Birth Weight, Neonatal Care, and Infant Mortality: Evidence from Macrosomic Babies

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Abstract

This study demonstrates that rule-of-thumb health treatment decision-making exists when assigning medical care to macrosomic newborns with an extremely high birth weight and estimates the short-run health return to neonatal care for infants at the high end of the birth weight distribution. Using a regression discontinuity design, we find that infants born with a birth weight above 5000 grams have a 2 percentage-point higher probability of admission to a neonatal intensive care unit and a 1 percentage-point higher probability of antibiotics receipt, compared to infants with a birth weight below 5000 grams. We also find that being born above the 5000-gram cutoff has a mortality-reducing effect: infants with a birth weight larger than 5000 grams face a 0.15 percentage-point lower risk of mortality in the first week and a 0.20 percentage-point lower risk of mortality in the first month, compared to their counterparts with a birth weight below 5000 grams. We do not find any evidence of changes in health treatments and mortality at macrosomic cutoffs lower than 5000 grams, which is consistent with the idea that such treatment decisions are guided by the higher expected morbidity and mortality risk associated with infants weighing more than 5000 grams.

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1. Introduction

This study examines the relationship between birth weight, neonatal care, and infant mortality among high-risk newborns at the upper end of the birth weight distribution. Prior work has mainly focused on newborns with a low birth weight (LBW). Medical research has shown that being born with a LBW increases the risk of developmental problems, which worsens as birth weight decreases (Hack et al., 1995, Abernethy et al., 2002). Economic studies have shown that health treatments received by very LBW children are effective in reducing the risk of infant mortality and at improving subsequent health and academic achievement (Bharadwaj et al., 2013, Almond et al., 2010, Cutler and Meara, 2000, Breining et al., 2015). Since these findings only apply to LBW infants, it is important to analyze the return to medical care for high-risk newborns with a high birth weight (HBW), who have been not been studied in the early life literature.

Recent data from the CDC Wonder System indicate that, over the past decade, the rate of *macrosomia*, or the percentage of newborns who were born with a HBW has hovered around 8%.[1] In contrast to LBW newborns, the health risks associated with macrosomia worsen as birth weight *increases*. Medical studies have shown that the morbidity and mortality risks associated with a macrosomic newborn all grow as birth weight increases (Boulet et al., 2003, Zhang et al., 2008, Oral et al., 2001, Vidarsdottir et al., 2011), especially for infants heavier than 5000 grams (Chatfield, 2001, Gottlieb and Galan, 2007). As the health complications increase in number or complexity, there is likely to be a corresponding increase in health care costs associated with treating them.[2]

Building on prior research that has found that a rule of thumb is used for assigning medical care to very LBW newborns (Bharadwaj et al., 2013, Almond et al., 2010, Cutler and Meara, 2000, Breining et al., 2015), we demonstrate that a similar rule of thumb is used in the assignment of medical care to high-risk newborns in the macrosomic segment of the birth weight distribution, and exploit the resulting plausibly exogenous variation in medical care receipt to estimate the health returns to providing neonatal care to macrosomic babies. Our analysis uses data from the 2007-2013 Birth Cohort Linked Birth-Infant Death Files, which, starting in 2007,

[1] *Macrosomia* implies fetal growth beyond a specific birth weight. The diagnostic threshold for macrosomia has been variously defined. Please see Section 2 for detailed background information.

[2] As is the case for LBW infants, the health costs associated with a macrosomic birth are substantial. Lenoir-Wijnkoop et al. (2005) found that, in the U.S., the direct costs associated with neonatal complications for a macrosomic newborn are on average \$3,799 (in \$2009), which represents 24% of the total cost of a high-risk pregnancy and delivery involving a mother with gestational diabetes, and 49% of the total cost associated with a normal pregnancy and vaginal delivery.

has collected newly available information on the health treatments received by newborns. In a regression discontinuity framework, we use a sample of newborns born within 227 grams (half a pound) from a macrosomic cutoff to analyze whether being born above the cutoff affects the probability of receiving health treatments in the delivery hospital and the risk of infant mortality. The underlying assumption in our analysis is that babies born within a small birth-weight window around the macrosomic cutoff are relatively homogeneous, except for the extra medical care that newborns weighing-in above the macrosomic cutoff receive because of rule-of-thumb treatment decisions.

Our results indicate that being born above a weight of 5000 grams (extremely HBW [EHBW]) increases the probability of receiving antibiotics for suspected sepsis and admission to a neonatal intensive care unit (NICU) by around 1 and 2 percentage points, respectively, which correspond to an increase of 40% and 19%. We also find that the risk of 7-day and 28-day mortality drops by around 0.15 and 0.20 percentage points, respectively, as the 5000-gram cutoff is crossed from below, which are large relative to the mean mortality rates below the cutoff (0.09% and 0.12%, respectively). These results are robust to a wide variety of robustness and sensitivity checks. While the examination of health treatments represents our first-stage analysis, we interpret the reduction in mortality as the intention-to-treat effect of being an EHBW infant: even though it is plausible to link the reduced mortality for EHBW newborns to the increases in NICU-based treatments and antibiotics receipt, there may be other medical inputs that are not observable in our data that also change at the 5000-gram cutoff and contribute to the mortality reduction. We do not find similar discontinuities at macrosomic cutoffs below 5000 grams, which is consistent with the idea that the sensitivity of rule-of-thumb health treatment assignment may grow with the higher expected morbidity and mortality risks associated with heavier macrosomic babies.

The rest of the paper is organized as follows. Section 2 provides background information on fetal macrosomia and presents descriptive evidence on health treatments and mortality for macrosomic newborns, while Section 3 describes the data. Section 4 discusses the empirical strategy. Section 5 focuses on the 5000-gram cutoff and presents our main results, the results from a battery of robustness and sensitivity checks, as well as additional evidence on the mortality effects. Section 6 analyzes other macrosomic cutoffs, and, finally, section 7 concludes.

2. Fetal macrosomia

2.1. Background

At present, a general consensus on the definition of fetal macrosomia does not exist. Authors have defined it as a birth weight of either at least 4000 grams, at least 4500 grams, or at least 5000 grams, regardless of gestational age. In the 2016 *Clinical Management Guidelines for Obstetrician-Gynecologists*, the American College of Obstetricians and Gynecologists (ACOG) recognizes a continuum of risk and divide macrosomia into three categories: (1) birth weight of 4000-4499 with increased risk of labor abnormalities and newborn complications; (2) birth weight of 4500-4999 grams with additional risk of maternal and newborn morbidity; and (3) birth weight of 5000 grams or greater with additional risk of stillbirth and neonatal mortality (ACOG, 2016).

The medical literature has identified several risk factors associated with a higher likelihood of having a macrosomic newborn, such as the baby's sex and the mother's race, but the most important determinants of macrosomia are the diabetes history of the mother and her pre-pregnancy weight or weight gain during pregnancy (Boulet et al., 2003, Stotland et al., 2004, Chatfield, 2001, ACOG, 2016).[3] Since a mother's diabetic status is a strong determinant of macrosomia, a common outcome for these infants is neonatal hypoglycemia, which may worsen when feeding difficulties are present (Cordero et al., 1998). However, the most severe complications associated with a macrosomic newborn are mainly due to prolonged labor and delivery difficulties, and are thus more likely to arise in the case of a vaginal birth, either completed or attempted. Birth traumas, such as shoulder dystocia (Nesbitt et al., 1998, Chauhan et al., 2005) and respiratory problems, mainly due to an insufficient intake of oxygen (Wirbelauer and Speer, 2009, Gallacher et al., 2016), often require immediate interventions in order to conclude the delivery with an emergency cesarean section (c-section) and/or to provide emergency care to the newborn. Hook et al. (1997) also show that the trial of labor, especially if failed and concluded with an emergency c-section, is associated with higher rates of suspected and confirmed sepsis.

Given all the complications associated with a vaginal delivery, the ACOG has supported the use of elective c-section as a preventive treatment, even though very often this is not

[3] In Table A.1 in the Appendix we present an analysis of determinants of macrosomia in our analysis sample of newborns within 227 grams from the 5000-gram cutoff, which shows that gestational diabetes, and weight gain during pregnancy significantly increase the risk of delivering an EHBW newborn. A mother's general diabetic status was not included in the analysis presented in Table A.1 because of its strong collinearity with gestational diabetes (the correlation coefficient between the two variables is 0.83 (p-value=0.000)). However, in the analysis below we consider both gestational diabetes and general diabetes status.

implemented because of the inaccurate ultrasound estimation of birth weight during pregnancy and thus imprecise diagnosis of macrosomia (ACOG, 2016, Dudley, 2005). Furthermore, even in the case of a c-section, the newborn may face a risk of respiratory complications or sepsis (Linder et al., 2014, Hook et al., 1997, Shane et al., 2017), which may induce medical intervention and hospitalization.

When serious complications associated with fetal macrosomia arise, they cannot be treated in a general department but instead require admission to a specialist department, such as a NICU. While sepsis and respiratory distress represent major causes for admissions to NICUs (Signore and Klebanoff, 2008, Tolosa and Calhoun, 2017), Modanlou et al. (1980) report that macrosomic newborns experience a higher rate of NICU admission than do appropriate-weight, term-size newborns. The most serious complications are more likely to arise for the largest fetuses, i.e., for newborns at the very high end of the birth weight distribution. Among all newborns weighing 4000 grams or more, the chance of a prolonged NICU stay has been found to be more than twice as high for babies born at or above 5000 grams (Gillean et al., 2005, Linder et al., 2014, Tolosa and Calhoun, 2017). Ye et al. (2014) found that infants with a birth weight from 4000 to 4499 grams are not at increased risk of mortality or morbidity versus those weighing between 3500 and 3999 grams, whereas those with a birth weight between 4500 and 4999 grams or higher have a significantly higher risk of neonatal mortality, especially because of birth asphyxia and birth injury. This is in line with the ACOG definitions of macrosomia (ACOG, 2016), which document that the risk of neonatal morbidity increases for newborns between 4000 and 4999 grams, and that the risk of neonatal mortality is highest for those weighing more than 5000 grams.

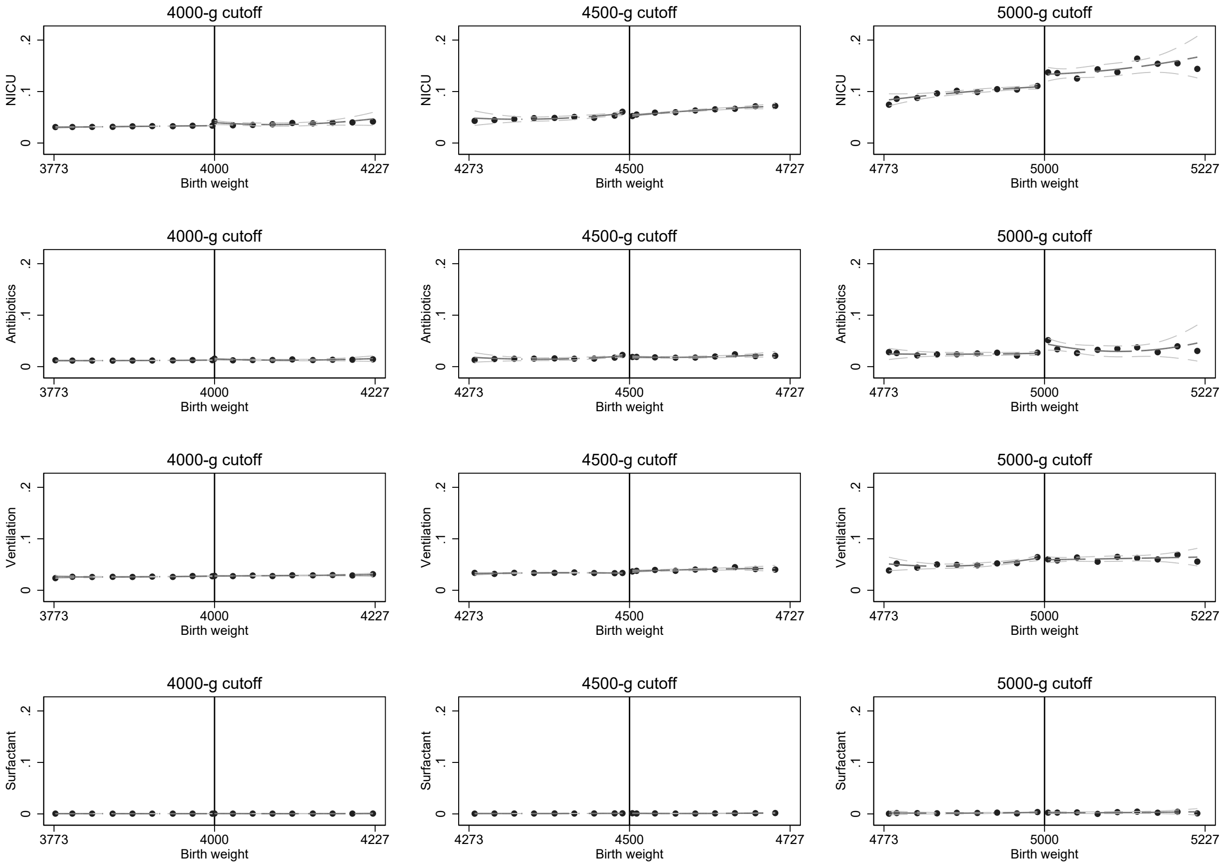
While the medical evidence supports the idea of a differential risk associated with being born above the 4000-, 4500- or 5000-gram cutoffs, to the best of our knowledge, there are no guidelines on the specific health treatments or interventions that should be performed when a newborn's birth weight is above one of the thresholds. Thus, testing whether being born above a certain macrosomic cutoff induces changes in health treatments and, ultimately, in health outcomes, represents an empirical question that we directly address in this paper.

2.2. Treatments and health outcomes for macrosomic infants

In this section, we provide visual evidence of whether the differences in morbidity and mortality risk associated with each macrosomic category translate into changes in neonatal treatments and health outcomes, measured by mortality. More precisely, we consider the three main macrosomic cutoffs identified by the medical literature (i.e., at 4000, 4500 and 5000

Figure 1

Neonatal treatments around the macrosomic birth-weight thresholds.



Notes: The dots represent averages of the treatment indicators inside 28-gram bins, constructed by radiating from each threshold, and plotted against the median birth weight in each bin. The fit lines are quadratic polynomials fitted on each side of each macrosomic cutoff and weighted using triangular weights, using individual observations, with 95% confidence intervals. Sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from each cutoff, after dropping observations with missing information in the health treatments or mortality indicators.

grams),[4] and focus on the sample of births within 227 grams from each cutoff.[5] In the data, which we describe in greater detail in the next section, we observe whether a newborn was admitted to a NICU, received antibiotics, required assisted ventilation immediately after birth, or was given surfactant replacement therapy.[6] Importantly for our analysis, these neonatal treatments represent choices that hospital staff make after observing the actual birth weight of the child.

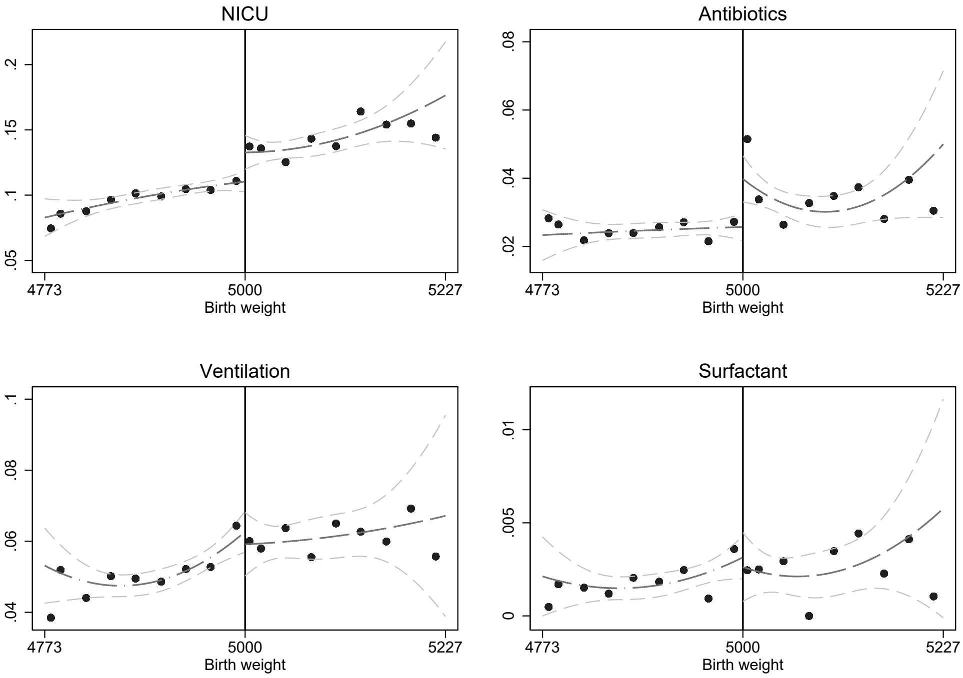
[4]In principle, we could also consider all three cutoffs – 4000 grams, 4500 grams and 5000 grams – together. However, given the medical evidence that infants above 4000, 4500 and 5000 grams face different probabilities of morbidity and mortality, we expect health practitioners to behave differently depending on whether a newborn crosses the lowest or the highest macrosomic cutoff. The results from an analysis with all the three cutoffs stacked together show no effects of being above a macrosomic cutoff on health treatments or mortality, confirming that pooling the cutoffs together hide the heterogeneity across cutoffs that we document in the paper. Results from this analysis are available upon request from the authors.

[5]We provide additional details on the choice of the bandwidth in Section 4.

[6]Assisted ventilation and surfactant replacement therapy are treatments to address respiratory distress.

Figure 2

Neonatal treatments around the 5000-gram threshold.



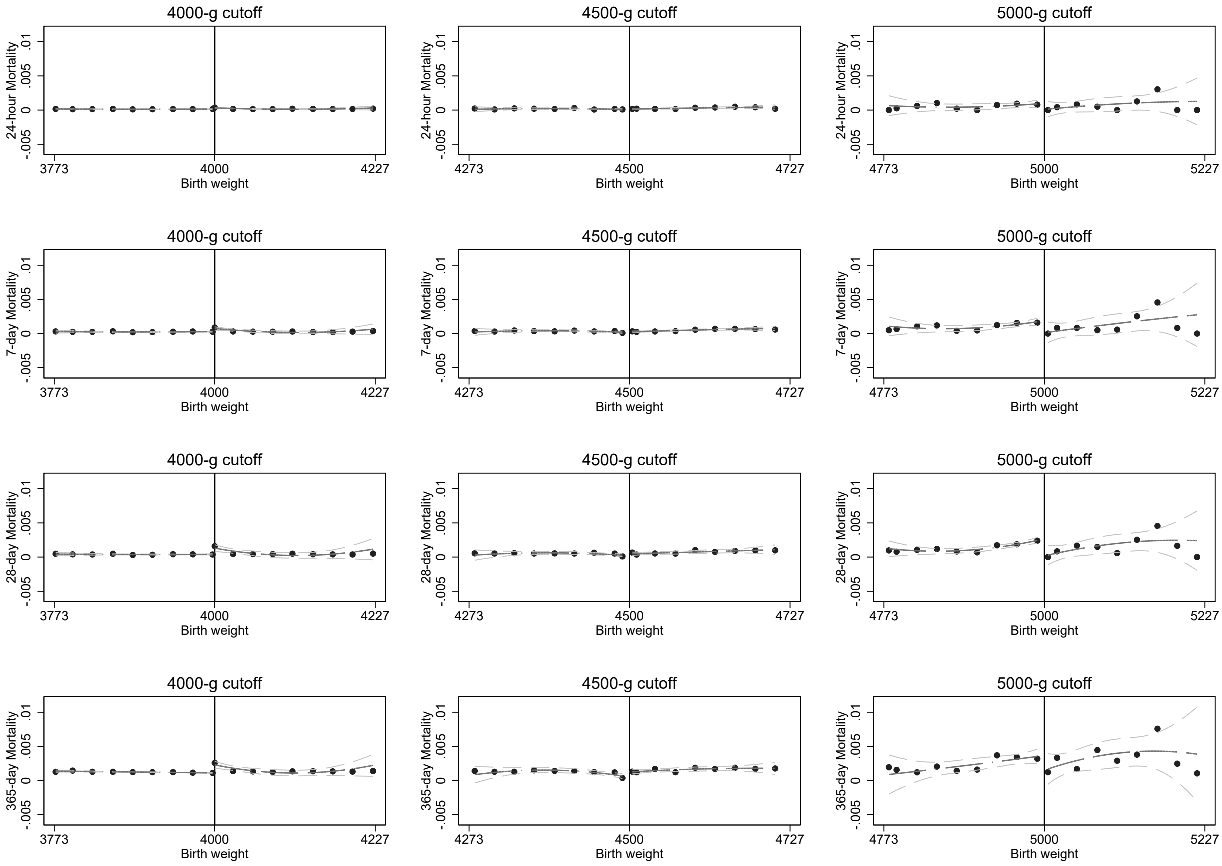
Notes: The dots represent averages of the treatment indicators inside 28-gram bins, constructed by radiating from the threshold, and plotted against the median birth weight in each bin. The fit lines are quadratic polynomials fitted on each side of the macrosomic cutoff at 5000 grams and weighted using triangular weights, using individual observations, with 95% confidence intervals. We use a sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from the 5000-gram cutoff, after dropping observations with missing information in the health treatments or mortality indicators.

Figure 1 reports the patterns of these health treatment indicators at each macrosomic cutoff. The figure suggests that there are no changes in health treatments at the 4000- and 4500-gram cutoffs, but there is an increase in the probability of being admitted to a NICU and in the receipt of antibiotics at the 5000-gram threshold. Figure 2 zooms in on the patterns in health treatments around the 5000-gram cutoff: the probability of being admitted to a NICU increases from almost 12% for newborns whose birth weight is just below 5000 grams to almost 14% for those with a birth weight just above 5000 grams, while receipt of antibiotics for suspected sepsis also shows a sizable jump from about 3% below the cutoff to about 5% above the cutoff. Figure 2 does not show meaningful discontinuities in treatments associated with respiratory distress (ventilation and surfactant) around the 5000-gram cutoff.

We now consider whether infants above a certain macrosomic threshold have different health outcomes, by looking at mortality indicators at 24 hours, 7 days, 28 days and one year. Figure 3 shows that there is no apparent change in mortality at the 4000- and 4500-gram thresholds, while there is a noticeable reduction at the 5000-gram threshold. The visual evidence around the 5000-gram cutoff provided by Figure 4 confirms that there is a sizable discontinuous drop

Figure 3

Mortality around the macrosomic birth-weight thresholds.

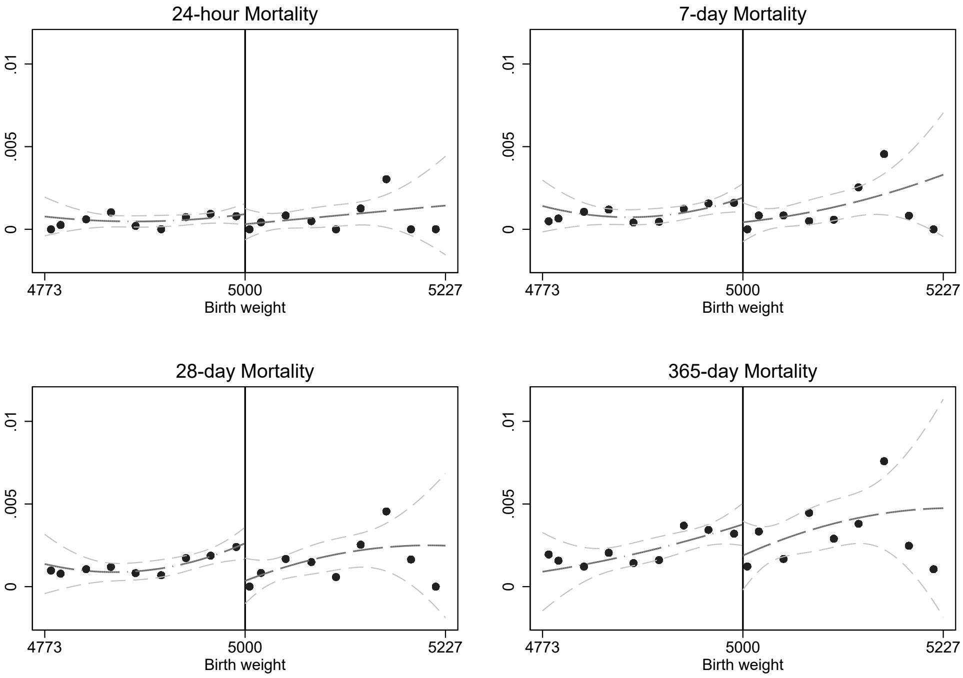


Notes: The dots represent averages of the mortality indicators inside 28-gram bins, constructed by radiating from each threshold, and plotted against the median birth weight in each bin. The fit lines are quadratic polynomials fitted on each side of each macrosomic cutoff and weighted using triangular weights, using individual observations, with 95% confidence intervals. Sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from each cutoff, after dropping observations with missing information in the health treatments or mortality indicators.

in the risk of death as birth weight crosses the 5000-gram cutoff from below, and shows that the drop in mortality risk is largest in the first 28 days.

Summing up, this descriptive analysis suggests that there may be changes in treatments and mortality at the 5000-gram cutoff, but not at the others. Since the most dire health risks are associated with newborns born above 5000 grams, practitioners may be most sensitive at the 5000-gram cutoff when considering additional health treatments for macrosomic babies, and this is what is suggested by patterns we observe in the data. For this reason, we focus our baseline analysis on the 5000-gram birth weight cutoff but, in Section 6, we formally test for differences in health treatments and mortality at other macrosomic cutoffs.

Figure 4
Mortality around the 5000-gram threshold.



Notes: The dots represent averages of the mortality indicators inside 28-gram bins, constructed by radiating from the threshold, and plotted against the median birth weight in each bin. The fit lines are quadratic polynomials fitted on each side of the macrosomic cutoff at 5000 grams and weighted using triangular weights, using individual observations, with 95% confidence intervals. We use a sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from the 5000-gram cutoff, after dropping observations with missing information in the health treatments or mortality indicators.

3. Data

Data for this study were obtained from the 2007-2013 Birth Cohort Linked Birth-Infant Death Files.[7] These files are compiled by the U.S. National Center for Health Statistics, based on information provided by U.S. states under the Vital Statistics Cooperative Program. Our data set includes information from the birth certificate and, if the infant died before the first birthday, information from the death certificate. The birth certificate provides information on the child's and the mother's demographic characteristics, the child's health conditions at birth, information on maternal behavior during pregnancy, and the method of delivery. Critical for our analysis, starting in 2007, the birth certificate includes information on the health treatments received by the newborn in the delivery hospital and, for this reason, we focus on the latest available years of data, i.e., from 2007 to 2013.[8] The death certificate, if applicable, reports the

[7]This data set contains information on deaths of all infants born in a given calendar year, linked to their corresponding birth certificates, whether the death occurred in the same calendar year or the year after.

[8]We cannot observe if, after delivery, the child was discharged from the hospital and transferred to another clinic where he or she received additional health treatments.

age of death. We construct four measures of infant mortality, according to whether the child died within 24 hours, 7 days, 28 days, or 1 year after birth.

For the main analysis we use observations within 227 grams from the cutoff, corresponding to 8 ounces. Studies focusing on the 1500-gram cutoff used bandwidths that range from 85 grams to 200 grams (Almond et al., 2010, Bharadwaj et al., 2013, Breining et al., 2015). The bandwidth we use in the analysis is wider, given the smaller number of births around the larger cutoff value under investigation here.[9] We also restrict our analysis to singleton births, which represent about 99 percent of the sample of macrosomic newborns, and observations without missing information on birth weight, health treatments, and mortality indicators. The final analysis sample consists of 55,581 observations.[10]

Table 1

Descriptive statistics for the sample around the 5000-gram threshold.

	All sample				Below 5000 g	Above 5000 g
	Mean	SD	Min	Max	Mean	Mean
Birth weight $\geq$ 5000 grams	0.2591	(0.4382)	0	1		
NICU	0.1073	(0.3095)	0	1	0.0951	0.1423
Antibiotics	0.0271	(0.1623)	0	1	0.0248	0.0337
Ventilation	0.0528	(0.2237)	0	1	0.0500	0.0610
Surfactant	0.0019	(0.0440)	0	1	0.0017	0.0026
24-hour Mortality	0.0006	(0.0236)	0	1	0.0005	0.0007
7-day Mortality	0.0010	(0.0314)	0	1	0.0009	0.0012
28-day Mortality	0.0013	(0.0355)	0	1	0.0012	0.0015
365-day Mortality	0.0024	(0.0485)	0	1	0.0020	0.0033
N		55581			41178	14403

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the above variables.

Table 1 reports the descriptive statistics for the main variables of the analysis, while Table A.3 in the Appendix reports the descriptive statistics for the covariates. Table 1 indicates that 26% of observations lie to the right of the 5000-gram cutoff. The most frequently used treatment for these newborns is admission to a NICU, which occurs for 10.7% of the infants. About 3% of infants in the sample received antibiotics for suspected sepsis, while 5% required assisted ventilation; the use of surfactant therapy occurred only in 0.2% of the cases. The

[9]However, as we discuss below, our main results and conclusions hold when the bandwidth is decreased or increased in both parametric and non-parametric regressions.

[10]By focusing on singleton births and infants for which we have birth weight, health treatments and mortality information, we exclude 25% of observations. In Table A.2 in the Appendix, we show that these characteristics (i.e., multiple births and missing information) do not change discontinuously at the cutoff.

frequency of all treatments increases for the newborns with a birth weight above 5000 grams. Mortality rates are quite low in this sample: they range from 0.06% for 24-hour mortality to 0.24% for 1-year mortality. To give an idea of the size of these values, consider that the rate of 24-hour and 1-year mortality in our sample was 141 and 594 deaths per 10 million macrosomic (≥4000-gram) births over the 2007-2013 period, respectively.

4. Empirical strategy

In order to identify the effect of having a birth weight above a certain macrosomic threshold on both health treatments and infant mortality, we adopt a regression discontinuity (RD) design. We specify the following parametric regression:

$$y_i = \beta + \gamma I[bw_i \geq \bar{bw}] + f(bw_i - \bar{bw}) + \epsilon_i \tag{1}$$

where γ captures the effect of being above a macrosomic cutoff. In the baseline analysis we consider the highest diagnostic threshold for macrosomia identified in the medical literature, i.e. $\bar{bw} = 5000$, while in Section 6 we also examine other cutoffs. The term $f(bw_i - \bar{bw})$ is a polynomial in the distance from the cutoff; in the analysis, we control for separate linear or quadratic trends in the running variable on each side of the 5000-gram cutoff, thus allowing the slopes to differ on either side of the cutoff.[11]

Equation 1 is estimated by weighted OLS, using the sample of newborns within a birth-weight window of 227 grams. By choosing a relatively large bandwidth, we have prioritized precision over bias because of the relatively small number of observations in the 5000-gram sample. However, we also test the sensitivity of the results to the bandwidth size by using smaller bandwidths. This analysis results in less bias in the estimates, but also in less statistical power due to the smaller sample sizes. All the parametric regressions use a triangular weight, which is decreasing in the distance from the cutoff, so observations near the cutoff receive higher weight than do observations farther from the cutoff. Following Lee and Card (2008), given that our running variable, birth weight, is discretized due to rounding, our standard errors are clustered at the gram level of birth weight in all specifications.[12]

We consider a variety of outcome variables, which are represented by y_i in equation (1).

[11] Following Gelman and Imbens (2019), we report results from parametric regressions with linear and quadratic polynomials (but not higher-order polynomials) and complement this analysis with results from non-parametric regressions.

[12] However, as shown below, our results and conclusions hold if we do not cluster the standard errors at the gram level of birth weight.

For the analysis of health treatments, we focus on whether the newborn (i) was admitted to a NICU, which likely captures a deployment of one or more specific treatments, (ii) received antibiotics for suspected sepsis, (iii) required assisted ventilation, or (iv) was given surfactant replacement therapy. We also consider mortality at 24 hours, 7 days, 28 days, and 1 year. The analysis of the various health treatments represents our first-stage analysis, which helps to understand the channels that may drive any effect on infant mortality. However, we interpret the effects on mortality as the intention-to-treat effect of the additional medical care provided to EHBW infants because other treatments that we cannot observe, given either within the NICU or in another department, may also change when crossing the 5000-gram threshold from below.

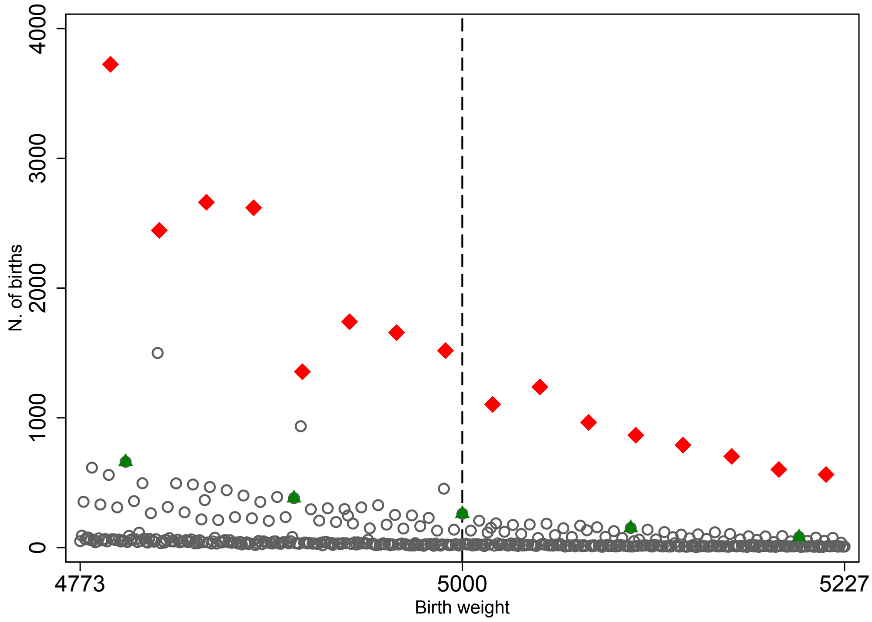
4.1. Tests for the identifying assumptions

In this section, we discuss whether the assumptions required for the RD framework to identify the effect of having a birth weight above 5000 grams are met in our setting. First, as is satisfied in our setting with birth weight, there must be a continuous measure of health risk that is observed by health practitioners. Second, identification relies on the assumption that a diagnostic threshold generates a discontinuity in medical care receipt. The fulfillment of this assumption is demonstrated in Figure 2, which shows that NICU admission and antibiotics receipt rates behave in a discontinuous fashion around the 5000-gram cutoff.

Third, there should not be heaping of observations at the cutoff point. While manipulation of birth weight is very unlikely to occur – given the difficulty in estimating fetal weight – it might be the case that newborns are over-represented at certain birth weight values because of rounding by hospital staff. Figure 5 reports the frequency of births in the sample centered at the 5000-gram cutoff: the figure shows the number of births per gram (circles), the number of births at ounce multiples (diamonds), and the number of births at 100-gram multiples (triangles). We observe peaks at ounce and 100-gram multiples, but we do not observe systematically different heaps around the 5000-gram threshold of interest. We formally test for the existence of a discontinuity in the number of births at the cutoff value in two ways. We first follow Almond et al. (2010) and Bharadwaj et al. (2013) and collapse the data at the gram level and test in a framework similar to equation (1) whether more or fewer births are reported just above the cutoff compared to just below the cutoff. The coefficient (std. error) associated with the 5000-gram cutoff dummy is -5.14 (54.38) when using a linear-trends specification, and -21.8 (78.22) when using a quadratic-trends specification. Next, since our running variable – birth weight – is discrete, we perform the test for the smoothness of a discrete running variable proposed

Figure 5

Frequency of births around the 5000-gram threshold

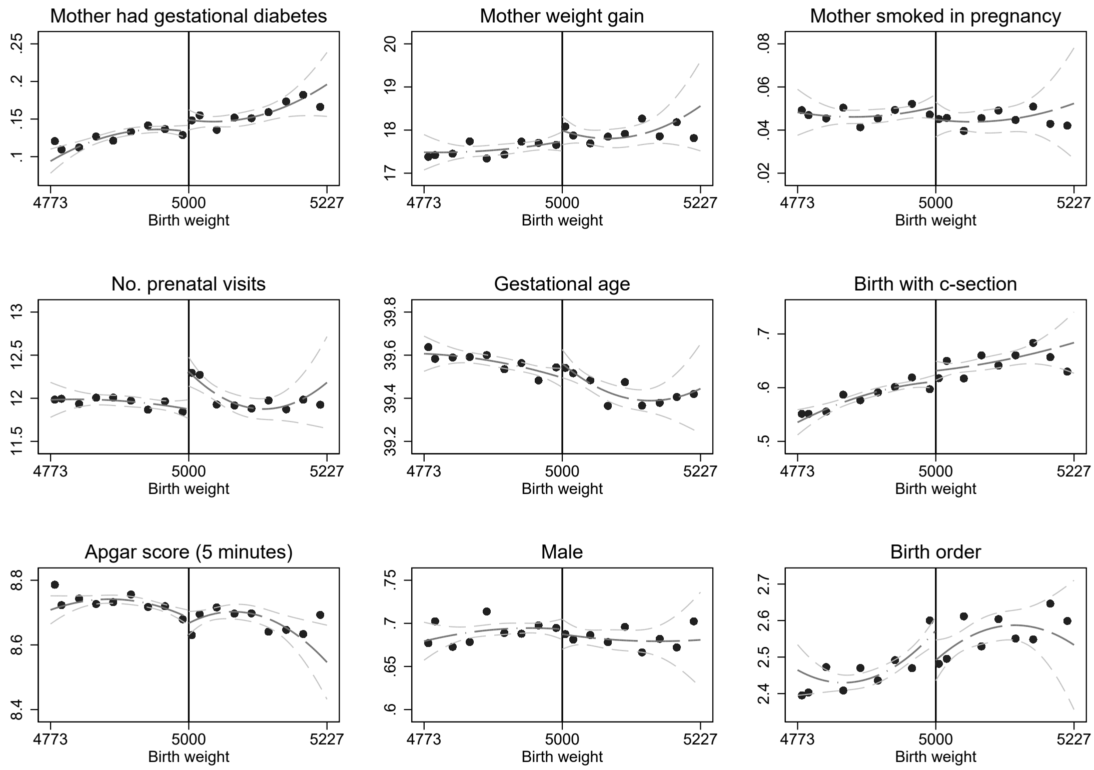


Notes: The circles represent the number of births per gram; the diamonds indicate the number of births at ounce multiples; the triangles indicate the values corresponding to 100-gram multiples. Sample of U.S. singleton births in 2007-2013 with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1.

by Frandsen (2017). When using the whole sample the test rejects the null hypothesis of no heaping in the running variable (p-value= 0.000), but when we drop observations at the cutoff value, the null is not rejected (p-value= 0.776). Given these mixed results, we always present estimates from the entire sample, from the sample where observations at the cutoff have been dropped (*Donut* specification), and from the sample where observations within 1 gram from the cutoff have been excluded (*Donut1* specification).

Four, identification relies on the assumption that other observable pre-determined characteristics of the infant and the mother are continuous across the threshold (Imbens and Lemieux, 2008, Lee and Lemieux, 2010). In the data, we have access to a set of variables about the pregnancy (whether the mother was diagnosed gestational diabetes, her weight gain, her smoking behavior, the number of prenatal visits), the birth (gestational age, whether the birth occurred through c-section) and the infant (APGAR score, gender and birth order). Regarding the mother, we have access to basic demographic characteristics, such as age at birth, level of education, marital status and race, as well as information on whether she has diabetes and whether she has had a c-section in a previous delivery. Figures 6 and 7 report the distribution of clinical and demographic factors around the 5000-gram threshold, while Tables A.4 and A.5 in the Appendix formally test for significant changes at the cutoff, by using these variables as

Figure 6
Distribution of covariates around the 5000-gram threshold: birth and pregnancy characteristics.



Notes: The dots represent averages of the treatment indicators inside 28-gram bins, constructed by radiating from the threshold, and plotted against the median birth weight in each bin. The fit lines are quadratic polynomials fitted on each side of the macrosomic cutoff at 5000 grams and weighted using triangular weights, using individual observations, with 95% confidence intervals. We use a sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from the 5000-gram cutoff, after dropping observations with missing information in the variables listed in Table 1.

outcomes in a framework similar to Equation (1).[13]

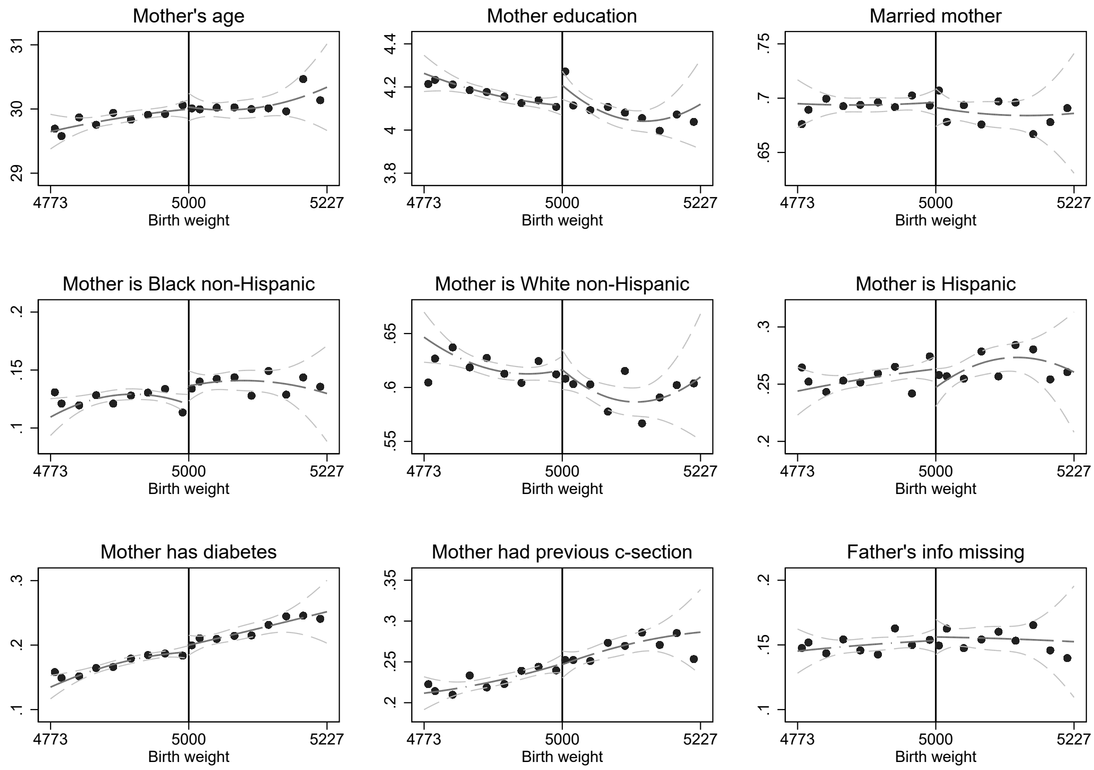
The results show that there are no significant changes at the 5000-gram cutoff for the mother's characteristics, but that some variables associated with the pregnancy and the infant (number of prenatal visits, gestational diabetes, child's gender and birth order) show significant changes at the cutoff, even though the estimates tend not to be statistically significant in all specifications and the effect sizes tend to be small in magnitude.[14] For example, for prenatal visits, the variable showing the most robust statistically significant discontinuity among the

[13]The variables included in Figures 6 and 7 have been chosen in such a way that the main determinants of macrosomia, as described in Section 2.1, are taken into account. As mentioned in Section 2.1, a c-section is often performed for the delivery of macrosomic infants, either because it was previously planned or because it was made necessary in emergency after labor complications. Since the data do not provide information on whether a c-section was planned or not, we used available information on trial of labor to generate a measure of "emergency c-section" – as defined by a c-section that was preceded by trial of labor – and tested and confirmed that this measure is continuous at the cutoff. The results are reported in Appendix Table A.6.

[14]In robustness checks below, we further investigate the implications of these changes in pre-determined characteristics across the 5000-gram cutoff.

Figure 7

Distribution of covariates around the 5000-gram threshold: mother's characteristics.



Notes: The dots represent averages of the treatment indicators inside 28-gram bins, constructed by radiating from the threshold, and plotted against the median birth weight in each bin. The fit lines are quadratic polynomials fitted on each side of the macrosomic cutoff at 5000 grams and weighted using triangular weights, using individual observations, with 95% confidence intervals. We use a sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from the 5000-gram cutoff, after dropping observations with missing information in the variables listed in Table 1.

checks for continuity in pre-determined variables, the largest estimate shown in Column (5) of Table A.4 implies that the increase in the number of prenatal visits associated with being born with an EHBW corresponds to less than 5% of the average number of prenatal visits for infants below 5000 grams of birth weight. A comparison of the coefficients in Tables A.4 and A.5 to sample means shown in Table A.3 shows that most of the other effect sizes are even smaller.

A potential concern is that differences in income (and provider quality) across the cutoff could potentially lead to a larger number of prenatal visits and higher likelihood of diagnosis of gestational diabetes. Our data do not provide information on the mother's or family's income, but following Choi and Lee (2019) we include among the covariates an indicator for having missing information on the newborn's father (age and race): as the authors state, the lack of availability of father's information "represents resources or income, because it is likely to be only those mothers at the bottom of socioeconomic scale who cannot provide information on [the] father."[15] Reassuringly, while about 15% of the sample is missing information on the father, we find small and insignificant changes in this proxy variable for income across the cutoff (see Figure 7). We perform an additional check along the income channel by using information on whether the delivery payment was covered by public insurance. This variable is available only from 2011 onward, thus the sample used for the analysis is significantly reduced. The results from this additional analysis are reported in Table A.6 and while about 40% of this sub-sample's delivery was paid for by public insurance, we find small and insignificant changes across the cutoff.

Even though the analysis involving birth order reported in Table A.4 shows a marginally significant change in only one specification, it raises the question of whether a macrosomic birth impacts subsequent fertility decisions of the mother. We cannot directly test for this in our data because they do not provide longitudinal information on the same mother. We thus perform a supplementary analysis of data from the National Longitudinal Survey of Youth (NLSY), focusing on all women of the 1979 NLSY cohort who have had at least 1 child as of the year 2014. More precisely, we regress the probability of having a second child and the spacing (in months) between the first and the second child on (i) a dummy indicating whether the mother had a macrosomic (i.e., with birth weight $\geq$ 4000 grams) first-born, or (ii) three dummies indicating whether the mother's first born weighed more than 4000, 4500 and 5000 grams. The results do not support the notion that a macrosomic birth affects the likelihood of having a subsequent birth or the spacing between births.[16]

Finally, in order to estimate the effects of being EHBW, there should not be other policy changes at the 5000-gram threshold. One important concern relates to birth-weight categories being linked to the reimbursement that hospitals receive for treatments in strictly defined diagnosis related groups (DRGs). Previous research indicates that there is an incentive to

[15]Indeed, in our data, we observe that mothers who cannot provide information on the father are less likely to have a college education (the correlation is -0.2213, p-value=0.000), less likely to be married (corr=-0.3731, p-value=0.000) and more likely to use public insurance as a source of payment for the delivery (corr=0.2350, p-value=0.000).

[16]In the NLSY estimation sample, which includes 4,300 observations, about 78.5% of mothers had a second child and the average distance between the first and the second child is 60.57 months. For the analysis involving the probability of having a second child as a dependent variable, the coefficient (std. error) associated with the dummy for having a macrosomic first birth (overall) is 0.006 (0.029), while the coefficient (std. error) associated with the dummies for having a first birth above 4000, 4500 and 5000 grams are 0.007 (0.031), 0.024 (0.066) and -0.251 (0.300), respectively. When birth spacing is the dependent variable, the coefficient (std. error) associated with the dummy for having a macrosomic first birth (overall) is -2.457 (3.099), while the coefficient (std. error) associated with the dummies for having a first birth above 4000, 4500 and 5000 grams are -3.245 (3.075), 2.310 (10.655) and -9.811 (29.602), respectively. Our results and conclusions are similar if we condition on a set of pre-determined characteristics at birth (e.g. a mother's age, a mother's education, and family income) and are available upon request from the authors.

manipulate birth weight at the low end of the birth weight distribution because modification of admission weights can affect reimbursement (Abler et al. (2011), Jurges and Koberlein (2015) and Reif et al. (2018)). However, to the best of our knowledge, the same phenomenon has not been documented for birth weight thresholds at the upper part of the birth weight distribution, and thus we expect that provider incentives to manipulate birth weight in the macrosomic population are more limited than in the LBW population.[17]

5. Results

The results from the baseline analysis, where we consider observations in a bandwidth of 227 grams centered at the 5000-gram threshold, are presented in Table 2. Columns (1), (3) and (5) report regressions where we control for linear trends in the running variable; Columns (2), (4) and (6) report regressions where we control for quadratic trends. The table reports results from an analysis conducted on the whole sample, on the sample where we drop observations with a birth weight equal to the cutoff (*Donut*), and on the sample where we drop observations with a birth weight between 4999 and 5001 grams (*Donut1*). All regressions use a triangular weight that prioritizes observations near the cutoff, and cluster standard errors at the gram level of birth weight.[18]

Panel A reports the estimated effect of being EHBW on the probability of being admitted to a NICU. Confirming the discontinuity that we observe in Figure 2, we find a large positive and statistically significant effect. The estimate in Column (1) indicates that the probability of being admitted to a NICU is about 1.8 percentage points higher for EHBW newborns, which corresponds to 19% of the average NICU admission rate below the 5000-gram cutoff (9.5%). Of note is that the coefficients are quite stable across the different specifications. Also consistent with the visual evidence in Figure 2, Column (1) of Panel B shows that we estimate an EHBW outcome to raise the likelihood of antibiotics receipt by about 1 percentage point or 40% of the mean below 5000 grams (2.5%). Finally, Panels C and D of the table confirm that there is not a similar effect on respiratory distress-related treatments, namely assisted ventilation and the use of surfactant therapy, as was suggested by the descriptive evidence presented in Figure 2.

The infant mortality results are reported in Panels E to H of Table 2. We find a large

[17] For instance, in the US, six birth weight ranges that represent distinct demands on hospital resources are used in assigning neonatal DRGs: $< 750g$, $750 - 999g$, $1000 - 1499g$, $1500 - 1999g$, $2000 - 2499g$, and $> 2499g$ (3MHIS, 2003). Importantly, there are no DRGs tied to birth weight thresholds above 2500g, let alone in the macrosomic patient population.

[18] We also perform the baseline analysis without clustering the standard errors at the gram level of birth weight. Results are reported in Table A.7 in the Appendix and are similar to those from the baseline analysis.

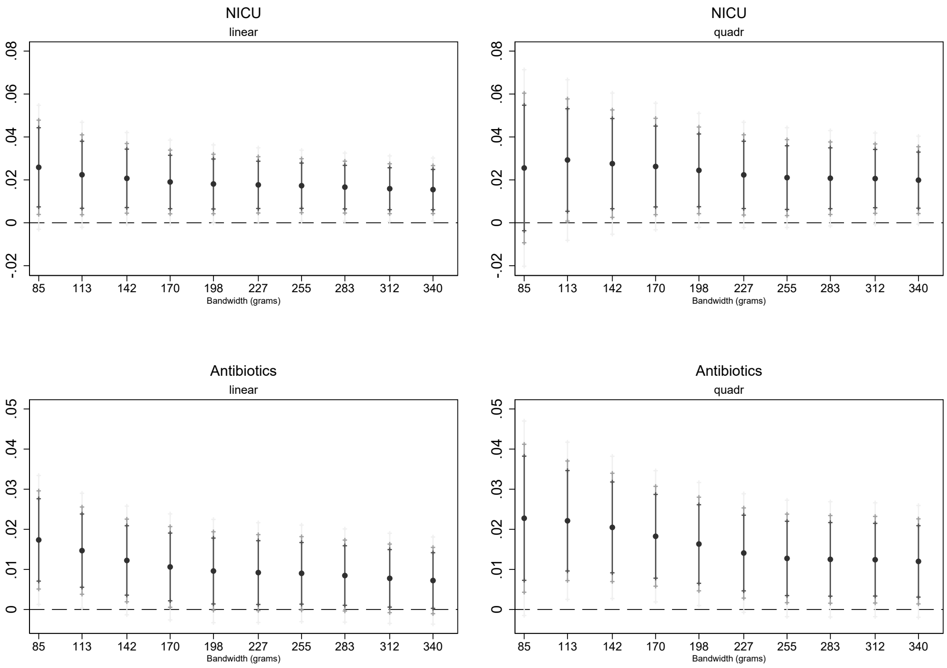
Table 2
Parametric estimations of the effect of being EHBW on health treatments and mortality.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. NICU						
Birth weight ≥ 5000 g	0.0177***	0.0223**	0.0151**	0.0175*	0.0154**	0.0182**
	(0.0067)	(0.0095)	(0.0064)	(0.0090)	(0.0063)	(0.0089)
Panel B. Antibiotics						
Birth weight ≥ 5000 g	0.0092*	0.0141**	0.0089*	0.0144**	0.0083	0.0131**
	(0.0048)	(0.0057)	(0.0052)	(0.0068)	(0.0050)	(0.0065)
Panel C. Ventilation						
Birth weight ≥ 5000 g	0.0007	-0.0036	-0.0006	-0.0063	-0.0008	-0.0068
	(0.0052)	(0.0071)	(0.0053)	(0.0072)	(0.0053)	(0.0072)
Panel D. Surfactant						
Birth weight ≥ 5000 g	-0.0006	-0.0005	-0.0004	-0.0000	-0.0002	0.0004
	(0.0010)	(0.0015)	(0.0010)	(0.0017)	(0.0010)	(0.0016)
Panel E. 24-hour Mortality						
Birth weight ≥ 5000 g	-0.0004	-0.0006	-0.0004	-0.0005	-0.0004	-0.0005
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Panel F. 7-day Mortality						
Birth weight ≥ 5000 g	-0.0012**	-0.0015**	-0.0012**	-0.0014**	-0.0012**	-0.0014**
	(0.0005)	(0.0006)	(0.0005)	(0.0007)	(0.0005)	(0.0007)
Panel G. 28-day Mortality						
Birth weight ≥ 5000 g	-0.0016***	-0.0023***	-0.0015***	-0.0022***	-0.0015***	-0.0022***
	(0.0005)	(0.0007)	(0.0005)	(0.0007)	(0.0005)	(0.0007)
Panel H. 365-day Mortality						
Birth weight ≥ 5000 g	-0.0016*	-0.0019	-0.0017*	-0.0023	-0.0017*	-0.0023
	(0.0009)	(0.0014)	(0.0010)	(0.0015)	(0.0010)	(0.0015)
N	55581	55581	55320	55320	55268	55268
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Whole sample	✓	✓				
Donut			✓	✓		
Donut1					✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 5000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1. The specification *Donut* indicates that observations with birth weight equal to the cutoff have been dropped from the sample, while the specification *Donut1* indicates that also observations with birth weight within +/-1 gram from the cutoff have been excluded. Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

negative effect of being above 5000 grams on mortality measures at 7 and 28 days. The coefficient estimates in Column (1), Panels F and G, suggest that being born with an EHBW lowers the risk of 7-day mortality by 0.12 percentage points, and of 28-day mortality by 0.16 percentage points. These effects are substantial: they correspond to about 130% relative to the mean 7-day and 28-day mortality rate among newborns with a birth weight below 5000 grams. However, these estimates have relatively wide confidence intervals due to small sample size, which limits our ability to precisely estimate the effect on a rare outcome such as mortality. Of note is that the confidence intervals include much smaller but still economically important effects: for instance, the lower bound of the 95-percent confidence interval indicates a 24% reduction in 7-day mortality and a 50% reduction in 28-day mortality. Finally, the results in Table 2 indicate that being born with an EHBW does not significantly impact mortality at 24 hours – which is likely due to lack of power – and also that the effect on 365-day mortality is not statistically significant across all specifications. After presenting the results from a battery of sensitivity analyses in the next section, in Section 5.2, we further investigate the persistence of the effects on the different mortality measures.

Figure 8
Parametric estimations of the effect of being EHBW on NICU admission and antibiotics, with different bandwidth size. Whole sample.



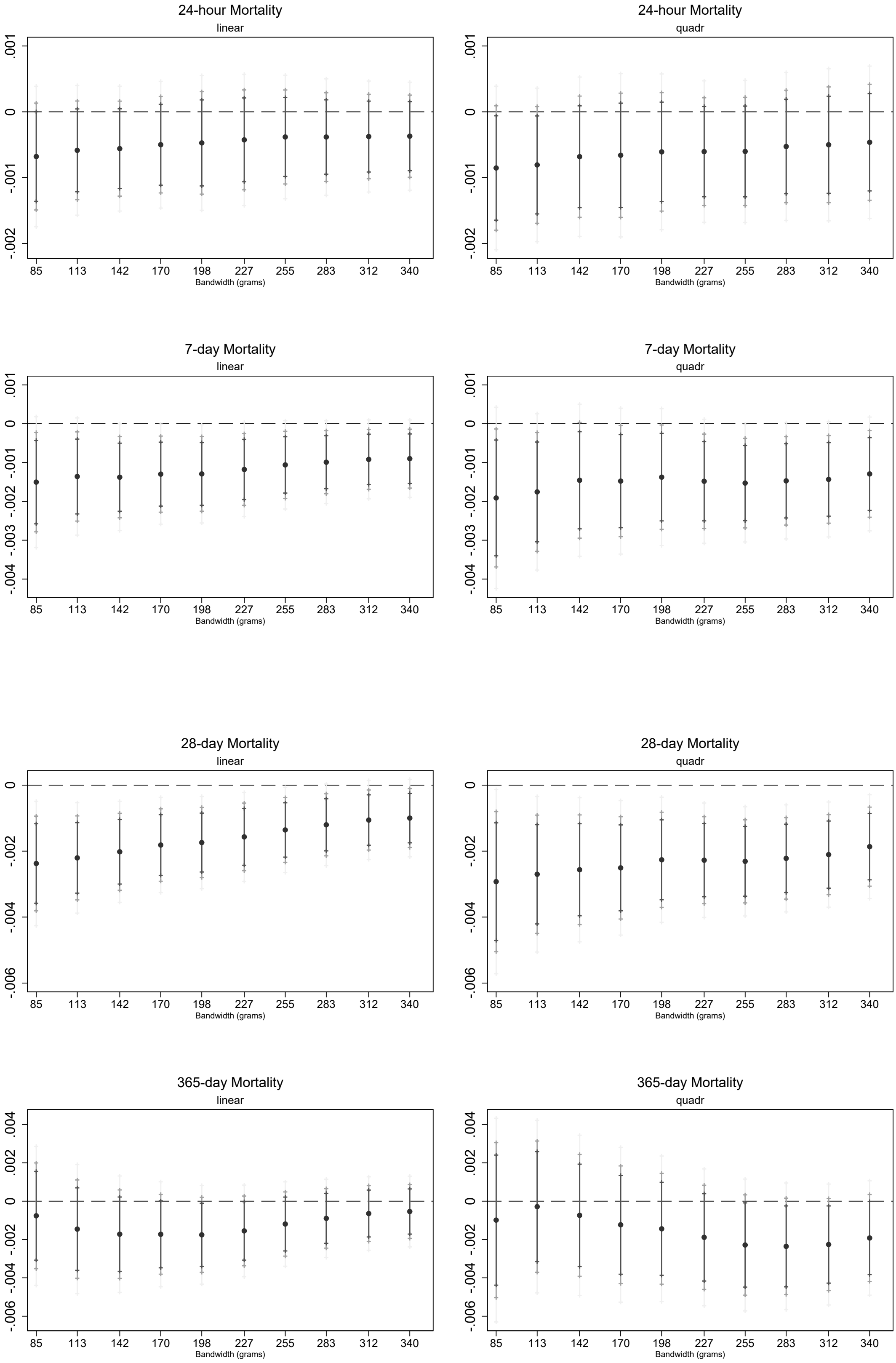
Notes: The graphs report the parametric estimates and 90%, 95% and 99% confidence intervals of the effects of being EHBW using, for each estimation, a bandwidth ranging between 85 and 340 grams. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birthweight ranging between 4773 and 5227 grams, without observations with missing information in the variables listed in Table 1.

5.1. Robustness and sensitivity checks

We test the robustness of our results along three main dimensions: (i) the size of the bandwidth, (ii) the implications of potentially confounding factors changing discontinuously at the 5000-gram threshold, and (iii) the potential bias introduced in the estimates by the heaping and decreasing trend in number of births in our macrosomic sample.

In the baseline analysis we adopt a bandwidth of 227 grams. In what follows, we repeat the baseline analysis by varying the bandwidth from 85 grams (i.e. 3 ounces) to 340 grams

Figure 9
Parametric estimations of the effect of being EHBW on mortality, with different bandwidth size. Whole sample.



Notes: The graphs report the parametric estimates and 90%, 95% and 99% confidence intervals of the effects of being EHBW using, for each estimation, a bandwidth ranging between 85 and 340 grams. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birthweight ranging between 4773 and 5227 grams, without observations with missing information in the variables listed in Table 1.

(corresponding to 12 ounces). Figure 8 reports the estimated coefficients (and 90%, 95% and 99% confidence intervals) for NICU admission and antibiotics receipt, when using linear (left panel) and quadratic trends (right panel): the figure shows that the effects of being EHBW on these treatments are very stable across the different specifications and, as expected, they become less precisely estimated when the bandwidth is narrowed. Figure A.1 in the Appendix shows the estimated coefficients for ventilation and surfactant use, which are never statistically different from zero. Figure 9 shows the estimated effects of being EHBW on all mortality indicators in samples with different bandwidth sizes. The figure confirms the estimates for 7-day and 28-day mortality, which are quite stable across specifications, although they are less precisely estimated with smaller bandwidths; the estimated coefficients for 24-hour and 365-day mortality are not statistically different from zero, for any bandwidth size.[19]

We further test the issue of bandwidth size, and also of the functional form adopted in the baseline analysis, by estimating non-parametrically the effect of weighing more than 5000 grams at birth. For the non-parametric analysis, we use again triangular weights and the optimal bandwidth computed following the procedure proposed by Calonico et al. (2014). The results are reported in Table 3 and confirm that the NICU admission and antibiotics receipt estimates hover around 2 percentage points, while the 28-day mortality estimates hover around 0.2 percentage points. The coefficients for 7-day mortality are similar in size to the ones presented in Table 2 but, due to the smaller bandwidth and sample used, not statistically significant.

We now carefully explore the implications of the significant changes in some covariates that we documented in Section 4 for our baseline results, in several ways. First, we repeat the baseline analysis by (i) controlling for the subset of covariates showing even marginally significant coefficients (birth order, number of prenatal visits, gestational diabetes, and sex), and (ii) controlling for the entire set of pre-determined covariates (i.e., all the variables listed in Table A.3). In addition, we also perform an analysis in which we condition on year fixed effects, in order to account for time-varying determinants of birth weight, medical inputs, and mortality. The results for the entire sample are reported in Table 4, while Table A.8 in the Appendix reports the results for the *Donut* sample, and Table A.9 in the Appendix reports the results for the *Donut1* sample. The results are very similar to the baseline, and confirm that being born with an EHBW leads to a higher probability of NICU admission and antibiotics

[19]Figures A.2 and A.3 in the Appendix present results for the *Donut* sample, and Figures A.4 and A.5 in the Appendix show results for the *Donut1* sample.

Table 3
Non-parametric regressions for health treatments and mortality around the 5000-gram threshold.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. NICU						
RD Estimate	0.0260**	0.0287**	0.0205*	0.0239*	0.0216*	0.0252*
	(0.0116)	(0.0133)	(0.0119)	(0.0134)	(0.0120)	(0.0134)
Bandwidth	37	92	36	95	36	93
Panel B. Antibiotics						
RD Estimate	0.0211***	0.0236**	0.0365***	0.0340***	0.0269***	0.0303***
	(0.0080)	(0.0093)	(0.0121)	(0.0122)	(0.0099)	(0.0117)
Bandwidth	22	64	18	54	20	56
Panel C. Ventilation						
RD Estimate	-0.0035	-0.0051	-0.0072	-0.0071	-0.0081	-0.0079
	(0.0066)	(0.0100)	(0.0075)	(0.0094)	(0.0077)	(0.0094)
Bandwidth	51	82	41	98	39	97
Panel D. Surfactant						
RD Estimate	-0.0003	-0.0004	0.0000	0.0004	0.0004	0.0010
	(0.0012)	(0.0017)	(0.0013)	(0.0021)	(0.0014)	(0.0020)
Bandwidth	80	157	76	137	71	137
Panel E. 24-hour Mortality						
RD Estimate	-0.0006	-0.0001	-0.0005	-0.0001	-0.0005	-0.0003
	(0.0006)	(0.0011)	(0.0006)	(0.0012)	(0.0007)	(0.0011)
Bandwidth	60	34	57	33	57	37
Panel F. 7-day Mortality						
RD Estimate	-0.0014	-0.0019	-0.0014	-0.0021	-0.0014	-0.0022
	(0.0009)	(0.0014)	(0.0011)	(0.0015)	(0.0011)	(0.0015)
Bandwidth	50	46	38	44	37	45
Panel G. 28-day Mortality						
RD Estimate	-0.0024**	-0.0029*	-0.0022**	-0.0030*	-0.0022**	-0.0032*
	(0.0011)	(0.0016)	(0.0011)	(0.0017)	(0.0011)	(0.0017)
Bandwidth	39	47	43	45	43	45
Panel H. 365-day Mortality						
RD Estimate	-0.0007	-0.0007	-0.0013	-0.0039*	-0.0012	-0.0038
	(0.0018)	(0.0025)	(0.0018)	(0.0022)	(0.0018)	(0.0023)
Bandwidth	39	56	33	44	34	44
Order Loc. Poly. (p)	0	1	0	1	0	1
Whole sample	✓	✓				
Donut			✓	✓		
Donut1					✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The table reports Robust RD estimates, generated from local linear polynomial regressions, which were obtained using a triangular kernel function and the optimal bandwidth computed following the procedure proposed by Calonico et al. (2014). The specification *Donut* indicates that observations with birth weight equal to the cutoff have been dropped from the sample, while the specification *Donut1* indicates that also observations with birth weight within +/-1 gram from the cutoff have been excluded. Sample of U.S. singleton births in 2007-2013 with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

receipt, and induces a reduction in 7-day and, especially, 28-day mortality, which is robust across all specifications.

Second, we perform an analysis in which we regress each outcome variable on all the covariates listed in Table A.3 and test in a framework similar to Equation (1) whether the predicted value of outcomes (based on the full set of pre-determined observables) changes discontinuously at the cutoff. Table 5 reports the results from this analysis and shows small and insignificant changes at the cutoff, which suggests that the baseline results are not driven by differences in

Table 4

Parametric estimations conditional on covariates and year fixed effects. Whole sample.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. NICU						
Birth weight≥ 5000 grams	0.0174**	0.0213**	0.0183***	0.0279***	0.0176***	0.0221**
	(0.0070)	(0.0106)	(0.0070)	(0.0098)	(0.0067)	(0.0095)
Panel B. Antibiotics						
Birth weight≥ 5000 grams	0.0088*	0.0131**	0.0090*	0.0141**	0.0092*	0.0141**
	(0.0047)	(0.0056)	(0.0050)	(0.0066)	(0.0048)	(0.0057)
Panel C. Ventilation						
Birth weight≥ 5000 grams	0.0014	-0.0019	-0.0005	-0.0024	0.0006	-0.0037
	(0.0058)	(0.0080)	(0.0047)	(0.0064)	(0.0052)	(0.0072)
Panel D. Surfactant						
Birth weight≥ 5000 grams	-0.0009	-0.0012	-0.0011	-0.0012	-0.0006	-0.0006
	(0.0009)	(0.0014)	(0.0011)	(0.0017)	(0.0010)	(0.0015)
Panel E. 24-hour Mortality						
Birth weight≥ 5000 grams	-0.0004	-0.0006	-0.0009*	-0.0011**	-0.0004	-0.0006
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0004)	(0.0004)
Panel F. 7-day Mortality						
Birth weight≥ 5000 grams	-0.0012**	-0.0015**	-0.0013**	-0.0015*	-0.0012**	-0.0015**
	(0.0005)	(0.0007)	(0.0006)	(0.0009)	(0.0005)	(0.0006)
Panel G. 28-day Mortality						
Birth weight≥ 5000 grams	-0.0016***	-0.0023***	-0.0019***	-0.0025**	-0.0016***	-0.0023***
	(0.0005)	(0.0007)	(0.0007)	(0.0010)	(0.0005)	(0.0007)
Panel H. 365-day Mortality						
Birth weight≥ 5000 grams	-0.0020**	-0.0025*	-0.0019**	-0.0024	-0.0015*	-0.0019
	(0.0009)	(0.0014)	(0.0010)	(0.0015)	(0.0009)	(0.0014)
N	53467	53467	45070	45070	55581	55581
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Controls						
Birth order, No. Visits, Gest. diab.	✓	✓				
All covariates			✓	✓		
Year FE					✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 5000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1. Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

pre-determined characteristics but rather by differential treatment of macrosomic newborns.

Third, since the significant changes in some covariates at the cutoff may suggest that some mothers could self-select into treatment, we also implement the bounding exercise for RD estimations proposed by Gerard et al. (2018): the test estimates the proportion of units that are always assigned to the treatment (and hence *manipulated*), and also compute the bounds of the RD estimates once this manipulation is taken into account. Gerard et al. (2018) discuss several examples of manipulation in a RD setting that may be identified through the *rdbounds* command, and some of them, such as the one that the authors label as *Manipulation through Local Selection*, may pertain to our setting: for instance, it could be the case that mothers expecting macrosomic infants self-select into better-equipped hospitals, where they know they (and the newborns) could get better treatments during the delivery and after birth. However, the analysis using the *rdbounds* package reports a zero proportion of manipulated units, and this result holds for all the outcome variables and for several bandwidth sizes. This result implies

Table 5
Parametric estimations on predicted values of the outcome variables, conditional on pre-determined covariates.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. NICU						
Birth weight $\geq$ 5000 g	0.0023	0.0014	0.0016	-0.0001	0.0016	0.0000
	(0.0026)	(0.0033)	(0.0026)	(0.0033)	(0.0026)	(0.0033)
Average of dep. var.			[0.1091]			
Panel B. Antibiotics						
Birth weight $\geq$ 5000 g	0.0006	0.0004	0.0004	-0.0000	0.0003	-0.0001
	(0.0006)	(0.0008)	(0.0006)	(0.0007)	(0.0006)	(0.0007)
Average of dep. var.			[0.0279]			
Panel C. Ventilation						
Birth weight $\geq$ 5000 g	0.0010	0.0006	0.0003	-0.0006	0.0002	-0.0008
	(0.0016)	(0.0020)	(0.0015)	(0.0018)	(0.0015)	(0.0018)
Average of dep. var.			[0.0537]			
Panel D. Surfactant						
Birth weight $\geq$ 5000 g	0.0000	-0.0000	-0.0000	-0.0001	-0.0000	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Average of dep. var.			[0.0021]			
Panel E. 24-hour Mortality						
Birth weight $\geq$ 5000 g	0.0001	0.0000	0.0000	-0.0000	0.0000	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Average of dep. var.			[0.0005]			
Panel F. 7-day Mortality						
Birth weight $\geq$ 5000 g	0.0001	0.0000	-0.0000	-0.0001	-0.0000	-0.0001
	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0001)	(0.0002)
Average of dep. var.			[0.0008]			
Panel G. 28-day Mortality						
Birth weight $\geq$ 5000 g	0.0001	0.0000	-0.0000	-0.0002	-0.0000	-0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Average of dep. var.			[0.0011]			
Panel H. 365-day Mortality						
Birth weight $\geq$ 5000 g	0.0001	0.0000	-0.0000	-0.0002	-0.0000	-0.0002
	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Average of dep. var.			[0.0021]			
N	45070	45070	44845	44845	44801	44801
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Whole sample	✓	✓				
Donut			✓	✓		
Donut1					✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The dependent variables of the regressions are the predicted values of each outcome listed in the first column, conditional on the covariates listed in Table A.3. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 5000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1. The specification *Donut* indicates that observations with birth weight equal to the cutoff have been dropped from the sample, while the specification *Donut1* indicates that also observations with birth weight within +/-1 gram from the cutoff have been excluded. Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels. The average of dependent variables are reported in square brackets.

that both the lower and the upper bounds coincide with the non-parametric RD estimates obtained without taking manipulation into account, which are similar to the ones reported in

Table 3.[20] We interpret this result as evidence that, while the type of behavior mentioned earlier (i.e., mothers of macrosomic infants choosing better hospitals) may occur in general, it is very unlikely to differ below and above the 5000-gram cutoff due to the difficulty in estimating the fetal weight before birth. In other words, even if a mother is expecting an infant with a very high fetal weight and, as a consequence, chooses a better-equipped hospital for the delivery, she may end up having a newborn weighing either more or less than 5000 grams because the fetal weight was estimated with error. This assures us that mothers and infants are potentially assigned either to the treatment (i.e., weighing more than 5000 grams) or to the control group (i.e., weighing less than 5000 grams).

Table 6
Parametric estimations conditional on number of observations per gram, ounce-multiple and 100-gram-multiple fixed effects. Whole sample.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. NICU								
Birth weight$\geq$ 5000 grams	0.0168***	0.0191**	0.0165***	0.0194**	0.0163**	0.0197**	0.0156***	0.0177**
	(0.0054)	(0.0080)	(0.0053)	(0.0077)	(0.0064)	(0.0089)	(0.0052)	(0.0074)
Panel B. Antibiotics								
Birth weight$\geq$ 5000 grams	0.0086**	0.0119**	0.0083**	0.0120**	0.0087*	0.0133**	0.0081**	0.0118**
	(0.0041)	(0.0052)	(0.0038)	(0.0049)	(0.0049)	(0.0060)	(0.0039)	(0.0051)
Panel C. Ventilation								
Birth weight$\geq$ 5000 grams	0.0013	-0.0016	0.0016	-0.0015	0.0007	-0.0035	0.0013	-0.0021
	(0.0045)	(0.0064)	(0.0046)	(0.0065)	(0.0052)	(0.0071)	(0.0045)	(0.0063)
Panel D. Surfactant								
Birth weight$\geq$ 5000 grams	-0.0006	-0.0007	-0.0006	-0.0006	-0.0004	-0.0002	-0.0005	-0.0003
	(0.0010)	(0.0015)	(0.0010)	(0.0015)	(0.0010)	(0.0015)	(0.0010)	(0.0015)
Panel E. 24-hour Mortality								
Birth weight$\geq$ 5000 grams	-0.0004	-0.0006	-0.0004	-0.0006	-0.0004	-0.0005	-0.0004	-0.0005
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Panel F. 7-day Mortality								
Birth weight$\geq$ 5000 grams	-0.0012**	-0.0015**	-0.0012**	-0.0015**	-0.0012**	-0.0015**	-0.0012**	-0.0015**
	(0.0005)	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0006)	(0.0005)	(0.0007)
Panel G. 28-day Mortality								
Birth weight$\geq$ 5000 grams	-0.0016***	-0.0023***	-0.0016***	-0.0023***	-0.0016***	-0.0023***	-0.0016***	-0.0023***
	(0.0005)	(0.0007)	(0.0005)	(0.0007)	(0.0005)	(0.0007)	(0.0005)	(0.0007)
Panel H. 365-day Mortality								
Birth weight$\geq$ 5000 grams	-0.0016*	-0.0019	-0.0016*	-0.0019	-0.0016*	-0.0020	-0.0016*	-0.0020
	(0.0009)	(0.0014)	(0.0009)	(0.0014)	(0.0009)	(0.0014)	(0.0009)	(0.0014)
N	55581	55581	55581	55581	55581	55581	55581	55581
Linear+Interactions	✓		✓		✓		✓	
Quadratic+Interactions		✓		✓		✓		✓
Controls								
No. Births per gram	✓	✓						
Ounce-multiple FE			✓	✓			✓	✓
100-g-multiple FE					✓	✓	✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 5000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations without missing information in the variables listed in Table 1. Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

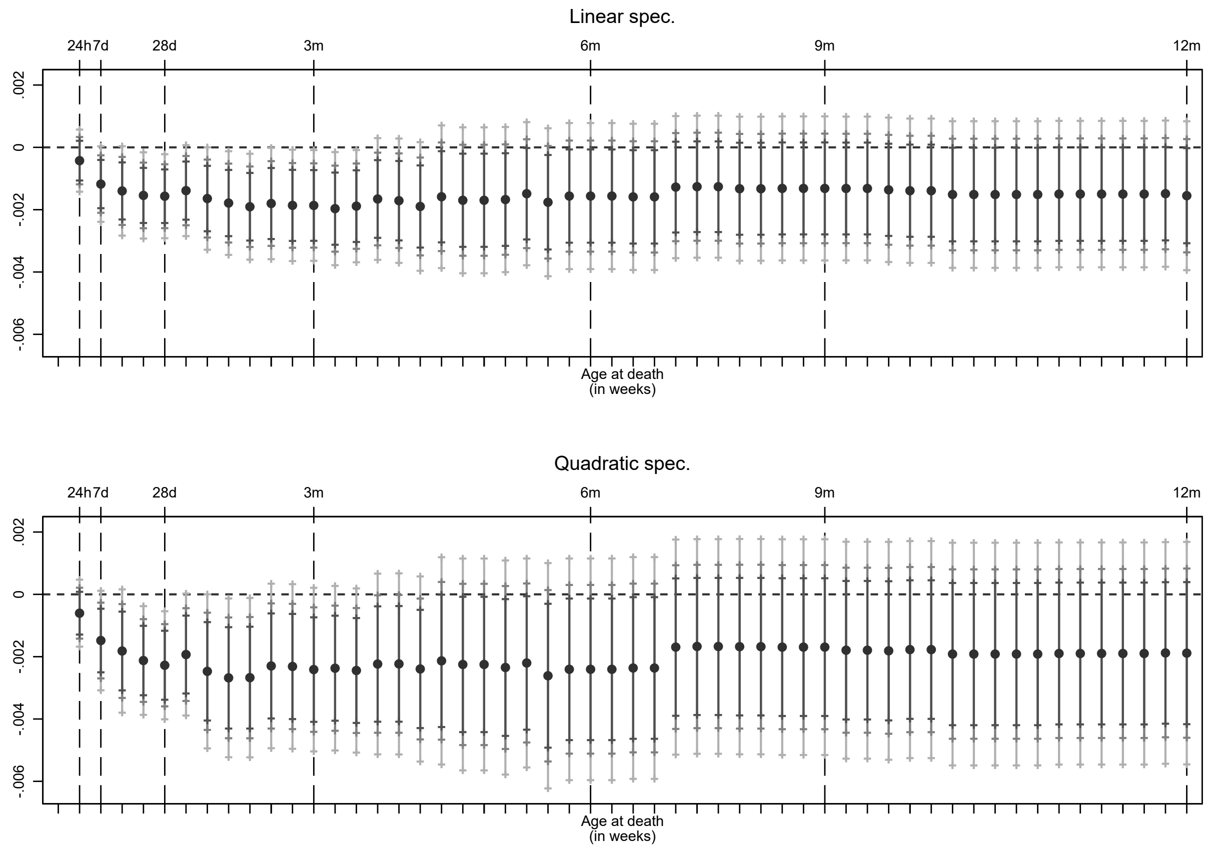
Finally, we test the sensitivity of the results to the inclusion of controls that take into account the distribution and density of observations in the macrosomic sample. Table 6 reports

[20]The detailed results are available upon request from the authors.

the results of the analysis where we control for (i) the gram-specific number of births, (ii) ounce-multiple fixed effects, (iii) 100-gram-multiple fixed effects, or (iv) both ounce- and 100-gram-multiple fixed effects, for the entire sample, while Tables A.10 and A.11 in the Appendix show the estimations in the *Donut* and *Donut1* samples, respectively. The results and conclusions do not differ from those of our baseline analysis.[21]

Figure 10

Mortality estimates by age at death. Whole sample.



Notes: The graphs report the parametric estimates and 90%, 95% and 99% confidence intervals of the effects of being EHBW on mortality indicators defined according to the week of death of the infant. All estimations control for linear (top panel) and quadratic (bottom panel) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, without observations with missing information in the variables listed in Table 1.

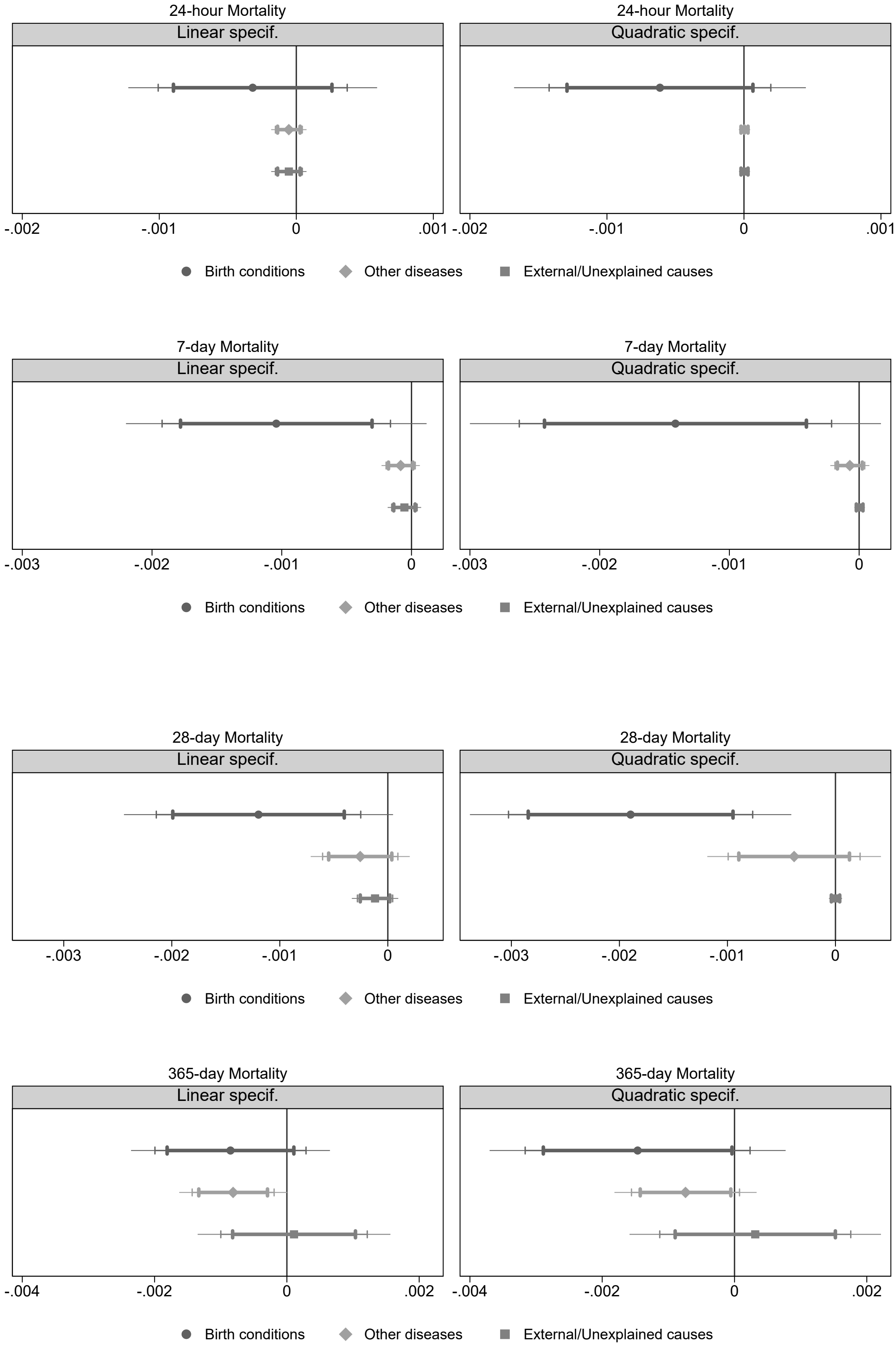
5.2. Persistence of mortality effects

In the previous sections, we have documented a mortality-reducing effect of being above the 5000-gram cutoff, plausibly due to the extra health treatments that infants above the threshold receive. More precisely, we document a reduction in mortality at 7 and 28 days, which is

[21] We also estimated a more demanding specification where we include either linear or quadratic trends in the ounce-multiple fixed effects and the 100-gram-multiple fixed effects. The results are qualitatively similar and are available upon request from the authors.

Figure 11

Parametric estimation of the effect of being EHBW on mortality, by cause of death. Whole sample.



Notes: The graph reports the coefficients associated with a variable indicating whether a newborn is EHBW, and the corresponding 99%, 95% and 90% confidence intervals. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. *Birth conditions* include perinatal and congenital causes; *Other diseases* include all causes related to diseases of the respiratory, digestive and nervous systems; *External/unexplained causes* include causes such as accidents, homicides, and SIDS. Sample of U.S. singleton births in 2007-2013 with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1.

robust across all specifications and sensitivity checks, while the effects on 24-hour and 365-day mortality are less apparent and robust. In this subsection, we further analyze the persistence of the effect on mortality, and discuss some potential explanations.

Figure 10 reports the mortality estimates using the whole sample, by age at death.[22] The figure shows that the effect is concentrated in the first three months of life of the infants, and fades out later on. This result may seem in contradiction with what studies on very LBW infants have found. For instance, Almond et al. (2010) find that the health gains associated with the additional treatments for very LBW infants are mostly realized within the first 28 days, but are present at 24 hours and linger through the first year of life. To explain the different effect on 24-hour mortality that we find, we would like to point out that, given the low mortality rate in our macrosomic sample, lack of power likely prevents us from estimating a clear 24-hour mortality effect: indeed, we find significant mortality effects at 7 days when the mortality rate is almost double the 24-hour mortality rate. Moreover, our results for 7-day and 28-day mortality are in line with recent evidence on the effects of medical treatments during and after delivery for infants born at the vicinity of 37 weeks of gestation (Daysal et al., 2019): as the sample of macrosomic infants under consideration in our study, these infants, despite being considered to pose a lower risk than very LBW infants, still face positive morbidity and mortality risks, which can be reduced by health interventions immediately after birth.

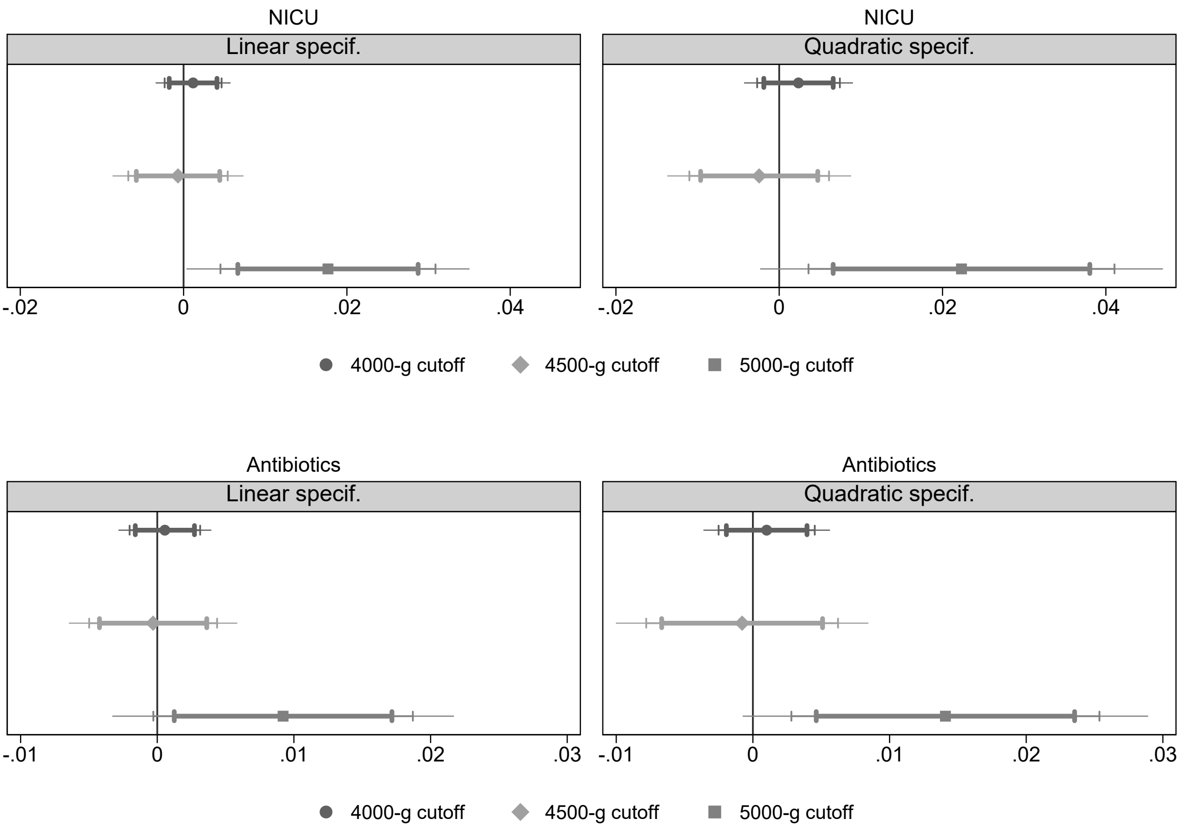
Finally, a possible reason for the lack of effects in our macrosomic sample on longer-run mortality may be due to the differences in causes of deaths at different ages of the infant.[23] Figure A.6 in Appendix reports the cumulative number of deaths, by also distinguishing between causes of death. The figure shows that most of the cases related to birth conditions, which are likely to be more responsive to changes in neonatal health treatments, occur within the first three months, and do not grow significantly after this age. On the contrary, the cases related to external or unexplained causes are almost zero for the first month and become more frequent afterward. In order to provide additional evidence on this matter, we replicate the baseline analysis by distinguishing between causes of death. Figure 11 reports the coefficients associated with an infant being EHBW on the likelihood of mortality due to birth conditions,

[22]Figures A.7 and A.8 in the Appendix report the mortality estimates by week at death for the *Donut* and *Donut1* sample, respectively.

[23]Neonatal follow-up programs for babies that have faced health complications after birth are less commonly available for EHBW babies, as follow-up clinics tend to focus on premature infants (Needelman and Jackson, 2018). This may also contribute to the lack of a mortality-reducing effect at one year that we document in the paper.

other diseases or external/unexplained causes.[24,25] The figure confirms that the 5000-gram cutoff induces a reduction in mortality only for birth-related conditions, and that the effect is statistically significant only for 7-day and 28-day mortality.

Figure 12
Parametric estimation of the effect of being HBW on NICU admission, at the macrosomic cutoffs of 4000, 4500 and 5000 grams. Whole sample.



Notes: The graph reports the coefficients associated with a variable indicating whether a newborn has high birth weight, i.e. larger than 4000, 4500 and 5000 grams, and the corresponding 99%, 95% and 90% confidence intervals. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from the corresponding threshold, after dropping observations with missing information in the variables listed in Table 1.

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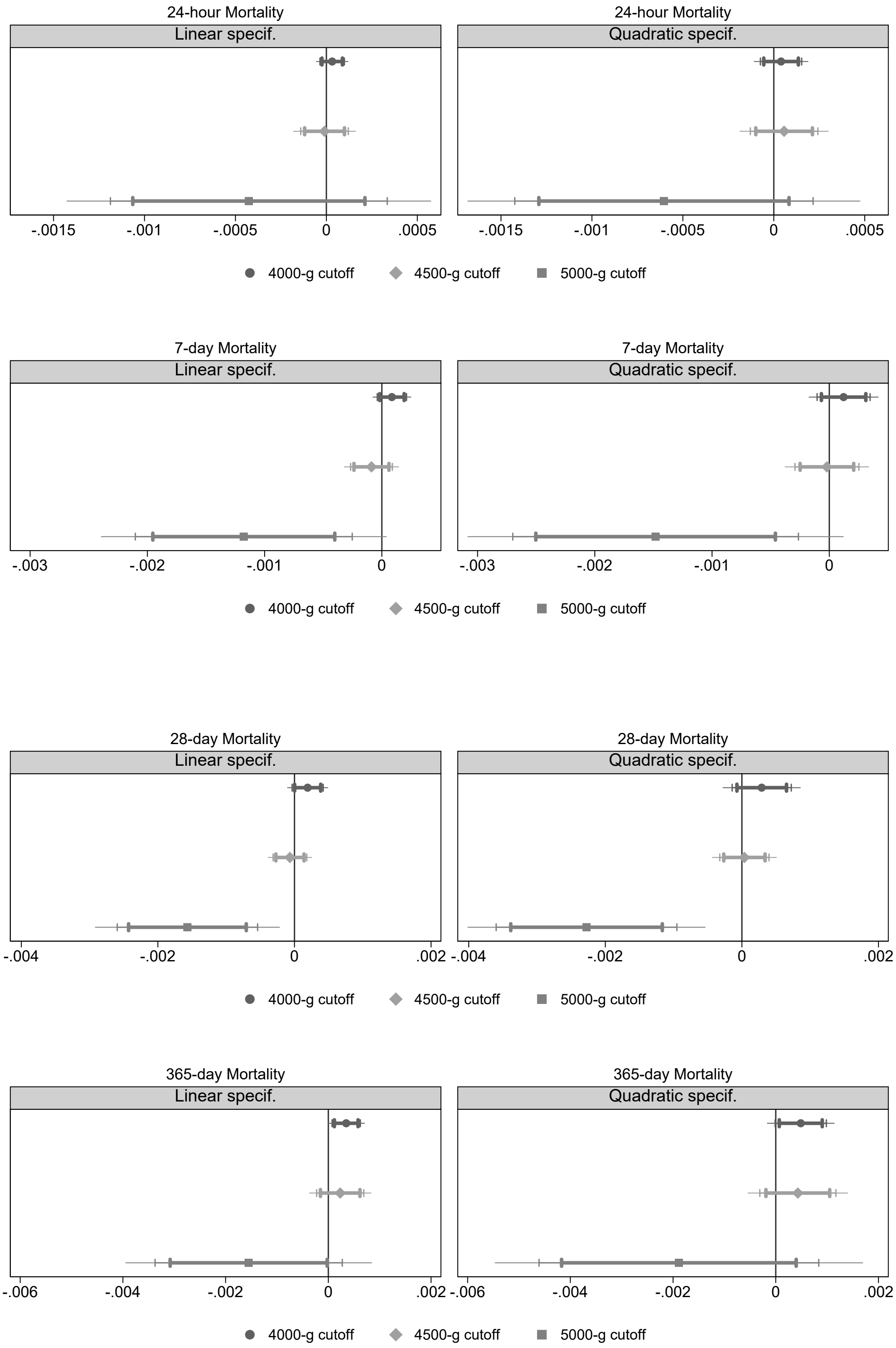
[24] *Birth conditions* include perinatal and congenital causes; *Other diseases* include all causes related to diseases of the respiratory, digestive and nervous systems; *External/unexplained causes* include causes such as accidents, homicides, and SIDS. For each outcome, the analysis has been performed by comparing infants dying because of that specific cause with those not dying, i.e. dropping infants dying because of a different cause. However, the results are very similar when keeping all observations, and are available upon request from the authors.

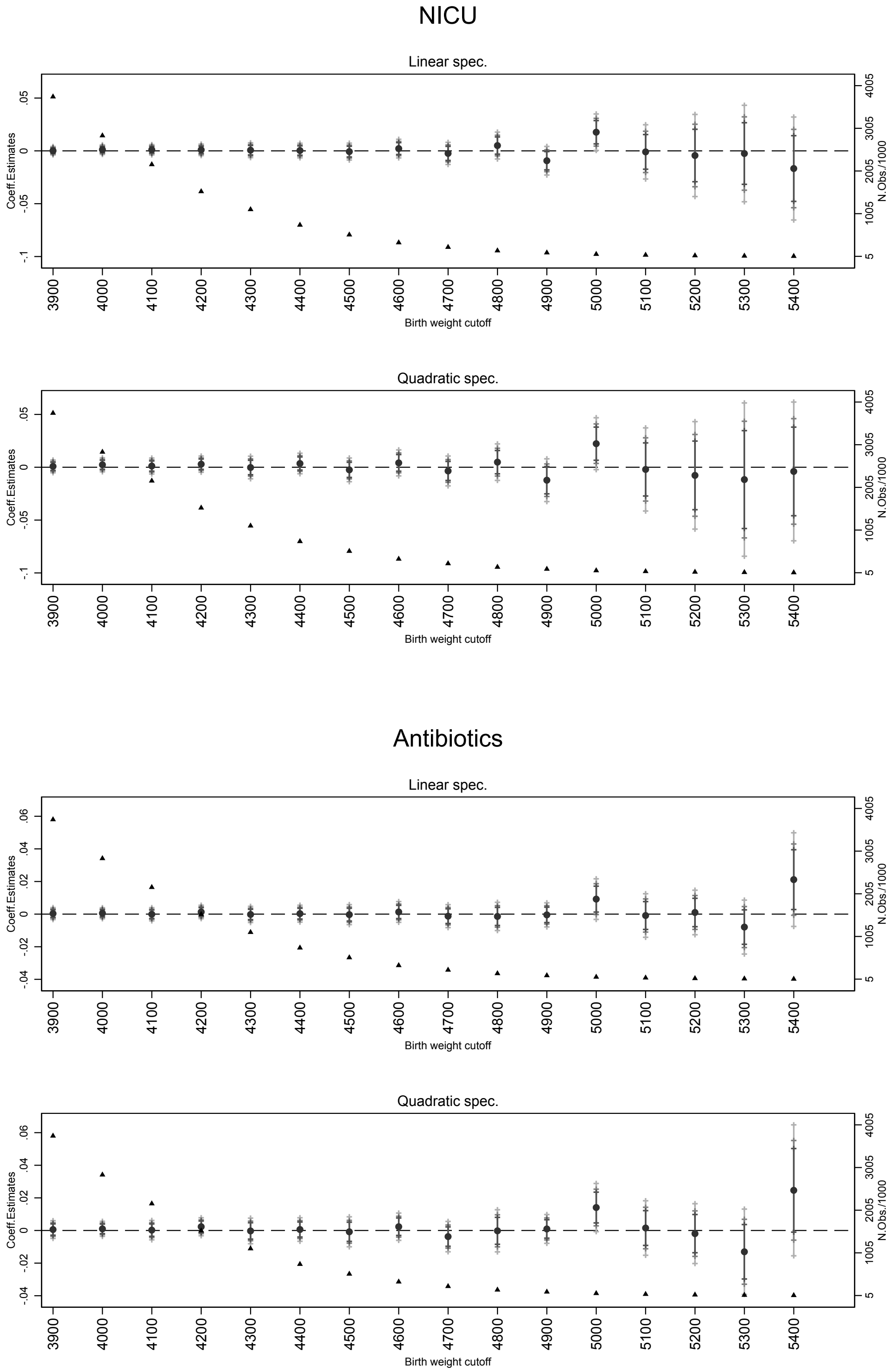
[25] Figure 11 refers to the whole sample, while Figures A.9 and A.10 in the Appendix replicate the analysis on the *Donut* and *Donut1* samples.

Figure 13
Parametric estimation of the effect of being HBW on mortality, at the macrosomic cutoffs of 4000, 4500 and 5000 grams. Whole sample.



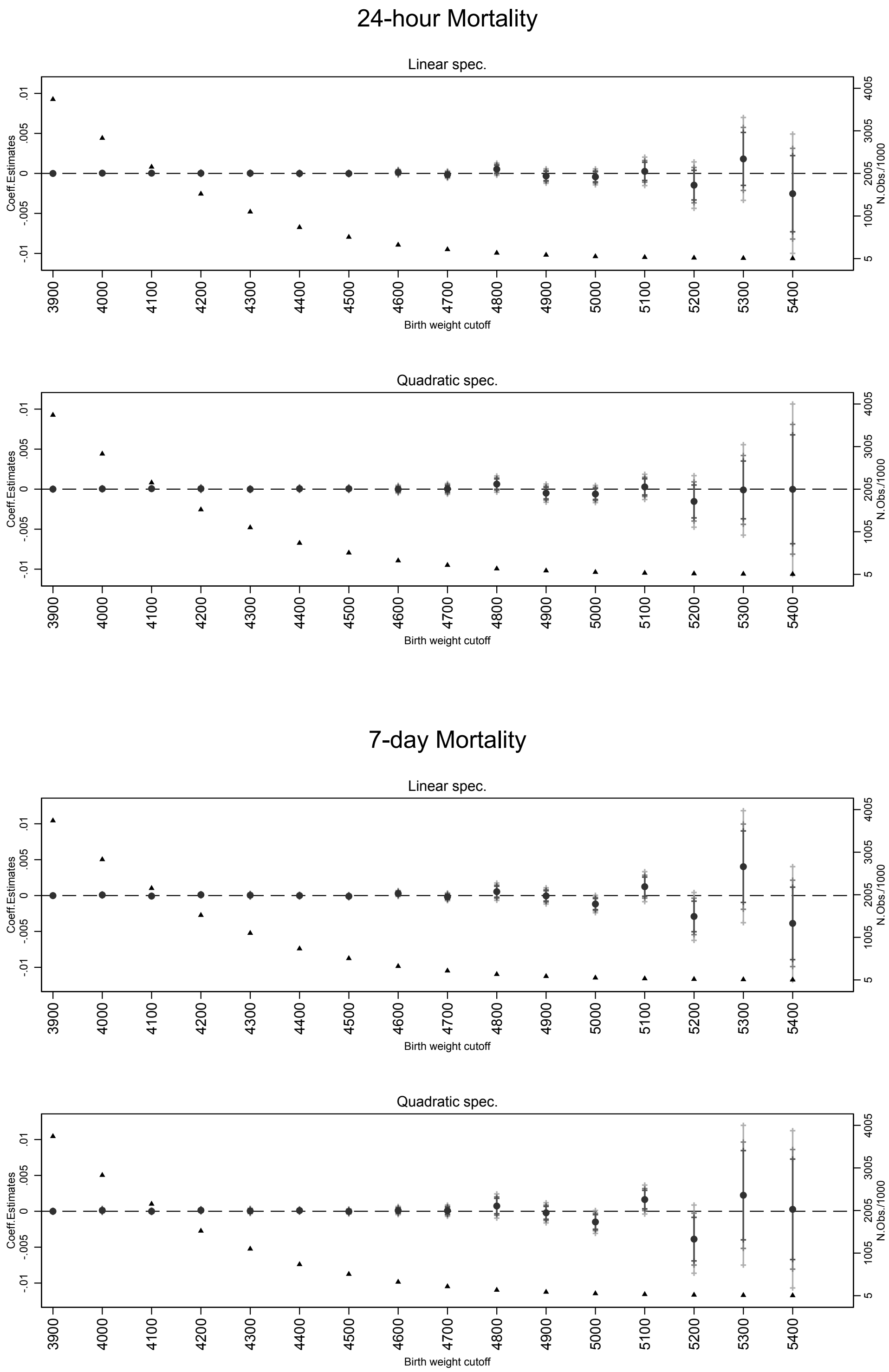
Notes: The graph reports the coefficients associated with a variable indicating whether a newborn has high birth weight, i.e. larger than 4000, 4500 and 5000 grams, and the corresponding 99%, 95% and 90% confidence intervals. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from the corresponding threshold, after dropping observations with missing information in the variables listed in Table 1.

Figure 14
Parametric estimation of the effect of being HBW on NICU admission and antibiotics, by using 100-gram apart thresholds in the 3900- to 5400-gram segment. Whole sample.



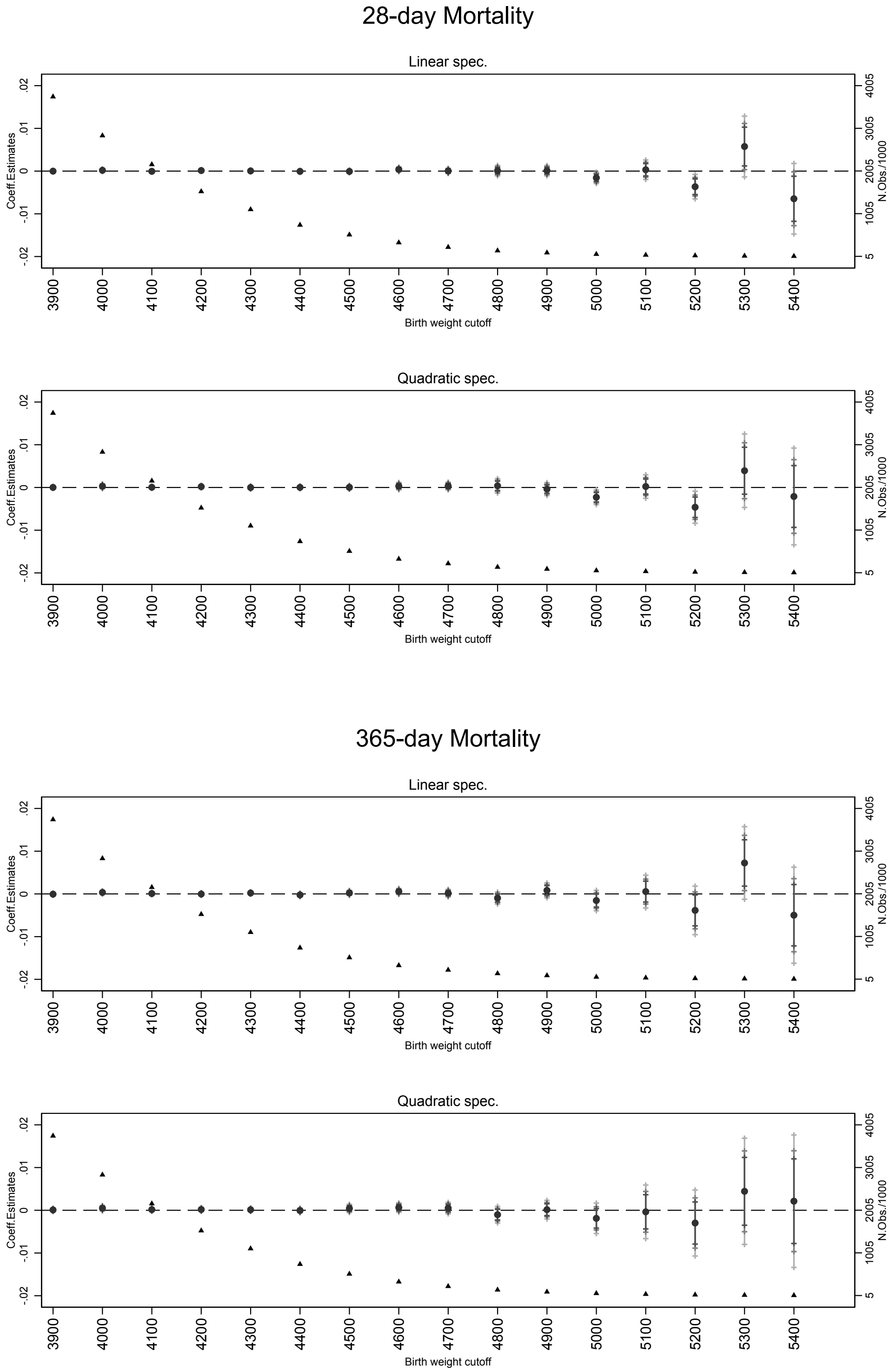
Notes: The graph reports the coefficients associated with a variable indicating whether a newborn has high birth weight, i.e. larger than the corresponding cutoff, and the corresponding 99%, 95% and 90% confidence intervals. All estimations control for linear (panel to the top) and quadratic (panel to the bottom) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from the corresponding threshold, after dropping observations with missing information in the variables listed in Table 1. The triangles indicate the number of observations for each regression sample, whose label is reported in the y-axis to the right.

Figure 15
Parametric estimation of the effect of being HBW on 24-hour and 7-day mortality, by using 100-gram apart thresholds in the 3900- to 5400-gram segment. Whole sample.



Notes: The graph reports the coefficients associated with a variable indicating whether a newborn has high birth weight, i.e. larger than the corresponding cutoff, and the corresponding 99%, 95% and 90% confidence intervals. All estimations control for linear (panel to the top) and quadratic (panel to the bottom) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from the corresponding threshold, after dropping observations with missing information in the variables listed in Table 1. The triangles indicate the number of observations for each regression sample, whose label is reported in the y-axis to the right.

Figure 16
Parametric estimation of the effect of being HBW on 28-day and 365-day mortality, by using 100-gram apart thresholds in the 3900- to 5400-gram segment. Whole sample.



Notes: The graph reports the coefficients associated with a variable indicating whether a newborn has high birth weight, i.e. larger than the corresponding cutoff, and the corresponding 99%, 95% and 90% confidence intervals. All estimations control for linear (panel to the top) and quadratic (panel to the bottom) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from the corresponding threshold, after dropping observations with missing information in the variables listed in Table 1. The triangles indicate the number of observations for each regression sample, whose label is reported in the y-axis to the right.

6. Analysis at other macrosomic cutoffs

In this section, we repeat the baseline estimation that we have performed for the 5000-gram cutoff, for the 4000- and 4500-gram birth weight thresholds, by using, as before, a bandwidth of 227 grams. The estimates for all cutoffs are reported in Figure 12 for NICU admission and antibiotics receipt, and in Figure 13 for mortality, and show that, unlike at the 5000-gram cutoff, there is no evidence of both extra medical care and a mortality reduction at either the 4000- or 4500-gram cutoffs.[26]

We also investigate whether there is evidence of other diagnostically relevant thresholds, by repeating the baseline analysis involving birth weight thresholds at 100-gram intervals in the 3900- to 5400-gram segment. Results for NICU admission and antibiotics receipt are reported in Figure 14, while the results for mortality are reported in Figures 15 and 16. Figure A.12 in the Appendix reports the results for ventilation and surfactant use. Only at the 5000-gram cutoff do we find systematic evidence of extra medical care as well as a reduction in mortality risk as the cutoff is approached from below.

7. Conclusions

In this study, we use a regression discontinuity design to estimate the short-run health returns to providing medical care to macrosomic newborns. We find that there are economically important and statistically significant effects of being born with an EHBW on one specific health treatment (antibiotics receipt for suspected neonatal sepsis) and what may entail a battery of health treatments (NICU admission). We also find that being born with an EHBW substantially reduces the risk of infant mortality, especially within the first week and the first month of life.

A mortality-reducing effect of the additional medical care for EHBW newborns is consistent with what studies have found for high-risk LBW newborns (Almond et al., 2010, Bharadwaj et al., 2013). The results from Bharadwaj et al. (2013) suggest that surfactant therapy plays a role in the link between neonatal care and mortality risk among very LBW infants. In our analysis at the high-risk, high end of the birth weight distribution, we do not find discontinuities in respiratory treatments (assisted ventilation and surfactant therapy) around the 5000-gram cutoff. This suggests that, for macrosomic newborns, the decision to provide respiratory treatments may be linked to the actual occurrence of respiratory complications after birth and may

[26]Figure A.11 in the Appendix reports the estimated coefficients for ventilation and surfactant use. Tables A.12 and A.13 in the Appendix report the detailed estimation results for all outcomes around the 4000- and 4500-gram thresholds, including the analysis of the *Donut* and *Donut1* samples.

be less sensitive to the higher expected morbidity and mortality risks associated with an EHBW outcome than the other health treatment decisions we observe in the data. More specifically, since neonatal sepsis is a major cause of neonatal mortality (Shane et al., 2017) and a primary NICU admitting diagnosis for macrosomic babies (Tolosa and Calhoun, 2017), the hospital staff may be more sensitive to the EHBW cutoff when deciding on NICU admission or the provision of antibiotics for suspected sepsis.

Our findings have important policy implications because maternal obesity, a major risk factor for macrosomia, is becoming more prevalent, which may result in a greater number of medical providers facing rule-of-thumb health treatment decisions at macrosomic cutoffs. Much attention has been paid to identifying and addressing the health risks associated with (very) LBW babies, but our results suggest that there are also substantial short-run health gains associated with health treatments given to macrosomic babies whose mortality rates are much lower. In other words, even among comparatively healthier babies who generally have better survival odds, neonatal care for macrosomic babies may improve their odds of survival further still.

Despite the strengths of our study, our analysis leaves space for additional research. First, it is important to note that we cannot isolate the specific medical inputs provided to macrosomic infants in NICUs that may translate into large short-run health gains in the macrosomic patient population, nor can we rule out that other medical inputs, not observable in our data, also improve the health of macrosomic infants. Pinning down the type and quantity of medical inputs provided to macrosomic newborns within and outside of NICUs would allow for a comprehensive comparison of the costs and benefits associated with medical care for macrosomic babies. Second, since infant mortality is an extreme health event, future work on the impacts of neonatal care on other health (and non-health) outcomes of macrosomic babies is warranted.

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Appendix A. Additional tables and figures – intended for online publication

Table A.1

Analysis of determinants of having a birth weight heavier than 5000 grams.

	OLS	LOGIT
Mother's age	0.0001	0.0005
	(0.0004)	(0.0023)
Mother's education	-0.0035**	-0.0185**
	(0.0016)	(0.0083)
Married mother	-0.0005	-0.0020
	(0.0063)	(0.0330)
Mother is White Non-Hisp	-0.0182**	-0.0922*
	(0.0087)	(0.0478)
Mother is Hispanic	-0.0202***	-0.1029**
	(0.0078)	(0.0401)
Father's info missing	-0.0007	-0.0041
	(0.0094)	(0.0487)
Mother had gestational diabetes	0.0352***	0.1737***
	(0.0087)	(0.0432)
Mother had previous c-section	0.0098*	0.0474*
	(0.0054)	(0.0276)
Mother weight gain in pregnancy	0.0014***	0.0071***
	(0.0003)	(0.0014)
Mother smoked in pregnancy	-0.0098	-0.0511
	(0.0118)	(0.0610)
No. Prenatal visits	0.0012*	0.0059*
	(0.0006)	(0.0034)
Gestational age	-0.0031*	-0.0160*
	(0.0016)	(0.0083)
C-section	0.0479***	0.2572***
	(0.0074)	(0.0286)
Birth order	0.0125***	0.0650***
	(0.0029)	(0.0109)
2007 cohort	0.0086	0.0459
	(0.0086)	(0.0467)
2008 cohort	0.0201**	0.1065**
	(0.0097)	(0.0500)
2009 cohort	0.0137	0.0732
	(0.0090)	(0.0494)
2010 cohort	0.0245***	0.1289***
	(0.0086)	(0.0471)
2011 cohort	0.0126	0.0675
	(0.0085)	(0.0437)
2012 cohort	0.0180*	0.0955**
	(0.0095)	(0.0465)
Constant	0.2906***	-0.8980**
	(0.0827)	(0.4234)
N	45326	45326

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1 and in the above variables. Robust standard errors that are clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

Table A.2
Parametric estimations of the effect of being EHBW on the characteristics according to which we select the baseline sample.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Multiple births						
Birth weight $\geq$ 5000 g	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0003)
Average of dep. var.	[0.0003]					
Panel B. Missing info on outcomes						
Birth weight $\geq$ 5000 g	-0.0211	-0.0331	-0.0144	-0.0201	-0.0145	-0.0204
	(0.0376)	(0.0532)	(0.0377)	(0.0555)	(0.0379)	(0.0563)
Average of dep. var.	[0.2439]					
N	73528	73528	73222	73222	73156	73156
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Whole sample	✓	✓				
Donut			✓	✓		
Donut1					✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 5000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. births with birth weight between 4773 and 5227 grams. The specification *Donut* indicates that observations with birth weight equal to the cutoff have been dropped from the sample, while the specification *Donut1* indicates that also observations with birth weight within +/-1 gram from the cutoff have been excluded. Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

Table A.3
Descriptive statistics for the mother, pregnancy and newborn characteristics in the sample around the 5000-gram threshold.

	Mean	SD	Min	Max	N
Mother had gestational diabetes	0.1317	(0.3382)	0	1	55503
Mother weight gain	17.6290	(8.3440)	0	44.4528	52102
Mother smoked in pregnancy	0.0466	(0.2107)	0	1	50126
Prenatal visits	11.9725	(4.2087)	0	49	53700
Gestational age	39.5388	(1.7161)	32	47	55501
Birth with c-section	0.5952	(0.4908)	0	1	55549
APGAR score (5 minutes)	8.7178	(0.9218)	0	10	55146
Birth order	2.4804	(1.4569)	1	8	55311
Male	0.6886	(0.4631)	0	1	55581
Mother's age	29.8764	(5.6811)	12	50	55581
Mother education	4.1575	(1.7473)	1	8	54864
Married mother	0.6916	(0.4618)	0	1	55581
Mother is Black non-Hispanic	0.1283	(0.3344)	0	1	55141
Mother is White non-Hispanic	0.6149	(0.4866)	0	1	55141
Mother is Hispanic	0.2568	(0.4369)	0	1	55141
Mother has diabetes	0.1802	(0.3844)	0	1	55503
Mother had previous c-section	0.2351	(0.4240)	0	1	55520
Father's info missing	0.1511	0.3581	0	1	55581

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1.

Table A.4
Parametric estimations of the effect of being EHBW on the pregnancy and newborn characteristics.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Mother had gest. diabetes						
Birth weight $\geq$ 5000 g	0.0015	0.0159*	0.0019	0.0181*	0.0021	0.0186*
	(0.0082)	(0.0090)	(0.0087)	(0.0102)	(0.0088)	(0.0104)
Panel B. Mother's weight gain in pregn.						
Birth weight $\geq$ 5000 g	0.1477	0.2509	0.1613	0.3076	0.1537	0.2942
	(0.1430)	(0.1840)	(0.1503)	(0.1908)	(0.1506)	(0.1905)
Panel C. Mother smoked in pregn.						
Birth weight $\geq$ 5000 g	-0.0057	-0.0059	-0.0061	-0.0066	-0.0065	-0.0074
	(0.0043)	(0.0064)	(0.0047)	(0.0074)	(0.0047)	(0.0075)
Panel D. No. prenatal visits						
Birth weight $\geq$ 5000 g	0.2907***	0.4350***	0.3141***	0.5091***	0.3221***	0.5296***
	(0.1041)	(0.1621)	(0.1089)	(0.1739)	(0.1095)	(0.1761)
Panel E. Gestational age						
Birth weight $\geq$ 5000 g	0.0197	0.0656	0.0201	0.0734	0.0129	0.0592
	(0.0497)	(0.0742)	(0.0522)	(0.0787)	(0.0528)	(0.0790)
Panel F. C-section						
Birth weight $\geq$ 5000 g	0.0116	0.0201	0.0117	0.0208	0.0118	0.0211
	(0.0142)	(0.0179)	(0.0149)	(0.0191)	(0.0150)	(0.0193)
Panel G. Apgar score (5 mins)						
Birth weight $\geq$ 5000 g	-0.0093	-0.0164	0.0049	0.0082	0.0057	0.0099
	(0.0245)	(0.0326)	(0.0211)	(0.0269)	(0.0213)	(0.0273)
Panel H. Male						
Birth weight $\geq$ 5000 g	-0.0103	-0.0058	-0.0152**	-0.0160	-0.0158**	-0.0174
	(0.0081)	(0.0128)	(0.0075)	(0.0111)	(0.0076)	(0.0112)
Panel I. Birth order						
Birth weight $\geq$ 5000 g	-0.0183	-0.0814	-0.0216	-0.0933*	-0.0179	-0.0864
	(0.0405)	(0.0498)	(0.0418)	(0.0519)	(0.0420)	(0.0524)
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Whole sample	✓	✓				
Donut			✓	✓		
Donut1					✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1 and in the variables above. The specification *Donut* indicates that observations with birth weight equal to the cutoff have been dropped from the sample, while the specification *Donut1* indicates that also observations with birth weight within +/-1 gram from the cutoff have been excluded. Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

Table A.5

Parametric estimations of the effect of being EHBW on the mother's characteristics.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Mother's age						
Birth weight $\geq$ 5000 g	-0.0410	0.0314	-0.0788	-0.0387	-0.0749	-0.0296
	(0.0909)	(0.1340)	(0.0859)	(0.1274)	(0.0866)	(0.1293)
Panel B. Mother's education						
Birth weight $\geq$ 5000 g	0.0653	0.0934	0.0534	0.0759	0.0505	0.0704
	(0.0458)	(0.0732)	(0.0455)	(0.0742)	(0.0457)	(0.0748)
Panel C. Married mother						
Birth weight $\geq$ 5000 g	-0.0054	-0.0048	-0.0046	-0.0030	-0.0042	-0.0021
	(0.0094)	(0.0139)	(0.0097)	(0.0150)	(0.0098)	(0.0153)
Panel D. Mother black non-Hispanic						
Birth weight $\geq$ 5000 g	0.0119	0.0160	0.0095	0.0103	0.0089	0.0089
	(0.0108)	(0.0149)	(0.0109)	(0.0151)	(0.0109)	(0.0152)
Panel E. Mother white non-Hispanic						
Birth weight $\geq$ 5000 g	-0.0015	0.0001	-0.0001	0.0049	-0.0005	0.0041
	(0.0205)	(0.0314)	(0.0212)	(0.0327)	(0.0214)	(0.0333)
Panel F. Mother Hispanic						
Birth weight $\geq$ 5000 g	-0.0104	-0.0161	-0.0094	-0.0152	-0.0083	-0.0131
	(0.0158)	(0.0247)	(0.0163)	(0.0258)	(0.0164)	(0.0260)
Panel G. Mother has diabetes						
Birth weight $\geq$ 5000 g	0.0054	0.0105	0.0065	0.0129	0.0075	0.0151
	(0.0078)	(0.0100)	(0.0083)	(0.0113)	(0.0083)	(0.0115)
Panel H. Mother had previous c-section						
Birth weight $\geq$ 5000 g	0.0026	-0.0011	-0.0002	-0.0076	-0.0002	-0.0078
	(0.0088)	(0.0131)	(0.0086)	(0.0127)	(0.0087)	(0.0129)
Panel I. Father's information missing						
Birth weight $\geq$ 5000 g	0.0025	0.0027	0.0025	0.0025	0.0023	0.0021
	(0.0089)	(0.0122)	(0.0095)	(0.0142)	(0.0095)	(0.0144)
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Whole sample	✓	✓				
Donut			✓	✓		
Donut1					✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1 and in the variables above. The specification *Donut* indicates that observations with birth weight equal to the cutoff have been dropped from the sample, while the specification *Donut1* indicates that also observations with birth weight within +/-1 gram from the cutoff have been excluded. Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

Table A.6
Parametric estimations of the effect of being EHBW on type of health insurance and emergency cesarean sections.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Public insurance						
Birth weight $\geq$ 5000 g	0.0122	0.0252	0.0119	0.0273	0.0119	0.0276
	(0.0140)	(0.0221)	(0.0147)	(0.0240)	(0.0148)	(0.0244)
N	27953	27953	27816	27816	27789	27789
Average of dep. var.	[0.4037]					
Panel B. Emergency c-section						
Birth weight $\geq$ 5000 g	0.0035	0.0109	0.0039	0.0123	0.0034	0.0113
	(0.0074)	(0.0110)	(0.0077)	(0.0121)	(0.0078)	(0.0121)
N	54944	54944	54686	54686	54635	54635
Average of dep. var.	[0.1375]					
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
No Donut	✓	✓				
Donut			✓	✓		
Donut1					✓	✓

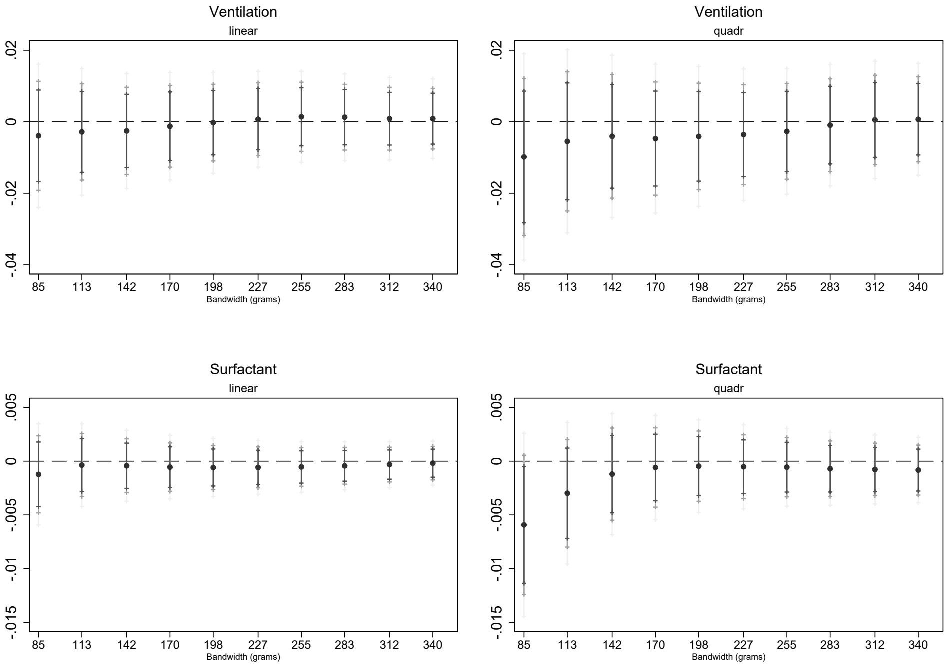
Notes: Authors' calculations using linked birth/death certificates data for the years 2011-2013 in Panel A, and 2007-2013 in Panel B. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1 and in the variables above. The specification *Donut* indicates that observations with birth weight equal to the cutoff have been dropped from the sample, while the specification *Donut1* indicates that also observations with birth weight within +/-1 gram from the cutoff have been excluded. Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels. The average of the dependent variables is provided in square brackets.

Table A.7
Parametric estimations of the effect of being EHBW on health treatments and mortality, without clustered SEs.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. NICU						
Birth weight $\geq$ 5000 g	0.0177***	0.0223**	0.0151**	0.0175*	0.0154**	0.0182*
	(0.0068)	(0.0099)	(0.0069)	(0.0103)	(0.0069)	(0.0104)
Panel B. Antibiotics						
Birth weight $\geq$ 5000 g	0.0092**	0.0141**	0.0089**	0.0144**	0.0083**	0.0131**
	(0.0036)	(0.0055)	(0.0037)	(0.0059)	(0.0037)	(0.0058)
Panel C. Ventilation						
Birth weight $\geq$ 5000 g	0.0007	-0.0036	-0.0006	-0.0063	-0.0008	-0.0068
	(0.0048)	(0.0071)	(0.0049)	(0.0074)	(0.0049)	(0.0074)
Panel D. Surfactant						
Birth weight $\geq$ 5000 g	-0.0006	-0.0005	-0.0004	-0.0000	-0.0002	0.0004
	(0.0010)	(0.0016)	(0.0011)	(0.0018)	(0.0011)	(0.0017)
Panel E. 24-hour Mortality						
Birth weight $\geq$ 5000 g	-0.0004	-0.0006	-0.0004	-0.0005	-0.0004	-0.0005
	(0.0005)	(0.0006)	(0.0005)	(0.0007)	(0.0005)	(0.0007)
Panel F. 7-day Mortality						
Birth weight $\geq$ 5000 g	-0.0012*	-0.0015*	-0.0012*	-0.0014	-0.0012*	-0.0014
	(0.0006)	(0.0009)	(0.0007)	(0.0009)	(0.0007)	(0.0010)
Panel G. 28-day Mortality						
Birth weight $\geq$ 5000 g	-0.0016**	-0.0023**	-0.0015**	-0.0022**	-0.0015**	-0.0022**
	(0.0007)	(0.0010)	(0.0008)	(0.0011)	(0.0008)	(0.0011)
Panel H. 365-day Mortality						
Birth weight $\geq$ 5000 g	-0.0016	-0.0019	-0.0017	-0.0023	-0.0017	-0.0023
	(0.0011)	(0.0015)	(0.0011)	(0.0015)	(0.0011)	(0.0016)
N	55581	55581	55320	55320	55268	55268
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Whole sample	✓	✓				
Donut			✓	✓		
Donut1					✓	✓

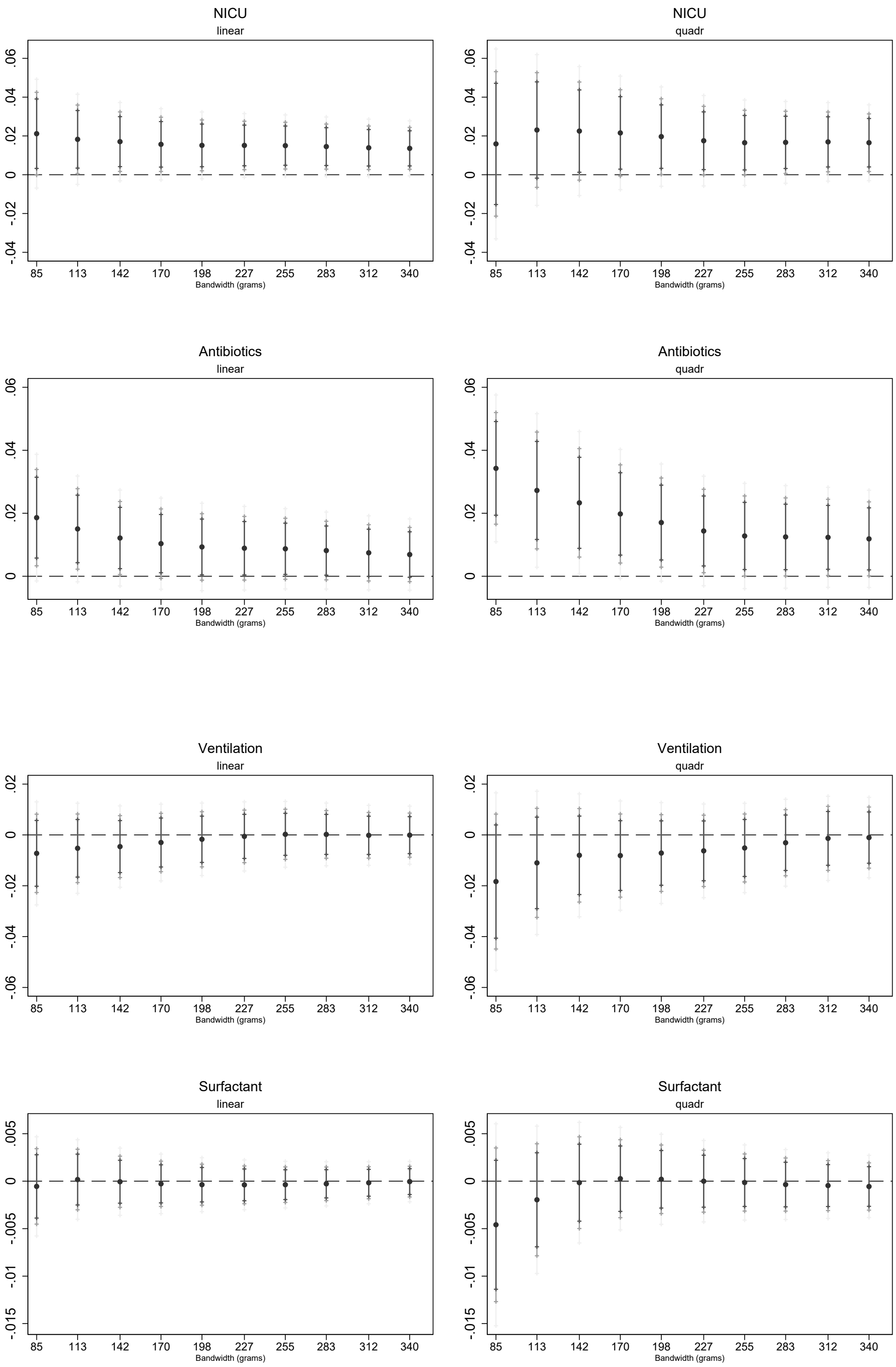
Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 5000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1. The specification *Donut* indicates that observations with birth weight equal to the cutoff have been dropped from the sample, while the specification *Donut1* indicates that also observations with birth weight within +/-1 gram from the cutoff have been excluded. Heteroskedasticity-robust standard errors are in parenthesis. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

Figure A.1
Parametric estimations of the effect of being EHBW on ventilation and surfactant use, with different bandwidth size. Whole sample.



Notes: The graphs report the parametric estimates and 90%, 95% and 99% confidence intervals of the effects of being EHBW using, for each estimation, a bandwidth ranging between 85 and 340 grams. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birth weight within 227 grams from the 5000-gram cutoff, without observations with missing information in the variables listed in Table 1.

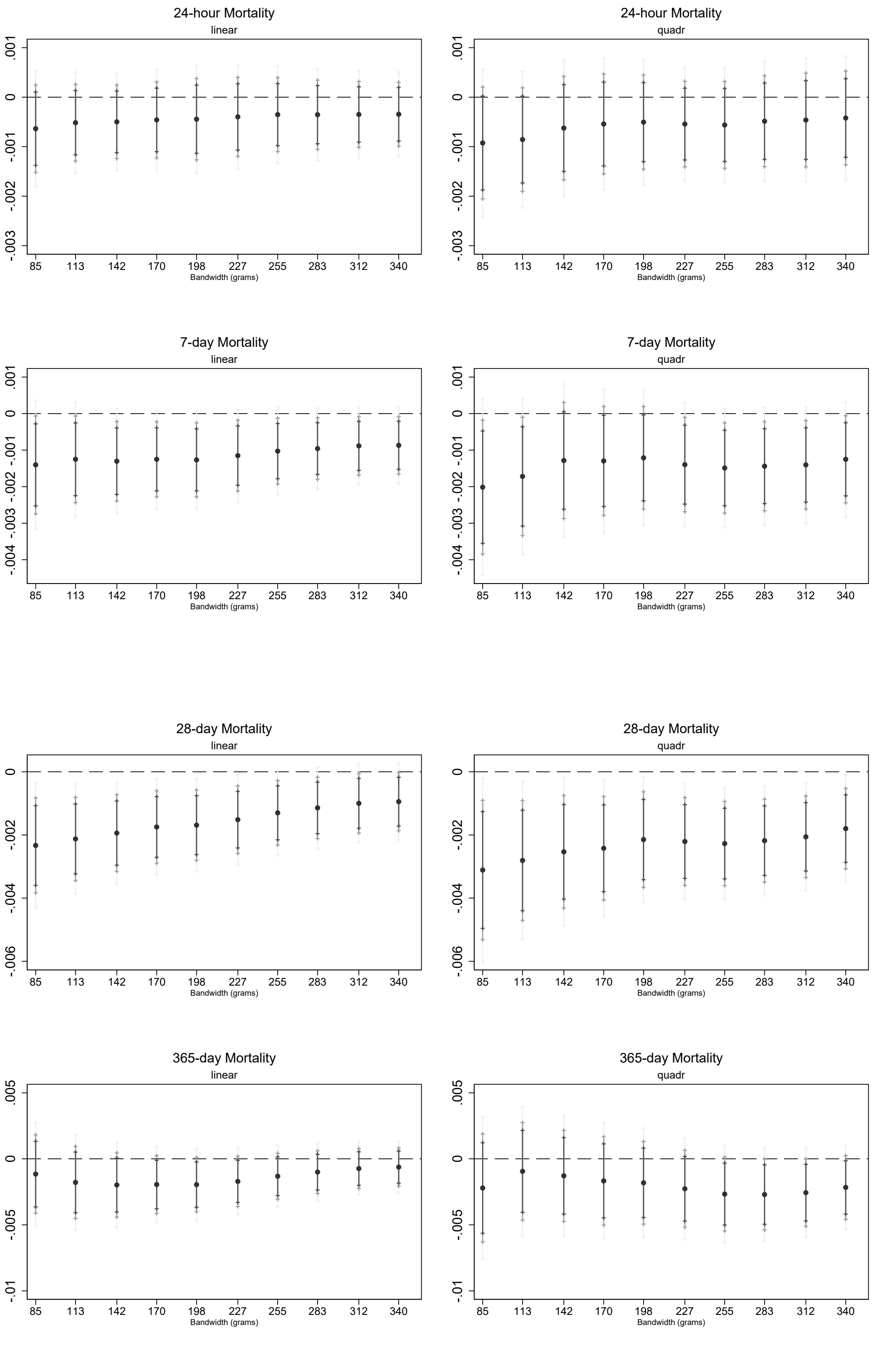
Figure A.2
Parametric estimations of the effect of being EHBW on neonatal treatments, with different bandwidth size. *Donut* sample.



Notes: The graphs report the parametric estimates and 90%, 95% and 99% confidence intervals of the effects of being EHBW using, for each estimation, a bandwidth ranging between 85 and 340 grams. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birth weight within 227 grams from the 5000-gram cutoff, without observations with missing information in the variables listed in Table 1; for the *donut* sample also observations with a birth weight equal to the cutoff value have been dropped.

Figure A.3

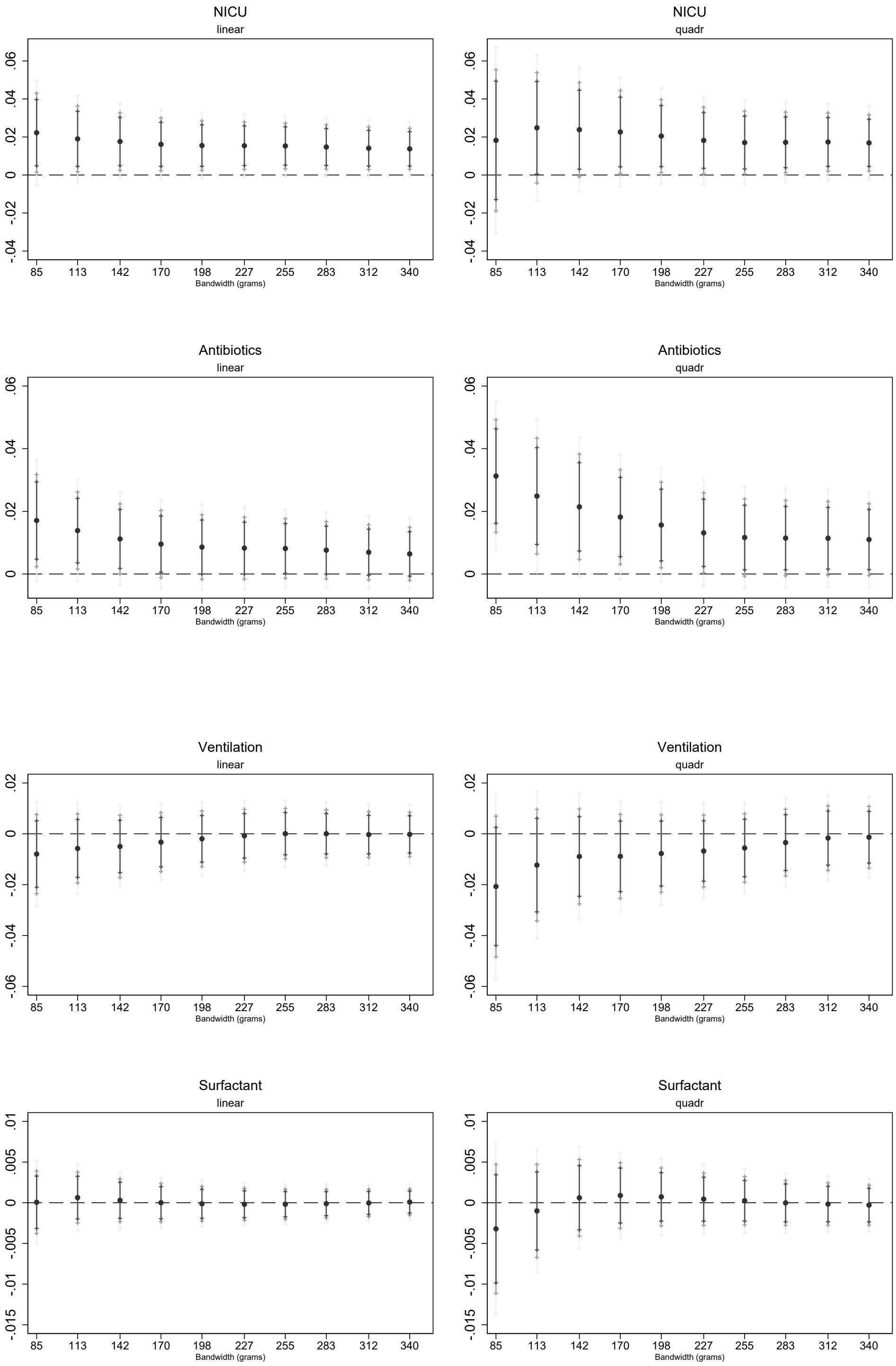
Parametric estimations of the effect of being EHBW on mortality, with different bandwidth size. *Donut* sample.



Notes: The graphs report the parametric estimates and 90%, 95% and 99% confidence intervals of the effects of being EHBW using, for each estimation, a bandwidth ranging between 85 and 340 grams. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birth weight within 227 grams from the 5000-gram cutoff, without observations with missing information in the variables listed in Table 1; for the *donut* sample also observations with a birth weight equal to the cutoff value have been dropped.

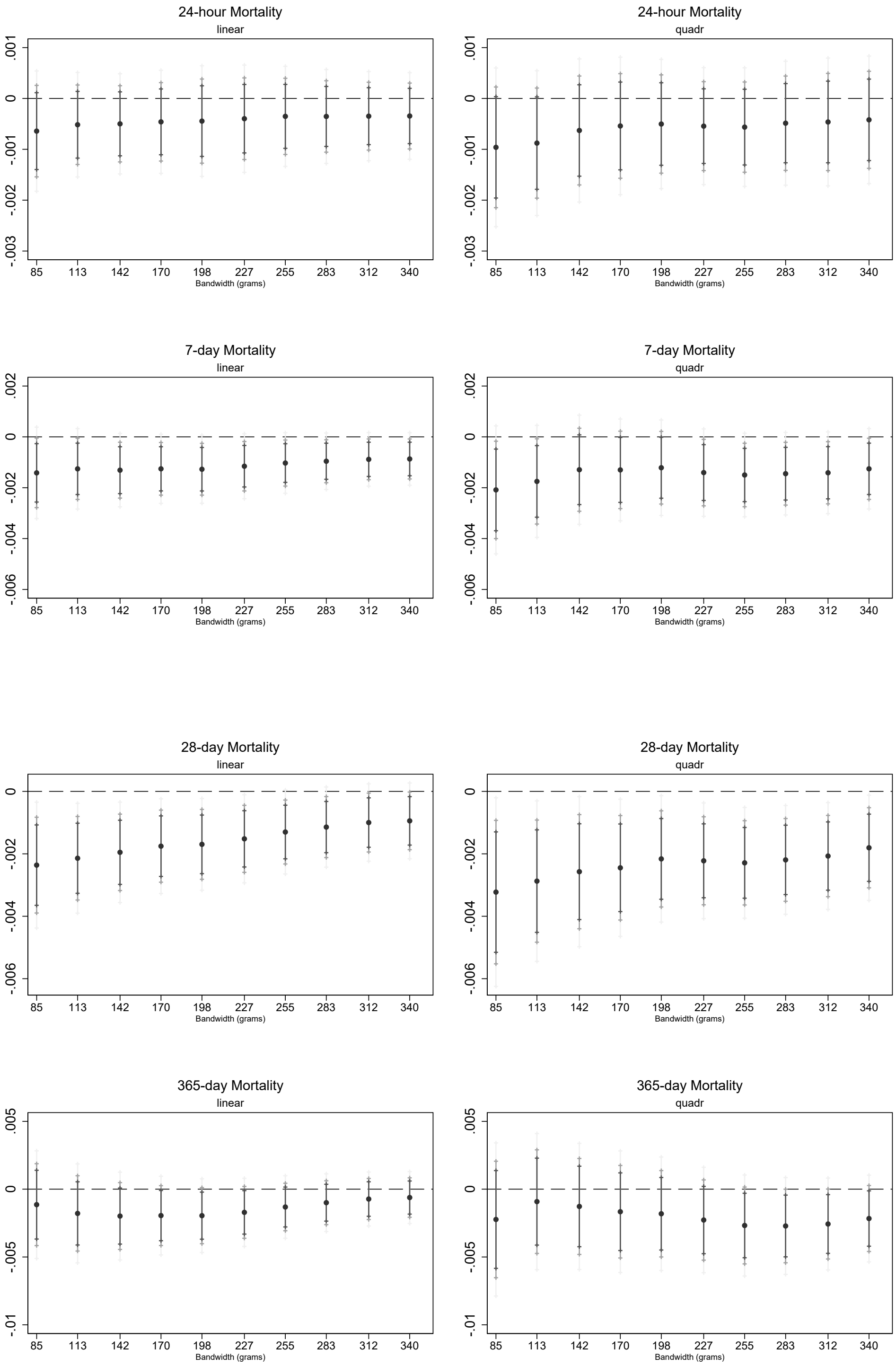
Figure A.4

Parametric estimations of the effect of being EHBW on neonatal treatments, with different bandwidth size. *Donut1* sample.



Notes: The graphs report the parametric estimates and 90%, 95% and 99% confidence intervals of the effects of being EHBW using, for each estimation, a bandwidth ranging between 85 and 340 grams. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birth weight within 227 grams from the 5000-gram cutoff, without observations with missing information in the variables listed in Table 1; for the *Donut1* sample also observations with a birth weight within $+/-1$ gram from the cutoff value have been dropped.

Figure A.5
Parametric estimations of the effect of being EHBW on mortality, with different bandwidth size. *Donut1* sample.



Notes: The graphs report the parametric estimates and 90%, 95% and 99% confidence intervals of the effects of being EHBW using, for each estimation, a bandwidth ranging between 85 and 340 grams. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birth weight within 227 grams from the 5000-gram cutoff, without observations with missing information in the variables listed in Table 1; for the *Donut1* sample also observations with a birth weight within $+/-1$ gram from the cutoff value have been dropped.

Table A.8

Parametric regressions conditional on covariates and year fixed effects. *Donut* sample.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. NICU						
Birth weight$\geq$ 5000 grams	0.0142**	0.0153	0.0166**	0.0254**	0.0151**	0.0173*
	(0.0064)	(0.0097)	(0.0070)	(0.0102)	(0.0063)	(0.0090)
Panel B. Antibiotics						
Birth weight$\geq$ 5000 grams	0.0084*	0.0131**	0.0090*	0.0150*	0.0090*	0.0144**
	(0.0050)	(0.0065)	(0.0054)	(0.0079)	(0.0051)	(0.0067)
Panel C. Ventilation						
Birth weight$\geq$ 5000 grams	-0.0001	-0.0050	-0.0014	-0.0043	-0.0007	-0.0063
	(0.0058)	(0.0080)	(0.0050)	(0.0068)	(0.0053)	(0.0072)
Panel D. Surfactant						
Birth weight$\geq$ 5000 grams	-0.0007	-0.0008	-0.0008	-0.0006	-0.0004	-0.0000
	(0.0010)	(0.0015)	(0.0011)	(0.0018)	(0.0010)	(0.0017)
Panel E. 24-hour Mortality						
Birth weight$\geq$ 5000 grams	-0.0004	-0.0006	-0.0008	-0.0010**	-0.0004	-0.0005
	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0004)	(0.0004)
Panel F. 7-day Mortality						
Birth weight$\geq$ 5000 grams	-0.0012**	-0.0014*	-0.0012*	-0.0012	-0.0011**	-0.0014**
	(0.0005)	(0.0007)	(0.0006)	(0.0009)	(0.0005)	(0.0007)
Panel G. 28-day Mortality						
Birth weight$\geq$ 5000 grams	-0.0015***	-0.0022***	-0.0017**	-0.0023**	-0.0015***	-0.0022***
	(0.0006)	(0.0008)	(0.0007)	(0.0010)	(0.0005)	(0.0007)
Panel H. 365-day Mortality						
Birth weight$\geq$ 5000 grams	-0.0022**	-0.0030**	-0.0021**	-0.0029*	-0.0017*	-0.0023
	(0.0009)	(0.0014)	(0.0010)	(0.0015)	(0.0010)	(0.0015)
N	53215	53215	44845	44845	55320	55320
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Controls						
Birth order, No. Visits, Gest. diab.	✓	✓				
All covariates			✓	✓		
Year FE					✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 5000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1, and with a birth weight equal to the cutoff value (*Donut* specification). Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

Table A.9

Parametric regressions conditional on covariates and year fixed effects. *Donut1* sample.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. NICU						
Birth weight$\geq$ 5000 grams	0.0144**	0.0158*	0.0166**	0.0255**	0.0154**	0.0180**
	(0.0064)	(0.0095)	(0.0070)	(0.0102)	(0.0063)	(0.0089)
Panel B. Antibiotics						
Birth weight$\geq$ 5000 grams	0.0077	0.0117*	0.0082	0.0135*	0.0083*	0.0132**
	(0.0048)	(0.0062)	(0.0052)	(0.0076)	(0.0050)	(0.0065)
Panel C. Ventilation						
Birth weight$\geq$ 5000 grams	-0.0004	-0.0056	-0.0016	-0.0048	-0.0009	-0.0069
	(0.0059)	(0.0080)	(0.0050)	(0.0069)	(0.0053)	(0.0072)
Panel D. Surfactant						
Birth weight$\geq$ 5000 grams	-0.0005	-0.0003	-0.0006	-0.0001	-0.0002	0.0004
	(0.0010)	(0.0015)	(0.0011)	(0.0017)	(0.0010)	(0.0016)
Panel E. 24-hour Mortality						
Birth weight$\geq$ 5000 grams	-0.0004	-0.0006	-0.0008	-0.0010**	-0.0004	-0.0005
	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0004)	(0.0004)
Panel F. 7-day Mortality						
Birth weight$\geq$ 5000 grams	-0.0012**	-0.0014*	-0.0012*	-0.0012	-0.0011**	-0.0014**
	(0.0005)	(0.0007)	(0.0006)	(0.0009)	(0.0005)	(0.0007)
Panel G. 28-day Mortality						
Birth weight$\geq$ 5000 grams	-0.0015***	-0.0022***	-0.0017**	-0.0023**	-0.0015***	-0.0022***
	(0.0006)	(0.0008)	(0.0007)	(0.0010)	(0.0005)	(0.0007)
Panel H. 365-day Mortality						
Birth weight$\geq$ 5000 grams	-0.0022**	-0.0030**	-0.0021**	-0.0029*	-0.0017*	-0.0023
	(0.0009)	(0.0015)	(0.0010)	(0.0015)	(0.0010)	(0.0015)
N						
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Controls						
Birth order, No. Visits, Gest. diab.	✓	✓				
All covariates			✓	✓		
Year FE					✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 5000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1, and with a birth weight within one gram from the cutoff value (*Donut1* specification). Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

Table A.10

Parametric regressions conditional on number of observations per gram, ounce-multiple and 100-gram-multiple fixed effects. *Donut* sample.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. NICU								
Birth weight≥ 5000 grams	0.0145***	0.0147*	0.0144***	0.0154**	0.0151**	0.0176*	0.0144***	0.0155**
	(0.0052)	(0.0077)	(0.0053)	(0.0078)	(0.0064)	(0.0090)	(0.0053)	(0.0077)
Panel B. Antibiotics								
Birth weight≥ 5000 grams	0.0085*	0.0124**	0.0084**	0.0128**	0.0089*	0.0144**	0.0084**	0.0129**
	(0.0044)	(0.0060)	(0.0040)	(0.0055)	(0.0051)	(0.0068)	(0.0040)	(0.0056)
Panel C. Ventilation								
Birth weight≥ 5000 grams	-0.0002	-0.0045	-0.0000	-0.0047	-0.0006	-0.0063	-0.0001	-0.0048
	(0.0045)	(0.0063)	(0.0044)	(0.0062)	(0.0053)	(0.0072)	(0.0044)	(0.0062)
Panel D. Surfactant								
Birth weight≥ 5000 grams	-0.0004	-0.0002	-0.0004	-0.0001	-0.0004	-0.0000	-0.0004	-0.0001
	(0.0010)	(0.0016)	(0.0010)	(0.0016)	(0.0010)	(0.0017)	(0.0010)	(0.0016)
Panel E. 24-hour Mortality								
Birth weight≥ 5000 grams	-0.0004	-0.0005	-0.0004	-0.0005	-0.0004	-0.0005	-0.0004	-0.0005
	(0.0004)	(0.0005)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Panel F. 7-day Mortality								
Birth weight≥ 5000 grams	-0.0012**	-0.0014**	-0.0011**	-0.0014**	-0.0011**	-0.0014**	-0.0011**	-0.0014**
	(0.0005)	(0.0007)	(0.0005)	(0.0007)	(0.0005)	(0.0007)	(0.0005)	(0.0007)
Panel G. 28-day Mortality								
Birth weight≥ 5000 grams	-0.0015***	-0.0023***	-0.0015***	-0.0022***	-0.0015***	-0.0022***	-0.0015***	-0.0022***
	(0.0006)	(0.0007)	(0.0006)	(0.0007)	(0.0005)	(0.0007)	(0.0006)	(0.0007)
Panel H. 365-day Mortality								
Birth weight≥ 5000 grams	-0.0017*	-0.0023	-0.0017*	-0.0023	-0.0017*	-0.0023	-0.0017*	-0.0023
	(0.0010)	(0.0015)	(0.0010)	(0.0015)	(0.0010)	(0.0015)	(0.0010)	(0.0015)
N	55320	55320	55320	55320	55320	55320	55320	55320
Linear+Interactions	✓		✓		✓		✓	
Quadratic+Interactions		✓		✓		✓		✓
Controls								
No. Births per gram	✓	✓						
Ounce-multiple FE			✓	✓			✓	✓
100-g-multiple FE					✓	✓	✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 5000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1, and with a birth weight equal to the cutoff value (*Donut* specification). Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

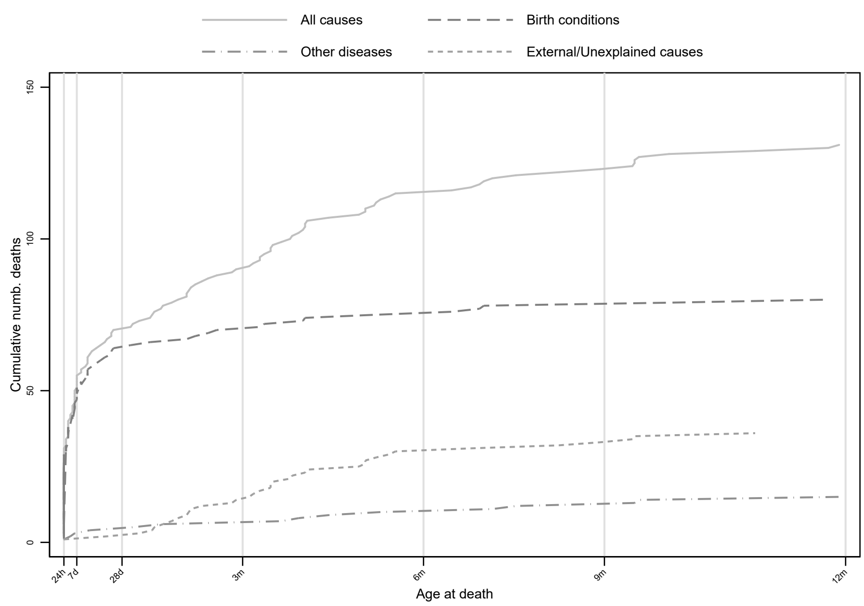
Table A.11
Parametric regressions conditional on number of observations per gram, ounce-multiple and 100-gram-multiple fixed effects. *Donut1* sample.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. NICU								
Birth weight≥ 5000 grams	0.0148***	0.0154**	0.0147***	0.0161**	0.0154**	0.0183**	0.0147***	0.0162**
	(0.0051)	(0.0077)	(0.0053)	(0.0077)	(0.0063)	(0.0089)	(0.0053)	(0.0077)
Panel B. Antibiotics								
Birth weight≥ 5000 grams	0.0079*	0.0112*	0.0078*	0.0116**	0.0083*	0.0132**	0.0078**	0.0117**
	(0.0043)	(0.0058)	(0.0039)	(0.0054)	(0.0050)	(0.0065)	(0.0039)	(0.0054)
Panel C. Ventilation								
Birth weight≥ 5000 grams	-0.0004	-0.0050	-0.0003	-0.0052	-0.0008	-0.0068	-0.0003	-0.0053
	(0.0045)	(0.0063)	(0.0044)	(0.0063)	(0.0053)	(0.0072)	(0.0045)	(0.0063)
Panel D. Surfactant								
Birth weight≥ 5000 grams	-0.0002	0.0003	-0.0002	0.0004	-0.0002	0.0004	-0.0002	0.0003
	(0.0010)	(0.0016)	(0.0010)	(0.0016)	(0.0010)	(0.0016)	(0.0010)	(0.0016)
Panel E. 24-hour Mortality								
Birth weight≥ 5000 grams	-0.0004	-0.0005	-0.0004	-0.0005	-0.0004	-0.0005	-0.0004	-0.0005
	(0.0004)	(0.0005)	(0.0004)	(0.0005)	(0.0004)	(0.0004)	(0.0004)	(0.0005)
Panel F. 7-day Mortality								
Birth weight≥ 5000 grams	-0.0012**	-0.0014**	-0.0012**	-0.0014**	-0.0012**	-0.0014**	-0.0012**	-0.0014**
	(0.0005)	(0.0007)	(0.0005)	(0.0007)	(0.0005)	(0.0007)	(0.0005)	(0.0007)
Panel G. 28-day Mortality								
Birth weight≥ 5000 grams	-0.0015***	-0.0023***	-0.0015***	-0.0023***	-0.0015***	-0.0022***	-0.0015***	-0.0023***
	(0.0006)	(0.0007)	(0.0006)	(0.0007)	(0.0005)	(0.0007)	(0.0006)	(0.0007)
Panel H. 365-day Mortality								
Birth weight≥ 5000 grams	-0.0017*	-0.0023	-0.0017*	-0.0023	-0.0017*	-0.0023	-0.0017*	-0.0023
	(0.0010)	(0.0015)	(0.0010)	(0.0015)	(0.0010)	(0.0015)	(0.0010)	(0.0015)
N	55268	55268	55268	55268	55268	55268	55268	55268
Linear+Interactions	✓		✓		✓		✓	
Quadratic+Interactions		✓		✓		✓		✓
Controls								
No. Births per gram	✓	✓						
Ounce-multiple FE			✓	✓			✓	✓
100-g-multiple FE					✓	✓	✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 5000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1, and with a birth weight within one gram from the cutoff value (*Donut1* specification). Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

Figure A.6

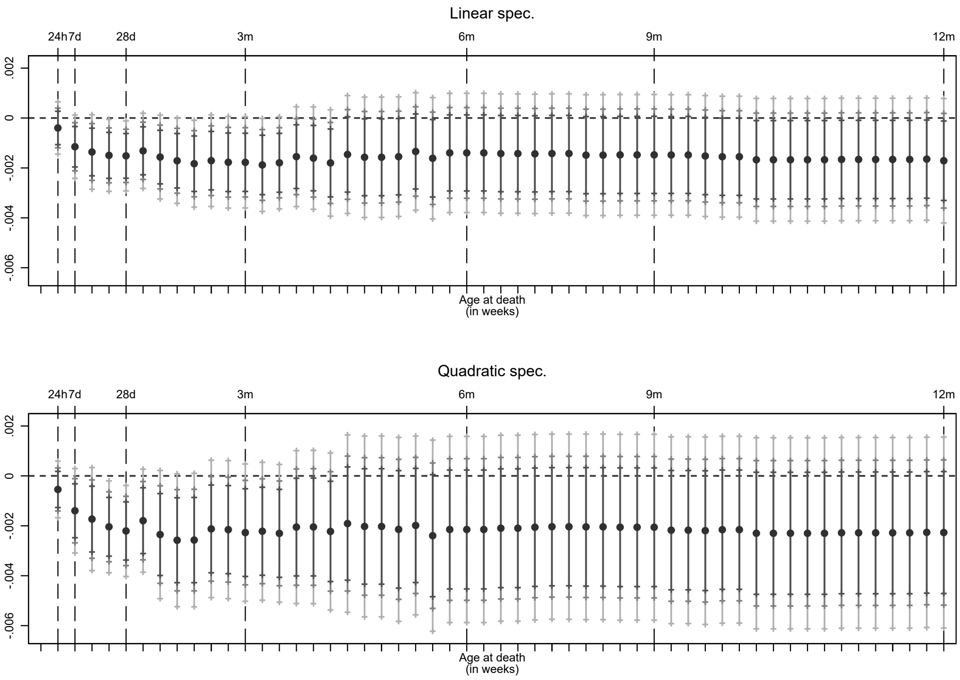
Cumulative number of deaths, by cause of death.



Notes: The graphs report the cumulative number of death cases by age and cause of death. *Birth conditions* include perinatal and congenital causes; *Other diseases* include all causes related to diseases of the respiratory, digestive and nervous systems; *External/unexplained causes* include causes such as accidents, homicides, and SIDS. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1.

Figure A.7

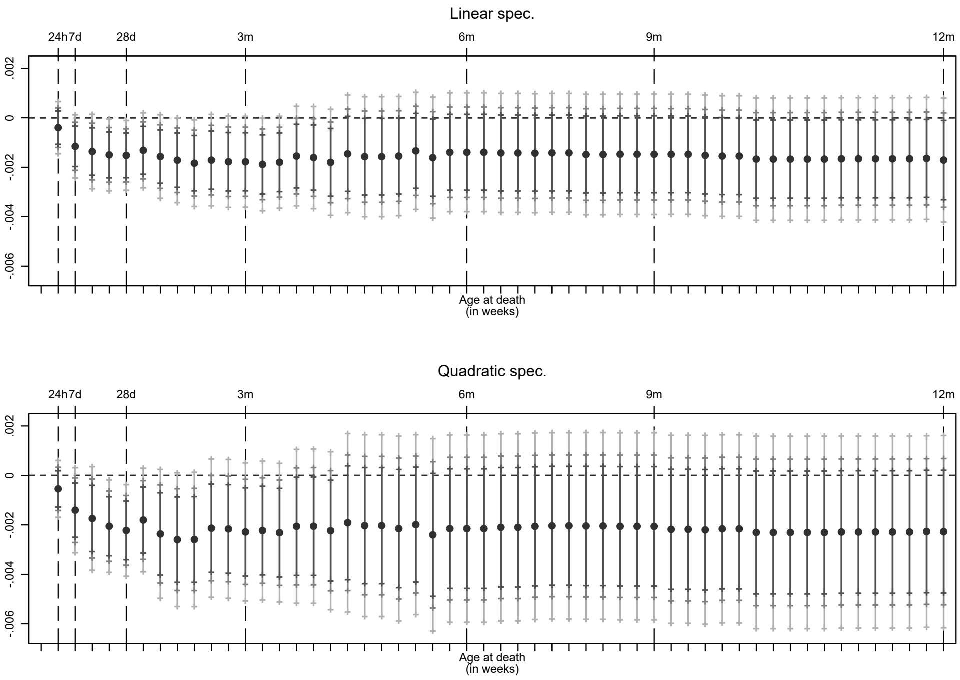
Mortality estimates by age at death. *Donut* sample.



Notes: The graphs report the parametric estimates and 90%, 95% and 99% confidence intervals of the effects of being EHBW on mortality indicators defined according to the week of death of the infant. All estimations control for linear (top panel) and quadratic (bottom panel) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1, and with a birth weight equal to the cutoff value (*Donut* specification).

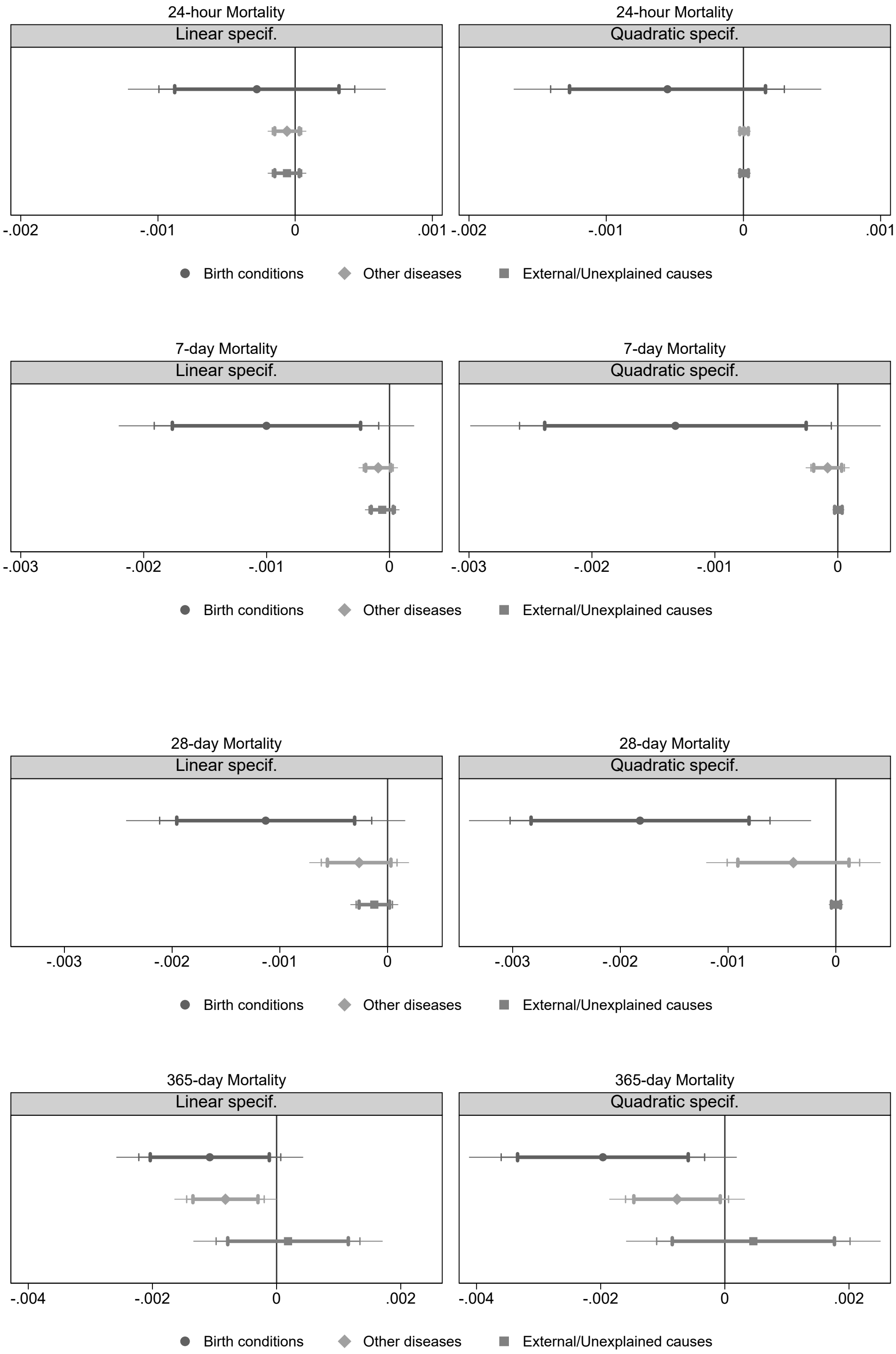
Figure A.8

Mortality estimates by age at death. *Donut1* sample.



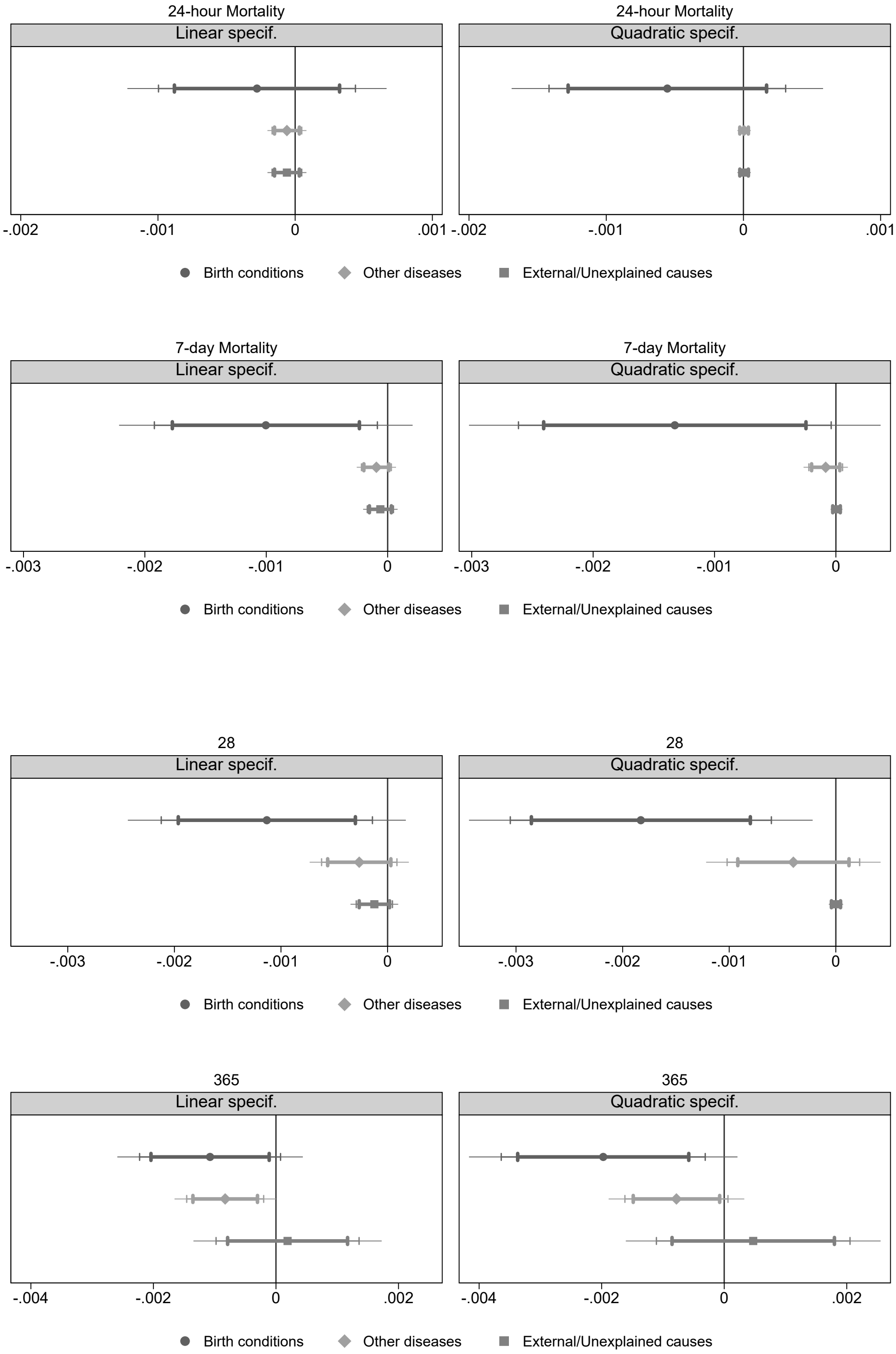
Notes: The graphs report the parametric estimates and 90%, 95% and 99% confidence intervals of the effects of being EHBW on mortality indicators defined according to the week of death of the infant. All estimations control for linear (top panel) and quadratic (bottom panel) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1, and with a birth weight $+/-1$ gram from the cutoff value (*Donut1* specification).

Figure A.9
Parametric estimation of the effect of being EHBW on mortality, by cause of death. *Donut* sample.



Notes: The graph reports the coefficients associated with a variable indicating whether a newborn is EHBW, and the corresponding 99%, 95% and 90% confidence intervals. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. *Birth conditions* include perinatal and congenital causes; *Other diseases* include all causes related to diseases of the respiratory, digestive and nervous systems; *External/unexplained causes* include causes such as accidents, homicides, and SIDS. Sample of U.S. singleton births in 2007-2013 with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1, and with a birth weight equal to 5000 grams.

Figure A.10
Parametric estimation of the effect of being EHBW on mortality, by cause of death. *Donut1* sample.



Notes: The graph reports the coefficients associated with a variable indicating whether a newborn is EHBW, and the corresponding 99%, 95% and 90% confidence intervals. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. *Birth conditions* include perinatal and congenital causes; *Other diseases* include all causes related to diseases of the respiratory, digestive and nervous systems; *External/unexplained causes* include causes such as accidents, homicides, and SIDS. Sample of U.S. singleton births in 2007-2013 with birth weight between 4773 and 5227 grams, after dropping observations with missing information in the variables listed in Table 1, and with a birth weight within $+/-1$ gram from the cutoff.

Table A.12
Parametric regressions for health treatments and mortality around the 4000-gram threshold.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. NICU						
Birth weight $\geq$ 4000 g	0.0012	0.0024	0.0003	0.0004	0.0003	0.0004
	(0.0018)	(0.0026)	(0.0016)	(0.0022)	(0.0016)	(0.0022)
Panel B. Antibiotics						
Birth weight $\geq$ 4000 g	0.0006	0.0010	0.0003	0.0005	0.0003	0.0004
	(0.0013)	(0.0018)	(0.0013)	(0.0019)	(0.0013)	(0.0019)
Panel C. Ventilation						
Birth weight $\geq$ 4000 g	-0.0002	-0.0011	-0.0004	-0.0015	-0.0004	-0.0016
	(0.0011)	(0.0014)	(0.0012)	(0.0015)	(0.0011)	(0.0015)
Panel D. Surfactant						
Birth weight $\geq$ 4000 g	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Panel E. 24-hour Mortality						
Birth weight $\geq$ 4000 g	0.0000	0.0000	0.0000	-0.0000	0.0000	-0.0000
	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Panel F. 7-day Mortality						
Birth weight $\geq$ 4000 g	0.0001	0.0001	0.0000	-0.0000	0.0000	0.0000
	(0.0001)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Panel G. 28-day Mortality						
Birth weight $\geq$ 4000 g	0.0002*	0.0003	0.0001*	0.0000	0.0001*	0.0000
	(0.0001)	(0.0002)	(0.0000)	(0.0001)	(0.0000)	(0.0001)
Panel H. 365-day Mortality						
Birth weight $\geq$ 4000 g	0.0003**	0.0005*	0.0002**	0.0002*	0.0002**	0.0002
	(0.0001)	(0.0003)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
N	2834152	2834152	2821031	2821031	2818461	2818461
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Whole sample	✓	✓				
Donut			✓	✓		
Donut1					✓	✓

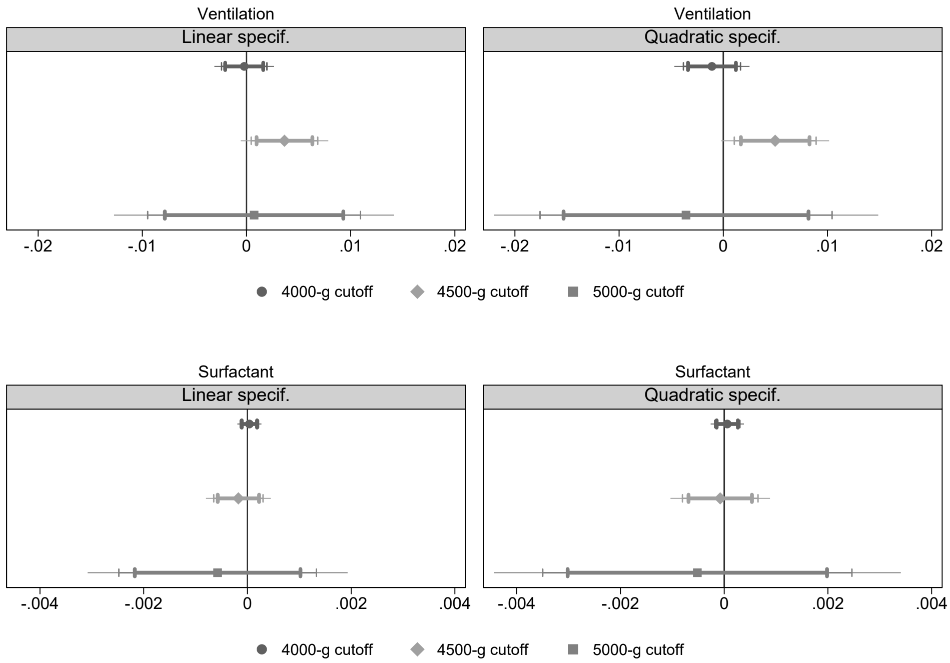
Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 4000-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 3773 and 4227 grams, after dropping observations with missing information in the variables listed in Table 1. The specification *Donut* indicates that observations with birth weight equal to the cutoff (4000 grams) have been dropped from the sample, while the specification *Donut1* indicates that also observations with birth weight within one gram from the cutoff have been excluded. Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

Table A.13
Parametric regressions for health treatments and mortality around the 4500-gram threshold.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. NICU						
Birth weight $\geq$ 4500 g	-0.0007	-0.0025	-0.0011	-0.0032	-0.0008	-0.0027
	(0.0031)	(0.0044)	(0.0031)	(0.0044)	(0.0032)	(0.0045)
Panel B. Antibiotics						
Birth weight $\geq$ 4500 g	-0.0003	-0.0008	-0.0007	-0.0014	-0.0007	-0.0015
	(0.0024)	(0.0036)	(0.0024)	(0.0036)	(0.0024)	(0.0037)
Panel C. Ventilation						
Birth weight $\geq$ 4500 g	0.0036**	0.0050**	0.0034**	0.0046**	0.0034**	0.0046**
	(0.0016)	(0.0020)	(0.0017)	(0.0022)	(0.0017)	(0.0023)
Panel D. Surfactant						
Birth weight $\geq$ 4500 g	-0.0002	-0.0001	-0.0002	-0.0001	-0.0003	-0.0003
	(0.0002)	(0.0004)	(0.0002)	(0.0004)	(0.0002)	(0.0003)
Panel E. 24-hour Mortality						
Birth weight $\geq$ 4500 g	-0.0000	0.0001	-0.0000	0.0000	-0.0000	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Panel F. 7-day Mortality						
Birth weight $\geq$ 4500 g	-0.0001	-0.0000	-0.0001*	-0.0001	-0.0001*	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Panel G. 28-day Mortality						
Birth weight $\geq$ 4500 g	-0.0001	0.0000	-0.0001	-0.0001	-0.0001	-0.0001
	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Panel H. 365-day Mortality						
Birth weight $\geq$ 4500 g	0.0002	0.0004	0.0002	0.0004	0.0002	0.0004
	(0.0002)	(0.0004)	(0.0002)	(0.0004)	(0.0002)	(0.0004)
N	510584	510584	508326	508326	507886	507886
Linear+Interactions	✓		✓		✓	
Quadratic+Interactions		✓		✓		✓
Whole sample	✓	✓				
Donut			✓	✓		
Donut1					✓	✓

Notes: Authors' calculations using linked birth/death certificates data, 2007-2013. The regressions include either linear or quadratic trends in the distance to the cutoff value of birth weight, on each side of the 4500-gram cutoff. All the regressions are weighted using triangular weights. Sample of U.S. singleton births with birth weight between 4273 and 4727 grams, after dropping observations with missing information in the variables listed in Table 1. The specification *Donut* indicates that observations with birth weight equal to the cutoff (4500 grams) have been dropped from the sample, while the specification *Donut1* indicates that also observations with birth weight within one gram from the cutoff have been excluded. Robust standard errors clustered at the gram level of birth weight are in parentheses. Asterisks denote statistical significance at the * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ levels.

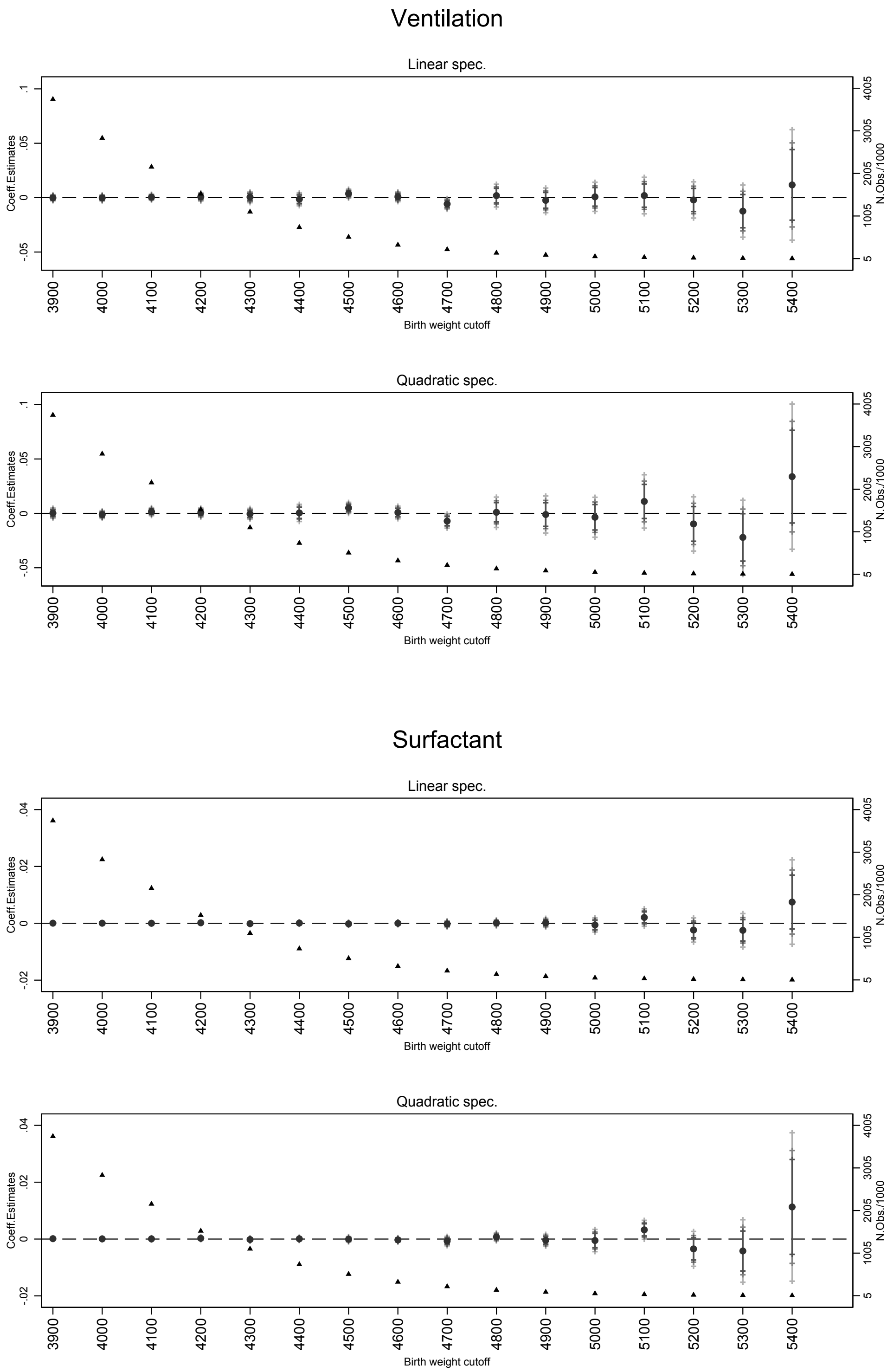
Figure A.11
Parametric estimations of the effects of being HBW on ventilation and surfactant use, at the macrosomic cutoffs of 4000, 4500 and 5000 grams. Whole sample.



Notes: The graph reports the coefficient associated with a variable indicating whether a newborn has high birth weight, i.e. larger than 4000, 4500 and 5000 grams, and the corresponding 99%, 95% and 90% confidence intervals. All estimations control for linear (panel to the Left) and quadratic (panel to the Right) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births with birth weight within 227 grams from the corresponding threshold, after dropping observations with missing information in the variables listed in Table 1.

Figure A.12

Parametric estimation of the effect of being HBW on ventilation and surfactant, by using 100-gram apart thresholds in the 3900- to 5400-gram segment. Whole sample.



Notes: The graph reports the coefficients associated with a variable indicating whether a newborn has high birth weight, i.e. larger than the corresponding cutoff, and the corresponding 99%, 95% and 90% confidence intervals. All estimations control for linear (panel to the top) and quadratic (panel to the bottom) trends, clustering the standard errors at the gram level of birth weight. Sample of U.S. singleton births in 2007-2013 with birth weight within 227 grams from the corresponding threshold, after dropping observations with missing information in the variables listed in Table 1. The triangles indicate the number of observations for each regression sample, whose label is reported in the y-axis to the right.