**Does economic recession impact newborn health?**

**Evidence from Greece**

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**Abstract**

This study examines the impact of the Greek recession on newborn health. Using a large administrative dataset of 838,700 births from 2008 to 2015, our analysis shows that birth weight (BW) and pregnancy length are generally procyclical with respect to prenatal economic climate, while the risk of low birth weight and preterm birth are both countercyclical. We report heterogeneity in the relationship between business cycle fluctuations during pregnancy and newborn health across socioeconomic groups. Birth outcomes of children born to low socioeconomic status (SES) families are sensitive to economic fluctuations during the first and third trimesters of the pregnancy, whereas those of high-SES newborns respond to economic volatility only in the first trimester. These results are robust, even after using different measures of economic climate and uncertainty. After accounting for potential selection into pregnancy, we find that in utero exposure to economic crisis is linked with a BW loss, which is driven by the low-SES children. Our findings have social policy implications. The impact of economic crisis on birth indicators is more detrimental for the low-SES children, resulting in a widening of the BW gap between children of low- and high-SES families. This could, in turn, exacerbate long-term socioeconomic and health inequalities and hinder social mobility.

**Keywords:** newborn health,birth outcomes, birth weight, business cycle fluctuations, economic crisis, recession, Greece

**1. Introduction**

In the late 2000s, Greece faced a severe sovereign debt crisis, revealing the Eurozone’s structural problems and threatening its stability. Despite the previous global financial crisis, there was little concern about sovereign debt sustainability in Europe, and the markets were relatively calm in 2008, all the way until late 2009 (Lane, 2012). The sovereign debt crisis began in autumn of 2009, when the Greek government announced a revision of the budget deficit that was more than twice the size of the previous estimate, exceeding 15% of the GDP (Zettelmeyer et al., 2013). Greece was the first European country to be shut out of the bond market, and subsequently, the country reached a bailout agreement with its creditors.

The Eurozone crisis gradually broadened and deepened, with several other countries facing similar problems. However, the Greek economy was hit much harder than its counterparts. It experienced a massive and prolonged recession, which was possibly the most severe economic crisis among developed countries in the post-war period (Reinhart and Rogoff, 2014). The strict economic adjustment programme that followed entailed heavy conditionality, extreme fiscal consolidation measures, and a grinding process of internal devaluation, mainly through salary adjustments in both the public and private sectors (Kyriopoulos et al., 2019; OECD, 2014).

Even before the recent crisis, the impact of recessions on health attracted scholarly interest. However, research findings have been inconclusive due to the presence of several countervailing pathways (Catalano, 2009). For example, there is evidence that population health indicators, such as all-cause mortality, tend to deteriorate during periods of economic prosperity (Laporte, 2004; Ruhm, 2003, 2000; Toffolutti and Suhrcke, 2014). The higher mortality rates appear to be driven by deaths from cardiovascular conditions, motor vehicle accidents, influenza/pneumonia, liver disease and other accidents, whereas some other cause-specific deaths are generally countercyclical (Gerdtham and Ruhm, 2006; Neumayer, 2004). Another strand of the literature, however, challenges the previous findings, with several studies reporting acyclical variations for mortality and others suggesting that economic downturns are detrimental to health (Gerdtham and Johannesson, 2005; McInerney and Mellor, 2012; Ruhm, 2015; Svensson, 2007). Generally speaking, it appears that the effects of recessions vary with the level of analysis, country context, extent and severity of the recession, studied health outcomes, and potential role of the welfare state (Suhrcke and Stuckler, 2012).

Evidence from Greece shows that all-cause mortality fell after the onset of the economic crisis but the rate of decline was significantly lower (Laliotis et al., 2016). Using self-rated health as a measure of health status, several other studies showed that health trends deteriorated during economic recession (Kentikelenis et al., 2011; Vandoros et al., 2013; Zavras et al., 2013). Mental health indicators also worsened during the Greek crisis (Mylona et al., 2014), with the prevalence of major depression substantially increasing from 3.3% to 12.3% (Economou et al., 2016).

Despite a growing number of studies on health consequences of the recent recession in Greece—and more generally, in Europe—a systematic review points out that evidence is ‘*still unclear and fragmented*’ The effects of the crisis on health indicators appear to be heterogeneous, and studies have tended to focus on adult health (Parmar et al., 2016). Additionally, there is scant evidence on the effects of the crisis on newborn health, and little is known about the potential socioeconomic differential in the impact of economic recession on health. Previous evidence is contradictory and inconclusive (Eiríksdóttir et al., 2013; Margerison Zilko, 2010), with some studies showing newborn health improvements (Dehejia and Lleras-Muney, 2004), and others suggesting worse newborn birth outcomes during economic downturns (Bozzoli and Quintana-Domeque, 2014; Catalano et al., 1999; Olafsson, 2016).

Our analysis concentrates on birth outcomes. Focusing on newborn health indicators is crucial from both public health and socioeconomic perspectives. Adverse birth outcomes are associated with greater mortality and morbidity, not only during infancy but also later in life, during childhood and adulthood (Blumenshine et al., 2010). For example, LBW children appear to have greater rates of coronary heart disease, stroke, high blood pressure, diabetes, metabolic syndrome, and osteoporosis (Almond et al., 2005; Gluckman et al., 2008). Thus, newborn health can be considered an input in a health production function that approximates the initial endowment of ‘human health capital’. Besides its association with various health indicators, poor newborn health can also affect cognitive function and development, educational attainment, labour market outcomes, and earnings (Black et al., 2007).

Against this background, this study aims to examine the relationship between economic conditions during pregnancy and birth outcomes. It contributes to the existing literature in several ways. First, we use a large administrative dataset from Greece, a country that faced an unprecedented economic crisis in terms of duration and severity. The Greek case is important since previous research focused on shorter recessions that had a lower impact on economic and social indicators. Previous studies examined the 2001–2002 crisis in Argentina and the 2008 financial collapse in Iceland (Bozzoli and Quintana-Domeque, 2014; Olafsson, 2016), both of which lasted almost three years and were less severe than the Greek crisis (Reinhart and Rogoff, 2014). Second, compared to most other studies—which tend to focus on the link between unemployment and newborn health (Alessie et al., 2017; Schempf and Decker, 2010)—we examine the relationship between the economic climate and economic uncertainty during pregnancy, and birth indicators using two alternative measures: the Economic Sentiment Indicator (ESI) and the Economic Policy Uncertainty Index (EPU). Different from previous analyses, our analysis captures the overall economic climate, expectations, and uncertainty, which are not directly reflected by standard measures of economic activity, such as GDP and unemployment rate (Gelper and Croux, 2010). Third, we use various detrending techniques to capture the cyclical component of economic indicators, and we test the robustness of our findings. Fourth, to the best of our knowledge, this is the first study documenting a socioeconomic differential in an economic crisis’ impact on newborn health. Lastly, using propensity score matching (PSM), we address potential selection arising from compositional changes on the type of mothers who conceive.

**Hypothesis development**

In this study we test three hypotheses, formulated as follows.

During economic recessions, the prevalence of depression and psychosocial stress tends to increase (Economou et al., 2016; Frasquilho et al., 2016), with both being risk factors for adverse perinatal outcomes (Grote et al., 2010). Additionally, household financial distress may impede access to nutritious food (Brinkman et al., 2010; Studdert et al., 2001). Increased levels of maternal stress and poor maternal nutrition during pregnancy may adversely affect gestational length, and intrauterine growth respectively (Bernabé et al., 2004; Hedegaard et al., 1996), both of which, in turn, influence birth outcomes (Kramer, 1987). On this basis, we formulate our first hypothesis:

**Hypothesis 1:** Birth outcomes are sensitive to business cycle fluctuations during pregnancy, and the relationship varies depending on the stage of gestation.

During economic recessions, low-SES households are more likely to compromise food quality and quantity due to financial hardship (Bonaccio et al., 2017; Brinkman et al., 2010). This might not apply to the high-SES families, who have access to a wide range of coping mechanisms and can smooth consumption without resorting to unhealthy dietary changes. Additionally, low-SES individuals are more susceptible to stress and mental health problems while also facing more limited access to mental health services during economic contraction (Catalano and Bruckner, 2005; Hauksdottir et al., 2013; Wahlbeck and McDaid, 2012; World Health Organization, 2011). Considering this range of impacts, we develop the following hypothesis:

**Hypothesis 2:** There is heterogeneity in the relationship between prenatal business cycle fluctuations and birth outcomes across socioeconomic groups.

Economic distress might be associated with fertility postponement and changes in the types or characteristics of women who conceive during periods of economic adversity (Chevalier and Marie, 2017; Dehejia and Lleras-Muney, 2004). This implies compositional changes in the cohort of women who give birth (or selection into pregnancy during an economic downturn). Hence, we form our third hypothesis:

**Hypothesis 3:** An economic crisis affects BW, even after accounting for selection into motherhood.

**2. Methods**

**2.1. Data**

Our analysis is based on administrative data from the National Registry of Births, collected by the Hellenic Statistical Authority. The main advantage of our dataset is that it includes all births (838,700 births) from 2008–2015 in Greece, and it provides information about birth outcomes, gestational characteristics, and parental sociodemographic variables.

We also rely on publicly available data for the monthly seasonally adjusted ESI (Eurostat, 2018). ESI is a survey-based and composite indicator, and its construction relies on the weighted aggregation of the following confidence indicators: (a) industrial confidence indicator (weight: 40%), (b) service confidence indicator (30%), (c) consumer confidence indicator (20%), (d) construction confidence indicator (5%), and (e) retail trade confidence indicator (5%) (Eurostat, 2018). Different from other economic variables, ESI contains information about the current economic climate according to economic agents, and it also incorporates relevant expectations about future trends. Thus, compared to standard measures such as the GDP, industrial production, or unemployment rate, ESI captures relevant economic information more quickly (Gelper and Croux, 2010).

**2.2. Dependent variable**

The main dependent variable of our analysis is BW (measured in grams), and we also use additional birth outcomes such as pregnancy length, foetal growth rate, and binary indicators for LBW, preterm birth, macrosomia, stillbirth and the probability of maleness in newborns. LBW is an established medical term that refers to babies who weigh less than 2,500 grams, and foetal growth is defined as BW divided by gestational age (in weeks) (Black et al., 2007; Wehby et al., 2016). Preterm birth occurs when a baby is born before the 37th week of pregnancy, while macrosomic babies are those weighing more than 4,000 grams at birth. We include macrosomia as a dependent variable as it is linked to long-term health consequences such as obesity, hypertension, and diabetes (Zhang et al., 2008). Lastly, based on a strand of the literature suggesting that exposure to population stressors is associated with reduced odds of male birth (Catalano, 2003; Catalano and Bruckner, 2005), we modelled the probability of male birth to test whether unfavourable economic conditions impacted the sex ratio.

**2.3. Independent variables**

The independent variable is based on a monthly measure of business cycle fluctuations. Using a Hodrick-Prescott (HP) filter of the log-transformed ESI, we construct variables that capture the cyclical component of ESI for each month of pregnancy (Bozzoli and Quintana-Domeque, 2014; Hodrick and Prescott, 1997). We rely on the approach proposed by Ravn and Uhlig (2002) to choose the smoothing parameter for the HP filter (Ravn and Uhlig, 2002).

We control for three variables (i.e., one for each trimester of pregnancy), since economic fluctuations or other exogenous events may influence birth outcomes differently depending on their occurrence in a trimester of pregnancy (Camacho, 2008; Torche, 2011). Each of the three variables corresponds to the average cyclical component of the (a) first, second, and third month of pregnancy (for the first trimester), (b) fourth, fifth, and sixth month of pregnancy (for the second trimester), and (c) seventh, eighth, and ninth month of pregnancy (for the third trimester). Additionally, we control for the following regressors: marital status, maternal age, education, employment, nationality, number of previous children, multiple births, and newborn gender. Lastly, our models include month-of-birth fixed effects (FE), year-of-birth FE, day-of-week fixed effects, and prefecture FE. More details on variable definitions are presented in the Appendix, Table A1.

To check the robustness of our findings, we use a monthly measure of economic uncertainty (EPU) instead of the ESI. The EPU is compiled from the textual analysis of digital archives of major newspapers, and it reflects the frequency of articles with key terms related to the economy, uncertainty, and policy (Baker et al., 2016). A detailed description of the construction of the Greek version of the EPU can be found in Hardouvelis et al. (2018). Recent literature has employed this index to test the impact of economic uncertainty on adult health in the UK (Antonakakis and Gupta, 2017; Vandoros et al., 2019, 2018). In our case, EPU and ESI are negatively correlated (ρ=-0.38, p-value=0.0001). The negative correlation coefficient is expected, since ESI falls and EPU tends to increase as economic activity declines (Hardouvelis et al., 2018). In this context, we test the robustness of our results even after employing an alternative economic indicator, which is only modestly correlated with the ESI.

**2.4 Empirical strategy**

Building on Bozzoli and Quintana-Domeque (2014), the first part of our analysis relies on both linear and non-linear specifications. Our main model is linear, and the regression coefficients are estimated by OLS. The main empirical specification is given by the following expression:

$BW\_{i,m,y,r}=β\_{0}+β\_{1}FTR\_{m,y}+β\_{2}STR\_{m,y}+β\_{3}TTR\_{m,y}+β\_{4}Χ\_{i}+a\_{r}+γ\_{m}+φ\_{y}+ε\_{i,m,y,r}$ (1)

where,

$BW\_{i,m,y,r}$ is the birth weight of a child *i* who was born at month *m* and year *y* by a mother who lives in a region *r*

$FTR\_{m,y}$ measures the average cyclical component in the first trimester of pregnancy

$STR\_{m,y}$ measures the average cyclical component in the second trimester of pregnancy

$TTR\_{m,y}$ measures the average cyclical component in the third trimester of pregnancy

$Χ\_{i}$ is a vector of several sociodemographic, gestational, and other variables

$a\_{r}$ is a region FE term

$γ\_{m}$ is a month-of-birth FE term

$φ\_{y}$ is a year-of-birth FE term

$ε\_{i,m,y,r}$ is the error term

We also employ linear regression models using pregnancy length and foetal growth rate as outcome variables and logistic regression models for the binary indicators. In this case, the regression coefficients are estimated by MLE.

To examine potential heterogeneity in the association between economic conditions during pregnancy and birth outcomes, we stratify the sample by parental education, which is a proxy for family socioeconomic status. After stratifying the sample, we estimate Equation (1) for newborns whose parents have both completed university education (high-SES) and for children of parents with a lower educational level (low-SES).

As pointed out above, the characteristics of mothers who conceive and give birth during recessions might differ from those of mothers who conceive in stable economic periods. To address potential selection into pregnancy, we conduct a propensity score matching (PSM) analysis (Rosenbaum and Rubin, 1983). The aim of PSM is to construct a control group of untreated observations that have observable characteristics similar to those exposed to the treatment. Using propensity scores as the single source of information for the matching process, the main advantage of this technique is that it overcomes the ‘curse of dimensionality’ (Becker and Ichino, 2002; Rosenbaum and Rubin, 1983). In this study, we use a nearest neighbour algorithm and match each treated observation with an observation from the control group that has the closest propensity score (Caliendo and Kopeinig, 2008). This practically implies that the birth of each child exposed in utero to the crisis is paired with the single most similar observation from the comparison group.

We compare the BW of two cohorts: (a) children born before the onset of the sovereign debt crisis in October of 2009, and (b) children who were conceived before but born after the onset of the crisis (thus, they were exposed in utero to the crisis). The latter cohort is the treatment group, consisting of children conceived before October of 2009 and born after October of 2009. In particular, we define this cohort as a treatment group, since the effects of the crisis were not evident and had not fully kicked in at the time of conception (Geanakoplos, 2014; Matsaganis, 2013; Zettelmeyer et al., 2013). This group of children, however, experienced intrauterine exposure to the economic crisis. Comparing the two cohorts thus allows us to consider selection into pregnancy associated with maternal characteristics (Bozzoli and Quintana-Domeque, 2014).

As indicated above, we assume the Greek crisis began in October of 2009. This is a reasonable assumption if one considers the broader political and socieconomic environment in Greece in 2009. First, a large body of academic evidence and policy reports corroborate that the Greek crisis became evident in October of 2009 (Geanakoplos, 2014; Gibson et al., 2014; Lane, 2012; Provopoulos, 2014; Zettelmeyer et al., 2013). Second, there were no sings of large-scale fiscal consolidation measures and potential salary cuts until late 2009, and households did not expect or experience substantial changes in their income, employment prospects and living conditions. According to the EU-SILC data, for example, deterioration in average household income and perceived financial difficulties did not occur in 2008 and 2009 (Eurostat, 2019). Third, the unemployment rate did not significantly deviate from the historical rates until late 2009, before which it was generally comparable with the corresponding OECD and EU average (OECD, 2019). The trend in sovereign debt yields, which started increasing in late 2009 (see Figure A1 in the Appendix), provides further evidence for the timing of the crisis onset. We also use other key dates to test the robustness of our results. Instead of October 2009, the alternative dates used were as follows: (a) December of 2009, when credit rating agencies downgraded Greek bonds and the government announced several reforms; (b) January of 2010, when the government announced a plan to reduce the budget deficit; and (c) April of 2010, when the Greek government actually signed the bailout agreement.

**3. Results**

**3.1. Newborn health and business cycle fluctuations during pregnancy**

The descriptive evidence indicates that BW can be regarded as procyclical (details are presented in the Appendix, Table A2). The procyclicality of BW is further documented in Figure 1, which shows the evolution of annual average ESI and average BW in each year.

**(Figure 1 here)**

Table 1 shows the main findings of our analysis. Model 1 presents the OLS estimates of Equation (1), using BW as a dependent variable. Our analysis shows a strong relationship between economic fluctuations in the first and third trimesters of pregnancy and the BW, while showing a weaker relationship with fluctuations in the second trimester. We also find a strong negative relationship between prenatal economic conditions and the probability of LBW. According to Model 3, the probability of LBW is countercyclical with respect to business cycle fluctuations in the first and third trimesters of pregnancy, but this does not apply to economic fluctuations during the second trimester. For example, a 10% reduction of the detrended ESI (i.e., a 0.1. change in logarithmic scale) during the first trimester of pregnancy would decrease BW by 12.6 grams. Controlling for a variable that captures the economic fluctuations during the whole period of gestation, a similar deterioration of economic conditions during the whole pregnancy period would be associated with a BW loss of 22.1 grams and an increase in the probability of LBW by 0.87 percentage points. Similarly, Models 5 and 6 show that economic conditions during the first and third trimesters are associated with the length of pregnancy and the probability of preterm birth, respectively. Thus, the results are consistent and suggest that birth outcomes respond to business cycle fluctuations mainly in the first and third trimesters, while corresponding fluctuations in the second trimester are either weak or insignificant. To provide another example, our estimates suggest that a negative economic fluctuation of 10% would be expected to increase the probability of preterm birth by 1.16 percentage points.

**(Table 1 here)**

Our findings also reveal that business cycle volatility in the first pregnancy trimester is linked with the risk of macrosomia. Although some studies show that economic decline affects the sex ratio, our analysis does not support this finding. We do not find a statistically significant link between economic conditions during a pregnancy and the probability of male birth, regardless of the trimester. Lastly, Model 10 (Table 1) shows that economic conditions during the first and third trimesters are associated with the foetal growth rate.

As reported in Table 1, boys are on average 128 grams heavier than girls. Additionally, children born to married mothers tend to be heavier; they also have a lower probability of LBW, preterm birth, and stillbirth. Our analysis suggests that maternal age is negatively associated with BW and positively linked with the risk of LBW, preterm birth, and stillbirth. A socioeconomic gradient in newborn health is also documented. Lastly, we show that children born to Greek mothers are more likely to have LBW and are generally lighter than other children. Although this finding seems counterintuitive, it is consistent with the so-called ‘healthy migrant effect’ (Wingate and Alexander, 2006).

Our results are robust across different specifications, and the sensitivity analysis is presented in the Appendix, Table A3. Additionally, we perform placebo (falsification) tests, and we find that business cycle volatility in the postnatal period is not associated with BW and the risk of LBW (see Columns 2 and 4 in Table 1). This finding further strengthens our results regarding the relationship between prenatal economic fluctuations and birth outcomes. Lastly, we estimate Equation (1) using the following: (a) the EPU instead of the ESI (regression estimates are presented in the Appendix, Table A4); (b) the ESI, without employing a HP filter (Table A5 in the Appendix); and (c) a Butterworth filter instead of an HP filter (Angelini and Mierau, 2014; Gómez, 2001) (Table A6 in the Appendix). Our results are robust and consistent, even after changing the measure of the economic climate and detrending technique.

**3.3. Heterogeneity across socioeconomic groups**

To test the second hypothesis, we split our sample by parental educational level, which is a proxy for socioeconomic status. We thus estimate Equation (1) for the children born to high- and low-SES families.

**(Table 2 here)**

According to Table 2, the BW of children born to low-SES families is responsive to economic fluctuations during the first and third trimesters of pregnancy. As shown in Columns 1 and 3, we do not report similar findings for babies born to high-SES families. Only first-trimester economic conditions matter for the BW of children born to high-SES families (significant at a 10% level). Again, using education as a proxy for socioeconomic status, we find similar results for the probability of LBW children born to low- and high-SES families (Columns 3 and 7 in Table 2). Additionally, as shown in the Appendix Tables A7 and A8, our results are robust after using different indicators of economic climate and detrending techniques.

**3.4. Addressing selection issues**

Economic recession might affect fertility decisions differently across population groups, giving rise to changes in the cohort of women who give birth. In other words, women who conceive during recessions may have different characteristics than women who conceive during periods of economic normality. To address this issue, we employ a PSM analysis and compare the BW of two specific cohorts of children, as described in the Methods section. We compare the cohort of children born before October of 2009 with children who were conceived before but born after October of 2009 (i.e., children born between October of 2009 and June of 2010). The latter cohort was exposed to the crisis, but their mothers could not have expected the extent and severity of the crisis when they conceived.

 Table 3 (Panel A) shows that BW dropped by 12 grams following the economic crisis. After splitting the sample by parental socioeconomic status, we find that BW decreased by approximately 18 grams for children of lower socioeconomic status, whereas the treatment effect for babies in more privileged families is not statistically significant. We also employ an alternative matching process and show that the results are very similar (see Panel B in Table 3): the BW loss amounted to 11 grams, with an effect of almost 18 grams for children born to low-SES families and an insignificant effect for their high-SES counterparts.

**(Table 3 here)**

In addition to the baseline scenario, we conduct robustness checks using alternative key dates: (a) December of 2009, when credit rating agencies downgraded Greek bonds and the government announced several reforms, (b) January of 2010, when the government announced a plan to reduce the budget deficit; and (c) April of 2010, when the Greek government actually signed the bailout agreement.

**(Table 4 here)**

Table 4 shows additional estimates derived from our robustness checks. According to the first scenario, for example, the BW loss ranges between 18 and 19 grams and is greater among children born to low-SES families. Similar to the baseline estimates, the corresponding BW change following the economic crisis is not statistically significant among high-SES newborns. According to Table 4, the BW loss from the economic crisis ranges between 18.4 and 21.9 grams. The corresponding loss for children born to low-SES families is greater: between 22.1 and 26.5 grams. Lastly, these results confirm our baseline findings for children born to high-SES families. Using other scenarios, we present additional estimates in the Appendix Table A9; these are also consistent with our main findings.

**4. Discussion**

Our analysis focuses on newborn health, using a large administrative dataset. Apart from serving as health indicators, birth outcomes can also be inputs in a health production function that approximates the initial endowment of ‘human health capital’. The variables we examine are individual-level health indicators, but contrary to most variables used in previous micro-level studies (e.g., self-reported health indicators), they do not suffer from measurement error.

Τhe first hypothesis examines the relationship between economic fluctuations and birth outcomes, which can be explained by two main mechanisms. First, economic distress changes the quantity and quality of maternal nutrition, which in turn affects intrauterine growth (Bernabé et al., 2004). In households experiencing financial constraints, maternal access to nutritious food may be compromised, resulting in food insecurity during pregnancy (Brinkman et al., 2010; Studdert et al., 2001). Second, economic recession and financial difficulties lead to increased psychosocial stress and depression, which can also precipitate LBW (Hedegaard et al., 1996).

A strand of the literature maintains that these mechanisms change with gestational stage. In particular, BW is particularly sensitive to nutritional changes during the third trimester of pregnancy (Almond et al., 2011; Stein and Lumey, 2000). BW has also been found to be responsive to maternal stress, especially when it occurs during the first months of the pregnancy (Camacho, 2008; Paarlberg et al., 1999; Torche, 2011). In this context, the finding that BW is procyclical with respect to the first and third trimesters could reflect the influence of psychosocial stress and maternal nutrition, respectively.

Our results are consistent with a study on Argentina’s crisis in 2001–2002 (Bozzoli and Quintana-Domeque, 2014) but not with evidence for the 2008 financial collapse in Iceland (Eiríksdóttir et al., 2013). In Iceland, babies exposed to the financial collapse during the first trimester tended to be lighter; this was not the case for those exposed in other trimesters. This may be because the short-term economic slowdown in Iceland did not precipitate changes in maternal nutrition, which would have been reflected in the BW of the children exposed in the third trimester (Olafsson, 2016).

We also focus on some additional perinatal outcomes. For example, we find strong evidence for a relationship between first- and third-trimester economic conditions, pregnancy length, and foetal growth. In the same vein, economic contraction during these trimesters appears to increase the risk of preterm birth. Contrary to some studies supporting that the ratio of male to female births falls during periods of economic contraction (Catalano, 2003; Catalano and Bruckner, 2005), our findings suggest that business cycle volatility during pregnancy is not associated with the probability of giving birth to a male child.

After splitting the sample by socioeconomic status, we test our second hypothesis and show that economic conditions during the first and third trimesters affect BW and the risk of LBW in children born to low-SES households. However, this is not the case for LBW in high-SES families, which is only responsive to economic fluctuations in the first trimester. This difference could be attributed to nutritional deprivation, which would mostly affect low-SES households. In contrast, privileged households are able to smooth consumption; thus, they would not be expected to suffer from food insecurity during economic recession. On the other hand, low-SES households experience more severe financial challenges during economic recessions, which could influence nutritional habits and compromise the quantity and quality of food (Bonaccio et al., 2017; Brinkman et al., 2010). In Greece, recent data show that more than half of poor households cannot afford meat, chicken, fish, or nutritionally equivalent vegetables. For non-poor households, the corresponding percentage was only 1.8% (Hellenic Statistical Authority, 2017). This analysis also finds that business cycle volatility during the first trimester is associated with LBW for children in both low- and high-SES households. This finding could be attributed to the psychosocial stress from economic volatility that appears to affect both low- and high-SES families.

In our third hypothesis, we employ a PSM and address potential selection issues by comparing two cohorts of children. We find that newborns exposed to the crisis tend to be lighter; this is mostly driven by newborns in low-SES families. The estimated BW loss for newborns of low-SES parents is greater, whereas the corresponding loss for newborns in high-SES families is insignificant.

The estimated effect is not negligible. Among children born to low-SES families, the BW loss associated with the economic crisis is 18–27 grams, whereas BW loss for all newborns is 12–22 grams. To put this in context, we benchmark the findings against the impact of other stressors and risk factors on BW. For instance, Camacho (2008) found that stress from landmine explosions in Colombia led to a significant decline in BW, approximating 8.7 grams. Another study showed that children exposed to 10 or more bomb casualties during the first trimester tended to be approximately 10 grams lighter (Quintana-Domeque and Ródenas-Serrano, 2017). The estimated BW effects from exposure to the 9/11 terrorist attacks were 5–15 grams (Brown, 2014), while another study found a slightly larger BW loss of 8–19 grams (Eccleston, 2011). Intrauterine exposure to floods was associated with a BW loss of 17.9 grams, which was the greatest BW loss associated with various natural disasters (Simeonova, 2011). Our estimated BW loss is similar to the BW loss associated with family bereavement in Sweden (11 grams) (Persson and Rossin-Slater, 2016), but it is half of the BW loss associated with bereavement in Norway (Black et al., 2016). Several studies have also examined the effects of maternal smoking on BW. For example one study found that smoking reduces BW by 57 grams (Tominey, 2007), while other studies showed a larger BW loss, approximating 100 grams (Abrevaya, 2006; Wüst, 2010). Thus, the estimated impact of economic crisis on BW is approximately 10–20% that of maternal smoking. This effect is much greater for the children born to low-SES families.

Several policy implications emanate from our findings. Children born to low-SES parents are already at a disadvantage, since family background is associated with future socioeconomic outcomes (Jerrim, 2015). Based on our findings, they also have poorer birth outcomes, a fact that intensifies their socioeconomic disadvantage. On top of that, children born to low-SES families are more severely hit by a crisis, and their health appears to be more sensitive to business cycle volatility. Thus, low-SES children are born with a poor initial endowment that deteriorates even further in the presence of economic recession.

Hence, the impact of economic crisis on birth outcomes is more detrimental for the children of poorer families, resulting in a widening of the BW gap between children of low- and high-SES families. This could exacerbate future socioeconomic and health inequalities and hinder social mobility as a result of long-term effects of poor birth outcomes on adult health, educational attainment, labour market outcomes, and earnings (Black et al., 2007). Conley and Bennett (2000) aptly described the aforementioned phenomena as *‘an intergenerational loop of social inequality and LBW’* that incorporates biological factors into the discussion on the intergenerational transmission of poverty (Conley and Bennett, 2000). As a potential policy response, the government could introduce a targeted programme that subsidizes nutrients and healthy foods (e.g., through vouchers), contributes to nutritional education, and aims at improving pregnant women’s nutritional habits and healthy behaviours. Such initiatives are generally successful in improving newborn health indicators (Bitler and Currie, 2005; Hoynes et al., 2011; Kowaleski-Jones and Duncan, 2002).

Our study has some limitations. First, we do not know the extent to which each mother was exposed to the adverse effects of the crisis. This is a common limitation in studies that have examined the effects of exogenous wide-scale events on birth outcomes (Carlson, 2015; Quintana-Domeque and Ródenas-Serrano, 2017). Unlike bereavement, for example, economic crisis is not a stressor in and of itself. Therefore, we rely on economic climate indicators during pregnancy to carry out our assessment. Second, similar to most studies using administrative data, we do not control for mode of delivery, health behaviours, or prenatal care utilisation due to data limitations. This might not be a serious problem, however, since all pregnant women in Greece have free access to a comprehensive programme of prenatal care (Delvaux et al., 2001). Third, a richer dataset would allow us to examine the potential impact of economic fluctuations on additional birth outcomes, such as neonatal diseases, Apgar scores, and congenital malformations. Last, our study examines the Greek recession. Generally speaking, the health effects of recessions may differ depending on the country context, extent and severity of the recession, and protective role of the welfare state (Suhrcke and Stuckler, 2012; Toffolutti and Suhrcke, 2014). Hence, our findings should be discussed along with evidence from other countries, especially when drawing generalised conclusions about the effects of recession on newborn health.

**5. Conclusion**

Many studies have explored the effects of the recent economic crisis on adult health but not on newborn health. Considering the recession’s effects on newborn health in Greece is particularly interesting because of the unprecedented duration and intensity of the Greek economic crisis. The National Registry of Births provides a comprehensive dataset, with individual-level information about objective indicators of newborn health. This data serves as the basis of our study and has allowed us to contribute to the existing literature on the health effects of the European crisis. We find that economic climate and uncertainty during pregnancy is associated with newborn health indicators. The risk of LBW and preterm birth is countercyclical with respect to business cycle fluctuations in the first and third trimesters of pregnancy. Our analysis also reveals heterogeneity in the relationship between prenatal economic conditions and newborn health across socioeconomic groups. Birth indicators of low-SES children are sensitive to economic climate during the first and third trimesters of pregnancy, whereas those of high-SES newborns respond to economic volatility only in the first trimester. To account for potential selection, we employ PSM and find that, during pregnancy, maternal exposure to economic crisis is linked with a BW loss that is driven mostly by the low-SES newborns. The estimated BW loss is not statistically significant for children of high-SES families. Therefore, in addition to the socioeconomic gradient in newborn health, there is also a clear socioeconomic differential on the impact of economic recession on newborn health. In other words, children born to low-SES families were hit more severely by the recent economic recession, and they bear greater health costs. These findings have social policy implications, as they suggest the possibility of widening health and socioeconomic inequalities over time, in light of the nexus between newborn health and future health and socioeconomic outcomes.

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**Figure Caption**

**Figure 1: Average birth weight and Economic Sentiment Indicator (2008–2015)**

**Tables**

**Table 1: Business cycle fluctuations and birth outcomes, 2008–2015**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|  | BW | BW | LBW | LBW | Pregnancy length | Preterm birth | Macrosomia | Stillbirth | Male | Foetal growth |
|  |  |  |  |  |  |  |  |  |  |  |
| BC 1st trimester | 125.8\*\*\* | 127.6\*\*\* | -1.066\*\*\* | -1.059\*\*\* | 0.625\*\*\* | -0.820\*\*\* | 0.365\*\* | -0.302 | 0.0479 | 2.489\*\*\* |
|  | (22.58) | (24.59) | (0.212) | (0.216) | (0.116) | (0.247) | (0.178) | (0.638) | (0.0615) | (0.545) |
| BC 2nd trimester | 42.95\*\* | 38.87\* | 0.00522 | -0.0108 | 0.110 | -0.229 | 0.428 | -1.221\*\* | 0.0730 | 0.665 |
|  | (17.76) | (19.82) | (0.190) | (0.200) | (0.0951) | (0.213) | (0.261) | (0.594) | (0.0823) | (0.402) |
| BC 3rd trimester | 60.28\*\*\* | 63.97\*\*\* | -0.505\*\*\* | -0.490\*\*\* | 0.548\*\*\* | -0.541\*\*\* | 0.142 | -0.192 | 0.00259 | 0.889\*\* |
|  | (14.84) | (17.29) | (0.140) | (0.134) | (0.0872) | (0.181) | (0.190) | (0.743) | (0.0664) | (0.341) |
| BC 9 months after birth |  | -10.29 |  | -0.0415 |  |  |  |  |  |  |
|  |  | (19.05) |  | (0.115) |  |  |  |  |  |  |
| Married | 98.43\*\*\* | 98.42\*\*\* | -0.558\*\*\* | -0.558\*\*\* | 0.188\*\*\* | -0.451\*\*\* | 0.235\*\*\* | -0.757\*\*\* | 0.0313\*\*\* | 2.285\*\*\* |
|  | (6.588) | (6.592) | (0.0205) | (0.0205) | (0.0220) | (0.0285) | (0.0658) | (0.0461) | (0.0104) | (0.136) |
| 25-29 | -3.099 | -3.094 | 0.0833\*\*\* | 0.0833\*\*\* | -0.0757\*\*\* | 0.0177 | 0.100\*\*\* | 0.0936 | -0.00307 | 0.0503 |
|  | (2.989) | (2.989) | (0.0198) | (0.0198) | (0.0117) | (0.0203) | (0.0276) | (0.0716) | (0.00925) | (0.0686) |
| 30-34 | -20.76\*\*\* | -20.76\*\*\* | 0.209\*\*\* | 0.209\*\*\* | -0.214\*\*\* | 0.155\*\*\* | 0.0658\*\* | 0.149\*\* | -0.00999 | -0.135 |
|  | (3.535) | (3.536) | (0.0226) | (0.0226) | (0.0141) | (0.0179) | (0.0286) | (0.0718) | (0.00891) | (0.0828) |
| 35-39 | -45.99\*\*\* | -45.99\*\*\* | 0.377\*\*\* | 0.377\*\*\* | -0.383\*\*\* | 0.356\*\*\* | 0.0216 | 0.444\*\*\* | -0.00742 | -0.466\*\*\* |
|  | (3.382) | (3.382) | (0.0240) | (0.0240) | (0.0177) | (0.0230) | (0.0275) | (0.0668) | (0.0101) | (0.0827) |
| Over 40 | -120.9\*\*\* | -120.9\*\*\* | 0.745\*\*\* | 0.745\*\*\* | -0.699\*\*\* | 0.752\*\*\* | -0.181\*\*\* | 0.681\*\*\* | -0.0262\*\*\* | -1.860\*\*\* |
|  | (3.931) | (3.932) | (0.0242) | (0.0242) | (0.0254) | (0.0253) | (0.0548) | (0.0804) | (0.0101) | (0.0966) |
| Lower secondary education | 27.26\*\*\* | 27.27\*\*\* | -0.151\*\*\* | -0.151\*\*\* | 0.0349\* | -0.197\*\*\* | 0.101\*\*\* | -0.0894 | -0.00410 | 0.642\*\*\* |
|  | (5.287) | (5.289) | (0.0330) | (0.0330) | (0.0193) | (0.0341) | (0.0309) | (0.0656) | (0.00984) | (0.122) |
| Upper secondary education | 43.61\*\*\* | 43.61\*\*\* | -0.323\*\*\* | -0.323\*\*\* | 0.0121 | -0.228\*\*\* | 0.0869\*\*\* | -0.237\*\*\* | -0.00652 | 1.142\*\*\* |
|  | (5.748) | (5.748) | (0.0361) | (0.0361) | (0.0252) | (0.0331) | (0.0329) | (0.0718) | (0.00910) | (0.125) |
| University education | 67.88\*\*\* | 67.89\*\*\* | -0.460\*\*\* | -0.460\*\*\* | 0.0651\* | -0.316\*\*\* | 0.104\*\*\* | -0.568\*\*\* | 0.00129 | 1.676\*\*\* |
|  | (5.147) | (5.150) | (0.0344) | (0.0344) | (0.0355) | (0.0433) | (0.0269) | (0.0849) | (0.0106) | (0.117) |
| Total children | 19.85\*\*\* | 19.85\*\*\* | -0.132\*\*\* | -0.132\*\*\* | -0.0718\*\*\* | 0.00475 | 0.116\*\*\* | -0.0129 | 0.00335 | 0.698\*\*\* |
|  | (1.901) | (1.901) | (0.0125) | (0.0125) | (0.00607) | (0.00763) | (0.0121) | (0.0295) | (0.00288) | (0.0539) |
| Multiple birth | -958.3\*\*\* | -958.3\*\*\* | 3.639\*\*\* | 3.639\*\*\* | -3.015\*\*\* | 3.160\*\*\* | -4.900\*\*\* | 1.539\*\*\* | -0.0556\*\*\* | -20.50\*\*\* |
|  | (4.245) | (4.243) | (0.0171) | (0.0171) | (0.0360) | (0.0236) | (0.374) | (0.0480) | (0.0104) | (0.0829) |
| Male | 128.2\*\*\* | 128.2\*\*\* | -0.330\*\*\* | -0.330\*\*\* | -0.0421\*\*\* | 0.0709\*\*\* | 0.818\*\*\* | 0.131\*\*\* |  | 3.422\*\*\* |
|  | (1.776) | (1.775) | (0.00985) | (0.00985) | (0.00421) | (0.00657) | (0.0162) | (0.0421) |  | (0.0530) |
| Greek nationality | -118.0\*\*\* | -118.0\*\*\* | 0.395\*\*\* | 0.395\*\*\* | -0.276\*\*\* | 0.284\*\*\* | -0.645\*\*\* | -0.101 | -0.0188\*\*\* | -2.495\*\*\* |
|  | (3.409) | (3.410) | (0.0273) | (0.0273) | (0.0323) | (0.0318) | (0.0239) | (0.0828) | (0.00574) | (0.128) |
| Employment | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year-of-birth FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Month-of-birth FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Day-of-week FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | 3,031\*\*\* | 3,030\*\*\* | -1.786\*\*\* | -1.788\*\*\* | 38.502\*\*\* | -1.897\*\*\* | -3.950\*\*\* | -4.603\*\*\* | 0.0615\*\*\* | 78.28\*\*\* |
|  | (7.940) | (8.229) | (0.0670) | (0.0682) | (0.0758) | (0.0885) | (0.0699) | (0.144) | (0.0153) | (0.270) |
|  |  |  |  |  |  |  |  |  |  |  |
| Observations | 800,970 | 800,970 | 800,970 | 800,970 | 805,105 | 805,105 | 800,970 | 810,410 | 807,244 | 799,668 |
| R-squared | 0.189 | 0.189 |  |  | 0.171 |  |  |  |  | 0.161 |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 2: Business cycle fluctuations and birth outcomes by parental education**

|  |  |  |
| --- | --- | --- |
|  | High-SES | Low-SES |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|  | BW | BW | LBW | LBW | BW | BW | LBW | LBW |
|  |  |  |  |  |  |  |  |  |
| BC 1st trimester | 79.35\* | 78.45\* | -0.841\*\* | -0.799\*\* | 180.1\*\*\* | 184.7\*\*\* | -1.370\*\*\* | -1.378\*\*\* |
|  | (40.96) | (39.89) | (0.357) | (0.359) | (28.44) | (30.71) | (0.241) | (0.244) |
| BC 2nd trimester | 46.47 | 48.76 | 0.151 | 0.0416 | 20.57 | 11.04 | -0.00413 | 0.0134 |
|  | (42.59) | (45.91) | (0.367) | (0.390) | (27.05) | (24.68) | (0.218) | (0.215) |
| BC 3rd trimester | 35.48 | 33.72 | -0.222 | -0.132 | 109.6\*\*\* | 119.1\*\*\* | -0.751\*\*\* | -0.769\*\*\* |
|  | (41.53) | (40.47) | (0.383) | (0.374) | (20.12) | (24.09) | (0.217) | (0.230) |
| BC 9 months after birth |  | 6.054 |  | -0.293 |  | -22.93 |  | 0.0437 |
|  |  | (32.80) |  | (0.248) |  | (24.79) |  | (0.169) |
| Married | 27.49\*\* | 27.47\*\* | -0.315\*\*\* | -0.315\*\*\* | 65.43\*\*\* | 65.47\*\*\* | -0.399\*\*\* | -0.399\*\*\* |
|  | (11.46) | (11.44) | (0.104) | (0.104) | (10.42) | (10.42) | (0.0708) | (0.0708) |
| 25–29 | -6.699 | -6.703 | 0.0297 | 0.0299 | 2.060 | 2.072 | 0.0175 | 0.0175 |
|  | (11.79) | (11.80) | (0.103) | (0.103) | (3.733) | (3.731) | (0.0264) | (0.0264) |
| 30–34 | -30.40\*\*\* | -30.40\*\*\* | 0.166\* | 0.167\* | -15.65\*\*\* | -15.65\*\*\* | 0.158\*\*\* | 0.158\*\*\* |
|  | (10.41) | (10.41) | (0.0978) | (0.0977) | (4.262) | (4.262) | (0.0308) | (0.0308) |
| 35–39 | -62.09\*\*\* | -62.09\*\*\* | 0.350\*\*\* | 0.350\*\*\* | -39.99\*\*\* | -39.98\*\*\* | 0.322\*\*\* | 0.322\*\*\* |
|  | (10.84) | (10.84) | (0.0900) | (0.0899) | (4.676) | (4.675) | (0.0329) | (0.0329) |
| Over 40 | -146.6\*\*\* | -146.6\*\*\* | 0.804\*\*\* | 0.805\*\*\* | -115.8\*\*\* | -115.8\*\*\* | 0.695\*\*\* | 0.695\*\*\* |
|  | (11.28) | (11.29) | (0.101) | (0.101) | (5.039) | (5.038) | (0.0379) | (0.0379) |
| Total children | 39.66\*\*\* | 39.66\*\*\* | -0.281\*\*\* | -0.281\*\*\* | 14.13\*\*\* | 14.12\*\*\* | -0.0940\*\*\* | -0.0940\*\*\* |
|  | (1.582) | (1.585) | (0.0182) | (0.0182) | (2.156) | (2.156) | (0.0162) | (0.0162) |
| Multiple birth | -969.4\*\*\* | -969.4\*\*\* | 3.838\*\*\* | 3.838\*\*\* | -948.5\*\*\* | -948.5\*\*\* | 3.566\*\*\* | 3.566\*\*\* |
|  | (4.840) | (4.843) | (0.0225) | (0.0225) | (5.260) | (5.261) | (0.0232) | (0.0232) |
| Male | 130.4\*\*\* | 130.4\*\*\* | -0.366\*\*\* | -0.366\*\*\* | 129.1\*\*\* | 129.1\*\*\* | -0.337\*\*\* | -0.337\*\*\* |
|  | (3.845) | (3.849) | (0.0204) | (0.0205) | (1.264) | (1.264) | (0.0105) | (0.0105) |
| Greek nationality | -63.42\*\*\* | -63.42\*\*\* | 0.136\*\* | 0.136\*\* | -116.8\*\*\* | -116.8\*\*\* | 0.347\*\*\* | 0.348\*\*\* |
|  | (5.783) | (5.783) | (0.0689) | (0.0689) | (3.404) | (3.404) | (0.0232) | (0.0232) |
| Employment | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year-of-birth FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Month-of-birth FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Day-of-week FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | 3,104\*\*\* | 3,104\*\*\* | -1.996\*\*\* | -2.007\*\*\* | 3,094\*\*\* | 3,093\*\*\* | -2.101\*\*\* | -2.098\*\*\* |
|  | (19.41) | (19.03) | (0.223) | (0.225) | (13.51) | (13.67) | (0.0862) | (0.0891) |
|  |  |  |  |  |  |  |  |  |
| Observations | 156,794 | 156,794 | 156,794 | 156,794 | 438,889 | 438,889 | 438,889 | 438,889 |
| R-squared | 0.236 | 0.236 |  |  | 0.177 | 0.177 |  |  |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 3: Propensity score matching analysis for the impact of economic crisis on BW**

|  |
| --- |
| **Panel A: NN 1:1 with replacement** |
| **Group** | **ATT**  | **Standard error** | **t -statistic** |
| Total | -12.0\*\*\* | 2.28 | -5.26 |
| Low-SES | -17.6\*\*\* | 2.92 | -6.03 |
| High SES | -0.8 | 5.56 | -0.14 |
| **Panel B: NN 3:1 with replacement** |
| **Group** | **ATT**  | **Standard error** | **t -statistic** |
| Total | -11.1\*\*\* | 2.25 | -4.94 |
| Low-SES | -17.8\*\*\* | 2.89 | -6.17 |
| High SES | 4.3 | 5.50 | 0.79 |

**Table 4: Propensity score matching analysis for the impact of economic crisis on BW (robustness checks)**

|  |
| --- |
| **Panel A: NN 1:1 with replacement** |
|  | **December 2009** | **January 2010** | **April 2010** |
|  | **ATT** | **Standard error** | **t -statistic** | **ATT** | **Standard error** | **t -statistic** | **ATT** | **Standard error** | **t -statistic** |
| Total | -19.1\*\*\* | 2.25 | -7.11 | -18.7\*\*\* | 2.22 | -8.40 | -21.9\*\*\* | 2.19 | -9.97 |
| Low-SES | -22.1\*\*\* | 2.89 | -7.65 | -22.8\*\*\* | 2.85 | -8.00 | -25.0\*\*\* | 2.83 | -8.81 |
| High SES | -6.8 | 5.45 | -1.24 | -6.1 | 5.35 | -1.13 | -7.9 | 5.25 | -1.51 |
| **Panel B: NN 3:1 with replacement** |
|  | **December 2009** | **January 2010** | **April 2010** |
|  | **ATT** | **Standard error** | **t -statistic** | **ATT** | **Standard error** | **t -statistic** | **ATT** | **Standard error** | **t -statistic** |
| Total | -18.4\*\*\* | 2.22 | -8.30 | -18.8\*\*\* | 2.19 | -8.60 | -21.5\*\*\* | 2.16 | -9.95 |
| Low-SES | -22.1\*\*\* | 2.86 | -7.74 | -23.2\*\*\* | 2.82 | -8.21 | -26.5\*\*\* | 2.80 | -9.46 |
| High SES | -4.5 | 5.40 | -0.84 | -6.0 | 5.29 | -1.13 | -9.2\* | 5.20 | -1.77 |

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Figure 1: Average birth weight and Economic Sentiment Indicator (2008-2015)**

