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THE EFFECTS OF GENDER-SPECIFIC LOCAL LABOR DEMAND ON BIRTH AND LATER OUTCOMES

Mika Akesaka
Nobuyoshi Kikuchi

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The Institute of Social and Economic Research
Osaka University
6-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan

The Effects of Gender-Specific Local Labor Demand on Birth and Later Outcomes*

Mika Akesaka† Nobuyoshi Kikuchi‡

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Abstract

We study the effects of local labor market conditions during early pregnancy on birth and later outcomes. Using a longitudinal survey of newborns in Japan, we find that improvements in employment opportunities increase the probability of low birth weight and premature birth. We also examine the effects of gender-specific labor market conditions. An increase in labor demand for women has a large negative effect on gestational age, especially for mothers who gave birth at relatively young ages. However, we find little evidence of a lasting negative effect of an increase in labor demand during early pregnancy on serious health conditions or developmental delays in early childhood. Using prefecture-level panel data, we confirm that the negative effect on infant birth weight is not driven by selective fertility and mortality.

Keywords: labor market conditions, newborn health, low birth weight, recession.

JEL Classification: I10, J13, J16, J23, R11.

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†Research Institute for Economics and Business Administration, Kobe University; 2-1 Rokkodai-cho, Nada-ku, Kobe, Hyogo 657-8501, Japan. E-mail: mika_akesaka@rieb.kobe-u.ac.jp

‡Corresponding author: Faculty of Political Science and Economics, Takushoku University. Department of Economics, The University of Tokyo; 7-3-1, Hongo, Tokyo 113-0033, Japan. E-mail: nobuyoshi.kikuchi@e.u-tokyo.ac.jp.

1 Introduction

Understanding the impact of economic conditions on health is essential to estimating the costs of economic fluctuations. It leads to contemplating the need for stabilization and redistribution policy measures. The literature widely reports a statistical association between economic fluctuations and health, especially for men in their prime (e.g., Ruhm, 2000; Ruhm and Black, 2002; Sullivan and von Wachter, 2009). However, little is known about its effect on other populations at different life stages. It is important to examine its effect even on babies in utero as they would also be affected by the impact of economic fluctuations on their parents. Maternal health, for example, worsened during the Great Recession (e.g., Currie et al., 2015).

If economic shocks causally affect prenatal health conditions, then they also potentially influence future health and welfare costs. As extant literature suggests, birth outcomes, as a measure of prenatal health, have long-lasting effects on later life, ranging from health to labor market outcomes (see e.g., Currie, 2009; Almond and Currie, 2011). Despite the suggested relationship between economic downturns and prenatal health, its causality and importance remain unclear, with the literature reporting mixed results in this regard (improved: e.g., Aparicio et al., 2020; Dehejia and Lleras-Muney, 2004; van den Berg et al., 2020; deteriorated: e.g., Alessie et al., 2018; De Cao et al., 2022; Kohara et al., 2019; Margerison-Zilko et al., 2017; Olafsson, 2016).

One reason for these inconsistent results is the focus on abstract measures of economic conditions, such as the total unemployment rate. This may mask the different effects of changes in labor market conditions on mothers vis-à-vis fathers. For example, if employment opportunities for fathers, who are often the breadwinners, decrease due to a recession, then it may drastically reduce the household income. Consequently, infant health may be negatively affected (e.g., Lindo, 2011). On the contrary, if there is a decline in mothers' employment opportunities, infant health may actually improve because of the reduced physical burden and absence of work-related psychological stress (e.g., Rossin, 2011). Changes in mothers' and fathers' employment opportunities have been reported to have different impacts on children's health (e.g., Page et al., 2019; Schaller and Zerpa, 2019) and maltreatment status (e.g., Lindo et al., 2018). With respect to infant health, we would expect even a greater difference in the effects on fathers vis-à-vis mothers; however, these differences are yet to be determined.

In this study, we aim to evaluate the impact of economic conditions on neonatal and infant health using changes in gender-specific labor demand during early pregnancy. For neonatal health, we use data on birth weight and gestational age from the population survey of all children born during a specific period in Japan. Using our dataset's panel structure, we further examine the impact on children's development and health status at ages one to four.

Based on the method proposed by Bartik (1991), we focus on predicted employment growth rates instead of the common measure of unemployment rates in prior studies as a measure of economic conditions. This is because the unemployment rate, by definition, is affected by labor supply, and thus cannot be separated from exogenous changes in labor demand (Page et al., 2019). Labor supply decisions are likely to depend on the unobservable preferences and attributes of parents that impact newborn health. Therefore, if we use unemployment rates as a proxy for labor market conditions, then these unobserved confounders could create a bias in the estimates.

We can summarize our results as follows. First, an increase in the overall predicted employment growth rate statistically significantly reduces birth weight and weeks of gestation, and therefore increases the probability of low birth weight and preterm birth. Second, we examine the differential effects of an increase in the predicted employment growth rate for men and women, and find that women's employment has heterogeneous negative effects on newborn health across maternal age at birth and educational attainment. Notably, the effect on gestational age is larger for newborns of mothers who gave birth at age 24 or younger than for those who gave birth at age 25 or older. Moreover, the effect on birth weight is larger for newborns of mothers who graduated from university or junior high school than for those who graduated from high school. Finally, we find that an increase in the predicted employment growth rate has a small and statistically insignificant impact on the probability of hospitalization for illness at ages 1.5 to 4.5. Furthermore, we find little evidence of significant negative effects on language development at age 2.5, the tendency to aggression at age 3.5, and the tendency to inattention and hyperactivity at age 3.5.

Our results are robust to concerns with pregnancy, infant mortality, and sample attrition. First, using prefecture-level panel data, we confirm that changes in the predicted employment growth rates during early pregnancy are significantly related to low birth weight, but not to pregnancy rates or neonatal and infant mortality rates. Second, adding prefecture- and municipal-level controls for local availability of obstetrician and gynecology care and center-based childcare, we confirm that our main results for birth outcomes are insensitive to these controls. Finally, we verify that changes in the predicted employment growth rates during early pregnancy are not significantly associated with sample attrition or migration.

We use Japanese data for this study because its setting provides two advantages. First, under the Japanese universal health insurance system, the coverage and benefits do not rely on employment contracts. Thus, the impact of a labor market shock does not include the effects of changes in access to healthcare based on health insurance coverage. In a health insurance system in which coverage depends strongly on employment status, such as in the US, changes in the labor market could also affect coverage (see e.g., Schaller and Stevens, 2015).

Second, elective cesarean sections are unlikely to influence infants' health because cesarean births are not as prevalent in Japan as in other developed countries (see Figure A.1 in Appendix A). Borra et al. (2019) and Schulkind and Shapiro (2014), for example, suggested that artificially accelerated births due to institutional factors can negatively affect infants' health conditions. If a greater reliance on elective cesarean sections increases the likelihood of artificial birth date manipulation, then a low cesarean rate is less likely to cause an intended manipulation that confounds the effects of economic shock on birth outcomes.

Our study contributes to the literature in two ways. First, we examine the gender-heterogeneous effects of labor market conditions on birth outcomes. Although information on whether effects on birth outcomes occur through the employment channel of the father or mother is essential for policy interventions, studies in both developed countries (e.g., Dehejia and Lleras-Muney, 2004) and developing countries (e.g., Baird et al., 2011; Bhalotra, 2010) have not fully examined the effects by gender. Exceptions are De Cao et al. (2022) and van den Berg et al. (2020). De Cao et al. (2022) found that both female and male unemployment rates have pro-cyclical effects on birth weight in the UK. Further, they found that the magnitude of the effect is much larger for the female unemployment rate. By contrast, van den Berg et al. (2020) found the counter-cyclical effects in Sweden. They suggested that an increase in the probability of very low birth weight due to higher unemployment could only be attributed to the male unemployment rate.

Second, this study is one of the first to examine the impact of economic conditions during pregnancy on child outcomes beyond the first year of life. Recent studies found that some events that cause maternal stress, such as the passing of a mother's close relatives during pregnancy (Persson and Rossin-Slater, 2018) or exposure to the ravages of war (Lee, 2014), can have negative impacts in the long run. However, the impact of economic conditions during pregnancy on child outcomes is still not well understood. In this study, we observe no statistically significant relationship between labor market conditions during pregnancy and developmental delays and serious health conditions in early childhood. Our results are consistent with Maruyama and Heinesen (2020), who reported that the low birth weight effect on infant health diminishes over time.

The remainder of this paper is organized as follows. Section 2 describes the background of the study. Sections 3 and 4 describe the data and provide an overview of the empirical framework, respectively. Section 5 reports the results, and we present our conclusions in Section 6.

2 Background

2.1 Female Labor Force Participation

Women's employment in Japan is characterized by low labor force participation rates relative other developed countries, wide variations across age groups, and low rates of full-time employment. In Appendix A, Figure A.2 depicts the labor force participation rates of women aged 20–44. During the survey period, the rates had been increasing in Japan but remained consistently lower than in almost all other developed countries.

Figure A.3 shows the age profile of the labor force participation rates in the cross-section available around the pregnancy periods of our main analysis. The rates were low for women in their teens due to the high upper secondary school enrollment rate, but rose to the level of other developed countries as women reached their 20s, declined in their 30s, and then rose in their 40s again. It is commonly considered that Japanese female workers leave the labor force after marriage and childbirth, remain out while raising their young children, and then return as their children grow older.[1]

Figure A.4 shows the trends in the proportion of full-time workers. Japan has been in a downward trend, with its level moving toward the lowest group. This trend implies that a certain number of Japanese female workers are employed in part-time work, which is sensitive to economic fluctuations. In Japan, full-time workers are basically regular workers rarely dismissed, while part-time workers are non-regular workers who are usually on a fixed-term contract. Previous studies suggest that firms in Japan respond to economic shocks by adjusting employment through the turnover of non-regular workers (see, for example, Hijzen et al., 2015; Yokoyama et al., 2021).

[1]For a more detailed discussion, see, e.g., Abe (2011) and Esteban-Pretel and Fujimoto (2020).

2.2 Prenatal Care

The basic prenatal care system in Japan is standardized and publicly funded based on the MHLW guidelines under the law. The Maternal and Child Health Act requires that national and local governments make efforts to maintain and promote the health of mothers and infants. Based on the Act's provisions, the MHLW issued a notice on the desirable standard for prenatal checkups, including the recommended number and guidelines for items and procedures. Since 1996, the standard number of prenatal checkups has been 13 or 14 (MHLW Notice No. 934 of February 27 in 1996). Until 2006, two prenatal checkups were uniformly subsidized using funding from a national tax allocated to local governments. Since 2007, the number of publicly subsidized prenatal checkups gradually grew. In 2009, the MHLW noted that the standard 14 checkups should be publicly subsidized (MHLW Notice No. 0227001 of February 27 in 2009), and a survey conducted in April 2010 confirmed that 14 checkups were publicly subsidized in all municipalities (MHLW Notice No. 0608001 of June 8 in 2010, "The Results of a Survey on the Status of Public Funding of Prenatal Checkups").

The Act asks a parent or other family member to report the pregnancy to the municipality of residence. After submitting the pregnancy notification, the municipality must issue a Maternal and Child Health Handbook. This Handbook is a personal record of birth and infant health that includes necessary information on childbirth, child care, and daily living precautions such as the timing and content of standard health check-ups, vaccinations, and nutritional intake. The municipality must also help a pregnant mother and her family members access maternal and infant health check-ups at public expense, counseling services by public health nurses or midwives, and various information services such as childbirth classes.

In addition, the public health insurance system subsidizes the cost of childbirth. It covers only abnormal deliveries, including cesarean sections and aspiration deliveries associated with risk factors such as threatened premature labor, placenta previa, and ectopic pregnancy. However, it also provides lump-sum, no-means-tested benefits for all births (the Lump-sum Allowance for Childbirth and Childcare of Articles 101 and 104 of the Health Insurance Act).

Prenatal care in Japan appears to be at least comparable to that in other developed countries. Figures A.5 and A.6 in Appendix A shows that maternal and neonatal mortality rates remain very low in Japan, as in other developed countries.

A striking feature of the perinatal health situation in Japan is that the rate of low birth weights is consistently higher than in other developed countries. In Figure A.7, over our sample period for individual data analysis, the measure is trending upward, rising from about 8.6% in 2000 to about 9.6% in 2010, but decreasing very slightly since 2014. One reason for this trend of relatively high incidence of low birth weight may be the large proportion of underweight pregnant women under the strict standards for pregnancy weight gain recommended by the Japanese Society of Obstetrics and Gynecology (JSOG) based on the 1999 guideline (Nakabyashi, 1999).[2] The JSOG stopped recommending the 1999 guideline and revised the standards in 2019 (Kanayama, 2019), after our sample period.

3 Data

3.1 The Children's Panel Survey

The main data source for this study is the Longitudinal Survey of Newborns in the 21st Century (LSN21) conducted by the Japanese Ministry of Health, Labour and Welfare (MHLW). It is a population-wide survey of children born during January 10–17 in 2001, July 10–17 in 2001, and May 10–24 in 2010. Our analyses are based on pooled five-wave panel data of these birth month

[2]For further explanation, see, e.g., Kato et al. (2021), Normile (2018) and Takemoto et al. (2016). See also Itoh et al. (2018), who comment on Normile (2018). These authors suggest that commitment to the 1999 JSOG guideline is not a major factor explaining the low birthweight trend.

cohorts. In the first wave, the parents/guardians of six-month-old children were contacted, with annual follow-ups on the same dates. The response rate for the first wave was over 87.8% and remained at around 90% in the follow-up surveys.

The LSN21 reports parents' demographic and socioeconomic data. For mothers, we use their age, educational attainment, and employment status one year before childbirth. Unfortunately, marital status and whether the father was absent during pregnancy could not be determined from the survey. Therefore, we control for the father's educational attainment with a missing dummy variable to capture both nonreporting and father-absent effects. Note that in Japan, the proportion of births outside marriage is very low, and thus the effects of births outside marriage should be limited.[3]

Our data also include birth date, birth length, birth weight, gestational age, multiple birth, and primiparity. This birth-related information is derived from the merged data of the vital statistics collected by the MHLW. The vital statistics are based on administrative vital records, including birth registrations under the Family Register Act. A birth registration document is submitted to the local government by a parent or other family member, accompanied by a birth certificate in which the birth-related information is verified by a doctor or midwife.

Appendix Table B.1 presents summary statistics for the outcome and control variables from the LSN21 with their definitions and measures of economic conditions explained in the following sections. Following the literature, we restrict our data to single-birth children with mothers who gave birth at ages 16–49. In our sample, over 48% mothers are primipara and over 70% were aged between 25 and 34 at the time of childbirth. Among the mothers whose educational attainment is available, the most, about 34%, completed high school, about 18% completed vocational school, about 23% completed 2-year college, about 19% completed university (4-year college), and the fewest, about 5%, completed junior high school (i.e., finished compulsory schooling). Over 58% of

[3]The proportion was about 1.2% in 1995, which increased slightly and has been around 2% since the 2000s. It is one of the lowest among OECD countries, which averaged about 41% in 2018 (OECD, 2022a).

mothers were employed one year before childbirth.

3.2 Outcome Variables

We focus on three sets of outcomes. Our primary interest is in birth outcomes. We consider birth weight, birth length, and gestational age as measures of maternal-fetal health conditions. Following De Cao et al. (2022), we calculate the ratio of birth weight to gestational age (in grams/weeks), as a proxy for fetal growth. To capture the negative aspects of fetal health, we create an indicator of low birth weight (<2,500 grams), very low birth weight (<1,500 grams), preterm birth (born at or under 37 weeks of completed gestation), very preterm birth (at or under 32 weeks), and small for gestational age (SGA) babies (below the 10th percentile of birth weight by gestational age distribution).[4]

Second, we consider child health outcomes at ages 1.5–4.5. We construct an indicator of health conditions based on the parent/guardian's response, namely, whether the child was hospitalized for an illness in the previous 12 months.[5] We focus on hospitalizations rather than doctor visits because the decision to see a doctor is the parent/guardian's choice based on their preferences and constraints, and it might not reflect the severity of the child's health condition.

The third set of outcomes concerns child development and mental health measures. We create three indices based on Yamaguchi et al. (2018): language development at age 2.5, tendency toward aggression at age 3.5, and inattention and hyperactivity at age 3.5. In the survey, the respondents, mostly the mothers, answer a set of binary questions about their child's language development. The items include whether the child could put together two-word sentences. These are equivalent to

[4]The reference percentile charts for birth weight at gestational age by gender are from Ogawa et al. (1998), which were the national standards until 2010. The main results are robust to applying the updated reference charts from Itabashi et al. (2014), which were adopted officially in 2011. See Ogawa et al. (1998) and Itabashi et al. (2014) for more details on the construction of the reference charts.

[5]In each wave of the survey, the parent or guardian indicates whether the child experienced any episodes of illness or diseases such as asthma, atopic dermatitis, cold, congenital disease, conjunctivitis, convulsion, dermatitis, diarrhea, eczema, food allergy, impetigo, influenza, intussusception, Kawasaki disease, measles, mumps, otitis media and externa, pertussis, pharyngeal conjunctival fever, rhinitis, roseola, rubella, streptococcal infection, varicella, and/or others.

those included in the list of developmental milestones by the US Centers for Disease Control and Prevention, which pediatricians commonly use to measure child development. The respondents also select all applicable items regarding the child's disruptive, inattentive, and hyperactive/impulsive behavior. These are comparable to those in the guidelines set by the American Psychiatric Association.[6] We construct an index by totaling the number of selected items in each measure and standardizing them to a Z-score with a mean of 0 and a standard deviation (SD) of 1.

Appendix Table B.1 reports that the average birth weight is about 3,037.4 grams, the low birth weight rate is about 7.72%, and the very low birth weight rate is about 0.51% in our sample. Additionally, the table shows that the average gestational age is about 39.33 weeks. The proportion of infants born with a gestational age of 37 weeks or less is about 4.3%, and that of 32 weeks or less is about 0.52%. Around 11.7% of the children in the sample were hospitalized due to illness at age 1.5, while it decreased as they got older to around 5.2% at age 4.5. Around 23.5% of the children experienced hospitalizations for illness at ages 1.5–4.5.

3.3 Predicted Employment Growth Rate

We construct our measure of economic conditions, the predicted employment growth rate, as follows:

$$D_{pt} = \sum_j G_{jt} \times \frac{E_{jp0}}{E_{p0}}, \tag{1}$$

where G_{jt} is the annual growth rate of industry j in pregnancy period t based on the Japanese Research Institute of Economy, Trade, and Industry (RIETI) and Hitotsubashi University's the Japan Industrial Productivity (JIP) 2021 database; and E_{jp0}/E_{p0} is the share of employment of industry j in prefecture p in base period 0 from the 1997 Employment Status Survey by the Statistics Bureau.[7] This measure captures the demand-driven employment shocks that vary by 47 prefectures due to

[6]For more detailed explanations of the indices, see Yamaguchi et al. (2018).

[7]For a detailed explanation of the construction of the JIP database, see Fukao et al. (2007) and Fukao et al. (2021).

predetermined differences in the distribution of employment opportunities across 24 industries.[8]

To capture the direct heterogeneous shocks to labor demand mothers and fathers face, we construct gender-specific labor demand conditions following Lindo et al. (2018), Page et al. (2019), and Schaller (2016). The gender-specific predicted employment growth rate is

$$D_{pgt} = \sum_j G_{jt} \times \frac{E_{jgp0}}{E_{pg0}}, \tag{2}$$

where the subscripted g indicates the gender group; thus, the share of employment in a prefecture is gender specific.

We define the pregnancy period as the first 22 weeks following conception, rather than the nine months or one-year pregnancy period used in previous studies. As the minimum gestational age in this sample is 22 weeks, we avoid reflecting variations in economic conditions after birth on those during pregnancy.[9] This definition is consistent with the literature suggesting that the first and second trimesters are significantly linked with birth outcomes (e.g., Kyriopoulos et al., 2019; Margerison-Zilko et al., 2011, 2017).

By the definition of the pregnancy period, the differences in conception date are also a source of variation in the predicted employment growth rate. Figure B.1 in Appendix B suggests that conception dates substantially vary within each cohort (144, 127, and 152 days for January 2001, July 2001, and May 2010, respectively).

The JIP database's employment records are an annual measure based on several statistical

[8] The industry categories are agriculture; forestry; fisheries; mining; manufacturing of food, beverages, tobacco, and feed; manufacturing of textile mill products; manufacturing of chemical and allied products; manufacturing of iron and steel, metal products; manufacturing of machinery, equipment; manufacturing of miscellaneous categories; construction; electricity, gas, heat supply, and water; transport, information, and communications; wholesale trade; retail trade; eating and drinking places; finance and insurance; real estate; services of living-related and personal; services of business; services of medical, health care, and welfare; services of education; services of miscellaneous categories; and government services.

[9] The Maternal Health Act defines the period in which artificial abortions are allowed as "a period when the unborn child cannot survive outside the mother's body." Notice No. 55 of March 20, 1990 by the Ministry of Health under the Act specifies it as gestational age of 22 weeks or less. Hence, births under 22 weeks are basically treated as stillbirths in neonatal care in Japan (Minakami et al., 2011, 2014).

surveys as of October 1, collected by the Statistics Bureau of the Ministry of Internal Affairs and Communications for the official statistics. Consequently, in the spirit of Page et al. (2019), we calculate the number of employees working on a given day by linear interpolation based on employment as of October 1 in adjacent years depending on the day of pregnancy and taking the average of the 22-week pregnancy period.

In Appendix Table B.1, the sample mean (standard deviation; SD) value of the predicted employment growth rate is -0.0139 (0.0044) overall, -0.0129 (0.0033) for women, and -0.0145 (0.0064) for men. As our sample period coincides with a period of prolonged stagnation, the predicted employment growth rates are negative. Figure C.1 in Appendix C plots the predicted overall employment growth rates and the actual employment growth rates from 2000 to 2018 at the prefecture level.[10] We find a positive correlation between them, as the OLS estimate of the coefficient of the predicted employment growth rate in the simple regression model is about 0.89. This result suggests that the constructed variable predicts the actual variations well.

Figure C.2 presents the distribution of predicted employment growth rates for men and women. We find a large variation in the raw data of gender-specific predicted employment growth rates. A key source of the differences between the female and male rates is attributable to heterogeneity in the share of industry employment by gender and prefecture.

Figure C.3 plots the industry's share of employment at the prefecture level for each industry category. In a prefecture, if the industry's employment contribution is equally important for both men and women, then the prefecture would be on the 45-degree line. We observe two key features from Figure C.3. First, we find a gender-disproportional contribution to local employment across industries. Second, each industry shows a substantial variation in the relative share of employment exists across prefectures.

[10]The actual employment growth rate is based on the RIETI and Hitotsubashi University's Regional-level Japan Industrial Productivity (R-JIP) Database 2021. For a detailed explanation of the construction of the R-JIP database, see Tokui et al. (2013) and Tokui and Makino (2022).

The construction of the predicted employment growth rate is similar to that of the shift share-type instrumental variables. Goldsmith-Pinkham et al. (2020) show that the exogeneity condition of the instrumental variables can be expressed in terms of the initial shares.[11] Therefore, we follow Goldsmith-Pinkham et al. (2020) and calculate the Rotemberg weights to further assess the contributions of each industry share to the variations of the predicted employment growth rates.

In Appendix D, Table D.1 reports the industries with the five largest Rotemberg weights as well as their proportions among all positive weights. The results suggest gender differences in the relative importance of industries. For women, services of medical, health care, and welfare account for the greatest contribution, while for men, it is wholesale trade. Although the industry with the largest contribution occupies a considerable part among the positive weights, especially for women, the contribution is still dispersed across the other industries. This dispersion of the contributions suggests that no single industry dominates the whole variation of the predicted employment growth rate. In Section 5.4, we revisit this point to examine whether only a single industry drives the main results by removing the top industry from our original Bartik variable.

In Figure 1, we plot the residuals from a regression of the gender-specific employment growth rate on the birth month cohort fixed effects and prefecture fixed effects. Clustering on the 45-degree line implies a lack of independent variation in male and female employment growth rates, except for fixed differences. Figure 1 indicates a positive correlation between female and male employment growth rates; however, it also shows a considerable variation off the 45-degree line. This suggests that independent variations in employment opportunities for men and women make it possible to identify gender-specific effects.

[11] The instrumental variables also satisfy the exogeneity condition if the growth shocks are exogenous. See Borusyak et al. (2022) and Goldsmith-Pinkham et al. (2020) for more details.

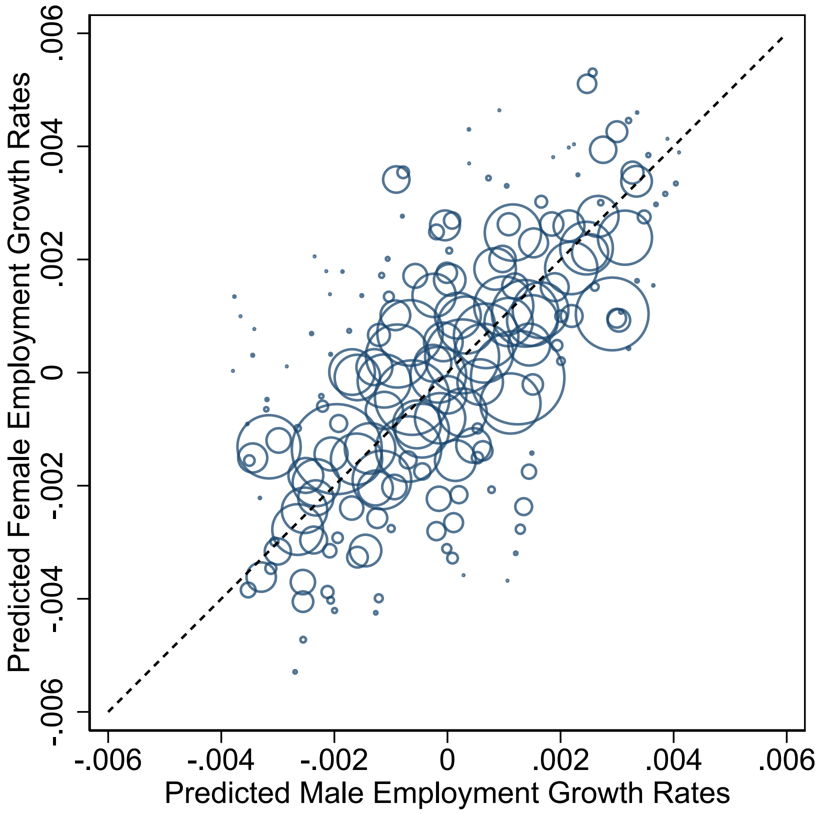

Figure 1: Scatter plots of the predicted female and male employment growth rates

Notes: This figure displays the residuals of the predicted female and male employment growth rates after controlling for the birth month cohort fixed effects and prefecture fixed effects for the regression sample. The data are binned in intervals of 0.005 and weighted by the number of observations.

4 Empirical Framework

In the main analysis, we examine the effects of labor market conditions on birth and later outcomes at the individual level. We estimate the following model:

$$Y_{icpt} = \alpha + \beta D_{pt} + \theta_c + \psi_p + \gamma X_i + \epsilon_{ipct}, \tag{3}$$

where subscripts i, c, p, and t refer to the child, pregnancy period, prefecture, and birth month cohort, respectively. In the data set, we can identify the prefecture where the child lived in the first-wave survey and define it as her/his local prefecture. Y_{ipct} denotes the outcome variable. D_{pt} represents the overall employment growth rate, and β is its coefficient, our primary parameter of interest. X_i is a vector of dummy variables for individual controls, including the child's gender, mother's first childbirth, mother's age at the time of childbirth, mother's employment status one year before pregnancy, and parents' educational attainment. θ_c indicates birth month fixed effects, ψ_p denotes prefecture fixed effects, and ϵ_{ipct} is an idiosyncratic error term assumed conditional mean independent of D_{pt}.

To identify the effects of labor demand shocks for mothers and fathers separately, we include both variables in the following regression model:

$$Y_{ipct} = \alpha + \beta_f D_{pft} + \beta_m D_{pmt} + \theta_c + \psi_p + \gamma X_i + \epsilon_{ipct}, \tag{4}$$

where D_{pgt} represents the gender-specific employment growth rate, and the subscript $g \in \{f, m\}$ refers to gender. Hence, the coefficient of the predicted female employment growth rate indicates the effect of an increase in the variable, while holding the predicted male employment growth rate constant and vice versa.

We also investigate selective fertility using aggregate-level data before turning to the main results.

We estimate the following model:

$$Y_{p\tau} = \alpha + \beta D_{p\tau} + \psi_p + \xi_\tau + \epsilon_{p\tau}, \tag{5}$$

where subscripts p and τ refer to the prefecture and (fiscal) year, respectively. $Y_{p\tau}$ denotes the outcome variable. $D_{p\tau}$ represents the overall employment growth rate, and β is its coefficient, our primary parameter of interest. ψ_p denotes the prefecture fixed effects, ξ_τ indicates the year fixed effects, and $\epsilon_{p\tau}$ is an idiosyncratic error term assumed conditional mean independent of $D_{p\tau}$. We also examine the effects of the gender-specific employment growth rate using a similar specification to that in equation (4).

In all results tables, we estimate the model using ordinary least squares and multiply the coefficient estimates by 100 to represent the effect of a one-percentage-point increase in the predicted employment growth rate. Following the literature, we cluster standard errors at a prefecture level to account for the error term's correlation across time periods within each prefecture.

5 Results

5.1 Fertility and Maternal Age

Here, we briefly assess the relationship between the predicted employment growth rate and fertility across maternal ages. To do so, we estimate variants of equation (5) using prefecture-level panel data from 2000 to 2018. Because we use aggregate data available on an annual basis here, we average the predicted employment growth rates over a one-year period. This one-year period of the economic conditions variable is similar to that used in previous studies employing state- or prefecture-level yearly panel data, such as Dehejia and Lleras-Muney (2004) and Kohara et al. (2019).

5.1.1 Pregnancy, Birth, and Mortality Rates

In Table E.1 in Appendix E, we investigate the decision regarding fertility by estimating the impact of labor demand shock on pregnancy and childbirth. Columns (1) and (2) show a statistically insignificant association between the predicted employment growth rates and pregnancy rate, suggesting that pregnancy decisions might be strongly unaffected by labor demand shocks.

In columns (3) and (4) in Panel A, the results suggest that the predicted overall employment growth rate is negatively and statistically significantly associated with the birth rate. For example, in column (3), a one-percentage-point increase in the predicted overall employment growth rate reduces the birth rate by about 0.137 percentage-points (pps). The gender-specific predicted employment growth rate is also negatively associated with the birth rate; however, the result is statistically insignificant. This pattern suggests a negatively associated decision for childbirth, while the significance of the impacts remains inconclusive.

In columns (5)–(8), to further investigate the effects on childbirth, we estimate the impact on the risks of stillbirth and perinatal mortality. The predicted overall and female employment growth rates are positively associated with these rates, and the female rate is statistically significant. The results suggest that an improvement in mothers' employment opportunities increases the risk of stillbirths, and thus decreasing the live birth rate.

In columns (9)–(12), we examine the effect of a labor demand shock on neonatal and infant mortality rates. We find no evidence of significant effects on mortality rates. The results confirm that the negative effect on newborn health is not driven by sample selection related to changes in neonatal and infant mortality.

To summarize, an increase in the predicted female employment growth rate does not significantly affect the deaths of live-born infants or the selection of pregnancies, but statistically significantly increases the risk of fetal deaths during the perinatal period. Note that this selection into live births could potentially attenuate the deteriorating effect on newborn health, suggesting that fertility selection was not the main driver of the observed negative effect, which we will show in the main results of our study. If an improvement in female labor demand deteriorates the health of a pregnant mother and her fetus, then it would increase the risk of stillbirth. This could lead to a higher average health endowment of neonates because stillbirths truncate the lower tail of the health endowment distribution. We may thus understate the true magnitude of the negative effect of the predicted female employment growth rate on birth outcomes. Nevertheless, our estimates are informative because they can be considered a lower bound on the magnitude of the negative effect.[12]

5.1.2 Composition of Maternal Age

Next, we examine the effects on the composition of mothers' age at childbirth. When labor demand for women increases, for example, women might refrain from giving birth due to an increase in opportunity costs. If relatively younger women were to change their fertility decisions more easily, a disproportionate composition in maternal ages could worsen the birth outcomes. This is because childbirth at an older age is associated with a higher risk of low birth weight and premature births.

In columns (1) and (2) of Table E.2, we examine the effects of predicted employment rate on average age of mothers at childbirth. The results show that the predicted overall and female employment growth rates are negatively associated, and the male rate is positively associated with the average age of mothers at childbirth. However, the estimates are statistically insignificant, and the magnitude is small.

In columns (3)–(8), we further look into the composition change of the mother's age at childbirth.

[12]In our main analysis, we use a sample of all children, including only children, born in a specific period. We control for the mother's primiparity and age at childbirth and the child's birth month fixed effects. Still, we pay less attention to the mother's endogenous choice of birth spacing and stopping. A few previous studies, such as those by De Cao et al. (2022), Dehejia and Lleras-Muney (2004), and van den Berg et al. (2020), control for fertility selection bias using the mother-fixed effect framework that compares differential exposures of unemployment rates across siblings born to the same mother. This framework, however, can apply only to a selective sample of mothers with at least two children. It would therefore not correct the endogenous selection of both birth timing and spacing. Further studies that account for birth spacing and fertility are needed.

We examine the impact on the number of births by mothers in a maternal age group per all births. Columns (3) and (4) show that the predicted employment growth rate is insignificantly associated with the proportion of births by mothers who gave birth at ages 20 to 24. In columns (5) and (6), the proportion of mothers who gave birth at ages 25 to 34 is statistically significantly increased by the predicted female employment growth rate, while it is reduced by the male rate. Along with these effects, the proportion of mothers who gave birth at ages 35 to 44 is statistically significantly reduced by the female rate and increased by the male rate. However, these proportions are not significantly associated with the predicted overall employment growth rate.

To summarize, we find no strong evidence that the predicted overall employment growth rate affects the composition of mothers' age at birth. The predicted female and male employment growth rates do not significantly affect the youngest group of mothers, but they affect the composition of the middle and oldest groups of mothers in opposite directions. An increase in the predicted female employment growth rate reduces the number of births that include advanced-age births with a higher risk of maternal complications.[13] By contrast, an increase in the predicted male employment growth rate increases the number of such births. This suggests that the compositional change may positively (negatively) bias the estimate of the effect of an increase in the predicted female (male) employment growth rate on newborn health.

In columns (9)–(12), we focus on mothers at first childbirth. We find that the predicted employment growth rate has no statistically significant impact on the average age at first birth and the proportion of primiparous mothers, except for that of the predicted male employment rate in columns (11) and (12). The results suggest that the composition of first-time mothers does not vary systematically over the economic fluctuations.

[13]See, e.g., Frederiksen et al. (2018) and Kenny et al. (2013) for associations between advanced maternal age and adverse pregnancy outcomes.

5.2 Birth Outcomes

We investigate the effects of the predicted employment growth rates on child's health outcomes using the individual-level data. Table 1 shows the main results of the effects on child's birth outcomes. As evident in Panel A, improvements in employment opportunities are negatively associated with birth weight, length and gestational age. Columns (1), (2) and (3) show that a negative association between the predicted overall employment growth rate and the absolute value of the maternal-fetal health measure; it corresponds to a decrease in birth weight by about 70.37 grams, in gestational age by about 0.445 weeks and in fetal growth by about 1.12. We obtain a similar result with an alternative measure of neonatal health. Column (4) suggests that a one-percentage-point increase in the predicted employment growth rate reduces the birth length by 0.4152 cm. These results are statistically significant.

The negative impact on birth outcomes is remarkable when we focus on the lower tail of the birth weight and gestational age distributions. Columns (5) and (6) show that a one-percentage-point increase in the predicted overall employment growth rate is associated with a 4.31-pp increase in the probability of an infant having a birth weight of less than 2,500 grams (low birth weight) and a 1.30-pp increase in the probability of having a birth weight of less than 1,500 grams (very low birth weight). Columns (7) and (8) show that a one-percentage-point increase in the predicted overall employment growth rate is statistically significantly associated with a 3.82-pp increase in the probability of preterm birth (<37 weeks), a 1.35-pp increase in the probability of a very preterm birth (<32 weeks).

In Panel B, we report the estimates based on our preferred specification that allows for the disproportionate effect of changes in employment opportunities between men and women. The results suggest that shocks to labor demand for women are the main driver of the negative association between the predicted employment growth rates and birth outcomes shown in Panel A. A one-percentage-point increase in the predicted female employment growth rate reduces weight by about 66.67 grams, gestation by 0.5006 weeks, fetal growth by 0.8942, and length by 0.4477 cm. It increases the probability of having an infant with a low birth weight by 3.18 pps, with a very low birth weight by 1.42 pps, with a preterm birth by 3.42 pps, with a very preterm birth by 1.32 pps. These estimates are statistically different from zero. The coefficients of the predicted male employment growth rate show the same tendency, but the magnitude is smaller and statistically insignificant. The Wald tests of equality between the male and female coefficients indicate that the two are statistically insignificantly different at the 0.05 level, while the p-values in columns (2) and (4) are 0.0506 and 0.0519, respectively.

As reported in column (9) in Panel A, the predicted overall employment growth rate is positively, but statistically insignificantly, associated with SGA. In Panel B, the predicted employment growth rate for women is negatively associated with an infant being born SGA. Column (9) also shows that if male employment opportunities increase, fetuses are more likely to be born SGA. However, these are statistically insignificant. The Wald test of equality between the female and male coefficients shows that the coefficient of the male rate is statistically insignificantly different from that of the female rate.

Overall, we find a negative association between the predicted employment growth rates and birth outcomes. The sign and magnitude of the negative effect are consistent for the predicted overall and female employment growth rates. This finding suggests that the shock to labor demand for women appears to play an important role, although the difference between the female and male effects is marginally statistically insignificant.

Furthermore, we might underestimate the negative effect of the predicted female employment growth rate on newborn health. This is because an increase in the predicted female employment growth rate could reduce the proportion of advanced-aged births with a higher risk of maternal complications and thus poor newborn health, as suggested by the result of the change in the composition of maternal age at birth (Appendix Table E.2). The estimated negative effect is therefore robust to this sample selection that biases the estimate toward a positive effect.

By contrast, an increase in the predicted male employment growth rate increases the proportion of births at older ages. This negative selection makes us overestimate the negative effect of the predicted male employment growth rate on newborn health; thus, it may obscure the difference between the effects of the predicted male and female employment growth rates.

The negative effect of local labor demand on newborn health is consistent with the results of recent studies, such as that of van den Berg et al. (2020), who find counter-cyclical effects of the unemployment rate on birth weight, although they suggest that the effect stems mostly from the male unemployment rate. They show that a one SD increase in the male unemployment rate statistically significantly reduces the probability of an infant having a very low birth weight by about 0.34 pps, and the female unemployment rate reduces it by about 0.14 pps; however, it is statistically insignificant. The corresponding estimates of our study are about 0.05 ($\approx 0.08 \times 0.64$) pps for the male employment growth rate and about 0.47 ($\approx 1.42 \times 0.33$) pps for the female employment growth rate.[14]

De Cao et al. (2022) suggest a greater effect of a shock on the female labor market than that of the male labor market, which is similar to our findings. However, they find a pro-cyclical effect for both the male and female unemployment rates in the UK. One caveat is that their and our regression model specifications are different; they estimate the effect of the male and female unemployment rates in a separate regression model, as does van den Berg et al. (2020). In addition, they find that the overall unemployment rate has a counter-cyclical impact on birth weight in a region with a higher income level, which may be similar to the results from Sweden and Japan. This finding calls for further analysis of the heterogeneity of the effects across the population subgroups.

[14]The corresponding estimate is calculated as $100 \cdot \hat{\beta}_g \times 1\text{SD}$ pps, where $g \in \{f, m\}$. The coefficient estimate, $\hat{\beta}_g$, is from column (6) in Table 1, which is the estimate for a one-percentage-point increase in the predicted employment growth rate. The SD of the gender-specific predicted employment growth rate is from Appendix Table B.1.

Table 1: Predicted employment growth rates and birth outcomes

	(1) Birth weight (grams)	(2) Gestation (weeks)	(3) Fetal growth (grams/weeks)	(4) Birth length (cm)	(5) Low birth weight <2500 grams	(6) Low birth weight <1500 grams	(7) Premature birth <37 weeks	(8) Premature birth <32 weeks	(9) SGA
Panel A: Overall effects									
Overall	-70.3677***	-0.4450***	-1.1239***	-0.4152***	0.0431***	0.0130***	0.0382***	0.0135***	0.0028
	(16.7356)	(0.0937)	(0.3111)	(0.0901)	(0.0100)	(0.0033)	(0.0095)	(0.0035)	(0.0062)
Panel B: Gender-specific effects									
Female	-66.6655**	-0.5006***	-0.8942*	-0.4477**	0.0318*	0.0142**	0.0342**	0.0132*	-0.0124
	(22.9492)	(0.1320)	(0.4216)	(0.1357)	(0.0131)	(0.0051)	(0.0119)	(0.0051)	(0.0080)
Male	-12.5814	-0.0155	-0.3431	-0.0185	0.0163	0.0008	0.0090	0.0023	0.0139
	(20.0805)	(0.1361)	(0.3566)	(0.1079)	(0.0129)	(0.0053)	(0.0126)	(0.0053)	(0.0076)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.1587	0.0506	0.4261	0.0519	0.5109	0.1719	0.2512	0.2636	0.0709
Mean	3037.3793	39.3290	77.1020	49.0004	0.0772	0.0051	0.0428	0.0052	0.0884
Observations	83185	83185	83185	83034	83185	83185	83185	83185	83185

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. P-value is based on the Wald test of equality between the female and male coefficients. Mean indicates the sample mean level of the outcome variable. Child's gender, mother's first childbirth, mother's age, mother's employment status before pregnancy, parental education, birth month cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

5.2.1 Heterogeneity

In this section, we estimate the model allowing for heterogeneous effects across mothers' age at childbirth and mothers' education levels.

Mothers' Age at Childbirth The predicted employment growth rate could affect the birth outcomes by changing the composition of maternal age at birth. Here, we examine how the effect on the birth outcomes varies across the maternal age at birth. We interact the maternal age group dummy with the predicted employment growth rates and control variables. We divide the mothers into three groups: mothers who gave birth at age 24 or younger, at age 25–34, and at age 35 or older.

In Table 2, we focus on the effects on the key birth outcomes, which are birth weight and gestational age. We report the estimates of the coefficients of the predicted employment growth rates based on the interaction model with the age 24 or younger group as the reference, along with the average marginal effect (AME) of a one-percentage-point increase in the predicted employment growth rate evaluated at each mother's age group.

In column (1) of Panel A, we find negative effects of the predicted overall employment growth rate on birth weight, similar to the main results without interactions. In addition, the interaction term for the age 35 or older group is statistically significantly negative. This suggests that the magnitude of the negative effect is statistically significantly greater for the age 35 or older group than for the age 24 or younger group.

Column (1) of Panel B reports the gender-specific effects on birth weight. The AMEs of the predicted female employment growth rate are negative. Although the estimates suggest that the magnitude of the effect is the largest for the age 24 or younger group, we do not find statistically significant differences in the effects across the age groups. The coefficient estimates of the male rate suggest that those in the 25–34 and 35 or older age groups are statistically significantly different from those in the reference age group. However, the sign of the AME of the predicted male employment growth rate is unstable due to the imprecise estimates. We only find a statistically significant negative AME for the 35 or older age group. The test of equality across the gender-specific effects suggests a statistical difference between the effects of the female and male rates for the age 24 or younger group.

Column (2) shows the results of the effects on weeks in gestation. The AMEs of an increase in the predicted overall and female employment rates are negative and statistically significant, except for the female rate in the age 35 or older group. The magnitude of the effect is the largest in the age 35 or older group for the overall rate and in the age 24 or younger group for the female rate. Again, the AMEs of the male rate show an inconsistent sign of the effects across the mother's age groups. The AME of the male rate in the age 35 or older group is statistically significantly negative. However, given the test for equality of the gender-specific effects, we cannot reject the null hypothesis of equal effects in the age 35 or older group. We find statistically significantly different gender-specific effects in the age 24 or younger and 25–34 groups.

The results suggest that the negative effect of an increase in the predicted overall and female employment growth rates on the birth outcomes is robust to the alternative specifications that allow for heterogeneity in the effects across the mother's age at childbirth. Focusing on the gender-specific effects, the AMEs of the predicted female employment growth rate are consistently negative for newborns of mothers who gave birth at age 34 or younger. Moreover, the AMEs for those of mothers who gave birth at age 24 or younger are statistically significantly different from that of the predicted male employment growth rate. The magnitude of the effect of the predicted female employment growth rate on gestational age is larger for the age 24 or younger group than for those of mothers who gave birth at age 25 or older. It is worth noting that the composition of the age 24 or younger group is not significantly affected by the predicted employment growth rate.

Table 2: Predicted employment growth rates and birth outcomes by mothers' age

	(1) Birth weight (in grams) Coef.	(1) AME	(2) Gestational age (in weeks) Coef.	(2) AME
Panel A: Overall effects				
Overall:				
Age < 25 (reference)	-45.6023*	-45.6023*	-0.3745**	-0.3745**
	(20.0642)	(20.0642)	(0.1286)	(0.1286)
25 ≤ Age < 35	-16.8344	-62.4367***	-0.0454	-0.4200***
	(19.2240)	(16.3021)	(0.1294)	(0.0906)
35 ≤ Age	-84.5406*	-130.1429***	-0.2974	-0.6719***
	(37.3994)	(34.6529)	(0.1771)	(0.1746)
Panel B: Gender-specific effects				
Female:				
Age < 25 (reference)	-119.4929**	-119.4929**	-0.8600***	-0.8600***
	(41.4487)	(41.4487)	(0.1973)	(0.1973)
25 ≤ Age < 35	46.3674	-73.1255**	0.3379*	-0.5221***
	(34.5549)	(24.0035)	(0.1548)	(0.1458)
35 ≤ Age	73.2716	-46.2213	0.5521*	-0.3078
	(61.8611)	(47.0896)	(0.2502)	(0.1834)
Male:				
Age < 25 (reference)	66.0880	66.0880	0.4254	0.4254
	(37.7307)	(37.7307)	(0.2301)	(0.2301)
25 ≤ Age < 35	-66.1709*	-0.0829	-0.4003*	0.0251
	(30.1872)	(22.5859)	(0.1964)	(0.1424)
35 ≤ Age	-153.3483**	-87.2602*	-0.8498**	-0.4243*
	(49.6322)	(39.0308)	(0.2815)	(0.1849)
Mean	3037.3793		39.3290	
Observations	83185		83185	
p-value (Age < 25)		0.0191		0.0021
p-value (25 ≤ Age < 35)		0.0879		0.0445
p-value (35 ≤ Age)		0.5970		0.7117

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. Coef. indicates the coefficient estimates based on the regression model including the interactions of the predicted employment growth rate and mothers' age group dummies, where the mothers aged 24 or younger at childbirth group is the reference group. AME indicates the average marginal effect evaluated at each mother's age group. The estimates are for a one-percentage-point increase in the predicted employment growth rate. Mean indicates the sample mean level of the outcome variable. P-value is based on the Wald test of equality between the female and male marginal effects evaluated at each mothers' age group. Child's gender, mother's first childbirth, mother's employment status before pregnancy, parental education, birth month cohort dummies, a set of dummies for prefecture of residence, and their interactions with the mothers' age group dummies, and the mothers' age group dummies are also controlled in the regression model but not reported. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

Mothers' Education Levels The literature suggests that during the Great Recession, the negative effects of economic fluctuations were concentrated among the less educated (e.g., Currie et al., 2015; Hoynes et al., 2012), whereas the heterogeneity in the effects across mothers' education levels is undetermined for children's health outcomes (Dehejia and Lleras-Muney, 2004; Page et al., 2019). Looking at a subset of mothers' educational attainment, we approach a potential source of the heterogeneity in the effects that could be driven by changes in labor demand for women.

In Table 3, we examine the heterogeneity in the effects by mothers' education level. Because large differences in the point estimates are likely to occur by chance when using small subgroup samples, we use the high school with the largest subpopulation as the reference group and test the statistical significance of the interaction terms.

Column (1) reports the effects on birth weight. In Panel A, an increase in the predicted overall employment growth rate statistically significantly reduces birth weight. The magnitudes of the effects for the 2-year college and university groups are statistically significantly larger than that for the high school group, and the AME is the largest for the university group.

If we focus on the gender-specific effects in Panel B, the effects of the predicted female employment growth rate are consistent with those of the overall rate; there are statistically significant negative effects on the birth outcomes. The magnitudes of the effects are statistically significantly larger for the junior high school and university groups than for the high school group.

For the predicted male employment growth rate, the effects are not significant due to the large standard errors, and their sign is also unstable across subgroups. There are no statistical differences between the high school group and other subgroups. The test of equality between the male and female coefficients suggests that the effects are statistically significantly different in the junior high school and university groups.

Column (2) reports the effects on gestational age. For the overall effects in Panel A, the results show similar patterns to the effects on birth weight. The negative effect of the predicted overall employment growth rate is statistically significantly larger for the college and university groups than for the high school group. For the gender-specific effects in Panel B, we find a negative AME of the predicted female employment growth rate on gestational age. However, we find no statistical differences in the effects across the mothers' education levels. The test of equality suggests a statistical difference between the effects of the female and male rates for the high school and college groups.

In sum, we find that the negative effect of an increase in labor demand during pregnancy on birth weight is larger for more educated mothers. This pattern is common to the effects of the predicted overall and female employment growth rates. The effect of labor demand for women is also larger for mothers in the junior high school group than for those in the high school group. However, the share of the junior high school group in the full sample is about 5% (Appendix Table B.1); hence, the contribution of the effect of labor demand for the subgroup to that for the full sample might be limited. In addition, we do not find statistically significant heterogeneous effects of labor demand for men.

Therefore, the negative association between labor demand during early pregnancy and birth outcomes appears to be mainly driven by changes in female employment opportunities for more educated mothers, especially those who gave birth at relatively young ages. This finding is consistent with the patterns of the female labor force participation rate across ages in Appendix Figure A.3, suggesting that more younger educated women are more likely to be attached to the labor market. As our variable of changes in local labor demand proxies for changes in the local employment growth rate, it may mainly capture the extensive margin of labor adjustment.

Table 3: Predicted employment growth rates and birth outcomes by mothers' educational attainment

	(1) Birth weight (in grams)		(2) Gestational age (in weeks)	
	Coef.	AME	Coef.	AME
Panel A: Overall effects				
Overall:				
Jr. high school	-59.2667	-81.8010	-0.3667	-0.6265***
	(50.7035)	(45.6643)	(0.1937)	(0.1729)
High school (reference)	-22.5343	-22.5343	-0.2597**	-0.2597**
	(18.6382)	(18.6382)	(0.0910)	(0.0910)
Vocational school	-42.9175	-65.4518*	-0.1556	-0.4153**
	(35.7322)	(30.9420)	(0.1363)	(0.1228)
2-year college	-69.0616*	-91.5959**	-0.2488**	-0.5086***
	(29.8544)	(28.3129)	(0.0862)	(0.0983)
University or more	-110.6374**	-133.1717***	-0.3959*	-0.6556**
	(34.6341)	(35.2422)	(0.1747)	(0.1942)

(continued)

(continued)

	(1) Birth weight (in grams)		(2) Gestational age (in weeks)	
	Coef.	AME	Coef.	AME
Panel B: Gender-specific effects				
Female:				
Jr. high school	-185.0373*	-207.4647*	-0.4621	-0.9625*
	(76.1202)	(78.4321)	(0.3641)	(0.3698)
High school (reference)	-22.4274	-22.4274	-0.5004**	-0.5004**
	(30.9172)	(30.9172)	(0.1823)	(0.1823)
Vocational school	-18.5666	-40.9939	0.0738	-0.4266*
	(44.1677)	(43.4996)	(0.1737)	(0.1885)
2-year college	-42.2476	-64.6750	-0.0766	-0.5770***
	(45.0119)	(40.9735)	(0.1541)	(0.1475)
University or more	-151.3487**	-173.7761***	-0.1912	-0.6916***
	(48.7077)	(47.5301)	(0.2200)	(0.1963)
Male:				
Jr. high school	105.3390	102.6245	0.0735	0.2573
	(56.3697)	(67.6619)	(0.2688)	(0.2966)
High school (reference)	-2.7146	-2.7146	0.1838	0.1838
	(26.9855)	(26.9855)	(0.1732)	(0.1732)
Vocational school	-31.3299	-34.0444	-0.2399	-0.0561
	(46.3939)	(47.6152)	(0.1745)	(0.1900)
2-year college	-32.6390	-35.3535	-0.1946	-0.0108
	(46.3726)	(40.7640)	(0.1267)	(0.1297)
University or more	15.7959	13.0813	-0.2810	-0.0972
	(37.2803)	(33.3395)	(0.2308)	(0.2354)
Mean	3038.4258		39.3333	
Observations	74773		74773	
p-value (Jr. high)		0.0302		0.0627
p-value (High)		0.7183		0.0477
p-value (Vocational)		0.9351		0.3019
p-value (College)		0.6980		0.0258
p-value (University)		0.0095		0.1179

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. Coef. indicates the coefficient estimates based on the regression model including the interactions of the predicted employment growth rate and mothers' education level dummies, where mothers with high school is the reference group. AME indicates the average marginal effect evaluated at each mothers' education level. The estimates are for a one-percentage-point increase in the predicted employment growth rate. Mean indicates the sample mean level of the outcome variable. P-value is based on the Wald test of equality between the female and male marginal effects evaluated at each mothers' education level group. Child's gender, mother's first childbirth, mother's age, mother's employment status before pregnancy, parental education, birth month cohort dummies, a set of dummies for prefecture of residence, and their interactions with the mothers' education level dummies, and mothers' education level dummies are also controlled in the regression model but not reported. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

5.3 Later Outcomes

Next, we analyze the association between predicted employment growth rates and physical health and mental development in early childhood. A large body of epidemiology literature suggests that low birth weight is associated with poor physical and mental health from infancy through adolescence (e.g., McCormick et al., 1992; Saigal et al., 1996). However, anthropometric measures such as low birth weight might reflect unmeasured genetic and socio-economic backgrounds (Almond and Currie, 2011). Due to potential paths and confounding from unmeasured factors, the observed poor neonatal health does not necessarily imply that economic shocks affect future health outcomes.

5.3.1 Health Conditions

Panel A of Table 4 shows that improvements in labor market opportunities are positively associated with the probability of childhood hospitalization for illness, except when the child is 1.5 years old. The estimates are statistically insignificant, and the magnitude is small. Even the largest impact of the predicted overall employment growth rate on children aged 4.5 is only about a 0.71-pp change.

We should be cautious about these statistically insignificant results. Because hospitalizations are rare events, the test may lack statistical power. Therefore, to examine the robustness of the result, we construct a cumulative measure of hospitalization at any time from age 1.5 to age 4.5. Column (5) shows that impact of the predicted overall employment growth rate on hospitalizations during ages 1.5–4.5 is small and statistically insignificant.

We also examine the gender-specific effects on childhood hospitalization for illness. Panel B shows no statistically significant association between the predicted employment growth rates and hospitalization at ages 1.5–4.5. These results suggest that labor demand shocks during pregnancy have no substantial impact on children's health in early childhood.

In contrast to the effects of labor demand shock during pregnancy on newborn health, we find no evidence of a significant impact on children's health later in life. Previous studies suggest that the current labor market fluctuations could have a negative impact on children and mothers' health (e.g., Page et al., 2019; Schaller and Zerpa, 2019). These findings indicate that changes in employment opportunities are more likely to be relevant for health conditions in the short run.

Table 4: Predicted employment growth rates and hospitalization for illness

	(1) at age 1.5	(2) at age 2.5	(3) at age 3.5	(4) at age 4.5	(5) at ages 1.5–4.5
Panel A: Overall effects					
Overall	-0.0011	0.0033	0.0006	0.0071	0.0110
	(0.0090)	(0.0081)	(0.0059)	(0.0074)	(0.0130)
Panel B: Gender-specific effects					
Female	-0.0010	-0.0036	0.0082	-0.0004	-0.0003
	(0.0120)	(0.0141)	(0.0098)	(0.0101)	(0.0217)
Male	0.0017	0.0078	-0.0061	0.0097	0.0145
	(0.0148)	(0.0169)	(0.0110)	(0.0120)	(0.0244)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.9146	0.7056	0.4770	0.6341	0.7394
Mean	0.1169	0.0856	0.0585	0.0515	0.2347
Observations	73935	71820	67919	64669	64669

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. P-value is based on the Wald test of equality between the female and male coefficients. Mean indicates the sample mean level of the outcome variable. Child's gender, mother's first childbirth, mother's age, mother's employment status before pregnancy, parental education, birth month cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

5.3.2 Language and Mental Development

Table 5 reports the association between labor demand during pregnancy and children's language and mental development. In column (1), Panel A shows that a one-percentage-point increase in the overall employment growth rate is associated with a 0.0118-SD increase in the children's language development index. In Panel B, the corresponding estimate for women is a 0.0099-SD increase and for men, it is a 0.0002-SD decrease. We see that the magnitude of all estimates is small, and the standard errors are large.

Column (2) indicates the impacts on children's tendency toward aggression. In Panel A, an increase in the predicted overall employment growth rate is associated with a 0.0315-SD decrease but is statistically insignificant. In Panel B, the predicted female employment growth rate is statistically significantly associated with a 0.0744-SD decrease in children's tendency toward aggression, but the magnitude of the effect is small. It is about a 0.0246-SD decrease for a one SD increase in the predicted female employment growth rate ($\approx$ 0.0744-SD$\times$ 0.33 pps). By contrast, the effect of the predicted male employment growth rate is statistically insignificant and has the opposite sign.

Column (3) shows the impacts on children's tendency toward inattention and hyperactivity. The effect of the predicted overall and male employment growth rate is positive, while that of the female is negative; however, they are statistically insignificant due to their large standard errors. Thus, there are no significant effects of labor demand during pregnancy on these outcomes, except for female labor demand on the aggression index.

To summarize, the results in Tables 4 and 5 suggest that the negative impact of a labor demand shock on birth outcomes does not persist in the long run for subsequent outcomes. We find a statistically significant effect of an increase in the predicted employment growth rate only with respect to that of the female rate, reducing the tendency toward aggression. At first glance, this seems to contradict previous studies that found long-term negative effects of low birth weight; however, the result requires careful interpretation. In this study, we focus on the total effects of economic fluctuations, not necessarily the effects only through low birth weight. In addition, our key identification variations differ from previous studies based on variations in fetal growth restriction in twins that may have long-term effects. Maruyama and Heinesen (2020), using exogenous variations in gestational age as an instrumental variable, found that the negative effect of low birth weight diminishes over time. Our results are consistent with their findings as our estimates suggest that the main factor of low birth weight is a shorter gestation period.

Table 5: Predicted employment growth rates and child development

	(1) Language development	(2) Aggression	(3) Inattention & Hyperactivity
Panel A: Overall effects			
Overall	0.0118	-0.0315	0.0102
	(0.0238)	(0.0449)	(0.0260)
Panel B: Gender-specific effects			
Female	0.0099	-0.0744*	-0.0197
	(0.0328)	(0.0359)	(0.0551)
Male	-0.0002	0.0407	0.0276
	(0.0303)	(0.0609)	(0.0567)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.8626	0.2154	0.6666
Mean	0.0000	0.0000	0.0000
Observations	72770	66876	65329

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. P-value is based on the Wald test of equality between the female and male coefficients. Mean indicates the sample mean level of the outcome variable. The outcome variable is standardized to mean 0 and standard deviation 1. Child's gender, mother's first childbirth, mother's age, mother's employment status before pregnancy, parental education, birth month cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

5.3.3 Heterogeneity

We also examine the heterogeneous effects across the mothers' age groups and education levels on later outcomes. In Appendix F, Table F.1 presents the results from the model with the mothers' age at childbirth interactions. Column (1) shows that for children's ever experienced hospitalizations at ages 1.5–4.5, the magnitude of the impact is still small and statistically insignificant. Columns (2)–(4) present the results for children's language development, tendency toward aggression, and tendency toward inattention and hyperactivity index. Across the mothers' age groups, the interaction terms are statistically insignificant throughout. The AMEs of the overall and gender-specific effects are also statistically insignificant and unstable.

Table F.2 reports the results from the model with the mothers' education level interactions. For the overall and gender-specific effects, few heterogeneity patterns stand out. One exception is the effect on children's language development. For example, for the junior high school group, the difference in the effects of the overall rate relative to the high school group is statistically significant. The magnitude of the AME is -0.3111-SD, which is about a 0.1369-SD decrease in the children's language development index for a one SD increase in the overall rate (≈ -0.3111-SD$\times$ 0.44 pps). We also find that the effect of the female rate for the 2-year college group is statistically significantly larger than that for the high school group. However, the magnitude of the AME is small (0.1501-SD), corresponding to about a 0.0495-SD increase for a one SD increase in the female rate (≈ 0.1501-SD$\times$ 0.33 pps). In addition, we cannot reject the equality between the female and male AMEs. We can reject the equality of the gender-specific effects only for the high school group.

Across the mothers' age groups and education levels, the effects are basically small and their sign is unstable. This finding confirms the lack of strong evidence that an increase in the predicted employment growth rate deteriorates children's health conditions and development in early childhood, which are similar to the results in Tables 4 and 5.

5.4 Robustness Check

5.4.1 Model Specifications

Due to the sampling of newborns, our main results might be sensitive to unobserved factors that affect fertility decisions. For example, if individuals from a certain socioeconomic group such as skilled labor postpone or give up plans to have a child in response to an industry-specific shock to labor demand, then the decision creates a systematic change in the composition of parents. It would lead to a correlation between labor demand shock and the health conditions of newborns among a group that chose to give birth. To mitigate this concern, we control for primiparity, maternal age, maternal employment status before childbirth, and parents' educational level in the baseline regression models.

One concern is that the control variables might rather bias the estimates if they are endogenous. To investigate this possibility, we estimate the effects on birth weight and gestational age based on different specifications in Table G.1 in Appendix G, where we add a control variable to the model step-by-step. In column (1), we reproduce our baseline estimates from Table 1 for comparison. In column (2), we estimate a simple model that controls only the birth month cohort and prefecture-fixed effects. The signs and significance of the effects are quite similar to those of the estimates in column (1), while the magnitude of the effects is slightly smaller for birth weight in Appendix Table G.1a.

Adding the child's basic characteristics, gender, and primiparity returns results almost identical to the baseline. Further, the results are basically robust to controlling for the additional individual characteristics such as mother's age at childbirth, parents' education level, and mother's employment status one year before childbirth. Therefore, our main results are basically insensitive to the model specifications after adding controls for individual characteristics.

5.4.2 Prefecture and Municipality Controls

We further examine the sensitivity of the results by controlling for prefecture- and municipality-level variables that may be correlated with both labor market conditions and fertility decisions or children's health. The prefecture control variable is the number of hospitals that offer obstetrics and gynecology services per the number of women aged 20–44. The municipality control variables are the ratio of the accredited childcare center capacity to the number of children aged 0–5 and share of nuclear family households.[15]

We include these municipality controls because the literature suggests that local accessibility to center-based childcare could change the fertility rate, and the effect is pronounced in regions where households are unlikely to include grandparents (e.g., Fukai, 2017). Although some of these regional control variables may be affected by labor demand shocks, they could also capture unobserved factors that determine the selection for childbirths. Therefore, including them allows us to partly address concerns on selection on unobservables.

Appendix Table G.2 shows that the pattern and magnitude of the estimates are not sensitive to including prefecture and municipality control variables. Controlling for the regional variables also does not affect the statistical difference between the effects of the female and male rates, with the exception of the effects on gestational age (p-value = 0.0471 in column (6)). This suggests that our main results are relatively robust to concerns about selective fertility and confounding related to the unobserved regional factors.

In addition, we conduct an alternative robustness check suggested by Pei et al. (2019). They point out that the estimated coefficient movement might be uninformative if the included control is a noisy proxy of the unobserved confounding factor. Therefore, following their suggestion, we conduct a left-hand-side (LHS) and right-hand-side (RHS) balancing test under similar specifications to the

[15]The number of hospitals is from the Survey of Medical Institutions of the MHLW. The number of childcare centers is from the Survey of Social Welfare Institutions of the MHLW. Population and household data are based on the national census.

equations (3) and (4). In the LHS test, we regress each regional control on the predicted employment growth rates. In the RHS test, we regress the predicted employment growth rate on the regional controls.

In Appendix Table G.3, the estimate for the LHS test suggests a statistically insignificant association between the predicted employment growth rate and the regional control variable, except for that between the predicted male employment growth rate and the share of nuclear family households. The p-values of the LHS joint balancing test suggest that we cannot reject the hypothesis that the three controls are not correlated with the predicted overall and female employment growth rates. Moreover, based on the RHS joint balancing test under the hypothesis that the three controls are balanced, the p-values suggest that we cannot reject the null at any conventional significance level for the predicted overall, female, and male employment growth rates. These results suggest that prefecture and municipal unobserved factors are unlikely to affect our main results, especially for the effects of the predicted overall and female employment growth rates.

5.4.3 Sample Attrition

Another concern is a selection issue due to children endogenously being dropped from the analysis sample for later outcomes. For example, if improvements in employment opportunities during pregnancy worsen newborn health, then they could also increase infant mortality. In such a case, this sample selection might attenuate negative associations between labor demand shock and children's health in early childhood.

We address this concern by examining whether the predicted employment growth rate causes sample attrition in early childhood. Here, the dependent variable is a dummy variable that equals one if the child is dropped from the base regression sample until the follow-up survey. Appendix Table G.4 shows that the estimates of the effects of predicted employment growth rates are statistically insignificant and with very small magnitudes in all columns. The results suggest that our findings on health and development in early childhood are robust to sample attrition.

5.4.4 Migration

We might also be concerned about endogenous migration during pregnancy. For example, if mothers who have a low risk of prenatal health issues are more likely to relocate in response to labor demand changes during pregnancy, this selective relocation could provide significant associations between labor demand changes and birth outcomes. To address this concern, we estimate correlations between the predicted employment growth rates and relocation during pregnancy.

Although there is limited information on migration during pregnancy in the LSN21, only for the January 2001 and July 2001 cohorts, we can identify whether the family had relocated because of pregnancy or childbirth between one year prior to childbirth and when the child was 6 months old. Appendix Table G.5 shows no statistically significant association between the predicted employment growth rates and relocation during pregnancy. Hence, we find no strong evidence that selective migration drives the main results.

5.4.5 Pregnancy Periods

In our baseline specification, we define the pregnancy period for the predicted employment growth rates as the first 22 weeks of pregnancy to accommodate the minimum gestational age in our sample. Here, we examine the sensitivity of the definition of the pregnancy period. In Appendix Table G.6, we also present the estimates with 20 and 24 weeks for the pregnancy period. The estimates are similar to the ones from the baseline specification, suggesting that the main results are insensitive to the definition of the pregnancy period.

5.4.6 Rotemberg Weights

In this section, we address the concern that only a single industry may drive our main results. If the variation in employment opportunities is not dominated by one industry with large Rotemberg weights, then even if we omit the industry, we would still find negative effects of the predicted employment growth rate on birth outcomes.

In Table D.1 of Appendix D, we reconstruct the predicted employment growth rate, by dropping one industry in each row from all industries and normalizing the sum of the employment shares of the remaining 23 industries to one. Columns of the effect and the standard errors (SE) report the estimates of the coefficient of the predicted employment growth rate based on the equations (3) and (4) using the reconstructed predicted employment growth rates.

We find that an increase in the predicted overall and female employment growth rate statistically significantly reduces birth weight, which is consistent with the main results in Table 1. This result suggests that the negative impact is not solely driven by a specific industry.

5.4.7 Prefecture-level Analysis

Finally, we re-examine the impact of the employment growth rate on birth weight using prefecture-level panel data from 2000 to 2018. In Table E.3 of Appendix E, we confirm a significant impact of labor demand shocks on birth weight at the prefecture level. Columns (3) and (4) show that the predicted overall employment growth rates are statistically significantly associated with the proportion of low birth weight births. Columns (1)–(4) show that the female rates are statistically significantly associated with the average birth weight and the proportion of low birth weight births. These factors reduce birth weight, resulting in increasing the risk of causing low birth weight.

6 Conclusion

This study examines the effects of local labor market conditions during early pregnancy on childbirth outcomes in Japan. Studies in developed countries produced mixed results, with recessions having both better and worse outcomes for prenatal health. This study contributes to the ongoing discussion by providing new evidence that the impacts of labor market conditions vary by gender. We take advantage of the fact that men and women are often engaged in different industries to capture gender-specific labor market conditions.

Our results demonstrate that improvements in labor market opportunities for women during early pregnancy worsen birth outcomes. However, we do not observe a significant change in birth weight and gestational age when labor market opportunities for men improve. These results imply that maternal employment rather than paternal employment, is a key factor in prenatal health in developed countries.

One possible mechanism is that an increase in labor demand for women increases work-related stress. In addition, it increases the opportunity cost of time for health-related investment, such as exercise and health checkups, and it could thus deteriorate the health conditions of pregnant women. A heavy workload for pregnant women could increase stress-dependent health problems, which might lead to deteriorating birth outcomes. For instance, based on a large-scale prospective cohort study of pregnant women in Japan, Suzumori et al. (2020) found that long working hours during pregnancy are associated with the risks of hypertensive disorders of pregnancy, and vacuum or forceps delivery.

This result is consistent with our findings that the negative effect is larger for younger mothers who gave birth at age 24 or younger, as younger women are more likely to be attached to the labor market, and thus more likely to be in employed around the pregnancy. A larger magnitude of the effect for more educated mothers is also suggestive because they might have a greater incentive to work during pregnancy than less educated mothers.

The present study uses changes in economic situations during the early stages of pregnancy. The analysis suggests policy interventions during early pregnancy, targeting to improve prenatal health conditions, consistent with the evidence that an expansion of maternity leave programs can improve prenatal health conditions (e.g., Rossin, 2011). Note that, maternity leave is guaranteed for only six weeks prior to the expected date of delivery under the current Japanese law (the Article the Labor Standards Act).

We also investigate the impact of economic conditions during pregnancy on subsequent child health and development. Although previous studies demonstrate that maternal mental stress during pregnancy worsens children's future outcomes, the long-term impact of economic conditions during pregnancy is still not well understood. In this study, we find little evidence that an increase in the predicted employment growth rate during pregnancy deteriorates child health and development several years later. This finding suggests that the negative effects of improved economic conditions through a deterioration in birth outcomes could be obscured in early childhood.

This study has three limitations. First, we were unable to observe the actual employment status during pregnancy. We would need detailed data on maternal employment during pregnancy to identify a potential channel of the impact of economic fluctuations better.

Second, we lacked access to information regarding maternal health behaviors during pregnancy, such as dietary intake for weight gain. Previous studies suggest that birth weight, energy intake, height, and body mass index shared declining trends over four decades in Japan (e.g., Kato et al., 2021; Maruyama and Nakamura, 2018; Normile, 2018; Ogawa et al., 2018). To control unknown differences across cohorts, we include cohort fixed effects in the analysis. If pregnant women change their health behaviors in response to economic shocks, then it would present an interesting mechanism to analyze.

Finally, for the outcome of child health and development, we were only able to track children aged 0 to 4.5. Labor demand shocks could influence health-related socioeconomic outcomes later in life since poor neonatal health effects remain latent for many years, such as the effects on heart disease, which become apparent in middle age (Almond and Currie, 2011). Future research needs longer-term data to analyze the impact of economic status during pregnancy on future outcomes.

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Appendices (for Online Publication)

A International Comparisons

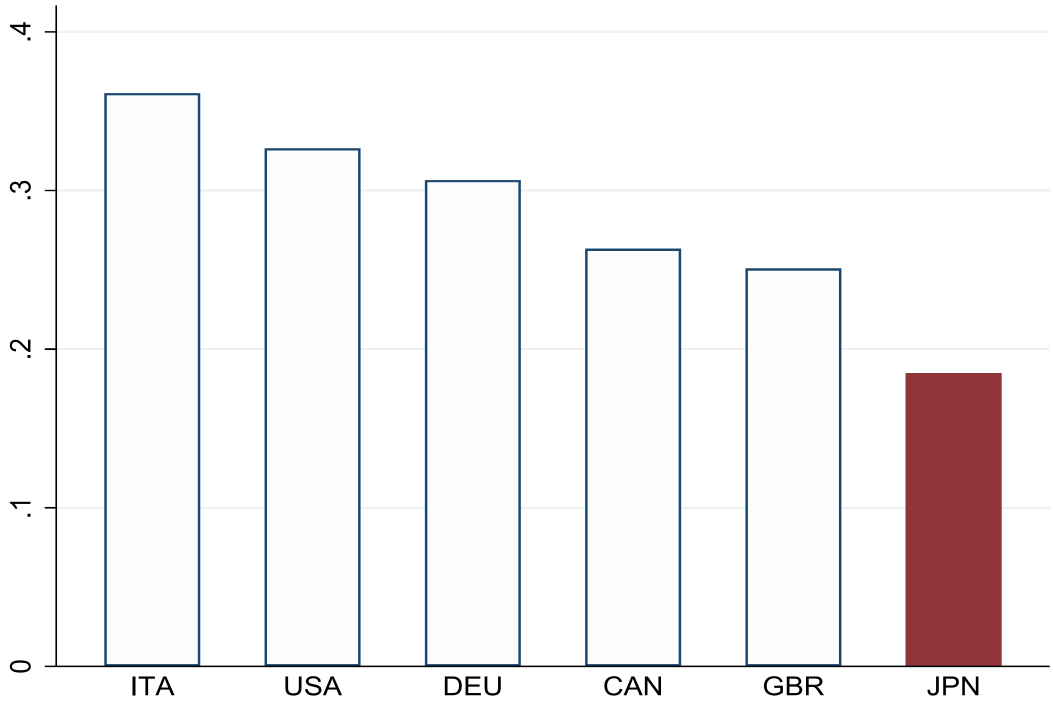

Figure A.1: Proportion of cesarean sections in live births

Notes: This figure displays the number of live births delivered by cesarean section per all live births in 2013. Source: OECD (2022b).

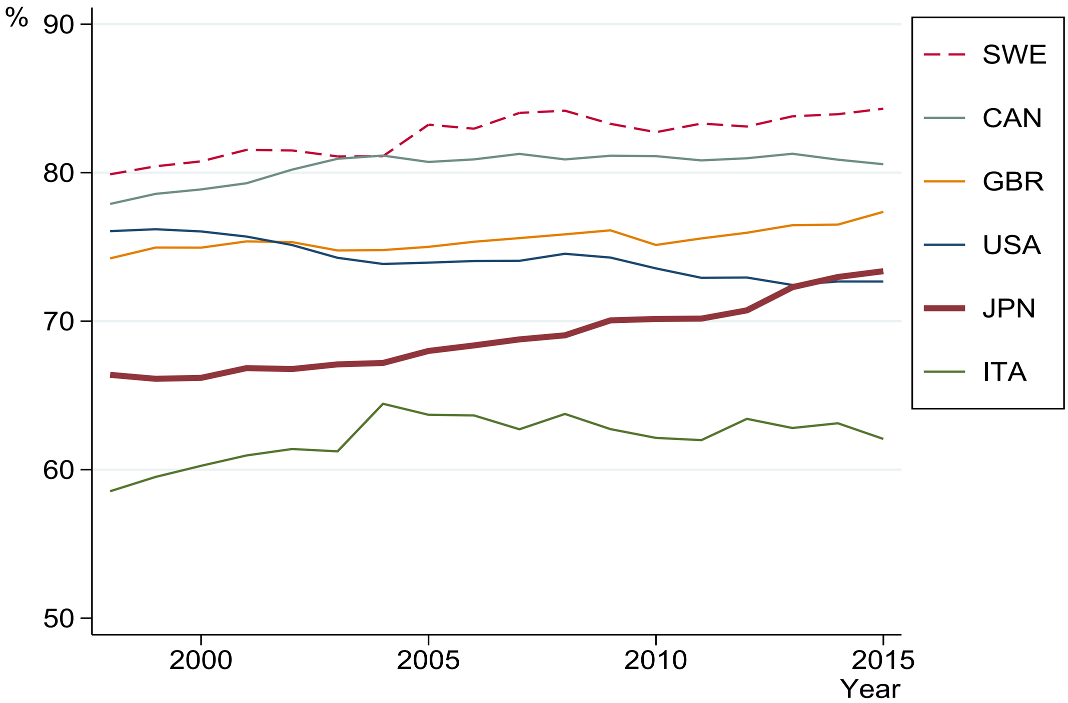

Figure A.2: Female labor force participation rate

Notes: This figure displays the labor force participation rate of women aged 20–44.
Source: OECD (2022d).

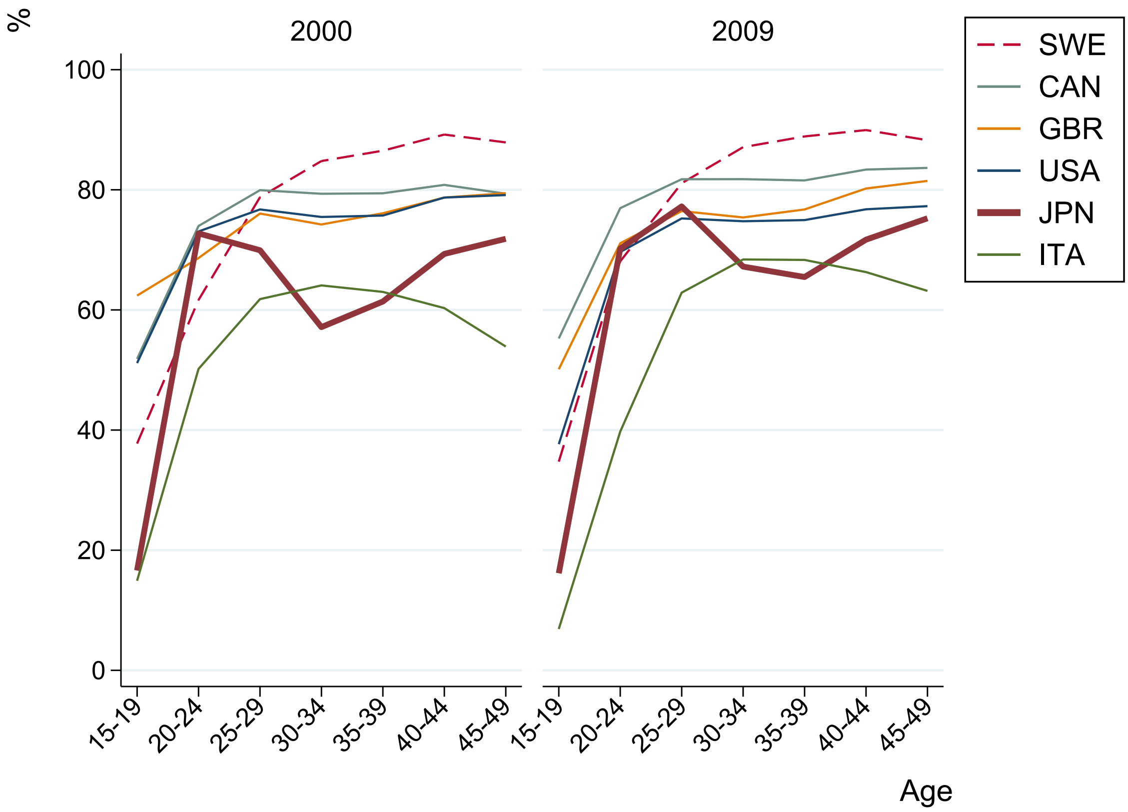

Figure A.3: Female labor force participation rate by age cohort in 2000 and 2009

Notes: This figure displays the labor force participation rate of women by age cohort.
Source: OECD (2022d).

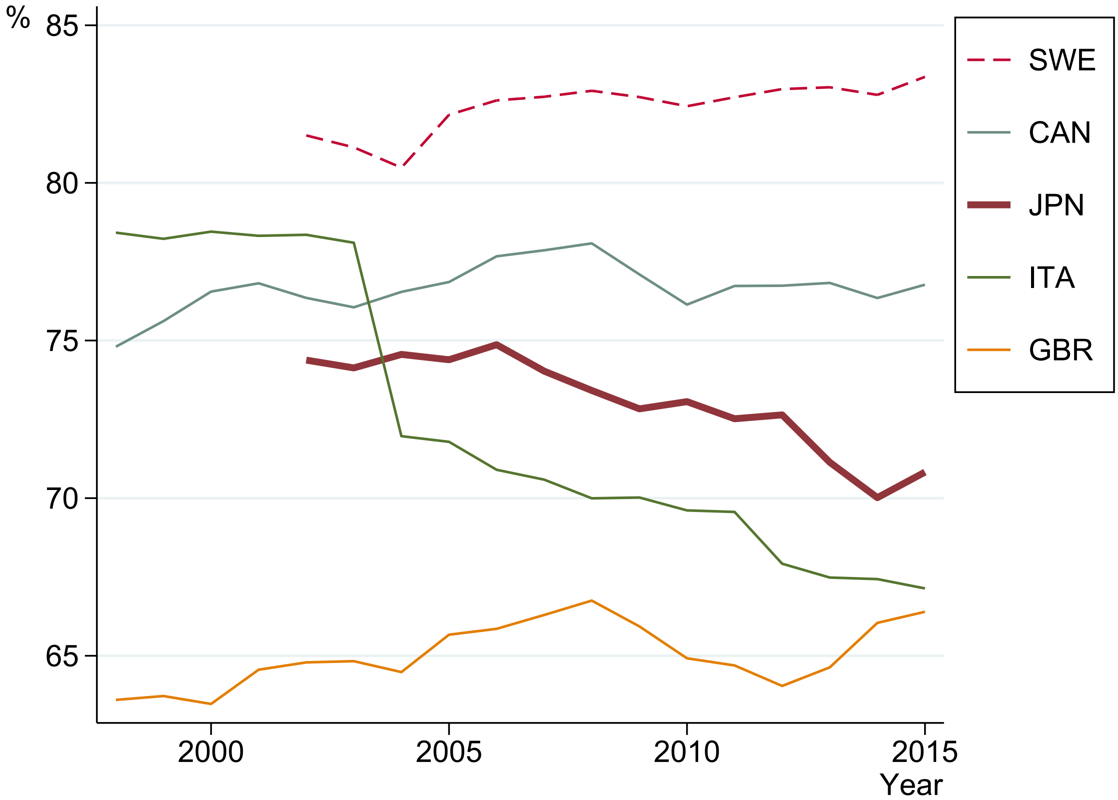

Figure A.4: Proportion of female full-time workers

Notes: This figure displays the proportion of female full-time workers among female full- and part-time workers aged 20–44, defined based on the common definition of 30-usual weekly hours of work in the main job.
Source: OECD (2022d).

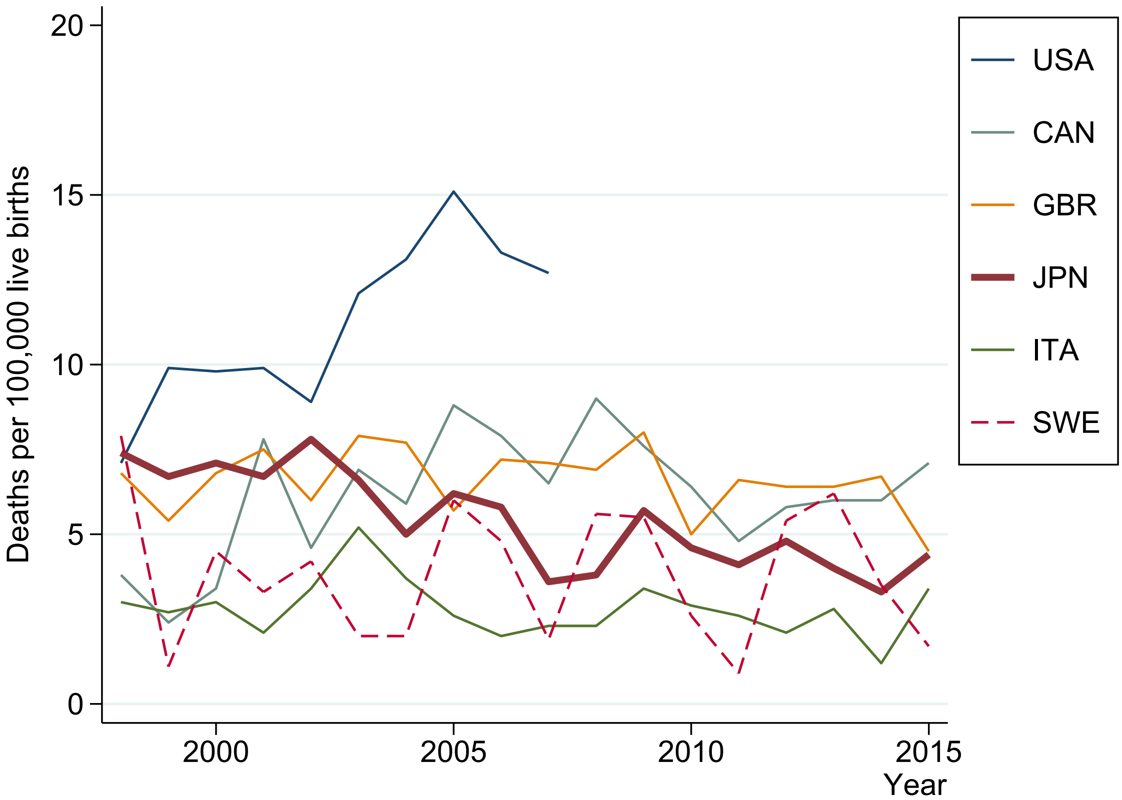

Figure A.5: Maternal mortality rates

Notes: This figure illustrates the maternal mortality rates calculated as the number of maternal deaths with all causes per 100,000 live births.
Source: OECD (2022c).

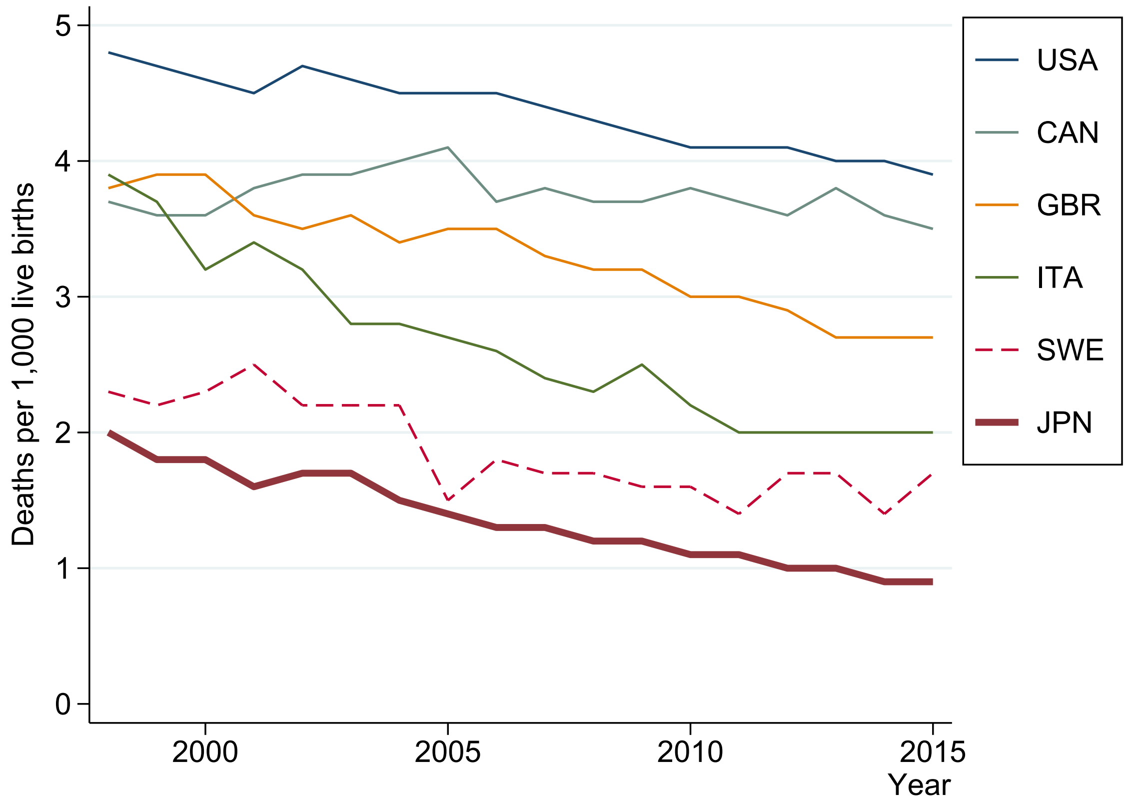

Figure A.6: Neonatal mortality rates

Notes: This figure displays the neonatal mortality rates calculated as the number of deaths of children under 28 days of age per 1,000 live births. The number of deaths counted has no minimum threshold of gestation period or birth weight.
Source: OECD (2022c).

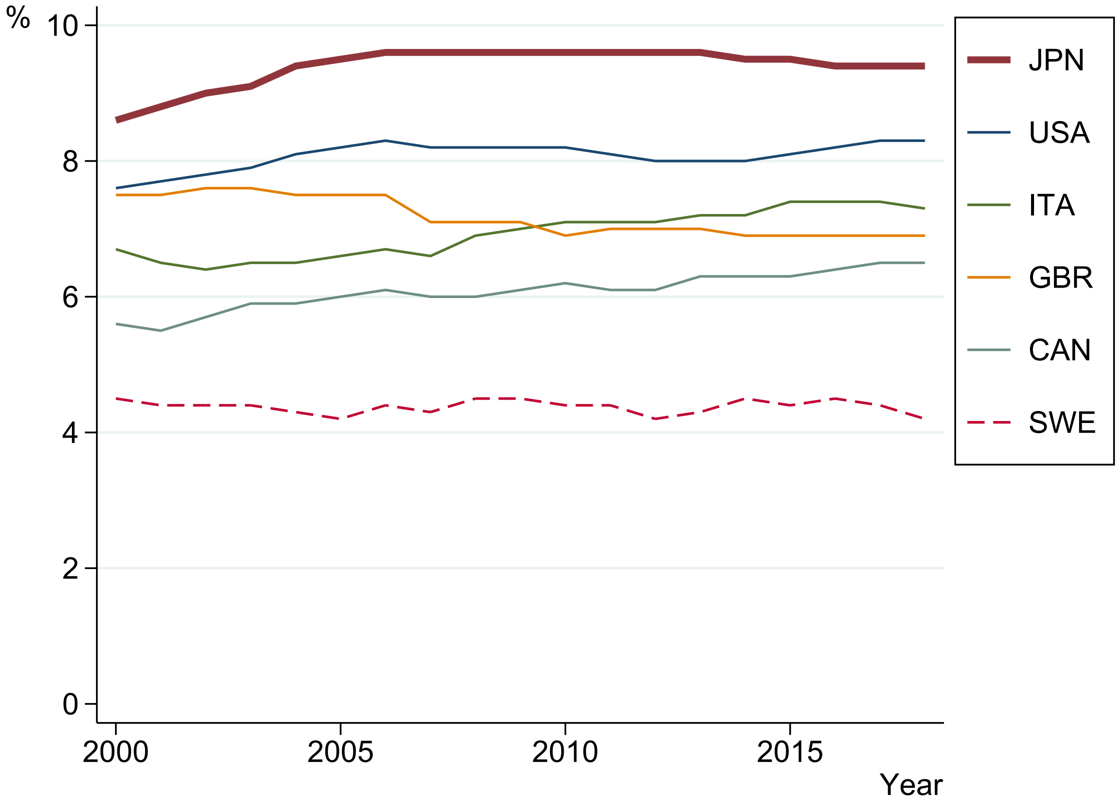

Figure A.7: Low birth weight rates

Notes: This figure displays the proportion of low birth weight infants calculated as the number of live births less than 2,500 grams divided by the total number of live births.
Source: OECD (2022c).

B Descriptive Statistics

Table B.1: Summary statistics

	Mean	SD	Observations
Child birth outcomes			
Birth weight (in grams)	3037.3793	416.6259	83185
<2500 grams	0.0772	0.2669	83185
<1500 grams	0.0051	0.0712	83185
Birth length (in cm)	49.0004	2.2578	83034
Gestational age (in weeks)	39.3290	1.5436	83185
<37 weeks	0.0428	0.2024	83185
<32 weeks	0.0052	0.0719	83185
Fetal growth (grams/weeks)	77.1020	9.5169	83185
Small for gestational age	0.0825	0.2752	83185
Child health outcomes			
Hospializations for illness			
at age 1.5	0.1169	0.3213	73935
at age 2.5	0.0856	0.2798	71820
at age 3.5	0.0585	0.2347	67919
at age 4.5	0.0515	0.2211	64669
at ages 1.5–4.5	0.2347	0.4238	64669
Child language and emotional outcomes			
Language development	0.0000	1.0000	72770
Aggression	0.0000	1.0000	66876
Inattention and Hyperactivity	-0.0000	1.0000	65329
Predicted employment growth rates			
Overall	-0.0139	0.0044	83185
Female	-0.0129	0.0033	83185
Male	-0.0145	0.0064	83185

(continued)

Table B1: Summary statistics (continued)

Birth month			
January	0.2722	0.4451	83185
May	0.4523	0.4977	83185
July	0.2755	0.4468	83185
Child's characteristics			
Girl	0.4827	0.4997	83185
Mother's first childbirth	0.4840	0.4997	83185
Mother's age at childbirth			
19 years or younger	0.0113	0.1058	83185
20–24 years	0.1085	0.3110	83185
25–29 years	0.3428	0.4746	83185
30–34 years	0.3585	0.4796	83185
35–39 years	0.1562	0.3630	83185
40 years or older	0.0227	0.1489	83185
Mother's employment status 1 year before childbirth			
Not work	0.4165	0.4930	83185
Self-employed or Misc.	0.0524	0.2228	83185
Part-time	0.1903	0.3926	83185
Full-time	0.3408	0.4740	83185
Mother's education			
Junior high school (Lower secondary)	0.0468	0.2112	83185
High school (Upper secondary)	0.3069	0.4612	83185
Vocational	0.1653	0.3715	83185
2-year college	0.2058	0.4043	83185
University or higher	0.1740	0.3791	83185
Misc. or missing	0.1011	0.3015	83185
Father's education			
Junior high school (Lower secondary)	0.0668	0.2496	83185
High school (Upper secondary)	0.3190	0.4661	83185
Vocational	0.1204	0.3254	83185
2-year college	0.0289	0.1676	83185
University or higher	0.3512	0.4773	83185
Misc. or missing	0.1138	0.3175	83185

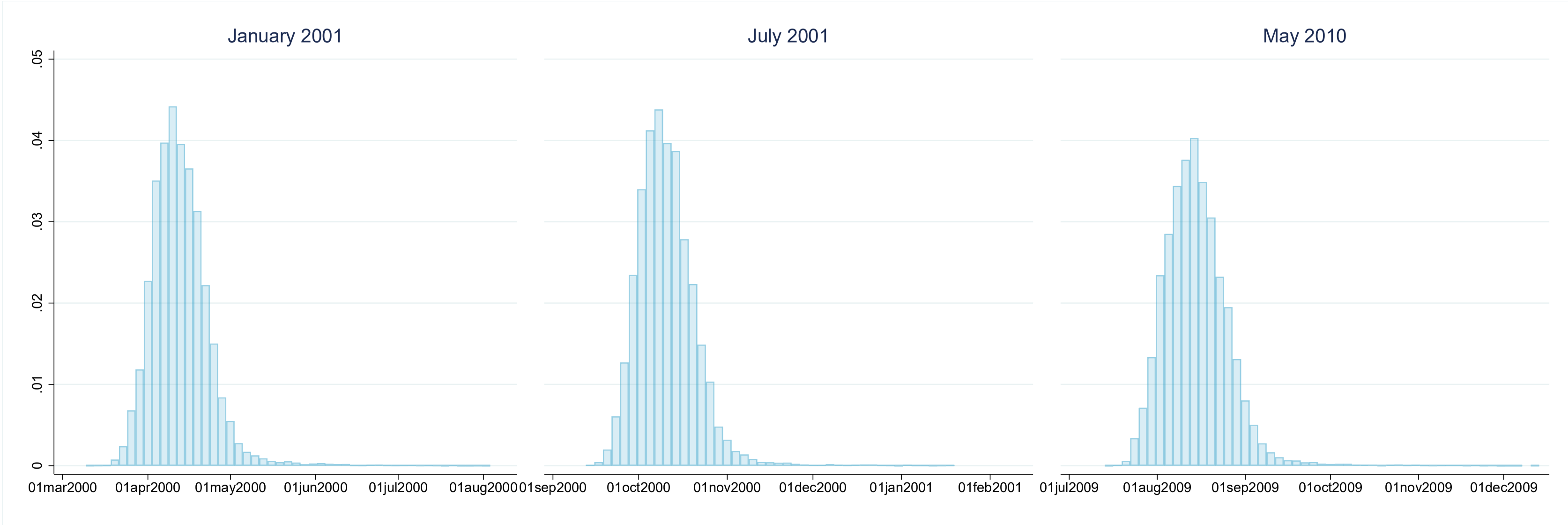

Figure B.1: Density of conception dates

Notes: This figure displays density of conception dates for the regression sample. The data are binned in intervals of 3 days.

C Predicted Employment Growth Rates

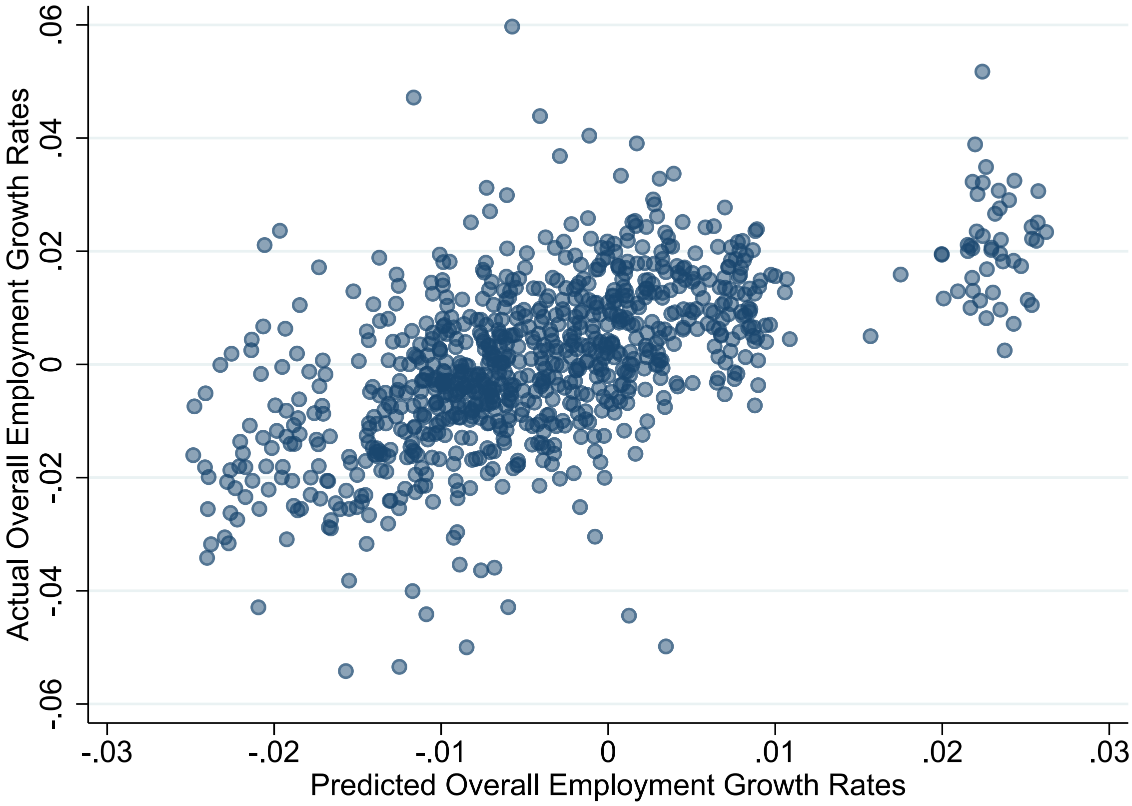

Figure C.1: Scatter plots of the actual and predicted overall employment growth rates

Notes: This figure plots the actual overall employment growth rates and the predicted overall employment growth rates from 2000 to 2018 at the prefecture level.

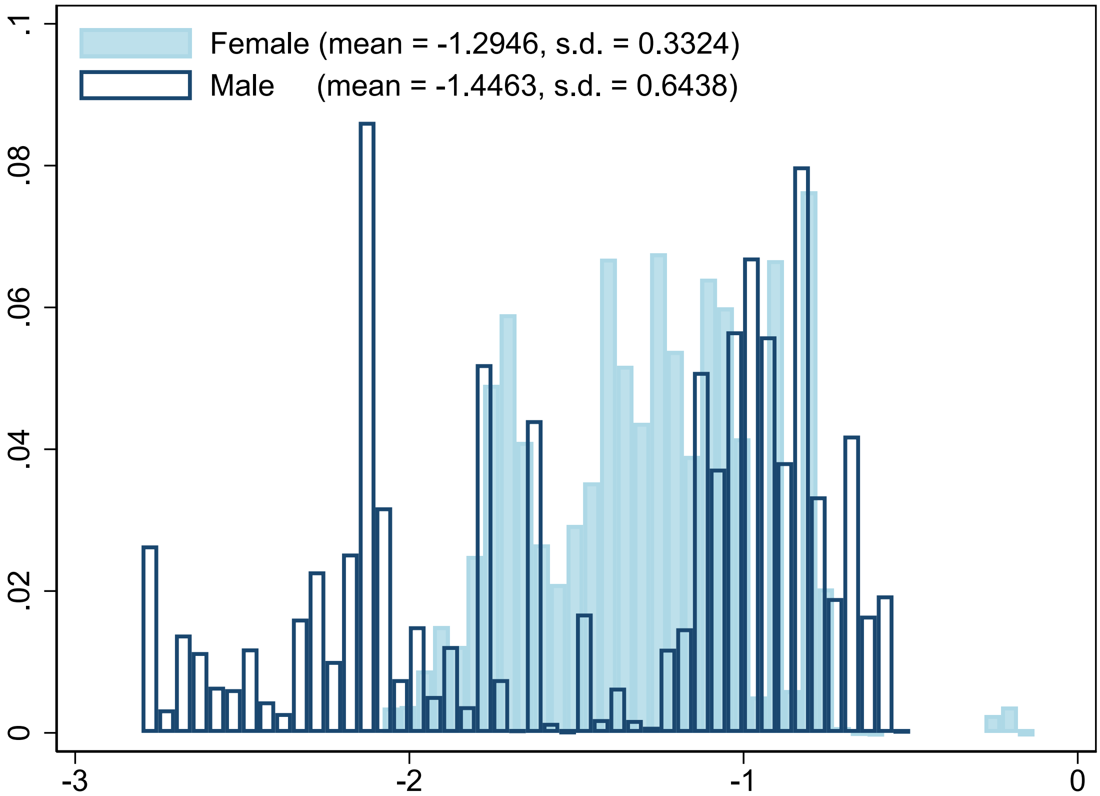

Figure C.2: Density of the predicted female and male employment growth rates (in %)

Notes: This figure displays the density of the predicted female and male employment growth rates for the regression sample. The data are in percentage units and binned in intervals of 0.05.

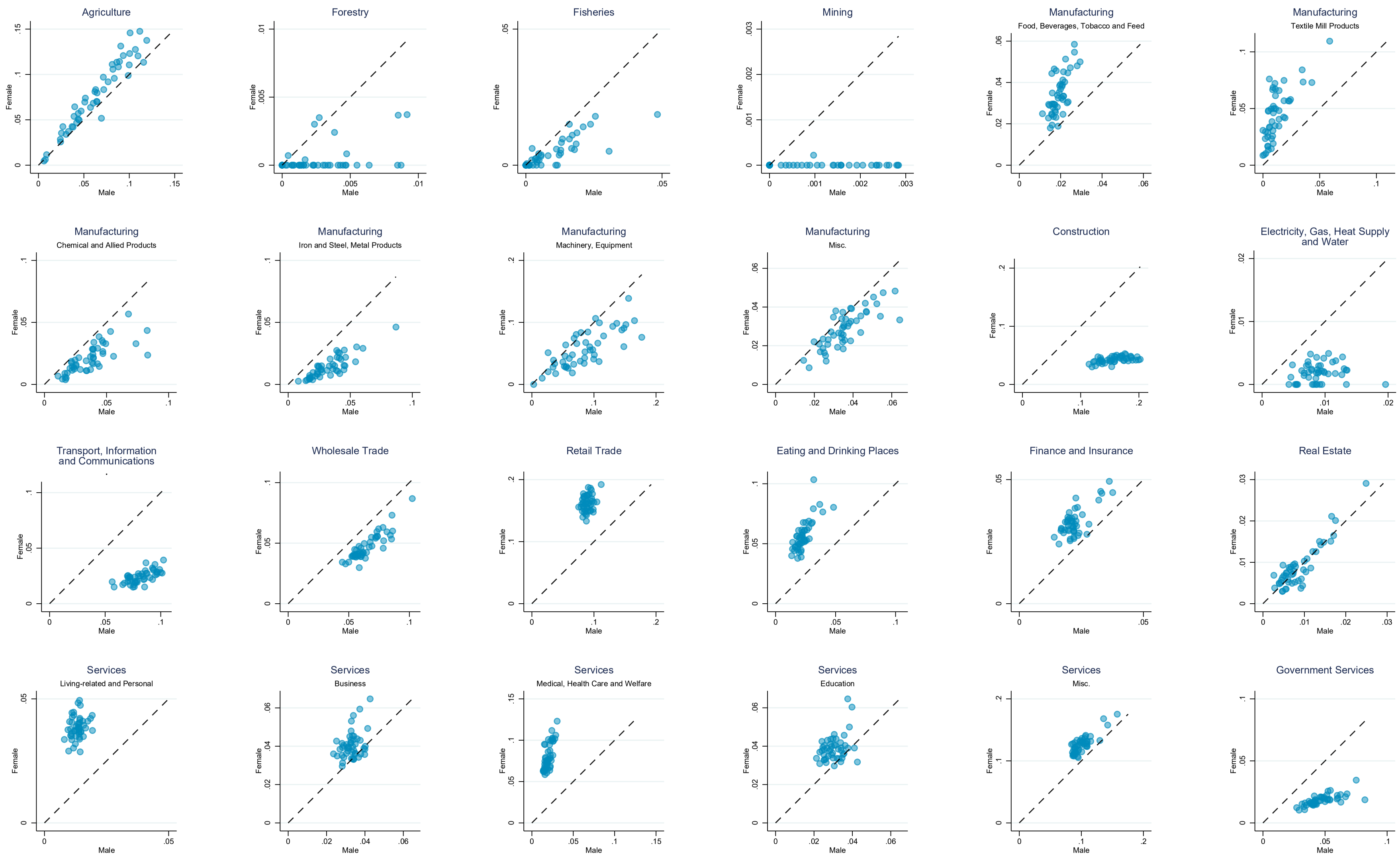

Figure C.3: Scatter plots of the share of industry employment for women and men

Notes: This figure displays the base-period share of female and male employment in an industry in each prefecture by industry category.

D Rotemberg Weights

Table D.1: Industries with the top five Rotemberg weights

Industry	Rotemberg	Share	Effect	SE
Panel A: Overall				
Wholesale Trade	0.2568	0.1819	-47.1986 ***	(12.8988)
Medical, Health Care and Welfare Services	0.2332	0.1652	-95.7519 ***	(20.8538)
Manufacturing: Textile Mills Products	0.1823	0.1292	-70.8376 ***	(17.2540)
Agriculture	0.1521	0.1078	-79.6114 ***	(17.9464)
Manufacturing: Miscellaneous	0.0983	0.0696	-62.3343 ***	(15.1793)
Panel B: Female				
Medical, Health Care and Welfare Services	0.3358	0.2520	-226.9838**	(82.1989)
Manufacturing: Textile Mills Products	0.2546	0.1910	-73.5662 **	(24.2156)
Wholesale Trade	0.1698	0.1274	-61.2954 **	(19.6094)
Agriculture	0.1664	0.1248	-70.2298 **	(24.0810)
Finance and Insurance	0.0789	0.0592	-74.7830 **	(24.5753)
Panel C: Male				
Wholesale Trade	0.3108	0.2183	6.1827	(21.1103)
Agriculture	0.1880	0.1321	-15.7422	(19.1147)
Construction	0.1330	0.0934	-35.8255	(18.3221)
Manufacturing: Textile Mills Products	0.1190	0.0836	-5.3707	(19.8814)
Manufacturing: Miscellaneous	0.1172	0.0823	-5.1732	(19.0534)

Notes: This table reports the top five industries with the highest Rotemberg weights for the overall (panel A), female (panel B), and male (panel C) predicted employment growth rates. Rotemberg indicates the Rotemberg weights. Contribution indicates the proportion of the Rotemberg weights in the sum of all positive weights, calculated based on the sample for column (1) of Table 1. The computation routine is based on bartik_weight.ado provided by Goldsmith-Pinkham et al. (2020). The outcome variable is birth weight, the endogenous variable is the observed predicted employment growth rate, and the instrumental variables are a set of the employment share of the industry with the annual growth rate of the industry as weights. By construction, all Rotemberg weights sum to one. The Effect column reports the estimates of the effect of the reconstructed predicted employment growth rate in which we drop the industry of each row and re-normalize the sum of the 23 industries' share of employment to be 1. SE indicates the standard errors clustered at the prefecture level. The effects of the reconstructed predicted employment growth rates are estimated using the specifications of equations (3) and (4). Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

E Aggregate Analysis of Fertility and Maternal Age

The tables in this Appendix present the results of an analysis using prefecture-level aggregate data. The definition of the outcome variables is as follows. The pregnancy rate is the number of reported pregnancies per 1,000 women aged 20–44. The childbirth rate is the number of live births per 1,000 population. The stillbirth rate is the number of stillbirths of 22 or more gestational weeks per 1,000 total births. The perinatal mortality rate is the number of stillbirths of 22 or more gestational weeks and infants who die within 7 days of birth divided by 1,000 total births. The neonatal mortality rate is the number of neonates who die within 28 days per 1,000 live births. The infant mortality rate is the number of infants who die within a year of birth per 1,000 live births.

The data source of the variables are as follows. The female population is from the Population Census and Population Estimates of the Statistics Bureau. The number of pregnancies is from the Report on Regional Public Health Services and Health Promotion Services of the MHLW. The number of live births, stillbirths, and neonatal and infant deaths, average age of mothers, number of first-time mothers, average birth weight of single-birth infants, and the number of single-birth infants born weighing less than 2,500 grams are from the National Vital Statistics.

Table E.1: Prefecture-level analysis on predicted employment growth rates and pregnancy, childbirth, and mortality rates

	(1) Pregnancy	(2) Pregnancy	(3) Birth	(4) Birth	(5) Stillbirth	(6) Stillbirth	(7) Perinatal mortality	(8) Perinatal mortality	(9) Neonatal mortality	(10) Neonatal mortality	(11) Infant mortality	(12) Infant mortality
Panel A: Overall effects												
Overall	-0.4676	-0.3628	-0.1370*	-0.1168*	0.1165	0.1187	0.0919	0.0797	-0.0723	-0.1055	-0.1957	-0.2494
	(0.4037)	(0.3860)	(0.0582)	(0.0554)	(0.1403)	(0.1351)	(0.1522)	(0.1464)	(0.1496)	(0.1477)	(0.2205)	(0.2154)
Panel B: Gender-specific effects												
Female	-0.9434	-0.7691	-0.1058	-0.0715	0.3749*	0.3811*	0.4427*	0.4248*	0.2414	0.1863	0.1465	0.0559
	(0.6787)	(0.6980)	(0.1090)	(0.1066)	(0.1802)	(0.1792)	(0.2013)	(0.1941)	(0.1744)	(0.1649)	(0.2925)	(0.2764)
Male	0.3487	0.3012	-0.0336	-0.0430	-0.1986	-0.2002	-0.2861	-0.2812	-0.2836	-0.2686	-0.3182	-0.2935
	(0.5253)	(0.5306)	(0.0575)	(0.0613)	(0.1560)	(0.1582)	(0.1783)	(0.1788)	(0.1916)	(0.1970)	(0.3082)	(0.3166)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.2608	0.3641	0.6528	0.8596	0.0662	0.0660	0.0422	0.0461	0.1290	0.1847	0.4140	0.5362
Mean	57.2613	57.2613	8.2559	8.2559	3.4985	3.4985	4.4130	4.4130	2.1732	2.1732	4.6747	4.6747
Observations	893	893	893	893	893	893	893	893	893	893	893	893
Controls		✓		✓		✓		✓		✓		✓

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The pregnancy rate is the number of reported pregnancies per 1,000 women aged 20–44. The birth rate is the number of live births per 1,000 population. The stillbirth rate is the number of stillbirths of 22 or more weeks gestation per 1,000 total births (live births and stillbirths of 22 or more gestation). The perinatal mortality rate is the number of stillbirths of 22 or more weeks gestation and the number of neonates dying before reaching 7 days of age per 1,000 total births (live births and stillbirths of 22 or more gestation). The neonatal mortality rate is the number of neonates dying before reaching 28 days of age per 1,000 live births. The infant mortality rate is the number of deaths of children less than one year of age per 1,000 live births. These variables are in percentage. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. P-value is based on the Wald test of equality between the female and male coefficients. Mean indicates the sample mean level of the outcome variable. Prefecture and year fixed effects are also controlled in the regression model but not reported. Controls indicate that the number of hospitals offering obstetrics and gynecology services per women aged 20–44 are included in the regression model. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

Table E.2: Prefecture-level analysis on predicted employment growth rates and maternal age

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Average age of all mothers		Proportion of births by mothers aged 20–24		aged 25–34		aged 35–44		Average age of first-time mothers		Proportion of first-time mothers	
Panel A: Overall effects												
Overall	-0.0076	-0.0120	-0.0009	-0.0008	0.0020	0.0020	-0.0017	-0.0019	-0.0308	-0.0355	-0.0004	-0.0004
	(0.0193)	(0.0197)	(0.0014)	(0.0012)	(0.0036)	(0.0035)	(0.0025)	(0.0024)	(0.0228)	(0.0219)	(0.0017)	(0.0017)
Panel B: Gender-specific effects												
Female	-0.0409	-0.0487	-0.0048	-0.0046	0.0156*	0.0158*	-0.0106*	-0.0109*	-0.0390	-0.0472	-0.0046	-0.0046
	(0.0359)	(0.0359)	(0.0031)	(0.0029)	(0.0071)	(0.0069)	(0.0047)	(0.0047)	(0.0512)	(0.0508)	(0.0031)	(0.0030)
Male	0.0289	0.0310	0.0029	0.0028	-0.0108**	-0.0108**	0.0071**	0.0072**	0.0048	0.0071	0.0032	0.0032
	(0.0237)	(0.0234)	(0.0019)	(0.0019)	(0.0036)	(0.0035)	(0.0022)	(0.0022)	(0.0385)	(0.0386)	(0.0017)	(0.0016)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.2228	0.1610	0.1126	0.1104	0.0125	0.0105	0.0098	0.0093	0.6157	0.5346	0.0974	0.0837
Mean	30.6655	30.6655	0.1182	0.1182	0.6679	0.6679	0.1985	0.1985	29.2068	29.2068	0.4590	0.4590
Observations	893	893	893	893	893	893	893	893	893	893	893	893
Controls		✓		✓		✓		✓		✓		✓

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. Mean indicates the sample mean level of the outcome variable. P-value is based on the Wald test of equality between the female and male coefficients. Prefecture and year fixed effects are also controlled in the regression model but not reported. Controls indicate that the number of hospitals offering obstetrics and gynecology services per women aged 20–44 are included in the regression model. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

Table E.3: Prefecture-level analysis of predicted employment growth rates and birth weight

	(1)	(2)	(3)	(4)
	Average birth weight (in grams)		Birth weight below 2500 grams	
Panel A: Overall effects				
Overall	-2.7232	-2.0754	0.1264*	0.1062*
	(1.4407)	(1.2492)	(0.0559)	(0.0501)
Panel B: Gender-specific effects				
Female	-6.4204*	-5.3448*	0.2421*	0.2090*
	(2.5899)	(2.3373)	(0.1057)	(0.1014)
Male	3.0789	2.7858	-0.0778	-0.0687
	(1.8905)	(1.8283)	(0.0936)	(0.0919)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.0310	0.0472	0.1028	0.1452
Mean	3028.0963	3028.0963	8.0676	8.0676
Observations	893	893	893	893
Controls		✓		✓

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. Mean indicates the sample mean level of the outcome variable. Prefecture and year fixed effects are also controlled in the regression model but not reported. Controls indicate that the number of hospitals offering obstetrics and gynecology services per women aged 20–44 are included in the regression model. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

F Heterogeneity: Later Outcomes

Table F.1: Predicted employment growth rates and later outcomes by mothers' age

	(1) Hospitalization		(2) Language		(3) Aggression		(4) Inattention & Hyperactivity	
	Coef.	AME	Coef.	AME	Coef.	AME	Coef.	AME
Panel A: Overall effects								
Overall:								
Age < 25 (reference)	0.0534	0.0534	-0.1170	-0.1170	-0.1025	-0.1025	-0.0083	-0.0083
	(0.0353)	(0.0353)	(0.1049)	(0.1049)	(0.0635)	(0.0635)	(0.0907)	(0.0907)
25 ≤ Age < 35	-0.0434	0.0100	0.1662	0.0492	0.0685	-0.0340	0.0379	0.0296
	(0.0347)	(0.0175)	(0.1090)	(0.0251)	(0.0747)	(0.0456)	(0.0937)	(0.0280)
35 ≤ Age	-0.0486	0.0048	0.0715	-0.0455	0.1010	-0.0016	-0.0303	-0.0387
	(0.0456)	(0.0276)	(0.1435)	(0.0749)	(0.0921)	(0.0892)	(0.0835)	(0.0553)
Panel B: Gender-specific effects								
Female:								
Age < 25 (reference)	0.0680	0.0680	0.0399	0.0399	-0.0844	-0.0844	-0.0833	-0.0833
	(0.0770)	(0.0770)	(0.1268)	(0.1268)	(0.1201)	(0.1201)	(0.1390)	(0.1390)
25 ≤ Age < 35	-0.0640	0.0040	-0.0264	0.0135	0.0169	-0.0675	0.0875	0.0041
	(0.0716)	(0.0208)	(0.1251)	(0.0363)	(0.1350)	(0.0453)	(0.1384)	(0.0671)
35 ≤ Age	-0.0929	-0.0248	-0.0065	0.0334	-0.0443	-0.1287	0.0061	-0.0773
	(0.0775)	(0.0347)	(0.1518)	(0.0754)	(0.1481)	(0.0885)	(0.1666)	(0.0862)
Male:								
Age < 25 (reference)	-0.0060	-0.0060	-0.1645	-0.1645	-0.0166	-0.0166	0.0766	0.0766
	(0.0828)	(0.0828)	(0.1252)	(0.1252)	(0.1119)	(0.1119)	(0.1374)	(0.1374)
25 ≤ Age < 35	0.0162	0.0102	0.1994	0.0349	0.0470	0.0304	-0.0534	0.0232
	(0.0780)	(0.0212)	(0.1192)	(0.0339)	(0.1286)	(0.0625)	(0.1240)	(0.0626)
35 ≤ Age	0.0313	0.0253	0.0792	-0.0853	0.1424	0.1258	-0.0397	0.0369
	(0.0800)	(0.0290)	(0.1752)	(0.0966)	(0.1451)	(0.1053)	(0.1447)	(0.0750)
Mean	0.2347		0.0000		0.0000		0.0000	
Observations	64669		72770		66876		65329	
p-value (Age < 25)		0.6364		0.3694		0.7627		0.5447
p-value (25 ≤ Age < 35)		0.8696		0.7428		0.3368		0.8809
p-value (35 ≤ Age)		0.3773		0.4576		0.1540		0.4529

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Hospitalization indicates the hospitalization for illness at ages 1.5–4.5. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. Coef. indicates the coefficient estimates based on the regression model including the interactions of the predicted employment growth rate and mothers' age group dummies with the mothers aged 24 or younger at childbirth group as the reference group. AME indicates the average marginal effect evaluated at each mother's age group. The estimates are for a one-percentage-point increase in the predicted employment growth rate. Mean indicates the sample mean level of the outcome variable. P-value is based on the Wald test of equality between the female and male marginal effects evaluated at each mothers' age group. Child's gender, mother's first childbirth, mother's employment status before pregnancy, parental education, birth month cohort dummies, a set of dummies for prefecture of residence, and their interactions with the mothers' age group dummies, and the mothers' age group dummies are also controlled in the regression model but not reported. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

Table F.2: Predicted employment growth rates and later outcomes by mothers' educational attainment

	(1) Hospitalization		(2) Language		(3) Aggression		(4) Inattention & Hyperactivity	
	Coef.	AME	Coef.	AME	Coef.	AME	Coef.	AME
Panel A: Overall effects								
Overall:								
Jr. high school	0.0172	0.0142	-0.3785***	-0.3111**	0.0537	-0.0021	-0.0208	-0.0096
	(0.0515)	(0.0485)	(0.1071)	(0.1148)	(0.1543)	(0.1769)	(0.1155)	(0.1014)
High school (reference)	-0.0031	-0.0031	0.0674	0.0674	-0.0558	-0.0558	0.0112	0.0112
	(0.0194)	(0.0194)	(0.0530)	(0.0530)	(0.0555)	(0.0555)	(0.0378)	(0.0378)
Vocational school	0.0389	0.0359	-0.0598	0.0076	0.0495	-0.0063	-0.0192	-0.0080
	(0.0236)	(0.0259)	(0.0834)	(0.0539)	(0.0618)	(0.0590)	(0.0753)	(0.0594)
2-year college	0.0030	-0.0001	-0.0228	0.0446	0.0051	-0.0508	0.0361	0.0472
	(0.0303)	(0.0225)	(0.0948)	(0.0560)	(0.0563)	(0.0367)	(0.0591)	(0.0552)
University or more	0.0387	0.0356	-0.0801	-0.0127	0.1088*	0.0529	-0.0343	-0.0231
	(0.0311)	(0.0274)	(0.0747)	(0.0524)	(0.0491)	(0.0697)	(0.0609)	(0.0498)

(continued)

(continued)

	(1)		(2)		(3)		(4)	
	Hospitalization		Language		Aggression		Inattention & Hyperactivity	
	Coef.	AME	Coef.	AME	Coef.	AME	Coef.	AME
Panel B: Gender-specific effects								
Female:								
Jr. high school	0.0465	0.0562	-0.2281	-0.3375*	0.1475	0.0289	0.1783	0.0645
	(0.0848)	(0.0747)	(0.1493)	(0.1472)	(0.1756)	(0.1973)	(0.1844)	(0.1494)
High school (reference)	0.0097	0.0097	-0.1094	-0.1094	-0.1185	-0.1185	-0.1138	-0.1138
	(0.0325)	(0.0325)	(0.0667)	(0.0667)	(0.0607)	(0.0607)	(0.0700)	(0.0700)
Vocational school	-0.0148	-0.0051	0.1685*	0.0591	0.0878	-0.0308	0.0593	-0.0546
	(0.0496)	(0.0350)	(0.0821)	(0.0650)	(0.0786)	(0.0707)	(0.1230)	(0.1403)
2-year college	-0.0205	-0.0108	0.2595*	0.1501*	0.0278	-0.0907	0.1399	0.0261
	(0.0393)	(0.0344)	(0.1005)	(0.0642)	(0.0850)	(0.0540)	(0.1048)	(0.0706)
University or more	-0.0149	-0.0052	0.1287	0.0193	0.1284	0.0099	0.2179*	0.1041
	(0.0637)	(0.0510)	(0.0991)	(0.0775)	(0.0766)	(0.0554)	(0.1004)	(0.0846)
Male:								
Jr. high school	-0.0333	-0.0431	-0.1799	-0.0139	-0.0729	-0.0143	-0.1425	-0.0322
	(0.0887)	(0.0792)	(0.1258)	(0.1280)	(0.1877)	(0.2441)	(0.1556)	(0.1314)
High school (reference)	-0.0098	-0.0098	0.1660*	0.1660*	0.0586	0.0586	0.1103	0.1103
	(0.0313)	(0.0313)	(0.0754)	(0.0754)	(0.0805)	(0.0805)	(0.0658)	(0.0658)
Vocational school	0.0597	0.0499	-0.2277*	-0.0617	-0.0351	0.0235	-0.0658	0.0445
	(0.0443)	(0.0401)	(0.0900)	(0.0674)	(0.0760)	(0.0758)	(0.1031)	(0.1248)
2-year college	0.0227	0.0129	-0.2592	-0.0932	-0.0242	0.0343	-0.0846	0.0257
	(0.0335)	(0.0367)	(0.1317)	(0.0802)	(0.0880)	(0.0481)	(0.0959)	(0.0685)
University or more	0.0514	0.0417	-0.1911	-0.0251	-0.0088	0.0498	-0.2252*	-0.1150
	(0.0442)	(0.0397)	(0.1072)	(0.0728)	(0.0669)	(0.0836)	(0.1023)	(0.0727)
Mean	0.2367		0.0000		0.0000		0.0000	
Observations	62764		69493		64781		63295	
p-value (Jr. high)		0.4993		0.2016		0.9154		0.7122
p-value (High)		0.7497		0.0455		0.1915		0.0932
p-value (Vocational)		0.4368		0.3192		0.6856		0.7030
p-value (College)		0.7247		0.0840		0.1956		0.9978
p-value (University)		0.5881		0.7525		0.7512		0.1442

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Hospitalization indicates the hospitalization for illness at ages 1.5–4.5. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. Coef. indicates the coefficient estimates based on the regression model including the interactions of the predicted employment growth rate and mothers' education level dummies with mothers who graduated from high school as the reference group. AME indicates the average marginal effect evaluated at each mothers' education level. The estimates are for a one-percentage-point increase in the predicted employment growth rate. Mean indicates the sample mean level of the outcome variable. P-value is based on the Wald test of equality between the female and male marginal effects evaluated at each mothers' education level group. Child's gender, mother's first childbirth, mother's age, mother's employment status before pregnancy, parental education, birth month cohort dummies, a set of dummies for prefecture of residence, and their interactions with the mothers' education level dummies, and the mothers' education level dummies are also controlled in the regression model but not reported. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

G Robustness Check

Table G.1: Sensitivity to the model specifications

(a) Birth weight (in grams)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Overall effects								
Overall	-70.3677***	-67.0356***	-68.5400***	-70.0950***	-70.5402***	-69.9572***	-70.3235***	-70.5767***
	(16.7356)	(16.8330)	(16.8919)	(16.8826)	(16.7701)	(16.8627)	(16.7390)	(16.7614)
Panel B: Gender-specific effects								
Female	-66.6655**	-60.5110**	-62.1862**	-65.7344**	-67.1077**	-65.0406**	-66.5557**	-67.1674**
	(22.9492)	(22.2733)	(22.9591)	(23.0957)	(23.0485)	(23.0357)	(22.9730)	(23.0363)
Male	-12.5814	-15.1672	-15.2362	-13.3390	-12.3671	-13.8443	-12.6590	-12.3321
	(20.0805)	(20.5727)	(20.8492)	(20.4577)	(20.1263)	(20.4414)	(20.1192)	(20.0974)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.1587	0.2342	0.2309	0.1781	0.1555	0.1873	0.1610	0.1543
Mean	3037.3793	3037.3793	3037.3793	3037.3793	3037.3793	3037.3793	3037.3793	3037.3793
Observations	83185	83185	83185	83185	83185	83185	83185	83185
Control variables:								
Child's gender	✓		✓	✓	✓	✓	✓	✓
First childbirth	✓			✓	✓	✓	✓	✓
Mother's age	✓				✓		✓	✓
Parental education	✓					✓	✓	
Mother's employment	✓							✓

(b) Gestational age (in weeks)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Overall effects								
Overall	-0.4450***	-0.4521***	-0.4485***	-0.4398***	-0.4460***	-0.4393***	-0.4449***	-0.4460***
	(0.0937)	(0.0959)	(0.0954)	(0.0953)	(0.0938)	(0.0952)	(0.0937)	(0.0939)
Panel B: Gender-specific effects								
Female	-0.5006***	-0.5140***	-0.5101***	-0.4902***	-0.5023***	-0.4898***	-0.5015***	-0.5011***
	(0.1320)	(0.1365)	(0.1348)	(0.1340)	(0.1317)	(0.1340)	(0.1319)	(0.1319)
Male	-0.0155	-0.0105	-0.0103	-0.0209	-0.0148	-0.0209	-0.0144	-0.0161
	(0.1361)	(0.1381)	(0.1367)	(0.1400)	(0.1354)	(0.1400)	(0.1356)	(0.1360)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.0506	0.0480	0.0468	0.0647	0.0485	0.0650	0.0491	0.0506
Mean	39.3290	39.3290	39.3290	39.3290	39.3290	39.3290	39.3290	39.3290
Observations	83185	83185	83185	83185	83185	83185	83185	83185
Control variables:								
Child's gender	✓		✓	✓	✓	✓	✓	✓
First childbirth	✓			✓	✓	✓	✓	✓
Mother's age	✓				✓		✓	✓
Parental education	✓					✓	✓	
Mother's employment	✓							✓

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. The outcome variable is birth weight in Table G.1a and gestational age in Table G.1b. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. Mean indicates the sample mean level of the outcome variable. Control variables indicate individual controls that are included in the baseline specification based on the equations (3) and (4). Column (1) replicates the baseline result from columns (1) or (2) of Table 1 for comparison. Column (2) controls birth month cohort dummies and a set of dummies for the prefecture of residence. Column (3) adds a dummy for child gender to the model of column (2). Column (4) adds a dummy for the mother's first childbirth to the model of column (3). Column (5) adds a set of dummies for the mother's age at childbirth to the model of column (4). Column (6) adds a set of dummies for the mother's and father's education level to the model of column (4). Column (7) adds a set of dummies for the mother's and father's education level to the model of column (5). Column (8) adds a set of dummies for the mother's employment status one year before childbirth to the model of column (5). Birth month cohort dummies and a set of dummies for the prefecture of residence are also controlled in columns (3)–(8). Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

Table G.2: Predicted employment growth rates and birth outcomes with controls for prefecture and municipality variables

	(1)	(2)	(3)	(4)	(5)	(6)
	Birth weight (in grams)			Gestational age (in weeks)		
Panel A: Overall effects						
Overall	-70.3677***	-70.7817***	-70.7661***	-0.4450***	-0.4515***	-0.4505***
	(16.7356)	(17.3370)	(17.6351)	(0.0937)	(0.0972)	(0.0977)
Panel B: Gender-specific effects						
Female	-66.6655**	-67.3072**	-67.3430**	-0.5006***	-0.5000***	-0.5073***
	(22.9492)	(21.7854)	(22.1239)	(0.1320)	(0.1277)	(0.1304)
Male	-12.5814	-11.7102	-11.3076	-0.0155	-0.0165	-0.0068
	(20.0805)	(20.3038)	(20.4978)	(0.1361)	(0.1405)	(0.1424)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.1587	0.1340	0.1363	0.0506	0.0503	0.0471
Mean	3037.3793	3037.3793	3037.3797	39.3290	39.3290	39.3295
Observations	83185	83185	82758	83185	83185	82758
Prefecture controls		✓	✓		✓	✓
Municipality controls			✓			✓

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. Columns (1) and (4) show the baseline estimates. Mean indicates the sample mean level of the outcome variable. Child's gender, mother's first childbirth, mother's age, mother's employment status before pregnancy, parental education, birth month cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. Prefecture controls include the number of clinics and hospitals offering obstetrics and gynecology services per women aged 20–44. Municipality controls include the share of nuclear households and the ratio of the accredited childcare center capacity to the number of children aged 0–5. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

Table G.3: Balancing test: Predicted employment growth rates and controls for prefecture and municipality variables

	(1) Ob-gyn hospitals	(2) Childcare	(3) Nuclear families
Panel A: Overall effects			
Overall	0.0569	-0.0009	0.0395
	(0.0783)	(0.0107)	(0.0244)
LHS joint balancing test (p-value):		0.4260	
RHS joint balancing test (p-value):		0.4783	
Panel B: Gender-specific effects			
Female	-0.0961	0.0003	-0.0613
	(0.1275)	(0.0261)	(0.0418)
Male	0.1300	-0.0045	0.0851*
	(0.1403)	(0.0298)	(0.0334)
LHS joint balancing test (p-value):			
Female		0.3977	
Male		0.0081	
RHS joint balancing test (p-value):			
Female		0.3677	
Male		0.1515	

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions for the LHS (left-hand-side) balancing test, where the dependent variable is the number of hospitals that offer obstetrics and gynecology services per number of women aged 20–44 (ob-gyn hospitals), the ratio of accredited childcare center capacity to the number of children aged 0–5 (childcare), and share of nuclear family households (nuclear families). Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. Child's gender, mother's first childbirth, mother's age, mother's employment status before pregnancy, parental education, birth month cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. The p-values of the LHS joint balancing test are based on the F-test for the joint significance of the coefficients of the predicted employment growth rates, stacking the equations of the three columns. The p-values of the RHS (right-hand-side) joint balancing test are based on the F-test for the joint significance of the coefficients of the ob-gyn hospitals, childcare, and nuclear families variables, where the dependent variable is the predicted overall, female, and male employment growth rate. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

Table G.4: Predicted employment growth rates and sample attrition

	(1) at age 1.5	(2) at age 2.5	(3) at age 3.5	(4) at age 4.5
Panel A: Overall effects				
Overall	0.0012	0.0094	-0.0025	-0.0032
	(0.0014)	(0.0064)	(0.0057)	(0.0061)
Panel B: Gender-specific effects				
Female	-0.0008	0.0060	-0.0028	-0.0045
	(0.0017)	(0.0079)	(0.0085)	(0.0100)
Male	0.0020	0.0043	0.0000	0.0010
	(0.0015)	(0.0094)	(0.0074)	(0.0085)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.3257	0.9161	0.8513	0.7493
Mean	0.0962	0.1216	0.1695	0.2071
Observations	83185	83185	83185	83185

Notes: Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. The outcome variable is a dummy variable that equals one if the child is dropped from the base regression sample until the follow-up survey. Mean indicates the sample mean level of the outcome variable. Child's gender, mother's first childbirth, mother's age, mother's employment status before pregnancy, parental education, birth month cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

Table G.5: Predicted employment growth rates and relocation between one year prior to birth and when the child was 6 months old

Panel A: Overall effects	
Overall	0.0439
	(0.0487)
Panel B: Gender-specific effects	
Female	-0.0070
	(0.0427)
Male	0.0441
	(0.0472)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.5106
Mean	0.1102
Observations	44989

Notes: Standard errors clustered at the prefecture level are in parentheses. The sample only includes cohorts born in 2001. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. The outcome variable is a dummy variable that equals one if the household relocated because of the pregnancy or childbirth during the period from one year prior to childbirth to the first survey when the child was 6 months old. Mean indicates the sample mean level of the outcome variable. Child's gender, mother's first childbirth, mother's age, mother's employment status before pregnancy, parental education, birth month cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.

Table G.6: Sensitivity to the definition of the pregnancy period in the predicted employment growth rates

	(1)	(2)	(3)	(4)	(5)	(6)
Def. of the pregnancy period:	20 weeks	22 weeks (base)	24 weeks	20 weeks	22 weeks (base)	24 weeks
	Birth weight (in grams)			Gestational age (in weeks)		
Panel A: Overall effects						
Overall	-62.3154***	-70.3677***	-78.1740***	-0.3929***	-0.4450***	-0.4957***
	(15.5008)	(16.7356)	(17.9427)	(0.0846)	(0.0937)	(0.1024)
Panel B: Gender-specific effects						
Female	-58.8161**	-66.6655**	-81.0547**	-0.4544***	-0.5006***	-0.5882***
	(21.2969)	(22.9492)	(25.4540)	(0.1214)	(0.1320)	(0.1491)
Male	-11.3986	-12.5814	-7.4687	-0.0038	-0.0155	0.0123
	(18.5427)	(20.0805)	(22.5033)	(0.1253)	(0.1361)	(0.1528)
p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$)	0.1818	0.1587	0.0885	0.0493	0.0506	0.0329
Mean	3037.3793	3037.3793	3037.3793	39.3290	39.3290	39.3290
Observations	83185	83185	83185	83185	83185	83185

Notes: The pregnancy period is defined as the first 22 weeks of pregnancy in the main analyses, see Section 3.3. Standard errors clustered at the prefecture level are in parentheses. The columns of estimates in each panel are from separate regressions. Overall indicates the predicted overall employment growth rate. Female (Male) indicates the predicted female (male) employment growth rate. The coefficient estimates are for a one-percentage-point increase in the predicted employment growth rate. Mean indicates the sample mean level of the outcome variable. Child's gender, mother's first childbirth, mother's age, mother's employment status before pregnancy, parental education, birth month cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. Significance at 0.1%, 1%, and 5% levels are indicated by ***, **, and *, respectively.