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

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

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**Abstract**

We examine 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, attributable to shortened gestation. This negative effect is mainly driven by the impact of economic shocks on the female labor market. However, we do not find a lasting effect of economic shocks during early pregnancy on severe health conditions or developmental delays in early childhood. Using prefecture-level panel data, we confirm that improvements in female employment opportunities are significantly negatively associated with infant birth weight, but not with the fertility and infant mortality rate.

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

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

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# 1 Introduction

Understanding the impact of economic conditions on health is essential to estimate the costs of economic fluctuations. It leads to cogitating 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, they also have the potential to change 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 (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., Dehejia and Lleras-Muney, 2004; van den Berg et al., 2020; deteriorated: e.g., Kohara et al., 2019; Margerison-Zilko et al., 2017).

One reason for this inconsistency in results is the focus on an abstract measure of economic conditions, such as the total unemployment rate. This may have masked 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, 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 administrative population survey of all children born during a specific period in Japan. We also create an indicator of small for gestational age (SGA) based on gestational age and birth weight. 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 unemployment rates that are widely used in the literature 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 were to use unemployment rates as a proxy for labor market conditions, these unobserved confounders could create a bias in the estimates.

Our results are summarized as follows. First, an increase in the predicted employment growth rate is significantly associated with an increase in the probability of preterm birth and low birth weight. However, when we evaluate neonatal health by SGA, we do not find any negative effects, suggesting that a short gestation period causes low birth weight. Second, estimating the differential effects of economic shocks on labor demand for men and women, the results indicate that women's employment is the main driver of the significant negative effects observed in newborn health. Finally, labor demand shocks during pregnancy have no statistically significant lasting effects on developmental delays or serious health conditions in early childhood.

Our results are robust to concerns on pregnancy, mortality, and sample attrition. First, adding prefecture- and municipal-level controls for local availability of obstetrician and gynecology care and center-based childcare, we confirm that our main results on birth outcomes are insensitive to these controls. Second, 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. 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 benefit generosity 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 relying on health insurance coverage. In a health insurance system where the coverage is strongly dependent on the employment status, such as in the US, the coverage could also be affected by changes in the labor market.

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 the 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 would increase the likelihood of artificial birth date manipulation, a high cesarean rate may confound 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 the information on whether effects on birth outcomes are exerted 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. One exception is van den Berg et al. (2020), who suggested that the increase in the probability of very low birth weight due to higher unemployment in Sweden 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 subsequent child outcomes. Recent studies have 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 do not observe any statistically significant relationship between labor market conditions during pregnancy and developmental delays and serious health conditions in early childhood. Our results are consistent with the findings of Maruyama and Heinesen (2020), who reported that the low birth weight effect on infant health diminishes over time.

The remainder of this study is organized as follows. Section 2 describes the data, Section 3 provides an overview of the empirical framework, Section 4 reports the results, and Section 5 presents our conclusions.

# 2 Data

## 2.1 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 these three periods: 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 cohorts. In the first wave, 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 seeks 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.[1]

Our data also include birth date, length at birth, birth weight, gestational age, multiple

[1] The proportion was about 1.2% in 1995, which slightly increased and has been around 2% since the 2000s. It is one of the lowest among OECD countries, which averaged about 41% in 2018 (OECD, 2021c).

birth, and primiparity. This birth-related information is derived from merged data of the vital statistics collected in the national survey of the MHLW.

Appendix Table A.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. In our sample, over 48% mothers had experienced childbirth earlier, and over 75% were aged between 25 and 34 at the time of childbirth. Over 95% mothers whose educational attainment is available had completed at least high school, and over 38% of these had completed 2-year college or university (4-year college) education.

## 2.2 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. To capture the negative aspects of fetal health, we create an indicator of low birth weight (<2500 gram), very low birth weight (<1500 gram), preterm birth (born at or under 37 weeks of completed gestation), very preterm birth (at or under 32 weeks), and SGA babies (below the 10th percentile of birth weight by gestational age distribution).[2]

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: whether the child had been hospitalized for an illness in the previous 12 months.[3] The reason we focus on hospitalizations rather than doctor visits is that the decision to see a doctor is the parent/guardian's choice

[2] The reference percentile charts for birth weight at gestational age by gender are from Itabashi et al. (2014).

[3] In each wave of the survey, the parent or guardian indicates whether the child had 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 others.

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: 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 mother, answers a set of binary questions about their child's language development. The items include whether the child could put together two-word sentences. The respondent also selects all applicable items regarding the child's disruptive, inattentive, and hyperactive/impulsive behavior. Based on Yamaguchi et al. (2018), 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 A.1 shows that the average birth weight is about 3021.7 gram, the low birth weight rate is about 8.93%, and the very low birth weight rate is about 0.63% in our sample. Figure A.2 in the Appendix A shows that low birth weights are consistently higher in Japan compared with other developed countries. Over our sample period, the measure has been trending upward, rising from about 8.6% in 2000 to about 9.6% in 2010. It has been decreasing very slightly since 2014.

Table A.1 also shows that the average gestational age is around 39.27 weeks; the proportion of infants born with a gestational age of 37 weeks or less is around 5.2%, and that of 32 weeks or less is around 0.6%. Around 11.8% of the children were hospitalized due to illness at age 1.5, while it decreased as they got older to around 5.2% at age 4.5.

## 2.3 Predicted Employment Growth Rate

Our measure of economic conditions, which is the predicted employment growth rate, is constructed 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's the Japan Industrial Productivity (JIP) database 2021; 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.[4] This measure captures demand-driven employment shocks that vary across prefectures due to predetermined differences in the distribution of employment opportunities across industries.

To capture direct heterogeneous shocks to labor demand faced by mothers and fathers, 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 defined as:

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

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

We define the pregnancy period as the first 22 weeks of pregnancy, rather than the nine months or one-year pregnancy period used in previous studies. As the minimum gestational

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

age in this sample is 22 weeks, we avoid reflecting variations in economic conditions after birth on those during pregnancy.[5] 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).

The JIP database's employment records are an annual measure based on the national census and several other sources of administrative data available annually from October 1. 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 average them over 22 weeks of the pregnancy period.

Appendix Table A.1 shows that the sample mean value of predicted employment growth rate is -0.0137 overall, -0.0128 for women, and -0.0143 for men. Since our sample period is during a prolonged stagnation, the predicted employment growth rates take negative values over the period. Figure A.3 in the Appendix A presents the distribution of predicted employment growth rates for men and women. It shows 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 A.4 in the Appendix A plots each industry category's share of employment by prefecture level. In a prefecture, if the industry's employment contribution is equally important for both men and women, the prefecture would be on the 45-degree line. We observe two key features from Figure A.4. First, there is a gender-disproportional contribution to local

[5] The Maternal Health Act defines that a period when artificial abortions are allowed as "a period when the unborn child cannot survive outside the mother's body." Notice No. 55 of March 20 in 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).

employment across industries. Second, in each industry, a substantial variation in the relative share of employment exists across prefectures.

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. When these plots cluster on the 45-degree line, it implies that there is no 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.

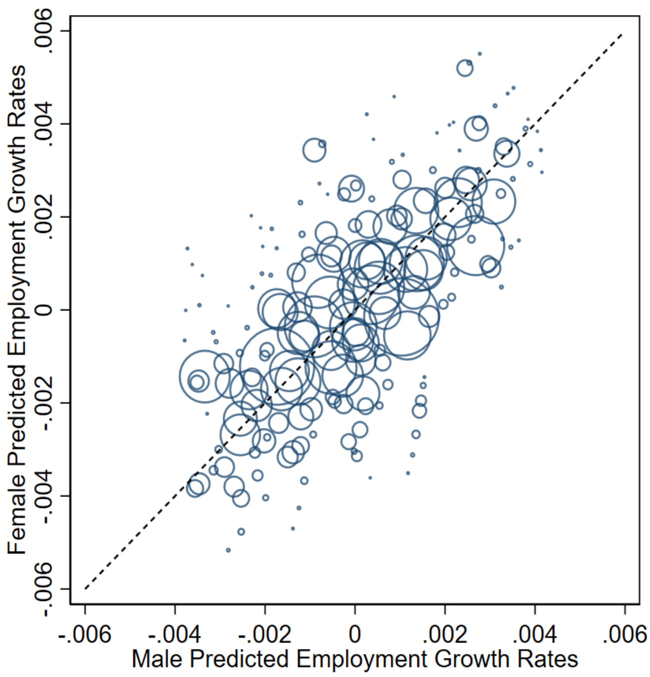


Figure 1: Scatter plots of the female and male predicted employment growth rates

Notes: This figure displays the residuals of the female and male predicted 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.

# 3 Empirical Framework

We estimate the following model:

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

where the subscript $i$ refers to the child, $c$ refers to the birth month cohort, $t$ refers to the pregnancy period, and $p$ refers to the prefecture. 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 $\beta$ is its coefficient, our primary parameter of interest. $X_i$ is a vector of dummy variables for individual controls, including the child's gender, multiple births, mother's first childbirth, mother's age at the time of childbirth, mother's employment status one year before pregnancy, and parents' educational attainment. $\theta_c$ indicates birth month fixed effects, $\psi_p$ denotes prefecture fixed effects, and $\epsilon_{ipct}$ is an idiosyncratic error term assumed conditional mean independent of $D_{pt}$.[6]

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

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

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

[6]The construction of the predicted employment growth rate is similar to that of shift share-type instrumental variables. Recent studies show that these instruments satisfy the exogeneity condition if either growth shocks or initial shares are exogenous. See Borusyak et al. (2021) and Goldsmith-Pinkham et al. (2020) for more details.

growth constant and vice versa.

In all result 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.

# 4 Results

## 4.1 Birth Outcomes

We begin by examining the relationship between the predicted employment growth rates and birth outcomes. Table 1 focuses on birth weight and length. As evident in Panel A, improvements in employment opportunities are negatively associated with birth weight and length. Columns (1) and (2) show that a one-percentage-point increase in the overall predicted employment growth rate is associated with a 0.0446-point increase in the probability of an infant having a birth weight of less than 2500 grams (low birth weight) and a 0.0163-point increase in the probability of having a birth weight of less than 1500 grams (very low birth weight).

These relationships do not rely on the outcome variables' specification focusing on the lower tail of the birth weight distribution. Column (3) shows a negative association between the overall predicted employment growth rate and the absolute value of the infant's birth weight; it corresponds to a decrease in birth weight by about 76.38 grams. 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 0.4590 cm. These results are statistically significant.

In Panel B, we report the estimates based on our preferred specification that allows for changes in employment opportunities disproportionately affecting 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. An increase of one percentage point in the female predicted employment growth rate increases the probability of having an infant with a low birth weight by 0.0338 points and of having an infant with a very low birth weight by 0.0167 points. It is also negatively associated with actual birth weight and length, reducing weight by about 73.09 grams and length by 0.4956 cm. These estimates are statistically different from zero. The coefficients of the male predicted employment growth rate show the same tendency, but the magnitude is smaller and statistically insignificant. Wald tests of equality between the male and female coefficients indicate that the two are statistically significantly different only in column (4).

In Table 2, maternal-fetal health conditions are evaluated by gestational age. Negative impacts of improvements in employment opportunities are also evident for this alternative outcome. In Panel A, a one-percentage-point increase in the overall predicted employment growth rate is statistically significantly associated with a 0.0432-point increase in the probability of preterm birth (<37 weeks), a 0.0176-point increase in the probability of a very preterm birth (<32 weeks), and a 0.4784-week decrease in gestational age.

The pattern in these estimates is striking only for female employment, as shown in Panel B. An increase of one percentage point in the predicted employment growth rate for women is statistically significantly associated with a 0.0421-point increase in the probability of preterm birth, a 0.0163-point increase in the probability of very preterm birth, and a 0.5224-week decrease in gestational age. However, we find no statistically significant association between the predicted employment growth rate for men and prematurity.

As demonstrated in column (4) in Panel A, the overall predicted 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, while the magnitude is small and statistically insignificant. As the SGA indicates that the child was born relatively small conditional on gestational age, these results suggest that a large part of the negative impact on birth weight is attributable to a reduction in weeks of gestation. Column (4) also shows that if male employment opportunities increase, fetuses are more likely to be born SGA. The Wald test of equality between the female and male coefficients shows that the magnitude for men is statistically significantly different from the coefficient for women.

Overall, we find that there is a negative association between predicted employment growth rates and birth outcomes, and the key driving force is the shock to labor demand for women. This result is consistent with recent studies such as van den Berg et al. (2020), finding countercyclical effects of the unemployment rate on birth weight, although they suggest that the effect mostly stems from the male unemployment rate. They show that one SD increase in the male unemployment rate statistically significantly reduces the probability of an infant having a very low birth weight by about 0.339 percentage points, and the female unemployment rate reduces it by about 0.144 percentage points; however, it is statistically insignificant. The corresponding estimates of our study are about 0.128 percentage points for the male employment growth rate and about 0.554 percentage points for the female employment growth rate.

Table 1: Predicted employment growth rates and birth weight and length

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | | Birth weight | | Birth length |
| | <2500 gram | <1500 gram | (in grams) | (in centimeters) |
| **Panel A: Overall effects** | | | | |
| Overall | 0.0446**** | 0.0163**** | -76.3804**** | -0.4590**** |
| | (0.0101) | (0.0037) | (17.0297) | (0.0910) |
| **Panel B: Gender-specific effects** | | | | |
| Female | 0.0338** | 0.0167*** | -73.0905*** | -0.4956*** |
| | (0.0138) | (0.0054) | (24.6797) | (0.1435) |
| Male | 0.0161 | 0.0019 | -13.0063 | -0.0211 |
| | (0.0134) | (0.0055) | (20.0274) | (0.1079) |
| p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$) | 0.4755 | 0.1476 | 0.1354 | 0.0393 |
| Mean | 0.0893 | 0.0063 | 3021.7374 | 48.9239 |
| Observations | 84855 | 84855 | 84855 | 84682 |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients 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, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, parental education, 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%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

Table 2: Predicted employment growth rates and gestational age and SGA

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | | Gestational age | | SGA |
| | <37 weeks | <32 weeks | (in weeks) | |
| **Panel A: Overall effects** | | | | |
| Overall | 0.0432**** | 0.0176**** | -0.4784**** | 0.0086 |
| | (0.0102) | (0.0038) | (0.0975) | (0.0054) |
| **Panel B: Gender-specific effects** | | | | |
| Female | 0.0421*** | 0.0163*** | -0.5224**** | -0.0103 |
| | (0.0137) | (0.0059) | (0.1408) | (0.0074) |
| Male | 0.0067 | 0.0036 | -0.0306 | 0.0175*** |
| | (0.0141) | (0.0060) | (0.1408) | (0.0065) |
| p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$) | 0.1632 | 0.2571 | 0.0598 | 0.0338 |
| Mean | 0.0522 | 0.0062 | 39.2676 | 0.0819 |
| Observations | 84855 | 84855 | 84855 | 84855 |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients 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, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, parental education, 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%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

## 4.2 Later Outcomes

Next, we turn to the analysis of 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 have effects on future health outcomes.

### 4.2.1 Health Conditions

Panel A of Table 3 shows that improvements in labor market opportunities are positively associated with the probability of childhood hospitalization for illness, except for the coefficient when the child is 1.5 years old. The estimates are statistically insignificant, and the magnitude is small. Even the largest impact of the overall predicted employment growth rate on children aged 4.5 is only about a 0.0065-percentage point change.

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 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 3: 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 |
|---|---|---|---|---|
| **Panel A: Overall effects** | | | | |
| Overall | -0.0002 | 0.0031 | 0.0005 | 0.0065 |
| | (0.0089) | (0.0088) | (0.0061) | (0.0073) |
| **Panel B: Gender-specific effects** | | | | |
| Female | 0.0004 | -0.0007 | 0.0080 | -0.0017 |
| | (0.0120) | (0.0153) | (0.0100) | (0.0104) |
| Male | 0.0016 | 0.0051 | -0.0059 | 0.0104 |
| | (0.0149) | (0.0181) | (0.0113) | (0.0119) |
| p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$) | 0.9626 | 0.8575 | 0.5020 | 0.5752 |
| Mean | 0.1179 | 0.0860 | 0.0588 | 0.0516 |
| Observations | 75387 | 73210 | 69238 | 65942 |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients 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, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, parental education, 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%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

#### 4.2.2 Language and Mental Development

Table 4 shows the association between labor demand 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 0.0077-SD decrease in the children's language development index. In Panel B, the corresponding estimate for women is a 0.0077-SD increase and for men, it is a 0.0121-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 overall predicted employment growth rate is associated with a 0.0278-SD decrease but is statistically insignificant. In Panel B, the female predicted employment growth rate is significantly associated with a 0.0715-SD reduction in children's tendency toward aggression. In contrast, the coefficient for the demand for male labor is statistically insignificant and has an opposite sign. In column (3), we find a positive association between the predicted employment growth rates and the tendency toward inattention and hyperactivity; however, the magnitudes of the estimates are small and their standard errors are large. 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 3 and 4 suggest that the negative impact of labor demand shock on birth outcomes does not persist in the long run for subsequent outcomes. At first glance, this seems to contradict previous studies that found long-term negative effects of low birth weight; however, it should be cautiously interpreted. 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 twin 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, find that the negative effect of low birth weight diminishes over time. Our results are consistent with their findings since our estimates suggest that the main factor of low birth weight is a shorter gestation period.

Table 4: Predicted employment growth rates and child development

| | (1) Language development | (2) Aggression | (3) Inattention & Hyperactivity |
|---|---|---|---|
| **Panel A: Overall effects** | | | |
| Overall | -0.0077 | -0.0278 | 0.0119 |
| | (0.0252) | (0.0456) | (0.0329) |
| **Panel B: Gender-specific effects** | | | |
| Female | 0.0077 | -0.0715* | -0.0006 |
| | (0.0385) | (0.0360) | (0.0493) |
| Male | -0.0121 | 0.0420 | 0.0128 |
| | (0.0344) | (0.0603) | (0.0578) |
| p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$) | 0.7714 | 0.2168 | 0.8968 |
| Mean | 0.0000 | 0.0000 | 0.0000 |
| Observations | 74181 | 68052 | 66478 |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients estimates are for a one-percentage-point increase in the predicted employment growth rate. 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, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, parental education, 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%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

## 4.3 Heterogeneity

In this section, we re-estimate the model for subsamples defined by mothers' education levels (high school or below, college or above). 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 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 heterogeneity in the effects that could be driven by changes in the labor demand for women.

### 4.3.1 Birth Outcomes

In Table A.2 in the Appendix A, we examine the association between the predicted employment growth rates and key birth outcomes, which are (very) low birth weight and (very) premature birth. Panel A shows statistically significant effects of an increase in the overall predicted employment growth rate. Columns (1)–(4) show that the effects on (very) low birth weight are larger for more educated mothers than for less educated mothers. In columns (5)–(8), the effects on the risk of (very) preterm birth are also larger for more educated mothers.

Panel B switches to the gender-specific effects. The results suggest that labor demand shocks to female employment opportunities are more likely to drive the impacts. In columns (1) and (2), the estimate of the effect of the predicted growth rate in female employment opportunities on low birth weight is larger for more educated mothers (0.0522) compared with the less educated (0.0324), and larger than our baseline estimate (0.0338) from Table 1. Similar patterns are evident for very low birth weight between columns (3) and (4). In columns (5) and (6), the estimate of 0.0432 for preterm birth among mothers with a higher educational level is similar to the estimate for mothers with a low educational level for female labor shocks. However, the estimates are insignificant for the male predicted employment growth rate. As demonstrated in columns (7) and (8), we find larger effects on very preterm births for more educated mothers.

To summarize, the negative association between labor demand changes during pregnancy and birth outcomes appears to be driven by labor demand changes for mothers with a higher level of education than for those with lower educational levels. It is prominent in the impact on the probability of having very poor birth outcomes. One interpretation of these results is that more educated mothers are considered to have a greater incentive to work during pregnancy.

### 4.3.2 Later Outcomes

We also examine the heterogeneous effects across mothers' education levels on later outcomes. Appendix Table A.3 presents the results for children's hospitalizations at ages 1.5–4.5. The size of the coefficient estimates for the subsample is slightly greater than that for the full sample in Table 3, but the magnitude of impact is still small and is statistically insignificant. Across the ages in both overall and gender-specific panels, few heterogeneity patterns stand out.

Appendix Table A.4 shows the results of the subsample analysis of children's language and mental development in early childhood. The patterns of heterogeneity are not evident in the results; the sign of the effect is not stable among education levels. There are no statistically significant effects of labor demand on child development, except for the effect of female labor demand on the inattention and hyperactivity index for the subsample of more educated mothers.

Across the mothers' education subgroup analyses, the estimates are statistically insignificant and unstable throughout. It confirms that there are no significant effects of the predicted employment rate on hospitalizations and child development in early childhood, and are similar to those found in the full sample analyses. It is difficult to figure out the heterogeneity of the effects on the later outcomes due to the unsystematic patterns and larger standard errors of the estimates.

## 4.4 Robustness Check

### 4.4.1 Prefecture and Municipality Controls

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 a systematic change in the composition of parents is generated. 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. 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 variables are the fraction of 2-year and 4-year college graduates, number of clinics and hospitals that offer obstetrics and gynecology services per the number of women aged 20–44, and annual growth rate of the number of pregnancies.

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.[7]

We include these municipality controls because the literature suggests that local accessibility to center-based childcare could change the fertility rate, and it is pronounced in a region where households are unlikely to include grandparents (e.g., Fukai, 2017). Although some of these 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.

In the Appendix A, Table A.5 shows that the pattern and magnitude of the estimates are not sensitive to including prefecture and municipality control variables. This suggests that our main results are relatively robust to concerns about selective fertility.

#### 4.4.2 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, 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

[7] The number of clinics and hospitals is from the Survey of Medical Institutions of the MHLW. The number of pregnancies is from the Report on Regional Public Health Services and Health Promotion Services 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.

survey. Table A.6 in the Appendix A shows that the estimates of the effects of predicted employment growth rates are statistically insignificant and the magnitude is very small in all columns. The results suggest that our findings on health and development in early childhood are robust to sample attrition.

#### 4.4.3 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 A.7 shows no statistically significant association between the predicted employment growth rates and relocation during pregnancy, except for the coefficient estimate of the male. Hence, we find no strong evidence that selective migration drives the main results.

#### 4.4.4 Pregnancy Periods

In our baseline specification, we define the pregnancy period for the predicted employment growth rates as the first 22 weeks of pregnancy accommodating the minimum gestational age in our sample. Here, we examine the sensitivity of the definition of the pregnancy period. In

Appendix Table A.8, 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.

#### 4.4.5 Prefecture-level Analysis

Finally, we re-examine the impact of the employment growth rate on selective birth using prefecture-level panel data from 2000 to 2018. In Table A.9 in the Appendix A, we begin by confirming the significant impact of labor demand shocks on birth weight at a prefecture level. Columns (1)–(4) show that the overall and female predicted employment growth rates are significantly associated with the fraction of low birth weight and average birth weight; they increase the risk of causing low birth weight, as well as reducing birth weight.

Next, we examine the effects on the composition of mothers' age at childbirth. When the 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 having low birth weight and premature births. In columns (5) and (6), the predicted employment growth rate is not associated with the average age of mothers at childbirth. In columns (7) and (8), we look at maternal age at first childbirth and find no significant impact. These results suggest that the composition of maternal age does not vary systematically over the economic fluctuations.

In Appendix Table A.10, we investigate the decision regarding fertility by estimating the impact of labor demand shock on pregnancy and childbirth. Columns (1) and (2) show the effects on the pregnancy rate, which is defined as the number of reported pregnancies per 1000 women aged 20–44. We find no statistically significant 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), we estimate the effects on the childbirth rate, which is defined as the number of live births per 1000 population. The overall predicted growth rate is negatively and statistically significantly associated with the birth rate. The gender-specific predicted employment growth rate is also negatively associated with the birth rate; however, it is statistically insignificant. The pattern suggests that there is a negatively associated decision for childbirth, while the significance of the impacts remains inconclusive. In columns (5)–(8), we examine the effect of labor demand shock on neonatal and infant mortality rates. The neonatal mortality rate is computed as the number of neonates who die within 28 days per 1000 live births, and the infant mortality rate is computed as the number of infants who die within a year of birth per 1000 live births. 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 mortality.

# 5 Conclusion

This study examines the effects of local labor market conditions during early pregnancy on birth outcomes in Japan. Studies in developed countries have 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 are heterogeneous across genders. 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 childbirth outcomes. However, we do not observe a significant change in childbirth outcomes when labor market opportunities for men improve. These results imply that maternal employment, not paternal employment, is a key factor in prenatal health in developed countries, suggesting policy interventions targeting mothers to improve prenatal health conditions. This is consistent with the evidence that an expansion of maternity leave programs can improve prenatal health conditions (e.g., Rossin, 2011).

We also investigate the impact of economic conditions during pregnancy on subsequent child health and development. Although previous studies have shown that maternal mental stress during pregnancy worsens children's future outcomes, the long-term impact of the economic condition during pregnancy is still not well understood. Our analysis shows that improvements in labor market conditions for women during pregnancy are negatively associated with birth outcomes, but not significantly related to child health and development several years later.

We face two limitations. First, we were unable to observe the actual employment status during pregnancy. We would need detailed data on work status during pregnancy to identify the channels of the impact of economic fluctuations better. Second, for the outcome of child health and development, we were only able to track children aged 0 to 4.5. Labor demand shocks could have an impact on health-related socioeconomic outcomes later in life since poor neonatal health effects remain latent for many years, such as the effects on heart disease that 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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# Appendix A Additional Figures and Tables

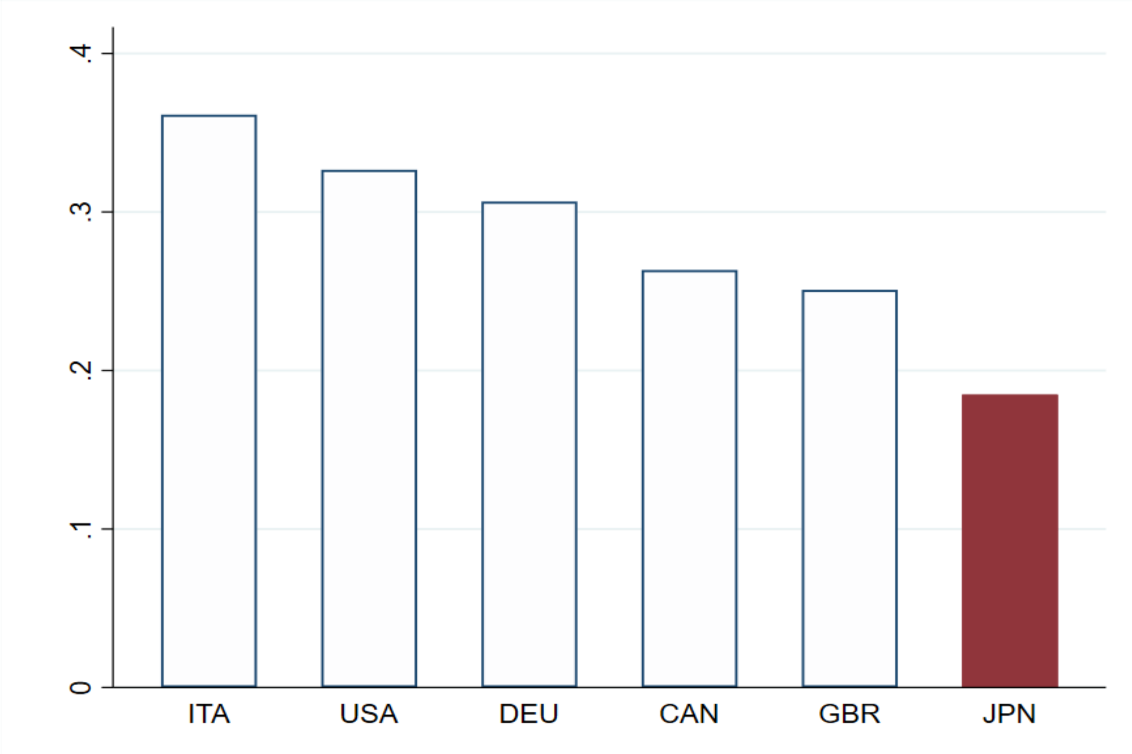


Figure A.1: Fraction of cesarean sections in live births

Notes: This figure displays the number of live births delivered by cesarean section per all live births in 2013. Source: OECD (2021a).

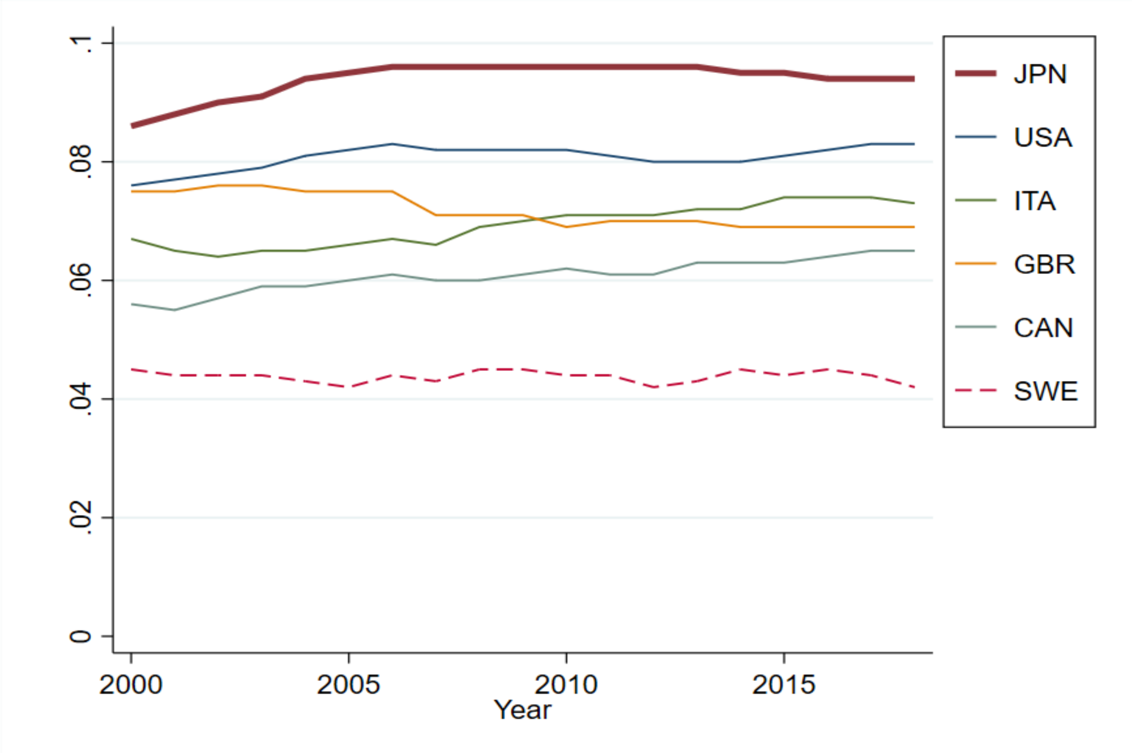


Figure A.2: Fraction of low birth weight infants in live births

Notes: This figure displays the proportion of low birth weight infants calculated as the number of live births less than 2500 grams divided by the total number of live births.
Source: OECD (2021b).

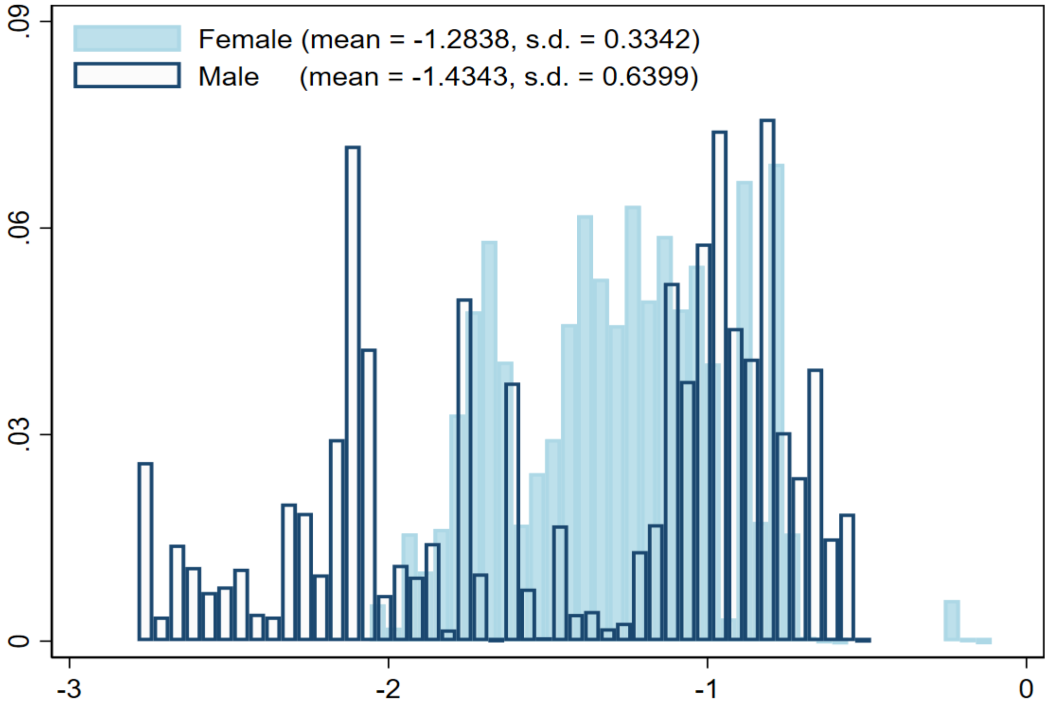


Figure A.3: Density of the female and male predicted employment growth rates (in %)

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

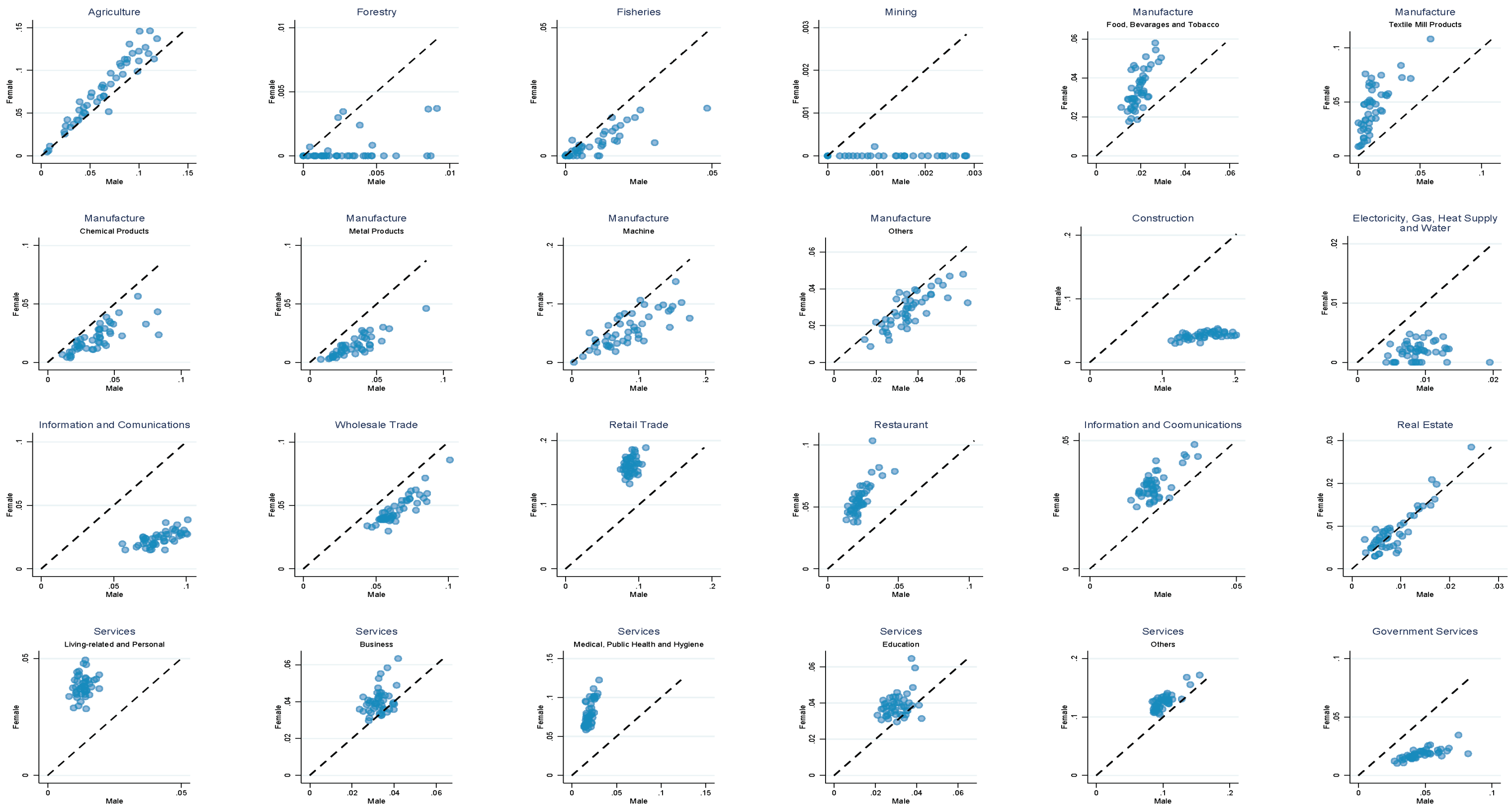


Figure A.4: Scatter plots of the share of industry employment for women and men

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

Table A.1: Summary statistics

| | Mean | SD | Observations |
|---|---|---|---|
| **Child birth outcomes** | | | |
| Birth weight (in grams) | 3021.7374 | 431.8514 | 84855 |
| <2500 gram | 0.0893 | 0.2852 | 84855 |
| <1500 gram | 0.0063 | 0.0789 | 84855 |
| Birth length (in centimeters [cm]) | 48.9239 | 2.3476 | 84682 |
| Gestational age (in weeks) | 39.2676 | 1.6176 | 84855 |
| <37 weeks | 0.0522 | 0.2224 | 84855 |
| <32 weeks | 0.0062 | 0.0784 | 84855 |
| Small for gestational age | 0.0819 | 0.2742 | 84855 |
| **Child health outcomes** | | | |
| Hospitalizations for an Illness at age 1.5 | 0.1179 | 0.3224 | 75387 |
| at age 2.5 | 0.0860 | 0.2803 | 73210 |
| at age 3.5 | 0.0588 | 0.2352 | 69238 |
| at age 4.5 | 0.0516 | 0.2212 | 65942 |
| **Child language and emotional outcomes** | | | |
| Language development | 0.0000 | 1.0000 | 74181 |
| Aggression | 0.0000 | 1.0000 | 68052 |
| Inattention and Hyperactivity | 0.0000 | 1.0000 | 66478 |
| **Predicted employment growth rates** | | | |
| Overall | -0.0137 | 0.0043 | 84855 |
| Female | -0.0128 | 0.0033 | 84855 |
| Male | -0.0143 | 0.0064 | 84855 |

(continued)

Table A.1: Summary statistics (continued)

| | | | |
|---|---|---|---|
| **Birth month** | | | |
| January | 0.2723 | 0.4451 | 84855 |
| May | 0.4518 | 0.4977 | 84855 |
| July | 0.2759 | 0.4470 | 84855 |
| **Child's characteristics** | | | |
| Girl | 0.4827 | 0.4997 | 84855 |
| Multiple birth | 0.0199 | 0.1396 | 84855 |
| Mother's first childbirth | 0.4832 | 0.4997 | 84855 |
| **Mother's age at childbirth** | | | |
| 19 years or younger | 0.0113 | 0.1055 | 84855 |
| 20–24 years | 0.1080 | 0.3104 | 84855 |
| 25–29 years | 0.3413 | 0.4741 | 84855 |
| 30–34 years | 0.3596 | 0.4799 | 84855 |
| 35–39 years | 0.1570 | 0.3638 | 84855 |
| 40 years or older | 0.0228 | 0.1494 | 84855 |
| **Mother's employment status 1 year before childbirth** | | | |
| Not work | 0.4169 | 0.4930 | 84855 |
| Self-employed or Misc. | 0.0526 | 0.2232 | 84855 |
| Part-time | 0.1903 | 0.3926 | 84855 |
| Full-time | 0.3402 | 0.4738 | 84855 |
| **Mother's education** | | | |
| Junior high school (Lower secondary) | 0.0463 | 0.2102 | 84855 |
| High school (Upper secondary) | 0.3067 | 0.4611 | 84855 |
| Vocational | 0.1652 | 0.3713 | 84855 |
| 2-year college | 0.2063 | 0.4047 | 84855 |
| University or higher | 0.1739 | 0.3790 | 84855 |
| Misc. or missing | 0.1016 | 0.3021 | 84855 |
| **Father's education** | | | |
| Junior high school (Lower secondary) | 0.0668 | 0.2496 | 84855 |
| High school (Upper secondary) | 0.3181 | 0.4657 | 84855 |
| Vocational | 0.1202 | 0.3252 | 84855 |
| 2-year college | 0.0290 | 0.1677 | 84855 |
| University or higher | 0.3518 | 0.4775 | 84855 |
| Misc. or missing | 0.1141 | 0.3179 | 84855 |

Table A.2: Predicted employment growth rates and birth outcomes by mother's educational attainment

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Subsample: | high school | college | high school | college | high school | college | high school | college |
| | <2500 gram | | <1500 gram | | <37 weeks | | <32 weeks | |
| **Panel A: Overall effects** | | | | | | | | |
| Overall | 0.0256** | 0.0706**** | 0.0095*** | 0.0238**** | 0.0334*** | 0.0514**** | 0.0129**** | 0.0215**** |
| | (0.0106) | (0.0133) | (0.0035) | (0.0060) | (0.0100) | (0.0133) | (0.0036) | (0.0056) |
| **Panel B: Gender-specific effects** | | | | | | | | |
| Female | 0.0324 | 0.0522*** | 0.0107 | 0.0270*** | 0.0438** | 0.0432*** | 0.0107 | 0.0249*** |
| | (0.0193) | (0.0166) | (0.0067) | (0.0097) | (0.0182) | (0.0148) | (0.0070) | (0.0092) |
| Male | -0.0022 | 0.0263* | 0.0002 | 0.0008 | -0.0051 | 0.0152 | 0.0038 | 0.0003 |
| | (0.0188) | (0.0141) | (0.0064) | (0.0084) | (0.0179) | (0.0142) | (0.0069) | (0.0084) |
| p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$) | 0.3464 | 0.3275 | 0.4013 | 0.1212 | 0.1615 | 0.2561 | 0.6089 | 0.1358 |
| Mean | 0.0883 | 0.0871 | 0.0061 | 0.0061 | 0.0512 | 0.0503 | 0.0062 | 0.0059 |
| Observations | 43973 | 32263 | 43973 | 32263 | 43973 | 32263 | 43973 | 32263 |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. A column of high school indicates estimates for a subsample of mothers with high school or lower education. A column of college is for a subsample of those with 2-year college or higher education. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients 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, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, mother's education (high school and vocational dummies in the models for columns (1) and (3), university or higher dummy in the models for columns (2) and (4)), father's education, cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. Children whose mother's educational level is misc. or missing are excluded from the sample. Significance at 0.1%, 1%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

Table A.3: Predicted employment growth rates and hospitalization for illness by mother's educational attainment

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Subsample: | high school | college | high school | college | high school | college | high school | college |
| | at age 1.5 | | at age 2.5 | | at age 3.5 | | at age 4.5 | |
| **Panel A: Overall effects** | | | | | | | | |
| Overall | -0.0044 | 0.0092 | 0.0146 | -0.0105 | 0.0070 | -0.0100 | 0.0023 | 0.0099 |
| | (0.0129) | (0.0089) | (0.0128) | (0.0106) | (0.0072) | (0.0086) | (0.0098) | (0.0087) |
| **Panel B: Gender-specific effects** | | | | | | | | |
| Female | 0.0091 | -0.0045 | -0.0099 | 0.0073 | 0.0103 | 0.0011 | -0.0036 | 0.0039 |
| | (0.0189) | (0.0131) | (0.0200) | (0.0175) | (0.0123) | (0.0139) | (0.0113) | (0.0153) |
| Male | -0.0103 | 0.0147 | 0.0262 | -0.0168 | -0.0024 | -0.0095 | 0.0086 | 0.0084 |
| | (0.0229) | (0.0119) | (0.0222) | (0.0189) | (0.0115) | (0.0155) | (0.0129) | (0.0151) |
| p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$) | 0.6306 | 0.4153 | 0.3706 | 0.4952 | 0.5758 | 0.7068 | 0.5905 | 0.8792 |
| Mean | 0.1251 | 0.1079 | 0.0925 | 0.0769 | 0.0639 | 0.0519 | 0.0552 | 0.0474 |
| Observations | 43164 | 31783 | 39739 | 30243 | 37920 | 29172 | 35878 | 28123 |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. A column of high school indicates estimates for a subsample of mothers with high school or lower education. A column of college is for a subsample of those with 2-year college or higher education. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients 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, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, mother's education (high school and vocational dummies in the models for columns (1), (3), and (5), university or higher dummy in the models for columns (2), (4), and (6)), father's education, cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. Children whose mother's educational level is misc. or missing are excluded from the sample. Significance at 0.1%, 1%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

Table A.4: Predicted employment growth rates and child development by mother's educational attainment

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Subsample: | high school | college | high school | college | high school | college |
| | Language development | | Aggression | | Inattention & Hyperactivity | |
| **Panel A: Overall effects** | | | | | | |
| Overall | -0.0060 | -0.0122 | -0.0347 | 0.0027 | 0.0063 | 0.0221 |
| | (0.0336) | (0.0480) | (0.0576) | (0.0376) | (0.0410) | (0.0370) |
| **Panel B: Gender-specific effects** | | | | | | |
| Female | 0.0799 | -0.0562 | -0.0724 | -0.0577 | -0.0735 | 0.0983* |
| | (0.0594) | (0.0384) | (0.0546) | (0.0446) | (0.0761) | (0.0559) |
| Male | -0.0726 | 0.0341 | 0.0373 | 0.0570 | 0.0734 | -0.0642 |
| | (0.0559) | (0.0476) | (0.0821) | (0.0479) | (0.0810) | (0.0576) |
| p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$) | 0.1738 | 0.2245 | 0.3983 | 0.1894 | 0.3416 | 0.1299 |
| Mean | 0.0179 | -0.0216 | 0.0762 | -0.0993 | 0.0801 | -0.1048 |
| Observations | 40230 | 30610 | 37114 | 28816 | 36301 | 28114 |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. A column of high school indicates estimates for a subsample of mothers with high school or lower education. A column of college is for a subsample of those with 2-year college or higher education. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients 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, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, mother's education (high school and vocational dummies in the models for columns (1), (3), and (5), university or higher dummy in the models for columns (2), (4), and (6)), father's education, cohort dummies, and a set of dummies for prefecture of residence are also controlled in the regression model but not reported. Children whose mother's educational level is misc. or missing are excluded from the sample. Significance at 0.1%, 1%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

Table A.5: Predicted employment growth rates and birth outcomes, controlling for prefecture and municipality variables

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | <2500 gram | | | <1500 gram | | | <37 weeks | | | <37 weeks | |
| **Panel A: Overall effects** | | | | | | | | | | | | |
| Overall | 0.0446$^{****}$ | 0.0461$^{****}$ | 0.0459$^{****}$ | 0.0163$^{****}$ | 0.0174$^{****}$ | 0.0174$^{****}$ | 0.0432$^{****}$ | 0.0460$^{****}$ | 0.0456$^{****}$ | 0.0176$^{****}$ | 0.0185$^{****}$ | 0.0184$^{****}$ |
| | (0.0101) | (0.0111) | (0.0112) | (0.0037) | (0.0042) | (0.0042) | (0.0102) | (0.0115) | (0.0114) | (0.0038) | (0.0042) | (0.0042) |
| **Panel B: Gender-specific effects** | | | | | | | | | | | | |
| Female | 0.0338$^{**}$ | 0.0393$^{**}$ | 0.0391$^{*}$ | 0.0167$^{***}$ | 0.0163$^{**}$ | 0.0166$^{**}$ | 0.0421$^{***}$ | 0.0410$^{**}$ | 0.0409$^{*}$ | 0.0163$^{***}$ | 0.0166$^{*}$ | 0.0173$^{**}$ |
| | (0.0138) | (0.0192) | (0.0194) | (0.0054) | (0.0076) | (0.0077) | (0.0137) | (0.0200) | (0.0204) | (0.0059) | (0.0083) | (0.0084) |
| Male | 0.0161 | 0.0100 | 0.0100 | 0.0019 | 0.0024 | 0.0021 | 0.0067 | 0.0082 | 0.0078 | 0.0036 | 0.0032 | 0.0025 |
| | (0.0134) | (0.0193) | (0.0195) | (0.0055) | (0.0088) | (0.0089) | (0.0141) | (0.0218) | (0.0218) | (0.0060) | (0.0091) | (0.0093) |
| Mean | 0.08931 | 0.08931 | 0.08920 | 0.00627 | 0.00627 | 0.00627 | 0.05221 | 0.05221 | 0.05218 | 0.00619 | 0.00619 | 0.00617 |
| Observations | 84855 | 84855 | 84418 | 84855 | 84855 | 84418 | 84855 | 84855 | 84418 | 84855 | 84855 | 84418 |
| Prefecture controls | | Yes | Yes | | Yes | Yes | | Yes | Yes | | Yes | Yes |
| Municipality controls | | | Yes | | | Yes | | | Yes | | | Yes |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients estimates are for a one-percentage-point increase in the predicted employment growth rate. Columns (1), (4), (7), and (10) show the baseline estimates. Mean indicates the sample mean level of the outcome variable. Child's gender, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, parental education, 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 fraction of college graduates, the number of clinics and hospitals offering obstetrics and gynecology services per women aged 20–44, and the annual growth rate of the number of pregnancies. 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%, 5%, and 10% levels are indicated by $^{****}$, $^{***}$, $^{**}$, and $^{*}$, respectively.

Table A.6: Predicted employment growth rates and sample attrition

| | (1)<br>at age 1.5 | (2)<br>at age 2.5 | (3)<br>at age 3.5 | (4)<br>at age 4.5 |
|---|---|---|---|---|
| **Panel A: Overall effects** | | | | |
| Overall | 0.0011 | 0.0090 | -0.0026 | -0.0022 |
| | (0.0013) | (0.0069) | (0.0062) | (0.0063) |
| **Panel B: Gender-specific effects** | | | | |
| Female | -0.0004 | 0.0071 | -0.0012 | -0.0015 |
| | (0.0016) | (0.0083) | (0.0083) | (0.0100) |
| Male | 0.0014 | 0.0028 | -0.0014 | -0.0007 |
| | (0.0014) | (0.0100) | (0.0074) | (0.0086) |
| p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$) | 0.4984 | 0.8033 | 0.9921 | 0.9641 |
| Mean | 0.0967 | 0.1223 | 0.1701 | 0.2075 |
| Observations | 84855 | 84855 | 84855 | 84855 |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients 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, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, parental education, 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%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

Table A.7: Predicted employment growth rates and relocation between one year prior to the childbirth and when the child was 6 months old

| | |
|---|---|
| **Panel A: Overall effects** | |
| Overall | 0.0560 |
| | (0.0504) |
| **Panel B: Gender-specific effects** | |
| Female | -0.0310 |
| | (0.0437) |
| Male | 0.0779* |
| | (0.0445) |
| p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$) | 0.1422 |
| Mean | 0.1106 |
| Observations | 45934 |

Notes: Standard errors clustered at the prefecture level are in parentheses. The sample only includes cohorts born in 2001. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients 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 had relocated because of the pregnancy or the childbirth during the period from one year prior to the 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, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, parental education, 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%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

Table A.8: Sensitivity to the definition of the pregnancy period in the predicted employment growth rates

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Def. of the pregnancy period: | 20 weeks | 22 weeks (base) | 24 weeks | 20 weeks | 22 weeks (base) | 24 weeks | 20 weeks | 22 weeks (base) | 24 weeks | 20 weeks | 22 weeks (base) | 24 weeks |
| | | <2500 gram | | | <1500 gram | | | <37 weeks | | | <32 weeks | |
| **Panel A: Overall effects** | | | | | | | | | | | | |
| Overall | 0.0425**** | 0.0444**** | 0.0465**** | 0.0158**** | 0.0163**** | 0.0168**** | 0.0419**** | 0.0439**** | 0.0460**** | 0.0171**** | 0.0175**** | 0.0181**** |
| | (0.0098) | (0.0101) | (0.0104) | (0.0037) | (0.0038) | (0.0039) | (0.0100) | (0.0103) | (0.0106) | (0.0038) | (0.0039) | (0.0040) |
| **Panel B: Gender-specific effects** | | | | | | | | | | | | |
| Female | 0.0272** | 0.0321** | 0.0410*** | 0.0128** | 0.0156*** | 0.0191*** | 0.0354*** | 0.0414*** | 0.0529*** | 0.0118** | 0.0153** | 0.0195*** |
| | (0.0130) | (0.0138) | (0.0152) | (0.0051) | (0.0053) | (0.0057) | (0.0127) | (0.0137) | (0.0156) | (0.0057) | (0.0059) | (0.0062) |
| Male | 0.0179 | 0.0176 | 0.0137 | 0.0045 | 0.0030 | 0.0008 | 0.0092 | 0.0081 | 0.0019 | 0.0067 | 0.0046 | 0.0018 |
| | (0.0124) | (0.0134) | (0.0149) | (0.0050) | (0.0052) | (0.0056) | (0.0130) | (0.0141) | (0.0161) | (0.0056) | (0.0058) | (0.0062) |
| p-value ($\beta_{\text{Female}} = \beta_{\text{Male}}$) | 0.6881 | 0.5595 | 0.3228 | 0.3686 | 0.1924 | 0.0804 | 0.2629 | 0.1909 | 0.0833 | 0.6259 | 0.3271 | 0.1291 |
| Mean | 0.0894 | 0.0894 | 0.0894 | 0.0063 | 0.0063 | 0.0063 | 0.0524 | 0.0524 | 0.0524 | 0.0063 | 0.0063 | 0.0063 |
| Observations | 85498 | 85498 | 85498 | 85498 | 85498 | 85498 | 85498 | 85498 | 85498 | 85498 | 85498 | 85498 |

Notes: The pregnancy period is defined as the first 22 weeks of pregnancy in the main analyses, see Section 2.3. Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients 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, multiple birth, mother's first birth, mother's age, mother's employment status before pregnancy, parental education, 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%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

Table A.9: Prefecture-level analysis on predicted employment growth rates and birth weight and maternal age

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Birth weight below 2500 grams | | Average birth weight | | Average age of mothers | | Average age of first-time mothers | |
| **Panel A: Overall effects** | | | | | | | | |
| Overall | 0.1626*** | 0.1419*** | -0.0035** | -0.0031** | -0.0076 | -0.0135 | -0.0308 | -0.0367* |
| | (0.0544) | (0.0521) | (0.0013) | (0.0013) | (0.0188) | (0.0187) | (0.0222) | (0.0211) |
| **Panel B: Gender-specific effects** | | | | | | | | |
| Female | 0.3925**** | 0.3621**** | -0.0052* | -0.0045* | -0.0409 | -0.0501 | -0.0390 | -0.0491 |
| | (0.1017) | (0.0906) | (0.0028) | (0.0026) | (0.0350) | (0.0346) | (0.0498) | (0.0492) |
| Male | -0.1650** | -0.1582** | 0.0010 | 0.0008 | 0.0289 | 0.0308 | 0.0048 | 0.0075 |
| | (0.0766) | (0.0752) | (0.0028) | (0.0028) | (0.0230) | (0.0230) | (0.0374) | (0.0376) |
| Mean | 9.3545 | 9.3537 | 3.0117 | 3.0118 | 30.6655 | 30.6665 | 29.2068 | 29.2081 |
| Observations | 893 | 890 | 893 | 890 | 893 | 890 | 893 | 890 |
| Controls | | Yes | | Yes | | Yes | | Yes |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The coefficients 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 clinics and hospitals offering obstetrics and gynecology services per women aged 20–44 are included in the regression model. Significance at 0.1%, 1%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.

Table A.10: Prefecture-level analysis on predicted employment growth rates and pregnancy, childbirth, and mortality

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Pregnancy rate | | Birth rate | | Neonatal mortality rate | | Infant mortality rate | |
| **Panel A: Overall effects** | | | | | | | | |
| Overall | -0.4676 | -0.3386 | -0.1370** | -0.1188** | -0.0001 | -0.0001 | -0.0002 | -0.0003 |
| | (0.3929) | (0.3738) | (0.0567) | (0.0515) | (0.0001) | (0.0001) | (0.0002) | (0.0002) |
| **Panel B: Gender-specific effects** | | | | | | | | |
| Female | -0.9434 | -0.7015 | -0.1058 | -0.0720 | 0.0002 | 0.0002 | 0.0001 | 0.0000 |
| | (0.6605) | (0.6722) | (0.1061) | (0.1009) | (0.0002) | (0.0002) | (0.0003) | (0.0003) |
| Male | 0.3487 | 0.2676 | -0.0336 | -0.0442 | -0.0003 | -0.0003 | -0.0003 | -0.0003 |
| | (0.5112) | (0.5125) | (0.0560) | (0.0588) | (0.0002) | (0.0002) | (0.0003) | (0.0003) |
| Mean | 57.2613 | 57.2650 | 8.2559 | 8.2589 | 0.0022 | 0.0022 | 0.0047 | 0.0047 |
| Observations | 893 | 890 | 893 | 890 | 893 | 890 | 893 | 890 |
| Controls | | Yes | | Yes | | Yes | | Yes |

Notes: Standard errors clustered at the prefecture level are in parentheses. A column of estimates in each panel comes from a separate regression. Overall indicates the overall predicted employment growth rate. Female (Male) indicates the female (male) predicted employment growth rate. The pregnancy rate is the number of reported pregnancies per 1000 women aged 20–44. The birth rate is the number of live births per 1000 population. The neonatal mortality rate is the number of neonates dying before reaching 28 days of age per 1000 live births. The infant mortality rate is the number of deaths of children less than one year of age per 1,000 live births. The coefficients 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 clinics and hospitals offering obstetrics and gynecology services per women aged 20–44 are included in the regression model. Significance at 0.1%, 1%, 5%, and 10% levels are indicated by ****, ***, **, and *, respectively.