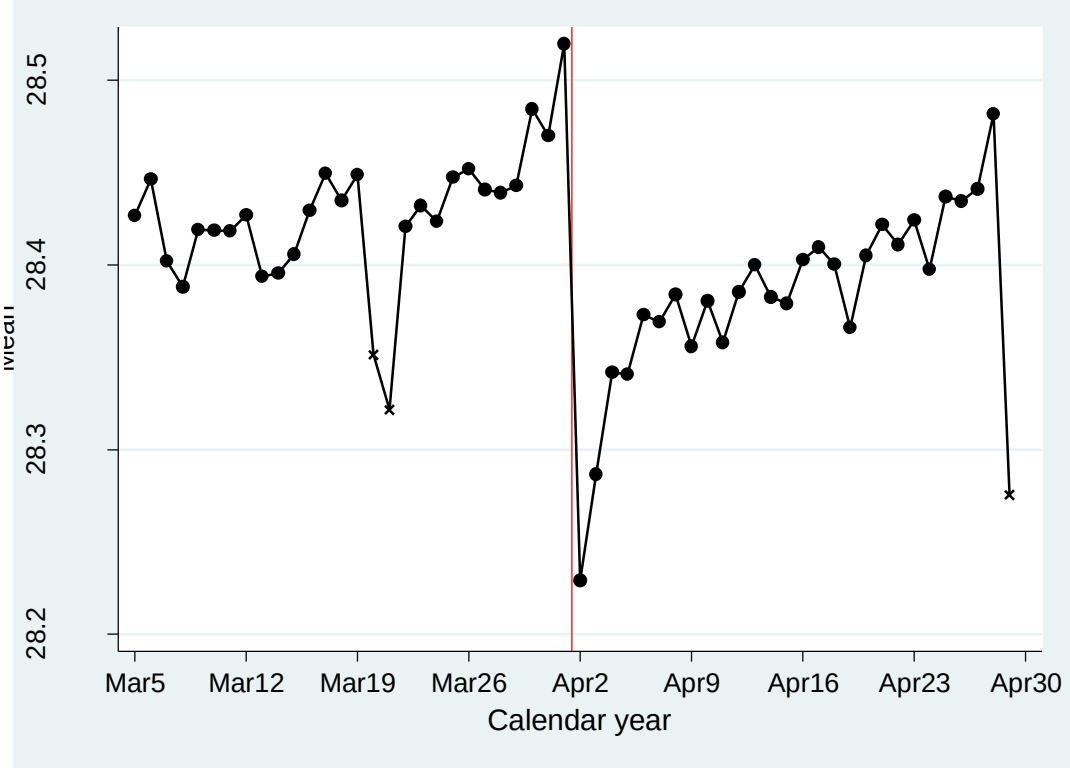
Note: The vertical line corresponds to April 2, which is the school entrance cut-off day in Japan. The data come from pooled 1974-2010 birth data. Each plot in Panel A is the number of births in each day. Each plot in Panel B is the mean of outcome in each day. The markers with cross sign in Panel A and B are holidays.

Figure 4: Heterogeneous responses, by mother's age

A. Number of births by mother's age



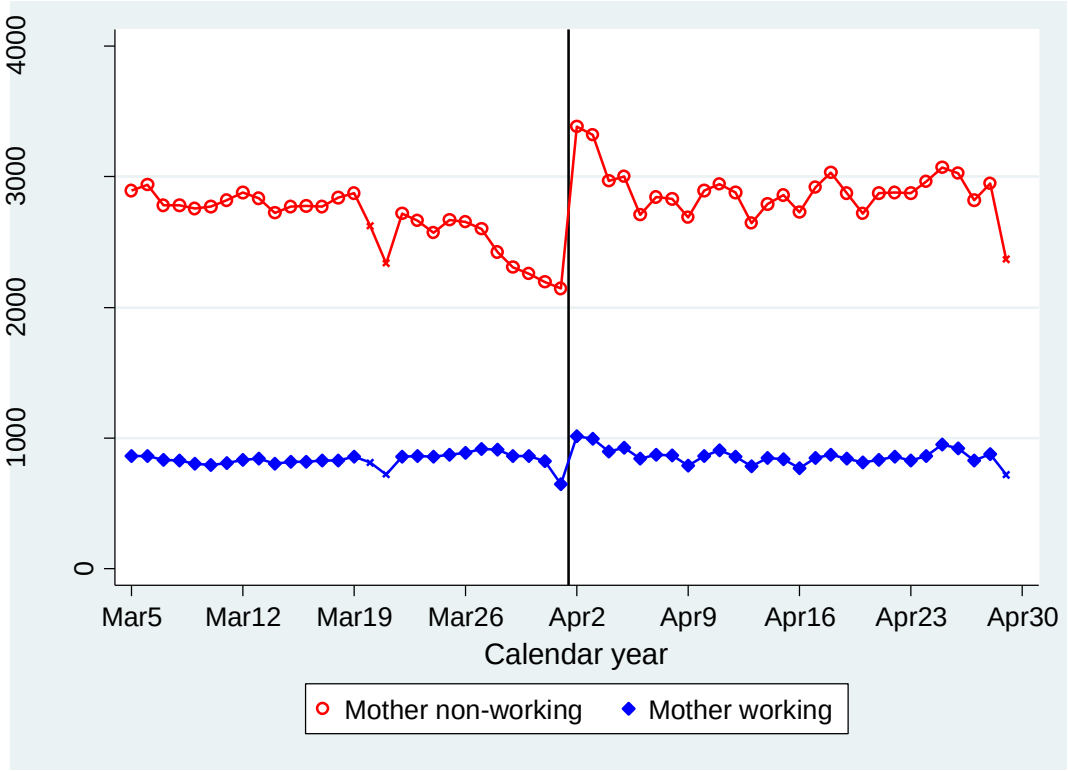
B. Mother's age



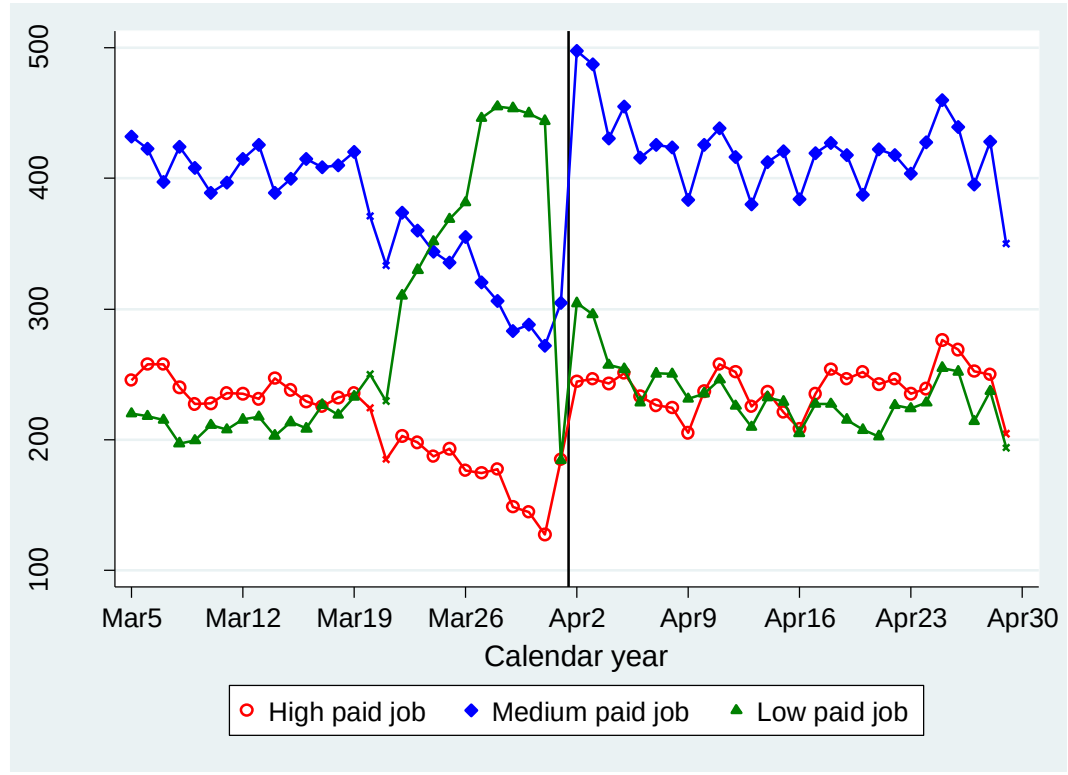
Note: The vertical line corresponds to April 2, which is the school entrance cut-off day in Japan. The data come from pooled 1974-2010 birth data. Each plot in Panel A is the number of births in each day. Each plot in Panel B is the mean of outcome in each day. The markers with cross sign in Panel A and B are holidays.

Figure 5: Heterogeneous responses, by mother's working status

A. Working vs. non-working mothers



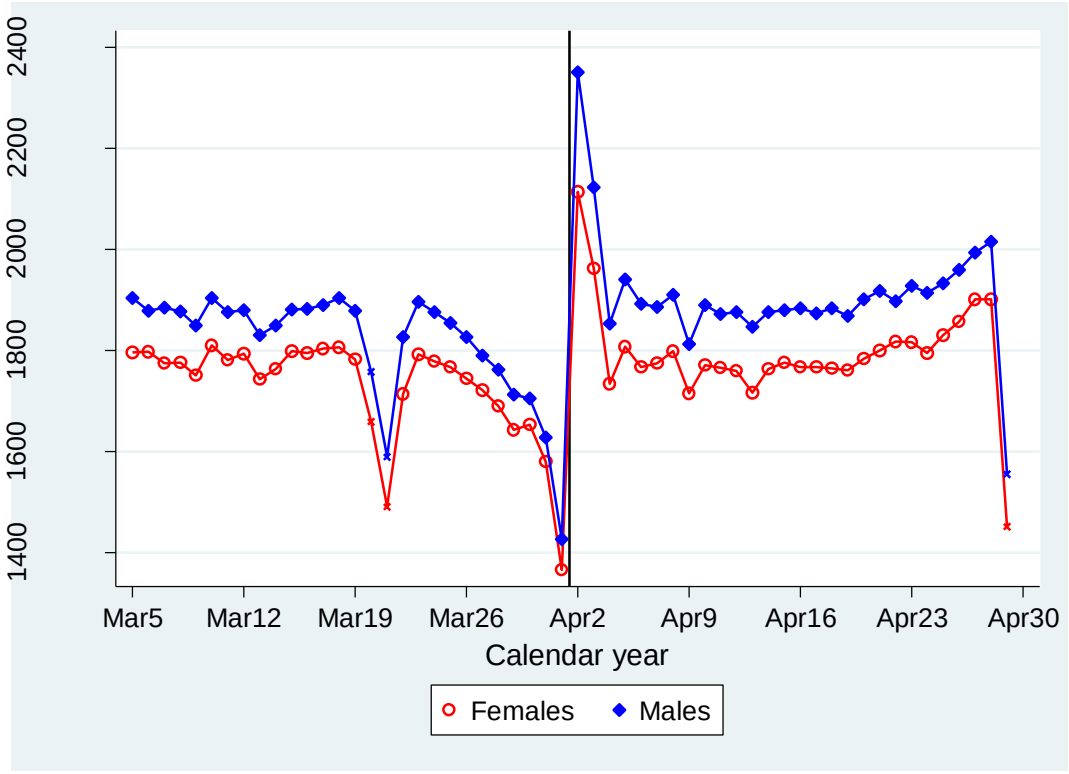
B. Among working mothers: Type of jobs



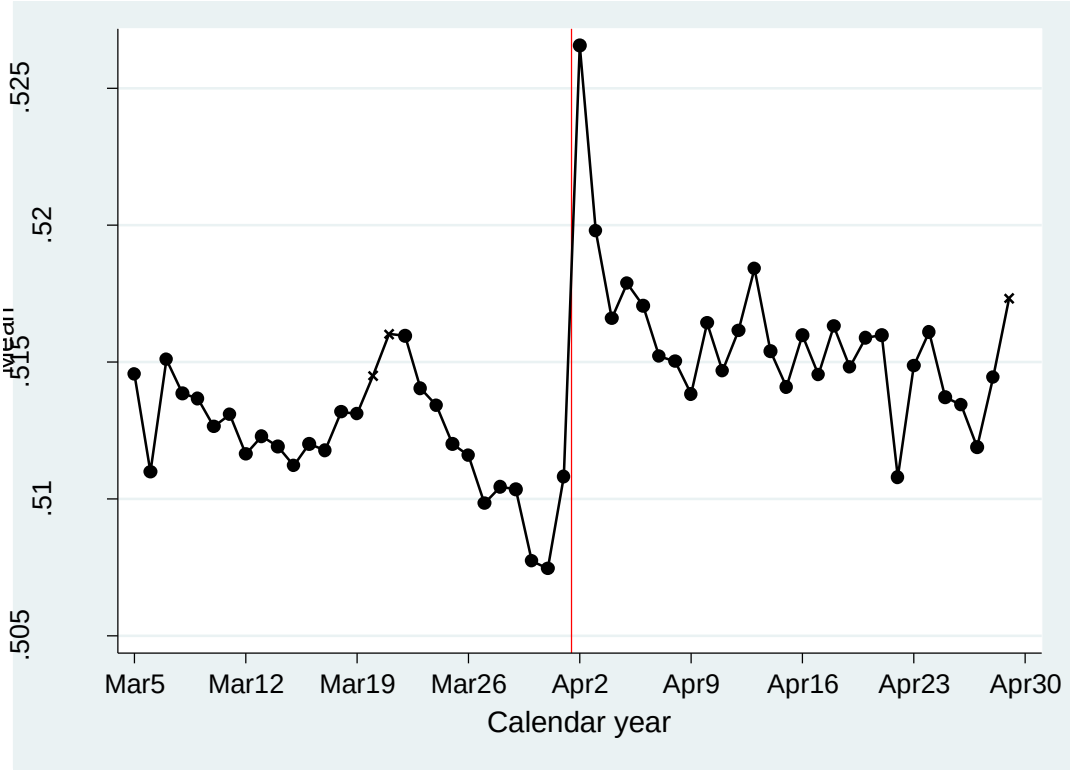
Note: The vertical line corresponds to April 2, which is the school entrance cut-off day in Japan. The data come from pooled 1974-2010 birth data. Each plot in Panel A is the number of births in each day. Each plot in Panel B is the mean of outcome in each day. The markers with cross sign in Panel A and B are holidays.

Figure 6: Heterogeneous responses, by gender

A. Number of births by gender



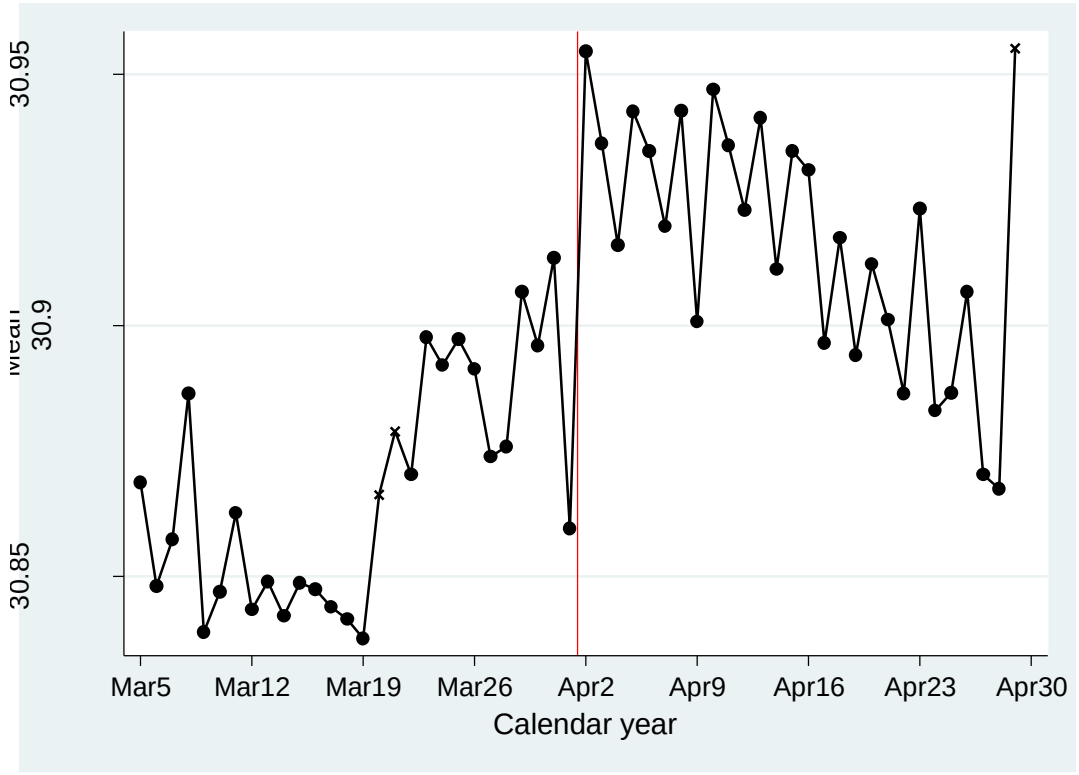
B. Ratio of male/female births



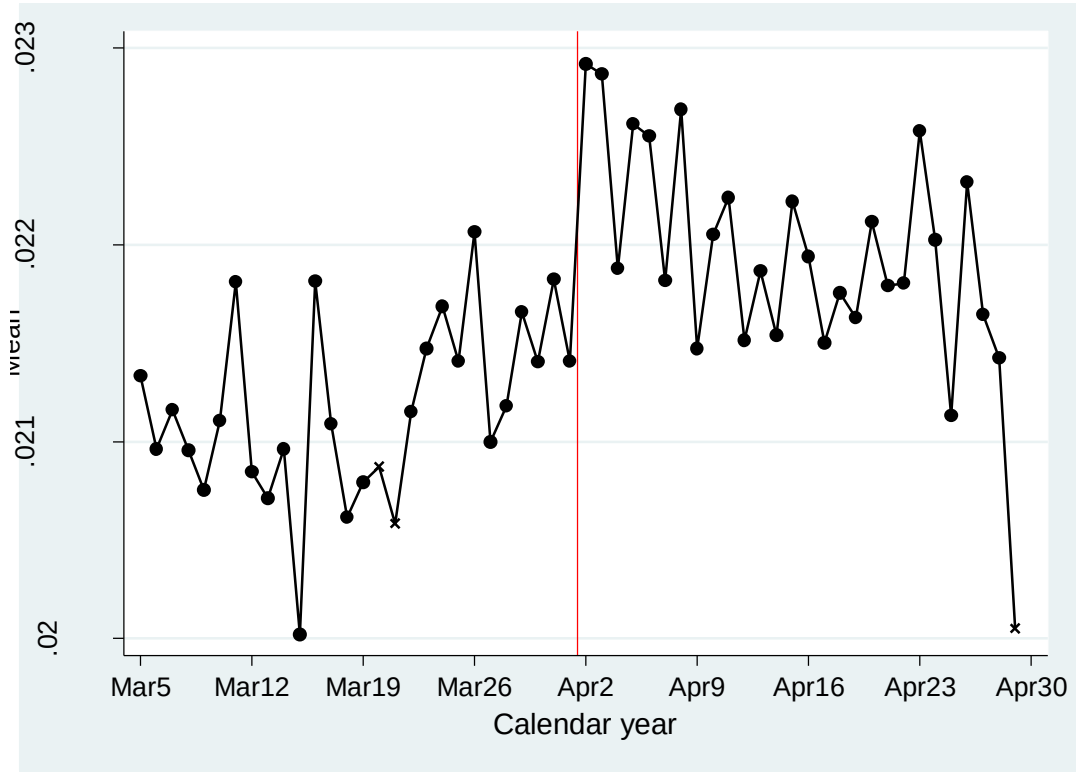
Note: The vertical line corresponds to April 2, which is the school entrance cut-off day in Japan. The data come from pooled 1974-2010 birth data. Each plot in Panel A is the number of births in each day. Each plot in Panel B is the mean of outcome in each day. The markers with cross sign in Panel A and B are holidays.

Figure 7: Birth weight, gestational length, and infant mortality

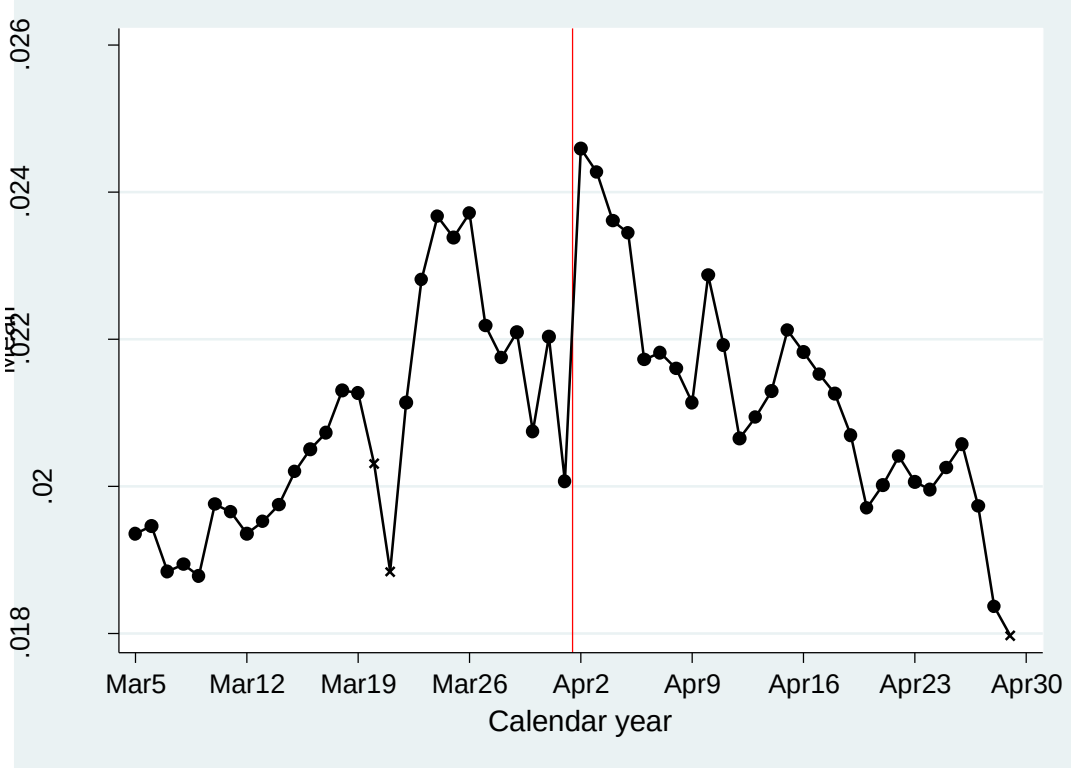
A. Mean Birth weight (100 grams)



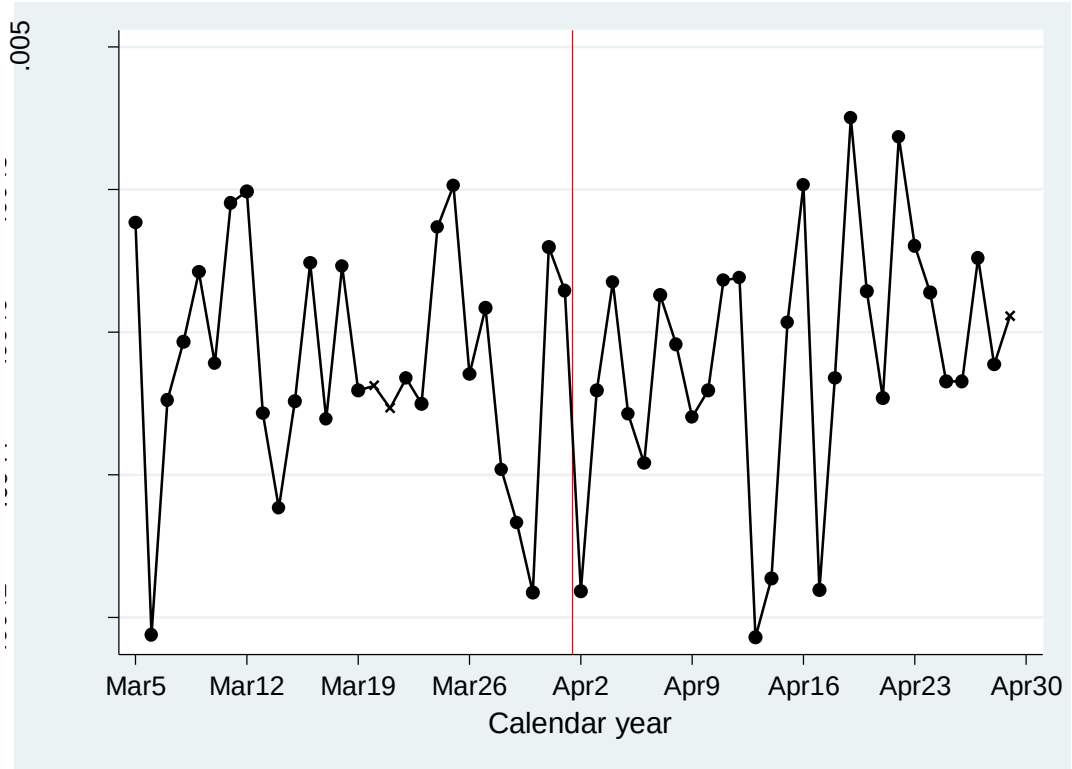
B. Ratio of above 4,000 grams



C. Mean gestational length (weeks)



D. Infant mortality



Note: The vertical line corresponds to April 2, which is the school entrance cut-off day in Japan. The data come from pooled 1974-2010 birth data. Each plot is the mean of outcome in each day. The markers with cross sign are holidays.

Table 1: Top 5 and bottom 5 of mean daily birth within a year

	Date	Mean daily births	Ratio to average daily birth
Top 5			
	April 2	**4,465**	**1.20**
	Sep 25	4,143	1.12
	Dec 25	4,122	1.11
	Sep 26	4,119	1.11
	April 3	**4,085**	**1.10**
Bottom 5			
	Feb 29	2,452	0.66
	Dec 31	2,757	0.74
	April 1	**2,791**	**0.75**
	Jan 2	2,798	0.75
	Jan 1	2,862	0.77

Notes: The ratio to the average is daily births divided by the mean daily births. Therefor a value of 1.1 represents a 10 percent increase in the daily births compared to the average in the year. Mean daily births during 1974-2010 are 3,711. Solid ones are within a week from April 2.

Table 2: Shift of births

	(1)	(2)	(3)	(4)
Windows	±7 days	±14 days	±21 days	±28 days
Panel A: Number of births				
After	524.2***	268.6***	178.9***	166.2***
	(55.1)	(30.0)	(20.4)	(16.5)
Number of births moved	*1,835*	*1,880*	*1,879*	*2,327*
N	518	1,036	1,554	2,072
R2	0.83	0.86	0.89	0.90
Panel B:ln(number of births)				
After	0.136***	0.070***	0.047***	0.043***
	(0.009)	(0.005)	(0.004)	(0.003)
Share of births moved	*7.0%*	*3.6%*	*2.4%*	*2.2%*
N	518	1,036	1,554	2,072
R2	0.86	0.88	0.90	0.91

Notes: Standard errors in parenthesis. * p<0.10, ** p<0.05, *** p<0.01. Sample is daily births within the relevant window from 1974–2010. All specifications include public holiday, and year*day of week fixed effects. Window denotes the number of days before and after April 2. For example, the ±7 day window covers the seven days prior to April 2, and the first seven days after April 2. Number of births moved is $W\beta/2$, where W is the number of days in the window. Share of births moved is $\exp(\beta/2)-1$.

Table 3: Heterogeneous response

			(1)	(2)	(3)	(4)
		Mean	±7 days	±14 days	±21days	±28 days
A. Parity						
1st child	After	1,645	0.1008***	0.0364*	0.007	-0.003
			(0.024)	(0.022)	(0.016)	(0.012)
	R2		0.952	0.889	0.890	0.895
	Share of births moved		*5.2%*	*1.8%*	*0.4%*	*-0.2%*
2nd child or above	After	1,938	0.1643***	0.0971***	0.0780***	0.0779***
			(0.033)	(0.028)	(0.020)	(0.015)
	R2		0.951	0.916	0.925	0.929
	Share of births moved		*8.6%*	*5.0%*	*4.0%*	*4.0%*
B. Mother's age						
Less than 30	After	2,253	0.1512***	0.0843***	0.0595***	0.0533***
			(0.029)	(0.025)	(0.018)	(0.013)
	R2		0.982	0.967	0.971	0.974
	Share of births moved		*7.9%*	*4.3%*	*3.0%*	*2.7%*
Above 30	After	1,330	0.1091***	0.0482**	0.0282*	0.0272**
			(0.028)	(0.024)	(0.017)	(0.013)
	R2		0.945	0.893	0.902	0.906
	Share of births moved		*5.6%*	*2.4%*	*1.4%*	*1.4%*
C. Gender						
Male	After	1,843	0.1534***	0.0813***	0.0560***	0.0495***
			(0.029)	(0.027)	(0.019)	(0.014)
	R2		0.952	0.899	0.909	0.917
	Share of births moved		*8.0%*	*4.1%*	*2.8%*	*2.5%*
Female	After	1,740	0.1179***	0.0588**	0.0373**	0.0348***
			(0.029)	(0.024)	(0.017)	(0.013)
	R2		0.948	0.909	0.918	0.923
	Share of births moved		6.1%	3.0%	1.9%	1.8%
	N		518	1,036	1,554	2,072

Notes: Standard errors in parenthesis. * p<0.10, ** p<0.05, *** p<0.01. Sample is daily births within the relevant window from 1974–2010. All specifications include public holiday, and year*day of week fixed effects. Window denotes the number of days before and after April 2. For example, the ±7 day window covers the seven days prior to April 2, and the first seven days after April 2. Share of births moved is $\exp(\beta/2)-1$.

Table 4: Heterogeneous response, by mother's employment

			(1)	(2)	(3)	(4)
		Mean	±7 days	±14 days	±21days	±28 days
A. Working status						
Not working	After	2,689	0.2146***	0.1400***	0.0989***	0.0822***
			(0.022)	(0.026)	(0.022)	(0.018)
	R2		0.950	0.909	0.904	0.906
	Share of births moved		*11.3%*	*7.2%*	*5.1%*	*4.2%*
Working	After	880	0.0697*	0.032	0.028	0.0343***
			(0.038)	(0.023)	(0.017)	(0.013)
	R2		0.731	0.714	0.733	0.758
	Share of births moved		3.5%	1.6%	1.4%	1.7%
B. Type of job						
High skilled	After	200	0.3775***	0.2565***	0.1750***	0.1355***
			(0.044)	(0.047)	(0.044)	(0.037)
	R2		0.864	0.670	0.560	0.530
	Share of births moved		*20.8%*	*13.7%*	*9.1%*	*7.0%*
Medium skilled	After	376	0.3741***	0.2576***	0.1697***	0.1329***
			(0.035)	(0.039)	(0.037)	(0.030)
	R2		0.938	0.872	0.836	0.836
	Share of births moved		*20.6%*	*13.7%*	*8.9%*	*6.9%*
Low skilled	After	333	-0.3842***	-0.3438***	-0.2129***	-0.1272**
			(0.104)	(0.065)	(0.074)	(0.061)
	R2		0.637	0.628	0.580	0.599
	Share of births moved		-17.5%	-15.8%	-10.1%	-6.2%
	N		98	196	294	392

Note: Standard errors in parenthesis. * p<0.10, ** p<0.05, *** p<0.01. Sample is daily births within the relevant window from 1975, 1980, 1985, 1990, 1995, 2000, and 2005 pooled birth data. All specifications include public holiday, and year*day of week fixed effects. Window denotes the number of days before and after April 2. For example, the ±7 day window covers the seven days prior to April 2, and the first seven days after April 2.

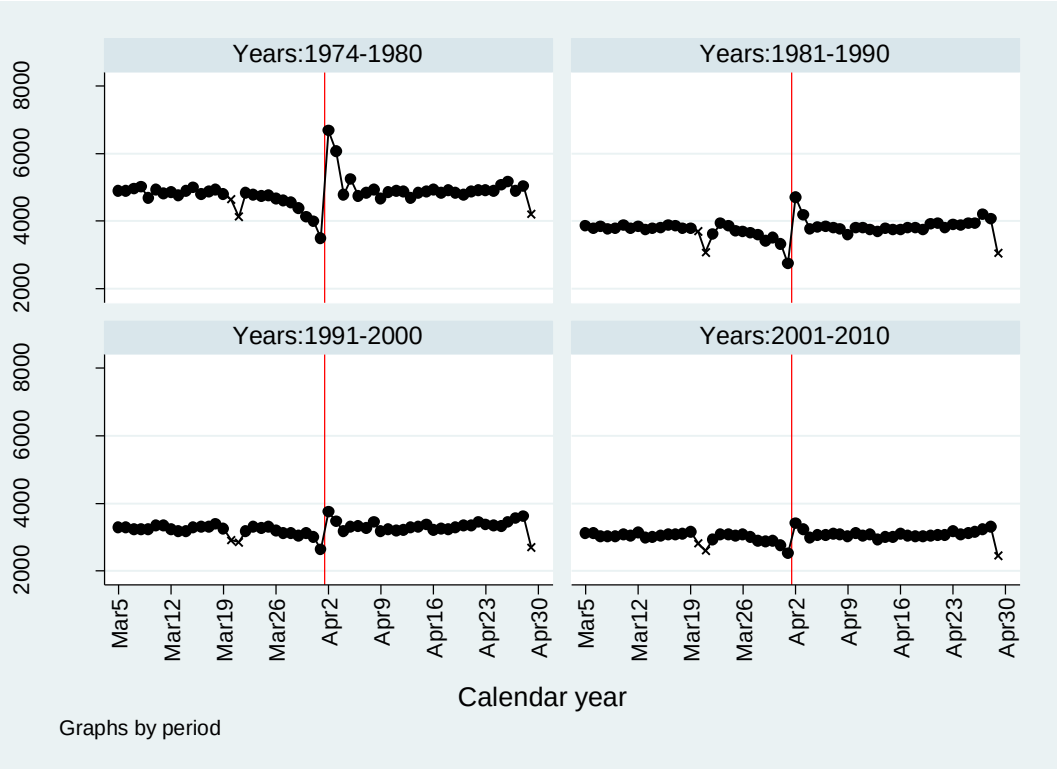
Table 5: Child's characteristics

		(1)	(2)	(3)	(4)
Windows	Mean	±7 days	±14 days	±21 days	±28 days
A: Birth weight (100 g)					
After	30.90	0.023***	0.038***	0.047***	0.045***
		(0.005)	(0.007)	(0.007)	(0.007)
N		1,847,984	3,689,329	5,579,356	7,477,055
R2		0.014	0.014	0.014	0.014
B: Birth weight>4000 g					
After	0.022	0.0005***	0.0006***	0.0007***	0.0007***
		(0.0002)	(0.0001)	(0.0001)	(0.0001)
N		1,847,984	3,689,329	5,579,356	7,477,055
R2		0.004	0.004	0.004	0.004
C: Gestation>42 wks					
After	0.023	0.0007***	0.0001	0.0003**	0.0005***
		(0.0002)	(0.0002)	(0.0002)	(0.0001)
N		1,846,441	3,686,276	5,574,761	7,470,764
R2		0.011	0.010	0.010	0.009
D: Mortality per 1000 births					
After	4.155	-0.090	-0.100	-0.030	-0.010
		(0.090)	(0.060)	(0.050)	(0.050)
N		518	1,036	1,554	2,072
R2		0.883	0.844	0.826	0.817

Notes: Standard errors in parenthesis. * p<0.10, ** p<0.05, *** p<0.01 significant at 1%. Sample is individual birth within the relevant window from pooled 1974–2010 birth data. All specifications include public holiday, and year*day of week fixed effects. Window denotes the number of days before and after the April 2. For example, the ±7 day window covers the seven days prior to April 2, and the first seven days after April 2.

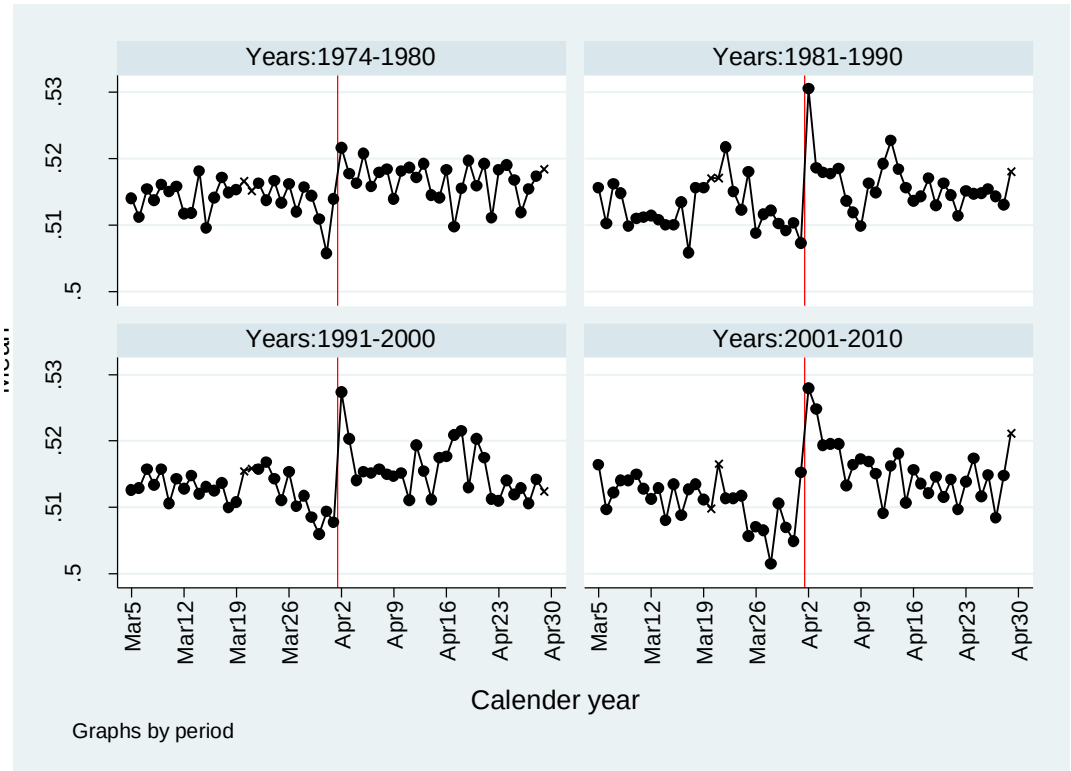
Appendix Figures and Tables

Figure A1: Mean daily number of births around April 2, by period



Note: The vertical line corresponds to April 2, which is the school entrance cut-off day in Japan. The data come from pooled 1974-2010 birth data. The markers with cross sign are holidays (see text for all the holidays in Japan). Each plot is the number of births in each day.

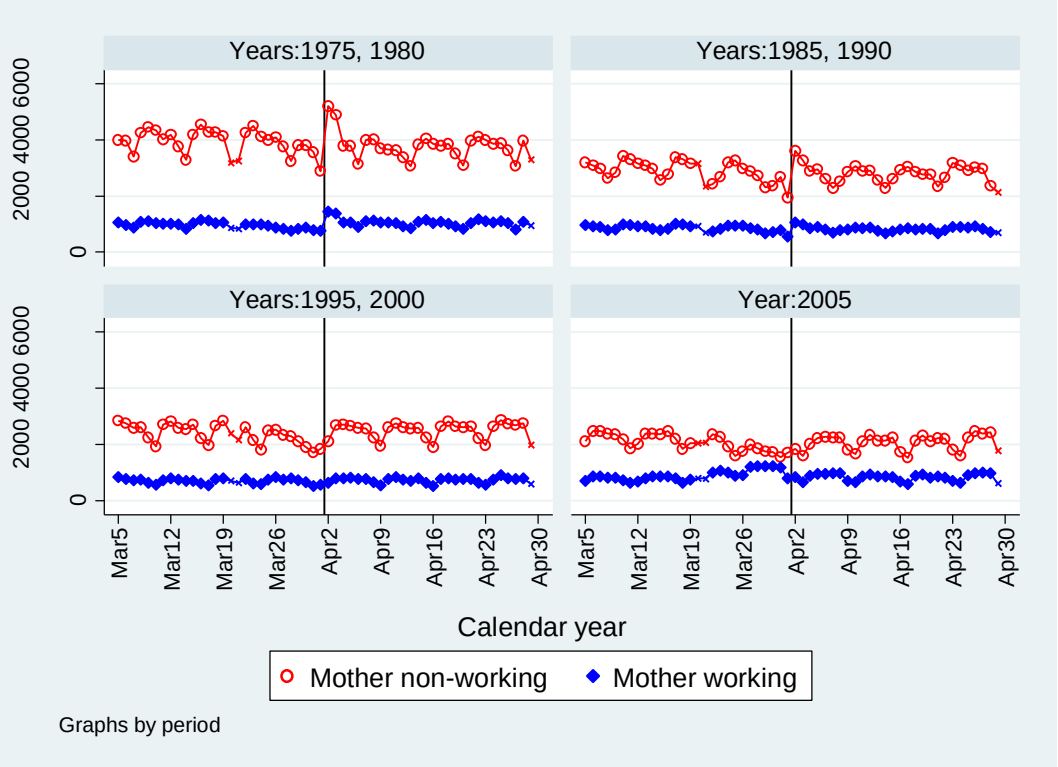
Figure A2: Ratio of male/female births by period



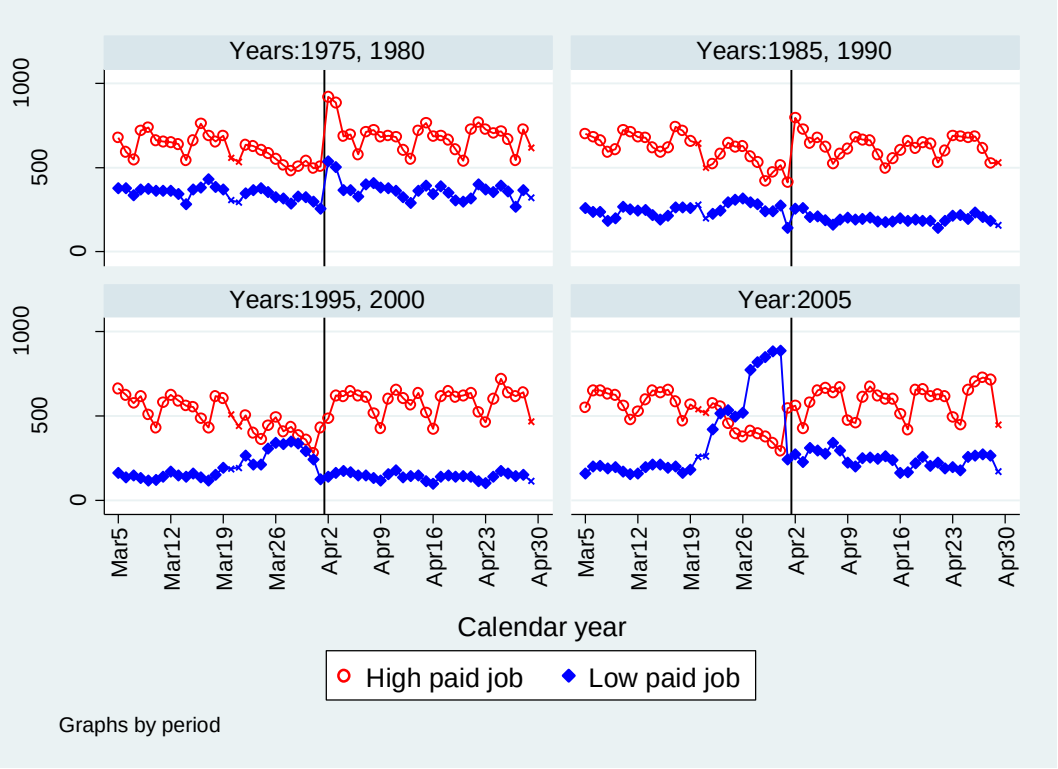
Note: The vertical line corresponds to April 2, which is the school entrance cut-off day in Japan. The data come from pooled 1974-2010 birth data. The markers with cross sign are holidays (see text for all the holidays in Japan). Each plot is the number of births in each day.

Figure A3: Heterogeneous responses: Mother's employment, by period

A. Working vs. Non-working mothers



B. Among working mothers: Type of jobs



Note: The sold vertical line corresponds to April 2, which is the school entrance cut-off day in Japan. Sample is daily births within the relevant window from 1975, 1980, 1985, 1990, 1995, 2000, and 2005 pooled birth data. Each plot is the number of births in each day.

Table A1: Type of mother's job

Skill level	Description
High skilled	Managers
	Professionals
Medium skilled	Clerical support workers,
	Service and sales workers
Low skilled	Skilled agricultural, forestry and fishery workers
	Craft and related trades workers
	Plant and machine operators, and assemblers
	Elementary occupations