School of Economics and Finance

Violence and Birth Outcomes: Evidence from Homicides in Brazil

Martin Foureaux Koppensteiner and Marco Manacorda

Working Paper No. 750 June 2015 ISSN 1473-0278

Queen Mary
University of London

Violence and Birth Outcomes: Evidence from Homicides in Brazil

This version: January 2015

Martin Foureaux Koppensteiner
University of Leicester

Marco Manacorda
Queen Mary University of London,
CEP (LSE), CEPR and IZA

This paper uses microdata from Brazilian natality and mortality vital statistics between 2000 and 2010 to estimate the impact of in-utero exposure to local violence - measured by homicide rates - on birth outcomes. The estimates show that exposure to violence during the first trimester of pregnancy leads to a small but precisely estimated increase in the risk of low birthweight and prematurity. Effects are found in both rural areas, where homicides are rare, and in urban areas, where violence is endemic and are particularly pronounced among children of poorly educated mothers, implying that violence compounds the disadvantage that these children already suffer as a result of their households' lower socioeconomic status. Our estimates imply that homicides are responsible for around 10 percent of the incidence of low birthweight (<=2.5 kg) in urban areas of Brazil.

JEL: I12, I15, I39, J13, K42

Keywords: Birth Outcomes, Birthweight, Homicides, Stress, Brazil.

Acknowledgements: we are grateful to Anna Aizer, Rodrigo Soares, and seminar and workshop participants in Barcelona, London, Mannheim, Surrey, IZA Bonn and the Inter-American Development Bank for comments and suggestions, to Ana Christina Barroso at the Prefeitura de Fortaleza for providing us with some of the data used in this project and to Lívia Menezes for excellent research assistance. Financial support from the IDB under the aegis of the program "The Cost of Crime in Latin America and the Caribbean" (RG-K1109 and RG-K1198) is gratefully acknowledged. This paper is a substantially revised version of IDB working paper IDB-WP-416. Corresponding author: Marco Manacorda, CEP, LSE, Houghton Street, London WC2A 2AE, ph. +44 207 955-6647, m.manacorda@lse.ac.uk.

1. Introduction

In this paper we analyze birth outcomes of children whose mothers were exposed to violence in their local environment during pregnancy. Exposure to violence is likely to induce fear and psychological stress, and the medical literature suggests that an increase in mother's psychological stress, especially in the first trimester of pregnancy, can lead to prematurity and low birthweight. Evidence though remains elusive and calculations of the cost of crime typically ignore this margin.

For the purpose of this exercise we link microdata from Brazilian natality vital statistics over eleven years to microdata from mortality vital statistics. Importantly, birth records provide information on the mother's place of residence while death records provide the place of occurrence as well as the precise cause of death, including death as a result of a homicide. This allows us to measure how birth outcomes vary when a homicide - our measure of violence - occurs in the mother's area of residence, and to estimate how the effect varies at different stages of pregnancy.

In particular, in the empirical analysis we exploit information available in the vital statistics data on the precise municipality of occurrence of a homicide and the municipality of residence of the mother. We focus on small, primarily rural, municipalities, for which municipality-level homicide rates provide a localized measure of violence. We complement the analysis with a study of the city of Fortaleza - one of the most violent cities in Brazil, or for that matter, in the world - for which the data provide detailed information on the mother's neighborhood of residence and the neighborhood of occurrence of homicides. This also allows us to contrast the effects of homicides in a setting where these are rare and presumably largely unexpected, and perhaps more traumatic events, as in rural areas, to a setting where homicides are frequent and violence is endemic, like in Fortaleza.

The information available in the vital statistics data allows us to measure the effect of homicides on a variety of outcomes, including birthweight and gestational length, as well as potential margins of selection due to fertility, abortion, and miscarriage. The richness of the data also allows us to investigate how these effects vary across a number of mothers' characteristics, among which, educational level, and hence to study whether high socio-economic status provides a buffer to the effects of local violence.

Other papers before ours, which we discuss at length below, investigate the effects of violence on birth outcomes. Some of these papers (Mansour and Rees 2012), though, exploit large secular rises in violence in connection to the onset of conflict, raising the possibility that other behavioral responses, which are known to be the result of conflict (e.g. falls in living standards), might be at work. By focusing on a setting where there is no secular trend in homicide rates or violence, in this paper we identify the direct stress-inducing effect of exposure to violent events separately from other behavioral responses that might arise in response to secular changes in violence and that might conflate or offset this effect.

By converse, other papers (Camacho 2008, Quintana-Domeque and Rodenas 2014, Eccleston 2012) focus on extreme events such as landmine explosions, car bombs or even the 9/11 attacks in New York City. Again it is possible that, given their extreme and very rare nature, in addition to instilling fear, these events also have additional indirect immediate effects on birth outcomes (e.g. disrupting access to medical services or to the workplace, or affecting, as in the case of 9/11, the level of environmental pollution). The rare and extreme nature of these events also makes it hard to generalize these results to the effect of homicides, let aside day-to-day violence and crime, on birth outcomes. It seems plausible a priori to speculate that extreme violent events might have larger adverse effects compared to single homicides, especially when violence is endemic. In this respect, our paper has the potential to generalize to many other countries and settings, as a much higher fraction of women worldwide are exposed to everyday violence and homicides compared to those who are exposed to events such as terrorist attacks or landmine explosions.

Even if not as extreme as car bombs and terrorist attacks, homicides are known to instil fear and induce anxiety. A large literature in criminology and psychology investigates the determinants of the fear of crime, i.e. the perceived risk of victimization. Not only exposure to crime and violence through direct victimization or witnessing of a crime but also exposure to the news of crimes and violence through friends, neighbors and coworkers are known to considerably raise the fear of crime (Skogan and Maxfield 1981). In part due to the amplifying role of the media, violent crimes, and in particular homicides, typically instill the strongest response, despite the fact that the risk of being a victim of a homicide may be objectively small compared to other crimes (Warr 2000).

The analysis focuses on Brazil, a country with one of the highest levels of violence worldwide (UNODC 2011), with a homicide rate of 21 per 100,000 population as of 2011, approximately five times the rate in the United States and more than 20 times the rate in the United Kingdom. Sixteen among the top 50 cities in the world ranked based on murder rate are in Brazil and 43 out of 50 are in Latin America and the Caribbean (with the remaining seven cities being either in the USA or in South Africa; Citizens' Council for Public Security and Criminal Justice 2014). Homicide is the leading cause of death in men aged 15-44

(Reichenheim et al. 2011), and day-to-day violence is a top concern among citizens of Brazil. According to Latinobarometer (2010), about 16 percent of Brazilian respondents listed violence and public security as the most important problem, and existing estimates put the direct costs of violence and crime at between 3 and 5 percent of annual GDP (Heinemann and Verner 2006, World Bank 2006).

As uniform crime reports are not publicly available for Brazil, homicide rates from death records constitute a unique and yet largely unutilized source of information on violence and crime that is uniform across space and time.

In order to proceed with our exercise, we adopt a difference-in-differences strategy across small geographical areas and time. In practice, we net out common time effects across areas and we compare mothers who were exposed to a homicide during pregnancy to otherwise similar mothers, residing in the same area, who happened not to be exposed, as they were pregnant at times when a homicide did not occur. Rather than using large changes in the homicide rate over time, we exploit within area variation in the precise timing of homicides. As these mothers are likely to live in similar environments, including in terms of the level of endemic violence, by exploiting the precise timing of homicides we are able to disentangle the true causal effect of a homicide from other correlated effects, including potential behavior responses to endemic violence.

Our main results show that gestational length and birthweight fall considerably among newborns exposed to a homicide during the first trimester of pregnancy. This is consistent with a large body of medical literature claiming that stress-inducing events affect birth outcomes through an increased rate of prematurity and that these effects act largely in the first trimester of pregnancy (see Section 2).

In particular, in small municipalities, one extra homicide during the first trimester of pregnancy leads to an increase in the probability of low birthweight (<=2.5 kg) of around 0.6 percentage points (an 8 percent increase) and an increase in the probability of extremely low birthweight (<=1 kg) of 0.1 percentage points (a 25 percent increase). This effect is largely ascribable to increased prematurity rather that intrauterine growth retardation. The estimated effect is economically meaningful, being approximately ten times the effect estimated for the United States of being a recipient of Food Stamps (Almond et al. 2011).

Estimates of the effect of one extra homicide during pregnancy for Fortaleza are around 15 percent of what found for small municipalities. This is consistent with our hypothesis that the effects of violence are relatively less pronounced when violence is endemic. Despite this, a much larger fraction of pregnant women is exposed to homicides in urban versus rural areas. In the conclusions to the paper, we calculate that homicides are a relatively more important contributor to adverse birth outcomes in Fortaleza versus rural areas.

In the analysis we also show that homicides have no effect on birth rates, implying that our estimates are unlikely to be affected by margins of endogenous fertility or fetus survival, through abortion or miscarriage, which might bias our estimates.

In order to bring ammunition to our claim that the estimated effects are causal, we show that homicides at different leads and lags from pregnancy have no effect on birth outcomes, hence ruling out additional effects due to omitted variables or behavioral responses to underlying levels of endemic violence. As an additional check, and for the purpose of lending further credibility to our identification assumption that - absent a homicide, treatment and control mothers would have had similar pregnancy outcomes - we also show that our results are robust to the inclusion in the regressions of a large array of observable mother, newborn, pregnancy and local characteristics, as well as to area (i.e., municipality or neighborhood of Fortaleza) specific time trends, which subsume differential trends in outcomes across areas with different homicide rates.

Importantly, we find that both socio-economic and biological factors, such as mothers' low levels of education and previous stillbirths appear to magnify the adverse consequences of violence on birth outcomes, implying that mother's high socio-economic status acts as a buffer to the effects of violence on birth outcomes and that violence compounds the disadvantage that low SES newborns already suffer.

The rest of the paper proceeds as follows. In Section 2 we discuss the literature on early life health and previous work in economics on maternal stress and birth outcomes. In Section 3 we provide information on the data used in the rest of the paper. Section 4 introduces the methodology. Section 5 presents the results of the empirical exercise while Section 6 concludes.

2. Maternal stress, violence and birth outcomes

The consequences of low birthweight and fetal health more generally on long-run outcomes, such as educational attainment, later life health, mortality, and labor market performance have been established in a large body of literature. Low-birthweight and premature infants display a greater risk of neonatal or infant death and are more likely to require additional outpatient care and hospitalization during childhood compared to newborns of normal weight, adding to the private and social costs of poor birth outcomes (Almond et al. 2005). Of those living into adulthood, some suffer from increased morbidity and cognitive and neurological impairment, conditions typically associated with lower productivity in a range of educational, economic, and other dimensions (Almond and Currie 2011, Black et al. 2007, Figlio et al. 2014, Royer 2009).

Mechanically, low birthweight can result from either reduced gestational length or intrauterine growth retardation (IUGR) (Kramer 1987). There is evidence that household income and maternal nutrition during pregnancy, especially in the last trimester, and the disease environment during pregnancy affect the incidence of low birthweight through IUGR (see for example Almond 2006, Almond and Mazumder, 2011, Almond et al. 2011, Amarante et al. 2014, Rocha and Soares 2015). Smoking is also a significant predictor of low birthweight (Almond et al. 2005).

There is less clear evidence on the determinants of prematurity. This - rather than the fact that prematurity has less serious consequences than IUGR - seems to explain why most of the existing policy interventions focus on the latter (e.g. through nutritional programs) rather than on the former (Almond et al. 2005).

There is some evidence in economics that environmental pollution reduces birthweight, apparently via reduced gestational length (see for example Currie at al. 2011 and Currie and Walker 2011), but little evidence on other factors impacting birthweight through lower gestational length.

The medical literature suggests that maternal stress during pregnancy is a significant predictor of prematurity and low birthweight, especially in the first trimester. The main biological mechanism appears to be excess release of maternal glucocorticoids in response to stress, which in turns speeds the hormonal cascade and the process of maturation of vital organs of the fetus, such as the lungs, leading to pre-term delivery (Wadhwa et al. 2001). From an evolutionary perspective this is seen as the result of a woman's need to balance investment in an individual pregnancy with the reproductive opportunities across the reproductive age. In order to allow for these responses and to limit maternal investments in pregnancies at risk of failure, cues of an adverse environment are most useful and hence more likely to prompt a response early during the pregnancy (Pike 2005, McLean et al. 1995).

Few papers directly study the effect of maternal stress on birth outcomes. Black et al. (2014) focus on grief associated with the death of the child's maternal grandparents and find small but statistically significant effects on birthweight and APGAR scores (but no evidence of longer-term adverse consequences). The authors also present suggestive evidence ruling out that other mechanisms, such as lack of parental support during pregnancy, are responsible for this effect. Aizer et al. (2009) find that, despite long-term adverse consequences, there is no significant association between elevated levels of cortisol during pregnancy and birth outcomes, although the interpretation of these findings is complicated by the selective nature of the sample considered in this study.[1]

Similar to our study, a small but growing body of literature focuses on violent events. These papers though typically study extreme, largely unexpected, violent events, such as terrorist attacks, car bombings and landmine explosions or focus on the onset of conflict. Mansour and Rees (2012) for example focus on the conflict in the West Bank and Gaza during the second Intifada and show that a higher number of noncombatant fatalities are associated to a modest fall in birthweight. While, similar to the channel we have in mind, conflict escalation is likely to affect birth outcomes directly through the mother's fear of victimization and increased psychological stress, this is also likely to affect outcomes through a variety of additional channels. Deterioration in living standards and changes in labor supply, household income and consumption, increased difficulties in, or higher cost of, accessing local health services, as well as resource diversion on the part of communities and households in order to prevent or counteract a rise in violence are all likely to have additional direct and indirect effects on newborns' well-being, hence complicating the interpretation of the underlying channels.

Other papers focus on terrorist attacks. These papers are more similar to ours in exploiting unexpected violent events that occur during pregnancy. Eccleston (2012), among others, focuses on the 9/11 attack in New York and finds that exposure in the first and second trimester of pregnancy leads to a reduction in birthweight and an elevated level of prematurity. Although this paper - as well as other papers (e.g. Eskenazi et al. 2007) - emphasizes the role of maternal stress and fear, the effect found may nevertheless be due to exposure to pollutants resulting from the attack (Currie and Schwandt 2014). Quintana-Domeque and Rodenas (2014) study the effects of the ETA terrorism in Spain on birth outcomes and find that exposure to car bombs in Madrid (i.e., away from the epicenter of the conflict) early in pregnancy leads to lower gestational length and an increase in the

[1] There is very little direct evidence on the effect of mother's victimization. One exception is Aizer (2011), which shows that mother hospitalization considerably reduces birthweight.

prevalence of low birthweight, while Camacho (2008) finds a significant negative effect of landmine explosions in Colombia during the first trimester of pregnancy on birthweight.

In an attempt to draw a distinction between the effect of rare, extreme events and endemic violence, in the following we contrast our estimates of the effects of homicides with estimates from these papers.

3. Data

3.1 Natality data

In order to characterize the distribution of birthweight and other birth outcomes, in the rest of the paper we use public use microdata from vital statistics from the Brazilian Ministry of Health between 2000 and 2010. This information comes from birth certificates issued by the health institution where the delivery occurred.[2] Microdata from vital statistics are publicly available through the System of Information on Life Births (SINASC) of DATASUS, literally the Brazilian *Departamento de Informática do Sistema Único de Saúde*.[3]

Data from the 2010 population census show that more than 99 percent of children born between 2000 and 2010 have birth certificates implying that coverage in the data is practically universal.

The data provide a large array of information on the pregnancy, the newborn(s) and the mother. Similar to other vital statistics systems in high income countries, such as those collected and administered by the National Center for Health Statistics (NCHS) and the Centers for Disease Control and Prevention (CDC) in the USA, the data include information on the precise date and place of birth, including an identifier for the health institution where delivery occurred (unless the birth occurred at home), mothers' characteristics (age, education, marital status, usual occupation and pregnancy history), characteristics of the pregnancy (gestation duration in classes, i.e., less than 22 weeks, 22 to 27, 28 to 31, 32 to 36, 37 to 41 and 42 or more, and number of prenatal visits, also in classes, i.e., 0, 1-3, 4-6 and 7

[2] In the case of a home birth, this information is provided by the midwife who attends the birth. If the home birth is not attended by a medical professional, a birth certificate is issued by the civil registry at the time of registering the birth. Only 1 percent of percent of births in Brazil are home births.
[3] The data can be downloaded at http://goo.gl/KIqhYA (data last downloaded in August 2012).

or more), as well as characteristics of the birth (e.g. if a C-section or a multiple birth) and of the newborn (race, gender, weight at birth, APGAR scores at 1 and 5 minutes after birth).[4]

Importantly, in addition to the precise place where the birth occurred, the data provide information on the mother's place of residence. This piece of information is particularly useful for the purposes of our analysis, as it allows us to identify the environment where the pregnancy developed, and hence to derive a measure of the fetus' exposure to local violence during this critical period.

Specifically, for all births, the data provide information on the mother's municipality of residence. Municipalities in Brazil are geographical units roughly equivalent to a U.S. county. At an average total population of just over 184 million over the period 2000-2010, each of the 5,566 municipalities of the country accounts on average for 33,000 individuals.[5] Obviously, however, population size varies tremendously across municipalities. While San Paulo and Rio de Janeiro have respectively more than 11 and 6 million inhabitants, according to standard national statistical office (IBGE) definitions nearly a quarter of Brazilian municipalities are small, i.e., with population of up to 5,000. In the rest we focus on these small municipalities, for which municipality-level homicide rates are more likely to provide a localized measure of violence. Small municipalities cover areas of approximately 22 X 22 km on average, and are geographically rather dispersed (see Figure 1).

Data for large municipalities also provide in some instances (for selected municipalities and only up to 2009) the neighborhood of residence of the mother. Unfortunately the classification of these neighborhoods in DATASUS does not typically correspond to the classification adopted by IBGE. The latter is crucial for normalizing homicides described below using official population numbers and for computing local demographic characteristics that we use as controls in the regressions. One exception is Fortaleza, the state capital of Ceará, in the North-east of Brazil, and the fifth largest city in Brazil (population just above 2.5 million). For this city there exists a one-to-one correspondence between the borders of its neighborhoods in DATASUS and the borders of the official neighborhoods of the city according to the IBGE definition. The average neighborhood in Fortaleza has a population of just above 21,000 and an extension of around

[4] There is no unique mother identifier in the data meaning that, unfortunately, subsequent births for the same mother cannot be identified.

[5] In the analysis we restrict to the 5,556 municipalities that are consistently defined over the period of observation and we drop municipalities that were at one point during the period split into smaller administrative units.

1.6 X 1.6 km. We were able to obtain official information from the municipal government of Fortaleza allowing us to link the neighborhood identifier from the vital statistics data to official census district data from IBGE. This also allows us to analyze the effect of homicides on birth outcomes across neighborhoods of the city of Fortaleza (see Figure 2).

The top panel of Table 1 presents descriptive statistics on births for all of Brazil, separately by municipality size, including for small municipalities that constitute the focus of our analysis. Although, as said, we have data for all births that occurred between January 2000 and December 2010, in the rest of the paper we restrict to the around 25 million births for which conception occurred between October 2000 and June 2009. We recover date of conception by subtracting gestational length from the precise date of birth.[6] This allows us to measure the effect of homicides at different leads and lags since the time of conception, which we use as additional regressors in the analysis below.

With an incidence of low birthweight (up to 2.5 kg) of around 9 percent, Brazil ranges above the average for OECD countries but considerably below some low-income countries (UNICEF 2006). Around respectively 1 and 0.5 percent of children are born very low (<=1.5 kg) and extremely low (<=1 kg) birthweight, while 6.6 percent of children are born premature (less than 37 weeks of gestation).

The risk of low birthweight is strongly associated with prematurity. This is evident in Figure 3, which plots the fraction of children classified as low, very low and extremely low birthweight as a function of gestational length, where a vertical line denotes 37 weeks. It is apparent that premature children are disproportionately at risk of being born low birthweight and that the risk of low birthweight decreases almost monotonically with the length of gestation.[7] [8]

Column (1) of Table 1 presents descriptive statistics for small municipalities.[9] With more than 500,000 births over the period considered, small municipalities account for around 2 percent of all births in the country (and 2.4 percent of the population). Roughly speaking, birth outcomes are better in small municipalities than in larger municipalities, with a lower

[6] As the length of gestation is recorded in intervals for most of the period, we use information on precise gestation in weeks available in the 2010 birth data to convert these intervals into average gestational length in weeks. In particular we assign a gestational length of 20, 26, 30 35, 39 and 42 weeks for gestational intervals of less than 22 weeks, 22 to 27 weeks, 28 to 31 weeks, 32 to 36 weeks, 37 to 41 weeks, and 42 weeks or more respectively.

[7] Also, approximately 46 per cent of low birthweight children and 89 percent of very low birthweight children are born premature.

[8] Interestingly, the fraction of low birthweight children born within week 22 is slightly off-trend, perhaps suggesting that survival probabilities are higher among very premature children who developed faster.

[9] Population classes are defined based on average population between 2000 and 2010.

incidence of low birthweight and prematurity. This is despite the fact that mothers in small municipalities have on average lower levels of education and lower living standards. One possible contributing factor to these differences is the much larger levels of violence in urban areas compared to rural areas (see section 3.2). Out of 1,000 newborns in small municipalities, around 79, 10 and 4 are born low, very low and extremely low birthweight, respectively, while around 59, 10 and 3 are born before 37, 32 and 28 weeks of gestation respectively.

Data for Fortaleza are reported in the last column of Table 1. With an incidence of low birthweight of around 83 per 1,000 children and a rate of prematurity on the order of 64 per 1,000 children, Fortaleza shows results that are slightly better than other large municipalities but worse than small municipalities.

Average data for the 109 neighborhoods of Fortaleza for which information is available in the vital statistics data are reported in Appendix Table A1.[10] Given that birth data only report the neighborhood of residence of the mother up to 2009 and that the death records only report the neighborhood of occurrence of a death since 2006 (see next section), and that we also include in the regressions leads and lags of the homicide rate, we only restrict to births that were initiated between January 2006 and December 2008. There are just over 110,000 births in Fortaleza over this period, with around 10 percent having a missing neighborhood of residence of the mother. Table A1 shows that results for these neighborhoods are roughly in line with data for the whole of Fortaleza in Table 1.

3.2. Mortality data

Mortality data come from death certificates that are also collected by DATASUS and are available for the period 2000-2010.[11] The data provide detailed information on the date and cause of death, and a variety of information on the characteristics of the deceased (age, gender, race, education, place of residence). The data also report information on the place of occurrence of the death, including, importantly, municipality of occurrence of the death and, for Fortaleza (as well as for other large municipalities), the neighborhood of occurrence of the death, although this piece of information is only available starting from 2006.

[10] There are 109 neighborhoods available in both natality and mortality data out of the 115 official neighborhoods of Fortaleza. These account for 94.6 percent of the total population.

[11] The data can also be downloaded at http://goo.gl/LvKpfT (data last downloaded in August 2012).

The data report a flag indicator for deaths due to non-natural causes. Similar to the classification used by the NCHS, this is an abstractor-assigned variable that builds upon information from a variety of sources (death certificate, coroner's statement and other sources).[12] Non-natural deaths are further classified into those resulting from accidents, homicides and suicides, plus a residual category. Homicides are defined as violent non-natural deaths occurring as a result of assault. For non-natural deaths, the data also report the place of occurrence of the death (but not of the injury that led to the death), separately for those that occurred in a health institution, in the public way, in one's residence or elsewhere.

In the rest of the paper we focus primarily on homicides for which the death occurred in the public way, as these are more likely to be visible to the public and to be associated to generalized measures of violence (as opposed to, say, homicides for which the death occurred in one's residence that might be more likely to result from domestic violence), and hence more likely to induce stress among pregnant women. This also allows us to exclude homicides for which the death occurred in a health institution and for which the injury at the origin of the death is likely to have occurred elsewhere, including possibly in another municipality.

Descriptive statistics on homicide rates per 100,000 individuals are reported in the bottom panel of Table 1. Averages across municipalities within each population class are weighted by municipal population. We standardize homicides to the municipality population to derive ratios. We derive population from Census data.[13]

During the period of observation, around 500,000 homicides are recorded throughout Brazil, equivalent to a yearly homicide rate of around 26 per 100,000 individuals. Unsurprisingly, homicide rates tend to be higher the larger the municipality: while there are around 7 homicides a year per 100,000 people in small municipalities, this number is about six times larger in large municipalities (>500,000 population). At an average population of respectively 3,400 and 1.5 million, this implies that there are on average around 0.25 homicides per year in small municipalities (7.186 X 3,418/ 100,000), i.e., a homicide every four years. By converse, in large municipalities there are around 600 homicides a year

[12] In line with CDC guidelines, we use the abstractor assigned indicator for homicides as opposed to using the cause of death from the WHO International Statistical Classification of Diseases and Related Health Problems (ICD-10), as the former typically more precisely identifies homicides.

[13] We use official data from IBGE on population by municipality for each year between 2000 and 2010 and we compute the population in each intervening month by simple linear interpolation, i.e., a regression of log population on a linear month trend. Data are available at http://goo.gl/xOO22 (data last downloaded in January 2015).

(41.132 X 1,487,000/ 100,000), i.e., roughly two homicides a day. Although this clearly signals that homicides are much rarer events in small municipalities compared to large municipalities, the homicide rate in small municipalities is still about seven times larger than the average in Western European countries (UNODC 2013).

Of all homicides, around one third occur in the public way, with this number being larger (around 45 percent) in larger cities where gang violence and street confrontations are more frequent.[14] [15] Unsurprisingly, in small cities, a much lower fraction of deaths related to homicides occur in health institutions compared to large cities, where hospitals are typically located. This is consistent with the hypothesis that a significant fraction of homicides for which the death occurs in a health institution are likely to be committed in other municipalities.

The last column of Table 1 reports homicide rates for Fortaleza.[16] In contrast to the moderate levels of violence in small municipalities and in line with data for other large municipalities, Fortaleza displays remarkably high homicide rates, with 32 homicides per 100,000 population, i.e., around 800 homicides per year, equivalent to three homicides per day. This very high homicide rate is matched by other crime indicators, with Fortaleza ranking among the top of state capitals for crime victimization, with 31 percent of the population reporting having been a victim of crime over the last 12 months (SSPDS 2014).

Data on homicides for the 109 neighborhoods of Fortaleza available in the vital statistics data are reported in Appendix Table A1.[17] For homicides where the victim dies in

[14] Although we have no way to identify the motives behind such high rates of homicide from these data, there is claim that a significant fraction of homicides in Brazil is associated with drug trafficking and the ensuing disputes among criminal gangs and between gangs and police forces (UNODC 2005). Recent evidence suggests a role for an institutionalized culture of violence, whereby people commit murder for trivial reasons as a way, for example, to settle disputes with neighbors or spouses, or during incidents of road rage (Waiselfisz 2013). There is also evidence that homicides are related to a wide variety of other violent activities, such as robberies, kidnapping, assaults, and muggings (Heinemann and Verner 2006). Indeed, homicide rates are often used as crime and violence indicators (UNODC 2011) and evidence for Brazil, in particular, shows a close correlation between different forms of violent crime and homicides (World Bank 2006).

[15] Appendix Figure A1 reports the incidence of low birthweight and homicide rates (in the public way) across all Brazilian municipalities. Although this is not immediately evident in the figure, a clear positive correlation exists between homicide rates and low birthweight. A GLS regression line of the incidence of low birthweight (multiplied by 1,000) on the homicide rate per 100,000 population with weights equal to the municipal population, gives an estimated coefficient of 0.175 (s.e. 0.017), implying that an extra homicide per 100,000 people is associated with 1.7 extra low birthweight children out of 1,000.

[16] We use official population data for the neighborhoods of Fortaleza provided to us by the municipal government of Fortaleza. As in the case of municipalities, we linearly interpolate across the two censuses dates to obtain estimates of the population in each month of observation.

[17] The data provide information on the neighborhood of occurrence for 48 percent of all homicides, irrespective of where the death occurred. In part this is due to the circumstance that the neighborhood of occurrence is not reported in the data when the death occurred in a health institution. This explains why the average homicide rate

the public way, information on the neighborhood of occurrence is available for 72 percent of cases. This implies that we are unable to assign a precise neighborhood of occurrence to around 28 percent of homicides for which the death occurred in the public way in Fortaleza. For this reason, one will need to exert some caution in interpreting estimates for Fortaleza, as our homicide indicator is likely to be affected by measurement error. Even considering a non-negligible fraction of underreporting due to missing neighborhood of occurrence, data in Table A1 reveal that there are on average around 12.9 homicides in the public way per 100,000 thousand people in a neighborhood of Fortaleza. At an average population of around 21,500, this implies a number of homicides in the public way by neighborhood of around 2.8 per year.[18]

3.3 Auxiliary data

We finally use microdata from the population censuses of 2000 and 2010 to obtain characteristics of municipalities. In particular, we recover data on average personal income (for people aged 10 or older expressed at 2000 prices), fraction of households with access to sewage, waste collection, electricity, and with ownership of radio, TV, computer, washing machine, fraction of individuals by race, gender X 10-years age groups, education groups and fraction illiterate.[19] Additional variables are obtained from *DATASUS*, including the number of *Bolsa Família* recipients and the total amount of *Bolsa Família* payments, the number of health institutions, and the number of nurses, local unemployment rate, urbanization rate and fraction of children in work.[20]

4. Econometric model

The difficulty in estimating the causal effect of violence on birth outcomes is that characteristics of different residential areas are unobservable to the econometrician. Some of these unobservable characteristics might be correlated with both newborns' health outcomes

---

across neighborhoods of Fortaleza (in Table A1) is lower than the average homicide rate in the overall municipality of Fortaleza (Table 1).

[18] If one is willing to re-impute back homicides for which a neighborhood of occurrence is missing (28 percent) this implies almost one homicide in the public way per neighborhood every quarter.

[19] As for population, we linearly interpolate across censuses and to compute the value of this variable in each intervening month. Data are available at http://goo.gl/nWxAq5 (data last downloaded in October 2012).

[20] These data are available at http://goo.gl/9V0sBG and http://goo.gl/tdwW (data last downloaded in October 2012).

and homicide rates, even in the absence of a causal effect of violence on birth outcomes. If, for example, children born in poorer areas are more likely to display negative birth outcomes due to the lower socioeconomic characteristics of their parents or worse provision of health services in their neighborhood, and, possibly, to be exposed to a higher degree of violence, one would erroneously conclude that higher homicide rates lead to worse birth outcomes, a classic case of failed inference based on observational data.

In order to circumvent this problem, we use a difference-in-differences identification strategy that relies on differential changes in homicide rates across small geographical areas: this provides a way to control for unobserved time-invariant municipality characteristics and to subsume aggregate time effects.

In formulas, we estimate the following model:

$$Y_{iat}=\beta_0+\beta_1\, HOM_{at}+X_{it}'\beta_2 + Z_{at}'\beta_3 + d_a + d_t + u_{iat} \quad (1)$$

where Y_{iat} is the individual outcome variable (birthweight, gestational length, etc.) in area (municipality or neighborhood) a at time t, HOM_{at} is the local homicide rate and d_a and d_t are respectively the mother's area of residence and month of conception-fixed effects, while u is an error term. X_{it} denote mother, pregnancy and newborn characteristics while and Z_{at} denote time varying area characteristics.

Model (1) identifies the causal effect of homicides on birth outcomes if - conditional on observable controls - mothers in the same area have similar birth outcomes other than because they were exposed to different homicide rates during pregnancy.

In order to check the validity of our identification assumption, we start by specifications with no controls other than area and time fixed effects and we present specifications that include a large array of observable controls for the newborn, the mother, the pregnancy and the area of residence. We also experiment with specifications that include area-specific time trends and that subsume differential unobserved trends in violence and birth outcomes across areas that might contaminate our estimates. We finally include leads and lags of the homicide rates in order to subsume generalized levels of violence in periods surrounding pregnancy and to test whether or not it is precisely homicides during pregnancy that have an effect on birth outcomes. This serves as a falsification exercise, as one would not expect homicide rates pre- and post-pregnancy to affect birth outcomes and finding a significant effect of these variables would point to a violation of the identification assumption.

In the empirical analysis, we use as regressors the homicide rate calculated over three month-intervals starting from the month of conception and we estimate the effect of the homicide rate at different stages of pregnancy (i.e., first, second, and third trimester). As explained in the previous section, we recover the month of conception based on the child's date of birth minus the length of gestation. This approach allows us to correctly measure exposure in different trimesters of pregnancy, which would not be possible if we counted retrospectively three trimesters from the time of birth and ignored the variation in the length of gestation across pregnancies. In the spirit of an ITT estimator, we assign the homicide rates in each trimester following conception to all mothers, irrespective of gestational length. This also allows us to circumvent the potential selection bias arising from the circumstance that mothers with shorter gestational length are mechanically exposed to lower homicide rates.

5. Empirical Results

5.1 Main results for small municipalities

Table 2 presents estimates of equation (1) for small municipalities (<=5,000 individuals).[21] The table reports, in order, results for average birthweight (in grams) and for the fraction of low, very low, and extremely low-weight births (per 1,000 births). Each row reports separately the effect of homicides in each trimester of pregnancy since conception. Standard errors are clustered by municipality.

Focusing on birthweight (columns 1 to 3), the specification in column (1) only includes municipality and month of conception fixed effects. Results show a clear, precisely estimated, negative effect of the homicide rate in the first trimester of pregnancy on birthweight, with a coefficient of -0.45. The estimates for the second and third trimester are much smaller in magnitude and not statistically significant at conventional levels, in line with

[21] Consistent with our hypothesis that municipal-level homicides are imperfect measure of localized violence in larger municipalities, we find no significant effect of homicides during pregnancy on birth outcomes in these municipalities (results not reported, available upon request).

evidence from the literature reviewed in Section 2 that the effect of maternal stress on birth outcomes manifests in the first trimester of pregnancy.

These estimates imply that an extra homicide per 100,000 population during the first trimester of pregnancy leads to a reduction in birthweight of around half a gram among exposed children. At an average municipal population of 3,418, this in turn implies that an extra homicide in a municipality of this class leads to a reduction in birthweight of around 13 grams (-0.45 X 100,000/ X 3,418).

Column (2) of Table 2 controls for a very rich set of characteristics of the child (race), the pregnancy (dummies for multiple births: singleton, twins, triplet or more), the mother (dummies for age, education and marital status, number of previously born alive and stillborn children) and the municipality (log population, log income, fraction of households with access to sewage, waste collection, electricity, fraction of households with radio, TV, computer, washing machine and in receipt of *Bolsa Família*, average *Bolsa Família* transfer per beneficiary household, fraction of individuals by race, gender X 10-years age groups, education groups, fraction illiterate, unemployment rate, urbanization rate, fraction of children in work). The regression also includes homicide rates in the three trimesters pre-pregnancy and post-birth. Remarkably, results remain almost unchanged compared to column (1). There is also no evidence of homicides pre- and post- pregnancy significantly affecting birthweight. Both these pieces of evidence speak in favor of our identification assumption that, absent homicides during pregnancy, treatment and control children would have displayed similar birth outcomes.

Finally, column (3) includes additionally municipality-specific month of conception trends. Results are effectively unchanged with, if anything, estimates becoming slightly larger in absolute value relative to columns (1) and (2), lending further credibility to our identification assumption.

Columns (4) to (12) of Table 2 report regression results for low, very low and extremely low birthweight. Once again, there is evidence that the effects are remarkably consistent across specifications and that homicide rates pre- and post-pregnancy are not significantly correlated with birth outcomes. Again, it appears that only the homicide rate in the first trimester of pregnancy matters for birthweight.

Taking the most saturated specifications in columns (6), (9) and (12), these imply that an extra homicide per 100,000 people during the first trimester of pregnancy leads to an increase in the risk of low, very low and extremely low birthweight of respectively 0.21, 0.08 and 0.05. This implies that one homicide during pregnancy in a small municipality leads to an extra 6, 2 and 1 children out of 1,000 being born low, very low and extremely low birthweight respectively. This is an 8, 20, and 25 percent increase (relative to a baseline incidence of 0.079, 0.010 and 0.004) respectively.

Figure 4 plots the estimated effect of one homicide in the first trimester of pregnancy on the probability of birthweight being not greater than different thresholds, for 100 grams thresholds between 1 kg and 4 kg. Again we use the most saturated specification as in columns (3), (6), (9) and (12) of Table 2. In the figure we report the estimated proportional change, i.e., the estimated reduction in the probability relative to the incidence in the population, alongside a 90 percent confidence interval. It is clear from the figure that the effect of homicides is effectively zero at high levels of birthweight, implying that the fall in average birthweight documented in columns (1) to (3) of Table 2 is driven by an increased risk of low-birthweight, and that the effect of homicides becomes increasingly larger at lower levels of birthweight.

To put our results in context, Camacho (2008) finds that one landmine explosion during early pregnancy reduces birthweight by 7.5 grams, while Mansour and Rees (2012) find that an additional non-combatant fatality during the second Intifada reduces the incidence of low birthweight by between 4 to 10 children out of 1,000. Quintana-Domeque and Rodenas (2014) find that a car bomb reduces birthweight by on average 0.7 grams. Assuming 10 casualties per bomb, this gives an effect very similar to that found by Camacho (2008) for Colombia, while Eccleston (2012) finds a negative effect of exposure to the 9/11 attack on birthweight of between 8 and 19 grams. All these results point in the direction of a homicide in a small rural municipality of Brazil producing similar effects to those of more rare, extreme events such as conflict and terrorist attacks.

Table 3 reports regression results for gestational length. Columns (1) to (3) present results for gestational length in weeks, while columns (4) to (12) present results for the probability of being born within 27, 31 and 36 weeks respectively. Results are by and large in line with those in Table 2, with a pronounced negative effect of homicides during the first trimester on average gestational length and, typically, no effect of homicides during other trimesters of pregnancy or in trimesters before and after pregnancy. Again, results are largely robust to the inclusion of additional controls. Once more, results are driven by an increased mass in the lower tail of the distribution. Focusing on the most saturated specifications in columns (3), (6), (9) and (12), these suggest that, in small municipalities, one extra homicide during the first trimester of pregnancy leads to a reduction in gestational length of 0.04

weeks, i.e., a third of a day, and an increase in the risk of being born before 37, 32 and 28 weeks of 6, 1 and 2 per 1,000 children, i.e. an increase of 10, 10 and 67 percent respectively.

The results above point in the direction of stress in the first trimester of pregnancy adversely affecting birth outcomes. The effect seems to work through increased risk of prematurity and an associated fall in birthweight.[22]

One channel of potential behavioral adjustment is selective fertility. Mothers exposed to violence might be less likely to initiate a birth or successfully complete a pregnancy due to abortion or miscarriage. Although, most likely, this channel would lead to estimates of homicide rates on birth outcomes that are systematically downward biased - as possibly children at higher risk of low birthweight or prematurity are the ones less likely to survive - it is worth directly investigating this margin of selection. In column (1) of Table 4, we present regression results for the effect of homicides on fertility. For each month and municipality, we compute the number of births initiated in that month and we regress the log number of births on homicides in the three following trimesters. We use the most saturated specification with lagged and leaded homicides rates, all controls and municipality specific linear time trends as in columns (3), (6), (9), (12) of Tables 2 and 3. Coefficients in this column are multiplied by 1,000. We find no evidence of homicide rates in the three months following conception affecting the number of births, suggesting that selective fetus mortality through miscarriage or abortion is unlikely to affect our estimates. We also find no evidence of lagged homicides affecting the number of births initiated in any given month (results not reported in the Table but available upon request). This also rules out fertility responses to past violence.

The remaining columns of Table 4 report results for additional birth outcomes. There is no evidence of violence affecting the probability of a C-section (in column 2), possibly the symptom of complications during pregnancy, or APGAR scores at one and five minutes after birth (columns 3 and 4). Although the latter might be a surprising result, given the effect of homicides on prematurity and low birthweight, APGAR scores are known to be very imprecise measures of health at birth and many studies fail to find effects on APGAR scores even when effects are found on birthweight.

Column (5) of Table 4 investigates the effect of homicides during pregnancy on the number of prenatal visits.[23] Ex-ante, it is difficult to predict if increased violence should lead

[22] In Appendix Table A2 we find no effect on birthweight for pregnancies of normal gestational length (i.e., 37 weeks or more). Although clearly this sample is selected, as gestational length is itself affected by birth outcomes, these results suggest that homicides have no effect on birthweight through IUGR.

to more or less prenatal visits. On the one hand, prenatal visits might increase if complications arise during the pregnancy as a result of exposure to violence. On the other hand, violence may deter pregnant women from attending health centers, due to increased safety concerns or just as a result of stress. As prenatal visits, especially during the first trimester of pregnancy, are known to be effective ways to detect and prevent adverse birth outcomes, this might in turn be a contributing factor to the adverse effect of violence on birth outcomes found in Tables 2 and 3. Column (5) though shows no significant effects of homicides at different stages of pregnancy on the number of pre-natal visits. We also do not find that exposure to violence changes the sex ratio at birth for example through sex specific propensity for miscarriage or abortion (column 6).

5.2 Main results for Fortaleza

Table 5 presents regression results for the neighborhoods of Fortaleza. We focus on the most saturated specification with lagged and leaded homicides rates plus mother, newborn and pregnancy controls and neighborhood controls (as in columns 2, 5, 8 and 11 of Tables 2 and 3).[24] Columns (1) to (4) of Table 5 present regression results for birthweight while columns (5) to (8) present results for gestational length. Standard errors in these regressions are clustered by neighborhood.

Despite the different samples (and different sample sizes), point estimates for Fortaleza are remarkably similar to those found for small municipalities, although unsurprisingly slightly less precise, with an effect of the homicide rate in the first trimester on average birthweight of around -0.41 grams, an increase in low birthweight of 0.30, and an increase in the probability of being born premature of 0.13 (although the latter effect is statistically insignificant).[25] Again, by and large, we find no statistically significant effects of homicides at other stages of pregnancy or pre- and post-pregnancy on birth outcomes.[26]

---

[23] As for gestational length, we convert number of controls in classes into a continuous variable. In particular we assign the values 0, 2, 5 and 7 for 0, 1-3, 4-6 and 7 or more controls respectively.

[24] IBGE provides statistics by neighbourhood from the 2000 and 2010 census but only for variables that are contained in the long census form. These are at available at http://goo.gl/XqHhsV and http://goo.gl/6Odwl3 (data last downloaded in January 2015), respectively for 2000 and 2010. These allow us to recover information on the fraction of households with access to waste collection and fraction of individuals by gender X 10-years age groups.

[25] Specifications are remarkably robust across specifications. Point estimates are essentially unchanged if we also include neighborhood effects X month of conception, although marginally less precise.

[26] Table A4 also reports similar results to those in Table 4 on additional birth outcomes for the city of Fortaleza. Again, there is no evidence of homicides affecting fertility, prenatal visits or APGAR scores.

At an average neighborhood population of 21,536, these estimates imply that one extra homicide in the mother's neighborhood of residence leads to an increase in the probability of a child being born low birthweight and premature of around 1 out of 1,000. These results are about 15 per cent the effects found in small municipalities (where this value is around 6). This suggests that in settings where homicides are frequent, each additional homicide has smaller adverse consequences on birth outcomes than when homicides are rare (although an alternative interpretation is that greater population density and population size imply that fewer women are affected in Fortaleza compared to small municipalities).

Despite the smaller marginal effects in urban areas compared to rural areas, homicides are much more frequent in the former compared to the latter, meaning that homicides are potentially a much larger contributor to low birthweight and prematurity in Fortaleza compared to rural municipalities. We revert to this in the conclusions, where we try to assess the overall contribution of homicides to the incidence of adverse birth outcomes in Brazil.

5.3 Heterogeneous effects by mother's characteristics

In Table 6 we report separate results by mothers and newborn's characteristics. Again we use the same specification as in columns (3), (6), (9), (12) of Tables 2 and 3 and we focus again on small municipalities for which the sample is larger, and hence for which results are more reliable. For brevity, in this table we focus only on the probability of low birthweight (<=2.5 kg) and of prematurity (gestation of less than 37 weeks) and we only present results on first trimester exposure (although the regressions also include exposure in subsequent trimesters of pregnancy and in both the pre- and post-pregnancy period). Columns (1) and (2) of Table 6 report separate effects by mother's level of education (up to 7 and more than 7 years of completed education), columns (3) and (4) report separate effects by mother's age (<=24 and 24 or more), while columns (5) and (6) report separate results for non-married (i.e., single, separated and divorced) and married mothers. Columns (7) and (8) report separate results for mothers who had previous birth complications, measured by at least one previous stillbirth, while columns (9) and (10) finally investigate whether effects differ as a function of the gender of the newborn

Looking at indicators of SES, it appears that the effects are larger among mothers with low levels of education compared to those with high levels of education. A possible explanation for these results is that mothers at the top of the SES distribution have ways to buffer the adverse consequences of shocks during pregnancy.

The results also suggest a clear biological risk factor associated to the probability of delivering a low birthweight and premature child. It appears in particular that the mother's history of stillbirths is a strong predictor of large adverse effects of violence on birth outcomes, with effects five to six times larger than those found at the mean (approximately 1 in column 7 of Table 6 compared to an effect of 0.16-0.21 in columns 5 of Tables 2 and 3).

We do not find clear gradients across mother's age or significant differences between married and unmarried women. Similarly, and despite evidence suggesting that boys are at greater at risk of pre-term delivery and neonatal death (Lawn et al. 2013), we do not find that the effects of violence on birth outcomes are larger for boys compared to girls: if anything the reverse is true (columns 12 and 13).

In sum, both socio-economic and biological factors, such as mothers' low levels of education and previous stillbirths, appear to magnify the adverse consequences of violence on birth outcomes, implying that mother's high socio-economic status acts as a buffer to the effects of violence on birth outcomes and that violence compounds the disadvantage that newborn from low SES already suffer.

6. Concluding remarks

Using a very rich dataset on the universe of births and homicides from vital statistics data over the period 2000-2010, we estimate the effect of in-utero exposure to homicides on a range of birth outcomes in Brazil.

We find a significant negative effect of exposure to violence during the first trimester of pregnancy on birthweight and gestational length. Speculatively, we ascribe this effect to increased maternal stress, which is known to have direct effects on the fetus' development and to lead to increased prematurity and, via this, to lower birthweight (although we cannot rule out that other behavioral mechanisms - such as increased smoking or increased alcohol consumption during pregnancy in response to stress, for which we have no data, act in magnifying these effects).

These results hold true both in small Brazilian rural municipalities and in neighborhoods of Fortaleza, one of the most violent cities in Brazil. However, while we find an effect of homicides on birth outcomes in small rural areas - where homicides are rare - that is comparable in magnitude to the effects found by others as a result of large terrorist attacks, landmine explosions or even conflict related deaths, estimates for Fortaleza - where violence is endemic - are significantly smaller (on the order of 15 percent compared to rural areas). We regard this finding as possibly consistent with our interpretation that violence affects birth outcomes through maternal stress, as homicides are more likely to be stress inducing when they are rare.

Clearly, a much higher fraction of pregnant women worldwide are exposed to violence and homicides compared to those who are exposed to terrorist attacks or landmine explosions. While, given their rare nature, these extreme events are not possible contributors to the incidence of low birthweight worldwide, day-to-day violence possibly is. Indeed, our exercise allows us to derive an estimate of the effect of homicides on birth outcomes in Brazil. While in rural areas of Brazil, where homicides are rare, homicides cannot possibly account for the incidence of low birthweight, back-of-the-envelope calculations suggest that in Fortaleza, where violence is endemic, homicide rates can account for around 10 percent of the incidence of low birthweight.[27]

This is possibly one factor contributing to rationalize the evidence that we have provided in the paper that, while mothers' living standards are higher (and the provision of health care services better) in urban areas compared to rural areas, urban children tend to suffer from poorer health at birth.

Our estimates are likely to be conservative estimates of the effect of violence on birth outcomes as we only restrict to homicides for which the death occurred in the street (hence excluding homicides that happened elsewhere, in particular in health establishments) and we clearly exclude other forms of violence and violent crime, although the latter are known to be strongly correlated with homicides.

Although our estimates refer to Brazil, results clearly have the potential to extend to other settings where violence is endemic. In particular low and middle income countries in Latin America and Africa display among the highest rates of homicide in the world and our study sheds light on one, yet largely ignored, additional cost of violence in these countries: violence imposes costs not only on the current generation but also on the one that follows.

[27] In order to derive these results we multiply the quarterly rate of homicides in the public way in Fortaleza (12.85 from Table A1 divided by 4 to obtain the quarterly rate) times the estimated coefficients on the effect of homicides on low birthweight from Table 4 (0.3017, which refers to 1,000 births) and we divide this by the overall incidence of low birthweight in Fortaleza from Table A1 (0.0091, also expressed per 1,000 children).

References

Aizer, A. (2011), 'Poverty, Violence and Health: The Impact of Domestic Violence during Pregnancy on Newborn Health'. Journal of Human Resources 46(3), pp. 518-38.

Aizer, A., Stroud, L. and Buka, S. (2009), 'Maternal Stress and Child Well-Being: Evidence from Siblings', mimeo, Brown University.

Almond, D. (2006), '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 114, pp.672-712.

Almond, D., Chay, K. and Lee, D. (2005), 'The Costs of Low Birthweight'. The Quarterly Journal of Economics 120(3), pp. 1031-83.

Almond, D. and Currie, J. (2011), 'Human Capital Development before Age Five'. In: O. Ashenfelter and D. Card (eds), Handbook of Labor Economics 4, pp.1315-1486.

Almond, D. and Mazumder, B. (2011), 'Health Capital and the Prenatal Environment: The Effect of Ramadan Observance during Pregnancy'. American Economic Journal, Applied Economics 3, pp. 56-85.

Almond, D., Hoynes, H. and Whitmore Schanzenbach, D. (2011), 'Inside the War on Poverty: The Impact of Food Stamps on Birth Outcomes'. The Review of Economics and Statistics 93(2), pp. 387-403.

Amarante, V., Manacorda, M., Miguel, E. and Vigorito, A. (2014), 'Do Cash Transfers Improve Birth Outcomes? Evidence from Matched Vital Statistics, Social Security and Program Data'. Mimeo. London School of Economics.

Black, S., Devereux, P. and Salvanes, K. (2007), 'From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes'. Quarterly Journal of Economics, 122(1), pp. 409-439.

Black, S., Devereux, P. and Salvanes, K. (2014), 'Does Grief Transfer across Generations? In-Utero Deaths and Child Outcomes'. *IZ*A DP No. 8043.

Camacho, A. (2008), 'Stress and Birthweight: Evidence from Terrorist Attacks'. American Economic Review 98(2), pp. 511-15.

Citizens' Council for Public Security and Criminal Justice (2014), *'Seguridad, Justizia Y Paz'.* Accessed online on 12/12/2014 at: http://goo.gl/4Som2e.

Currie, J., Greenstone, M. and Moretti, E. (2011), 'Superfund Cleanups and Infant Health'. *NBER Working Paper 16844*, Washington D.C.

Currie, J. and Walker, R. (2011), ‘Traffic Congestion and Infant Health: Evidence from E-ZPass’. American Economic Journals, Applied Economics 3, 65-90.

Currie, J. and Schwandt, H. (2014), ‘The 9/11 Dust Cloud and Pregnancy Outcomes: A Reconsideration’. NBER Working Paper 20368, Washington D.C.

Eccleston, M. (2012), ‘In Utero Exposure to Maternal Stress: Effects of 9/11 on Birth and Early Schooling Outcomes in New York City’. Mimeo. Cambridge, United States: Harvard University.

Eskenazi, B., Marks, A., Catalano, R., Bruckner, T. and Toniolo, P. (2007), ‘Birthweight in New York City and Upstate New York Following the Events of September 11th’. Human Reproduction, 22, pp. 3013-3020.

Figlio, D., Guryan, J., Karbownik, K. and Roth J. (2014), ‘The Effects of Poor Neonatal Health on Children’s Cognitive Development’. American Economic Review, 104(12), pp. 3921-3955.

Heinemann, A. and Verner, D. (2006), ‘Crime and Violence in Development: A Literature Review of Latin America and the Caribbean’. World Bank Policy Research Working Paper 4041. Washington, DC, United States: World Bank.

Kramer, M. (1987), ‘Determinants of Low Birth Weight: Methodological Assessment and Meta-Analysis’. Bulletin WHO.

Latinobarometer (2010), Annual Report. Latinobarómetro Corporation, Santiago, Chile.

Lawn, J., Blencowe, H., Darmstadt, G. and Bhutta, Z. (2013), ‘Beyond Newborn Survival: The World You are Born into Determines Your Risk of Disability-free Survival’. Pediatric Research, 74, pp. 1-3.

Mansour, H. and Rees, D. (2012), ‘Armed Conflict and Birthweight: Evidence from the al-Aqsa Intifada’. Journal of Development Economics, 99, pp. 190-99.

McLean, M., Bisits, A., Davies, J., Woods, R., Lowry, P. and Smith, R. (1995), ‘A Placental Clock Controlling the Lengths of Human Pregnancy’. Nature Medicine, 1, 460-463.

Pike, I. (2005), ‘Maternal Stress and Fetal Responses: Evolutionary Perspectives on Preterm Delivery’. American Journal of Human Biology, 17, pp. 55-65.

Quintana-Domeque, C., and Rodenas, P. (2014) ‘Fear in the Womb: The Effects of Terrorism on Birth Outcomes in Spain’. Mimeo. University of Oxford.

Reichenheim, M., Ramos de Souza, E., Leite Moraes, C., de Mello Jorge, M., Passos da Silva, C. and Minayo, M. (2011) ‘Violence and Injuries in Brazil: the Effect, Progress Made, and Challenges Ahead’. Lancet 377, pp. 1962-75.

Rocha, R. and Soares, R. (2015) 'Water Scarcity and Birth Outcomes in the Brazilian Semiarid'. Journal of Development Economics, 112, pp. 1843-1849.

Royer, H (2009), 'Separated at Girth: U.S. Twin Estimates of the Effects of Birthweight'. American Economic Journal: Applied Economics 1(1), pp. 49-85.

Skogan, W. G. and Maxfield, M. G. (1981), Coping with Crime: Individual and Neighborhood Reactions. Beverly Hills, CA, Sage Publications.

SSPDS (Secretaria de Segurança Pública e Defesa Social) (2014), Crime Statistics 2014. Fortaleza.

UNICEF (2006), Low Birthweight: Country, Regional and Global Estimates. Geneva, Switzerland: United Nations Children's Fund.

UNODC (2005), Country Report Brazil 2005. Regional Office Brazil. Brasilia, Brazil: United Nations Office on Drugs and Crime.

UNODC (2011), 2011 Global Study on Homicide. Trends, Contexts, Data. Vienna, Austria: United Nations Office on Drugs and Crime.

UNODC (2013), Homicide Statistics 2013. Vienna, Austria: United Nations Office on Drugs and Crime.

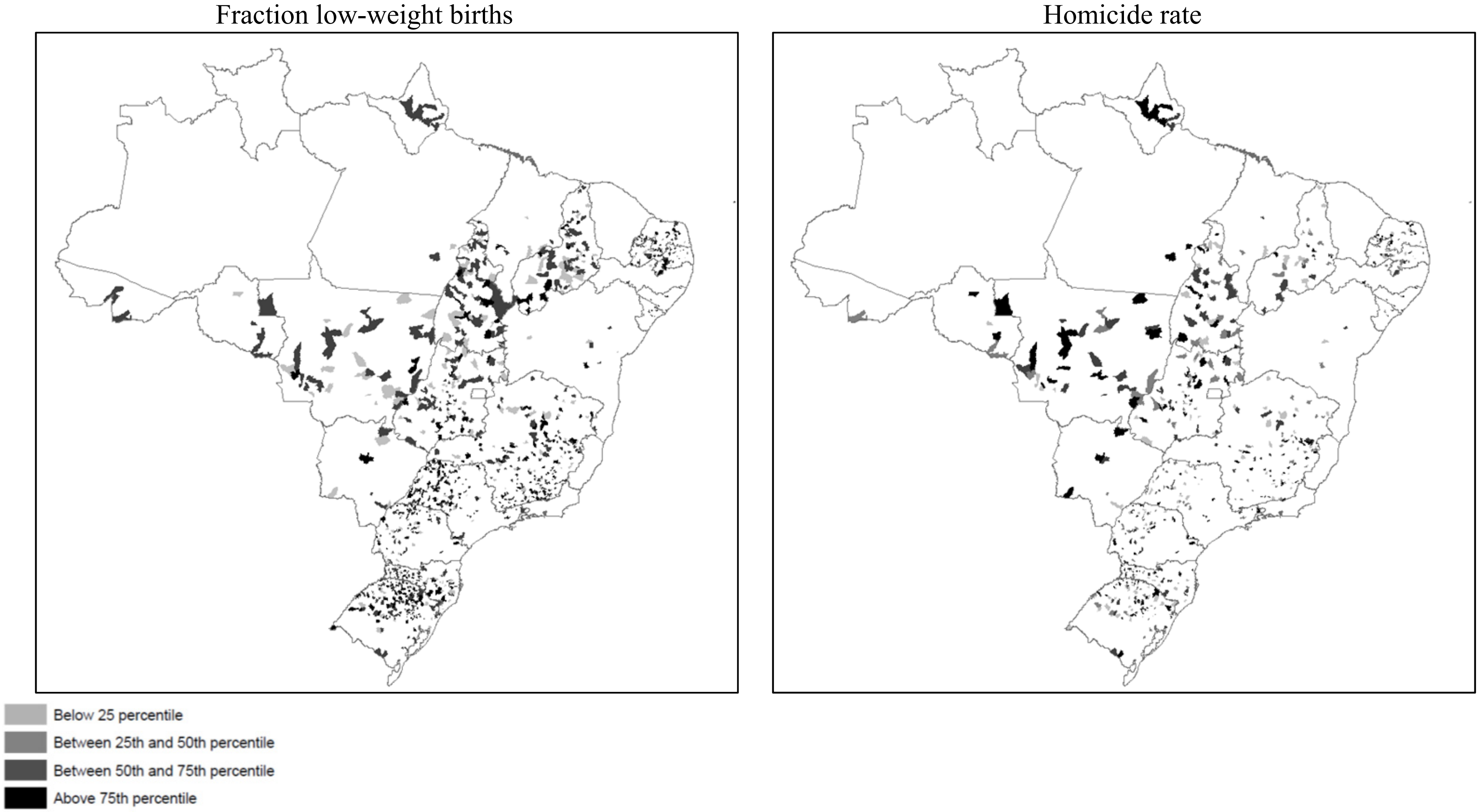
Waiselfisz, J. (2013), Homicídios e Juventude no Brasil. Mapa do Brasil 2013. Secretaria-Geral da Presidência da República, Brasília.

Wadhwa, P., Culhane, J., Rauh V. et al. (2001), 'Stress, Infection and Preterm Birth: a Biobehavioural Perspective'. Paediatric and Perinatal Epidemiology, 15, pp. 17-29.

Warr, M. (2000. 'Fear of Crime in the United States: Avenues for Research and Policy'. Criminal Justice, 4, pp. 451-489.

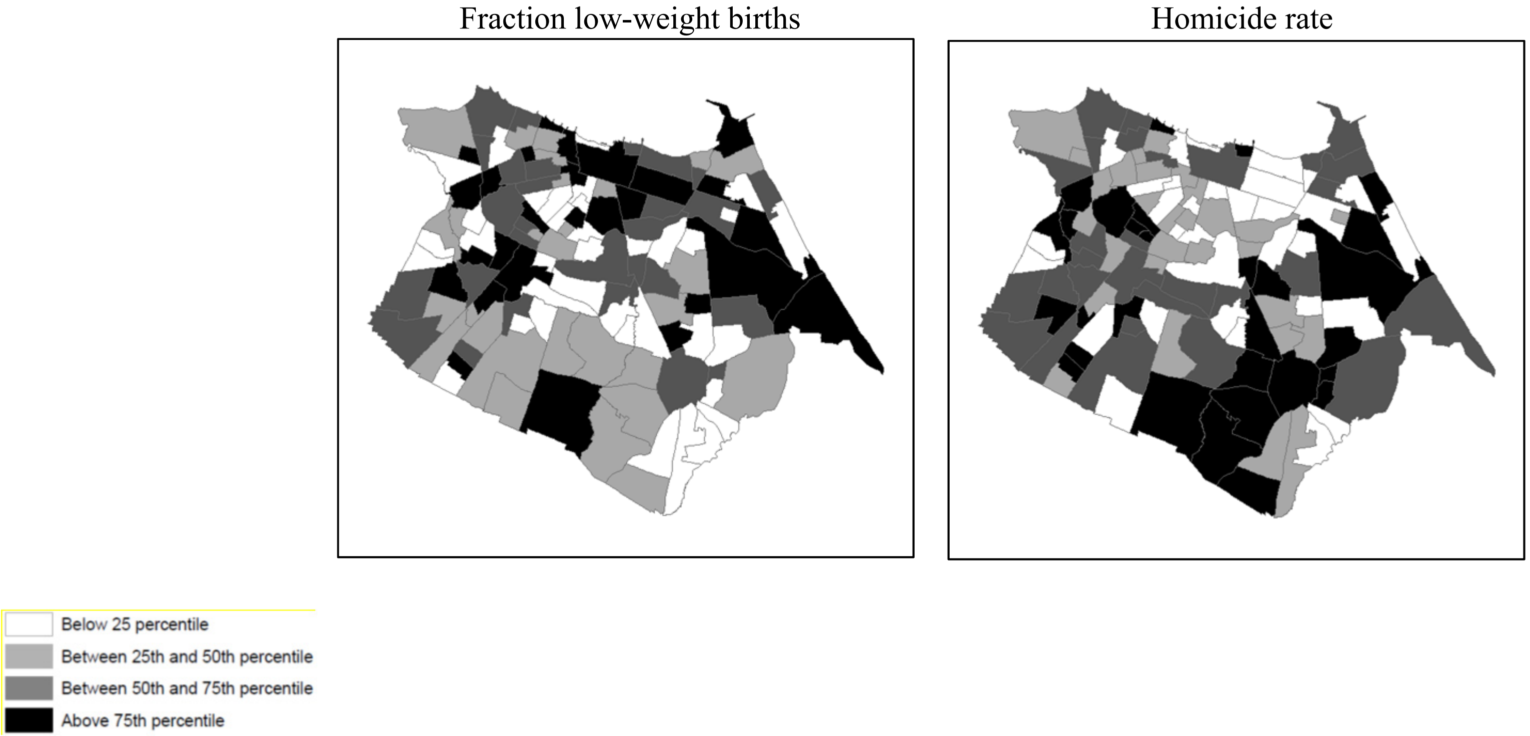
World Bank (2006), Crime, Violence and Economic Development in Brazil: Elements for Effective Public Policy. Poverty Reduction and Economic Management Sector Unit. Washington D.C., United States: World Bank.

Figure 1: Distribution of low birthweight and homicides across small Brazilian municipalities



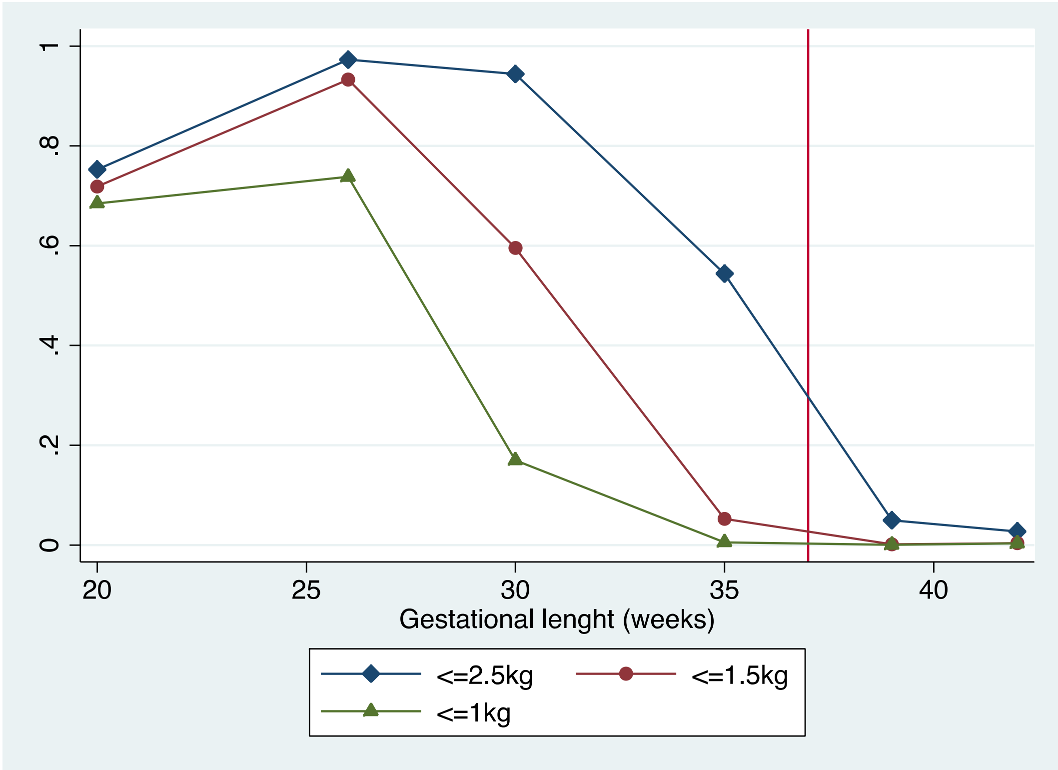
Notes: The figures report, respectively, the average fraction of low-weight births (<2.5 kg) and the homicide rate in the public way across Brazilian municipalities for municipalities of size no greater than 5,000.

Figure 2: Distribution of low birthweight and homicides across neigbhorhoods of Fortaleza



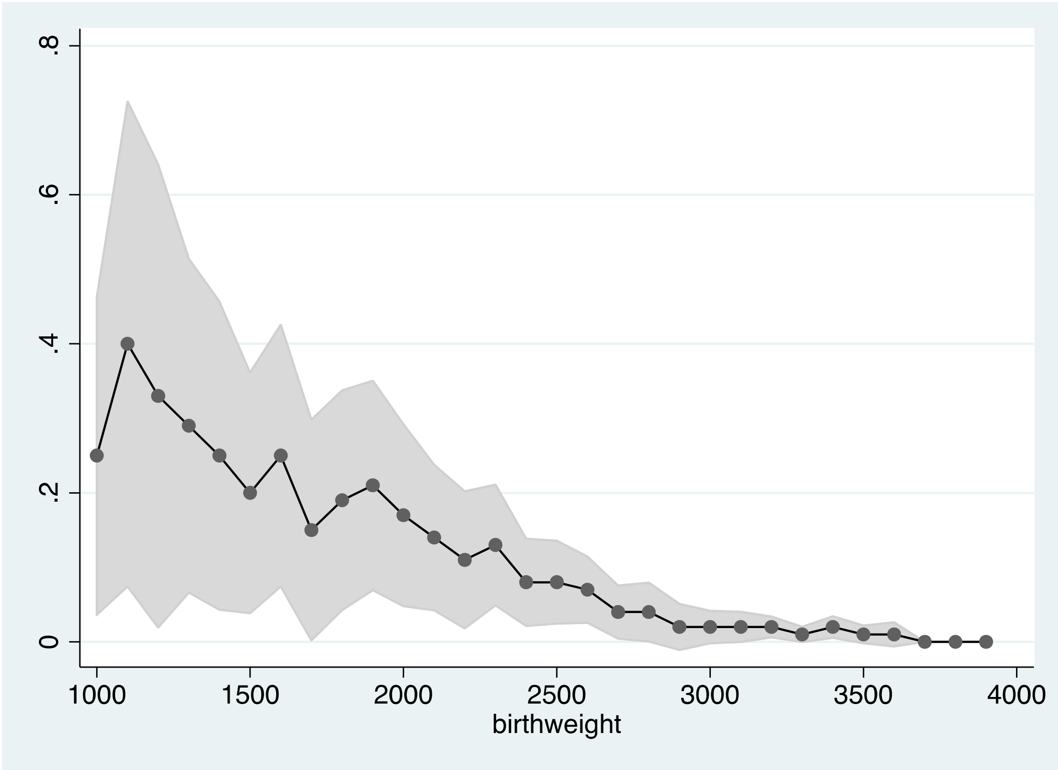
Notes: The figures report, respectively, the average fraction of low-weight births (<=2.5 kg) and the homicide rate in the public way across neighbourhoods of Fortaleza.

Figure 3: Association between low birthweight and gestational length



Note. The figure reports the fraction of low weight births as a function of gestational length. Gestational length is expressed in intervals (<22, 22-27, 28-31, 32-36, 37-41, 42 or more). Average gestational length for each interval is reported on the horizontal axis (20, 26, 30, 35, 39, 42). The data refer to all births that occurred Brazil between 2000 and 2010.

Figure 4: Effects of homicides in the first trimester on the probability of being below specific levels of birthweight



Notes. The figure the plots estimated effect of one extra homicide in the first trimester of pregnancy on the probability of birthweight being not greater than different thresholds, for 100 grams thresholds between 1 kg and 4 kg. Specification as in columns (3), (6), (9) and (12) of Table 2 used. The figure reports the estimated proportional change, i.e., the estimated reduction in the probability relative to the incidence in the population, alongside a 90 percent confidence interval. See also notes to Table 2.

Table 1: Descriptive Statistics - Brazilian municipalities

	Municipalities by population class					Fortaleza
Birth outcomes	1-5,000	5,001-20,000	20,000-100,000	100,000-500,000	>500,000	
Birthweight	3,212	3,223	3,208	3,164	3,151	3,217
Low birthweight	0.079	0.079	0.082	0.090	0.094	0.083
Very low birthweight	0.010	0.010	0.010	0.013	0015	0.014
Ext. low birthweight	0.004	0.004	0.004	0.005	0.006	0.006
Weeks gestation	38.752	38.755	38.749	38.657	38.612	38.682
Weeks gestation<37	0.059	0.058	0.055	0.070	0.079	0.064
Weeks gestation<32	0.010	0.010	0.010	0.012	0.013	0.011
Weeks gestation<28	0.003	0.003	0.004	0.004	0.005	0.004
Newborn characteristics						
Female	0.485	0.487	0.487	0.488	0.488	0.486
White	0.571	0.450	0.435	0.519	0.423	0.092
Black	0.020	0.023	0.020	0.018	0.019	0.004
Asian	0.005	0.005	0.004	0.002	0.002	0.003
Mixed	0.356	0.472	0.489	0.387	0.395	0.568
Indigenous	0.010	0.012	0.008	0.002	0.001	0.002
Birth and pregnancy characteristics						
C-section	0.434	0.360	0.393	0.476	0.505	0.495
Multiple birth	0.019	0.018	0.018	0.019	0.021	0.020
Prenatal visits	5.801	5.433	5.438	5.865	5.925	5.426
Mother characteristics						
Age	25.716	25.863	25.535	25.855	26.518	26.902
Single	0.442	0.517	0.545	0.516	0.548	0.595
No ed.	0.030	0.048	0.039	0.012	0.008	0.015
Years of ed.: 1-3	0.137	0.168	0.144	0.074	0.055	0.075
Years of ed.: 4-7	0.391	0.389	0.366	0.313	0.270	0.302
Years of ed.: 8-11	0.319	0.281	0.319	0.431	0.446	0.396
Years of ed.: >=12	0.103	0.086	0.105	0.150	0.197	0.158
Born alive children>0	0.621	0.658	0.653	0.614	0.589	0.675
Born alive children	1.231	1.434	1.385	1.161	1.055	1.278
Still births	0.097	0.111	0.116	0.105	0.104	0.084
Births	528,089	3,896,949	7,733,470	6,301,984	7,190,636	333,927
Municipality characteristics						
Homicide rate	7.186	10.848	17.509	31.233	41.132	31.599
Homicide rate - Public way	2.285	4.159	7.734	14.267	16.470	14.428
Homicide rate - Residence	2.090	2.483	2.835	3.336	2.750	3.189
Homicide rate - Health inst.	0.219	0.831	2.985	9.279	18.163	9.864
Homicide rate - Elsewhere	2.301	2.949	3.397	3.906	3.384	2.697
Population (,000)	3.418	10.807	39.460	204.562	1487.057	2341.745
Municipalities	1,341	2,653	2,653	216	35	1

Notes: Columns (1) to (5) of the table report descriptive statistics by groups of municipalities defined based on population size. Observations refer to all births conceived between October 2000 and June 2009. The last column refers to the municipality of Fortaleza. Homicide rates are expressed as a fraction per 100,000 people. Categories of variables might not add up to 100 due to missing values. Municipality characteristics are obtained as population weighted averages across all municipalities in each size class.

Table 2: The effect of homicides during pregnancy on birthweight - Small municipalities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Trimester	Birthweight			Low birthweight			Very low birthweight			Extremely low birthweight		
-3 (pre-conception)		-0.0282	-0.0421		-0.0327	0.0047		-0.0245	-0.0231		-0.0407**	-0.0415**
		(0.1848)	(0.1898)		(0.0939)	(0.0975)		(0.0347)	(0.0360)		(0.0189)	(0.0204)
-2 (pre-conception)		-0.1514	-0.1857		0.0661	0.1119		-0.0053	-0.0050		0.0068	0.0064
		(0.1847)	(0.1851)		(0.0899)	(0.0924)		(0.0319)	(0.0324)		(0.0215)	(0.0221)
-1 (pre-conception)		0.2090	0.2054		-0.0722	-0.0317		0.0068	0.0057		0.0113	0.0079
		(0.1863)	(0.1907)		(0.0862)	(0.0886)		(0.0340)	(0.0355)		(0.0227)	(0.0240)
1	-0.4465**	-0.4735***	-0.5178***	0.1342	0.1569*	0.2050**	0.0705*	0.0728*	0.0788**	0.0519*	0.0533*	0.0535*
	(0.1794)	(0.1724)	(0.1787)	(0.0890)	(0.0844)	(0.0864)	(0.0390)	(0.0384)	(0.0386)	(0.0277)	(0.0277)	(0.0277)
2	0.0048	-0.0123	-0.0639	0.0507	0.0572	0.1039	-0.0279	-0.0288	-0.0246	-0.0129	-0.0141	-0.0139
	(0.2075)	(0.1974)	(0.2029)	(0.1003)	(0.0952)	(0.0985)	(0.0344)	(0.0335)	(0.0344)	(0.0216)	(0.0214)	(0.0221)
3	0.1347	-0.0075	-0.0284	-0.0862	-0.0247	0.0173	0.0228	0.0310	0.0308	0.0139	0.0180	0.0147
	(0.2083)	(0.2011)	(0.2009)	(0.0910)	(0.0882)	(0.0917)	(0.0414)	(0.0406)	(0.0402)	(0.0316)	(0.0307)	(0.0295)
4 (post-birth)		-0.1484	-0.1372		0.0999	0.1257		0.0412	0.0374		0.0255	0.0212
		(0.1886)	(0.1901)		(0.0915)	(0.0914)		(0.0383)	(0.0378)		(0.0298)	(0.0286)
5 (post-birth)		0.1224	0.1000		-0.0469	-0.0136		-0.0461	-0.0457		-0.0157	-0.0156
		(0.1702)	(0.1752)		(0.0845)	(0.0875)		(0.0313)	(0.0316)		(0.0196)	(0.0208)
6 (post-birth)		-0.0648	-0.0687		0.0472	0.0790		0.0040	-0.0023		0.0264	0.0229
		(0.1882)	(0.1882)		(0.0908)	(0.0940)		(0.0284)	(0.0297)		(0.0218)	(0.0228)
Additional controls	505,253	505,253	505,253	505,253	505,253	505,253	505,253	505,253	505,253	505,253	505,253	505,253
Municip. X month			Yes			Yes		Yes	Yes		Yes	Yes

Notes. The table reports the estimated effect of homicide rates in different trimesters since the month of conception on birthweight in Brazilian municipalities with population up to 5,000. Low, very low and extremely low birthweight denote birthweight up to 2.5, 1.5 and 1 kg respectively. Coefficients in columns (4) to (12) are multiplied by 1,000. All specifications include municipality of residence and month fixed effects. Additional controls include: child race, dummies for singleton, twins, triplet or more, dummies for mother's age, education and marital status, number of previously born alive and born dead children and municipality characteristics (log population, log income, fraction of households with access to sewage, waste collection, and electricity, fraction with radio, TV, computer, washing machine and in receipt of *Bolsa Família*, average *Bolsa Família* transfer per beneficiary household, fraction of individuals by race, gender X 10-years age groups, education groups, fraction illiterate, unemployment rate, urbanization rate, fraction of children in work). Columns (3), (6), (9) and (12) also include the interaction between municipality fixed effects and a linear month of conception trend. Clustered standard errors by municipality of residence in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Number of observations: 505,253.

Table 3: The effect of homicides during pregnancy on gestational length - Small municipalities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Trimester	Weeks gestation			Week gestation<37			Weeks gestation<32			Weeks gestation<28		
-3 (pre-conception)		0.0008	0.0008		-0.1285	-0.1474*		-0.0230	-0.0241		-0.0173	-0.0074
		(0.0005)	(0.0005)		(0.0808)	(0.0813)		(0.0358)	(0.0370)		(0.0182)	(0.0189)
-2 (pre-conception)		0.0004	0.0003		-0.1374*	-0.1417*		-0.0216	-0.0226		0.0152	0.0252
		(0.0005)	(0.0005)		(0.0772)	(0.0807)		(0.0336)	(0.0339)		(0.0197)	(0.0201)
-1 (pre-conception)		0.0003	0.0003		-0.0000	-0.0173		-0.0313	-0.0320		-0.0009	0.0093
		(0.0005)	(0.0005)		(0.0875)	(0.0902)		(0.0320)	(0.0340)		(0.0213)	(0.0221)
1	-0.0012**	-0.0013**	-0.0013**	0.2063**	0.2115**	0.2063**	0.0449	0.0458	0.0506	0.0472**	0.0485**	0.0603***
	(0.0006)	(0.0006)	(0.0006)	(0.0901)	(0.0871)	(0.0868)	(0.0380)	(0.0374)	(0.0373)	(0.0238)	(0.0238)	(0.0233)
2	0.0006	0.0006	0.0005	0.0025	-0.0008	-0.0062	-0.0578*	-0.0597*	-0.0580*	-0.0118	-0.0123	-0.0026
	(0.0005)	(0.0005)	(0.0005)	(0.0780)	(0.0766)	(0.0791)	(0.0348)	(0.0337)	(0.0344)	(0.0208)	(0.0205)	(0.0216)
3	-0.0003	-0.0004	-0.0006	0.0063	0.0409	0.0456	0.0367	0.0445	0.0503	-0.0161	-0.0116	-0.0002
	(0.0005)	(0.0005)	(0.0005)	(0.0816)	(0.0803)	(0.0806)	(0.0368)	(0.0363)	(0.0369)	(0.0199)	(0.0198)	(0.0202)
4 (post-birth)		-0.0002	-0.0003		0.0962	0.1031		-0.0230	-0.0188		-0.0035	0.0045
		(0.0005)	(0.0005)		(0.0856)	(0.0885)		(0.0300)	(0.0312)		(0.0181)	(0.0186)
5 (post-birth)		0.0006	0.0004		-0.0522	-0.0486		-0.0335	-0.0303		-0.0160	-0.0080
		(0.0005)	(0.0005)		(0.0811)	(0.0804)		(0.0325)	(0.0320)		(0.0175)	(0.0173)
6 (post-birth)		0.0001	0.0000		-0.0617	-0.0796		0.0063	0.0064		0.0393*	0.0436**
		(0.0005)	(0.0005)		(0.0739)	(0.0749)		(0.0307)	(0.0310)		(0.0211)	(0.0218)
Additional controls		Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes
Municip. X month			Yes			Yes			Yes			Yes

Notes. The table reports the estimated effect of homicide rates in different trimesters since the month of conception on gestational length in small Brazilian municipalities (population up to 5,000). Coefficients in columns (4) to (12) are multiplied by 1,000. See also notes to Table 2. Number of observations: 505,253.

Table 4: The Effect of Homicides during pregnancy on additional outcomes - Small municipalities

	(1)	(2)	(3)	(4)	(5)	(6)
Trimester	Fertility	C-section	APGAR 1 minute	APGAR 5 minutes	Prenatal Visits	Female
1	0.0219	0.0001	-0.0005	-0.0001	0.0006	-0.0001
	(0.0364)	(0.0002)	(0.0006)	(0.0004)	(0.0006)	(0.0002)
2	-0.0599	-0.0001	-0.0002	-0.0000	0.0004	-0.0001
	(0.0395)	(0.0002)	(0.0006)	(0.0004)	(0.0007)	(0.0002)
3	0.0059	0.0000	0.0004	0.0003	0.0006	0.0002
	(0.0397)	(0.0002)	(0.0005)	(0.0004)	(0.0007)	(0.0002)

Notes. Column (1) of the table reports the effect of homicide rates on fertility. This is calculated as the log number of pregnancies initiated in any given month that led to a birth. Coefficients are multiplied by 1,000. Columns (2) to (6) report specifications similar to those as in columns (3), (6), (9), (12) of Tables 2 and 3 for additional outcomes. All specifications include homicide rates pre- and post-pregnancy, municipality and month of conception fixed effects, municipality controls and municipality fixed effects X month of conception. Columns (2) to (6) additionally control for mother, newborn and pregnancy characteristics. Number of observations in column (1): 130,039. See also notes to Table 2.

Table 5: The effect of homicides during pregnancy on birth outcomes - Neighbourhoods of Fortaleza

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trimester	Birthweight	Low birthweight	Very low birthweight	Extremely low birthweight	Weeks gestation	Week gestation<37	Weeks gestation<32	Weeks gestation<28
-3 (pre-conception)	0.2512	-0.0651	0.0203	0.0119	-0.0010	0.1721	0.1175	-0.0496
	(0.2856)	(0.1161)	(0.0983)	(0.0762)	(0.0010)	(0.1202)	(0.1110)	(0.0517)
-2 (pre-conception)	0.3302	0.0712	0.0525	0.0263	0.0007	-0.1262	0.0012	-0.0083
	(0.2232)	(0.1855)	(0.0703)	(0.0506)	(0.0009)	(0.1425)	(0.0597)	(0.0430)
-1 (pre-conception)	0.3217	-0.0760	-0.0734	0.0250	0.0003	-0.0780	-0.0040	0.0283
	(0.4304)	(0.2036)	(0.0936)	(0.0590)	(0.0012)	(0.1718)	(0.0818)	(0.0559)
1	-0.4105**	0.3017**	0.0963	0.0892**	-0.0013*	0.1369	0.0506	0.0878**
	(0.2068)	(0.1382)	(0.0708)	(0.0441)	(0.0008)	(0.1244)	(0.0561)	(0.0419)
2	-0.1659	-0.0173	0.0197	0.0975***	-0.0013	0.2102	0.0341	0.0958**
	(0.2552)	(0.1575)	(0.0549)	(0.0357)	(0.0009)	(0.1379)	(0.0474)	(0.0372)
3	-0.0105	0.0625	0.0732	0.1001**	-0.0007	-0.0543	0.0801	0.0839**
	(0.2196)	(0.1188)	(0.0564)	(0.0425)	(0.0006)	(0.0901)	(0.0502)	(0.0345)
4 (post-birth)	0.2261	0.2171	-0.0025	-0.0013	0.0002	0.0634	-0.0199	-0.0475
	(0.3492)	(0.1790)	(0.0502)	(0.0340)	(0.0008)	(0.1116)	(0.0548)	(0.0309)
5 (post-birth)	-0.1675	0.3083***	0.0634	0.0625	-0.0011	0.1846	0.0177	0.0368
	(0.2319)	(0.1119)	(0.0679)	(0.0662)	(0.0009)	(0.1145)	(0.0778)	(0.0558)
6 (post-birth)	-0.3131	0.2262*	0.0333	0.0469	-0.0007	0.0461	0.0899*	0.0230
	(0.2587)	(0.1314)	(0.0761)	(0.0429)	(0.0008)	(0.1123)	(0.0522)	(0.0584)

Notes. The table reports the estimated effect of homicide rates in different trimesters since the month of conception on birthweight (columns 1 to 4) and gestational length (columns 5 to 8) in the city of Fortaleza. All specifications include neighbourhood and month of conception fixed effects plus neighbourhood controls (log population, fraction of households with access waste collection, fraction of individuals by gender X 10-years age groups, similar to columns (2), (5), (8), (11) of Tables 2 and 3. Standard errors clustered by neighbourhood. Number of observations 100,814. See also notes to Table 2.

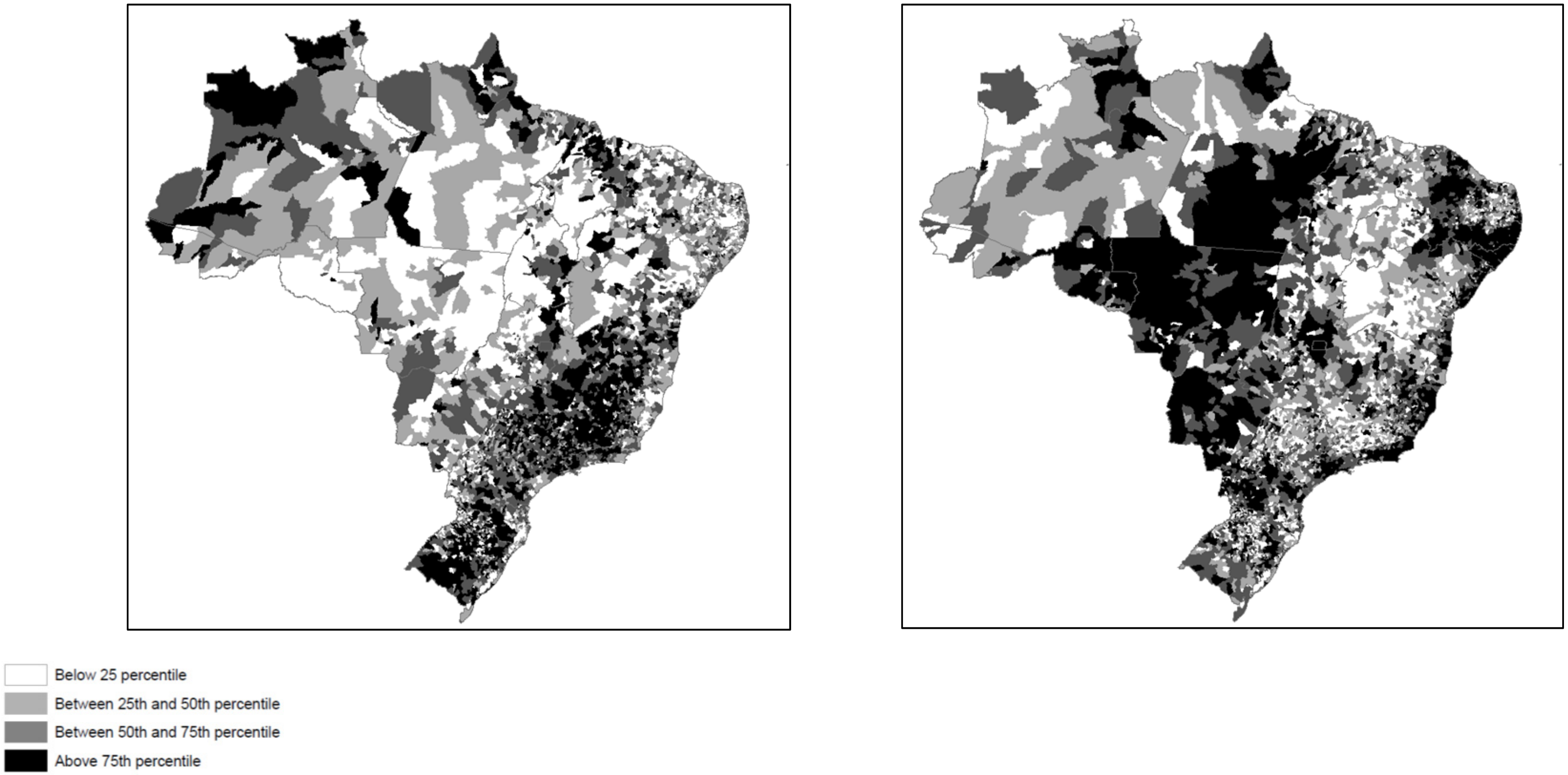
Table 6: The Effect of homicides during the first trimester of pregnancy on birth outcomes - Heterogeneous effects by mother and newborn's characteristics

	(1)	(3)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	By mother's years of education		By mother's age		By mother's marital status		By mother's birth history		By newborn's gender	
Trimester	<=7	>7	<=24	>24	Not married	Married	Stillbirths	No Still-births	Male	Female
					Low birthweight					
1	0.2540**	0.1373	0.2059	0.2174*	0.2420*	0.1858	1.2908***	0.0813	0.1689	0.2312*
	(0.1271)	(0.1367)	(0.1257)	(0.1295)	(0.1267)	(0.1329)	(0.3674)	(0.1007)	(0.1220)	(0.1256)
Observations	281,513	213,814	278,286	226,480	228,529	230,332	42,810	395,935	259,727	245,235
					Weeks gestation <37					
1	0.2600**	0.1553	0.1953	0.2253*	0.2154*	0.2160*	1.0338***	0.0507	0.1461	0.2533**
	(0.1156)	(0.1321)	(0.1227)	(0.1259)	(0.1285)	(0.1265)	(0.3381)	(0.0936)	(0.1193)	(0.1218)
Observations	281,513	213,814	278,286	226,480	228,529	230,332	42,810	395,935	259,727	245,235

Notes. The table reports the effect of homicide rates on birth outcomes in small Brazilian municipalities (population up to 5,000) separately for births defined based on different characteristics of the mother and the newborn. Specifications include all controls as in columns (3), (6), (9), (12) of Tables 2 and 3. See also notes to Table 2.

Figure A1: Distribution of low birthweight and homicides across Brazilian municipalities

Fraction low-weight births | Homicide rate



Notes: The figures report, respectively, the average fraction of low-weight births (<2.5 kg) and the homicide rate in the public way across Brazilian municipalities.

Table A1: Descriptive statistics - Neighborhoods of Fortaleza

	Fortaleza
Birth outcomes	
Birthweight	3,199
Low birthweight	0.091
Very low birthweight	0.017
Ext. low birthweight	0.008
Weeks gestation	38.628
Weeks gestation<37	0.071
Weeks gestation<32	0.013
Weeks gestation<28	0.006
Newborn characteristics	
Female	0.486
White	0.053
Black	0.002
Asian	0.001
Mixed	0.584
Indigenous	0.000
Birth and pregnancy characteristics	
C-section	0.554
Multiple birth	0.021
Prenatal visits	5.413
Mother characteristics	
Age	25.914
Single	0.668
No ed.	0.009
Years of ed.: 1-3	0.055
Years of ed.: 4-7	0.256
Years of ed.: 8-11	0.453
Years of ed.: >=12	0.189
Born alive children>0	0.613
Born alive children	1.119
Still births	0.054
Observations	100,814
Municipality characteristics	
Homicide rate	17.234
Homicide rate - Public way	12.850
Homicide rate - Residence	2.173
Homicide rate - Hospital	-
Homicide rate - Elsewhere	2.301
Population (,000)	21,536
Neighbourhoods	109

Notes. Columns (1) to (5) of the table report descriptive statistics by neighbourhood of Fortaleza. Observations refer to all births conceived between January 2006 and December 2008 and to births and homicides for which an indicator for the mother's neighbourhood of residence and the neighbourhood of occurrence of the homicide respectively are available. See also notes to Table 1.

Table A2: The Effect of homicides during pregnancy on birthweight - Small municipalities
Only pregnancies of normal gestational length

	(1)	(2)	(3)	(4)
Trimester	Birthweight	Low birthweight	Very low birthweight	Extremely low birthweight
1	-0.2244	0.1038	-0.0163	-0.0116
	(0.1658)	(0.0736)	(0.0117)	(0.0103)
2	-0.0805	0.0805	0.0055	0.0016
	(0.1855)	(0.0794)	(0.0151)	(0.0119)
3	0.0974	-0.0730	-0.0075	0.0019
	(0.1899)	(0.0782)	(0.0209)	(0.0204)

Note: The table reports the specifications to those in Tables 2 and 3, columns (3), (6), (9) and (12) only for pregnancies of normal length (37 weeks or more). Number of observations: 475,383. See notes to Table 2.

Table A3: The Effect of homicides during pregnancy on additional outcomes - Neighbourhoods of Fortaleza

	(1)	(2)	(3)	(4)	(5)	(6)
Trimester	Fertility	C-section	APGAR 1 minute	APGAR 5 minutes	Prenatal visits	Female
1	-0.1278	-0.0003	-0.0001	-0.0002	0.0006	-0.0001
	(0.1355)	(0.0002)	(0.0005)	(0.0003)	(0.0007)	(0.0002)
2	-0.0571	0.0003	-0.0001	-0.0005**	-0.0002	-0.0006***
	(0.0809)	(0.0002)	(0.0005)	(0.0003)	(0.0011)	(0.0002)
3	-0.0456	-0.0001	0.0011**	-0.0001	0.0007	0.0005**
	(0.0751)	(0.0002)	(0.0005)	(0.0004)	(0.0007)	(0.0002)

Notes. Number of observations in column (1): 3,891. See also notes to Tables 4 and 5.

Queen Mary
University of London

This working paper has been produced by the School of Economics and Finance at Queen Mary University of London

School of Economics and Finance
Queen Mary University of London
Mile End Road
London E1 4NS
Tel: +44 (0)20 7882 7356
Fax: +44 (0)20 8983 3580
Web: www.econ.qmul.ac.uk/research/workingpapers/