

Effect of Changing Business Condition on Prenatal Health

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Previous studies from developed countries suggest that babies conceived during recessions have better birth outcomes. However, the issue of whether the relationship between business condition and infant health differs across countries remains less clear. This paper investigates how the macroeconomic conditions to which mothers are exposed during pregnancy affect the birth outcomes of children. The analyses are based on the universe of birth registration records from 1993 to 2009 that are linked to the unemployment statistics by province and month of birth. Results indicate that prenatal exposure to higher unemployment significantly reduces birth weights and increases the risk of low birth weight. A recession has a stronger negative effect on fetal health during the first and second trimesters than in the final stage of pregnancy. The negative effects of prenatal exposure to higher unemployment rates on birth weight are observed only for the children of non-working mothers. Higher unemployment rates during pregnancy had considerably stronger negative effects on birth outcomes during the period before the financial crises of 1998 and 1999 than in the post-crisis period.

Keywords: Business cycle, Unemployment, Infant health, Birth weight

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I. Introduction

Job loss is widely believed to have negative consequences on the health of unemployed workers (Sullivan and Wachter 2009; Eliason and Storrie 2009; Rege *et al.* 2009; Schaller and Stevens 2014) and that of their children (Lindo 2011). By contrast, existing evidence suggests that various measures of health improve during recessions in developed countries (Ruhm 2000, 2004, 2007; Neumayer 2004; Tapia Granados 2005; Gerdtham and Ruhm 2006; Lin 2009; Miller *et al.* 2009). Recent studies focusing on infant health provide similar conclusions (Dehejia and Lleras-Muney 2004). However, the issue of whether the counter-cyclical change in infant health is a general phenomenon or is peculiar to particular countries remains less clear. Recent studies from other countries report a positive relationship between economic prosperity and infant health (Bhalotra 2010; Bozzoli and Quintana-Domeque 2014; Cao *et al.* 2022).

The current paper investigates how the macroeconomic conditions to which mothers are exposed during pregnancy affect the birth weights and the probability of the low birth weight (LBW) of the children in South Korea (Korea, hereafter). Except several recent studies, the existing evidence has largely been derived from the United States and European nations. Thus, new evidence from Korea can add to the understanding of how the effects of business cycle on infant health differ across countries.

To be more specific, several features of Korea provide a unique opportunity to examine how the relationship between macroeconomic conditions and infant health changes according to characteristics of labor-market and welfare system. First, the female labor force participation rate in Korea is lower than other countries with similar income levels. Thus, the income and substitution effects of changing business conditions on pregnant women in Korea could be different from those in other comparable nations. Second, Korea established or expanded social welfare programs within a short period of time following the Asian Financial Crisis in 1998. These include expansion of unemployment insurance to all employees, introduction of paid maternal leave, and increase in the coverage of National Health Insurance. The strengthening of welfare system may have altered potential effects of recessions on birth outcomes. Finally, deteriorations in employment conditions and job quality after the crisis may have

changed the association between unemployment and infant health.

The analyses are based on the universe of birth registration records from 1993 to 2009 that are linked to the unemployment statistics by province and month of birth. The records with complete information on the characteristics of the newborns and parents can be obtained from 1993. Although the data for more recent years are available, I limit the analysis to 2009 for the following reasons. First, choosing 2009 as the end year can balance the lengths of the post-crisis period (2000 and thereafter) and the years prior to 2000. Second, excluding the recent decade enables us to investigate a society where the female labor-force participation rate is comparatively low, and fertility decisions are less selective.¹

This study improves previous research on the topic in several aspects. First, I identify more accurately the macroeconomic conditions to which a mother is exposed during pregnancy. That is, I calculate the average unemployment rate in the province of birth for the exact period of gestation using the monthly unemployment statistics for each province and the information on the duration of gestation. Second, by analyzing individual-level micro data, I control parental education and occupation as well as various characteristics of birth (gender, parity order, and multiple births) in estimating the effect of unemployment rate on birth outcomes. Third, I examine how the effects of recessions on infant health differ by the timing (stage of pregnancy) of exposure by estimating the effect of average unemployment in each trimester of pregnancy.

The results of the paper suggest that prenatal exposure to recessions significantly reduces birth weights and increases the LBW risks in Korea. A recession has a stronger negative effect on fetal health during the first and second trimesters than in the final stage of pregnancy. The adverse effect of in-utero exposure to a recession on the risk of low birth weight (LBW) is slightly larger for girls than for boys, whereas the gender difference in the effect on birth weight is extremely small. The negative effects of prenatal exposure to higher unemployment rates on

¹ The percentage of women aged 25 to 39 (the prime age for childbearing in Korea) who are married fell from 62.7% in 2009 to 45.2% in 2021. Among married women aged 25 to 39, the fraction of those having no children increased from 10.7% in 2009 to 24.3% in 2021. Computed based on micro data on birth registration recodes and micro samples of population censuses.

birth weight are observed only for the children of non-working mothers. Higher unemployment rates during pregnancy had considerably stronger negative effects on birth outcomes during the period before the financial crises of 1998 and 1999 than in the post-crisis period.

The remainder of this paper is organized as follows. Section 2 introduces the literature on the issue and provides major motivations of the present study. Section 3 explains data and empirical methods used in the study. Section 4 presents the results of baseline regressions investigating how business conditions affect birth outcomes. Section 5 offers additional results on how the relationship between macroeconomic condition and infant health differ by gender, mother's labor-market status, and time periods. The final section summarizes the results and provides their implications.

II. Background

Job loss is believed to have negative consequences on the health of unemployed workers. For example, Sullivan and Wachter (2009) reveal that job displacement in Pennsylvania increased the mortality of the workers even after a prolonged period. Reduced income is suggested as a major pathway through which job loss increases mortality. Schaller and Stevens (2014) argue that job losses result in worse self-reported health and reduced insurance coverage in the United States. Studies based on data from Sweden and Norway also report that job displacement adversely affects the health of workers themselves (Eliason and Storrie 2009; Rege *et al.* 2009).

The negative consequences of job displacement extend to family members, especially children. Based on sibling fixed-effect model estimations, Lindo (2011) indicates that the job losses of husbands significantly reduce the birth weights of the children born after a displacement in the United States. Stevens and Schaller (2011) argue that a parental job loss increases the probability of the grade retention of children by approximately 15%. A study of a Canadian panel of administrative data (Oreopoulos, Page, and Stevens 2008) reports that the job displacements of fathers reduce the earnings of children by approximately 9%.

Job displacement is known to be harmful for the health of the unemployed; however, the existing evidence drawn from U.S. and international data generally suggests that various measures of health

improve during recessions (Ruhm 2000, 2004, 2007; Neumayer 2004; Tapia Granados 2005; Gerdtham and Ruhm 2006; Lin 2009; Miller *et al.* 2009).² The deterioration in health in times of low unemployment has largely been attributed to behavioral changes of individuals in response to the increased opportunity cost of time (*e.g.*, decrease in physical exercise and increase in smoking) and negative external effects (*e.g.*, increase in pollution and decline in the quality of health care) generated by economic booms (Ruhm 2000, 2003; Miller *et al.* 2009; Stevens *et al.* 2011).

Previous studies focusing on infant health provide similar conclusions. Investigating state-level data drawn from the U.S. Vital Statistics Natality records from 1975 to 1999, Dehejia and Lleras-Muney (2004) determine that babies conceived in times of high unemployment have a reduced incidence of LBW and a diminished rate of infant mortality. Dehejia and Lleras-Muney suggest that the improvement of infant health during recessions is partly attributable to the fact that the health-related behaviors of mothers improve when unemployment is high. The effect of fertility selections on the relationship between unemployment and infant health differs by race. Black mothers of low socioeconomic status (SES) are less likely to have babies during recessions, raising the average health of Black babies; by contrast, white mothers of low SES are more likely to have babies during recessions, reducing the average health of Whites. The study also provides supportive evidence from cross-country data.

Based on the analysis of state- and county-level data drawn from the U.S. Vital Statistics Natality records from 1989 to 1999, Menclova (2013) reveals that the interaction term of unemployment and Medicaid eligibility has a significant positive effect on prenatal care in the first trimester among Whites, whereas unemployment per se has a significant negative effect. For Blacks, both unemployment and its interaction with Medicaid eligibility have positive effects on prenatal care use, although the effects are statistically insignificant. Based on the results, the author argues that the positive effects of unemployment

² The relationship between unemployment and health might have changed in recent years. McInerney and Mellor (2012) indicate that elderly mortality is countercyclical during the period from 1994 to 2008. Ruhm (2013) reports that total mortality in the United States has shifted over the 1976–2009 period from strongly procyclical to being essentially unrelated to macroeconomic conditions.

on infant health are partly mediated by increased Medicaid eligibility during recessions. The differences by race are attributed to the differences in the relative strength of income and substitution effects that change the business conditions.

Even with the increasing number of studies on this subject, the issue of whether the counter-cyclical change in infant health is a general phenomenon or is peculiar to particular countries remains less clear. Existing evidence has largely been drawn from the United States and European nations. The effects of business cycle on infant health could differ across countries depending on social, economic, political, and institutional characteristics. Studies from other countries report a positive relationship between economic prosperity and infant health. Confirming this conjecture, Bhalotra (2010) indicates that rural infant mortality in India is countercyclical, whereas income shocks have no significant effect on mortality in urban households. Bozzoli and Quintana-Domeque (2014) similarly assert that birth weights in Argentina around the economic collapse of December 2001 were positively associated with business cycle, especially among the children of low-educated mothers.³ Cao *et al.* (2022) find that babies health is strongly pro-cyclical, with downturns leading to a decline in birth weight and fetal growth in England.

The relationship between business cycle and health in Asian countries is considerably underinvestigated. Based on country-level data from eight Asia-Pacific nations from 1976 to 2003, Lin (2009) contends that unemployment rate is negatively and significantly correlated with mortality. Lee and Kim (2017) suggest that the mortality rates in Korea changed from procyclical to countercyclical after the early 2000s. Hong *et al.* (2010) determine that economic downturns in Korea between 1983 and 2008 tend to increase the mortality rates of infants and the elderly with time lags. To our knowledge, this work is a rare attempt to understand how macroeconomic conditions during pregnancy affect birth outcomes in Korea.

³ The aforementioned studies on the United States suggest that the behavioral response of mothers to economic fluctuations differs by race. This result also indicates that the negative relationship between unemployment and health is more strongly present in nations with weaker social insurance programs among OECD nations (Gerdtham and Ruhm 2006).

III. Data and Methods

The data used for examining the determinants of birth outcomes in this study are the micro files of the Vital Statistics for birth in Korea from 1993 to 2009. These files contain the universe of the digitalized birth registration records for all children born in the given years, which provide information on the characteristics of the parents and the newborn babies. The Korean legal system requires all citizens to be registered with a local government office within one month after birth. The documents required for the registration include birth certificates that are recorded and issued by hospitals. Information on the characteristics of parents and babies is drawn largely from birth certificates. The variables offered by the data include the child's gender, place of birth, date of birth, duration of gestation (in weeks), and birth weight, as well as the age, education, and occupation of the parents. The micro files of the data are available from 1991, but birth weight began to be reported in 1993.

The monthly or quarterly unemployment rates in each province, the primary indices of business conditions that children born in particular places and times are exposed to, are drawn from the data on Economically Active Population Surveys available at the website of the Korean Statistical Office. The source provides monthly unemployment rates for each province from 1998, and quarterly unemployment rates for the period prior to 1998. The unemployment statistics for the city of Ulsan are available from 1998 after the city became an independent metropolitan city, detached from the province of Gyeongnam.

A key task required for this study is to determine the business condition that a newly born child was exposed to while in utero. For the purpose, the province-specific average unemployment rates for all possible timing and duration of pregnancy from 1992 to 2009 were computed, and assigned to each newborn from 1993 to 2009 by the month of birth and the duration of gestation. For instance, for the Seoul natives born in the first half of October 2009 after a nine-month gestation period, the unemployment rate in pregnancy is defined by the average unemployment rate in Seoul from January 2009 to September 2009. If babies with the same date and place of birth were born after an eight-month gestation period, the average unemployment rate in Seoul from February 2009 to September 2009 is assigned to them. For those born in the second half of October, the unemployment rate in October

is counted in computing the average for the period of pregnancy.

The primary variable on birth outcomes available from the Korean Vital Statistics is birth weight. In addition, I consider if the birth weight is lower than 2.5 kg (referred to as low birth weight). A voluminous literature has established that LBW has persistent adverse effects on health and socioeconomic outcomes over the life cycle (Currie and Hyson, 1999; Behrman and Rosenzweig, 2004; Black, Devereux, and Salvanes, 2007; Currie and Moretti, 2007). For example, Black, Devereux, and Salvanes (2007) analyzed Norwegian twins and indicated that LBW has long-run adverse effects on adult height, IQ, earnings, and education. Currie and Moretti (2007) stated that LBW among individuals born in California has modest but statistically significant negative effects on educational attainment and the probability of living in a wealthy neighborhood.

With the birth registration data linked to the data on unemployment rates, the following regression equation is estimated:

$$y_{it} = \alpha + \beta U_{it} + \gamma X_{it} + \delta Z_{it} + \tau_{it} + \nu_{it} + \varepsilon_{it}. \quad (1)$$

In Equation (1), y denotes the variable pertaining to birth outcomes (birth weight or the probability of LBW), U variable on unemployment rate in the province of birth during pregnancy (either the average or dummy variables for unemployment rate), X characteristics of birth (gender, multiple birth, and parity), Z parental SES (education and occupation), τ variable on the year of birth (either cubic terms of the year of birth or dummy variables for the year of birth), ν dummy variables for the province of birth, and ε error term.

IV. Regression Results

Table 1 presents the results of baseline regressions conducted for investigating the effects of prenatal exposure to macroeconomic conditions on birth weight based on three different specifications. In the first model (Column 1), only the variables of key determinants of birth weight, such as gender of the child (male), multiple birth (twins or triplets), and parity order (second, third, or higher) are included along with the average unemployment during pregnancy. In the second model (Column 2), the variables of the educational attainment and occupation of the parents are added. Schooling is classified into four categories,

TABLE 1
BUSINESS CONDITION DURING PREGNANCY AND BIRTH WEIGHT (IN GRAMS)

	Mean	(1)		(2)		(3)	
		$\hat{\partial}y/\hat{\partial}x$	P-value	$\hat{\partial}y/\hat{\partial}x$	P-value	$\hat{\partial}y/\hat{\partial}x$	P-value
Intercept		3223.125	<.0001	3230.635	<.0001	60222.2	<.0001
<u>Measure of Business Condition</u>							
Unemployment rate	3.5288	-3.419	<.0001	-3.779	<.0001	-3.267	<.0001
<u>Characteristics of Birth</u>							
Male	0.5240	99.222	<.0001	99.141	<.0001	98.814	<.0001
Twins	0.0177	-824.088	<.0001	-824.202	<.0001	-820.462	<.0001
Triplets	0.0002	-1042.590	<.0001	-1044.240	<.0001	-1044.92	<.0001
Birth parity: second	0.4073	29.234	<.0001	31.093	<.0001	29.755	<.0001
Birth parity: third or higher	0.0890	73.333	<.0001	90.564	<.0001	89.304	<.0001
<u>Mother's SES</u>							
Mother aged under 20	0.0095			-56.858	<.0001	-52.241	<.0001
Mother aged 20-24	0.1181			-8.903	<.0001	-10.179	<.0001
Mother aged 30 to 34	0.3117			-8.659	<.0001	-4.628	<.0001
Mother aged 35 to 39	0.0717			-33.446	<.0001	-28.328	<.0001
Mother aged 40 or older	0.0096			-77.093	<.0001	-71.945	<.0001
Mother Middle school or less	0.0553			-12.721	<.0001	-19.830	<.0001
Mother college or higher	0.4041			-4.996	<.0001	2.794	<.0001
Mother's education unknown	0.0050			-17.968	<.0001	-11.699	0.0121
Mother Professional job	0.0563			-3.969	<.0001	-4.324	<.0001
Mother Clerical job	0.0733			5.577	<.0001	9.491	<.0001
Mother Service/Sales	0.0261			6.400	<.0001	9.668	<.0001
Mother Farming	0.0076			6.368	0.0006	3.065	0.1008
Mother Skilled job	0.0029			-0.260	0.9226	5.065	0.0582
Mother Unskilled job	0.0015			-9.066	0.0150	1.952	0.6003
Mother Occupation unknown	0.0083			-9.415	<.0001	-6.683	0.0022
<u>Father's SES</u>							
Father aged under 20	0.0073			-73.256	<.0001	-70.616	<.0001
Father aged 20-24	0.0261			-13.849	<.0001	-13.810	<.0001
Father aged 25 to 29	0.2755			1.952	<.0001	0.683	0.0677
Father aged 35 to 39	0.1829			-5.777	<.0001	-2.650	<.0001
Father aged 40 or older	0.0428			-16.679	<.0001	-10.415	<.0001
Father Middle school or less	0.0583			-15.706	<.0001	-19.301	<.0001
Father college or higher	0.5019			10.559	<.0001	9.596	<.0001
Father's education unknown	0.0066			-54.315	<.0001	-56.180	<.0001
Father Professional job	0.1682			-0.961	0.0259	-0.545	0.2062
Father Service/Sales	0.2065			1.624	<.0001	2.860	<.0001
Father Farming	0.0279			-13.625	<.0001	-10.316	0.0160
Father Skilled job	0.1212			1.899	0.0002	-1.246	<.0001
Father Unskilled job	0.0574			-8.662	<.0001	-4.376	<.0001
Father Not working	0.0450			-12.996	<.0001	-7.177	<.0001
Father Occupation unknown	0.0160			-7.350	<.0001	-1.235	0.3922
<u>Timing and Place of Birth</u>							
Cubic cohort trend			No		No		Yes
Province dummy			No		No		Yes
R-square		0.0730		0.0750		0.0770	
F-value		121809		20793.5		14545.8	
P-value		<.0001		<.0001		<.0001	

Source: Micro data on the Korean Vital Statistics (Birth) for 1993 to 2009.

Note: The number of observations is 9,280,097. The dependent mean is 3266.64 grams. Omitted category (control group) is: first child; mothers aged 25 to 29; fathers aged 30 to 34; parents with high school education; fathers with clerical jobs; and mothers not working.

namely, (1) middle school or lower, (2) high school, (3) college or higher, and (4) education unknown. Occupation is classified into eight categories, namely, (1) professional, (2) clerical job, (3) service and sales, (4) farming, (5) skilled, (6) unskilled, (7) not working, and (8) occupation unknown. In the final model (Column 3), the polynomial terms of the year of birth of the child (YOB, YOB2, and YOB3) are included to consider the long-term changes in birth weight across birth cohorts as well as province dummy variables.

The results suggest that prenatal exposure to recession reduced the birth weights of children. The coefficient for the average unemployment during the gestation period is negative and significant (p -value < 0.0001). The magnitude of the coefficient suggests that a one percent increase in the unemployment during pregnancy lowers the birth weight of the child by approximately 3.4 grams (or roughly one percent of the average birth weight), controlling for key birth characteristics (Column 1). Adding parental socioeconomic characteristics (Column 2) slightly increases the magnitude of the effect of unemployment (3.8 grams), whereas controlling the timing and place of birth (Column 3) slightly reduces the size of the coefficient for the unemployment rate (3.3 grams).

The effects of birth characteristics and parental SES exhibit largely anticipated signs. Boys are heavier at birth than girls. Multiple births reduce birth weights, and higher-parity children are heavier at birth. Parental education is positively related to birth weight. The quality of parental occupation is not perfectly matched with offspring birth weight. For instance, children of professional mothers are significantly lighter than those of non-working mothers and mothers with clerical, service/sales, or skilled jobs. Similarly, children of fathers with service/sales jobs are slightly heavier at birth than those of fathers with professional jobs.

Table 2 presents the results of the linear probability model estimations of how in-utero exposure to recession influences the risks of LBW (*i.e.*, under 2.5 kg). Higher unemployment rates while in pregnancy not only reduce the average birth weight of the children, but also increase the probability that they are born with LBW. With parental SES controlled for (Column 2), a one-percentage point increase in unemployment during pregnancy is associated with a 0.04-percentage point (or 1.1% of the sample probability of LBW) increase in the probability of LBW. Controlling the cubic cohort trend and province

TABLE 2
 BUSINESS CONDITION DURING PREGNANCY AND PROBABILITY OF LOW BIRTH WEIGHT (<2.5KG)

	(1)		(2)		(3)	
	$\hat{\partial}y/\hat{\partial}x$	P-value	$\hat{\partial}y/\hat{\partial}x$	P-value	$\hat{\partial}y/\hat{\partial}x$	P-value
Unemployment rate	0.0003	<.0001	0.0004	<.0001	0.0002	<.0001
Characteristics of Birth	Yes		Yes		Yes	
Parental SES	No		Yes		Yes	
YOB, YOB ² ,YOB ³	No		No		Yes	
Province dummy	No		No		Yes	
R-square	0.0994		0.1015		0.1020	
F-value	170696.0		28977.4		19798.4	
P-value	<.0001		<.0001		<.0001	

Source: Micro data on the Korean Vital Statistics (Birth) for 1993 to 2009.

Note: The number of observations is 9,280,097. The dependent mean is 0.0372.

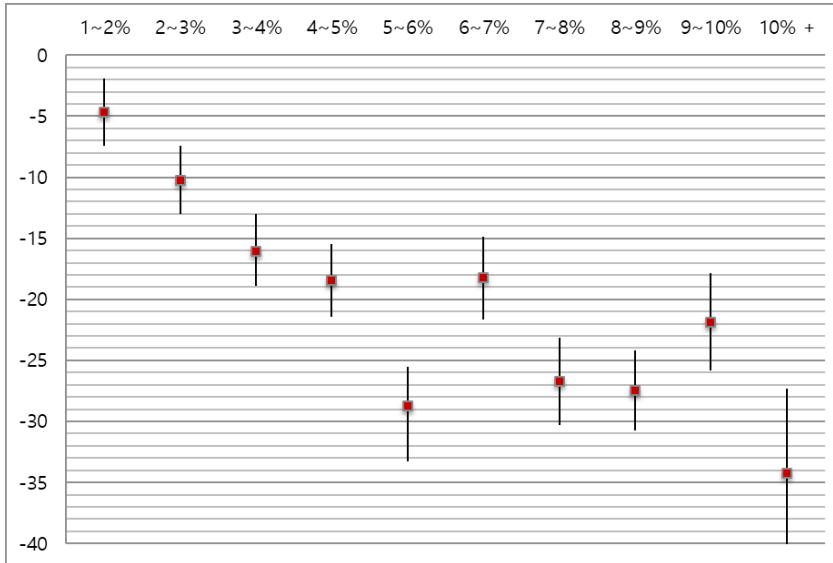
The same independent variables used in the regressions presented in Table 1 are included in the regressions but omitted from the table.

of birth (Column 3) diminishes the magnitude of the effect (0.02 percentage points).

Several robustness checks are performed. First, the true relationship between the business condition during pregnancy and birth outcomes may not be linear as implicitly assumed in the baseline specification. To consider this possibility, dummy variables for 11 ranges (each of the one-percentage point range from 0 to under 1%, to 9% to under 10%, and 10% and higher) of unemployment rates are included in the regressions.

The results reported in the first column of Table 3A (and also in Figure 1) suggest that birth weight sharply decreases as the unemployment rate increases between the unemployment rates from 0 to under 1% and 5 to 6%. The average birth weight of the babies who were prenatally exposed to the average unemployment between 5% and 6% were nearly 30 grams lighter than those who were in utero during a prosperous period with the average unemployment under 1%. The relationship between the unemployment rate during pregnancy and birth weight flattens for the range of higher unemployment rates, although the birth weight of a small fraction of babies (0.2% of the sample) who are exposed to the unemployment of 10% or higher are considerably lighter.

Similarly, the positive relationship between the unemployment rate



Note: Characteristics of children and parents as well as place and timing of birth are controlled. See text for the regression result.

FIGURE 1

EFFECT OF AGGREGATE UNEMPLOYMENT RATE ON BIRTH WEIGHT: 95% CONFIDENCE INTERVAL

during pregnancy and the probability of LBW is more strongly observed for the range of unemployment rates 0%–1% to 5%–6% (Column 2 of Table 3A). The babies prenatally exposed to the average unemployment between 5% and 6% are nearly 0.6 percentage points (or 15% of the sample mean) more likely to weigh under 2.5 kg than those who were exposed to the average unemployment under 1%. For the range of higher unemployment rates, the effect of macroeconomic condition on the risk of LBW becomes weaker: the coefficients for the unemployment rates 7%–8% and 9%–10% are statistically insignificant at the 5% level.

To consider the non-linear relationship between business condition while in utero and birth outcomes, the natural log value and quadratic terms of the unemployment rate during pregnancy are employed in the regressions (panels B and C of Table 3). To evaluate the effect around the sample mean of unemployment (3.529), the size of the decrease in birth weight associated with an increase in the unemployment rate from 3% to 4% is computed using the estimated the estimated

TABLE 3
 BUSINESS CONDITION DURING PREGNANCY AND BIRTH OUTCOMES: ALTERNATIVE SPECIFICATIONS

	Mean	(1) Birth Weight		(2) LBW	
		$\partial y/\partial x$	P-value	$\partial y/\partial x$	P-value
<u>(A) Unemployment Dummy Variable</u>					
Unemployment rate 1~2%	0.1366	-4.672	<.0001	0.0015	0.0072
Unemployment rate 2~3%	0.2671	-10.248	<.0001	0.0016	0.0060
Unemployment rate 3~4%	0.2900	-16.034	<.0001	0.0026	<.0001
Unemployment rate 4~5%	0.1721	-18.433	<.0001	0.0020	0.0011
Unemployment rate 5~6%	0.0366	-28.751	<.0001	0.0057	<.0001
Unemployment rate 6~7%	0.0244	-18.263	<.0001	0.0006	0.4017
Unemployment rate 7~8%	0.0169	-26.713	<.0001	0.0013	0.0801
Unemployment rate 8~9%	0.0301	-27.485	<.0001	0.0030	<.0001
Unemployment rate 9~10%	0.0105	-21.842	<.0001	0.0013	0.1242
Unemployment rate 10% or higher	0.0021	-34.273	<.0001	0.0049	0.0007
<u>(B) Natural Log of Unemployment</u>					
Log of unemployment rate	1.1555	-14.132	<.0001	0.0009	<.0001
<u>(C) Quadratic Terms for Unemployment</u>					
Unemployment rate	3.5288	-8.313	<.0001	0.0007	<.0001
Unemployment rate squared	15.3129	0.492	<.0001	-0.0001	<.0001
<u>(D) Year Fixed-Effect Model</u>					
Unemployment rate	3.5288	-1.6747	<.0001	0.0004	<.0001
<u>(E) Excluding the Crisis Years</u>					
Unemployment rate	3.5288	-2.9384	<.0001	0.0002	0.0584

Source: Micro data on the Korean Vital Statistics (Birth) for 1993 to 2009.

Note: The number of observations is 9,280,097 for (A) to (D) and 8,012,950 for (E). The dependent mean is 0.0372 for (1) and 0.0372 for (2). The omitted category for panel (A) is unemployment under 1%. The same independent variables used in the regressions presented in the column 3 of Table 1 (model 3) are included in the regressions but omitted from the table, except that the variables on cubic cohort trend is replaced by dummy variables on the year of birth in panel (E).

coefficients obtained from these specifications. The calculated decline in birth weight is 4.1 grams for panel B and 4.9 grams for panel C, which are larger than the baseline coefficient, 3.3 grams (Column 3 of Table 1). This outcome suggests that the results of the baseline model assuming a linear relationship may understate the effect of the unemployment rate during pregnancy on birth outcomes.

In the baseline model, the cubic terms of the year of birth are included in the regressions to control long-term changes in birth outcomes across birth cohorts that are not captured by the

characteristics of the newborns and parents considered in the analyses. To further control the unobservable heterogeneity across years, a year fixed effect model is estimated (panel D of Table 3). For birth weight, the effect of unemployment remains significantly negative, although the magnitude of the coefficient diminishes by half (Column 1). By contrast, the effect of in-utero business condition on LBW increases in magnitude if the year fixed effect is controlled (Column 2).

Finally, this study investigates how the financial crises of 1998 and 1999 during which the unemployment rate soared affected the estimated relationship between business condition and birth outcomes. It looks like that the crisis is not solely responsible for producing the results. If the two crisis years are excluded from the analyses, then the estimated coefficients for the unemployment rate remain negative, although that for LBW becomes marginally insignificant (panel E).

V. Discussion

The effect of in-utero exposure to recession could differ by the stage of pregnancy when the economic shock is received. Bozzoli and Quintana-Domeque (2014) report that the birth weights of children to low-educated mothers in Argentina are sensitive to macroeconomic fluctuations during the first and third trimesters of pregnancy; by contrast, those of high-educated mothers only react to the first trimester of pregnancy. To verify this possibility, the average unemployment rate during a particular trimester of pregnancy is computed and included in the regressions. For example, for the Seoul natives born in the first half of October 2009 after a nine-month gestation period, the unemployment rate during the first trimester of pregnancy is defined by the average unemployment rate in Seoul from January 2009 to March 2009. The average unemployment rates in the three trimesters of the children born in a given month are highly correlated with each other; thus, the unemployment rate for each trimester is individually included in the regression. In addition to the baseline model, quadratic specification is also attempted.

The regression results reported in Table 4 suggest that a recession has a stronger negative effect on fetal health during the first and second trimesters of pregnancy. The estimated decrease in birth weight associated with a one-percent increase in the unemployment rate during the first, second, and third trimesters are 3 grams, 3.4 grams,

TABLE 4
 BUSINESS CONDITION DURING PREGNANCY AND BIRTH OUTCOMES BY STAGE OF PREGNANCY

	Mean	(1)		(2)	
		Birth Weight		LBW	
		$\partial y/\partial x$	P-value	$\partial y/\partial x$	P-value
(A) 1st trimester unemployment rate	3.518	-3.042	<.0001	0.0002	<.0001
(B) 2nd trimester unemployment rate	3.522	-3.421	<.0001	0.0002	<.0001
(C) 3rd trimester unemployment rate	3.547	-2.086	<.0001	-0.0000	<.0001
(D) 1st trimester unemployment rate	3.518	-7.614	<.0001	0.0012	<.0001
1st trimester unemployment rate squared	15.474	0.440	<.0001	-0.0001	<.0001
(E) 2nd trimester unemployment rate	3.522	-10.035	<.0001	0.0015	<.0001
2nd trimester unemployment rate squared	15.492	0.640	<.0001	-0.0001	<.0001
(F) 3rd trimester unemployment rate	3.547	-3.741	<.0001	-0.0000	<.0001
3rd trimester unemployment rate squared	15.693	0.160	<.0001	0.0000	<.0001

Source: Micro data on the Korean Vital Statistics (Birth) for 1993 to 2009.
 Note: The number of observations is 9,280,097. The dependent mean is 0.0372 for (1) and 0.0372 for (2). The same independent variables used in the regressions presented in the column 3 of Table 1 (model 3) are included in the regressions but omitted from the table.

and 2.1 grams (panels A to C), respectively. Based on the results from the model with quadratic terms of unemployment rate (panels D to F), a change in the unemployment rate from 3% to 4% during the first, second, and third trimester would reduce birth weight by 4.5 grams, 5.6 grams, and 2.6 grams, respectively. Higher joblessness rates during the third trimester of pregnancy *decreases* the risk of LBW, although the magnitude of the effect is extremely small; by contrast, recessions in the first and second trimesters significantly increase the probability of LBW (Column 2 of Table 4).

The existing literature suggests that the health consequences of in-utero exposure to an adverse condition could differ by the gender of the child. To verify this case, the baseline regressions are conducted separately for boys and girls. The results reported in Table 5 indicate that the adverse effect of in-utero exposure to a recession on the risk of LBW is slightly larger for girls than for boys, whereas the gender difference in the effect on birth weight is extremely small. The coefficient for the unemployment among girls is more than 30% larger than that for boys (Panel A for Columns 3 and 4). If a quadratic function of the unemployment rate is applied (Panel B of Columns 3 and 4), an increase in the unemployment rate from 3% to 4% would raise the probability of LBW among girls by 0.048 percentage points, which is nearly three

TABLE 5
BUSINESS CONDITION DURING PREGNANCY AND BIRTH OUTCOMES BY SEX

	Birth Weight				LBW			
	(1) Boys		(2) Girls		(3) Boys		(4) Girls	
	$\hat{\partial}y/\hat{\partial}x$	P-value	$\hat{\partial}y/\hat{\partial}x$	P-value	$\hat{\partial}y/\hat{\partial}x$	P-value	$\hat{\partial}y/\hat{\partial}x$	P-value
(A)								
Unemployment rate	-3.256	<.0001	-3.287	<.0001	0.00016	0.0091	0.00021	0.0021
(B)								
Unemployment rate	-7.688	<.0001	-8.975	<.0001	0.00031	0.1748	0.00111	<.0001
Unemployment rate squared	0.432	<.0001	0.555	<.0001	-0.00002	0.4836	-0.00009	0.0005

Source: Micro data on the Korean Vital Statistics (Birth) for 1993 to 2009.

Note: The number of observations is 4,860,791 for boys and 44,19,306 for girls. The dependent mean is 3314.97 for (1), 3213.16 for (2), 0.0334 for (3), and 0.0414 for (4). The same independent variables used in the regressions presented in the column 3 of Table 1 (model 3) are included in the regressions but omitted from the table.

times larger than the estimate among boys (0.017 percentage points).

As previously noted, the evidence drawn from the United States suggests that exposure to a recession tends to improve the health of the newborns. This phenomenon may be explained by the fact that the substitution effect of an economic downturn dominates the potential negative income effect. That is, a weak business condition would decrease the opportunity costs of the women's time, which improve health behaviors during pregnancy. Another major mechanism (*i.e.*, changes in the composition of parents) is less problematic in this study because the parental characteristics are controlled using micro data.

The strength of the potential substitution and income effects of business cycle may differ based on the labor-market status of pregnant women. Thus, the effect of business condition on the health of the newborns could depend on whether the mother is working. The baseline regressions are performed separately on the samples of children born to mothers who were not working at the time of delivery and those born to working mothers (Panel A of Columns 1 and 2 of Table 6). I also conduct regressions on the full sample, adding the interaction term of the unemployment and the dummy variable for working mothers (Panel A of Column 3). The results indicate that the negative effects of prenatal exposure to higher unemployment rates on birth weight are observed only for the children of non-working mothers. The interaction term is

TABLE 6
 BUSINESS CONDITION DURING PREGNANCY AND BIRTH OUTCOMES BY MOTHER'S LABOR-MARKET STATUS

	(1)		(2)		(3)	
	Mother not working		Mother working		All	
	$\hat{\partial}y/\hat{\partial}x$	P-value	$\hat{\partial}y/\hat{\partial}x$	P-value	$\hat{\partial}y/\hat{\partial}x$	P-value
(A) Birth weight						
Unemployment rate	-1.9480	<.0001	-0.0437	0.9375	-3.3279	<.0001
Unemployment rate*Mother working					0.4193	0.0864
Mother working					2.8982	0.0021
(B) LBW						
Unemployment rate	0.0004	0.0002	0.0004	0.0750	0.0002	0.0008
Unemployment rate*Mother working					0.0002	0.0483
Mother working					-0.0010	0.0098

Source: Micro data on the Korean Vital Statistics (Birth) for 1993 to 2009.

Note: The number of observations is 7666324 for (1), 1613773 for (2), and 9,280,097 for (3).

The same independent variables used in the regressions presented in the column 3 of Table 1 (model 3) are included in the regressions but omitted from the table, except the variables on maternal occupation that were excluded from regressions (1) and (2).

positive and marginally significant. The effect of the business condition on LBW is similar in magnitude between the children of working and non-working mothers, but its statistical significance is substantially lower for the children of working mothers (Panel B of Columns 1 and 2).

The relative magnitudes of the potential substitution and income effects of business cycle may have changed over time. For the two decades under investigation, several aspects of the Korean economy had radically changed following the financial crises of 1998 and 1999. To take some examples relevant for the changing effects of business cycle on fetal health, the traditional lifetime employment system considerably weakened, the share of insecure temporary jobs increased, and a variety of social welfare programs, including the unemployment insurance benefits, were created or expanded in response to the hardships induced by the crisis. After the financial crisis, a series of policy reforms extended the protection of National Health Insurance to low-income individuals (Kim and Kwon 2014).

To verify if the aforementioned transformations influenced the effects of in-utero exposure to recessions on fetal health, I separately perform the regressions for the determinants of birth outcomes for the pre-crisis (1993 to 1997) and post-crisis (2000 to 2009) periods based on the year of birth (Panel A of Columns 1 and 2 of Table 7). I also conduct

TABLE 7
BUSINESS CONDITION DURING PREGNANCY AND BIRTH OUTCOMES: COMPARISON
BETWEEN PRE- AND POST-CRISIS PERIODS

	(1) Pre-Crisis (1993-1997)		(2) Post-Crisis (2000-2009)		(3) 1993-1997 and 2000-2009	
	$\hat{c}y/\hat{c}x$	P-value	$\hat{c}y/\hat{c}x$	P-value	$\hat{c}y/\hat{c}x$	P-value
(A) Birth weight						
Unemployment rate	-8.0679	<.0001	-1.6052	0.0082	-3.7905	<.0001
Unemployment rate *Post-crisis					3.5648	<.0001
Post-crisis					-22.7274	<.0001
(B) LBW						
Unemployment rate	0.0016	<.0001	-0.0004	0.1456	-0.0002	0.2451
Unemployment rate*Post-crisis					-0.0003	<.0001
Post-crisis					0.0076	<.0001

Source: Micro data on the Korean Vital Statistics (Birth) for 1993 to 2009.

Note: The number of observations is 3,108,230 for (1), 4,904,720 for (2), and 8012950 for (3).

The same independent variables used in the regressions presented in the column 3 of Table 1 (model 3) are included in the regressions but omitted from the table.

regressions with the sample of pre- and post-crisis births (excluding the births in 1998 and 1999), adding the interaction term of the unemployment and the dummy variable for the post-crisis period (Panel A of Column 3).

The results indicate that higher unemployment rates during pregnancy have significantly stronger negative effects on birth outcomes during the pre-crisis period. The size of the effect of unemployment rate on birth weight during the pre-crisis period is roughly five times larger in absolute value than that during the post-crisis period. The coefficient for the interaction term in the regression for birth weight is positive and statistically significant. The effect of unemployment rate on LBW changed from statistically significant positive during the pre-crisis period to insignificant negative during the post-crisis years. The coefficient for the interaction term in the regression for LBW is negative and statistically significant.

VI. Conclusion

This study investigates how the macroeconomic conditions to which mothers are exposed during pregnancy affect the birth weights and the probability of LBW of the children in South Korea. The analyses are

based on the universe of birth registration records from 1993 to 2009 that are linked to the unemployment statistics by province and month. This paper provides the initial evidence on the issue based on birth outcomes that are drawn from Korea.

The results suggest that prenatal exposure to recessions has negative effects on birth outcomes in Korea. The average birth weight of the babies who are prenatally exposed to the average unemployment between 5% and 6% were nearly 30 grams lighter than those who were in utero during a prosperous time and place with the average unemployment under 1%. The babies exposed to the average unemployment between 5% and 6% are nearly 0.6 percentage points (or 15% of the sample mean) more likely to weigh under 2.5 kg than those who were exposed to the average unemployment under 1%.

A recession has a stronger negative effect on fetal health during the first and second trimesters of pregnancy. The adverse effect of in-utero exposure to a recession on the risk of LBW is slightly larger for girls than for boys, whereas the gender difference in the effect on birth weight is extremely small. The negative effects of prenatal exposure to higher unemployment rates on birth weight are observed only for the children of non-working mothers. Higher unemployment rates during pregnancy had significantly stronger negative effects on birth outcomes during the period before the financial crises of 1998 and 1999 than in the post-crisis period.

This study suggests that the impact of macroeconomic conditions on fetal health could differ across countries or times. Completely understanding why the relationship between unemployment during pregnancy and birth outcomes in Korea differs from those found in the United States is beyond the scope of this paper. A possible explanation is that the adverse income effects of economic downturns are stronger than the potentially favorable substitution effects of recessions in Korea. For example, the labor force participation rate of married women in Korea is considerably lower than that in the United States. Recessions would not significantly change the health- or child care-related behaviors of non-working women; thus, this phenomenon might help explain why the income effects are stronger than the substitution effects in Korea. This hypothesis is also consistent with the result that the negative effects of recessions on birth outcomes are observed only for non-working women in Korea.

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