

Economic downturns during pregnancy and adverse birth outcomes: US 1989-2013
Working Paper

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Introduction

Despite substantial research examining effects of macroeconomic conditions on adult health (1-4), we know little about the impact of the economy on fetal health (5). Understanding this relationship is particularly important because growing evidence indicates that the environment—including economic conditions—during pregnancy may be linked to later-life health (6-8). Previous studies have examined associations between economic conditions and birth outcomes, but critical gaps remain in our understanding of the causal relationships between these factors. The recent Great Recession—the most devastating economic crisis in the U.S. since the 1930s—provides a unique opportunity to re-examine this question and to address critical gaps in the existing literature.

A key methodological challenge in this area of research lies in distinguishing the effects of economic conditions on fetal health from the effects of economic conditions on who is born (i.e., selection). That is, economic conditions prior to conception may affect women's choice or ability to conceive, and economic conditions during pregnancy may affect women's choice or ability to carry pregnancy to a live birth. Indeed, substantial research indicates that fertility declines during economic downturns; these declines appear to be largest in women under 30, who can postpone childbearing (9-11), and may be particularly pronounced among black teens (12, 13), who are at high risk of adverse pregnancy outcomes. Moreover, evidence suggests that economic downturns may be associated with differential pregnancy loss, leading to selection against weaker, male fetuses *in utero* (14-16). Taken together, these two lines of evidence suggest that birth outcomes may actually improve following economic downturns, due to selection against of higher risk pregnancies.

At the same time, economic conditions during pregnancy may also affect fetal health through non-selection pathways, such as those illustrated in Figure 1. Notably, economic downturn can affect not only women who personally experience job or income loss, but all members of affected communities, via real or perceived changes in income, working hours, and availability of resources. These economic sequelae may affect individuals' health behaviors or psychosocial stress levels, which may in turn influence the health of the developing fetus.

Very little empirical work has examined the associations between economic conditions and indicators of fetal health (5). In a seminal study of U.S. infants born between 1975 and 1999, Dehejia and Lleras-Muney (17) find evidence to suggest that declining fertility among low education black women during economic downturns led to decreased rates of low birth weight (LBW) and neonatal and infant mortality. This study, however, examined unemployment rates in the year prior to conception, limiting its ability to distinguish between selection effects and potential effects of economic conditions on the health of pregnancies that did result in live births. On the other hand, two studies using U.S. data from the 1980s and 1990s found that women exposed to increases in the unemployment rate in their state of residence *during* pregnancy gave birth to lower weight infants (18, 19). Catalano and Serxner (20) used a natural experiment—threatened layoffs of all state workers in Sacramento, California that never actually occurred—to examine the effect of ambient economic fear on birth weight, and found an increase in rates of low birth weight (LBW) among male gestations. A study using data from 1999-2008 in 4 U.S. states found that the announcement of mass layoffs (an indicator of fear related to the economy) during pregnancy was associated with declines in both birthweight and length of gestation even prior to the actual layoffs (21). Taken together, these studies indicate that economic downturns *during* pregnancy may lead to reduced fetal growth and/or length of gestation. These studies,

however, have not explicitly accounted for the potentially opposing forces of selection. Moreover, to our knowledge, no study has examined the associations between economic conditions during the Great Recession and fetal health.

The current study, therefore, aims to examine associations between state-level economic conditions during pregnancy and adverse birth outcomes as indicators of fetal health, using data on all singleton births in the U.S. from 1989-2013 and accounting for selection effects on who is born. We hypothesize that, after accounting for selection effects, exposure to economic downturn during pregnancy will be associated with higher rates of adverse outcomes, specifically small for gestational age (SGA) and preterm birth (PTB). We also examine differences in the relationship between state-level economic conditions and birth outcomes comparing the Great Recession and post-Recession periods to pre-Recession periods.

Methods

Data and study population. We obtained individual-level birth data from the National Center for Health Statistics (22) vital statistics natality all-county files, which include data on all live births in the U.S. from 1989-2013 (n=101,289,158), including maternal state of residence. Our analytic sample included singleton births to U.S. resident women 15-44 years of age in one of the 50 U.S. states or Washington D.C. (n=98,069,012). We excluded records missing data on length of gestation or birth weight and those with implausible combinations of birth weight and gestational age (23) (n=2,151,775) as well as records missing maternal age, nativity, parity, or education (n=4,724,404).

We then estimated months of pregnancy for each birth based on birth month and length of gestation, and linked monthly, state-level unemployment data from 1988-2013 obtained from the Bureau of Labor Statistics *Local Area Unemployment Statistics* (24) to individual birth

records by state and month of pregnancy. This linkage enabled us to assess exposure to state economic conditions by trimester of pregnancy. That is, for a pregnancy in the state of Alaska that began in January 2000, the average first trimester unemployment rate was based on the unemployment rate in Alaska from January-March, 2000, whereas the first trimester average for a pregnancy starting in February, 2000 was based on the unemployment rate from February-April, 2000. Our analyses focused on economic conditions in the 1st and 2nd trimester of pregnancy because 1) prior work suggests that economic conditions in early pregnancy trimester of pregnancy are most strongly associated with adverse birth outcomes (18, 19), and 2) gestations lasting <9 months will be missing data for the last trimester; missing data would therefore be completely informed by the outcome in some analyses. We restricted our sample to births conceived after January 1, 1989 to ensure that we had at least 12 months of pre-conception economic data on all births. Our analytic sample included 88,309,569 births.

Measures.

Unemployment rate. We calculated the average unemployment rate (i.e., the # of individuals seeking employment divided by the total # in the workforce) over each of the 1st and 2nd trimesters of pregnancy (hereafter, E_1 and E_2 , respectively). Unemployment rates are a commonly used measure of economic health and facilitate comparison of our findings to those of previous research. The unemployment rate may also provide a measure of the population's perception of the economy, as it is often reported in the media. We examined both the continuous average unemployment rate as well as a binary "high unemployment" variable defined as >8.8% unemployment, which corresponded to the 90th percentile of trimester-specific average unemployment.

Great Recession. In the U.S., the official time period of the Great Recession was December, 2007 to June, 2009 (<http://www.nber.org/cycles.html>). We classified births as either pre-Recession (born prior to December, 2007), exposed to the Recession (born between December, 2007 and March, 2010 [the last month of birth for which some portion of gestation could have been exposed to the official Recession]), or post-Recession (born after March, 2010).

Adverse birth outcomes. We examine two adverse birth outcomes: 1) preterm birth (PTB), defined as <37 weeks completed gestation and 2) small for gestational age (SGA), defined as <10th percentile of birth weight for gestational age using a published national reference (25).

Maternal characteristics. Maternal characteristics included: age (<20, 20-29, 30-39, >40 years), race/ethnicity (American Indian/Alaska Native, Asian/Pacific Islander, Hispanic, non-Hispanic black, non-Hispanic white, and other), nativity (U.S. born, foreign born), parity (nulliparous, primiparous, multiparous), marital status (married, not married), and educational attainment. We used previously published methods to reconcile differences between the 1989 and 2003 birth certificate in the measurement of educational attainment (26), resulting in the following five categories: no high school/<9 years, some high school/9-11 years, high school diploma/12 years, some college/13-15 years, college degree/ \geq 16 years.

Statistical analysis. We first calculated descriptive statistics (means and frequencies of all key variables) on all births in our dataset as well as within strata defined by the pre-Recession, Recession, and post-Recession periods.

Fixed effect logistic regression models. We followed the traditional “fixed effects” regression approach used in prior literature examining impacts of economic conditions on health. That is, we estimated logistic regressions of our outcomes (PTB and SGA) on the primary

exposure variables (E_1 and E_2), using both the continuous and binary specifications of unemployment. Model 1 included no additional covariates. Model 2 included fixed effects for month of birth (to control for seasonality), year of birth (to control for general secular trends associated with both birth outcomes and the economy), and state of birth (to account for time-invariant state characteristics associated with both birth outcomes and the economy). Models 3 and 4 accounted for selection in 2 ways. In Model 3, we included a control for the average unemployment rate in the 6 months prior to conception (E_0), which we hypothesized could influence birth outcomes via selection effects on who becomes pregnant. In Model 4, we controlled for observed maternal characteristics (Z) that may be related to both selection and birth outcomes: maternal age, race/ethnicity, nativity, marital status, parity, and education. In Model 5, we examined the association between exposure to the Recession or post-Recession periods (compared to pre-Recession) and adverse birth outcomes; in Model 6, we added an interaction term between E_1 and E_2 and the Recession variables to determine whether the association between state-level unemployment and adverse birth outcomes differed by time period.

Because these data are clustered by state of residence, we tested models using generalized estimating equations with exchangeable correlation by state; however, although standard errors from these models were larger than those from unclustered models (as expected), the increase in standard error did not change our inference. We therefore proceeded with unclustered models because the GEE estimation is extremely difficult using such large sample sizes. Because such large sample sizes can result in statistical significance for small differences, and because these data represent essentially the universe of births in our study sample, we interpreted our findings by placing greater weight on the practical significance and magnitude of observed differences

rather than statistical significance. All analyses were completed using SAS 9.4 (Cary, NC).

Results

Table 1 provides descriptive statistics on the 88,467,274 births in our analytic sample. About 60% of births were to non-Hispanic white (NHW) women, 15% were to non-Hispanic black (NHB) women, and 20% were to Hispanic women; 20% of births were to women born outside the U.S.. About 40% of births were to nulliparous women, and 65% were to married mothers. Approximately one-third of births were to mothers with no high school diploma, one-third were to women with a high school education, and the rest were to women with some college education or more. Almost ten percent of births were preterm, and 10.3% were SGA. The mean (SD) average unemployment rates in trimesters one and two were 6.0 (2.0) and 6.1 (2.0) percent, respectively, and about ten percent of all births were exposed to high unemployment in each trimester. The majority of births occurred prior to the Great Recession, but 10% were exposed to the Recession and 14% were post-Recession. Table 1 indicates that the characteristics of births differed by Recessionary period in terms of race/ethnicity, nativity, marital status, and educational attainment, supporting the need to include these variables in the analysis. Notably, births to NHW mothers in the later years of the data, as births to Hispanic and Asian/Pacific Islander (API) mothers increased, reflecting demographic trends; however, the data also suggest that Hispanic births declined slightly in post-Recession years, possibly reflecting the slowing tide of immigration due to fewer economic opportunities in the U.S. Increases, followed by decreases, in the proportion of foreign-born mothers may also reflect these secular trends in immigration. Declines in births to married women and women with a high school education or less are also evident. Furthermore, these descriptive data suggest that a higher proportion of infants were born preterm during the Recession (10%) compared to post-Recession (9.5%). It is

important to note, however, that PTB exhibits strong temporal trends (increasing from 1989-2006 and decreasing since 2006 (27, 28)), underscoring the need for analyses that account for secular trends.

Fixed effect logistic regression models. Table 2 provides results from the traditional fixed effects regression models for PTB only. Coefficients on the “high unemployment” variables represent the odds ratio for PTB comparing births to mothers whose state of residence had an average unemployment rate of $>8.8\%$ in the first and second trimester, respectively, to births to mothers whose state unemployment rate average was $\leq 8.8\%$ in those trimesters. Prior to adding the state, year, and month fixed effects, high unemployment in both trimesters is associated with modestly lower odds of PTB. After adding the fixed effects, however, high unemployment in the first trimester is no longer associated with PTB. Finally, after accounting for selection in Models 3 and 4, results indicate that high unemployment in the first trimester is not associated with PTB, and high unemployment in the second trimester is associated with a modest reduction in odds of PTB (Model 4 OR : 0.98, 95% confidence interval [CI]: 0.98, 0.98).

The Great Recession itself was not associated with odds of PTB (OR: 1.01, 95% CI: 1.00, 1.02) (Table 1, Model 5). However, the association between high unemployment and PTB differed significantly by Recession periods (p-value for interaction term <0.01). Prior to the Great Recession, high first trimester unemployment was associated with modestly increased odds of PTB (OR: 1.04, 95% CI: 1.03, 1.05). On the other hand, the previously described reduction in odds of PTB associated with high second trimester unemployment is apparent only during the Recession and post-Recession periods (Table 1, Model 6).

Associations between maternal covariates and odds of PTB were in the expected directions. Mother who were <20 and >30 years of age, of minority race/ethnicity, multiparous,

or unmarried had higher odds of PTB compared to women who were 20-39, non-Hispanic white, nulliparous, or married (Table 2). Foreign-born women, primiparous women, and women with a college education or more had lower odds of PTB compared to U.S.-born women, nulliparous women, and women with less than a college education (Table 2).

We found no significant associations between high unemployment in either trimester or the Great Recession periods and SGA (Appendix A). Findings using the continuous unemployment rate in the first and second trimesters of pregnancy were substantively similar to the findings presented in Table 2, however the magnitude of the coefficients was somewhat smaller—as expected, given that these coefficients represent only a one percent increase in the unemployment rate (data not shown).

Discussion

These analyses are the first of which we are aware to examine the associations between state-level unemployment and birth outcomes using data on all births in the U.S. for the past 25 years, and to examine this question in the context of the recent Great Recession. Our findings indicate that, during the time period of the Great Recession, odds of PTB among gestations exposed to high unemployment ($>8.8\%$ compared to $\leq 8.8\%$) in the second trimester of pregnancy was approximately 0.97 times the odds of PTB among unexposed gestations. Prior to the Great Recession, on the other hand, high unemployment in the first trimester of pregnancy was associated with a 4% increase in the odds of PTB. We found no associations between economic conditions during pregnancy and small for gestational age (SGA) birth. Our findings are notable because we take measures to account for the potential effects of economic conditions on selection into pregnancy and live birth by controlling for pre-conception unemployment as well as maternal characteristics potentially associated with both selection and birth outcomes.

Our finding that high unemployment in mid-pregnancy is associated with decreased odds of PTB during and in the aftermath of the Great Recession does not support our original hypothesis that exposure to economic downturn during pregnancy would be associated with higher rates of adverse birth outcomes. This finding is, however, consistent with prior literature indicating that stressful economic times may induce selection *in utero*, leading to better outcomes among gestations carried to term (30). This finding is also consistent with a recently proposed hypothesis that extending gestation during stressful times may act as an adaptive mechanism to protect both mother and offspring (31), which could result in declining PTB during economic downturns.

Our finding that high unemployment in early pregnancy was associated with increased odds of PTB pre-Recession is somewhat consistent with results of other work using pre-Recession data, although these previous studies typically found associations between economic downturn during pregnancy and lower birth weights or increased odds of SGA (18-20); we, in contrast, found no associations for SGA. The fact that we took more substantial measures to account for selection into pregnancy may partially explain these divergent findings. Moreover, in his study examining the impacts on pregnancy outcomes of mass layoff announcements, Carlson reports that most of the decrease in birth weight associated with these announcements could be attributed to declines in gestational age (21). Proposed mechanisms connecting exposure to economic downturn and increased odds of PTB include changes in maternal health behaviors (e.g., smoking or diet) or psychosocial stress in a way that increases risk for PTB (Figure 1). Few studies have investigated such pathways, although one study found that alcohol consumption increased among non-Hispanic black women exposed to economic downturn in early pregnancy (29).

It remains unknown, however, why we find that early pregnancy exposure to high state-level unemployment is associated with higher PTB *prior to* the Recession, while mid-pregnancy exposure is associated with lower PTB *during and after* the Recession. Although post-hoc, we propose 2 hypotheses to explain these findings. First, because the economic downturns of the early 1990s and early 2000s were relatively minor compared to the Great Recession, periods of high state-level unemployment during this pre-Recession era may have been more unexpected and therefore represented a more stressful event in comparison to high state-level unemployment during the Recession. Second, prior research has indicated substantial declines in fertility among young and Hispanic women in the U.S. during the Recession. Thus, compared to the pre-Recession births, births during and after the Recession may represent a different—and perhaps more select—group, in which the adaptive mechanisms of selection *in utero* and/or delayed gestation may outweigh the negative health impacts proposed in Figure 1. We note, however, that the magnitude of the associations between unemployment and PTB are small relative to associations for factors such as maternal age, race/ethnicity, parity, and education; given the large sample size, it remains possible that the observed associations reflect noise rather than causation.

The size and comprehensive nature of these natality data make them an unparalleled resource for this study. Furthermore, no prior study has examined the association between economic conditions and birth outcomes for the entire U.S. using recent birth certificate data. These data are, however, not without limitations. First, natality data do not include extensive individual- or household-level data on economic conditions (e.g. employment, income), limiting our ability to control for these variables. We emphasize, however, that we sought to estimate the “total effect” of macroeconomic conditions on adverse birth outcomes, including effects that are

mediated by individual job or income loss as well as effects mediated by more indirect mechanisms as illustrated by Figure 1. Second, it is nearly impossible to measure length of gestation with complete accuracy in naturally conceived pregnancies; our outcomes are therefore subject to measurement error. We do not anticipate that measurement error depends on economic conditions, so any resulting bias should be towards the null.

We chose to use the unemployment rate as a measure of macroeconomic conditions in a mother's state of residence during pregnancy because unemployment rates: 1) are available for the entire study period, 2) are a commonly used measure of economic conditions and facilitate comparison of our findings to those of other research, 3) typically increase during economic downturns, and 4) are more frequently reported in the media than other economic measures. However, the unemployment rate may not reflect economic conditions when many workers are discouraged from seeking work.

We still plan to undertake several additional steps in our analyses to fully understand the relationships between macroeconomic conditions and fetal health. (Analyses in these data take many hours to run; thus, it is not trivial to examine various model specifications and perfect our estimation techniques and we have not been able to complete all proposed analyses.) In our next steps, we intend to examine more refined versions of our outcomes to gain insight into the exact mechanisms contributing to our findings; that is, we will examine SGA separately among term and preterm births and we will examine categories of gestational age including early PTB, late PTB, and post-term birth. We will also examine other specifications of our economic measure including the employment rates and total wages in additional analyses. In addition, although the fixed effect models presented here are a mainstay of analyses of macroeconomic effects on health, they present an important challenge to making inference. That is, the coefficient on the

first trimester variable is interpreted as, for example, the association between a one-unit increase in high unemployment in the first trimester of pregnancy on the odds of PTB, holding constant high unemployment in the second trimester of pregnancy, the unemployment rate in the 6 months prior to pregnancy, and all maternal characteristics. We will therefore also conduct our analyses using the marginal structural model (MSM) methods presented by Robins and colleagues (32), which can parsimoniously incorporate information on selection factors and produce a smoothed estimate of the effect of unemployment on the odds of adverse birth outcomes. Finally, we will examine whether associations differ by maternal characteristics such as race/ethnicity, education, age, marital status, and parity, which will enable us to identify particularly vulnerable or resilient groups and may shed light on the mechanisms by which economic conditions impact birth outcomes.

In conclusion, our study finds that high unemployment in the first trimester of pregnancy is associated with higher odds of PTB prior to the Great Recession but that high unemployment in mid-prenancy is associated with lower odds of PTB during and after the Recession; these findings account for influences of macroeconomic conditions on selection into pregnancy. This study advances our understanding of how macro-level conditions, specifically those related to the economy, impact fetal health and provide up-to-date evidence on the impacts of the recent Great Recession on adverse birth outcomes in the US. In light of the fact that neither the high rates of or disparities in adverse birth outcomes in the US are fully explained by individual-level risk factors (33-35), this study provides modest evidence supporting the argument that the macro-level environment may at times play an important role in the health and outcomes of pregnancy.

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Table 1. Descriptive statistics for analytic sample of singleton U.S. births from 1989-2013 (n=88,309,569) overall and by period relative to the Great Recession.

		Pre GR	GR	Post GR
Sample size	88,309,569	66,797,585 (75.6)	8,966,366 (10.2)	12,545,618 (14.2)
		n (%)		
Maternal characteristics				
Race/ethnicity				
Non-Hispanic white	52,556,471 (59.5)	40,853,230 (61.2)	4,847,915 (54.1)	6,855,326 (54.6)
Non-Hispanic black	13,234,312 (15.0)	10,113,277 (15.1)	1,306,244 (14.6)	1,814,791 (14.5)
Hispanic	18,343,568 (20.8)	13,153,899 (19.7)	2,199,323 (24.5)	2,990,346 (23.8)
American Indian/Alaska Native	846,537 (1.0)	639,560 (1.0)	92,863 (1.0)	114,114 (0.9)
Asian/Pacific Islander	3,328,681 (3.8)	2,037,519 (3.1)	520,021 (5.8)	771,041 (6.2)
Age				
<20	9,817,226 (11.1)	7,884,984 (11.8)	918,316 (10.2)	1,013,926 (8.1)
20-29	47,005,656 (53.2)	35,672,797 (53.4)	4,780,320 (53.3)	6,552,539 (52.2)
30-39	29,636,772 (33.6)	21,939,380 (32.8)	3,048,076 (34.0)	4,645,316 (37.0)
>40	1,853,915 (2.1)	1,300,424 (2.0)	219,654 (2.5)	333,837 (2.7)
Nativity				
US born	70,333,037 (79.6)	53,855,902 (80.6)	6,796,634 (75.8)	9,680,501 (77.2)
Foreign born	17,976,532 (20.4)	12,941,683 (19.4)	2,169,732 (24.2)	2,865,117 (22.8)
Parity				
Nulliparous (0 previous live births)	36,013,523(40.8)	27,267,822 (40.8)	3,670,092 (40.9)	5,075,609 (40.5)
Primiparous (1 previous live birth)	28,428,072(32.2)	21,642,778 (32.4)	2,821,516 (31.5)	3,963,778 (31.6)
Multiparous (>1 previous live birth)	23,867,974(27.0)	17,886,985 (26.8)	2,474,758 (27.6)	3,506,231 (28.0)
Marital status				
Married	57,349,457 (64.9)	44601998 (66.8)	5296899 (59.1)	7450560 (59.4)
Unmarried	30,960,112 (35.1)	22195587 (33.2)	3669467 (40.9)	5095058 (40.6)
Education				
Less than high school	4,941,423 (5.6)	3,931,089 (5.9)	473,463 (5.3)	536,871 (4.3)
Some high school	13,871,447 (15.7)	10,879,979 (16.3)	1,347,135 (15.0)	1,644,333 (13.1)
High school	27,636,372 (31.3)	21,958,492 (32.9)	2,492,999 (27.8)	3,184,881 (25.4)
Some college	20,600,385 (23.3)	14,743,587 (22.1)	2,273,656 (25.4)	3,583,142 (28.6)
College graduate	13,527,743 (15.3)	9,708,504 (14.5)	1,513,185 (16.9)	2,306,054 (18.4)

Greater than college	7,733,199 (8.8)	5,576,934 (8.4)	865,928 (9.7)	1,290,337 (10.3)
Outcomes				
Preterm birth	8,736,578 (9.9)	6,630,261 (9.9)	911,443 (10.2)	1,194,874 (9.5)
Small for gestational age	8,096,202 (10.3)	5,983,261 (10.1)	869,356 (10.8)	1,243,585 (10.9)
Exposures				
First trimester high unemployment ¹	8,763,809 (9.9)	1,670,182 (2.50)	1,181,037 (13.17)	5,912,590 (47.13)
Second trimester high unemployment ¹	9,090,980 (10.3)	1,682,235 (2.52)	1,728,215 (19.27)	5,680,530 (45.28)

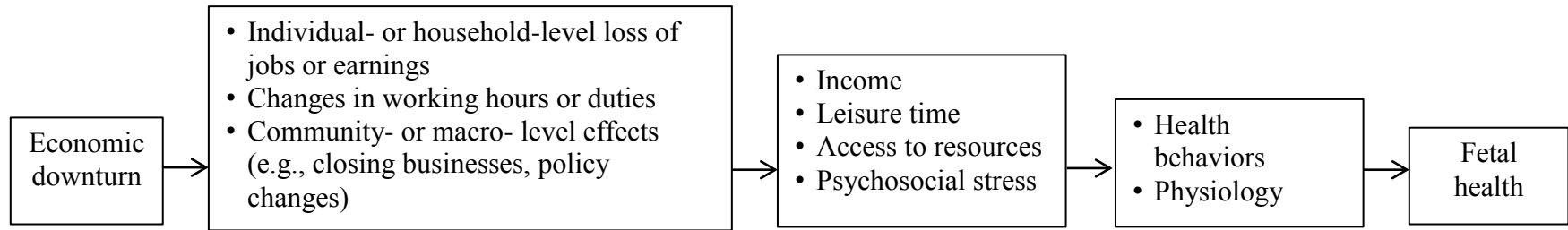
¹High unemployment indicates that the trimester average unemployment was >8.8%

Table 2. Unadjusted and adjusted odds ratios for preterm birth from logistic regression models for singleton U.S. births (1989-2013) .

	Odds Ratio (95% confidence interval)					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
High unemployment (>8.8%)						
First trimester	0.96 (0.96, 0.97)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)	--
Second trimester	0.98 (0.97, 0.98)	0.98 (0.97, 0.98)	0.98 (0.97, 0.98)	0.98 (0.98, 0.98)	0.98 (0.98, 0.98)	--
Average unemployment rate in 6 months pre-conception			1.00 (1.00,1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00,1.00)
Maternal age						
<20				1.04 (1.04, 1.04)	1.04 (1.04, 1.04)	1.04 (1.04,1.04)
20-29				Ref	Ref	Ref
30-39				1.17 (1.17, 1.18)	1.17 (1.17, 1.18)	1.17 (1.17, 1.18)
>40				1.61 (1.60, 1.61)	1.61 (1.60, 1.61)	1.61 (1.60, 1.61)
Maternal race/ethnicity						
NHW				Ref	Ref	Ref
NHB				1.69 (1.69, 1.70)	1.69 (1.69, 1.70)	1.69 (1.69, 1.70)
Hispanic				1.18 (1.18, 1.18)	1.18 (1.18, 1.18)	1.18 (1.18, 1.18)
AI/AN				1.19 (1.19, 1.20)	1.19 (1.19, 1.20)	1.19 (1.19, 1.20)
A/PI				1.30 (1.29, 1.30)	1.30 (1.29, 1.30)	1.30 (1.29, 1.30)
Maternal nativity						
US born				Ref	Ref	Ref
Foreign born				0.86 (0.86, 0.87)	0.86 (0.86, 0.87)	0.86 (0.86, 0.87)
Parity						
Nulliparous				Ref	Ref	Ref
Primiparous				0.91 (0.91,0.91)	0.91 (0.91,0.91)	0.91 (0.91,0.91)
Multiparous				1.02 (1.02,1.03)	1.02 (1.02,1.03)	1.02 (1.02,1.03)
Maternal marital status						
Married				Ref	Ref	Ref
Unmarried				1.25 (1.25,1.25)	1.25 (1.25,1.25)	1.25 (1.25,1.25)
Maternal education						
<HS				1.50 (1.50,1.51)	1.50 (1.50,1.51)	1.50 (1.50,1.51)
Some HS				1.53 (1.53, 1.54)	1.53 (1.53, 1.54)	1.53 (1.53, 1.54)

HS			1.34 (1.34, 1.34)	1.34 (1.34, 1.34)	1.34 (1.34, 1.34)
Some college			1.23 (1.22, 1.23)	1.23 (1.22, 1.23)	1.23 (1.22, 1.23)
College			1.03 (1.02, 1.03)	1.03 (1.02, 1.03)	1.03 (1.02, 1.03)
>College			Ref	Ref	Ref
Great Recession indicator					
Pre-recession				Ref	--
Recession				1.01 (1.00, 1.02)	--
Post-recession				1.01 (1.00, 1.02)	--
Great Recession*high unemployment					
Pre-recession					
1 st trimester					1.04 (1.03, 1.05)
2 nd trimester					1.01 (1.00, 1.02)
Recession					
1 st trimester					1.01 (1.00, 1.02)
2 nd trimester					0.97 (0.96, 0.98)
Post-recession					
1 st trimester					0.99 (0.99, 1.00)
2 nd trimester					0.97 (0.96, 0.98)
State fixed effect	Y	Y	Y	Y	Y
Month fixed effect	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y

Figure 1.



Appendix A. Unadjusted and adjusted odds ratios for small for gestational age from logistic regression models (n=78,806,363)

	Odds Ratio (95% confidence interval)					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
High unemployment (>8.8%)						
First trimester	1.03 (1.02, 1.03)	1.00 (1.00, 1.01)	1.00 (1.00, 1.01)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)	--
Second trimester	1.01 (1.01, 1.02)	1.00 (1.00, 1.01)	1.00 (1.00, 1.01)	1.01 (1.00, 1.01)	1.01 (1.00, 1.01)	--
Average unemployment rate in 6 months pre-conception			0.99 (0.99, 1.00)	1.00(1.00,1.00)	1.00(0.99,1.00)	1.00(0.99,1.00)
Maternal age						
<20				0.92 (0.92, 0.92)	0.92 (0.92, 0.92)	0.92 (0.92, 0.92)
20-29				Ref	Ref	Ref
30-39				1.00(1.00,1.00)	1.00(1.00,1.00)	1.00(1.00,1.00)
>40				1.18 (1.17, 1.18)	1.18 (1.17, 1.18)	1.18 (1.17, 1.18)
Maternal race/ethnicity						
NHW				Ref	Ref	Ref
NHB				1.74(1.74,1.75)	1.74(1.74,1.75)	1.74(1.74,1.75)
Hispanic				1.07(1.06,1.07)	1.07(1.06,1.07)	1.07(1.06,1.07)
AI/AN				0.90(0.90,0.91)	0.90(0.90,0.91)	0.90(0.90,0.91)
A/PI				2.02(2.01,2.03)	2.02(2.01,2.03)	2.02(2.01,2.03)
Maternal nativity						
US born				Ref	Ref	Ref
Foreign born				0.90(0.90,0.90)	0.90(0.90,0.90)	0.90(0.90,0.90)
Parity						
Nulliparous				Ref	Ref	Ref
Primiparous				0.68(0.68,0.69)	0.68(0.68,0.69)	0.68(0.68,0.69)
Multiparous				0.66(0.66,0.67)	0.66(0.66,0.67)	0.66(0.66,0.67)
Maternal marital status						
Married				Ref	Ref	Ref
Unmarried				1.28(1.27,1.28)	1.28(1.27,1.28)	1.28(1.27,1.28)
Maternal education						

<HS			1.68(1.67,1.69)	1.68(1.67,1.69)	1.68(1.67,1.69)
Some HS			1.83(1.82,1.83)	1.83(1.82,1.83)	1.83(1.82,1.83)
HS			1.47(1.47,1.48)	1.47(1.47,1.48)	1.47(1.47,1.48)
Some college			1.21(1.20,1.21)	1.21(1.20,1.21)	1.21(1.20,1.21)
College			0.99(0.98,0.99)	0.99(0.98,0.99)	0.99(0.98,0.99)
>College			Ref	Ref	Ref
Great Recession indicator					
Pre-recession				Ref	--
Recession				0.99 (0.98, 1.00)	--
Post-recession				1.01 (1.00, 1.03)	--
Great Recession*high unemployment					
Pre-recession					
1 st trimester					1.01 (1.00, 1.02)
2 nd trimester					1.01 (1.00, 1.02)
Recession					
1 st trimester					1.00 (0.99, 1.01)
2 nd trimester					1.02 (1.01, 1.03)
Post-recession					
1 st trimester					1.01 (1.01, 1.02)
2 nd trimester					1.00 (1.00, 1.01)
State fixed effect	y	y	y	y	y
Month fixed effect	y	y	y	y	y
Year fixed effect	y	y	y	y	y