Month of Birth and Socioeconomic Outcomes of Adults: Evidence from Brazil

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Abstract

This study provides evidence of the relationship between the season of birth and the socioeconomic outcomes of adults in Brazil. We find that individuals born during the summer months have worse health outcomes, educational attainment and earnings compared with persons born in other months. These results emphasize the importance of seasonal patterns in affecting environmental conditions at the time of birth and explaining the children's health and future socioeconomic outcomes among adults. Our results may have some implications for public policy, because they suggest that seasonal variations in health at birth matter for later socioeconomic outcomes. Thus, the understanding of the seasonal deterioration in the birth health outcomes and its implications may be useful for that the policy interventions focused on early-life conditions could effectively enhance the development of human capital among Brazilians.

Key words: Fertility; Family planning; Human Capital Brazil

Resumo

Este estudo fornece evidências da relação entre a estação de nascimento e os resultados socioeconômicos de adultos no Brasil. Nós achamos que indivíduos nascidos durante os meses de Verão apresentam piores resultados de saúde, nível de escolaridade e rendimentos em comparação com as pessoas nascidas em outros meses. Estes resultados reforçam a importância de padrões sazonais em afetar as condições ambientais no momento do nascimento e explicando a saúde das crianças e futuros resultados socioeconômicos entre os adultos. Nossos resultados podem ter algumas implicações para a política pública, porque sugerem que variações sazonais de saúde no nascimento são importantes para resultados socioeconômicos posteriores. Assim, a compreensão da deterioração sazonal nos resultados de saúde no nascimento e suas implicações podem ser úteis para que as intervenções políticas voltadas para as condições do início da vida possam efetivamente melhorar o desenvolvimento do capital humano entre os brasileiros.

Palavras-chave: Fertilidade; Planejamento familiar; Capital Humano; Brasil

Área ANPEC: Economia Social e Demografia Econômica

Classificação JEL: J13, J24, I13

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1. Introduction

Several studies have investigated the relationship between season of birth and socio-economic outcomes in adulthood. These studies have documented that individuals born in certain months have higher educational attainment, better health conditions and higher earnings (Buckles; Hungerman, 2013; Do; Phung, 2008). To explain this seasonal pattern, the literature has used the fetal origin hypothesis, which states that poor environmental conditions *in utero* have persistent health effects (ALMOND; MAZUMDER, 2011; ALMOND, 2006; BARRECA, 2010). Since health is both a type of human capital and a contributor to other forms of human capital (BECKER, 2007), an implication of fetal origin hypothesis is that the period in the uterus is a key timing where are shaped future abilities and, thereby, the earning pathways (ALMOND; CURRIE, 2011). Thus, it has been argued that the seasonality of birth in adult outcomes is explained by seasonal patterns in nutrition and disease conditions *in utero*. In the seasons with higher temperatures, the spread of certain diseases may be favored, adversely affecting fetal health (BARRECA, 2010). Furthermore, in some countries, agricultural productivity may be adversely affected in certain seasons of year due to weather conditions, which could lead to inadequate nutrition due to lower food production and less variety of diet.

Naturally, alterative arguments have emerged to explain the seasonality in adult outcomes. It has been argued that the families can planning the conception of their children based on cultural patterns, the involvement of the mother in agricultural activities, and the seasonality of marriages. To the extent to which the high socio-economic status families are likely to have a better planning, seasonal patterns in adult outcomes may simply reflect the family background. There is evidence consistent with this view. Lam and Miron (1994) show that in summer the number of conceptions is lower in the souther U.S. Panter-Brick (1996) finds empirical evidence suggesting that seasonality in the number of pregnancies is explained by seasonality in marriages, and marital disruptions related to the male outmigration in Nepal. More generally, Buckles and Hungerman (2013) show that infants that born at different times of the year in US are conceived by women with different socio-economic characteristics. Yet, there is no definitive consensus on the reasons why individuals born in certain months have better socio-economic outcomes in adulthood. Whether seasonal patterns in socio-economic outcomes are due to seasonality in environmental conditions or family planning, this would have implications for the debate on if interventions during the prenatal period are more or less effective in increasing human capital.

Most of the evidence documenting a relationship between season of birth and adult outcomes is focused in developed countries. Remarkably, the existing studies for developing countries use a limited number of adult outcome measures and relatively small samples, which has limited the development of clear stylized facts. The question is of particular interest for developing countries. Early-life conditions may be a more important determinant of adult outcomes in developing countries due to health insults are more frequent, and the ability to remedy is more limited (CURRIE; VOGL, 2013). This suggests that seasonality patterns in adult outcomes are likely to be more pronounced in these countries. In addition, the analysis for developing countries may differ substantially due to differences in climatic conditions. Thus, to extrapolate estimates from developed countries could lead to less accurate policy designs

This paper presents new evidence of the relationship between season birth and long-term outcomes in the Brazilian context. We explore a dimension of adult outcome that is prevalent in developing countries and has not been previously examined by the literature. Besides examining whether there is seasonality in socio-economic outcomes such as education, wages, employment and height, we also investigated the existence of seasonal patterns in informal employment. In the context of high informality, employment status is unlikely to be a good measure of success in the labor market. In developing countries like Brazil, a job with a registered contract and contribution to social security might be a more appropriate indicator of success in the labor market because it reflects better wages and greater employment stability. We also explore whether there is seasonality in height, which is a measure directly related to nutrition and health conditions during childhood. Differently from many previous studies, our analysis is based on several waves of a nationally representative survey with information on more than 1.5 million individuals, which allows us to obtain a large statistical power to detect any small effect. We also contribute to the literature by investigating potential mechanisms underlying the relationship between birth season and adult outcomes using natality data from a large number of births (about 32 millions of births). In particular, we investigate whether variations in the family background plays an important role.

To preview, we find that individuals born in the last months of the year have higher educational attainment, increased earnings, greater height, and lower likelihood of informal employment. We then investigated whether these results are consistent with seasonality in birth outcomes, which would provide evidence of pathways. We found that individuals born in the warm months are more likely to have better birth outcomes (measured by birth weight, length of gestation period and APGAR score).[3] In principle, these results suggest that variations in environmental conditions *in utero* may be an important explanation of the relationship between birth season and adult outcomes. However, our findings suggest that this relation is not the entirety of the story. Indeed, we found that individuals born in warmer months are likely to be conceived by mothers that are more educated, more likely to be married and less likely to be young. This suggests that family planning could also play a role.

As an attempt to disentangle these two channels, we investigated whether seasonal patterns in birth outcomes are affected when maternal characteristics are included as controls. We find that maternal characteristics have little influence on the seasonal patterns birth outcomes. This motivates our preferred interpretation that variations in environmental conditions *in utero*, such as the availability of food and the environment diseases, are the most important mechanism to explain seasonal patterns in adult outcomes. One implication of this is that part of inequalities in human capital and income may be explained by differences in the early health conditions. Thus, targeting interventions during the *in utero* period may contribute to reduce such inequalities.

At this point, we should emphasize that there are several caveats to our findings. First, it could be argued that poor environmental conditions *in utero* increase the rates of fetal death. If those surviving fetuses are the healthiest, then a selection bias could arise. Our main response to this concern is that to the extent that such selection bias is important, it will lead to a downward bias in the effect of birth season on adult outcomes. If it is so, our results showing large effects would become even more telling. Thus, we conservatively interpret our estimates as lower bounds of the true effect of birth season on later outcomes in life.

Second, our estimates represent the effect of the reduced form of the birth season. This generates alternative interpretations to our findings, and even though they have little empirical support, we cannot completely rule out them. Third, although our results suggest that variations in environmental conditions seem to play an important role, our analysis does not allow us to identify what specific type of environmental conditions are the most important. In particular, our analysis does not inform if the disease environment plays a more important role than variations in food production. Our approach provides only suggestive evidence of the combined effect of these channels. Fourth, it is unclear the degree of external validity for other developing countries. Taken together, our study is at least a clarion call for future research in this area.

The remainder of this paper is structured as follows. The following section presents a brief review of the mechanisms through which the season birth could be related to later outcomes in life. The third section describes the data used. The fourth presents the econometric model. The fifth section presents the empirical results. The sixth section presents empirical evidence on potential mechanisms. Finally, the seventh section concludes.

2. Linkages between Month-of-Birth and Later-Life Outcomes

[3] The APGAR test is a clinical test that is given to the newborn in which five parameters are assessed. The parameters evaluated are muscle tone, respiratory effort, heart rate, reflexes and skin color. The test provides a total score between 0 and 10, where a higher score means more healthy

In developing countries, literature have hypothesized that the seasonal patterns in later health outcomes are due to seasonal changes in nutrition, temperature (rainy and dry seasons in tropical regions) and infectious diseases. In particular, Lokshin and Radyakin (2012) formulate and test four hypotheses that might explain the relationship between the month of birth and health outcomes of young children in India: (i) the 'nutrition-disease' hypothesis which attributes this variation to the higher prevalence of diseases and malnutrition during the rainy season; (ii) the 'socio-economic' hypothesis which explains seasonal differences in birth for different socio-economic groups; (iii) the 'elective survival' hypothesis which assumes the heterogeneity in the health composition of survived children; and (iv) the 'unplanned pregnancy' hypothesis which associates the different seasonality of children's health to the variation in health outcomes for planned and unplanned children (see Lokshin and Radyakin, 2012, and the references therein). Their results indicate that higher prevalence of malnutrition and/or wider exposure to diseases during the lean season is the most likely explanation for the observed pattern of variations in children's health by month-of-birth. An important implication of such results is that prenatal and postnatal nutrition and the disease environment are relevant inputs or mechanism for children's health outcomes.

We can draw from the four hypotheses of Lokshin and Radyakin (2012) to identify the main mechanisms underlying the relationship between month-of-birth and outcomes later in life. We extrapolate from these hypotheses to the potential channels through which the month of a individual's birth is correlated with his/her later outcomes: disease-nutrition linkages, the socioeconomic status mechanism, the survivorship in early life and the unplanned pregnancy mechanism.

2.1 Disease-Nutrition Linkages

A vast amount of research spanning many scientific fields has investigated the relationship between month-of-birth and health outcomes, morbidity and mortality. Seasonality literature has consistently found that early exposure to infectious disease and/or nutritional deprivation can have long term severe consequences to health. The absence of infectious diseases and the adequate food supplies may work in synergy and is crucial for the children's growth (ALDERMAN; GARCIA, 1994). This channel is likely to operate via seasonal patterns of birth outcomes (such as birth weight and child height), i.e., associations between measures of early-life health and adult outcomes.[4]Lokshin and Radyakin (2012) find that children born during the monsoon months have worse health outcomes than children born during the fall and winter months. Their results indicate that seasonal variations affect the environmental conditions at the date of birth in India and determine the health outcomes later in life. Given that seasonal variation of the disease environment as well as prenatal and postnatal nutrition play an important role in determining health outcomes in early life (whether *in utero* or infancy)[5], the health at birth can be related to later life outcomes (health, future schooling, employment and earnings). In other words, "healthy children tend to become healthy and wealthy adults" (Almond and Currie, 2011).

Most of the literature on this topic has focused on the developed nations of the world. Almond (2006) linked data on adult outcomes to data on the affected cohort by health shock of the 1918 Influenza Pandemic and found that children of infected mothers were more likely to be disabled and experienced lower educational attainment and wage. Other studies find similar long-term damage for prenatal exposure to pandemic influenza in Great Britain (KELLY, 2011), Switzerland (NEELSEN; STRATMANN, 2011), Brazil (NELSON, 2010), United States (BROWN, 2011) and Taiwan (LIN; LIU, 2014). In particular, Lin (2011) used geographic variation in mortality as an indicator for the intensity of prenatal influenza exposure in Brazil and found that affected population achieve fewer years of schooling, lower wages and likelihood to be

[4] Reviews of the literature are in Lee et al(2006),Strand et al(2011), and Chodick et al.(2009). See also Currie and Schwandt 2013, and the references therein. For reviews of the literature in developing countries, see Currie and Vogl (2013).

[5] See Doblhammer and Vaupel(2001) and Lokshin and Radyakin (2012).

employed. Bleakley (2010) estimates that total eradication of malarial infections increased subsequent literacy and adult income but mixed results for years of schooling.

A number of recent studies examine the long-term effects of nutrition at particular critical periods. Field et al., (2009) examine the effect of fetal exposure to iodine supplementation (a prenatal beneficial shock) in Tanzania and find large, robust and positive impact on educational attainment. Empirical evidence from Guatemala provides strong support for the effect of children's nutritional supplements in stimulating high-level of cognitive ability and schooling attainment (BEHRMAN et al., 2009) and increasing wages by 46% (HODDINOTT et al., 2008). On the other hand, Almond and Mazumder (2011) found evidence that diurnal fasting during pregnancy (due to the Ramadan fast which is longer during summer months) increases the likelihood of adult disability with largely effects for mental/learning disabilities. In economics, research exploiting variations in infectious disease comprise seasonal variation in infections (COSTA; LAHEY, 2005) and improvements in reducing the burden of infectious disease such as typhoid and measles (CASE; PAXSON; ISLAM, 2009). In particular, Barreca (2010) examines that early-life malaria exposure can account for as much as 25% of the difference in long-term educational attainment between malaria afflicted and non-afflicted cohorts born in the early 20th Century. Likewise, there is evidence of the possible effects of maternal stress on infant health (see, e.g.,Aizer et al., 2009). For instance, Stoecker(2010) estimates negative effects of extreme cold during pregnancy on adult test scores in vulnerable populations.

Finally, there is evidence that the height and weight (indicators of health and nutritional status) of individuals are influenced by their month of birth in Japan (Tanaka et al., 2007) in Poland (Shephard et al., 1979; Kościński et al., 2004). As argued by some of the literature on this topic, adults who were born heavier or taller fare better on a range of cognitive and socioeconomic outcomes (see, e.g., Steckel 2008; Currie 2009).[6]There is also evidence of the link between height and various measures of wellbeing and success in the development economics literature (CURRIE; VOGL, 2013). It has long been recognized that taller individuals are more productive for being stronger and healthier (Haddad and Bouis 1991), Thomas and Strauss (1997), hold jobs of higher status and, on average, earn more than other workers because they are smarter (CASE; PAXSON; ISLAM, 2009).[7]

2.2 The Socioeconomic Status (SES) Mechanism

Women who give birth in different times of year are likely to have different socioeconomic characteristics. In other words, the well known association between month of birth and adult outcomes may not be purely due to natural phenomena that take place after conception, but may be largely determined by differences in fertility patterns across socioeconomic groups. This seasonality pattern may play an important role in determining the correlation between children's health outcomes and their months-of-birth. A reasonably explanation for this link is the difference in endowments of the children born in certain seasons and who come from better-educated and/or wealthier families (Bronson 1995; Lokshin and Radyakin, 2012). Therefore, differences in long-term outcomes may be attributed to the fact that some individuals come from families with favorable socioeconomic status. During early-life, people coming from higher socioeconomic status are likely to have more resources available for human capital development, and hence as adults, they are more likely to be selected into higher status occupations that require more advanced skills and by which they earn higher returns. On the other hand, it is possible that individuals living in wealthier households and

[6]In fact, birth weight is a little questioned proxy of the intra-uterine environment in order to retrieve the effects of early-life health on adult outcomes, once such relationship is appropriately controlling for family background characteristics (Currie and Vogl, 2013).

[7]Other papers posit that height affects individual achievement through self-esteem (see, e.g., Young and French 1996), social dominance (see, e.g., Hensley1993), or discrimination (see, e.g., Magnusson, Rasmussen and Gyllensten 2006). Some evidence from Phillipines (Haddad and Bouis, 1991), Mexico (VOGL, 2014), Brazil and Ghana (Thomas and Strauss, 1997; Schultz, 2003) indicates a strongly correlation between height and wagesin the context of developing economies.

with better-educated mothers have privileged health outcomes because they were planned to be conceived and born in a certain favorable months of the year. For instance, Darrow et al. (10) indicate that mothers with lower socioeconomic status tend to give birth during months with poorer average birth outcomes. Similarly, Lam et al. (9) documented large seasonality in nonwhite births compared to white ones.

A literature survey by Buckles and Hungerman (2013) reviews empirical and theoretical work and argues that the socioeconomic characteristics of women giving birth fluctuate systematically over the year in the United States. In particular, Buckles and Hungerman (2013) provide strong evidence that controls for family background characteristics may explain the relationship between quarter of birth and later health and professional outcomes. Other studies show that child and adult height are associated with parental socioeconomic status, access to clean water and sanitation during childhood (See, e.g., Thomas, 1994 and Checkley et al., 2004). Nonetheless, the explanation of the mechanism by which women with different characteristics tend to give birth at different seasons is still an empirical endeavor (Lam and Miron 1994; Buckles and Hungerman 2013; Currie and Vogl, 2013). Finally, several papers consider the effects of economic shocks around the time of birth on fetal health. Here, the focus tends to be health in adulthood rather than human capital. Findings in this last field are less consistent than in the studies of nutrition and infection described in the previous section because shocks are more diffuse in terms of timing (Almond and Currie, 2011; Currie and Vogl, 2013).

2.3 The Survivorship in Early Life

Selective mortality constitutes another potentially important linkage effect of the survivorship of children at birth and in childhood on seasonal differences in later outcomes. Samuelson and Ludvigsson(2001)pointed out that children that born and survive during the high-mortality season might be more strong and would have better outcomes later in their life. To the extent that survival of a child is a function of its health endowments at birth only stronger children born in high mortality seasons survive and the weaker ones die (Lokshin and Radyakin, 2012). For instance, the weight (as a proxy of health) of a child at birth influences his/her prospects for survival (see Rosenzweig and Schultz (1982) for a survey).MOORE et al., (2004) show that birth during the annual hungry season strongly influences susceptibility to mortality of young adults in Gambia and Bangladesh. Using adult height as a measure of health, Bozzoli,Deaton,Quintana-Domeque (2009) provide evidence in support of the positive association of child mortality and adult height in the poorest and highest mortality countries of the world. Otherwise, Deaton (2007)shows that in Africa, where mortality rates are high, declines in child mortality are associated with decreased height. In poorer settings, height (as a proxy of health) constitutes an input that reflects healthy growth in childhood and promotes indirectly the development of both physical and cognitive skills (CURRIE; VOGL, 2013). In this sense, the aforementioned findings suggest that mortality selection may be an important affect in determining the adult outcomes. Research in a diversity of countries, rich and poor, confirms this correlation (see e.g., Pathania 2008 for a survey). Yet, Currie and Vogl (2013) indicate that the likelihood of selective mortality hypothesis presents an obstacle to detecting a relationship between early childhood conditions and future outcomes due to the selection biases introduced by changes in the distribution of survivors.

2.4 The Planned Pregnancy Mechanism

The observed differences in later outcomes attributed to seasonality of birth's month may also be linked through the family planning. This effect may be due to the parents' believes. If parents believe that certain months are auspicious for their children to be born in, then they would plan their pregnancies to delivery during those months in order to improve their children's health outcomes (Lokshin and Radyakin, 2012). Thus, family planning may be one key mechanism leading not just to the observed fertility patterns but the outcomes in later life. The survey paper by Do and Phung (2008) observes that differences in health and education outcomes of individuals in Vietnam can be explained by their dates of births. Do and Phung (2008) found that birth cohorts in auspicious years according to Vietnamese astrology are significantly larger than in other year. They concluded that the children born in the favorable dates of birth are more likely to be wanted or planned by their parents and hence benefiting from more favorable conditions for enhanced human development. Because the fertility planning might play a role in explaining the differences in later outcomes, disadvantaged health status can be explained by the fact that children born during inauspicious months would more likely be a result of unplanned pregnancies (KOST; LANDRY; DARROCH, 1998). In addition, Lokshin and Radyakin (2012) rejected the hypothesis that the higher proportion of unplanned births during the monsoon season could be explain the observed variation in children's anthropometrics across the months of the year. That is, seasonal differences in children's health in India are not the result of the differences in health outcomes for planned and unplanned children (LOKSHIN; RADYAKIN, 2012).

3. Data

This study uses data from different sources. To investigate the relationship between month of birth and employment, wages, and educational attainment, we use data from *Pesquisa Nacional por Amostra de Domicilios* (PNAD). To explore the seasonality of birth in height during adulthood, we use data from *Pesquisa de Orçamentos Familiares.* To empirically investigate the origins of the seasonality of birth in adult outcomes, we use microdata on birth certificates provided by the Ministry of Health. We describe each of these data below.

3.1 Pesquisa Nacional por Amostra de Domicilios - PNAD

The PNAD is a nationally representative survey of Brazilian households and is conducted more or less annually since 1971 by the Brazilian Census Bureau (*Instituto Brasileiro de Geografia e Estatistica*, IBGE). The survey is not longitudinal and, thus, it is based on resampling and not necessarily the same households are surveyed. The survey investigates the employment history and educational attainment of all respondents. Importantly, the survey provides information on the month of birth of each respondent. In this study, we use data from ten waves of the PNAD (2001-2011)[8]. In total, there are 3,897,444 observations. We limit the analysis to individuals between 20 and 65 years of age, representing about 58% of all observations. We also exclude observations of individuals who reported no information on the birth month (about of 1.5%). Our final basic sample consists of 2,218,348 observations.

From the data of the PNAD, we investigated whether birth seasonality in employment, hourly wage, informal employment, years of schooling and illiteracy. For analysis of wage, we drop those individuals who reported a wage higher than 50,000 Brazilian Reais[9] in order to mitigate the influence of outliers[10]. Likewise, we also excluded those individuals who reported information on the number of hours worked. To create proxies for informal employment, we use the definitions suggested by Henley, Arabsheibani, andCarneiro (2009). Specifically, we use two definitions of informal employment. In the first definition, informal employment is defined as individual employment status comprising the categories of employed without possession of a signed labor card or a registered labor contract, household worker without a signed labor card, own-account work or self-employment, unpaid worker, worker in production for own consumption, and worker in construction for own use. In the second definition, informal employment is defined through membership of a social security institute or contribution to social security institutes (social protection coverage) in any job during the reference week. Table 1 presents summary statistics of the variables used.

[8] The PNAD was not performed for 2010.
[9] This is equivalent to US$ 15,661.2.
[10] Hourly wages are adjusted for inflation using the consumer price index. Wages are at constant prices of 2013.

3.2 Pesquisa de Orçamentos Familiares - POF

We use data from the last waves of the POF, which was also conducted by the Brazilian Census Bureau between May 2008 and May 2009. The survey aimed to provide information on the household budget composition and on population's life conditions as to measure the structures of consumption, expenditures and income sources. Information on anthropometric measures, such as height, was also collected from each member in the household during the period of the interview. The sampling of POF is part of the group of complex surveys which involves the use of three types of probability samples (simple random sampling, stratified sampling and cluster sampling). Firstly, census sectors, which are geographical areas defined in the Brazilian 2000 Demographic Census, were selected to form a chief sample used by IBGE in all household surveys of the bureau. These sectors were then divided in strata by a geographical and statistical stratification method[11]. Secondly, census sectors were sampled from each stratum and formed a subsample used to select the 55,970 households. In total, there are 206.482 observations. We excluded those individuals for whom it was not collected height measurement (about of 18,773 individuals). As with the PNAD, we limit the analysis to those between 20 and 65 years old. We also exclude individuals who reported no information on the month of birth. The final sample consists of 103,385 observations. A statistical summary of all variables used from the POF is presented in the Table 2.

3.3 Natality Files

From the Brazilian Health Ministry, birth certificate microdata are publicly available through the National System of Information on Birth Records (NSIBR). The NSIBR provides information about the date of birth, birth weight, APGAR score, and length of gestation. Information on the characteristics of mothers such as age, educational attainment and marital status are also available in the NSIBR. We use these data to test whether birth seasonality in birth outcomes and maternal characteristics, which would provide evidence on the causes of birth seasonality in adult outcomes. Then, we obtained these data for the period 2002-2012 within all municipalities in Brazil. Our basic sample consists of 32,492,779 birth records. The sample size varies through each analysis due to the presence of missing values in some variables.

To explore seasonality in birth weight, we use the log of birth weight and a binary variable indicating whether the infant was born at low weight (<2,500 gr). For the APGAR, we use a variable indicating whether the newborn presented a low Apgar score (less than 8). For the length of the gestation period, we constructed a dummy variable indicating whether the infant was born prematurely, defined as less than 38 weeks gestation. For the analysis of maternal characteristics, we construct binary variables for low education (defined as zero years of schooling), married and teenage mother. Table 3 presents descriptive statistics of the variables used.

4. Econometric Model

4.1. Theoretical framework

Our empirical strategy is conceptually simple. To correlate the role of month of birth on an adult's outcomes, we rely on a simple statistical framework of Currie and Volg (2013) that proposes human development as the link between early-life outcomes and adult achievement. Let y be an adult outcome (e.g., wages or employment), let x be an anthropometric measure (e.g., birth weight or Apgar score), and let z be an index (of the early-life conditions or childhood environment) determining x and y. In particular, z may reflect both genetic and non-genetic factors. Furthermore, assume that the reduced-form production functions of x and y can be expressed as:

[11] For more details on POF stratification method see the publication "*Despesas, rendimentos e condições de vida*" of IBGE (IBGE, 2010a).

$$y = \alpha_y + \beta_y z + \varepsilon_y \quad [1]$$

$$x = \alpha_x + \beta_x z + \varepsilon_x \quad [2]$$

where ε_x and ε_y are the error terms for the production function of *x* and *y*, respectively. It is observed that adult and early-life outcomes are linearly related with *z*. Since there is no accurate measure of *z*, we might correlate theoretically *y* with *x* to understand approximately about the parameters in equations [1] and [2]:

$$y = a_{yx} + b_{yx} x + u \quad [3]$$

According to Currie and Volg (2013), the probability limit of the slope coefficient (b_{yx}) in equation [3] is given by

$$\text{plim} b_{yx} = \frac{\beta_y}{\beta_x} \text{x} \frac{1}{1+\frac{\sigma_x^2}{\beta_x^2 \sigma_z^2}} \quad [4]$$

where $\sigma_x^2 = V[\varepsilon_x]$ and $\sigma_z^2 = V[\varepsilon_z]$. A simple implication of the expression [4] is that b_{yx} is decreasing in the effect of the early-life environment on birth outcomes (β_x) and increasing in the effect of the early-life environment on adult outcomes (β_y). On the other hand, if the residual in equation [2] has zero variance, then b_{xy} is equivalent to IV estimator with *z* as an instrument for *x* in order to estimate equation [3]. Nevertheless, to the extent that σ_x^2 increases relative to the component of the variance of *x* explained by *z* ($\beta_x^2 \sigma_z^2$), the slope coefficient (b_{yx}) decreases because *x* turns out a "noisier signal" of *z* (Currie and Volg, 2013). In developing country, there are two reasons to expect b_{yx} to be higher: (1) early-life conditions are more variable and (2) are worse in average (see Currie and Volg, 2013, p. 6-7). Thus, the inputs or initial endowments that promote healthy growth in childhood also encourage the development of outcomes later in life. As noted above, several studies in a variety of settings (developed and developing countries) confirm such correlation. Given the paucity of longitudinal data following individuals in developing countries from birth into adulthood, we focus on seasonality in order to explore the adult outcomes correlates indirectly of birth outcomes and family background in Brazil.

4.2. Empirical Implementation

We turn to the empirical specification of the model and introduce the indexes *a* and *b* for adult and birth outcomes, respectively. First, we examine month-of-birth's impact on adult outcomes. This relationship can be estimated as:

$$Outcome_a = \alpha_a + \beta_a M + \varphi X + \gamma_a L + \delta_a S + \theta_a Y + \varepsilon_a \quad [5]$$

where $Outcome_a$ represents adult outcomes which include (1) years of schooling (2) the percent of illiterate individuals (3) the percent of individuals with employment (3) log of average wages and (4) the percent of individuals without a formal employment; *M* indicates a set of 11 dummy variables for month of birth (with January omitted); *L* denotes the fixed-effects of municipality; *S* represents fixed-effects of Federal Unity; *Y* indicates year-of-birth fixed-effects; *X* indicates demographic control variables; ε_b is noise term. The demographic controls include dummies for white and women.

Second, we argue that the association between birth outcomes and the month of birth captures aspects of the early-life endowments and experience. To assess the magnitudes of the seasonal effects, we estimate the aforementioned relationship as:

$$Outcome_b = \alpha_b + \beta_b M + \gamma_b L + \delta_b S + \theta_b Y + \varepsilon_b \quad [6]$$

where $Outcome_b$ is either represents (1) birth outcomes which include (a) birth weight (b) low birth weight (c) Apgar score and (d) preterm birth or (2) family background characteristics which include the fraction of children born to (a) mothers with a low level of schooling (b) mothers with a high level of schooling (c) married mothers and (d) teenage mothers; M, L, S and Y are defined above; ε_b is the error term.

Finally, we consider to what extent the relationship between month of birth and birth outcomes is accounted for by variation in maternal and family background characteristics of children born throughout the year. we estimate:

$$Outcome_b = \alpha_b^* + \beta_b^* M + \rho_b Z + \gamma_b^* L + \delta_b^* S + \theta_b^* Y + \varepsilon_b \quad [7]$$

where Z contains controls for family background characteristics including dummies for mother having a low level schooling, married mother and teenage mother. It is feasible to test whether family background characteristics drive these seasonal relationships by comparing the month-of-birth coefficients ($\beta_b$and β_b^*) in [6] and [7]. Following Buckles and Hungerman (2013), the inclusion of controls for family characteristics would not change the estimates of the month-of-birth coefficients (β) under two conditions: (1) if family characteristics are orthogonal to month-of-birth or (2) if they have no direct impact on birth outcomes, i.e., the coefficients ρ_b in equation [7] are zero. If neither condition is met, the exclusion of maternal characteristics will lead to inconsistent estimates of β_b in equation [6]. Otherwise, if one of these conditions is satisfied, then equation [6] is correctly specified and its estimation will be both consistent and efficient due to the fact that the estimation would exclude the redundant variables added into equation [7].

5. Empirical results

Main Results

The first step of the investigation consists of looking at if the month of birth is associated with the adult outcomes. Table 4 presents the results of the specification [5] estimated using dummies for municipality, state and year-of-birth. We run the regressions using years of schooling, illiteracy, logarithm of wages, and formal and informal employment as a dependent variables. The regressions are for cohorts for adults aged between 20 and 65. Robust standard errors clustered by primary sampling unit are reported in brackets. The sample sizes and R^2's of the regressions are shown in the table. For years of schooling in column (1), January is the month with the lowest level of schooling, and the peak is in November. The column (2) shows that a person born in January are more likely to be illiterate than other persons. The estimates in column (3) show a statistically insignificant effect of seasonality on the probability of being employed. In the logged wages regression can be observed that wages for those born in January are lower on average than other individuals. The probability of having an informal employment is estimated in columns (5) and (6). The difference between these columns lies in the informal employment definition. Although not all the coefficients are statistically significant, especially among estimated coefficients in column (6), we find similar seasonal patterns in the likelihood of being informal employee across the months of birth. Based on the results of these columns, there is evidence of significant seasonal pattern on the probability of informal labor participation. Specifically, we find that adults born in January look different from other adults: they are more likely to be an informal employee. The last three columns estimate [5] where the outcome of interest is height. The most coefficients on month-of-birth dummies in these regressions are insignificant, providing us with no evidence for differentiating between the impacts of height on adult outcomes.

Table 5 shows the coefficients of the linear regressions of [5] for adult outcomes by gender: years of schooling, illiteracy, logarithm of wages, and formal and informal employment. The effect of the month-of-birth persists when we run the regressions by gender and control for municipality, state and year-of-birth. Given that the estimation is based on the PNAD, robust standard errors are clustered at primary sampling unit. In particular, the results in columns (1) and (2) confirm that November is the month with adults having the highest level of schooling, and individuals born in January obtain lower level of schooling on average than other adults. Because all of the coefficients in columns (3) and (4) are negative, individuals born in January have more likelihood of being illiterate on average than those born in other months of the year. The next pair of columns, (5) and (6), reports the results from a linear probability regression on the likelihood that an adult has an employment. There is no clear pattern in the seasonality of having an employment in the analysis by gender. For the other following two regressions on wages in columns (7) and (8), the statistically significant coefficients indicate that men born in the January obtain fewer earnings on average than other men while results for women exhibit the opposite pattern. The last four columns of Table 5 show a seasonal pattern for men in the likelihood of having an informal employment which is similar to that general pattern found in Table 4. Results for women indicate that the coefficients for month-of-birth dummies in this regression are insignificant, providing us with no evidence for seasonal pattern in female informal participation in the labor market.

6. Mechanism

6.1. Month of Birth and Health Outcomes Mechanism

While our main concern is with the relationship between adult outcomes and date of birth, it is useful to examine the seasonality in birth outcomes in order to understand the mechanisms that may explain the seasonal variation in such long-term outcomes. The estimates of equation [6] can be seen in the regression results in Table 6. This table presents month dummy variables from regressions on birth weight (column (1)), fraction of low birth weight (column (2)), 5 minute Apgar score (column (3)), low Apgar score (column (4) and preterm birth (column (5)). In all regressions the omitted month is January. Results are based on the NSIBR. The number of observations and R^2's for each regression is shown in the table. Regressions include dummies for municipality, state and year-of-birth, and robust standard errors clustered by Federative Unit are reported in brackets. Not surprisingly, most of the month of birth dummies is highly significant in all regressions. For the first pair of columns, (1) and (2), December and January are the months with the worse birth outcomes, and the peak is in September. The next two columns look at the Apgar score indicating that children born in January lower scores compared with children born during other months of the year. Relative to January, children born in other months have better health outcomes in terms of fraction of premature births, with the largest negative differences showing up in September and October. Premature infants have lower capability for development of human capital because they are at greater risk for cerebral palsy, delays in development, and vision and hearing problems. Overall, results in Table 6 depict clear seasonal patterns that are highly persistent across months of birth

6.2. The SES Mechanism

Table 7 present the results from estimating equation [6] on the second set of birth outcomes: fraction of children born to mothers with a low level of schooling, mothers with a high level of schooling, married mothers and teenage mothers. Regressions include dummies for municipality, state and year-of-birth, and robust standard errors clustered by Federative Unit are reported in brackets. For the two first columns, the estimates suggest that January is the month with the lowest SES mothers. However, columns (3) and (4) show that children born in January are less likely to be born to teenage mothers or unmarried mothers. An implication of these results is that there is evidence of seasonal changes in the characteristics of women giving birth throughout the year in Brazil.

To test the socioeconomic status mechanism, we estimate the equation [7] controlling for the mother's characteristics. The results are presented in Table 8. It is important to note that, the magnitude of the effect of month of birth is still predictive even after family background controls are included. These control variables are, overall, statistically significant and have the expected sign indicating that differences in birth outcomes may be indirectly driven by family background characteristics. But clearly variation in the underlying the environmental conditions around the month of birth of a person in Brazil play a crucial role in explaining differences in later outcomes for those born at different times of year. The coefficients estimated for month-of-birth dummies show that children born in December and January obtain lower birth weight on average than other children; these results are similar in magnitude to those shown in Table 6. Furthermore, a roughly comparison between the results for month-of-birth dummies in Table 7 and 8 shows that, in general, these effects (coefficients β_b and β_b^*) remain substantially equal by adding controls for family characteristics. In other words, controlling for family background does not reduce these estimates for all the month-of-birth dummies. Taken at face value, we can conclude that our empirical results provide no support of the socioeconomic mechanism. These results suggest that the other channels that we were not able to properly capture (i.e., survivorship in early life and planned pregnancy mechanism) are not likely to account for effect of month-of-birth on later outcomes within families in Brazil. As discussed above, this implication seems consistent with the mechanism in which early-life conditions may be a more important determinant of adult outcomes in developing countries due to health insults are more frequent, and the ability to redress is more limited.

7. Conclusions

A growing literature in economics holds that the month of a person's birth is associated with later socioeconomic outcomes. In this paper, we use data from PNAD, POF and NSIBR to explore the relationship between the month-of-birth and socioeconomic outcomes of adults in Brazil. The innovation in our approach is to exploit several waves of a nationally representative survey with information on more than 1.5 million individuals, which allows us to obtain a large statistical power to detect any small effect. In particular, we investigate the potential mechanisms underlying the relationship between birth season and adult outcomes using natality data from a large number of births (about 32 millions of births). We find that overall, being born in December and January decreases years of schooling and wages, and increases the likelihood of being illiterate and having an informal employment. Seasonality of birth outcomes estimations deliver comparable results, which induces us to claim that such differences in socioeconomic outcomes among adults are due to the higher solar radiation during this period favors the increase in temperatures and precipitation. During the "lean season" in Brazil (period December-January-February) there is a wider exposure to diseases. Thus, fertility pattern, fetal development during conception and birth outcomes may be affected by excess rainfall that can saturate the soil damaging to certain types of culture, and generate disorders at the time of harvest and agricultural practices. In terms of health outcomes, high levels of humidity and rain, providing the occurrence of colds or viruses (e.g., influenza, dengue) influence the future human capital development. Overall, seasonal pattern in environmental conditions *in utero* may be an important explanation of the relationship between birth season and adult outcomes.

However, our findings are not conclusive about the mechanism through which seasonal factors explain the variations in outcomes later in life. In fact, we found that individuals born in heater months are likely to be conceived by mothers that are more educated, more likely to be married and less likely to be young. But we tested the hypothesis that seasonal patterns in birth outcomes are affected by characteristics of the mothers and concluded that family background play a less relevant explicative role.

Our results may have some implications for public policy, because they suggest that seasonal variations in health at birth matter for later socioeconomic outcomes, and that adequate early-life conditions might be effective in fighting the seasonal deterioration in birth outcomes. Yet, the effectiveness of a specific intervention is a subject for future research.

It is also important to highlight an important limitation in the scope of our findings. Though our approach exploits richer data, the results may not be directly related. The main reason for this lies in the fact that there is a paucity of good longitudinal data following individuals from birth into adulthood. Further study of the effects of seasonal patterns in health at birth on socioeconomic outcomes among adults is an important area for future research.

References

AIZER, A.; STROUD, L.; BUKA, S. Maternal stress and child well-being: Evidence from siblings. **Unpublished manuscript, Brown University, Providence, RI**, 2009.

ALDERMAN, H.; GARCIA, M. Food Security and Health Security: Explaining the Levels of Nutritional Status in Pakistan. **Economic Development and Cultural Change**, v. 42, n. 3, p. 485–507 CR – Copyright © 1994 The University, 1 abr. 1994.

ALMOND, D. Is the 1918 Influenza Pandemic Over? Long-Term Effects of In Utero Influenza Exposure in the Post 1940 U.S. Population. **Journal of Political Economy**, v. 114, n. 4, p. 672–712, ago. 2006.

ALMOND, D.; CURRIE, J. Killing Me Softly: The Fetal Origins Hypothesis. **The journal of economic perspectives : a journal of the American Economic Association**, v. 25, n. 3, p. 153–172, 2011.

ALMOND, D.; MAZUMDER, B. Health Capital and the Prenatal Environment: The Effect of Ramadan Observance During Pregnancy. **American Economic Journal: Applied Economics**, v. 3, n. 4, p. 56–85, 1 out. 2011.

BARRECA, A. I. The Long-Term Economic Impact of In Utero and Postnatal Exposure to Malaria. **Journal of Human Resources** , v. 45 , n. 4 , p. 865–892, 21 set. 2010.

BECKER, G. S. Health as human capital: synthesis and extensions. **Oxford Economic Papers** , v. 59 , n. 3 , p. 379–410, jul. 2007.

BEHRMAN, J. et al. **The Impact of Nutrition During Early Childhood on Education Among Guatemalan Adults**. [s.l.] PIER Working Paper No. 06, 2009.

BLEAKLEY, H. Malaria Eradication in the Americas: A Retrospective Analysis of Childhood Exposure. **American economic journal. Applied economics**, v. 2, n. 2, p. 10.1257/app.2.2.1, abr. 2010.

BOZZOLI, C.; DEATON, A.; QUINTANA-DOMEQUE, C. Adult height and childhood disease. **Demography**, v. 46, n. 4, p. 647–669, 2009.

BROWN, R. **The 1918 US influenza pandemic as a natural experiment, revisited**Duke University. Conference paper. **Anais**...2011

CASE, A.; PAXSON, C.; ISLAM, M. Making sense of the labor market height premium: Evidence from the British Household Panel Survey. **Economics Letters**, v. 102, n. 3, p. 174–176, mar. 2009.

CHODICK, G. et al. Seasonality in Birth Weight: Review of Global Patterns and Potential Causes. **Human Biology**, v. 81, n. 4, p. 463–477, 1 ago. 2009.

COSTA, D. L.; LAHEY, J. N. PREDICTING OLDER AGE MORTALITY TRENDS. **Journal of the European Economic Association**, v. 3, n. 2-3, p. 487–493, 5 abr. 2005.

CURRIE, J. Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development. **Journal of Economic Literature**, v. 47, n. 1, p. 87–122, mar. 2009.

CURRIE, J.; SCHWANDT, H. Within-mother analysis of seasonal patterns in health at birth. **Proceedings of the National Academy of Sciences** , v. 110 , n. 30 , p. 12265–12270, 23 jul. 2013.

CURRIE, J.; VOGL, T. Early-Life Health and Adult Circumstance in Developing Countries. **Annual Review of Economics**, v. 5, n. 1, p. 1–36, jan. 2013.

DEATON, A. Height, health, and development. **Proceedings of the National Academy of Sciences** , v. 104 , n. 33 , p. 13232–13237, 14 ago. 2007.

DO, T.; PHUNG, T. Superstition, Fertility Timing and Human Development. **New York: World Bank. Unpublished**, 2008.

DOBLHAMMER, G.; VAUPEL, J. W. Lifespan depends on month of birth. **Proceedings of the National Academy of Sciences** , v. 98 , n. 5 , p. 2934–2939, 27 fev. 2001.

DOUGLAS ALMOND. Is the 1918 Influenza Pandemic Over? Long-Term Effects of In Utero Influenza Exposure in the Post-1940 U.S. Population. **Journal of Political Economy**, v. 114, n. 4, p. 672–712, 1 ago. 2006.

FIELD, E.; ROBLES, O.; TORERO, M. Iodine Deficiency and Schooling Attainment in Tanzania. **American Economic Journal: Applied Economics**, v. 1, n. 4, p. 140–169, 1 out. 2009.

HADDAD, L. J.; BOUIS, H. E. The impact of nutritional status on agricultural productivity: wage evidence from the Philippines. **Oxford bulletin of economics and statistics**, v. 53, n. 1, p. 45–68, 1991.

HENLEY, A.; ARABSHEIBANI, G. R.; CARNEIRO, F. G. On Defining and Measuring the Informal Sector: Evidence from Brazil. **World Development**, v. 37, n. 5, p. 992–1003, maio 2009.

HENSLEY, W. E. Height as a measure of success in academe. **Psychology: A Journal of Human Behavior**, v. 30, n. 1, p. 40–46, 1993.

HODDINOTT, J. et al. Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. **The Lancet**, v. 371, n. 9610, p. 411–416, 8 fev. 2008.

KELLY, E. The Scourge of Asian Flu: In utero Exposure to Pandemic Influenza and the Development of a Cohort of British Children . **Journal of Human Resources** , v. 46 , n. 4 , p. 669–694, 21 set. 2011.

KOŚCIŃSKI, K.; KRENZ-NIEDBAŁA, M.; KOZŁOWSKA-RAJEWICZ, A. Month-of-birth effect on height and weight in Polish rural children. **American Journal of Human Biology**, v. 16, n. 1, p. 31–42, 1 jan. 2004.

KOST, K.; LANDRY, D. J.; DARROCH, J. E. The Effects of Pregnancy Planning Status on Birth Outcomes and Infant Care. **Family Planning Perspectives**, v. 30, n. 5, p. 223–230, 1 set. 1998.

LEE, S. J.; STEER, P. J.; FILIPPI, V. Seasonal patterns and preterm birth: a systematic review of the literature and an analysis in a London-based cohort. **BJOG: An International Journal of Obstetrics & Gynaecology**, v. 113, n. 11, p. 1280–1288, 2006.

LIN, M.-J.; LIU, E. M. Does in utero exposure to Illness matter? The 1918 influenza epidemic in Taiwan as a natural experiment. **Journal of Health Economics**, v. 37, n. 0, p. 152–163, set. 2014.

LOKSHIN, M.; RADYAKIN, S. Month of Birth and Children's Health in India. **Journal of Human Resources** , v. 47 , n. 1 , p. 174–203, 21 dez. 2012.

MAGNUSSON, P. K. E.; RASMUSSEN, F.; GYLLENSTEN, U. B. Height at age 18 years is a strong predictor of attained education later in life: cohort study of over 950 000 Swedish men. **International Journal of Epidemiology** , v. 35 , n. 3 , p. 658–663, 1 jun. 2006.

MOORE, S. E. et al. Comparative analysis of patterns of survival by season of birth in rural Bangladeshi and Gambian populations. **International Journal of Epidemiology** , v. 33 , n. 1 , p. 137–143, 1 fev. 2004.

NEELSEN, S.; STRATMANN, T. Long-Run Effects of Prenatal Influenza-Exposure: Evidence from Switzerland. 2011.

NELSON, R. E. Testing the Fetal Origins Hypothesis in a developing country: evidence from the 1918 Influenza Pandemic. **Health Economics**, v. 19, n. 10, p. 1181–1192, 1 out. 2010.

PANTER-BRICK, C. Proximate determinants of birth seasonality and conception failure in Nepal. **Population Studies**, v. 50, n. 2, p. 203–220, 1996.

PATHANIA, V. The long run impact of drought at birth on height of women in rural India. **Job Market Paper, Dept of Economics, University of California: Berkeley. vikram. pathania. googlepages. com/vikram_jm_paper2, accessed in February**, 2008.

ROSENZWEIG, M. R.; SCHULTZ, T. P. The behavior of mothers as inputs to child health: the determinants of birth weight, gestation, and rate of fetal growth. In: **Economic aspects of health**. [s.l.] University of Chicago Press, 1982. p. 53–92.

SAMUELSSON, U.; LUDVIGSSON, J. Seasonal variation of birth month and breastfeeding in children with diabetes mellitus. **Journal of Pediatric Endocrinology and Metabolism**, v. 14, n. 1, p. 43–46, 2001.

SCHULTZ, T. P. Wage rentals for reproducible human capital: evidence from Ghana and the Ivory Coast. **Economics & Human Biology**, v. 1, n. 3, p. 331–366, 2003.

SHEPHARD, R. J. et al. Season of Birth and Variations in Stature, Body Mass, and Performance. **Human Biology**, v. 51, n. 3, p. 299–316, 1 set. 1979.

STECKEL, R. H. Biological Measures of the Standard of Living. **The Journal of Economic Perspectives**, v. 22, n. 1, p. 129–152 CR – Copyright © 2008 American Econo, 1 jan. 2008.

STOECKER, C. **Chill Out, Mom: The Long Run Impact of Cold Induced Maternal Stress In Utero**. [s.l.] Mimeo, 2010.

STRAND, L. B.; BARNETT, A. G.; TONG, S. The influence of season and ambient temperature on birth outcomes: A review of the epidemiological literature. **Environmental Research**, v. 111, n. 3, p. 451–462, abr. 2011.

TANAKA, H. et al. Correlation of month and season of birth with height, weight and degree of obesity of rural Japanese children. **The Journal of Medical Investigation**, v. 54, n. 1,2, p. 133–139, 2007.

THOMAS, D.; STRAUSS, J. Health and wages: Evidence on men and women in urban Brazil. **Journal of Econometrics**, v. 77, n. 1, p. 159–185, mar. 1997.

VOGL, T. S. Height, skills, and labor market outcomes in Mexico. **Journal of Development Economics**, v. 107, p. 84–96, 2014.

YOUNG, T. J.; FRENCH, L. A. Height and perceived competence of U.S. presidents. **Perceptual and Motor Skills**, v. 82, n. 3, Pt 1, p. 1002, 1996.

TABLES

Table 1. Summary Statistics PNAD

	Observations	Mean	Standar Deviation	Minimum	Maximum
Years of Schooling	2248646	8.435924	4.557063	1	17
Iliteracy	2248575	.0953617	.2937139	0	1
Employment	2248646	.7093543	.4540604	0	1
Informal Employment (1)	1588913	.5091001	.4999173	0	1
Informal Employment (2)	1588900	.4605055	.4984379	0	1
Wages, Logged	1449182	1.634923	.9375414	-5.706079	8.628225
Women	2248646	.5197529	.4996098	0	1
White	2248646	.5128769	.4998343	0	1
January	2218348	.0822894	.2748052	0	1
February	2218348	.0753718	.2639904	0	1
March	2218348	.0855308	.27967	0	1
April	2218348	.0828138	.2756007	0	1
May	2218348	.0871185	.2820087	0	1
June	2218348	.0857286	.279963	0	1
July	2218348	.084581	.2782573	0	1
August	2218348	.0869148	.2817102	0	1
September	2218348	.0860079	.2803758	0	1
October	2218348	.0860173	.2803896	0	1
November	2218348	.07912	.269926	0	1
December	2218348	.0785061	.2689663	0	1

Illiteracy is defined as the ability to read and write; wages are pre-tax wage and salary income over weeks worked and deflated using the producer price index (IPP), base 2013. Logged wages reports the log of average wages (<16.213 dollars per year); informal employment (1) is defined as individual employment status comprising the categories of employed without possession of a signed labor card or a registered labor contract, household worker without a signed labor card, own-account work or self-employment, unpaid worker, worker in production for own consumption, and worker in construction for own use; informal employment (2) is defined through membership of a social security institute or contribution to social security institutes (social protection coverage) in any job during the reference week for persons 10 years or older.

Table 2. Summary Statistics POF

	Observations	Mean	Standar Deviation	Minimum	Maximum
Height	1.05e+08	164.7713	9.478115	47.2	199.5
Women	1.24e+08	.5069173	.4999522	0	1
White	1.23e+08	.4847608	.4997677	0	1
January	1.23e+08	.0819006	.2742133	0	1
February	1.23e+08	.075427	.2640791	0	1
March	1.23e+08	.083716	.2769614	0	1
April	1.23e+08	.0816127	.2737738	0	1
May	1.23e+08	.0860752	.2804751	0	1
June	1.23e+08	.0821648	.2746157	0	1
July	1.23e+08	.0880556	.2833758	0	1
August	1.23e+08	.0861138	.280532	0	1
September	1.23e+08	.0854457	.2795438	0	1
October	1.23e+08	.0885585	.2841054	0	1
November	1.23e+08	.0801124	.2714672	0	1
December	1.23e+08	.0808175	.2725547	0	1

Height is defined as <250 centimeters.

Table 3. Summary Statistics NSIBR

	Observations	Mean	Standar Deviation	Minimum	Maximum
Birth Weight, Logged	32364790	8.046245	.2120483	3.970292	9.148465
Low Birth Weight	32364790	.0874875	.2825481	0	1
Apgar Score	30476420	9.283852	.9031416	1	10
Low Apgar Score	30476420	.0293995	.1689236	0	1
Preterm	32010916	.0750807	.2635215	0	1
Male	32492779	.5120755	.4998542	0	1
Low Schooling	31682515	.0210641	.1435981	0	1
Married Mother	31891265	.3608989	.4802613	0	1
Teenage Mother	32469257	.2684565	.4431564	0	1
January	32492779	.0832783	.2763024	0	1
February	32492779	.0798597	.2710758	0	1
March	32492779	.0918384	.2887977	0	1
April	32492779	.0878685	.2831036	0	1
May	32492779	.0899749	.2861457	0	1
June	32492779	.0844955	.2781294	0	1
July	32492779	.0842608	.2777785	0	1
August	32492779	.0819518	.2742912	0	1
September	32492779	.0822069	.2746797	0	1
October	32492779	.0800997	.2714475	0	1
November	32492779	.0759174	.2648659	0	1
December	32492779	.0782482	.2685617	0	1

Birth weight is measured in grams, Low birth weight is defined as <2500 grams, the Apgar score is a five-minute Apgar score, the low Apgar score is defined as a five-minute Apgar score <8, and preterm is defined as a birth of a baby at less than 37 weeks gestational age. Family controls include a dummy for mother having a low level schooling (years of schooling<12), a dummy for having a married mother and a dummy for having a teenage mother (age≤20).

Table 4. Month of birth and Adult Outcomes: Results from the PNAD and the POF

	Years of Schooling	Illiteracy	Employment	Wages, Logged	Informal Employment		Height		
							All	Males	Females
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Month of Birth:									
February	0.103	-0.0078	-0.000298	0.00906	-0.00525	-0.00622	-0.0828	-0.08	-0.0866
	[0.0160]***	[0.000992]***	[0.00163]	[0.00372]**	[0.00215]**	[0.00210]***	[0.170]	[0.242]	[0.241]
March	0.127	-0.00646	0.00251	0.0151	-0.00748	-0.00718	0.058	-0.208	0.262
	[0.0155]***	[0.000970]***	[0.00160]	[0.00375]***	[0.00214]***	[0.00208]***	[0.181]	[0.268]	[0.254]
April	0.121	-0.00719	0.000567	0.0142	-0.00416	-0.00457	0.249	0.365	0.131
	[0.0158]***	[0.00101]***	[0.00161]	[0.00405]***	[0.00221]*	[0.00205]**	[0.183]	[0.283]	[0.231]
May	0.0783	-0.00392	0.000122	0.0112	-0.00465	-0.00364	0.154	-0.0396	0.297
	[0.0163]***	[0.00101]***	[0.00166]	[0.00402]***	[0.00213]**	[0.00213]*	[0.174]	[0.264]	[0.225]
June	-0.00272	-0.00175	0.000965	-0.00578	-0.00186	-0.000925	0.0469	-0.112	0.154
	[0.0158]	[0.00105]*	[0.00161]	[0.00411]	[0.00218]	[0.00214]	[0.199]	[0.260]	[0.253]
July	0.106	-0.00825	0.00227	0.00464	-0.00336	-0.00324	0.000699	-0.319	0.246
	[0.0153]***	[0.000987]***	[0.00155]	[0.00416]	[0.00215]	[0.00215]	[0.176]	[0.250]	[0.248]
August	0.0356	-0.00565	-0.0000914	-0.00841	-0.000221	0.000686	0.129	0.154	0.0722
	[0.0162]**	[0.00101]***	[0.00158]	[0.00404]**	[0.00206]	[0.00204]	[0.176]	[0.258]	[0.248]
September	0.0849	-0.00771	-0.000213	-0.00438	-0.0024	-0.00146	0.0317	-0.161	0.158
	[0.0154]***	[0.00102]***	[0.00168]	[0.00406]	[0.00211]	[0.00199]	[0.174]	[0.254]	[0.228]
October	0.0965	-0.00781	0.00184	-0.00244	-0.00442	-0.0032	-0.104	-0.294	0.0584
	[0.0155]***	[0.00101]***	[0.00161]	[0.00377]	[0.00211]**	[0.00206]	[0.165]	[0.263]	[0.214]
November	0.137	-0.01	0.00106	0.000199	-0.00418	-0.00372	0.227	-0.0125	0.43
	[0.0165]***	[0.000988]***	[0.00169]	[0.00397]	[0.00221]*	[0.00214]*	[0.158]	[0.250]	[0.229]*
December	0.078	-0.00402	0.00169	-0.00654	-0.00152	-0.000241	-0.0359	-0.106	0.0126
	[0.0152]***	[0.00102]***	[0.00167]	[0.00405]	[0.00227]	[0.00222]	[0.196]	[0.257]	[0.269]
Observations	2218348	2218280	2218348	1430229	1567056	1567043	104855569	49757861	55097708
R-Squared	0.176	0.107	0.123	0.173	0.077	0.091	0.476	0.164	0.123
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-of-birth Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's elaboration based on the results of this paper.

Notes: Results from columns (1) to (6) are based on PNAD and from (7) to (9) are based on POF. Demographic Controls contains a dummy for women and a dummy for white in all columns. Robust standard errors in brackets are clustered at Primary Sampling Unit from columns (1) to (6) and at Sample Sector from columns (7) to (9). Illiteracy is defined as the ability to read and write; wages are pre-tax wage and salary income over weeks worked and deflated using the producer price index (IPP), base 2013. Logged wages reports the log of average wages (<16.213 dollars per year); informal employment in the sixth column (5) is defined as individual employment status comprising the categories of employed without possession of a signed labor card or a registered labor contract, household worker without a signed labor card, own-account work or self-employment, unpaid worker, worker in production for own consumption, and worker in construction for own use; informal employment in the seventh column (6) is defined through membership of a social security institute or contribution to social security institutes (social protection coverage) in any job during the reference week for persons 10 years or older; Height is defined as <250 centimeters. Each column is a separate regression; the number of observations and the R-squared are shown in the table. The omitted month is January. ** P<0.1; ** P<0.05; P<0.01.*

Table 5. Month of birth and Adult Outcomes by Gender: Results from the PNAD

	Years of Schooling		Illiteracy		Employment		Wages, Logged		Informal Employment			
									Definition 1		Definition 1	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	1	2	3	4	5	6	7	8	9	10	11	12
Month of Birth:												
February	0.123	0.0867	-0.00834	-0.00732	-0.00397	0.00337	0.0141	0.00254	-0.00879	-0.000924	-0.0101	-0.00159
	[0.0240]***	[0.0213]***	[0.00154]***	[0.00129]***	[0.00201]**	[0.00255]	[0.00502]***	[0.00630]	[0.00277]***	[0.00355]	[0.00269]***	[0.00350]
March	0.129	0.129	-0.00843	-0.00474	-0.000765	0.00565	0.0214	0.00707	-0.00948	-0.00501	-0.0102	-0.00355
	[0.0222]***	[0.0210]***	[0.00144]***	[0.00127]***	[0.00184]	[0.00253]**	[0.00496]***	[0.00589]	[0.00276]***	[0.00333]	[0.00268]***	[0.00332]
April	0.134	0.111	-0.00902	-0.00558	-0.00346	0.00458	0.0231	0.00134	-0.00657	-0.00119	-0.00778	-0.000533
	[0.0239]***	[0.0210]***	[0.00150]***	[0.00132]***	[0.00199]*	[0.00241]*	[0.00525]***	[0.00629]	[0.00281]**	[0.00352]	[0.00264]***	[0.00342]
May	0.0933	0.0657	-0.00623	-0.00178	-0.00193	0.00233	0.0148	0.00549	-0.00647	-0.0022	-0.00599	-0.000438
	[0.0232]***	[0.0212]***	[0.00146]***	[0.00134]	[0.00189]	[0.00264]	[0.00540]***	[0.00601]	[0.00280]**	[0.00325]	[0.00273]**	[0.00321]
June	-0.00809	0.00607	-0.00241	-0.00136	0.00112	0.00085	-0.00355	-0.00785	-0.00322	-0.000323	-0.00454	0.00349
	[0.0230]	[0.0223]	[0.00150]	[0.00138]	[0.00178]	[0.00251]	[0.00521]	[0.00638]	[0.00271]	[0.00353]	[0.00263]*	[0.00338]
July	0.102	0.111	-0.0096	-0.007	0.000537	0.00408	0.0106	-0.0045	-0.00566	-0.000317	-0.00586	0.000245
	[0.0225]***	[0.0207]***	[0.00152]***	[0.00128]***	[0.00187]	[0.00241]*	[0.00529]**	[0.00629]	[0.00284]**	[0.00337]	[0.00282]**	[0.00336]
August	0.0385	0.0352	-0.00727	-0.00422	-0.00308	0.00277	-0.00295	-0.0162	-0.00433	0.00518	-0.00315	0.00564
	[0.0227]*	[0.0215]	[0.00149]***	[0.00136]***	[0.00185]*	[0.00256]	[0.00520]	[0.00626]***	[0.00266]	[0.00333]	[0.00260]	[0.00327]*
September	0.089	0.0827	-0.0093	-0.00615	-0.00294	0.00253	0.00299	-0.0152	-0.00606	0.0022	-0.00464	0.00251
	[0.0227]***	[0.0210]***	[0.00153]***	[0.00132]***	[0.00188]	[0.00267]	[0.00517]	[0.00659]**	[0.00279]**	[0.00334]	[0.00264]*	[0.00320]
October	0.0961	0.0967	-0.00843	-0.00713	0.000698	0.0031	0.00335	-0.0109	-0.00764	-0.000314	-0.00715	0.00194
	[0.0231]***	[0.0202]***	[0.00149]***	[0.00133]***	[0.00187]	[0.00251]	[0.00505]	[0.00646]*	[0.00279]***	[0.00324]	[0.00269]***	[0.00323]
November	0.159	0.12	-0.0126	-0.00772	-0.00177	0.00397	0.00547	-0.00692	-0.00422	-0.00439	-0.00583	-0.00119
	[0.0231]***	[0.0227]***	[0.00143]***	[0.00135]***	[0.00204]	[0.00255]	[0.00531]	[0.00619]	[0.00284]	[0.00358]	[0.00277]**	[0.00340]
December	0.106	0.0571	-0.00699	-0.00143	-0.00174	0.00497	0.00155	-0.0172	-0.00396	0.00142	-0.00467	0.00512
	[0.0227]***	[0.0213]***	[0.00154]***	[0.00132]	[0.00188]	[0.00251]**	[0.00508]	[0.00654]***	[0.00296]	[0.00350]	[0.00284]	[0.00349]
Observations	1060746	1157602	1060710	1157570	1060746	1157602	847593	582636	894182	672874	894174	672869
R-Squared	0.172	0.183	0.11	0.108	0.050	0.044	0.194	0.142	0.078	0.075	0.099	0.083
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-of-birth Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's elaboration based on the results of this paper.

Notes: Demographic Controls contains a dummy for white. Robust standard errors clustered at primary sampling unit in brackets. Illiteracy is defined as the ability to read and write; wages are pre-tax wage and salary income over weeks worked and deflated using the producer price index (IPP), base 2013. Logged wages reports the log of average wages (<16.213 dollars per year); informal employment in the sixth column (5) is defined as individual employment status comprising the categories of employed without possession of a signed labor card or a registered labor contract, household worker without a signed labor card, own-account work or self-employment, unpaid worker, worker in production for own consumption, and worker in construction for own use; informal employment in the seventh (6) column is defined through membership of a social security institute or contribution to social security institutes (social protection coverage) in any job during the reference week for persons 10 years or older. Each column is a separate regression; the number of observations and the R-squared are shown in the table. The omitted month is January. ** P<0.1; ** P<0.05; P<0.01.*

Table 6. Infant Health Outcomes by Month of Birth: Results from the NSIBR

	Birth Weight, Logged	Low Birth Weight (<2500)	Apgar Score	Low Apgar Score (<8)	Preterm
	(1)	(2)	(3)	(4)	(5)
Month of Birth:					
February	0.000544	-0.00132	0.00536	-0.000859	-0.000982
	[0.000463]	[0.000588]**	[0.000924]***	[0.000254]***	[0.000687]
March	0.000697	-0.00286	0.00806	-0.00113	-0.00545
	[0.000635]	[0.000715]***	[0.00106]***	[0.000219]***	[0.000719]***
April	0.00116	-0.00362	0.0101	-0.00178	-0.00518
	[0.000581]*	[0.000623]***	[0.00138]***	[0.000231]***	[0.000726]***
May	0.00120	-0.00369	0.0107	-0.00176	-0.00607
	[0.000642]*	[0.000708]***	[0.00115]***	[0.000274]***	[0.000742]***
June	0.00129	-0.00367	0.0133	-0.00210	-0.00462
	[0.000675]*	[0.000664]***	[0.00132]***	[0.000268]***	[0.000769]***
July	0.00135	-0.00352	0.0145	-0.00203	-0.00511
	[0.000777]*	[0.000746]***	[0.00211]***	[0.000254]***	[0.000728]***
August	0.000945	-0.00206	0.0107	-0.00190	-0.00293
	[0.000711]	[0.000774]**	[0.00152]***	[0.000308]***	[0.000593]***
September	0.00432	-0.00667	0.0184	-0.00291	-0.00959
	[0.000712]***	[0.000705]***	[0.00152]***	[0.000392]***	[0.000602]***
October	0.00207	-0.00376	0.0171	-0.00220	-0.00615
	[0.000501]***	[0.000557]***	[0.00218]***	[0.000437]***	[0.000539]***
November	0.000744	-0.00268	0.0109	-0.00143	-0.00427
	[0.000233]***	[0.000287]***	[0.00190]***	[0.000447]***	[0.000598]***
December	-0.00211	0.000446	0.0121	-0.00147	-0.000715
	[0.000260]***	[0.000210]**	[0.00193]***	[0.000400]***	[0.000753]
Observations	32364790	32364790	30476420	30476420	32010916
R-Squared	0.004	0.001	0.027	0.002	0.006
Municipality Dummies	Yes	Yes	Yes	Yes	Yes
Year-of-birth Dummies	Yes	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes	Yes

Source: Author's elaboration based on the results of this paper.
Notes: Robust standard errors clustered at Federative Unit in brackets. Birth weight is measured in grams, Low birth weight is defined as <2500 grams, the Apgar score is a five-minute Apgar score, the low Apgar score is defined as a five-minute Apgar score <8, and preterm is defined as a birth of a baby at less than 37 weeks gestational age. Each column is a separate regression; the number of observations and the R-squared are shown in the table. The omitted month is January.* *P<0.1; ** P<0.05; P<0.01.*

Table 7. Month of Birth and Family Background: Results from the NSIBR

	High Schooling	Low Schooling	Married Mother	Teenage Mother
	(1)	(2)	(3)	(4)
Month of Birth:				
February	0.00121	-0.000881	0.000166	-0.000934
	[0.000565]**	[0.000304]***	[0.000960]	[0.000779]
March	0.00149	-0.00141	-0.00148	0.0000505
	[0.000702]**	[0.000418]***	[0.000875]	[0.000813]
April	0.000228	-0.00154	-0.00279	0.000554
	[0.000528]	[0.000419]***	[0.00114]**	[0.00110]
May	-0.000447	-0.00185	-0.00616	0.00133
	[0.000515]	[0.000537]***	[0.00130]***	[0.00116]
June	0.000227	-0.00194	-0.00797	0.00326
	[0.000512]	[0.000558]***	[0.00138]***	[0.00130]**
July	0.00229	-0.00220	-0.00863	0.00256
	[0.000675]***	[0.000660]***	[0.00137]***	[0.00102]**
August	0.00173	-0.00201	-0.00983	0.00394
	[0.000818]**	[0.000582]***	[0.00131]***	[0.00103]***
September	0.00667	-0.00296	-0.00611	0.00165
	[0.000804]***	[0.000748]***	[0.00152]***	[0.00103]
October	0.00611	-0.00307	-0.00258	-0.00145
	[0.00118]***	[0.000766]***	[0.00188]	[0.000876]
November	0.00284	-0.00339	-0.00597	-0.00232
	[0.000726]***	[0.000840]***	[0.00127]***	[0.000837]**
December	0.00615	-0.00385	-0.00314	-0.00390
	[0.000513]***	[0.000834]***	[0.00145]**	[0.000645]***
Observations	31682515	31682515	31891265	32469257
R-Squared	0.016	0.022	0.030	0.014
Municipality Dummies	Yes	Yes	Yes	Yes
Year-of-birth Dummies	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes

Source: Author's elaboration based on the results of this paper.
Notes: Robust standard errors clustered at Federative Unit in brackets. Each column is a separate linear-probability regression, where second column (1) is a regression on dummy for mother having a high level of schooling (years of schooling≥12), third column (2) is a regression on dummy for mother having a low level schooling (years of schooling<12), fourth column (3) is a regression on dummy for having a married mother, fifth column (4) is a regression on dummy for having a teenage mother (age≤20). The number of observations and the R-squared are shown in the table. The omitted month is January.* *P<0.1; ** P<0.05; P<0.01.*

Table 8. Maternal Characteristics and Birth Outcomes: Results from the NSIBR

	Birth Weight, Logged	Low Birth Weight (<2500)	Apgar Score	Low Apgar Score (<8)	Preterm
	(1)	(2)	(3)	(4)	(5)
Month of Birth:					
February	0.000551	-0.00131	0.00559	-0.000868	-0.00099
	[0.000443]	[0.000558]**	[0.000910]***	[0.000238]***	[0.000671]
March	0.000742	-0.00283	0.008	-0.00112	-0.00551
	[0.000640]	[0.000723]***	[0.00107]***	[0.000209]***	[0.000742]***
April	0.00118	-0.00359	0.0101	-0.00183	-0.00521
	[0.000560]**	[0.000614]***	[0.00135]***	[0.000226]***	[0.000711]***
May	0.00125	-0.00368	0.0109	-0.00174	-0.00616
	[0.000616]*	[0.000693]***	[0.00125]***	[0.000286]***	[0.000744]***
June	0.00141	-0.0037	0.0134	-0.00207	-0.00461
	[0.000668]**	[0.000683]***	[0.00139]***	[0.000265]***	[0.000777]***
July	0.00149	-0.00362	0.015	-0.00204	-0.00517
	[0.000753]*	[0.000728]***	[0.00208]***	[0.000246]***	[0.000721]***
August	0.0011	-0.00216	0.0113	-0.0019	-0.00296
	[0.000693]	[0.000754]***	[0.00147]***	[0.000293]***	[0.000590]***
September	0.00441	-0.00669	0.0186	-0.00288	-0.00953
	[0.000680]***	[0.000691]***	[0.00141]***	[0.000375]***	[0.000618]***
October	0.00196	-0.00361	0.0169	-0.00211	-0.00603
	[0.000479]***	[0.000532]***	[0.00206]***	[0.000416]***	[0.000548]***
November	0.000777	-0.00272	0.0111	-0.00138	-0.00424
	[0.000282]**	[0.000333]***	[0.00179]***	[0.000426]***	[0.000632]***
December	-0.0022	0.000567	0.0122	-0.0014	-0.000557
	[0.000283]***	[0.000239]**	[0.00185]***	[0.000375]***	[0.000796]
Family Controls:					
Low School Degree	-0.0125	0.0235	-0.0391	0.0116	0.00492
	[0.00194]***	[0.00232]***	[0.0168]**	[0.00132]***	[0.00316]
Married Mother	0.00997	-0.0113	0.0569	-0.0044	-0.00234
	[0.000697]***	[0.000756]***	[0.00615]***	[0.000396]***	[0.000677]***
Teenager Mother	-0.0253	0.013	-0.0344	0.00558	0.00859
	[0.00131]***	[0.00103]***	[0.00259]***	[0.000413]***	[0.000553]***
Observations	31202595	31202595	29534908	29534908	30933273
R-squared	0.008	0.002	0.029	0.003	0.007
Municipality Dummies	Yes	Yes	Yes	Yes	Yes
Year-of-birth Dummies	Yes	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes	Yes

Source: Author's elaboration based on the results of this paper.

Notes: Robust standard errors clustered at Federative Unit in brackets. Birth weight is measured in grams, Low birth weight is defined as <2500 grams, the Apgar score is a five-minute Apgar score, the low Apgar score is defined as a five-minute Apgar score <8, and preterm is defined as a birth of a baby at less than 37 weeks gestational age. Family controls include a dummy for mother having a low level schooling (years of schooling<12), a dummy for having a married mother and a dummy for having a teenage mother (age≤20). Each column is a separate regression; the number of observations and the R-squared are shown in the table. The omitted month is January.* *P<0.1; ** P<0.05; P<0.01.*