CARLOS ANDRES CHARRIS VIZCAINO

EARLY EXPOSURE TO MACROECONOMIC SHOCKS: GOLD BOOM AND BIRTH WEIGHT IN COLOMBIA

Dissertação apresentada à Universidade Federal de Viçosa, como parte das exigências do Programa de Pós Graduação em Economia Aplicada, para obtenção do título de Magister Scientiae.

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José Gustavo Féres
(Orientador)

A Deuse a toda a minha família.

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BIOGRAFIA

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ABSTRACT

CHARRIS VIZCAINO, Carlos Andres, M.Sc., Universidade Federal de Viçosa, February, 2017**. Early Exposure to Macroeconomic Shocks: Gold Boom and Birth Weight in Colombia.** Adviser: José Gustavo Féres.

The human capital literature has suggested a significant role of individual capabilities in the formation of human capital. There is substantial evidence that inequalities in capacities are consequences of differences in initial endowments (e.g. birth weight). In turn, there exists a hypothesis in the epidemiological literature pointing out that fetuses are vulnerable to environmental factors, which can have a positive or negative impact on their initial endowments. Taken together, this suggests that identifying shocks that affect health at birth must be of particular interest to researchers and policy makers. Therefore, this research attempted to provide further empirical evidence to the question whether macroeconomic shocks have effect on neonatal outcomes. The evidence came from of the study of collateral effects of the 2002 surge in international gold prices on the probability of low and very low birth weight in the Colombian context. Additionally, we verified whether this effect is correlated with measures of maternal exposure to the gold boom. Because changes in the return to gold-related work are accompanied by competing income and substitution effects, we estimated the net effect of the gold boom on health at birth. Our methodology followed a difference-in-differences approach by assessing whether changes in gold world prices affect birth outcomes disproportionately in municipalities that produce more of this commodity. Using the records of vital statistics from 1998 to 2014, we find that the surge in world gold prices disproportionately reduced the incidence of low and low birth weight in gold municipalities. We also find that the shock increased fertility for less-educated mothers and decreased use of prenatal care for all mothers. We conclude that, given that women's health behavior worsens with gold boom and that incomes are higher in this cycle, it would seem that the income effect is an important determinant of health at birth.

RESUMO

CHARRIS VIZCAINO, Carlos Andres, M.Sc., Universidade Federal de Viçosa, fevereiro de 2017. **Exposição prenatal a choques macroeconômicos: Boom do ouro e peso ao nascer na Colômbia**. Orientador: José Gustavo Féres.

A literatura sobre o capital humano tem sugerido um papel importante das capacidades individuais na formação de capital humano. Existem evidências de que as desigualdades observadas nas capacidades são conseqüências de diferenças nas dotações iniciais (por exemplo, peso ao nascer). Por sua vez, há uma hipótese na literatura epidemiológica apontando que os fetos são vulneráveis a fatores ambientais, os quais podem ter um impacto positivo ou negativo sobre as dotações iniciais deles. Em geral, isto sugere que a identificação de choques que afetam a saúde no nascimento deve ser de particular interesse para pesquisadores e formuladores de políticas. Portanto, esta pesquisa tentou fornecer mais evidências empíricas sobre a questão se os choques macroeconômicos têm efeitos sobre os resultados neonatais. A evidência provém do estudo dos efeitos colaterais do incremento dos preços internacionais do ouro (de 2002 a 2012) na probabilidade de baixo e muito baixo peso ao nascer no contexto colombiano. Adicionalmente, verificamos se este efeito está correlacionado com medidas de exposição materna ao boom do ouro. Como as mudanças no retorno ao trabalho relacionado ao ouro são acompanhadas por efeitos de renda e substituição concorrentes, estimamos o efeito líquido do boom do ouro na saúde ao nascer. A nossa metodologia seguiu o método de diferenças em diferenças ao avaliar se as mudanças nos preços mundiais do ouro afetam desproporcionalmente os resultados do nascimento nos municípios que produzem mais dessa commodity. Usando os registros de estatísticas vitais de 1998 a 2014, descobrimos que o aumento dos preços mundiais do ouro reduziu a incidência de baixo e muito baixo peso ao nascer em municípios produtores de ouro. Verificamos também que o choque aumentou a fertilidade para as mães menos educadas e diminuiu o uso do cuidado pré-natal para todas as mães. Conclui-se que, dado que o comportamento das mulheres respeito à saúde piora com o

boom do ouro e que a renda é mais alta neste ciclo, parece indicar que o efeito renda é um determinante importante da saúde ao nascer.

CHAPTER 1

INTRODUCTION

1.1. CONTEXT

Advance in human capital accumulation, both in quantity and quality aspect, is one of the fundamental input of economic progress in any modern economy. There is a growing consensus that human capital plays an important role in the determination of living standards and economic growth. As a consequence, international agencies have used this knowledge as the main pillar to promote education as an instrument through which to generate equitable opportunities for citizens during economic growth. Thus, this strategy of education has occupied an important place in the plans of government of most countries.

Evidence recognizes individual capabilities as a key determinant of human capital formation (HECKMAN; STIXRUD; URZUA, 2006). There are both empirical and theoretical contributions, which suggest that inequalities in capabilities are consequences of differences in endowments, where endowments are characteristics, for example, of health or cognitive abilities, determined before human capital accumulation process (CUNHA; HECKMAN, 2008, 2009). These disparities in endowments among people would be related to differences in levels and trajectory of education and individual earnings, among other labor market and behavioral outcomes. In view of this, there is a strong academic and political interest in understand the causes of these disparities. An explanation comes from the medical literature, which argues that poor birth outcomes may adversely affect these endowments. For example, it has

been documented that low and very low birth weight (i.e. a weight less than 2500 and 1500 grams, respectively) increases the incidence of problems such as poor visual-motor integration, cerebral palsy, deafness, epilepsy, blindness, asthma, chronic lung disease, impaired learning, dyspraxia, and attention deficit disorder (PANETH, 1995; RICHARDS et al., 2001;COUZIN, 2002, MARLOW; ROBERTS; COOKE, 1989 to name but a few).

Along these lines, poor environmental conditions in utero have been shown to have adverse consequences on birth outcomes (ALMOND; MAZUMDER, 2011; CURRIE; NEIDELL; SCHMIEDER, 2009; ROCHA; SOARES, 2015). In this regard, Currie (2011) argue that individuals may begin with very different endowments at birth because of events that happened during fetal growth and that these disparities at birth have been shown to be predictive of the health and economic outcomes in childhood and adulthood[1].

Taken together, these facts suggest that identifying shocks that affect health at birth must be of particular interest to researchers and policy makers. One intriguing hypothesis is that health outcomes at birth can be affected by macroeconomic cycle (e.g.,aggregate economic expansions and contractions or shocks by exogenous variations in the price of a key export product). To verify this relationship, we

[1]The proposition that health conditions at birth have a lasting impact on adult life achievements comes from the so-called "fetal origins hypothesis". The first premise originated with David Barker in the 1980s (ALMOND, 2006). See Barker(2001) for a review of the epidemiological evidence in support of this hypothesis.

investigate how infant health at birth in Colombia responds to boom in the world gold price. Unlike other fetal health shocks, such as weather shocks, the effects of economic shocks are ambiguous due to the different behavioral mechanisms through which these fluctuations impact birth outcomes. Specially, the effect of an increase in word gold price can be separated into substitution and income effect. On the one hand, an increase in returns to work decreases the opportunity cost of carrying out time-intensive activities and therefore, ceteris paribus, lowers the time devoted to children health production[2]. This is the substitution effect. On the other one, an increase in returns to work also increases current income and thereby rises expenditures on items vital to maternal and fetal health. This is the income effect.

In addition, the gold mining is specifically associated with heavy metal pollution such as lead, cadmium, chromium and nickel that come to the surface during the extractive process. Lead exposure in utero is associated with increased risk of premature birth, low birth weight and retarded growth (IYENGAR; NAIR, 2000). Unfortunately, we do not have information in our database that allows us to separately identify each of the previously mentioned effects. However, because they work in opposite directions, our empirical strategy will offer evidence about relative importance of time and environmental degradation versus current income in the production of healthy children. In other words, we will estimate the net effect of the boom in the international price of gold. Because credit constrains and other market imperfections are more common in

[2]For example, activities as practicing good hygiene and traveling to distant facilities for free preventive and primary health service require time to be performed.

developing countries, we expect that our empirical results be consistent with growing evidence that income shocks are a more powerful determinant of health at birth in developing countries than the opportunity cost of time to produce healthy children (BAIRD; FRIEDMAN; SCHADY, 2011;BURLANDO, 2014; BOZZOLI; QUINTANA-DOMEQUE, 2014).

In the first decade of the eleventh century, the Colombian mining sector experienced a positive dynamics in the production and export of its main commodities. According to the Ministry of Mines and Energy (2010),during the years 1990-2010 coal, ferronickel and gold was the minerals that showed a steady increase in production levels. With regard to gold, this mineral had its biggest change since 2002 and peaked in 2009 (with 47.84 tons).This increase in gold production levels was related to price trends of this metal in the international market and the implementation of new technologies that have allowed an increase in mineral recovery. In relation to Colombian exports, mineral products, not including hydrocarbons, presented a progressive increase in free on board value (average annual growth of 19.4%)[3].It was the result of an increase in value had gold exports, from 891 to 1,537dollars. Thus gold, which is a non-traditional exports, equaled in value to traditional exports such as coffee and exceeded ferronickel (MINISTRY OF MINES AND ENERGY, 2010)[4].

[3]The free on board (FOB) is an international marketing term which indicates the price of the goods on board the ship or aircraft.

[4]According to the Colombian national statistical agency the top exports of Colombia are Crude petroleum, Coal Briquettes, Refined Petroleum, Coffee and Gold. In addition, data on gold exports from UN Comtrade indicates that Colombia ranked 28th among gold exporters, between 1995 and 2005.

Colombia is a country with large regional differences in levels of development. In addition, it has high levels of malnutrition that limit its productive potential. In child health, low birth weight (LBW) is of great importance within perinatal mortality. The problem of low weight affected, according to the National Administrative Department of Statistics (DANE), 8.4% of live births in Colombia in 2006[5]. Compared with other countries in Latin America, Colombia ranks second among the countries of this hemisphere with a higher incidence of LBW, just behind Peru. Moreover, It is estimated that 76% of babies born with low weight come from families with low socioeconomic status .Taking into account this situation and the fact that poor health at birth has long lasting effects on individual well-being, it is of great interest to understand how the child health indicators respond to early-life health shocks. Motivated by these considerations, the purpose of this dissertation is to investigate empirically the questions listed below.

1.2. RESEARCH QUESTION AND CONTRIBUTION

According to World Health Organization (2004) report, the number of infants born with low weight is around 22 million (an estimated 15.5% of all births) with incidence of 16.5% per cent in developing countries and 7% in developed countries. This fact is indicator of public health problem because LBW is associated with features of health

[5] This proportion is close to the average rates of 10% observed in Central and South America, but higher than the average rate of 6% that prevails in Europe.

later in life, such as increased risk of neonatal mortality (ALMOND; CHAY; LEE, 2005), lung disease, cardiovascular disease, diabetes and hypertension. In addition, the LBW appears to be related with cognitive and neurological impairment that limits the accumulation of human capital, and thereby decreasing productivity and earnings as adults (BLACK; DEVEREUX; SALVANES, 2007;BEHRMAN; ROSENZWEIG, 2004). This suggests that, further public health issues, the LBW appears to asseverate inequality that is more difficult to overcome in developing countries since the incidence of LBW in such countries is more frequent than in developed world.

Besides showing that health at birth has a long-lasting impact on an individual's economic well-being, economists have been active in demonstrating that health at birth is influenced by many environmental factors, and not only by unchangeable genetic factors[6]. In this point, what becomes relevant is to understand the malleability of health at birth. Today it is not difficult to think that the consumption of tobacco, alcohol, and illegal drug cause intrauterine growth retardation, or that good nutrition and better access to medical care have positive effects on fetal health (CURRIE, 2011). Based on the above, we aim to explore the following issues in the Colombian context. First, we seek to understand the relationship between exogenous price shocks- during pregnancy -in international gold market and birth-endowments. Second, we assess how such an

[6] See Almond and Currie (2011) for a summary of these factors.

exposure affects parental behavior as possible mechanism through which the gold shock impacts birth outcomes.

There are three literatures related to our study. The first is focused on studying the relationship between economic shocks around the time of birth and birth outcomes. In this type of research, shocks are more diffuse in terms of time and mechanisms are not clear compared to other health shocks (ALMOND; CURRIE, 2011). The second literature related to our study estimates the relationship between exposure to economic shocks and behaviors health-related. In Dehejia and Lleras-Muney (2004) show that all mothers in their simple tend to increase their use of prenatal care when unemployment is high. The third type of literature that is associated with our study is that related to demography and economics. This literature has documented a procyclical pattern in fertility. As one example, Schaller (2016) found a countercyclical relationship between fertility and the unemployment rate in the United States from 1980–2009. In this dissertation, we link these three strands of the literature to children' health outcomes at birth.

Our study makes a few contributions to literature examining the effects of economic shocks on children health, which has yet to come to a consensus. First, although there is a rich theoretical literature that suggest that countries and regions with an abundance of natural resources fail to provide a better living standard for society (including SACHS; WARNER, 1999; MEHLUM; MOENE; TORVIK, 2006), our results show, at least in the short term, the gold boom had a positive impact on the living standards

of the local population, and in turn improved the children health. In addition, we examine whether there are gender differences. This is of particular interest in view of the literature on "fragile males", which supports the provocative evidence that male fetuses are more vulnerable to detrimental influences in utero than female fetuses (ALMOND; MAZUMDER, 2011; ERIKSSON et al., 2010; KRAEMER, 2000).

Second, we see our empirical work as the first to examine the effects of the abundance of gold within a country on birth outcomes of the cohorts affected by the gold boom. In order to perform this analysis, we exploit fluctuations in the gold world price that are driven by supply shocks originating in other nations, which helps ensure that they are exogenous to local conditions in producing municipalities in Colombia. Third, our work also contributes to literature on fertility. Specifically, our empirical evidence that the gold boom led to increases in fertility for disadvantaged women (low-educated women) is consistent with life-cycle models in which credit constraints and skill depreciation during pregnancy are important in fertility decisions.

Finally, we also highlight the importance of prenatal interventions as a mechanism to reduce disparities in the accumulation of human capital in the long-run. This is of particular interest in view of the growing evidence indicating that interventions focused on the prenatal period are more effective and substantially less expensive to be implemented (DOYLE et al., 2009) .This is especially important in the context of Colombia because current policies are focused on the population over six years old.

1.3. HYPOTHESIS

- ✓ Prenatal exposure to gold boom positively affects birth outcomes.

1.4. OBJECTIVES

1.4.1. General Objetive

- ✓ This dissertation aims to understand the cyclic relationship between health outcomes at birth and gold boom in Colombia.

1.4.2. Specific Objetives

- ✓ To examine the causal effect of an increase in international gold prices on LBW in Colombia.

- ✓ To examine the causal effect of an increase in international gold prices on Very low birth weight (VLBW) in Colombia.

- ✓ To examine, at the time of a baby's conception, the relationship between the gold boom and mother's characteristics.

- ✓ To analyze the effect of parental exposure to the gold boom on their behaviors related-health.

CHAPTER 2

BACKGROUND

2.1. THEORETICAL FRAMEWORK

Grossman and Joyce(1988) and Rosenzweig and Schultz(1983) are the two seminal papers that presented an infant health production functions. Under this framework, infant health is assumed to be a function of several factor. The first one is the baseline health status of the child, which depends on genetic endowments. The second factor is the time allocated on activities by the mother in order to improve infant's health conditions. The third are goods and services that mothers can purchase with the aim to improve their health and thus their infant; for example, good quality of doctors, hospitals, medicines, vaccines and healthy food. Finally, the fourth factor is exposure to different environmental shock during pregnancy. This can be illustrated in the context of a simple economic model of infant health in which birth weight represent the measure of infant's health condition at birth.

In this conceptual framework, we follow the specification adopted by Grossman and Joyce(1988), Rosenzweig and Schultz(1983) and Tolonen (2015) about the child health production function, which can be written as:

$$U_w = \varphi(X_k, Y_z, T_a, H), \qquad k = 1,\ldots,m \; ; \; z = m + 1, \ldots, n; \; a = n + 1,\ldots,r \qquad (1)$$

where U is a representative pregnant woman's utility function, X is a vector of health neutral goods , Y is a vector of health related goods that can affect health at birth, T are health inputs that require time and H is infant health.

The child health production function is:

$$H_{iwj} = f\left(Y_{iwj}, T_{iwj}, \theta_{wj,}\sigma_{iwj}\right) \qquad (2)$$

the subscript i refers to the child, w to the mother, and j to the area of residence;θ is a women's health endowment, and σ correspond to environmental shocks in-utero. In our study, this term would represent environmental quality shock which can affect directly birth outcomes through biological mechanism. Because changes in the world prices of gold are accompanied by income and substitution effects and changes in the quality of the environment, this generate that the sign of the boom in international gold prices on newborns' health, H, depend of the magnitude of the three effects. On the one hand, if the substitution effect is greater than the income effect in health, the sign of the effect of gold boom on H is negative (a counter-cyclical pattern in the health at birth). On the other hand, if the substitution effect is smaller than the income effect, the sign of the effect is positive (a procyclical pattern in the health at birth).

Consequently, representative pregnant woman maximizes (1), given (2), subject to the following budget constraint:

$$P_x X + P_y Y + P_t T = I_{dis} \quad (3)$$

The surge in international gold prices is an exogenous shock which enhances wages, in gold-producing regions, and thereby households can purchase more health-related goods (I_{dis} increses). However, the impact of health is ambiguous since with the change in wages the opportunity cost of carrying out time-intensive activities (P_t) changes too. That is, wage increases cause in P_t increases which in turn cause a deterioration of child's health. In addition, as previously mentioned, the exploitation of gold is associated with mercury contamination that results from the method of amalgamation of gold. Thus, the net effect of a change in international gold prices on children's health will depends on the relative magnitude of the income and substitution effect and the deterioration of the environment.

2.2. EMPIRICAL STUDIES

2.2.1. Economic Shocks and Birth Outcomes

The analysis of how infant health responds to different prenatal shock has attracted considerable attention. A reason for this particular interest is that effects of early-life shocks have important long-term effects on cognitive development, socioeconomic and health outcomes (BANERJEE et al., 2010;BARRECA, 2010; BLACK et al., 2007; OREOPOULOS et al., 2008; ALMOND, 2006 among others). If these are true, then it will be an important input for policymakers to understand which types of shock have effects on health at birth, and why. One intriguing hypothesis is that economic shocks experienced during early gestation periods affect the baby's health at birth. Households may be willing to reduce its investments on items vital to maternal and fetal health, such as medical care and nutritious food, during negative business cycles.

A number of interesting papers within the health economics have made contributions to this topic. For example, in the developed countries context, Dehejia and Lleras-Muney (2004) study the effect of the unemployment rate at the time of a baby's conception on parental characteristics, parental behaviors, and babies' health . Using data from the U. S. Vital Statistics Natality records from 1975 to 1999, the authors found that high unemployment rates leads to a decrease the likelihood in the children conceived in theses cycles of have low and very low birth weight, congenital malformations and of dying at an early age (before reaching 28 days of age or between 28 and 364 days of age). They argue that their finding are attributable to both selection

into pregnancy as well as changes in health behaviors during pregnancy. Specifically, Dehejia and Lleras-Muney (2004) show that the type of woman who decides to have children in times of high unemployment has a better socioeconomic status (higher educational level) than women who choose to postpone fertility. This is congruent with the hypothesis that women with low socioeconomic status (low-SES) and credit constraints postpone fertility in negative business cycles. Additionally, they found an improvement in health-related behaviors (such as smoking, drinking, and prenatal visits) when unemployment is high. Taken together, their estimates points to that countercyclical relationship between time-intensive health behaviors during pregnancy and unemployment rate is the most important determinat of children's health.

Following the same line, but in the context of a developing country, there is studies investigating how birth aoutcomes responds to transitory deviations in economic conditions. For example, Bozzoli and Quintana-Domeque (2014) assess the impact of the Argentine economic crisis of 2001-2002 on birth weight. Using administrative data of 4 millions individuals born between 2000 and 2005, they find a countercyclical relationship between LBW and economic activity. In addition to this general result, Bozzoli and Quintana-Domeque (2014) check two plausible channels through which procyclicality of birth weight in relation to economic fluctuations is generated: nutritional intake deficit and maternal stress. For this purpose, they divided the sample by education of the mother and estimated the effects of the macroeconomic shock in the three trimesters of the prenatal period. They found that the first semester (period at which birth weight is more sensitive to maternal stress) is important for both educated

and less educated mothers (high school or less), while the third trimester (period at which birth weight is more sensitive to nutritional intake) is only important for mothers with low educational level. This reinforces the idea that Low-LES mothers are more likely to have credit constrained, which prevents to do a complete consumption smoothing.

Another example of the effects of economic shocks on health status and parental behaviour and economic household conditions is provided by Burlando (2014). This author investigated the effect of a month-long electricity blackout occurred in Tanzania in May 2008 on earnings, short-run fertility, and birth weights. He found that babies who were conceived one month before the blackout reported a lower birth weight than those conceived a month after the shock. Moreover, he estimated an increase the probability of LBW. As a possible mechanism of transmission of the blackout, Burlando (2014) estimates the short-term effect of this shock on labor, earnings, and leisure of Tanzania citizens. He found that the power outage led to a significant but temporary decrease in earnings and hours worked in occupations employing electricity.

In general, the results obtained by the last two papers in this literature review suggest that, at least in developing countries, a predominance of the income effect. However, the direction of the effect of a macroeconomic shock on child health is not clear a priori due to the multiple mechanisms that emerge to different macroeconomic shocks. In fact, findings from developing country–level studies are mixed compared to results obtained in the context of the developed world (see, for example, PAXSON; SCHADY, 2005; BHALOTRA, 2010 and MILLER; URDINOLA, 2010).

CHAPTER 3

EMPIRICAL STRATEGY AND DATA

3.1. ECONOMETRIC MODEL

In this section we outline our empirical strategy, that is, how we exploited the heterogeneous distribution of the gold across municipalities and plausibly exogenous variation in the international price of this resource to assess the impact of mother's exposure during the gestational period to this price shocks on babies' health. Specifically, our econometric strategy follows a difference-in-differences estimator by assessing whether changes in gold prices affect birth outcomes disproportionately in municipalities that produce more of this commodity[7]. This analysis is based on a municipality-by month of birth panel. So, our baseline specification has the following structure

$$H_{mdgyt} = \alpha + \beta(Gold_{md} \times PGold_{av_{12}ty}) + \delta' X_{mdgyt} + \eta_{mt} + \gamma_{yt} + \eta_d \times y + \epsilon_{mdgyt} (4)$$

here the left-hand-side variable, H_{mdgyt} ,is a measure of health outcome (average) for infants born in municipality m , department d and with gender g (male or female) , on year y and month t (with t = 1, 2, …, 12). Our key dependent variable (H_{mdgyt}) are low and very low birth weight, but we also look at other health outcomes such as length of gestation, and APGAR score. X_{mdyt} is a vector that contains mother-specific controls such as age, educational attainment and marital status (municipality average). ($Gold_{md}$

[7] This type of methodology has been widely used in recent studies (See, for instant, Dube and Vargas (2013) and Miller and Urdinola (2010))

is the gold production level in municipality m and the department d during 2004 (before the increase in gold prices) and $PGold_{av_{12}ty}$ denotes the average of the natural log of the international gold price in the 12 months prior to birth in year y and month t[8]. We use the average in the 12-month period before birth to take into account the fact that the mother's nutritional status at the time of conception could also be an important predictor of child's initial health endowment. Note that the condition that all municipalities are facing the same prices implies that we must find a treatment variable which changes at the municipal level. In this way, we used the time series variation in global gold prices interacted with cross-sectional variation in the gold production at municipality level as a proxy for the intensity of mining activities[9]. In equation (4), the primary parameter of interest is β, which captures the differential impact of world gold price fluctuations on the birth outcomes of infants in municipalities producing more gold.

η_{mt} is a set of municipality-by-month fixed effects, which take into account the possibility that any time-invariant differences between municipalities (like Geographical-Features) may be correlated with ($Gold_{md} \times PGold_{av_{12}ty}$) and H. The γ_{yt} is a set of year-by-month fixed effects, which captures aggregate shocks impacting the entire country and secular trends in health outcomes at birth . However, despite the inclusion of municipality-by -month and year-by-month fixed effects, our estimator

[8] We measure prices in logs so we can assess its effects in percent terms, but the results are robust to specifying prices in levels.

[9] Note that this product equals zero for municipality with no gold production.

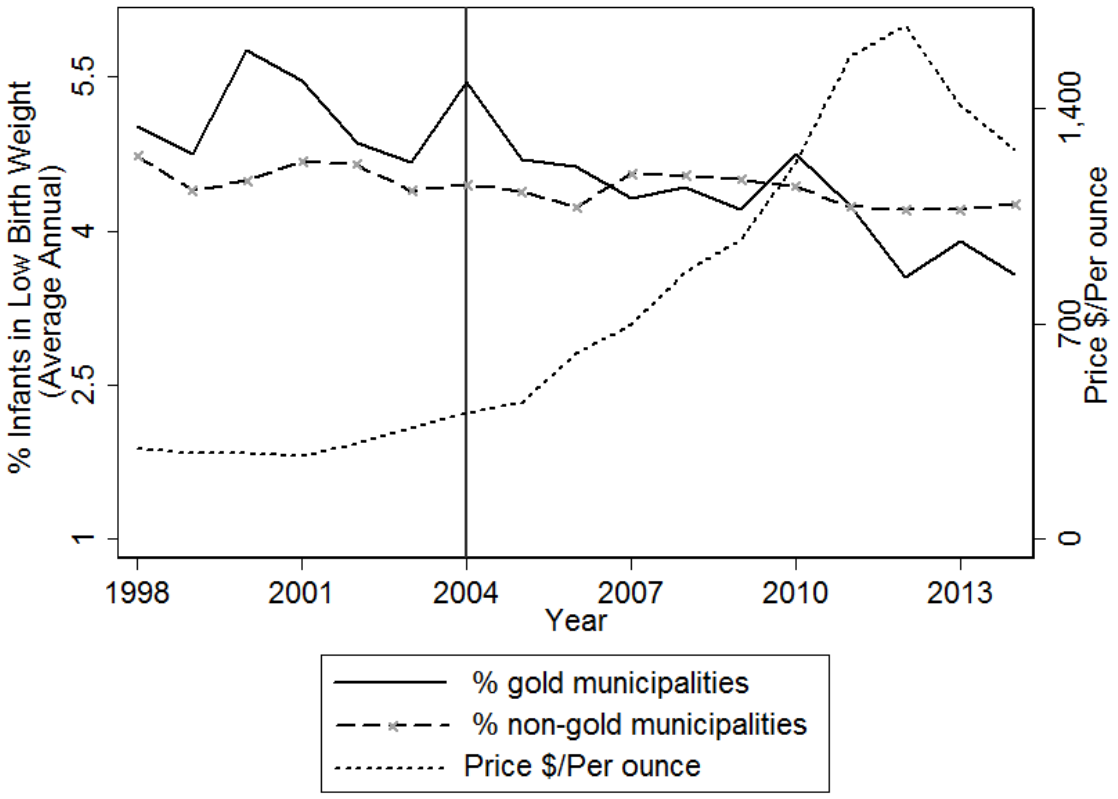
could be capturing a spurious correlation between outcomes at birth and our treatment variable, i.e., the health of children could trending upward based on other factors such as improvements in public health at the department level. To address potential long-run differences in improving public health and other socioeconomic characteristics across department, department-specific trends ($\eta_d \times y$) are included in our benchmark specification. This linear time trend is common to all municipalities included in a given department (average of 38 municipalities per department). Finally, due to the fact that the intensity of mining activities is a variable aggregate rather than an individual measure, we apply Huber-White robust standard errors throughout the analysis, clustered at the municipality-month level.

The identifying assumption of our empirical exercise can be summarized in three parts: First, the world price of gold is exogenous to local conditions in Colombian municipalities, i.e., it is not affected by Colombia's gold production. This assumption is not far from the reality, in fact, according to the latest report on the commodities market of the world bank (2016) Colombia is the 14th largest gold-producing economy, producing 49,9t (tonnes) on average of gold between 1995-2015 (it holds less than one percent of the world gold market). Second, we exploit the fact that this natural resource is not evenly distributed all over country (the distribution depend on natural factors), which produces a totally random assignment of the effect of a boon or bust in this mineral. Therefore, summarizing the above our identification relies on the assumption that changes in the proxy of intensity of mining activities – conditional on all our independent variables– is not correlated with any latent determinant of health at birth. Thus, we are able to identify the causal impact of gold shocks on early life outcomes.

Third, the heart of this difference-in-differences setup says that in the absence of a boon or bust in international gold price, our outcome variable (H_{mdyt}) evolves naturally over time in the same way in all municipalities. This trend is determinate by the sum of a X_{mdyt}, η_{mt} and γ_{yt}.

In this point may be useful to anticipate part of the discussion about the expected sign of the net effect of the gold boom on birth outcomes (β). To do this, we chart basic trend in gold price and low birth weight rate for non-gold and gold municipalities (municipalities with production value exceeding the 95th percentile of the distribution) in Figure 2. If the gold shock relates negatively to birth outcomes (β < 0), we should observe differential decrease in low birth weight rate in gold areas when the price of gold increases. In fact, on the one hand, note that the figure shows a countercyclical relationship between these two variables for producing municipalities. On the other hand, for non-producing municipalities a stable trend is observed in the period of analysis. In addition, the difference in trends between the two types of municipalities begins to be pronounced around 2004, which gives meaning to the application of our difference-in-differences setup. Nonetheless, we clarify that the graph presented show changes in raw means, which is not the variation used in our estimation strategy, since we do not control for any explanatory variable in its construction. Nevertheless, this figure seems to suggest that the gold price shock has a negative relationship to health outcomes at birth.

Figure 1. Gold Price and Birth Weight Trends 1998-2014



Note: Municipality-year average. Authors' calculation base on data from Vital statistics of Colombia and World Bank Commodity Price : 1998-2014. Gold municipalities are defined as those that have a production level greater than the value of the 95th percentile of the distribution.

3.2. DATA

The empirical strategy described above requires time series data on gold world prices, cross-sectional data on the gold production and information available on birth certificates on birth outcomes, mother's characteristics and the behavior of the mother during pregnancy. We describe the construction of our main data series below. Table 1 provides summary statistics on some of our main variables (In the annex we show the descriptive statistics by producing and non-producing municipalities of gold).

3.2.1. Vital Statistics Records

The main source of data for this study is the vital statistics of Colombia, Estadísticas Vitales – EEVV-, which is collected by the Administrative Department of Statistics (DANE) each year as from 1998. The EEVV correspond to the birth certificates filled out at the moment of birth usually in hospitals within the 1120 municipalities in Colombia. The data, besides recording the status of newborn health, contains information on the characteristics of the parents that includes age, marital status and education, type of insurance (contributive 36%, subsidized, vinculado, private, other). In addition to this information, the birth certificate allows us to observe the behavior of the mother during pregnancy, as it contains details about prenatal care. We obtained these data for 1998 and 2014 within the 1120 municipalities in Colombia- approximately 11 million birth records. An advantage of this data is that weight, length,

Apgar score[10], and gestation time recorded at the time of the delivery in the hospital should be accurately measured variables. The sample is limited to births that were certified by a physician, which implies a reduction of about 6%. We dropped the births that occurred in municipalities in which we have no information on the levels of production of gold. Thus, the final sample of our study consists of about 5,152,269 births. After debugging the database, we aggregate the data into cells defined by municipality of residence of the mother, year and months of birth, and gender of the baby.

As a general description of the sample, the table 1 shows a statistical summary of natality data. The prevalence of low birth weight in Colombia is on the order of 6.28%. Almost 0.58% of infants had very low birth weight. About 13% of the births in the analysis period had a weight above 3500 gr. The average of 5 minute Apgar score is 5.99.Of all infants born 51.28% were male. As for preterm deliveries, 13.11% of babies were born before week 37 and 0.23% of them were born before week 28. Regarding the characteristics of mothers, approximately 40.70% of infants were born to mothers with a primary education level or less (<5 years of schooling). Also, 25.63% of mothers are under 19 years of age, 19.21% were married. Finally, the average number of prenatal visits is around 5 visits. At least 50.85% of mothers in our sample had 5 or fewer prenatal visits.

[10]Apgar score is a composite index of a child's health at the first and fifth minute of birth. It takes into account factors: activity and muscle tone, heart rate, grimace, skin coloration, and respiration. Each of this factors is worth 2 points.

3.2.2. International gold price

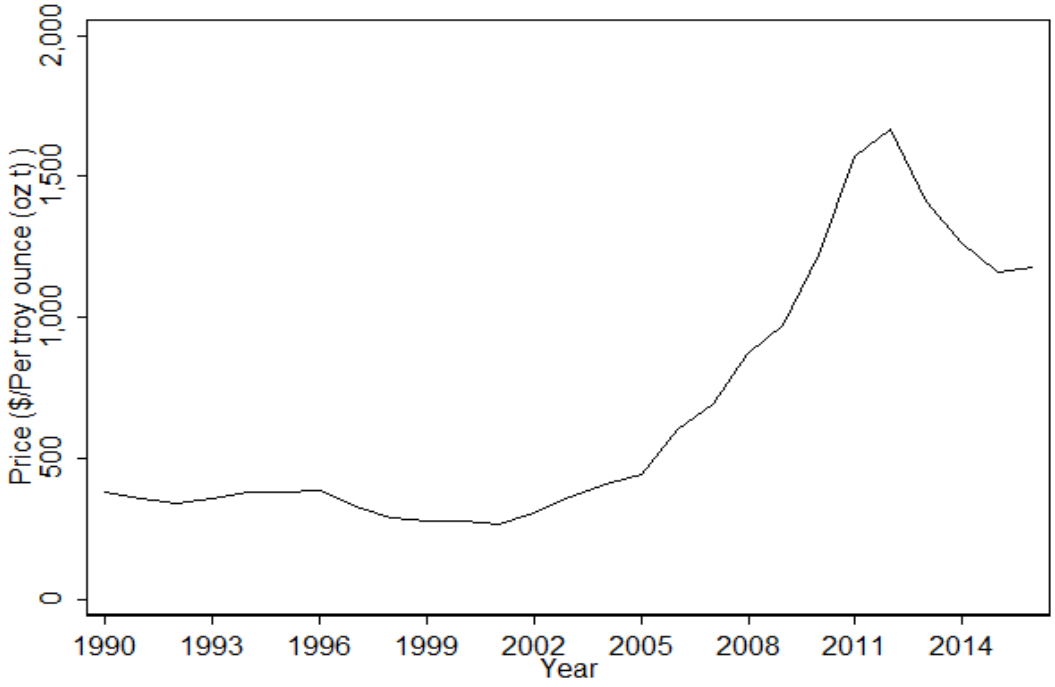
The global commodity boom has been reflected in a good performance of the international prices of products of great importance for Colombian mining such as gold and coal. In the specific case of gold, figure 2 shows the evolution of average annual of gold world prices for the period 1900 to 2014. From this figure, it is clear that the gold world prices rose dramatically between 2002 and 2012 from $309.97 per troy ounce in 2002 to a high of $1669.51 per troy ounce in 2012. Moreover, we can observe that the trend of prices was approximately stable between 1990 and 2001 and it increases continuously from 2002 to 2012. This gold boom could have been driven not only by the increase in China's commodity imports but also by the inflationary fears that were predominant in the period of analysis. In any case, local conditions in Colombian producing municipalities does not determine the world price of gold, as Colombia is a relatively small exporter of gold (the 14th largest gold-producing economy and the sixth-largest producer in Latin America).

Given the previous scenario, this work will provide further empirical evidence to the question whether macroeconomic shocks have effect on health at birth, measured by birth weight. The evidence will come from of the study of collateral effects of the 2002 surge in international gold prices on LBW and VLBW in Colombia. To achieve this objective, we use the average of the natural log of the international gold price in the 12 months prior to birth in year y and month t. The above can be expressed as follows:

$$PGold_{av_{12}ty} = (\sum_{k=0}^{11} Ln(PGold)_{t-k})/12 \quad (5)$$

For the construction of this average, we use the World Bank's commodities prices series, which offers monthly price information for different commodities (such as coffee, oil and coal, to name but a few) from 1960 to the present. Equation 5 assumes that events occurring before conception are equally important predictors of child health than those occurring in the prenatal period.

Figure 2 Gold World Prices Trend 1998-2014



Note: Authors' calculation base on data from World Bank Commodity Price : 1998-2014. The data are available at http://databank.worldbank.org/data/reports.aspx?source=global-economic-monitor-(gem)-commodities.

3.2.3. Local gold production

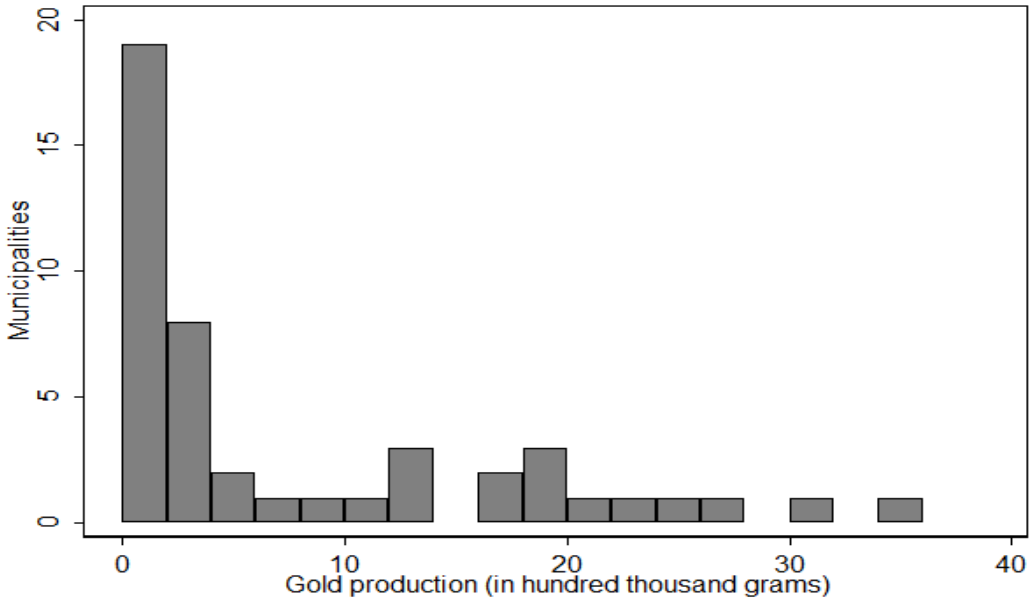
The primary independent variable of this work is an interaction between our measure of global gold price changes, $PGold_{av_{12}ty}$, and local gold production in 2004. This variable is a measure of exposure to the gold boom at the municipal-level. To build time series of the local gold production, we draw on data from two sources: First, we use gold production data provided by Dube and Vargas (2013) . This dataset includes information on other commodities, such as coffee, oil and coal. This information is useful not only for the analysis of gold boom, but also to make a series of robustness checks, which will support our empirical result. Second, we use the gold production data comes from The System of Mining Information of Colombia as a complement to avoid losses of municipalities that do not have records in the database of Dube and Vargas (2013). However, due to missing data in the gold production databases, we can only use information from 990 municipalities, which is equivalent to 88% of the total municipalities in Colombia.

Figures 3 and 4 shows the cross-sectional variation of gold production in 2004 across different areas of Colombia. In figure 3, we can observe that the distribution of production varies substantially across the municipalities that are at or above the 75th percentile. In this part of the distribution, the maximum production was 34.11 thousand grams, which was 33.56 thousand grams greater than the production of the municipality that produced the least (0.54 thousand grams). Additionally, the standard deviation in gold production across of these municipalities is around 10 thousand grams. As a result of this variation, as we shall see, different areas experienced differential changes in

child health in response to changing gold world prices. This is the basis of our empirical strategy.

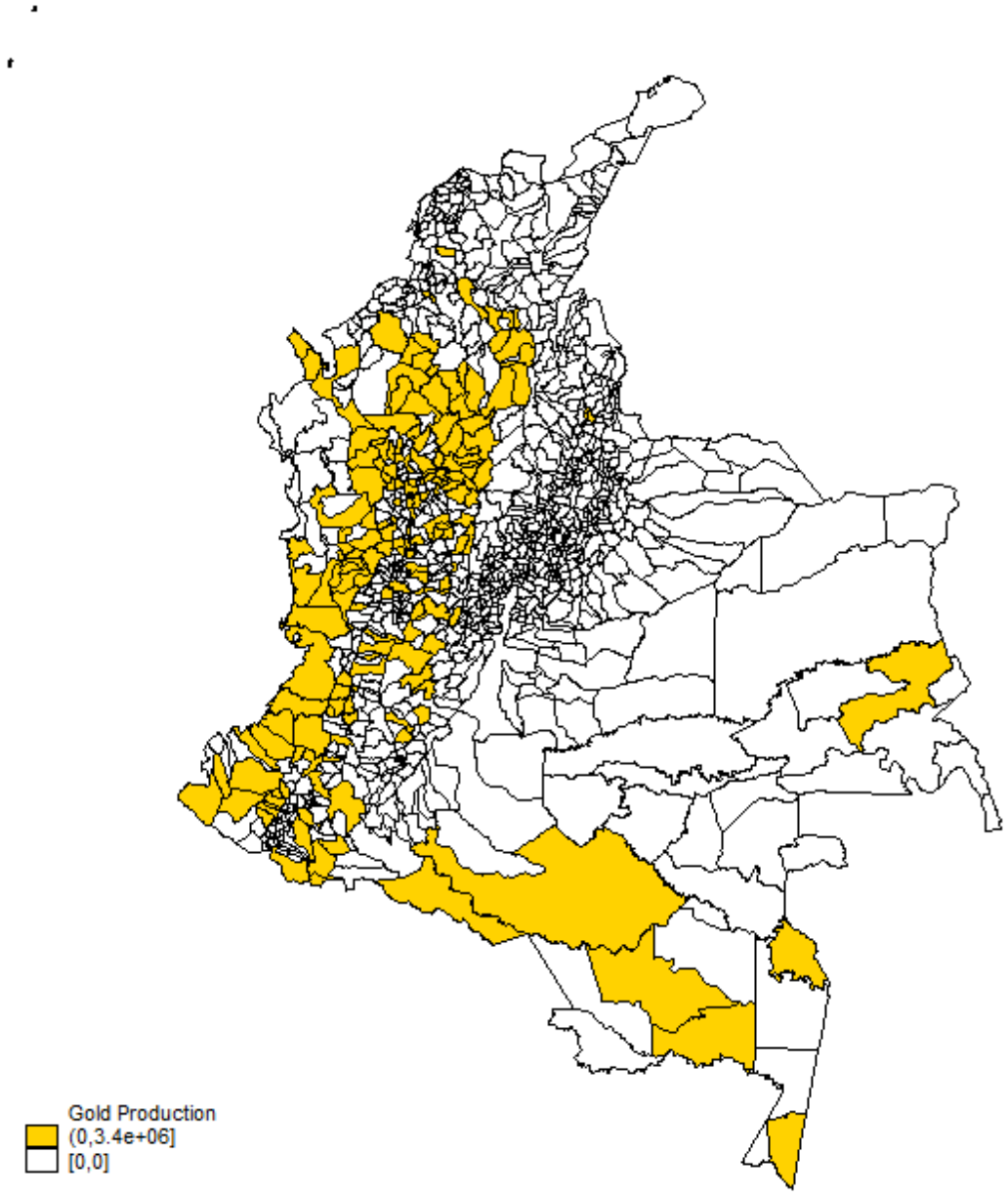
With respect to the geographical distribution of the production of gold, in Figure 4 note that the largest number of producing municipalities is located in the western of the country. This geographic dispersion also indicates that the importance of gold to the local economy varies among the municipalities of the country. In fact, for all the five major producing department of gold (in descending order: Antioquia, Bolivar, Cordoba, Caldas and Choco), the level of gold production represented more than 1% of the state GDP in 2005 (CÁRDENAS; REINA, 2008).

Figure 3. Distribution of gold production in 2004 by municipalities in Colombia.



Note: Authors' calculation base on data from Dube and Vargas (2013) and The System of Mining Information of Colombia. Municipalities are defined as those that have a production level equal or greater than the value of the 75th percentile of the distribution.

Figure 4. Map of geographical distribution of gold in 2004 in Colombia.



Note: Authors' calculation base on data from Dube and Vargas (2013) and The System of Mining Information of Colombia. This map displays the total amount of gold production in 2004 for each municipality.

Table 1. Descriptive Statistics

	Number of Municipalities	Number of Observations	Mean	Standard Deviation
***Child's characteristics (1998*–2014):**				
Number of births	990	5152269	195.69	220.53
%Male	990	5152269	51.28	49.98
Very low birth-weight rate($\leq$ 1500 gr)	990	5144737	0.58	1.21
Low birth-weight rate ($\leq$ 2500 gr)	990	5144737	6.28	5.36
% Birth weight $\leq$ 1000 gr	990	5140576	0.19	0.82
% Birth weight $\leq$ 2000 gr	990	5140576	1.57	2.73
% Birth weight $\leq$ 3000 gr	990	5140576	29.32	14.56
% Birth weight $\leq$ 3500 gr	990	5140576	72.04	14.96
% Birth weight $\geq$ 3500 gr	990	5140576	13.38	14.16
Extreme prematurity rate	990	4876512	0.23	0.84
Prematurity rate	990	5149050	13.11	8.48
APGAR score rate	990	5137364	5.90	10.31
Maternal Characteristic (1998-2014):				
mothers less than age 19 rate	990	5151106	25.63	9.58
mothers between age 20 and 39 rate	990	5151106	72.04	12.12
mothers greater than 39 rate	990	5151106	2.33	3.72
Moms with primary or less rate	990	5149063	40.71	19.72
Moms with high school incomplete or less rate	990	5149063	68.94	18.40
Moms with high school rate	990	5149063	22.44	11.89
Moms with college or more rate	990	4876640	4.48	5.35
moms married rate	990	5150031	19.21	13.76
% moms with health security	990	4875931	22.36	20.38

Table 1. (Continued)

	Number of Municipalities	Number of Observations	Mean	Standard Deviation
Prenatal Care (1998-2014) :				
No. of prenatal care visits	990	4872948	5.19	1.19
% with fewer than 5 prenatal	990	4872948	50.85	20.19
% with greater than 5 prenatal	990	4872948	32.78	18.25
Municipal-level variables :				
Gold production, hundred thousand grams,2004	990	990	0.354	2.61
Coffee intensity, thousands of hectares, 1997	990	971	0.835	1.54
Oil production, hundred thousand barrels/day,1988	990	990	0.003	0.05
Coal production, thousands of tons, 2004	990	990	1.885	12.80
Log int'l gold price, average twelve months before birth (1998-2014)	990	17	6.331	0.64
Log int'l gold price, average twelve months before conception (1998-2014)	990	17	6.389	0.66

Source: Research results. In panel of child's characteristics all variables are dummies, except for number of births. In panel of maternal characteristic all variables are dummies. Prematurity is the birth of an infant before 37 weeks of pregnancy. Extreme prematurity is the birth of an infant before 28 weeks of pregnancy.

CHAPTER 4

RESULTS FOR GOLD WORLD VARIATION AND BIRTH-ENDOWMENTS AND PARENTAL BEHAVIOUR

4.1. MAIN RESULTS

4.1.1. Net effect of gold shocks on the Infant Health

Following the identification strategies outlined above, in this section we present the main empirical results for the fraction of births that are under the condition of LBW and VLBW for 1998 to 2014. The results are obtained using OLS regression of LBW and VLBW on our measure of prenatal gold shocks controlling for different regressors. In our most basic specification presented in the first column, we regressed our child health measure on a set of controls, which includes month-by-year, municipality and year fixed effects. In the remaining columns we add to the firth specification other controls as follows: Column 2 with municipality-by-month fixed effects, column 3 with mothers' characteristics and newborns' sex, and (4) with department specific linear time trends. In this and all subsequent tables, we use robust standard errors clustered at the municipality-months level to account for the fact that the measure of gold shocks operates at the municipalities by year and month level.

The estimates corresponding to various forms of regression (4) are reported in table 2. Overall, the coefficients in columns (1)–(4) seem to suggest that gold price shocks have a cyclical relationship with infant health, that is to say: when international gold price

increases, health at birth improves differentially in municipalities that produce gold more intensively. In specific terms, the first four columns in panel A report the impact of the mothers' exposure twelve months before giving birth to gold shocks on the mean rate of LBW by infants' sex, municipality, month and year of birth. In all the specifications the coefficient on $(Gold_{md} \times PGold_{av_{12}ty})$,β, suggest a statistically significant decrease in the incidence of LBW caused by exposure to gold fluctuations during twelve months prior birth. It is notable that our results are extremely robust across specifications, including controlling for department-specific linear time trends and mother's characteristics. To understand the magnitude of the estimated, consider an increase in $\text{PGold}_{\text{av}_{12}\text{ty}}$ of 0.20 log points and the coefficient estimated in column (4), which is our specification base. For the average gold production in producing municipalities, which is 2.335 (hundred thousand grams), the coefficients imply that the increase in prices induced -0.02 less newborn babies with LBW, relative to the non-gold municipalities. Now when this effect is divided by mean of LBW rate, the resulting effect size is a decrease of -0.30% in the prevalence of LBW in producing municipalities relative to non-producers. We labeled in this and subsequent tables as ''% Impact ([coef * Δ log price* $\overline{Gold}$]/ mean)''. This impact is greater for municipalities with production levels greater than $\overline{Gold}$.

This effect estimated of -0.30% that we uncover for the boom in gold world price is almost three times smaller in absolute value than the -1.02% reduction in the cases of LBW due to the introduction of the Food Stamp Program (FSP) in United States estimated by Almond, Hoynes and Schanzenbach (2011). Moreover, our estimated

impact for LBW is a little lower than -0.50% reduction in babies with LBW explained by a 1% increase in the unemployment rate in the US labor market (see DEHEJIA; LLERAS-MUNEY, 2004). Comparing the coefficient found in our work (which is -0.04074) in relation to that found by Bozzoli and Quintana-Domeque (2014) for the Argentine economic collapse is 0.026 lower in absolute value than the -0.067 calculated by them. These comparisons suggest that our estimates are not so far from what has already been found in empirical studies analyzing economic shocks in the pregnancy stage.

Applying the same estimation procedure for VLBW, we obtain similar results for this outcome. Specifically, from column 1 through 4 in panel B of the Table 2, we observe a significantly negative coefficient -countercyclical relationship- of effect of the gold boom on the VLBW infants. These results are also very robust by adding more controls to the model. As in the panel A, we calculate the impact, evaluated in the average gold municipality, in percentage terms of an increase of 0.20 log points in $PGold_{av_{12}ty}$,the resulting effect size is between -0.68 % and -0.71 % of reduction in cases of very low birth weight in producing municipalities relative to non-producers. In general, in Table 2, we view the specification with department specific linear time trends as very encouraging, because we have addressed a potential concern regarding the possibility of that our estimator is driven by common omitted factors correlated both with $Gold_{md} \times PGold_{av_{12}ty}$ and health at birth.

To further investigate the effect of exposure in utero to gold shocks and thus give more support to our finding, we examine the impact of the gold boon on the distribution of

birth weight. That is, we use the specification (4) to estimate the effect of gold shocks on the probability that birth weight is below a given gram threshold: 1,000; 1,500; 2,000; 2,500; 3,000 and 3,500. In addition, we repeat the same procedure for the possibility that birth weight is above 3,500 grams. The results are presented in Table 3. On the one hand, we find that there is a negative and statistically significant- with the exception of birth weight below 3500 grams- correlation between gold price shocks and birth weight below certain threshold. Note that the largest reductions are obtained at the lower thresholds- 1,000 to 2,000-. The observed impact becomes gradually smaller as the threshold increases, until the point where gold price shocks do not generate effects on births below 3500. On the other hand, the last column shows that an increase of 0.20 log points in the international gold prices is associated with a 0.43% increase in the incidence of the birth weight above 3,500 grams in the average gold producing municipality.

In general, our estimates mirror a clear pattern: they show a positive relationship between gold price shocks and health at birth measured by birth weight, with price increases inducing a differential improved in child health among municipalities that exploit more this natural resource. Sensitivity analyses show these results are robust to alternative specifications or standard errors estimates (see appendix B), and the coefficients do not suffer large changes whether controls or fixed effects are included or excluded.

Taken together, this pattern of results seems to suggest that income shocks are a more powerful determinant of health at birth than the joint effect of the opportunity cost of

time and environmental degradation to produce healthy children. However, since these are aggregate, we cannot rule out that any confusing influence has changed in a specific way in response to the fluctuation of world gold prices. Specifically, our main result could be driven by changes in the composition of births, composition of women giving birth (fertility decisions) and the health-related behavior of pregnant women. To address these possible channels, we test for impacts of the gold shocks on total births, mothers' demographic characteristics and parental behaviors related-health. These results are presented in the following subsections.

To anticipate part of this discussion, Table 4 presents separate regressions for infant's sex and mother's educational. These estimates come from our benchmark specification (column four of the Table 2). The column (2) shows the results of impact of gold boom on LBW and LVBW for sample of infants born male, while the column (3) reports the results for female infants. For both outcomes at birth, the coefficients are statistically significant at 1%. Using the same analysis applied to interpret the estimates in Table 2, in the average gold producing municipality, an increase of 0.20 log points in the international gold prices is associated with a decrease of -0.35 % in the risk of LBW in newborns male, compared with a municipality without gold. Note that impact for female is similar to male (-0.27% for female), which tells us that there were no sex differences in the effects of early exposure to gold shocks. We obtain the same result when analyzing VLBW for male and female, the magnitudes of the effect are -0.67 and -0.70, respectively.

Thus it would seem that, this lack of pattern through birth outcomes does not support the hypothesis of fragile males[11].

Similarly, we stratified the sample by mother's education (an indicator of socioeconomic status) to investigate whether there are heterogeneous effects of prenatal exposure to gold shocks. Specifically, we divide the sample into mothers with less than high school and mothers with high school or above. Our data reveal that, for the average gold municipality, an increase of 0.20 log points in international gold prices generates a decrease of 0.27% in the risk of LBW and of 0.49% in VLBW for mom with less than high school, relative to the non-gold municipalities. Comparing magnitudes of effects with those of mothers with high school or above, we observed that there is little change in LBW which passes from -0.27% to -0.30 % in the analysis. In regard to VLBW, we see a somewhat greater difference in magnitude of effect between the two types of mothers which passes from -0.49% to -0.76 % in our analysis.

The Table 4 present also separate estimates for mother's married status and age. Columns (2) and (3) show the effects of exposure prenatal exposure to gold shock on LBW and VLBW rates by mother's married. The effect of exposure of the mother 12 months before giving birth on the risk of LBW and VLBW is slightly larger for married than unmarried. In fact, the estimated impact in average gold municipality for LBW rate goes from -0.27% to -0.33% when going from unmarried to married. A similar trend is observed in the case of VLBW. Finally, columns (4) and (5) show the results by age of the mother, note that the differential effect between mothers under 19 and

[11]This hypothesis suggests that male fetuses are more vulnerable than female fetuses to fetal health shocks (ALMOND, MAZUMDER, 2011, ERIKSSON et al., 2010; KRAEMER, 2000).

mothers not belonging to this age range is small for the two health measures at birth in statistical terms. Overall, the results suggest small difference by maternal characteristics.

Table 2. Effects of the Gold Prices Shocks on Birth Outcomes in Colombia, 1998-2014

	(1)	(2)	(3)	(4)
Panel A: Dependent variable is Low Birth-Weight Rate				
Gold production2004 x gold price	-0.05061***	-0.05054***	-0.05060***	-0.04074***
(Twelve months before birth)	[0.00381]	[0.00382]	[0.00376]	[0.00643]
% effect of 20% Δ in gold price	-0.377	-0.376	-0.376	-0.303
Observations	302101	302101	299456	299456
R-sq	0.252304	0.280820	0.291586	0.293949
Panel B: Dependent variable is Very Low Birth-Weight Rate				
Gold production2004 x gold price	-0.00879***	-0.00882***	-0.00875***	-0.00844***
(Twelve months before birth)	[0.00111]	[0.00112]	[0.00112]	[0.00148]
% effect of 20% Δ in gold price	-0.71	-0.709	-0.703	-0.678
Observations	302101	302101	299456	299456
R-sq	0.134930	0.169862	0.172270	0.173906
Departament x linear time				Yes
Other controls			Yes	Yes
Municipality x Month fixed effects		Yes	Yes	Yes
Month x year fixed effects	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of children born - by sex, municipality, month and year. The effect of a 20% increase in gold prices is computed by multiplying the average production of gold- producing municipalities by the coefficient on Gold production2004 x gold price, and dividing the resul ting value by the mean of dependent variable."Other controls" include the newborn's sex,mother's school attainment, maternal age and mother's marital status. Estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months level. Yes that means that the group of variables is included in the regressions. Significance: ∗ $p < 0.10$ ∗∗ $p < 0.05$, ∗∗∗ $p < 0.01$

Table 3.Effect of the Gold Prices Shocks on Distribution of Birth Weight in Colombia, 1998-2014

Dependent variable	Below 1,000 gr	Below 1,500 gr	Below 2,000 gr	Below 2,500 gr	Below 3,000 gr	Below 3,500 gr	Above 3,500 gr
Gold production2004 x gold price	-0.00264***	-0.00844***	-0.02123***	-0.04074***	-0.05513***	-0.00863	0.12244***
(Twelve months before conception)	(0.00087)	(0.00148)	(0.00294)	(0.00643)	(0.01135)	(0.01077)	(0.00821)
% effect of 20% Δ in gold price	-0.646	-0.678	-0.634	-0.303	-0.088	-0.006	0.427
Observations	299456	299456	299456	299456	299456	299456	299456
R-sq	0.089036	0.173906	0.264033	0.293949	0.368148	0.362237	0.613433
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Departament x linear time	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality x Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month x year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of children born - by sex, municipality, month and year. The effect of a 20% increase in gold prices is computed by multiplying the average production of gold-producing municipalities by the coefficient on Gold production2004 x gold price, and dividing the resulting value by the mean of dependent variable. "Other controls" include the newborn's sex,mother's school attainment, maternal age and mother's marital status. Estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months level. Yes that means that the group of variables is included in the regressions. Significance: $* p < 0.10$ $** p < 0.05$, $*** p < 0.01$.

Table 4. Heterogeneous Effects of the Gold Prices Shocks on Birth Outcomes in Colombia, 1998-2014

	All Sample	Male	Famele	Less than high school (>11 years)	High school or above (≤ 12 years)
		Panel A: Dependent variable is Low Birth-Weight Rate			
Gold production2004 x gold price	-0.05061***	-0.04262***	-0.03946***	-0.03761***	-0.03940***
(Twelve months before birth)	[0.00381]	[0.00651]	[0.00817]	[0.00682]	[0.01033]
% effect of 20% Δ in gold price	-0.30	-0.35	-0.27	-0.27	-0.30
Observations	302101	149826	149630	159586	114276
R-sq	0.252304	0.319303	0.316821	0.346568	0.360874
		Panel B: Dependent variable is Very Low Birth-Weight Rate			
Gold production2004 x gold price	-0.00879***	-0.00834***	-0.00865***	-0.00729***	-0.00844***
(Twelve months before birth)	[0.00111]	[0.00191]	[0.00188]	[0.00149]	[0.00200]
% effect of 20% Δ in gold price	-0.68	-0.67	-0.70	-0.49	-0.76
Observations	302101	149826	149630	159586	114276
R-sq	0.13493	0.202089	0.212438	0.219644	0.240645
Departament x linear time	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes
Municipality x Month fixed effects	Yes	Yes	Yes	Yes	Yes
Month x year fixed effects	Yes	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of children born - by sex, municipality, month and year. The effect of a 20% increase in gold prices is computed by multiplying the average production of gold- producing municipalities by the coefficient on Gold production2004 x gold price, and dividing the resulting value by the mean of dependent variable."Other controls" include the newborn's sex,mother's school attainment, maternal age and mother's marital status. Estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months level. Yes that means that the group of variables is included in the regressions. Significance: $* p < 0.10$ $** p < 0.05$, $*** p < 0.01$.

Table 4. (Continued)

	All Sample	Married	Not married	Mother's age less than 19	Mother's age greater than 19
	Panel A: Dependent variable is Low Birth-Weight Rate				
Gold production2004 x gold price	-0.05061***	-0.04081***	-0.03740***	-0.04327***	-0.03768***
(Twelve months before birth)	[0.00381]	[0.01540]	[0.00655]	[0.00719]	[0.00808]
% effect of 20% Δ in gold price	-0.30	-0.33	-0.27	-0.31	-0.29
Observations	302101	107559	159113	152194	145476
R-sq	0.252304	0.259944	0.386484	0.320778	0.331469
	Panel B: Dependent variable is Very Low Birth-Weight Rate				
Gold production2004 x gold price	-0.00879***	-0.00786**	-0.00786***	-0.00748***	-0.00988***
(Twelve months before birth)	[0.00111]	[0.00329]	[0.00163]	(0.00192)	(0.00221)
% effect of 20% Δ in gold price	-0.68	-0.72	-0.62	-0.62	-0.76
Observations	302101	107559	159113	152194	145476
R-sq	0.13493	0.207944	0.243802	0.186609	0.242772
Departament x linear time	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes
Municipality x Month fixed effects	Yes	Yes	Yes	Yes	Yes
Month x year fixed effects	Yes	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the fraction of children born - by sex, municipality, month and year The effect of a 20% increase in gold prices is computed by multiplying the average production of gold- producing municipalities by the coefficient on Gold produc tion2004 x gold price, and dividing the resulting value by the mean of dependent variable."Other controls" include the newborn's sex, mother's sch- ool attainment, maternal age and mother's marital status. Estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months level. Yes that means that the group of variables is included in the regressions. Significance: $* p < 0.10$ $** p < 0.05$, $*** p < 0.01$

4.2. ROBUSTNESS OF FINDINGS

In this subsection we present a number of robustness tests designed to assess the validity of our identification strategy. Specifically, we explore whether our findings are influenced by inclusion of postnatal gold prices and other commodities (coal, coffee and oil), changes in mother behavior and changes in the composition of births or women giving birth. In general, the results from these robustness checks are reassuring.

4.2.1. Mother Characteristics

The gold boom may be associated with several other outcomes. In fact, it can lead to a change in the type of mothers who are giving birth and thus generate a bias in our main estimator of the impact of the boom on health at birth. In particular, a positive gold shock can leads to increases in fertility for women with low educational level and credit restrictions against those women who have a better economic status. This change in the composition of the sample could bias downward the estimated effects of an increase in the international gold price on LBW in producing municipalities. To evaluate such channel, we test for impacts of the gold shock on the average characteristics of mothers from the following reduced-form specification:

$$CM_{mdyt} = \alpha + \beta(Gold_{md} \times BPGold_{av_{12}ty}) + \eta_{mt} + \gamma_{yt} + \eta_d \times y + \epsilon_{mdyt} \quad (6)$$

here the left-hand-side variable, $\mathrm{CM_{mdyt}}$, is the vector of characteristics of the mother (municipality average) in municipality m , on year y and month t (with t = 1, 2, …, 12). $\mathrm{BPGold_{av_{12}ty}}$ denotes the average of the natural log of the international gold price in the 12 months prior to conception in year y and month t. η_{mt}, γ_{yt}, $\eta_d \times y$ are

municipality-by-month fixed effects , of year-by-month fixed effects and department-specific trends, respectively. In equation (6) as in equation (4), all estimates are weighted using the number of births in the municipality-month, and the standard errors are clustered by municipality-month level.

Table 5a and 5b display the results of the equation (6) using different dependent variables. In this specification, all dependent variables are expressed in rates. The table 5a presents the results for mothers with primary or less, mothers with high school incomplete or less, mothers with high school and mother with college or more. The coefficients in columns (1) and (2) show that gold price shocks have a positive relationship with the proportion of mothers with low socioeconomic status (SES) who are having children: when the price of gold increases, babies born to low-SES (low-educated women) mothers increase differentially in municipalities that produce gold more intensively. As in our main results, an increase in international gold price by 0.20 log points, in the average gold municipality, induce 0.11% and 0.05% more newborns of mothers with primary or less and of mothers with high school incomplete or less, respectively. It is interesting to note that though the magnitudes of these effects are small, are statistically significant at the 1 percent level.

Table 5. Effect of the Gold Prices Shocks on Mother Characteristics

Dependent variable	% Moms with primary or less	% Moms with high school incomplete or less	% Moms with high school	% Moms with college or more
Gold production2004 x gold price (Twelve months before conception)	0.09291***	0.06704***	-0.03181**	-0.02558***
	[0.01139]	[0.01908]	[0.01531]	[0.00348]
Observations	305913	305913	305913	305913
R-sq	0.659689	0.672004	0.452724	0.60982
Departament x linear time	Yes	Yes	Yes	Yes
Municipality x Month fixed effects	Yes	Yes	Yes	Yes
Month x year fixed effects	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Notes: The dependent variable is the fraction of children born - by sex, municipality, month and year. Estimates are using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality- months level. Yes that means that the group of variables is included in the regressions. Significance: $*$ p < 0.10 $**$ p < 0.05, $***$ p < 0.01

Table 5.a also shows that the gold price shock exerts the opposite effect on the proportion of newborns who were conceived by high-SES mothers (high-educated women). The positive coefficient on the gold interaction term in column (4) indicates that a rise in international gold prices decreases the proportion of mothers with college or more differentially in areas with more gold extraction activity. For the average gold municipality, in which gold production is 2.33 hundred thousand grams, an increase of 0.2 log units in $BPGold_{av_{12}ty}$ leads to a decrease of 0.27% in the proportion of mothers with college or more, compared with a municipality without gold mining activity. This pattern in mothers' education distribution support the hypothesis of that low-SES

mothers who are more likely to face credit constraints will tend be more fertile than high-SES women when the economy experiences positive macroeconomic shocks (see DEHEJIA; LLERAS-MUNEY, 2004) . Overall, we consider the estimates in Table 5a are encouraging because they suggest that our main results (table 2) are biased downwards by endogenous sample selection, which means that the effects of gold shocks on health at birth is greater than estimated.

In the continuation of table 5 we also look at other mothers characteristics. On the one hand, the column (1) indicates that the proportion of young mothers (less than 19) decreases with an increase in our gold shock measure during the 12 months prior conception. This effect is statistically significant at 10% level. On the other hand, the column (3) shows that increase in $BPGold_{av_{12}ty}$ significantly increase the proportion of experienced mothers (39 and older). There are no significant changes in the proportion of mothers between 20 and 39.

Table 5. (Continued)

Dependent variable	% Mother's age less than 19	% Mother's age between 20 and 39	% Mother's age more than 39
Gold production2004 x gold price	-0.04185*	0.00744	0.00955*
(Twelve months before conception)	[0.02186]	[0.02680]	[0.00499]
Observations	308179	308179	308179
R-sq	0.081340	0.066078	0.068955
Departament x linear time	Yes	Yes	Yes
Municipality x Month fixed effects	Yes	Yes	Yes
Month x year fixed effects	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes

Source: Research results. <zaskpc

Notes: The dependent variable is the fraction of children born - by sex, municipality, month and year. Estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months level. Significance: ∗ p < 0.10 ∗∗ p < 0.05, ∗∗∗ p < 0.01

4.2.2. Behavioral changes

We next study the cyclicality of time-intensive child health investments. In addition to changes in the composition women giving birth, gold shocks could also encourage behaviors that could harm or improve infant health. In fact, the existing literature draws a countercyclical relationship between health-related activities (e.g., time-intensive health activities such as prenatal care) and macroeconomic shocks[12]. To the extent woman's health status is related to baby's health outcome, the changes in mother's health-related behavior could also influence the health of infants, even with the non-

[12]For exampleg, there are a series of studies have shown that health improves during economic downturns, Assuming that this effect arises by a change in the health-related behaviors (e.g. smoke and drink less, lose weight, exercise more etc.)(Ruhm (2000, 2003); Ruhm and Black (2002); Dehejia and Lleras-Muney (2004)).

existence of change in composition of births or the types of women giving birth. In order to verify whether the boom in world gold price generated a negative change in activities related to prenatal care in exposed mothers, in this subsection we examine the effect of gold boom on the average number of prenatal visits.

In Table 6, we present the results of this empirical exercise. To obtain these results, we use the specification of equation (4). As the existing literature has documented, we find a countercyclical relationship between prenatal care visits and the gold boom. From column (1) to (3), we observe a significant deterioration in the use of the prenatal care service among mothers: the average number of prenatal care visits decreases, the proportion of mothers with less than 5 prenatal care visits increases, and the proportion of mothers with more than 7 prenatal care visits decreases.

Table 6. Effect of the Gold Prices Shocks on Mother Behaviors

Dependent variable	**Average no. Of prenatal care visit**	**% < than 5 prenatal care visit**	**% > than 7 prenatal care visit**
Gold production2004 x gold price	-0.01068***	0.29785***	-0.35283***
(Twelve months before conception)	[0.00093]	[0.01829]	(0.02004)
Observations	299534	299534	299534
R-sq	0.618278	0.564033	0.545733
Departament x linear time	Yes	Yes	Yes
Other controls	Yes	Yes	Yes
Municipality x Month fixed effects	Yes	Yes	Yes
Month x year fixed effects	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes

Source: Research results.

Notes: In column (1), the dependent variable is the average number of prenatal visits by sex, municipality, month, and year. In column (2) and (3),The dependent variable is the fraction of children born - by sex, municipality, month and year. Estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months.Significance: ∗ $p < 0.10$ ∗∗ $p < 0.05$, ∗∗∗ $p < 0.01$

This pattern is consistent with the idea that a boom in the international price of gold generates an increase in the cost of time and consequently a decrease in time-intensive activities (substitution effect). Overall, our results in the tables 5a and 6 suggest that a boom led both to a negative compositional effect (deterioration of sample of mothers) and a decrease in prenatal care visits (time-intensive health activity). Despite these two negative effects, the net effect of the boon in the world gold price on children's health at birth is positive. This finding is consistent with the idea that the gold shock generated a positive dynamics in the labor market, which led to an increase in the real income of the households in the producing municipalities and subsequently to an improvement in the children's health at birth.

4.2.3. Composition of births

Another potential concern that could arise is that gold shocks may generate, through selective mortality, gradual changes in the composition of birth cohorts. Put differently, babies born during the gold boom may be different, for example in terms of health, from what would otherwise they have been. If prenatal exposure to the boom in world gold price leads to the improvement of fetus' health, we will expect an increase in the number of births due to increases in the probability of survival of marginal fetus.

To evaluate such channels, we use regression analysis to assess the effect of gold price shocks on total births for the period of analysis. Specifically, we use the specification of equation 4 with the total number of births per municipality-month-year as dependent variable and the interaction of the level of production for 2004 with the average of the

natural log of the price for the twelve months before birth as measure gold intensity. The results of this empirical exercise are presented in the table 7. The finding in column (1) suggests that gold price shocks have a procyclical relationship with the total number of births: when the price of gold increases, the total number of babies increases differentially in municipalities that produce gold more intensively. Alternatively, in the column (2), we verify whether this result is sensitive to the specification of the dependent variable. Note that the coefficient is robust to specifying total birth in natural logarithm. Overall, this result is reassuring, because the increase in total births could be interpreted as indicative of the improvement in survivability of marginal fetuses, which would lead to a negative composition effect on child health. That is to say, this change in composition of births leads to a bias downward in the estimated effect of the gold boom on health outcome at birth.

Table 7. Effect of the Gold Prices Shocks on Number of Births

Dependent variable	Number of births	log(Number of births)
Gold production2004 x gold price	0.09876**	0.01016***
(Twelve months before conception)	[0.03587]	[0.00097]
Observations	308896	308896
R-sq	0.925241	0.834923
Departament x linear time	Yes	Yes
Municipality x Month fixed effects	Yes	Yes
Month x year fixed effects	Yes	Yes
Municipality fixed effects	Yes	Yes
Year fixed effects	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of children born with - by sex, municipality, month and year. Robust standard errors are in parentheses and are clustered at the municipality-months level. Significance: $*$ p < 0.10 $**$ p < 0.05, $***$ p < 0.01.

4.2.4. Postnatal gold fluctuations

At this point, a possible problem with our estimation strategy would arise if the prevalence of LBW and VLBW are correlated with postnatal gold fluctuations (one to nine months after birth). We address this concern estimating our base specification (4) by controlling, in addition to $\text{PGold}_{\text{av}_{12}\text{ty}}$, for the average logarithm of the world gold price in the nine months after birth. Specifically, we estimate the following model:

$$H_{mdyt} = \alpha + \beta(Gold_{md} \times BPGold_{av_{12}ty}) + \sigma(Gold_{md} \times FPGold_{av_{12}ty}) + \delta' X_{mdyt} + \eta_{mt} + \gamma_{yt} + \eta_d \times y + \mu_{mdyt} \quad (7)$$

where $\text{FPGold}_{\text{av}_{12}\text{ty}}$ is the log-average of world gold price in the 12 months after to birth for a birth occurring in month t in year y and μ_{mdyt} is a random error term. The remaining controls are those used in our base specification (equation 4). H_{mdyt} is a measure of health outcome (municipality average) for children born in municipality m , on year y and month t. In this specification, the standard errors are also clustered at municipality-month level. σ reflects the sensitivity of health at birth to postnatal fluctuations in our measure of gold intensity.

Columns 1 and 2 in Table 8 show the results of these robustness checks. In the cases of column (2), the main coefficient (β) is similar to estimated in the baseline regression -column (1)-. Note that the interaction of gold production by municipalities indexed in 2004 with the average of the natural log of the international is insignificant, while the interaction with log-average of world gold price in the 12 months before to birth remains negative, with little change in magnitude and significant. This finding reduces

concerns that the baseline results reflect some anticipated effect of gold shocks. Indeed, we can take this result as a falsification test for our empirical strategy.

Table 8. Effects of the Gold Prices Shocks Twelve Months After Birth

	Base Specification	Future
	Panel A: Dependent variable is Low Birth-Weight Rate	
Gold production 2004 x gold price	-0.04074***	-0.045343**
(Twelve months before birth)	[0.00643]	[0.022845]
Gold production 2004 x gold price		0.000006
(Twelve months after birth)		[0.000029]
Observations	299456	299456
R-sq	0.293949	0.293949
	Panel B: Dependent variable is Very Low Birth-Weight Rate	
Gold production 2004 x gold price	-0.00844***	-0.011244***
(Twelve months before birth)	[0.00148]	[0.004321]
Gold production 2004 x gold price		0.000004
(Twelvemonths after birth)		[0.000005]
Observations	299456	299456
R-sq	0.173906	0.173907
Departament x linear time	Yes	Yes
Other controls	Yes	Yes
Municipality x Month fixed effects	Yes	Yes
Month x year fixed effects	Yes	Yes
Municipality fixed effects	Yes	Yes
Year fixed effects	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of children born with LBW an VLBW - by sex, municipality, month and year. The estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months level. Significance: $*$ $p < 0.10$ $**$ $p < 0.05$, $***$ $p < 0.01$.

4.2.5. Other commodity and child health

Another potential problem pervading our analysis concerns to the possibility existence of spillover effects across municipalities that are also producers of other commodities or are close to other municipalities that produce these commodities. In particular, since the boom in world gold prices occurred simultaneously with the fluctuation of prices of other commodities, it is possible that observed effect is not only by gold shocks but also by the variation in these prices. To address this concern, we use data from production levels of oil and coal, and hectares cultivated coffee for the years 1988, 2004 and 1997, respectability. Based on this data, we estimate a broader specification of our base model in which the H_{mdyt} is specified as:

$$H_{mdyt} = \alpha + \beta(Gold_{md} \times BPGold_{av_{12}ty}) + \delta' X_{mdyt} + \eta_{mt} + \gamma_{yt} + (\eta_d \times y) + \sum_{r=1}^{3} Commodity_{md}^{r} \times \gamma_{yt} + \xi_{mdyt} \quad (8)$$

where X_{mdyt}, γ_{yt},$\eta_{mt}$and $(\eta_d \times y)$ are again mother-specific controls , year-by-month fixed ,municipality-by-month fixed effects, and department-specific trend, respectively. The error term ξ_{mdyt} is clustered at municipality-month level. $Commodity_{md}^{r} \times \gamma_{yt}$ is an interaction between the production (or cultivated area) and year-by-month fixed. In this specification, we consider some possible contemporary booms or busts to gold in other commodities, which could drive our estimator of the impact of gold shocks on early health outcomes.

Table 9 places the results to this exercise for LBW and VLBW. Each column is from a separate regression. The column 1 is our benchmark specification, which we use to compare it with the other specifications. In columns (2) to (3) we look whether the main estimator changes in magnitude and significance when we control for oil production, coil production and coffee hectares. Note that the results for LBW and LVBW are reasonably robust across of these alternative specifications. Indeed, when we include all three commodities in the same specification, our finding remains unchanged in both the level of statistical significance and the magnitude of the effect. These results reduce concerns that the improved in health at birth reflecting a boom or brush in the price of commodities different than gold.

Table 9. Other Commodities and Birth Outcomes

	Base Specification	Oil	Coffee	Coal	All
	Panel A: Dependent variable is Low Birth-Weight Rate				
Gold production2004 x gold price	-0.04074***	-0.04063***	-0.03980***	-0.04090***	-0.03980***
(Twelve months before birth)	[0.00643]	[0.00643]	[0.00656]	[0.00643]	[0.00657]
Observations	299456	299456	299456	299456	299456
R-sq	0.293949	0.294755	0.294644	0.294678	0.296181
	Panel B: Dependent variable is Very Low Birth-Weight Rate				
Gold production2004 x gold price	-0.00844***	-0.00843***	-0.00821***	-0.00845***	-0.00820***
(Twelve months before birth)	[0.00148]	[0.00148]	[0.00151]	[0.00148]	[0.00151]
Observations	299456	299456	299456	299456	299456
R-sq	0.173906	0.176014	0.174774	0.174821	0.177813
Department x linear time	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes
Municipality x Month fixed effects	Yes	Yes	Yes	Yes	Yes
Coffee intensity1997 x (γ_{yt})			Yes		Yes
Oil production1988 x (γ_{yt})		Yes			Yes
Coal production2004 x(γ_{yt})				Yes	Yes
Month x year fixed effects	Yes	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of children born - by sex, municipality, month and year. Estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months level. Significance: $*$ p < 0.10 $**$ p < 0.05, $***$ p < 0.01.

4.3. OTHER NEWBORN OUTCOMES

We next explore whether the gold boom improves other health measures in addition to birth weight. To carry out this analysis, we use the same specification of equation 4. The birth health measures used are: the rate of premature babies (less than 37 weeks gestation), rate of extreme prematurity (less than 28 weeks gestation) and low 5 minutes APGAR (<8). The results are presented in Table 10. In panel A we show the results for the fraction of prematurity with different specifications. We can observed that coefficient is significantly negative coefficient and robust by including additional controls. Equal results we obtained for all other birth outcomes. Overall, the result reinforces the idea of a countercyclical relationship between health at birth and gold world price.

Table 10. Effects of the Gold Prices Shocks on other Birth Outcomes

	(1)	(2)	(3)	(4)
	Panel A: Dependent variable is Preterm			
Gold production2004 x gold price	-0.12570***	-0.12551***	-0.12645***	-0.09978***
(Twelve months before birth)	[0.00967]	[0.00978]	[0.00970]	[0.01181]
% effect of 20% Δ in gold price	-0.45	-0.45	-0.45	-0.36
Observations	306128	306128	303274	303274
R-sq	0.235162	0.262970	0.265751	0.271129
	Panel B: Dependent variable is Extreme Preterm			
Gold production2004 x gold price	-0.00302***	-0.00302***	-0.00295***	-0.00275***
(Twelve months before birth)	[0.00073]	[0.00075]	[0.00076]	[0.00083]
% effect of 20% Δ in gold price	-0.60	-0.60	-0.59	-0.55

Observations	306128	306128	303274	303274
R-sq	0.023455	0.063589	0.065404	0.065948
	Panel C: Dependent variable is Apgar Score			
Gold production2004 x gold price	-0.04209***	-0.04167***	-0.04082***	-0.09612***
(Nine months before birth)	[0.00875]	[0.00896]	[0.00896]	[0.01024]
% effect of 20% Δ in gold price	-0.33	-0.33	-0.32	-0.76
Observations	294885	294885	292580	292580
R-sq	0.159754	0.191071	0.193676	0.221663
Departament x linear time				Yes
Other controls			Yes	Yes
Municipality x Month fixed effects		Yes	Yes	Yes
Month x year fixed effects	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of children born - by sex, municipality, month and year The effect of a 20% increase in gold prices is computed by multiplying the average production of gold- producing municipalities by the coeff-icient on Gold production2004 x gold price, and dividing the resulting value by the mean of dependent variable. "Other controls"include the newborn's sex,mother's school attainment, maternal age and mother's marital status. Estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months level. Significance: $* p < 0.10$ $** p < 0.05$, $*** p < 0.01$.

4.4. EXPLORING MARKET CHANNEL

We next study whether the surge in gold world prices propelled economic activity in the municipalities that produce this precious metal. The literature on the curse of natural resources points out that the abundance of natural resources would fail to provide a better quality of life for the population, and in particular, under the context of poor quality institutions and bad governance. However, the debate is still open. A recent contribution by Aragón and Rud (2013) studied the effect of the expansion of the

largest gold mine in Peru on local living standards using households' survey data for the period 1997 to 2006. The authors found that the expansion of the mine has a positive impact on nominal and real income of the local population. They argue that a possible channel of transmission through which these effects emerge is the existence of backward linkages. Specifically, they show that with the existence of backward linkages, an increase in mining activity can affect the living standards of the local community through of a shock of positive demand for local inputs, which in turn leads to an increase real price of factors of production, such as land and labor.

Given our limited information on the labor market given our source, we will try to verify whether the increase in international gold prices led to an economic boom in the gold producing municipalities[13]. For this purpose, we will use information regarding the type of mother's social security regime in health. In particular, we estimate the relationship between the proportion of mothers with a contributory regime and the boom in gold world price. This type of social protection, according to the Ministry of Health of Colombia, covers people with ability to pay such as formal and independent workers, pensioners and their families.

Table 11 presents the results for this exercise. In this specification, we restricted the sample to municipalities with gold production in 2004. Note that in all cases, the estimates of are significantly positive and robust to including additional controls. This

[13] According to Ingeominas (Instituto Colombiano de Geología y Minería), the number of mining titles increased by 61% between 2001 and 2005 .This fact could suggest a positive dynamic in the economy of producing municipalities.

result suggests that the boon in gold world price is associated to the increase differentially, in municipalities that produce gold more intensively, of the proportion of mothers with contributory regimen. In other words, the estimate suggests that rising prices may have generated some dynamics in the local labor market. However, we cannot interpret these results as causal because they may be influenced by other variables that are not captured by our methodology. For this reason, these estimates should be interpreted with caution.

Table11. Health Security and Gold Prices Shocks

	(1)	(2)	(3)	(4)
Panel: variable dependent is % mothers with contributory regimen				
Gold production2004 x gold price	0.05244***	0.05203***	0.06684***	0.05753**
(Twelve months before birth)	[0.01420]	[0.01448]	[0.01487]	[0.01281]
N	55652	55652	55280	55280
R-sq	0.805307	0.810274	0.816869	0.833922
Departament x linear time				Yes
Other controls			Yes	Yes
Municipality x Month fixed effects		Yes	Yes	Yes
Month x year fixed effects	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of mothers with contributory regimen - by newborn's sex, municipality, month and year of birth."Other controls" include the newborn's sex,mother's school attainment, maternal age and mother's marital status. Estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months level. Significance: $*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$.

CHAPTER 5

FINAL REMARKS

The occurrence of a boom in the international price of gold approximately between 2001-2012 , combined with the information of around 11 million births between 1998 and 2014 recorded on the Colombia certificates of Live Birth, has allowed us to study the effect of prenatal exposure to these shocks by analyzing the behavior of an important infant health measure, birth weight. We have found that gold price shocks have a countercyclical relationship with LBW and VLBW. That is, exposure to gold boom improved the initial health endowments. To further support our finding, we investigated the effect of the boom on the probability that birth weight is below a given threshol: 1,000; 1,500; 2,000; 2,500; 3,000 and 3,500. In addition, we repeat the same procedure for the possibility that birth weight is above 3,500 grams. All these estimates maintain the expected effect of an improvement in birth outcomes. As an additional analysis, we investigate whether this pattern is maintained for other health measures at birth. In Table 10, the results show that there was an improvement also in the rate of prematurity, extreme prematurity and low APGAR score at birth.

Because the type of women who have children in positive business cycles may differ from those who choose to postpone fertility, we check whether the shock of gold led

to changes in the composition of women giving birth. Knowing this is important since parental characteristics are correlated to the health status of children and therefore, a change in the selective timing of conceptions can lead to differences in the birth outcomes during the economic cycle. In this analysis, we find that less-educated mothers are more likely to have children during gold boom, thus decreasing the average health status of their babies. In contrast, we observed that high-educated mothers choose to postpone fertility. In addition, the gold boom may lead to change in mothers' health-related behaviors. We find evidence that gold price shock had a negative effect on prenatal care visits, which would lead to a decrease in children's health.

Overall, our results can be interpreted as follows: fetal exposure to the boom in international gold price led to improved in initial health endowments differentially in areas that produce more gold, even with negative effects such as the increase in the proportion of low-SES mothers, decrease in the number of prenatal visits and the degradation of the environment. This suggests that, given that women's health behavior worsens with gold boom and that incomes are higher in this cycle, it would seem that the income effect is an important determinant of health at birth. Our main results are compatible with those obtained by Bozzoli and Quintana-Domeque (2014) and Burlando (2014) ,who found a net negative effect on health at the birth of the Argentine macroeconomic collapse between 2001 and 2002 and an electric blackout in Tanzania, respectively.

Regarding possible mechanisms through which fluctuations in the world gold price affect the results at birth. We verify whether the gold boom led to an increase in economic activity in producing municipalities. In particular, we analyze the relationship between the world price of gold and the proportion of women with a contributory health regime, which covers people with ability to pay. This exploratory analysis is based on the work of Aragón and Rud (2013). The authors found a positive effect of the expansion of the largest gold mine in Peru on real income, which is only observable in the supply market of the mine and surrounding areas. They argue that this positive effect seems to come from a market mechanic, specifically from backward linkages from extractive industries. For the specific case of our study, we found that the gold boom led to an increase in the proportion of mothers with a contributory health regime differentially in municipalities that produce gold more intensely. This suggests that the shock may have generated an increase in the real income of the locating households in the producing municipalities, which led to an improvement in the health of both the mother and the newborn. However we cannot rule out that this relationship is influenced by other factors not considered in our methodology. So it should be interpreted as a simple correlation analysis.

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APPENDIX A

Table A1. Summary statistics of key variables by gold producing municipality

	Gold Production				No Gold Production			
	Number of Municipalities	Number of Observations	Mean	Standard Deviation	Number of Municipalities	Number of Observations	Mean	Standard Deviation
Child's characteristics (1998–2014):								
Number of births	150	1267078	206.76	209.56	840	3885191	192.08	223.88
Very low birth-weight rate(> 1800 gr)	150	1266418	0.61	1.10	840	3878319	0.57	1.24
Low birth-weight rate (>2500 gr)	150	1266418	6.58	4.66	840	3878319	6.18	5.57
Extreme prematurity rate	150	1194133	0.24	0.80	840	3682379	0.23	0.86
Prematurity rate	150	1266685	13.32	7.73	840	3882365	13.03	8.71
APGAR score rate	150	1265336	1.36	4.99	840	3871100	2.43	10.24
Maternal Characteristic (1998-2014):								
mothers less than age 19 rate	150	1266939	26.94	8.42	840	3884679	25.21	9.89
mothers between age 29 and 39 rate	150	1122302	70.68	8.27	840	3477158	72.56	9.80
mothers greater than 39 rate	150	1194377	2.45	2.48	840	3684649	2.31	2.99
Moms with primary or less rate	150	1266685	41.15	18.27	840	3882378	40.56	20.17
Moms less high school or less rate	150	1266685	68.90	16.12	840	3882378	68.95	17.63
Moms with high school rate	150	1266685	23.26	11.42	840	3882378	22.17	12.03
Moms with college rate	150	1194136	3.81	3.78	840	3682504	4.40	4.86
moms married rate	150	1266790	18.73	13.86	840	3883241	19.36	13.72
% moms with health security	150	1193653	20.66	16.71	840	3682278	22.91	21.40

Table A1. (Continued)

Prenatal Care (1998-2014) :								
No. of prenatal care visits	150	1193645	5.17	1.15	840	3679303	5.20	1.21
% with fewer than 5 prenatal	150	1193645	50.95	19.49	840	3679303	50.82	20.42
% with greater than 5 prenatal	150	1193645	33.07	18.17	840	3679303	32.69	18.27
Municipal-level variables :								
Gold production, hundred thousand grams,2004	150	150	2.335	6.38	840	840	0.000	0.00
Coffee intensity, thousands of hectares, 1997	150	149	1.136	1.76	840	822	0.780	1.50
Oil production, hundred thousand barrels/day,1988	150	150	0.002	0.02	840	840	0.003	0.06
Coal production, thousands of tons, 2004	150	150	1.604	13.44	840	840	1.935	12.69

Source: Research results. In panel of child's characteristics all variables are dummies, except for number of births. In panel of maternal characteristic all variables are dummies.

APPENDIX B

Table B1. Effects of the Gold Prices Shocks on Birth Outcomes (Municipalities Producing Gold)

	(1)	(2)	(3)	(4)
Panel A: Dependent variable is Very Low Birth-Weight Rate				
Gold production2004 x gold price	-0.01229***	-0.01230***	-0.01214***	-0.01246***
(Twelve months before birth)	[0.00122]	[0.00123]	[0.00122]	[0.00177]
Observations	55594	55594	55245	55245
R-sq	0.142569	0.168779	0.169275	0.170906
Panel B: Dependent variable is Low Birth-Weight Rate				
Gold production2004 x gold price	-0.05970***	-0.05966***	-0.05974***	-0.05999***
(Twelve months before birth)	[0.00468]	[0.00471]	[0.00458]	[0.00762]
Observations	55594	55594	55245	55245
R-sq	0.243470	0.265998	0.280333	0.284098
Departament x linear time				Yes
Other controls			Yes	Yes
Municipality x Month fixed effects		Yes	Yes	Yes
Month x year fixed effects	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of children born with LBW and VLBW - by sex, municipality, month and year "Other controls" include the newborn's sex,mother's school attainment, maternal age and mother's marital status. Estimates are weighted using the number of birth. Robust standard errors are in parentheses and are clustered at the municipality-months level. Significance: $* p < 0.10$ $** p < 0.05$, $*** p < 0.01$

Table B2. Effects of the Gold Prices Shocks on Birth Outcomes (Using Cluster of Department by Month)

	Base Specification	Base Specification (2)
Panel A: Dependent variable is Low Birth-Weight Rate		
Gold production2004 x gold price	-0.04074***	-0.04074***
(Twelve months before birth)	[0.00643]	[0.00391]
N	299456	299456
R-sq	0.293949	0.293949
Panel B: Dependent variable is Very Low Birth-Weight Rate		
Gold production2004 x gold price	-0.00844***	-0.00844***
(Twelve months before birth)	[0.00148]	[0.00095]
N	299456	299456
R-sq	0.173906	0.173906
Other controls	Yes	Yes
Municipality x Month fixed effects	Yes	Yes
Month x year fixed effects	Yes	Yes
Municipality fixed effects	Yes	Yes
Year fixed effects	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of children born with LBW and VLBW - by sex, municipality, month and year."Other controls" include the newborn's sex,mother's school attainment, maternal age and mother's marital status. Estimates are weighted using the number of birth. Robust standard errors are in parentheses. Column (1) is clustered at the municipality-months level and Column (2) is clustered at the department -months level . Significance: $*$ $p < 0.10$ $**$ $p < 0.05$, $***$ $p < 0.01$

Table B3. Effects Of The Gold Prices Shocks On Birth Outcomes (Without Weight)

	Base Specification	Without Weight
Panel A: Dependent variable is Low Birth-Weight Rate		
Gold production2004 x gold price	-0.04074***	-0.01474*
(Twelvemonths before birth)	[0.00643]	[0.00764]
Observations	299456	299456
R-sq	0.293949	0.086517
Panel B: Dependent variable is Very Low Birth-Weight Rate		
Gold production2004 x gold price	-0.00844***	-0.00275
(Twelve months before birth)	[0.00148]	[0.00245]
Observations	299456	299456
R-sq	0.173906	0.076161
Departament x linear time	Yes	Yes
Other controls	Yes	Yes
Municipality x Month fixed effects	Yes	Yes
Month x year fixed effects	Yes	Yes
Municipality fixed effects	Yes	Yes
Year fixed effects	Yes	Yes

Source: Research results.

Notes: The dependent variable is the fraction of children born with LBW and VLBW - by sex, municipality, month and year."Other controls" include the newborn's sex,mother's school attainment, maternal age and mother's marital status. In this test of robustness, only equation (1) is estimated with the total number of births as weights . Robust standard errors are in parentheses. The estimates clustered at the municipality-months Level. Significance: $*$ $p < 0.10$ $**$ $p < 0.05$, $***$ $p < 0.01$

Table B4. Effects of the Gold Prices Shocks on Birth Outcomes (Without Logarithm in Prices)

	Base Specification	Without Logarithm
Panel A: Dependent variable is Low Birth-Weight Rate		
Gold production2004 x gold price	-0.04074***	-0.000050***
(Twelve months before birth)	[0.00643]	[0.000008]
Observations	299456	299456
R-sq	0.293949	0.293897
Panel B: Dependent variable is Very Low Birth-Weight Rate		
Gold production2004 x gold price	-0.00844***	-0.000010***
(Twelve months before birth)	[0.00148]	[0.000002]
Observations	299456	299456
R-sq	0.173906	0.174028
Departament x linear time	X	X
Other controls	X	X
Municipality x Month fixed effects	X	X
Month x year fixed effects	X	X
Municipality fixed effects	X	X
Year fixed effects	X	X

Source: Research results.

Notes: The dependent variable is the fraction of children born with LBW and VLBW - by sex, municipality, month and year. “Other controls” include the newborn's sex,mother’s school attainment, maternal age and mother's marital status. The estimates are weighted using the number of birth. In this test of robustness, only equation (1) is estimated with the average logarithm of the world gold price in the twelve months after birth . Robust standard errors are in parentheses. The estimates clustered at the municipality-months level. Significance: $*$ $p < 0.10$ $**$ $p < 0.05$, $***$ $p < 0.01$