Free Maternal Health Services and Childhood Mortality: Evidence from Rwanda

Jiwon Park*

September 2021

Abstract

In 2006, Rwanda initiated the Facility-Based Childbirth Policy (FBCP) to promote antenatal care (ANC) and facility-based delivery (FBD). This paper explores the effect of this reform on FBD and ABC use, and childhood mortality rates. To identify the causal effect, I utilize the geographical variation in FBD rate in the baseline period and the timing of the policy in a difference-in-differences framework. My estimates suggest that the health reform increased FBD and the number of ANC visits by 10-14 percentage points and 0.11-0.16 times, respectively. Next, I examine whether the health reform reduced childhood mortality rates. The reform had a substantial effect on the child (under five years) and infant (under one year) mortality rate, 25 and 12 reductions in deaths per 1,000 live births, respectively. On the other hand, there was an insignificant drop in neonatal (30 days) and newborn mortality rates. I show that FBCP induced positive breastfeeding and postnatal smoking behaviors, which may contribute to a reduction in delayed childhood deaths. My findings also suggest that the low service quality may have undermined the treatment effect on neonatal mortality.

Keywords: Facility-Based Delivery, Antenatal Care, Child Mortality, Rwanda

JEL: I1, I12, J10, J19

*Associate Research Fellow, Korea Institute for International Economic Policy, Email: jiwonpark@kiep.go.kr

Developing countries have promoted maternal health services in many different ways to reduce maternal and early neonatal deaths, such as banning traditional midwives, educating and licensing birth attendances, and encouraging antenatal care (ANC) visits and facility-based delivery (FBD) (Doctor, Nkhana-Salimu and Abdulsalam-Anibilowo, 2018). Sound clinical studies prove that a skilled attendant's presence during labor significantly reduces the chance of neonatal deaths in the developed world (De Bernis et al., 2003; De Brouwere, Tonglet and Van Lerberghe, 1998; Kumar et al., 2008). However, many studies find a limited impact of maternal health services on neonatal mortality in India (Fadel et al., 2015; Lim et al., 2010; Powell-Jackson, Mazumdar and Mills, 2015; Randive et al., 2014), Nepal (Powell-Jackson et al., 2009), and Malawi (Godlonton and Okeke, 2016), questioning the effectiveness of the policies.

ANC and FBD directly target maternal and neonatal mortality; however, they may affect the overall health of children and have a delayed effect on mortality rates. ANC and FBD may have an indirect positive impact on infant and child mortality: during mothers' visit, service provider my educate mothers about breastfeeding, nutrition, vaccination, healthy behaviors, and how to treat simple diseases and induce them to visit health facilities more often, which may have a long-term effect (Osungbade, Oginni and Olumide, 2008). Thus, it is important to test whether these maternal and neonatal health services have long-lasting effects; however, this potential effect is often overlooked in the literature.

In this paper, I examine the effects of a policy that promoted maternal-newborn health services in Rwanda. Rwanda initiated the Facility-Based Childbirth Policy (FBCP) in 2006, which provides a full package of ANC and FBD for all pregnant women free of charge. FBD rate has increased rapidly since the policy intervention, as Figure 1 shows, from 30 percent in 2005 to 96 percent in 2015. To evaluate the causal effect of this policy on service use and childhood mortality, I exploit the spatial variation in the program exposure represented by the extent of FBD before the policy intervention. To be specific, I combine the timing of the policy with the FBD rate in the baseline period and construct a difference-in-differences (DiD) estimator. The assumption is that the regions with lower baseline FBD rates have more scope to increase FBD and ANC utilization by the reform in 2006. I use the Rwandan Demographic and Health Survey (RDHS), which contains rich information on the birth history and socioeconomic and demographic variables of mothers and households.

I define the treatment districts as the low FBD districts in which the historical FBD rate is relatively low and show that those areas had a greater increase in FBD by 9.9 to 13 percent. The number of ANC visits increased by 0.11 to 0.16 times and the month at the first visit decreased by 0.13 to 0.21 months, indicating a success of FBCP to promote the use of health services. Next, I test whether this success is associated with reductions in deaths, which is the ultimate goal of the policy. The DiD estimator suggests that the pre-period low FBD use is associated with 25 and 12 fewer deaths per 1,000 live births for children (CMR, death in 5 years) and infants (IMR, death in a year), which is equivalent to 20 and 15 percent reduction, respectively. The reduction in deaths is concentrated on mortality at the age of one year to five years old. The results are robust to using alternative treatment definitions, such as using continuous treatment or adjusting the threshold of defining low FBD districts. Despite a substantial increase in FBD in the treatment districts, I find weak evidence on reduction in neonatal (NMR, death in 30 days) and newborn (NMR7, death in 7 days) mortality. The neonatal and newborn mortality rate is 4.9 and 5.1 lower per 1,000 live births in the low-FBD districts after the reform, respectively, in the most conservative specification; however, they are not statistically significant.

Next, I examine a possible mechanism for reducing CMR and IMR. I find that the FBCP had a positive impact on breastfeeding and postnatal smoking behaviors, which have a long-term effect on childhood health (Azuine et al., 2015; Reichman et al., 2010). However, the overall quality of ANC and FBD was not sufficiently high; most of the mothers did not receive complicated examinations and see a doctor. This may be a reason for the limited impact on NMR and NMR7. I further show that distance to secondary and tertiary facilities reinforces the treatment effect on childhood mortality rates, even for NMR and NMR7, emphasizing the role of service quality, similar to Godlonton and Okeke (2016).

Finally, I explore how FBCP interacted with other health policies that were imposed at a similar time. There were two other policies: Performance-Based Financing (PBF) and a universal health insurance scheme called Community-Based Health Insurance (CBHI). These policies were intended to improve health care quality and access, respectively (Bucagu et al., 2012). I show that the treatment effect on mortality rates did not vary by the district-level intensity of CBHI.[1] However, the impact on mortality rates is stronger in districts exposed longer to PBF. This result again implies that facilities' quality plays a vital role in increasing the impact of FBD and ANC.

[1]The Ministry of Health started the CBHI and PBF pilot programs in 1999 and expanded nationwide in 2006. Thus, pilot districts had been exposed longer to CBHI and PBF.

This paper has two important contributions. First, it contributes to the scant literature investigating the causal effect of maternal health services on the childhood mortality rate. Most previous studies also exploit policy interventions to examine the causal relationship. A notable example is the Janani Suraksha Yojana (JSY) program in India, a conditional cash transfer program that rewards mothers and health providers for FBD. This program has successfully increased the FBD rate, especially among poor and rural households in India; however, there is scarce evidence that it helped reduce NMR (Lim et al., 2010; Powell-Jackson, Mazumdar and Mills, 2015; Randive et al., 2014). Studies in other countries tell a similar story: a financial incentive program in Nepal (Powell-Jackson et al., 2009) and the ban on the traditional birth attendants in Malawi (Godlonton and Okeke, 2016). The results of my paper are consistent with these previous papers.[2] However, I also show that FBD and ANC may have a positive impact on mortality rates beyond the neonatal period, which is a rare finding in the literature.

Second, this paper is one of the few papers examining maternal health services in Rwanda. Rwanda is well-known for the surprising increase in FBD during the last two decades, but few causal evaluations have been conducted. Rwanda is one of the role models of maternal health policies, so it is important to assess whether the seemingly successful free maternal health service program has achieved its ultimate goal of reducing mortality rates. Chari and Okeke (2014) use the staggered roll-out of PBF policy in Rwanda and show PBF increased the FBD use but did not reduce the neonatal mortality rate. My paper focuses on a different policy and finds similar results for neonatal deaths. However, I expand the focus to older children and find an improvement in infant and child mortality rates. If these effects are overlooked, the true impact of maternal health policies would be underestimated. My paper implies that Rwanda was successful in reducing child deaths through promoting FBD and ANC and inducing behavioral changes.

This paper is structured as follows. Section I summarizes the institutional background relevant to this paper. Section II describes the data and descriptive statistics. Section III presents the empirical strategy. Section IV explains the main empirical results and Section V provides some robustness checks. In Section VI, I explore the possible mechanism, and section VII relates the result to other health initiatives. I conclude in Section VIII.

[2] On the other hand, some studies find a meaningful reduction in neonatal mortality through government intervention (Feng et al., 2011; McKinnon et al., 2015; Okeke and Abubakar, 2020).

I Institutional Background

I.1 Health Care Policies in Rwanda

In line with Millennium Development Goals to reduce maternal and neonatal mortality rates, Rwanda has initiated comprehensive health reforms since 2000 (Bucagu et al., 2012). In 2006, the government launched the national Facility-Based Childbirth Policy (FBCP), which provides a full package of ANC and FBD services free of charge regardless of insurance possession. This attempt seems to be very successful; the FBD rate had increased from 37 percent in 2005 to 95 percent in 2010 thanks to the reforms (Figure 1). This increase is notable compared to other sub-Saharan African countries with similar health policies (Doctor, Nkhana-Salimu and Abdulsalam-Anibilowo, 2018). In addition to the FBCP, two other notable programs were imposed nationally in 2006: performance-based financing (PBF), which determines the budget of each health facility based on its performance, and a universal health insurance plan called community-based health insurance (CBHI). The former is intended to improve the quality of the services while the latter is to improve access to (general) health services. See Table 1 for the entire timeline of these events and other important health reforms.

While this paper focuses on evaluating the policy effects of FBCP, two other health programs mentioned above may also interact with FBCP. First, both programs potentially affect the frequency of using maternal health services. Formal studies in other developing countries with CBHI show that having health insurance is associated with a higher probability of maternal care use, especially FBD (Wang, Temsah and Mallick, 2016). Health insurance may also increase the use of general health services, improving both maternal and child health (Ahmed et al., 2018). Furthermore, PBF may increase the utilization of maternal health services because clinics received payments for ANC visits under the PBF scheme, incentivizing health clinics to promote maternal health services (Okeke and N, 2014). Second, if PBF had successfully improved the quality of health facilities and health care, then it may reinforce the impact of maternal health services. Low-quality health care has been recognized as an obstacle to improving people's health in developing countries (Das, Hammer and Leonard, 2008), and maternal health service is no exception (Godlonton and Okeke, 2016). Nevertheless, I find evidence that FBCP alone has an impact on maternal service use and mortality rates. In Section VII, I examine whether these two health programs interact with the treatment effect of FBCP.

I.2 Health Care System in Rwanda

Under the Rwandan health care system, health centers and health posts handle most ANC and normal childbirth (vaginal delivery). Complicated pregnancies are referred to the higher-level health facilities such as district and provincial hospitals that are generally well equipped and capable to perform surgical procedures (Bucagu et al., 2012).[3] Most of the ANC and normal FBD service is provided by trained midwives and nurses in health posts or centers (Lundeen et al., 2019). According to Table 2, from 2006 to 2014, about 80 percent of mothers chose formal health facilities to deliver their children. Note that the rapid increase in FBD is almost solely led by FBD at health posts. FBD at health posts had increased substantially from 5 to 55 percent while it remained similar at health centers. Interestingly, women who gave birth at a government hospital (district or provincial hospitals) rather decreased after 2006. I suspect this is because of an increase in access to primary health facilities; those who have a strong preference for FBD now have an option to visit a close health center or post.

II Data

II.1 Data Sources

The main dataset used is the Rwandan Demographic and Health Survey (RDHS). I use the birth history data of 2005, 2008, 2010, and 2014/2015 waves of RDHS and stack them according to birth year to create a continuous set of births from 2000 to 2014. The birth history data includes all birth that the respondent (woman of reproductive age, 15–49 years old) gave retrospectively regardless of survival. For the children who have died, the respondents provide information on the age of death (in months when they died before 60 months). The RDHS also collects information on the place of birth and ANC visits for children under five years old. The data also provides useful information on households and mothers' socioeconomic status (SES), such as household wealth and mother's education. I use four measures of mor-

[3] The healthcare system in Rwanda reaches from community-level care to the national hospitals. At the most basic level, community workers visit households and identify each household member's healthcare needs. Health posts and centers are the primary care unit. Health posts are smaller than centers, reaching out to the most remote portions of the country. The more complicated illness that cannot be treated in primary care units is referred to higher-level facilities, such as district hospitals (secondary) and provincial and national referral hospitals (tertiary).

tality rates: Child Mortality (death in five years, CMR), Infant Mortality (death in one year, IMR), Neonatal Mortality (death in 30 days, NMR), and Newborn Mortality (death in seven days, NMR7). Following the traditional definition, the mortality rates are scaled per 1,000 live births. When defining each mortality rate, I only include births that passed the threshold of the definition.[4] Since the mortality rates had surged during the Rwandan genocide and thus led to a very different trend in the late 90s, I only include births from 2000 although the RDHS asks the full history of the birth career.[5]

One complication is the inconsistency in administrative districts over time. The Rwandan Government reformed its administrative areas in 2006 from 12 provinces and 106 districts to five provinces and 30 districts. Because of this change, it is difficult to compare the spatial change of FBD and other health outcomes across time. Using the geocodes of the primary sampling units (PSU, or clusters), I match 2008-2014 PSUs to the 106 old districts and construct a dataset with consistent geographic areas. Because the RDHS displaces the GPS coordinates for privacy issues,[6] some measurement error still exists.

For additional information on the district characteristics, I use the Integrated Household Living Condition Survey (EICV) of Rwanda, 2005 and 2014 waves. This survey provides information on changes in people's well-being, such as economic conditions, education, health and housing conditions, household consumption, etc. I use it as a supplementary data set to calculate the average insurance coverage rate, travel time to health facilities, and total population by district and year that RDHS does not provide. When calculating the average insurance coverage by district, I restrict the EICV sample to women 15-49 years old as the RDHS sample consists of reproductive-aged women.

II.2 Descriptive Statistics

Table 2 presents the summary statistics of the resulting data. I present the pre- and post-period relative to the free FBD policy. Panel A and B show the birth characteristics and mother's and household characteristics, respectively.

[4]For example, for CMR, I include children who were born at least five years (60 months) before the survey month.

[5]Including earlier birth can be potentially problematic for the following reasons as well. First, it is more likely that mothers imprecisely remember the child's information, especially when she did not survive (age at death, year of birth, and even omitting the birth). Second, I need to assume that the birth happened in the same district where the respondent currently lives. When including older births, the measurement error increases.

[6]The coordinates are displaced with some error; zero to two kilometers for the urban clusters and zero to five kilometers for rural.

Three things are notable in Panel A. First, the FBD rate had increased significantly, from 32 percent to 78 percent. As mentioned above, the increase is largely driven by an increase in FBD at health posts, the most primary level health facility. On the other hand, the probability of using ANC services had not changed because almost every pregnant woman had already been visiting ANC before the reform. However, after the reform, women had ANC visits earlier and more often during their pregnancy. Mortality rates had declined substantially for all four measures. To be specific, the CMR and IMR had almost halved, from 124 death to 66 death and from 78 to 43 deaths per 1,000 birth, respectively. The reduction in NMR and NMR7 is not as dramatic, however, still large. Panel B shows that the overall SES of mothers and households has only slightly improved during this period. Mothers who gave birth after 2006 are more likely to have any formal education. Other characteristics remained very similar.

III Empirical Strategy

III.1 Main Specification

To identify the causal effect of the FBCP on the use of maternal health services and mortality rates, I exploit spatial and temporal variation in the 'intensity of exposure' to the policy in a difference-in-differences (DiD) framework. To be specific, I use the baseline district-level home delivery rate (1-FBD rate) as the proxy for the intensity of exposure. In other words, my identification relies on the hypothesis that districts with low baseline FBD rates had a greater scope to increase the use of maternal health services, and thus are more affected by the policy. A similar identification strategy is found in previous works like Bleakley (2007); Godlonton and Okeke (2016); Osili and Long (2008).

I take the districts with a low FBD rate (below median) as the treatment districts and call them low-FBD districts.[7] Figure 2 displays how the treatment and control districts are distributed in Rwanda. Kigali area (capital, center of the country) and other large cities are mostly control treatment; however, the treatment districts are well-distributed within the country.

[7] The districts here are old districts that were used until 2006. See Section II for further information on administrative areas in Rwanda.

Specifically, the main regression equation is as follows:

$$y_{idpmt} = \beta_1 Low\ FBD_d \times \mathbb{1}(t \geq 2006) + X_i + \tau_d + \eta_m + \theta_t + \alpha_p \times t + \varepsilon_{ipdmt}, \quad (1)$$

in which y_{idpmt} is an outcome for child i born in district d in province p in month m of year t. The outcome variables include an indicator for FBD use, ANC information, and mortality rates. $Low\ FBD_d$ is one if the district has a low baseline FBD rate (or high home delivery rate) and $\mathbb{1}(t \geq 2006)$ is an indicator function whether t is greater or equal to 2006. X_i is a vector of birth and household characteristics. τ_d is the district fixed effect, and θ_t is the year fixed effect. η_m is the birth month fixed effect, controlling any possible seasonality. I include province-level time trends to absorb any long-term linear trend in the outcome variables that may vary across provinces. 2005 RDHS is representative at the old district level while the rest of the waves are at the new district level. Thus, I use the corresponding districts to cluster the standard errors. The coefficient of the interest is β_1, the reduced-form impact of the policy change on the outcome variables, capturing the difference in change in the outcome variables before and after the reform between the districts of high and low FBD.

III.2 Validity of Identification Strategy

The identifying assumption for Equation 1 is that the high FBD districts are a good control group for the low FBD districts. In other words, the trend of treatment and control districts should evolve in parallel in the absence of the treatment. A similar pre-trend between treatment and control districts suggests that the post-trend would have progressed similarly. To assess the existence of pre-trends, I present the trend of FBD and ANC use and mortality rates in both treatment and control districts in Figure 3 and 4, respectively. The vertical dashed line indicates the implementation of FBCP. The figures support that trends of FBD and ANC use are similar in treatment and control districts. The FBD rate and the number of ANC stayed stable from 2000 to 2005, followed by a rapid increase in service use. The month at the first ANC was already in a downward trend in both treatment and control districts in the pre-period, and the trend got accelerated after the reform. Notably, while the maternal service use is higher in control districts in the whole period, the differences get smaller in the post-period. There is also strong graphical evidence for mortality rates; while the relatively small sample size of RDHS gives an unsmooth trend of mortality rates, there were parallel downward trends for all mortality rates in the pre-period. Similar to maternal service use, the mortality rates converge after the reform in treatment and control districts. In addition, province-specific time trends in Equation 1 control for any effect through differential trends across regions, adding more robustness to the identification strategy.

Next, I conduct a placebo test to reject the hypothesis that the effect on mortality rates is confounded by a concurrent change in other factors that affect childhood deaths. For example, mortality rates may have been reduced more in treatment areas, not because of the policy, but because mothers in the treatment areas got relatively healthier, more educated, or wealthier. To address this concern, I examine whether changes in observable characteristics are associated with the treatment status. While this test is not complete for exclusion restriction, the absence of significant association with observable characteristics suggests similar results for unobservable characteristics (Altonji, Elder and Taber, 2005).

Figure 5 graphically presents the result of the balance test. In this figure, I plot the coefficients of the DiD estimator on each outcome variable. If the point estimate is statistically significant, it indicates a differential change between the two groups. Most of the coefficients are not distinguishable from zero. Birth characteristics such as sex, twin indicator, and whether the mother is under 20 (young mother) are all uncorrelated. The probability of being the first child decreased; This implies that the number of children in the treatment districts had relatively increased. In other words, the decline in fertility was smaller in treatment areas. The treatment status is not associated with the socioeconomic status of the household such as mothers' education, possession of automobile and pipe water, and wealth index. However, the point estimate for living in an urban area is significant. I suspect that urbanization was faster in treatment districts because these districts consist more of rural areas. Overall, results in Figure 5 indicate that treatment status balances almost all observable characteristics, and the research design is unlikely to be biased by changes in unobservable variables.

IV Results

IV.1 Effect on FBD and ANC

I present the DiD estimates of FCBP on FBD and ANC in different specifications in Table 3. The dependent variables are an indicator for FBD, number of ANC visits, and the month of pregnancy at the first ANC visit in Panel A, B, and C, respectively. Column 1 shows the basic specification without any control variables. In column 2, I include birth controls such as sex, birth order, an indicator for twins, and mother's age at birth and its square term. Column 3 adds SES variables, including mother's education and marriage status, household wealth in quintile, and an indicator for urban, pipe water, and possession of the automobile. Column 4, my preferred specification, additionally controls for province-specific linear time trends.

In all panels, the point estimates are stable across the specifications. In Panel A, FBCP significantly increased the FBD rate by 10.4 percent in the most conservative specification. Panel B and C suggest that FBCP positively affected prenatal care use as well: mothers took 0.13 more ANC visits and 0.14 months earlier. The results in Table 3 are consistent with Figure 3. In Appendix Figure A.1, I present the results in the event study framework, which shows a consistent increase in service use over time.

IV.2 Effect on the Mortality Rates

The previous results show that the FBCP in 2006 successfully increased the use of maternal health services in Rwanda. Here, I examine whether this is associated with a reduction in childhood mortality rates. The dependent variables are an indicator for deaths, and I multiply the point estimates by 1,000 to match the standard definition of the mortality rates (deaths per 1,000 live births). To test the comprehensive impact of FBCP on childhood mortality rates, I use the CMR (death in five years), IMR (one year), NMR (30 days), and NMR7 (seven days) as the dependent variables.

The DiD point estimates in the preferred specification are presented in Table 4.[8] Each cell is from separate regressions using Equation 1. Dependent variables are described in the column titles. Note that there is a large and significant decline in CMR and IMR. FBCP reduces CMR and IMR by 25 and 12 deaths per 1,000 live births, which correspond to 20 and 15 percent, respectively. On the other hand, I find no statistically significant impact on NMR and NMR7. This result has an important implication because the FBCP policy is mainly targeting maternal and neonatal mortality (Bucagu et al., 2012). In fact, this is not a new finding; many papers investigating government maternal health programs find no significant effect on NMR (Godlonton and Okeke, 2016; Powell-Jackson et al., 2009, 2016; Reichman et al., 2010). My results suggest that while FBCP has a limited impact on reducing deaths immediately, it may

[8] See Appendix Figure A.2 for event study results.

have reduced childhood deaths that happen later, which is an important and novel finding.

V Robustness Checks

V.1 Timing of Deaths

Previously, I present that the decline in mortality rates is stronger for CMR and IMR. However, the significant effect may be coming from the extensive definition of CMR and IMR, not because of the actual timing of deaths. Mortality rates are inclusive; CMR includes IMR, NMR, and NMR7. In Table 5, I investigate whether the death was coming from the exclusive timing; mortality rates of one to five years old (CMR-IMR), 30 days to one year (IMR-NMR), and seven days to 30 days. When estimating the impact on death in one to five years, I remove the sample who died before one year.

As expected, the treatment effect is strongest on deaths in one to five years. In column 1, I find that FBCP reduced mortality rates of children of one to five years old by 14.4 deaths per 1,000 live births. The decline in deaths during one to 12 months is also large although statistically insignificant because the treatment effect on IMR was marginally significant. Note that the sum of the three estimates in columns 1 to 3 (-23.27) is similar to -25.06, providing more robustness. Thus, FBCP has a delayed effect on childhood mortality rates, concentrated on one to five years.

V.2 Alternative Definitions of the Treatment

Before investigating the mechanism, I use alternative definitions of the treatment status for a robustness check in Table 6. My main model uses a binary treatment variable, using the median of baseline FBD rate as a threshold. This may be considered somewhat arbitrary, so I show my results are not sensitive to the choice of threshold or using other definitions for the treatment.

Panel A uses the home delivery (1-FBD) rate in a continuous form as the treatment variable. FBD rate increased by 47 percent when the baseline FBD rate decreases from 100 to 0 percent. Because of the scale of the treatment variable, the point estimates in Panel A are larger than the results in Tables 3 and 4. For example, the FBD rate increases by 4.6 percent after the reform in districts where the pre-period FBD rate is 10 percent lower. Panel B defines the low FBD districts as districts whose FBD rate is below the top 25th percentile. Because this definition results in a larger difference in pre-period FBD rates between treatment and control districts,[9] by defining the treatment variable this way, I get larger and more precise estimates for most outcome variables. However, limiting control districts to the top 25 percent of the FBD rate results in comparing rural and urban areas. To include rural areas in the control group, a more generous definition of treatment status is necessary.[10] In sum, my main results are not sensitive to the functional form or the choice of threshold.

In Panel C, I define a composite index that summarizes the pre-period maternal health service use (both FBD and ANC). I perform Principal Component Analysis (PCA) with district-level FBD rate, frequency of ANC visits, and month at the first ANC and take the first principal component (PC1) as the indicator.[11] Similar to the main specification, I define the treatment districts as the districts where their composite index is lower than the median (low use of maternal health services). Because I include the prenatal care measures as the treatment intensity measure, the point estimates get larger and more precise in columns 2 and 3. The impact on mortality rates is similar to the main specification with slightly smaller point estimates, although not precisely estimated.

VI Possible Mechanism

VI.1 Breastfeeding and Smoking

In the previous section, I find a positive impact on CMR and IMR but a weak effect on NMR and NMR7. This result may seem counterintuitive because NMR and NMR7 are direct targets of the policy. However, Reichman et al. (2010) point out that prenatal care may be "too little too late" to reduce NMR and NMR7, but improve health-related parenting practices like breastfeeding and smoking. Short- and long-term effects of breastfeeding are well-known; it prevents infectious diseases and reduces morbidity, which affects mortality rates in later life (Horta and Victora, 2013). Medical literature also supports the benefit of proper breastfeeding

[9] Before 2006, FBD was concentrated on a few districts, mostly in the Kigali area and other large cities.

[10] This specification estimates the result more precisely. However, there is a differential pre-trend in FBD rates between treatment and control districts, thus, I did not use it as the main specification.

[11] See Vyas and Kumaranayake (2006) for further information on PCA.

and links to CMR and IMR (Azuine et al., 2015). In addition, prenatal smoking and postnatal secondhand smoking are associated with sudden infant death syndrome, respiratory infections, asthma, etc (USDHHS, 2006). These behavioral changes may not be sufficient enough to reduce immediate deaths but have longer-term impacts. In Table 7, I investigate whether FBCP changed monthers' breastfeeding and smoking habits.

For breastfeeding, I assess three outcomes: duration of breastfeeding in months, whether breastfed more than six months, and whether the baby was breastfed in the first hour of life..[12] In columns 1 and 2, I restrict the sample to births that happened at least six months before the survey month. The point estimates indicate that FBCP increased breastfeeding duration by almost a month and the probability of breastfeeding more than six months by 2.12 percentage points. The impact on breastfeeding immediately is also high, 2.3 percentage points, although not statistically significant.

Columns 4 and 5 examine mothers' smoking behavior before and after birth. I define postnatal smoking status using the recent five-year birth samples. Because whether the mother had smoked during pregnancy is not available, I define prenatal smoking status with currently pregnant and smoking women in each survey. When estimating the treatment effect on prenatal smoking, I use the survey years, instead of using birth years, in Equation 1. The point estimate in column 4 indicates that postnatal smoking decreased by 1.35 percentage points. This is very large considering the average postnatal smoking before the reform was 5 percent. Column 5 shows a similar decline in prenatal smoking; however, the point estimate is not precisely estimated because of the small sample size.

VI.2 Quality of ANC and FBD

The main results show that the increase in health services use did not translate into a decline in NMR and NMR7 but reduced CMR and IMR. In this section, I present a possible mechanism for this.

While Rwanda was successful in increasing access to maternal health services, the quality of the services may not have been sufficient enough to reduce NMR. Table 8 presents whether ANC and FBD include certain factors.[13] Mothers are more likely to get their blood pressure and blood checked at ANC visits. However, other more complicated factors have no effect. In columns 3 to 7, FBCP did not increase the probability of getting a urine test, tetanus toxic

[12]WHO recommendations

[13]These factors are a subset of the WHO (2016)'s recommendation for ANC.

shot, drug for malaria, iron supplements, and examination by a doctor. [14] In addition, there is nearly zero effect on the FBD by a doctor, c-section, and postnatal care.

This is not a surprising finding. Table 2 shows that the increase in FBD was mainly driven by health posts, the most primary level facilities. The overall quality of health facilities in Rwanda, especially at the primary level, is still poor; for example, only one percent of health centers have X-ray machines. 45 percent and 13 percent of health centers do not have an autoclave and refrigerator, respectively, in 2016. Also, health posts and centers lack the capacity and equipment for a urine test (RMOH, 2017*a,b*). Furthermore, Rurangirwa et al. (2018) show that nurses and midwives in ANC services in Rwanda failed to report some important conditions that require an urgent referral and transfer to a higher level of health facility. There was also a lack of formal training; over 90 percent of nurses and midwives had not received in-service training over the past two years and over half never had. FBD is no different. C-sections are available at the district or provincial hospitals (secondary or tertiary facilities); however, the referral and transfer process is often not smooth. For example, travel time is often too long and patients need to wait too long from the cesarean decision to incision (Harrison and Goldenberg, 2016; Niyitegeka et al., 2017). If complicated deliveries were not successfully transferred in some areas, it might explain why newborn and neonatal mortality rates are relatively less affected. Surprisingly, the use of postnatal care does not increase as well, although postnatal care is included in FBCP. Overall, My results suggest that the quality of ANC and FBD may not be good enough to have an immediate effect on childhood death.

Godlonton and Okeke (2016) show that banning traditional midwives in Malawi did not reduce NMR in general; however, there was a significant decline in villages where the closest health facility's quality is high. Unfortunately, I cannot do a similar analysis with Rwanda because of data limitations. In the next subsection, I investigate whether proximity to secondary hospitals mattered to support the importance of service quality.

VI.3 Relation to Distance to Health Facilities

Most ANC and FBD happens in the primary level facilities–health posts and centers. When there is an urgent situation, patients are supposed to be referred to the district or provincial hospitals. This process is difficult when the hospital is too far away or transportation is poor (Aggarwal, 2021; Niyitegeka et al., 2017). If a mother lives close to a hospital, it would be more

[14]See Campbell and Graham (2006) for further information on each test.

convenient for her to visit the hospital when she was told of pregnancy complications and to get transferred under emergency, and potentially reduce the chance of early deaths. In Table 9, I explore this possibility.

The RMOH provides location information of current health facilities of all types. I only include the provincial and district hospitals that were already operating in 2006.[15] Using the geocodes of the facility and villages (in RDHS), I calculate the distance to the closest district or provincial hospital and divide the group into two groups in columns 1 and 2. The threshold distance is 8.8km, the median distance. Because there may be a large variation in actual travel time regardless of the distance due to road and transportation conditions, I use the average travel time by districts calculated using 2005 EICV in columns 4 and 5. The median travel time is 205 minutes.[16] [17]

Because mothers mostly visit health posts or centers for FBD and ANC, the impact on FBD and ANC use is similar in both groups of districts in columns 1 and 2 of Panel A. When using travel time in columns 4 and 5, there is a larger impact on districts where travel time to hospital is long, however, not statistically significant. In Panel B, I compare the treatment effect on mortality rates. While it is not statistically different in columns 1 and 2, the point estimates are larger in villages with shorter distances to hospitals. Especially, the point estimate on NMR and NMR7 are both large and statistically significant. NMR and NMR7 declined by 9.3 and 10.7 deaths per 1,000 live births in villages with greater access to hospitals, respectively. In columns 4 and 5, I compare districts with a longer vs. shorter travel time to a district hospital. The overall pattern is similar to columns 1 and 2; larger point estimates in districts with shorter travel time. The differences are significant for CMR and IMR. If we believe provincial and district hospitals offer better quality services and can cope with emergencies, then this table implies that the quality of health services and referral systems play an important role.

[15] RMOH had opened only five hospitals from 2006 to 2015 (RMOH, 2009, 2017*b*)

[16] EICV asks travel time to health facilities to each household head. I take the district-level average of travel time. This information is less accurate, however, because the question did not specify the transportation means.

[17] There was a substantial increase in the number of health posts and centers, and unfortunately, any information on opening dates of the lower-level facilities is very incorrect. Thus, analysis using 2015 facilities is prone to endogeneity. Nevertheless, I conduct a similar analysis for health centers in Appendix Table A.2.

VII Relation to Other Health Policies

Previously I show there were other health policies in the 2006 health reform in Rwanda. This section examines whether the treatment effect varies depending on the intensity of two other health programs: performance-based financing (PBF) and free universal insurance (community-based health insurance, or CBHI) (See Section I.). In Table 10, I show how these two policies interact with FBCP.

PBF started as a pilot program in three districts in the early 2000s. Thus, these districts were already exposed to PBF before the government expanded it as a nationwide program. If PBF was successful, then the average quality of facilities would be higher in these pilot districts. Considering the results in Section VI.2, longer exposure to PBF may affect the treatment effect. In columns 1 and 2, I separately estimate the treatment effect of FBCP in the pilot districts (districts that accept PBF earlier) and other districts (later). In Panel A, there is weak evidence that PBF reinforced the treatment effect of FBCP. I find a stronger effect on the number of ANC visits for PBF-later districts; however, it is inconsistent for the rest of the outcome variables. On the other hand, there is a consistent pattern in effects on mortality rates. The decline in mortality rates is greater in districts that implemented PBF earlier. Notably, the impact on NMR and NMR7 is large and significant, although not statistically different with point estimates in column 2. While PBF itself may not have increased the treatment effect of free FBD policy, my results imply that it may have improved health facilities' quality and thus reduce mortality rates.

Next, I explore how CBHI interacted with FBCP. Health insurance increases the frequency of using (general) health services, impacting the health of women and children. Also, mothers may use maternal health services more often as they get more familiar with facilities (Wang, Temsah and Mallick, 2016). From 2006, insurance coverage had increased significantly in Rwanda thanks to the expansion of CBHI. Like PBF, CBHI started as a pilot program in 1999 in three Health Districts and then became a national program in 2006 (Nyandekwe, Nzayirambaho and Kakoma, 2014).[18] This pilot program provides variation in insurance coverage before 2006, proxying the intensity of exposure to CBHI across regions. In other words, districts without CBHI experienced a greater increase in insurance coverage after 2006. Due to the lack of data, I cannot match each PSU to the Health Districts. Thus, I use the EICV and

[18]There are 40 Health Districts in Rwanda, which is a separate administrative area. They largely match the new 30 districts.

estimate the insurance coverage change between 2005 and 2014 in each district and use it to measure the intensity of exposure to CBHI.[19]

In columns 4 and 5 of Table 10, I compare the treatment effects on outcome variables in districts with larger vs. smaller changes in insurance coverage.[20] Because CBHI is related to improving the access to health services, it reinforces the treatment effect of FBCP on FBD. The treatment effect on ANC use is larger in column 4, but not statistically significantly different. CBHI also has a limited impact on the treatment effect on mortality rates in Panel B.[21]

VIII Conclusion

Many developing countries have lowered the financial barriers for maternal health services during the last thirty years to reduce mortality and morbidity. The evaluation of these programs is controversial; some of the well-known programs had a disappointing impact on maternal and neonatal mortality rates. However, most of the previous works concentrate on the impact on immediate deaths of newborns, overlooking and underestimating the potential long-term effect of the maternal health services programs. This paper provides the first empirical evidence of the impacts of free maternal health on childhood mortality rates beyond the neonatal period in Rwanda.

Rwanda is globally praised for its success in promoting FBD and ANC after initiating the Facility-Based Childbirth Policy (FBCP) in 2006. To examine the causal effect of this policy, I exploit a difference-in-differences framework that relies on the variation in FBD rate prior to the policy implementation. I show that the FBCP increased FBD by 10 percentage points. In addition, FBCP increased ANC visits by 0.13 times and made mothers visit ANC earlier by 0.14 months. The policy successfully reduced CMR and IMR by 25 and 12 deaths per 1,000 live births, respectively; however, had a limited impact on NMR and NMR7.

To examine the mechanism of how the policy had a long-term effect on childhood deaths, I explore the impact on breastfeeding and smoking, two important behavioral factors that may affect the survival rates of infants. I find that FBCP made mothers breastfeed longer, especially more than six months, and less likely to smoke during the postnatal period. Next, I

[19]Before the expansion in 2006, some districts independently had their own CBCHI or other public health insurance. Thus, comparing pilot and non-pilot districts may not be a good empirical strategy.

[20]Large increase districts are mostly districts with low baseline insurance coverage. Separating the sample by baseline insurance coverage results in a similar result (Results available upon request).

[21]I test the treatment effect of CBHI using Equation 1 in Appendix Table A.4. It seems that the expansion of CBHI is not associated with an increase in FBD and ANC use and a reduction in mortality rates.

investigate the quality of FBD and ANC to examine why there is limited impact on NMR and NMR7. I show that most of the ANC visits, as well as FBD, lack complicated examinations and procedures. The low quality of services at health posts and centers, where most of the deliveries happen, seems to be the obstacle. I support this by showing that the impact on mortality rates, even for NMR, is strong and significant in villages with better access to secondary and tertiary facilities. Also, districts that were exposed longer to performance-based financing (PBF) benefited more from FBCP, emphasizing the importance of service quality.

My results suggest that FBD and ANC may be still important although they may not immediately have a visible impact on mortality rates, however, have a long-term effect. Research evaluating similar policies in other countries points out this limitation and asserts a further investment in a fully functioning referral system and quality of maternal health services (Campbell and Graham, 2006; Godlonton and Okeke, 2016; Powell-Jackson, Mazumdar and Mills, 2015). While it is a valid comment, I argue that omitting mortality in later childhood may underestimate the true effect of the policies. FBCP in Rwanda had positive effects on health-related behavioral outcomes such as breastfeeding and smoking. As the literature shows that these behavioral changes have a long-term effect, we need to expand to the long-term outcomes when evaluating maternal health policies. Of course, efforts to improve access to quality services and establish a well-functioning referral system must come together.

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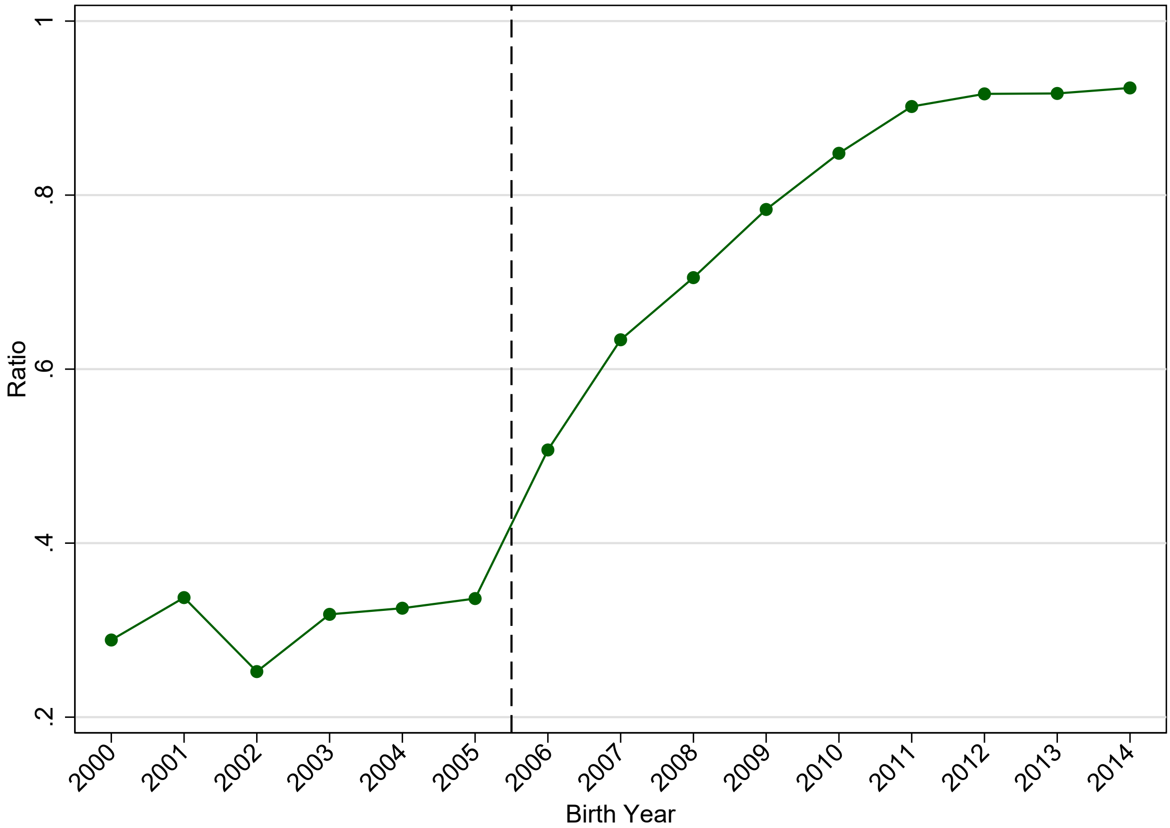
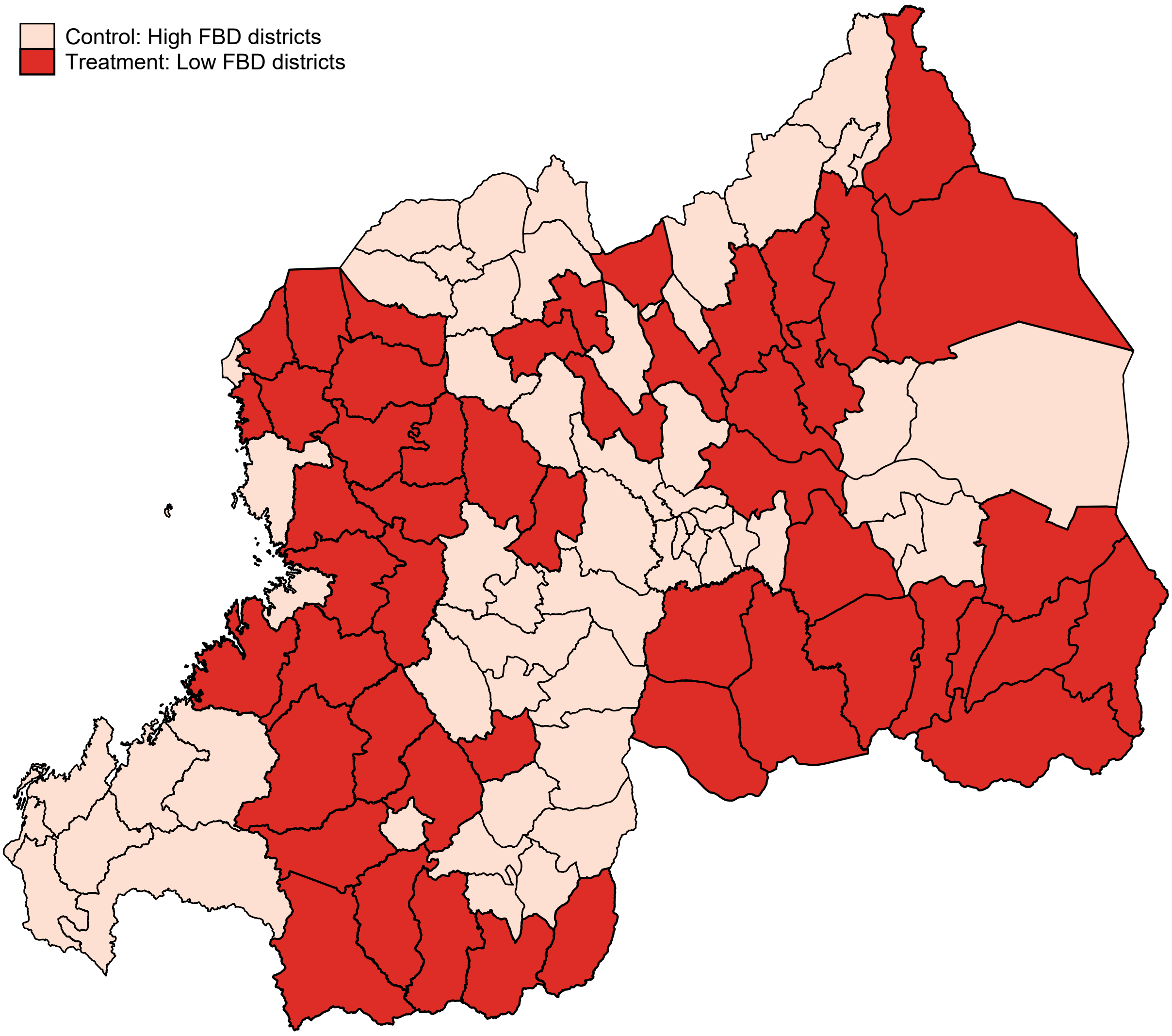
Figures

Figure 1: Trend of Facility-Based Delivery in Rwanda



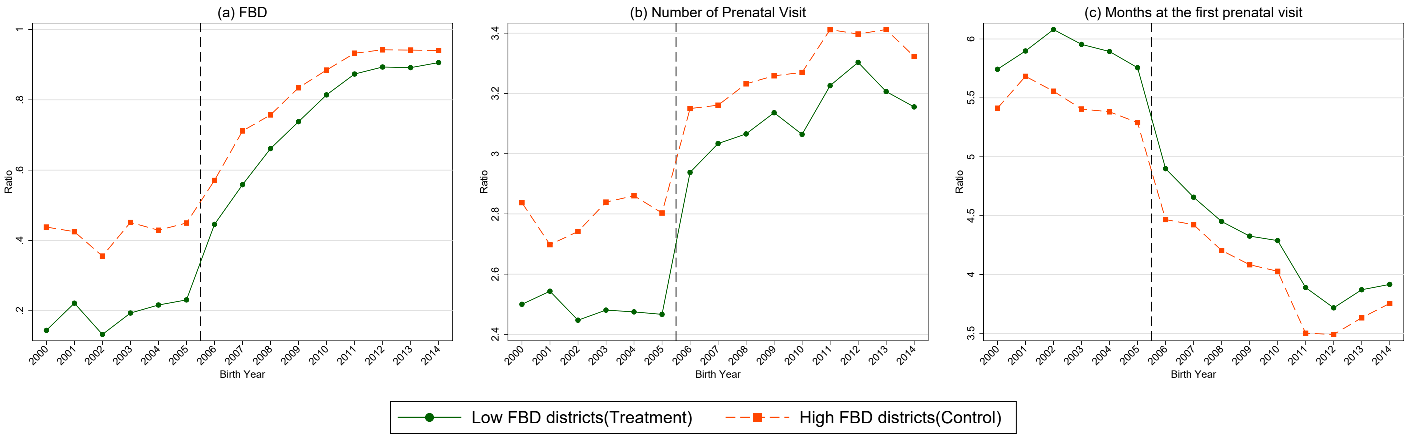
Note: Data from the Rwandan Demographic and Health Survey (RDHS). I combine multiple rounds of RDHS to show the trend of FBD. The Facility-Based Childbirth Policy (FBCP) was implemented in 2006, and the dashed line separates before and after the policy intervention. The figure presents a steep increase in FBD rate after the policy implementation.

Figure 2: Treatment/Control Assignment



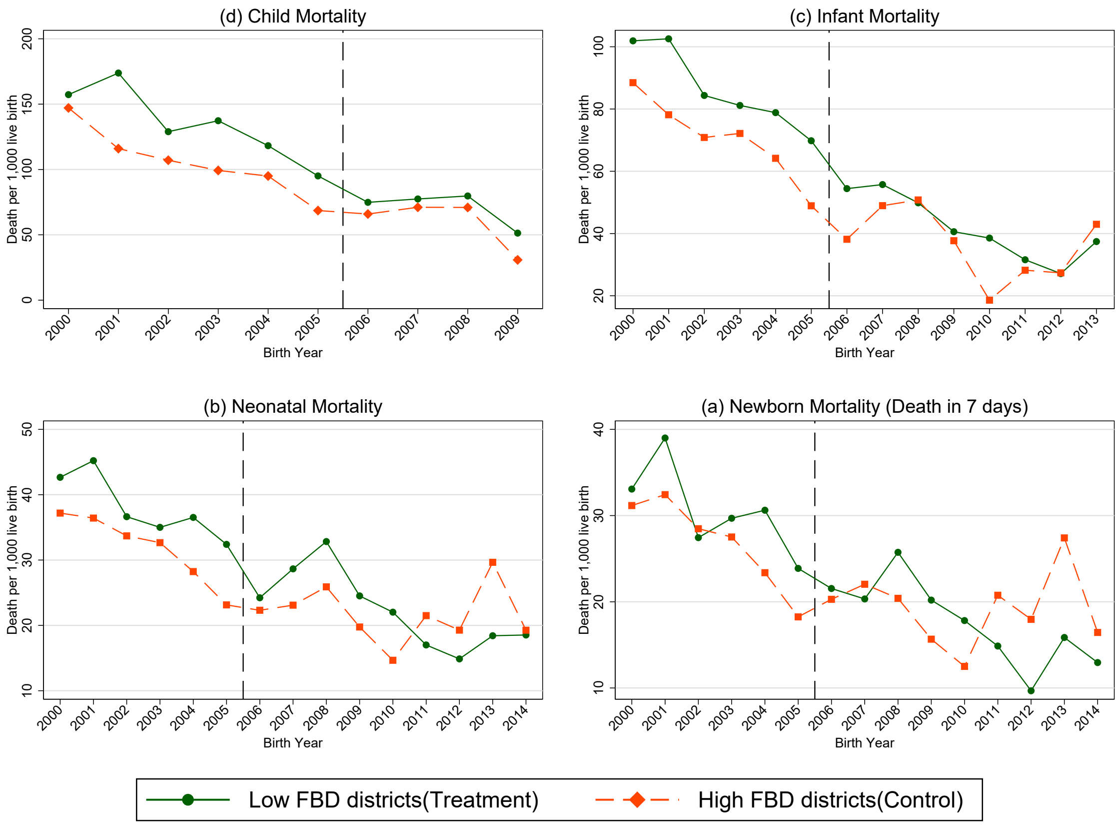
Note: This figure shows the map of Rwanda with its administrative districts in 2005. The treatment districts or the low FBD districts are depicted in the darker shade. The treatment districts are districts whose baseline average FBD rates are below the 50th percentile. High FBD or control districts are concentrated on the Kigali area (center of the country) and other urban cities, however, not entirely.

Figure 3: Trend of Facility-Based Delivery and Prenatal Care



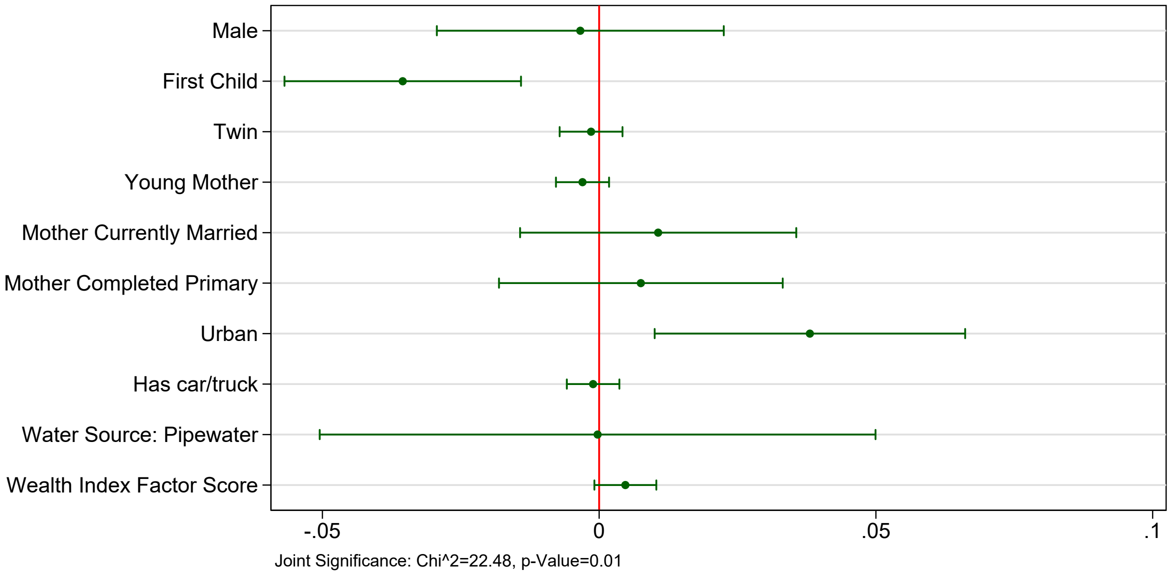
Note: This figure shows the trend of FBD (Panel A), the number of ANC visits (Panel B), and the month at the first ANC visit (Panel C) in treatment and control districts. Treatment and control status is defined as the same in Figure 2. The solid green line and dashed orange line represent treatment and control districts, respectively. Three figures all show that the difference between treatment and control districts got smaller after 2006, implying the policy was effective.

Figure 4: Trend of Mortality Rates



Note: This figure shows the trend of CMR (deaths in five years), IMR (one year), NMR (30 days), and NMR7 (seven days) by the treatment status. Treatment and control status is defined as the same in Figure 2. The solid green line and dashed orange line represent treatment and control districts, respectively. Because I cannot determine the survival status of children who have lived less than the threshold period, I drop the observations when estimating the mortality rates. For example, babies born less than a year ago are all omitted when estimating the infant mortality rate. Therefore, the sample size is smaller when estimating infant mortality and child mortality. It seems that CMR and IMR have relatively declined in treatment districts, while it is not clear for NMR and NMR7.

Figure 5: Balance Test



Note: This figure graphically shows the result of the balance test. I separately run regressions using Equation 1 with the dependent variables described in the vertical axis and plot the DiD estimates (β_1 with 95% confidence interval. Controls are not included. Standard errors are clustered at the proper district level. (Old districts for the 2005 wave and new districts for the rest of the data.)

Tables

Table 1: Rwanda Health Policy Events, 1999-2010

Year	**Policy Description**
1999	Pilot project on community based health insurance (CBHI)
2001	Performance-based financing contracts (PBFC) pilot projects
2005	Rwanda Health Sector Policy (including Sexual and Reproductive Health)
2006	**Facility-Based Childbirth Policy** **PBFC introduced in all districts** **CBHI becomes mandatory** National family planing policy
2007	Government declares family planning a development priority
2008	Health facilities made autonomous Community health program enhanced Maternal death reviews institutionalized

Source: Bucagu et al. (2012)

Table 2: Summary Statistics

	Birth Year≤2005			Birth Year≥2006		
	Mean	SD	Observation	Mean	SD	Observation
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Birth Characteristics						
Male	0.51	0.50	33,455	0.51	0.50	25,205
Birth Order	3.62	2.30	33,455	3.31	2.24	25,206
Twin	0.03	0.17	33,455	0.03	0.17	25,207
FBD	0.32	0.47	5,969	0.78	0.42	13,751
FBD at Health Post	0.05	0.22	5,969	0.55	0.50	13,751
FBD at Health Center	0.16	0.36	5,969	0.17	0.37	13,751
FBD at Government Hospital	0.10	0.29	5,969	0.04	0.20	13,751
Prenatal Care	1.00	0.04	5,969	1.00	0.06	13,751
Number of Prenatal Visits	2.65	1.02	5,969	3.19	0.89	13,751
Month at First Prenatal Visit	5.63	1.49	5,969	4.14	1.48	13,751
Child Mortality (CMR, Under five years)	123.60	329.13	22,097	65.68	247.74	6,531
Infant Mortality (IMR, Under one year)	79.40	270.36	31,810	42.86	202.56	21,179
Neonatal Mortality (NMR, Under 30 days)	35.07	183.96	33,455	23.22	150.59	25,205
Newborn Mortality (NMR7, Under seven days)	28.75	167.10	33,455	19.39	137.88	25,205
Panel B. Mother and Household Characteristics						
Age at Birth	28.22	6.31	33,455	28.41	6.28	25,205
Currently Married	0.85	0.36	33,455	0.84	0.36	25,205
Some Education	0.74	0.44	33,455	0.81	0.39	25,205
Urban	0.13	0.34	33,455	0.14	0.35	25,205
Has Piped Water	0.31	0.46	33,455	0.34	0.47	25,205
Has Car/Truck	0.01	0.09	33,455	0.01	0.10	25,205

Note: This table shows the summary statistics of the entire data used. The unit of observation is each birth. The year at the top of the columns indicates the birth year. In Panel A, I present the variables related to children or births. There is a considerable variation in the observation number because FBD and ANC information is only available for the births in recent five years. Survival status, gender, birth order (from the same mother), twin indicator, and the mother's age at birth is available for the whole birth sample. Because the observation unit is birth, some children (births) in the sample are from the same mother. Panel B presents the summary statistics of the variables of the mothers and households. Because the unit of observation is birth, some mothers are duplicated if she has more than one child.

Table 3: Effect on Facility-Based Delivery and Prenatal Care

	(1)	(2)	(3)	(4)
Panel A. FBD				
Low FBD District	0.145***	0.153***	0.143***	0.104***
× Post	(0.0161)	(0.0160)	(0.0170)	(0.0166)
Panel B. Number of ANC				
Low FBD District	0.160***	0.165***	0.159***	0.127***
× Post	(0.0395)	(0.0392)	(0.0408)	(0.0409)
Panel C. Month at the First ANC				
Low FBD District	-0.198**	-0.212***	-0.206***	-0.135*
× Post	(0.0769)	(0.0762)	(0.0787)	(0.0752)
Birth Controls		Yes	Yes	Yes
SES Controls			Yes	Yes
Province Time Trend				Yes
Observations	19,924	19,924	19,924	19,924

Note: This table presents the treatment effect on FBD and ANC. Dependent variables are presented in the panel title. Each cell presents β_1 of Equation 1 with different specifications described in the bottom part of the table. The point estimate is interpreted as following: in column 4 (preferred specification) of Panel A, the FBD rate increases by 9.9 percentage points in treatment districts. SES controls include maternal education, household wealth, urban indicator, and an indicator for possession of a car and piped water. Birth controls include gender, twin indicator, a full set of dummies of birth order, marital status, and mother's age at birth and its square term. Because Rwanda changed its administrative boundaries in 2006 (from 106 to 30 districts) and the RDHS is representative at the district level at the survey time, I use the districts appropriate to the time to cluster standard errors, i.e., the old districts in the 2005 survey and the new districts in 2008-2014 surveys. Regressions are weighted using sample weights from the RDHS. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table 4: Effect on Mortality Rates

	CMR (1)	IMR (2)	NMR (3)	NMR7 (4)
Low FBD District	-25.06**	-12.05*	-4.895	-5.121
× Post	(10.98)	(6.532)	(3.401)	(3.205)
Observation	28,628	52,989	58,660	58,660

Note: This table shows the treatment effect on different mortality rates. Dependent variables are presented at the column title. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). Because I cannot determine the survival status of the children who did not pass the thresholds for each definition, I drop all the children who did not reach the threshold at the survey. This makes the number of observations smallest for CMR. Controls are as same in Table 3. See the notes of Table 3 for further information. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table 5: Effect on Timing of Deaths

	Timing of the Deaths		
	1-5 year (1)	1-12 month (2)	7-30 days (3)
Low FBD District	-14.40***	-7.558	-1.316
× Post	(5.495)	(4.951)	(2.039)
Observation	26,611	51,347	57,441

Note: This table shows the treatment effect on the timing of the deaths. Dependent variables are presented at the column title. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). When estimating, I remove the death that happened before entering each period. For example, deaths during zero to one year are excluded in column 1. Controls are as same in Table 3. See the notes of Table 3 for further information. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table 6: Alternative Definitions of Treatment

		ANC		Mortality Rates			
	FBD	Frequency	First Month	CMR	IMR	NMR	NMR7
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Continuous Home Delivery (1-FBD) Rate							
Treatment	0.460***	0.624***	-0.647**	-63.09**	-29.41*	-10.08	-9.479
× Post	(0.0506)	(0.128)	(0.261)	(29.97)	(16.60)	(10.08)	(9.117)
Panel B. Home Delivery Rate Above 25th Percentile							
Treatment	0.114***	0.179***	-0.236***	-23.86**	-11.94**	-6.887**	-5.392*
× Post	(0.0185)	(0.0462)	(0.0885)	(11.02)	(5.290)	(3.017)	(3.128)
Panel C. Composite Index of Maternal Helath Service							
Treatment	0.0948***	0.220***	-0.301***	-20.80	-7.337	-3.584	-3.734
× Post	(0.0159)	(0.0405)	(0.0752)	(12.84)	(6.642)	(3.809)	(3.502)
Observation	19,924	19,924	19,924	28,628	52,989	58,660	58,660

Note: This table shows the treatment effect on different outcome variables using alternative definitions of treatment. Dependent variables are presented as the column title. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). Panel A uses the continuous home delivery rate (1-FBD) of each district as the treatment variable. Panel B defines low FBD districts as those whose home delivery rate is above the 25th percentile (FBD rate below the 75th percentile). I define a composite index combining FBD and ANC in Panel C. I construct the index using the Principal Component Analysis (PCA) and taking the first component (PC1). The treatment variable is defined as the same in the main specification: low use if the index is below the median. See the main text for further information. Controls are as same in Table 3. See the notes of Table 3 for further information. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table 7: Effect on Breastfeeding and Smoking Behavior

	Breastfeeding			Smoking	
	Duration	≥ 6 months	Immediately	After Childbirth	Pregnant
	(1)	(2)	(3)	(4)	
Low FBD District	0.942*	0.0218**	0.0229	-0.0135*	-0.0171
× Post	(0.481)	(0.0090)	(0.0191)	(0.0073)	(0.0159)
Observation	17,137	17,137	19,624	16,629	2,506

Note: This table shows the treatment effect on a mother's breastfeeding and smoking behaviors. Dependent variables are presented at the top of each column. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). In columns 1 and 2, I include only those who survived the first six months. In column 4, I define postnatal smoking to be equal to one when a mother who delivered a child within five years smokes. Because prenatal smoking information is not available, I use the currently pregnant women in each survey to define prenatal smoking. I replace the birth year with the survey year when estimating column 5. Controls are as same in Table 3. See the notes of Table 3 for further information. Birth controls are excluded when estimating clRobust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table 8: Heterogeneity by Exposure to Other Policies

	(1)	(2)	(3)	(4)	(5)
	Blood Pressure	Blood Test	Urine Test	Tetanus Toxic Shot	Drug for Malaria
Low FBD District	0.0430**	0.0892***	-0.0284	0.0207	0.0132
× Post	(0.0207)	(0.0251)	(0.0217)	(0.0177)	(0.0161)
Observations	19,924	19,924	19,924	19,924	19,924
	(6)	(7)	(8)	(9)	(10)
	Iron Tablet/Syrup	ANC by Doctor	FBD by Doctor	C-section	Postnatal Care
Low FBD District	0.0054	0.0039	-0.0001	-0.0037	-0.0245
× Post	(0.0208)	(0.0122)	(0.0111)	(0.0079)	(0.0271)
Observations	19,924	19,924	19,924	19,924	15,083

Note: This table shows the treatment effect on the quality of ANC and FBD. Factors for ANC and FBD are presented in columns 1 to 7 and 8 to 10, respectively. Dependent variables are presented at the top of each column. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). Columns 1 to 3 indicate whether the mother got an examination. Controls are as same in Table 3. See the notes of Table 3 for further information. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table 9: Heterogeneity by Distance and Travel Time to Provincial or District Hospitals

	Distance		P-value of	Travel Time		P-value of
	Close	Far	the Difference	Short	Long	the Difference
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. FBD and ANC						
Facility-Based Delivery	0.1062***	0.0788***	0.4538	0.0732***	0.1263***	0.1004
	(0.0199)	(0.0301)		(0.0246)	(0.0216)	
Number of ANC	0.0831	0.1095**	0.7043	0.1070**	0.1455**	0.6444
	(0.0536)	(0.0510)		(0.0519)	(0.0659)	
Month at the First ANC	-0.0843	-0.1064	0.8708	-0.0602	-0.2594**	0.1784
	(0.1055)	(0.0906)		(0.0962)	(0.1146)	
Panel B. Mortality Rates						
Child Mortality (5 years)	-30.5677***	-17.6239	0.6377	-48.2165***	9.8525	0.0047***
	(11.8326)	(22.6410)		(14.3602)	(14.8946)	
Infant Mortality (1 year)	-19.2714**	-4.5328	0.2384	-25.5659**	7.2419	0.0073***
	(8.7207)	(9.5099)		(10.1115)	(6.9170)	
Neonatal Mortality (30 days)	-9.3460*	-1.1759	0.2665	-7.4713	-1.6962	0.4378
	(5.4599)	(5.1528)		(5.4975)	(5.0392)	
Newborn Mortality (7 days)	-10.7123**	-0.1203	0.1422	-5.9246	-3.1023	0.6983
	(5.3807)	(4.6610)		(5.2801)	(5.0689)	

Note: This table shows the heterogeneity in the treatment effect by distance and travel time to provincial or district hospitals. I use the location data of health facilities provided by RMOH. I include hospitals that opened before 2006. I calculate the district to the closest hospital in each PSU using the geocodes and divide the sample into two groups in columns 1 and 2. The threshold distance is 8.8 km, the median. To consider the actual travel time, in columns 4 and 5, I use the average travel time to the closest hospital by district constructed using 2005 EICV. Similar to columns 1 and 2, I divide the sample into two groups using the median travel time, 205 minutes. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). The differences between the two groups are presented with the p-value. Panel A shows the effect on FBD and ANC and B shows the mortality. Controls are as same in Table 3. See the notes of Table 3 for further information. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table 10: Heterogeneity by Exposure to Other Policies

	Performance-Based Finance		P-value of	Change in Insurance Coverage		P-value of
	Earlier	Later	the Difference	Large	Small	the Difference
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. FBD and ANC						
Facility-Based Delivery	0.1005***	0.1063***	0.858	0.1291***	0.0509**	0.0217**
	(0.0241)	(0.0224)		(0.0255)	(0.0230)	
Number of ANC	0.0091	0.1696***	0.0828*	0.1119*	0.1023**	0.8926
	(0.0809)	(0.0474)		(0.0580)	(0.0427)	
Month at the First ANC	-0.1767	-0.1122	0.7002	-0.117	-0.041	0.5811
	(0.1474)	(0.0851)		(0.1079)	(0.0879)	
Panel B. Mortality Rates						
Child Mortality (5 years)	-37.6575	-21.1826*	0.5615	-22.4734	-29.4191***	0.7608
	(25.7400)	(12.6050)		(20.4609)	(10.4823)	
Infant Mortality (1 year)	-28.9349**	-5.2105	0.1469	-15.4167	-7.1691	0.5216
	(14.6791)	(7.4832)		(11.4747)	(5.9042)	
Neonatal Mortality (30 days)	-11.8010**	-3.1236	0.2331	-3.6721	-4.4702	0.9057
	(5.7794)	(4.4927)		(4.8196)	(4.7809)	
Newborn Mortality (7 days)	-15.4270***	-1.6214	0.0370**	-5.0103	-4.0353	0.8819
	(5.1853)	(4.1828)		(4.1166)	(5.1760)	

Note: This table shows the heterogeneity in the treatment effect by the exposure to other health policies. In 2006, the Rwandan Ministry of Health implemented Performance-Based Financing (PBF) and universal health insurance (CBHI) nationwide. Because the government started these programs earlier as pilot programs in some districts, there is a regional variation in the exposure to the policies. In columns 1 and 2, I split the sample by the timing of the implementation of PBF. The PBF pilot districts are identified by Rusa and Fritsche (2007). Early indicates districts where PBF was implemented before 2006 and later is after. PBF intends to improve the health facility's quality, so in principle, the early implemented districts are expected to have better quality facilities. The PBF districts are also in the new administrative boundaries. In columns 4 and 5, I divide the sample by districts with large and small changes in insurance coverage. The district-level insurance coverage is estimated with EICV. I estimate the insurance coverage change between 2014 and 2005 and separate them into two groups. The cutoff is an 80 percent increase, which is the median. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). The differences between the two groups are presented with the p-value. Panel A shows the effect on FBD and ANC and B shows the mortality. Controls are as same in Table 3. See the notes of Table 3 for further information. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Appendix

A Subsample Analysis

In this section, I remove some advantageous households for additional robustness. Control districts have more advantageous households by definition; they have high baseline FBD rates and only better-off households were able to use the service before 2006. In Table A.1 I remove some of these high SES households to show that the main results are not coming from the comparison between high vs. low SES households. Also, I can show that the effect is not mainly coming from wealthy or educated households in the treatment districts catching their peers up in control districts. I choose three SES measures: (1) living in the capital, (2) living in an urban area, (3) finished primary school, and (3) wealth (top 20 percent).

Overall in columns 1 to 3, the results are very similar to the main effects of this paper. The treatment effect on FBD and ANC use is slightly smaller because the baseline difference in FBD gets smaller when I remove the high SES groups. However, the impact on mortality rates is almost identical.

B Travel Time to Health Centers

In Table A.2, I conduct the similar analysis I do in columns 4 to 5 in Table 9. While RMOH provides the list of current health facilities in the country, unfortunately, the opening dates of health centers and posts are very inaccurate. Thus, I only use the travel time information available in 2005 EICV.[22]

Travel time to health centers has a mixed effect in Table A.2. The treatment effect on maternal health service use is stronger in districts with longer travel time, which is counterintuitive. This may be because there was a larger increase in health post opening in these remote areas. Since the increase in maternal health service use was mainly coming from health posts, a rapid increase in health posts may have made FBD and ANC easier. On the other hand, the impact on mortality rates in these remote areas is insignificant and smaller than the main results, inconsistent with the outcomes in Panel A. If health posts were driving the differences in Panel A, it seems to be reasonable that the mortality rates in these districts had no significant effect.

[22] Distance or travel time to health posts is also not available.

C Effect on Use of Other Health Services

FBCP may have removed the psychological and financial barriers to health facilities. Mothers may feel more comfortable visiting health facilities more often for different reasons. In Table A.3, I examine whether mothers' health service use had increased due to FBCP. In columns 1 and 3, FBCP increased the probability of a woman visiting health facilities and getting HIV tested by 7.2 and 8.5 percentage points, respectively. Impact on visiting family plans and adopting modern contraception is positive but not statistically significant. Considering that facility visit includes a visit for ANC and HIV tests also frequently happen during ANC, it seems that FBCP has a limited impact on other facility use.

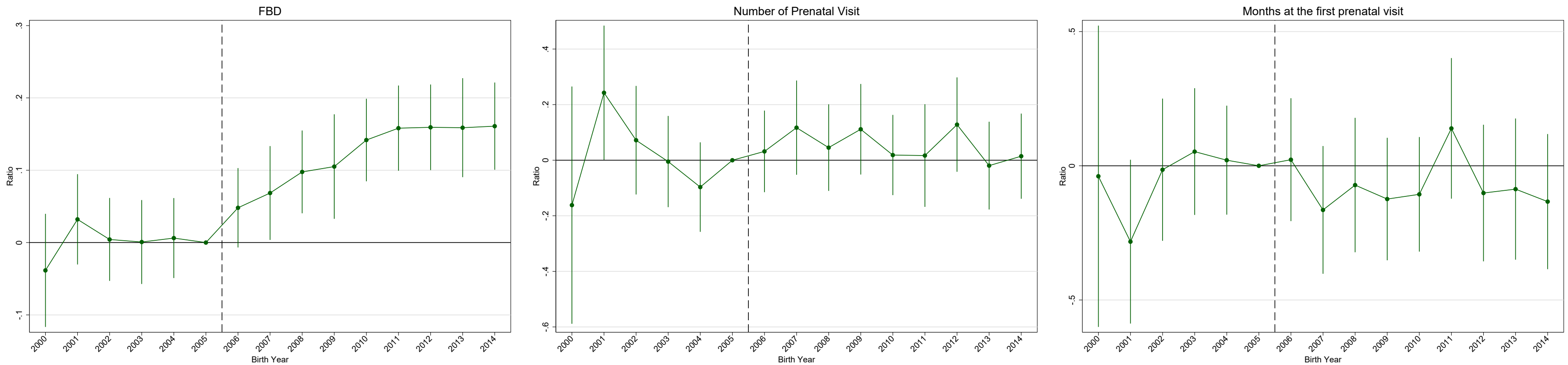
D Effect of the Expansion of Universal Health Insurance

Expansion of universal health insurance is another policy that potentially increased FBD and ANC utilization. This section examines how much expansion of the CBHI scheme is associated with maternal service use and mortality rates. The strategy I use here is similar to the main strategy. I define the treatment districts as those whose baseline insurance coverage is below the 75th percentile. I use the 75th percentile as the threshold because health insurance coverage is more skewed than the FBD rate in the baseline period.

Table A.4 shows the treatment effect of insurance coverage. Unlike Tables 3 and 4, the effect on FBD and prenatal care is small and statistically insignificant. The point estimates are smaller for mortality rates. Only is the effect on child mortality statistically significant, with a similar magnitude in Table 4. This result is consistent with Table 10, where an increase in insurance coverage is not associated with the treatment effect of free FBD and prenatal care policy. To summarize, Tables 10 and A.4 imply that FBCP was the main driver promoting FBD and prenatal care.

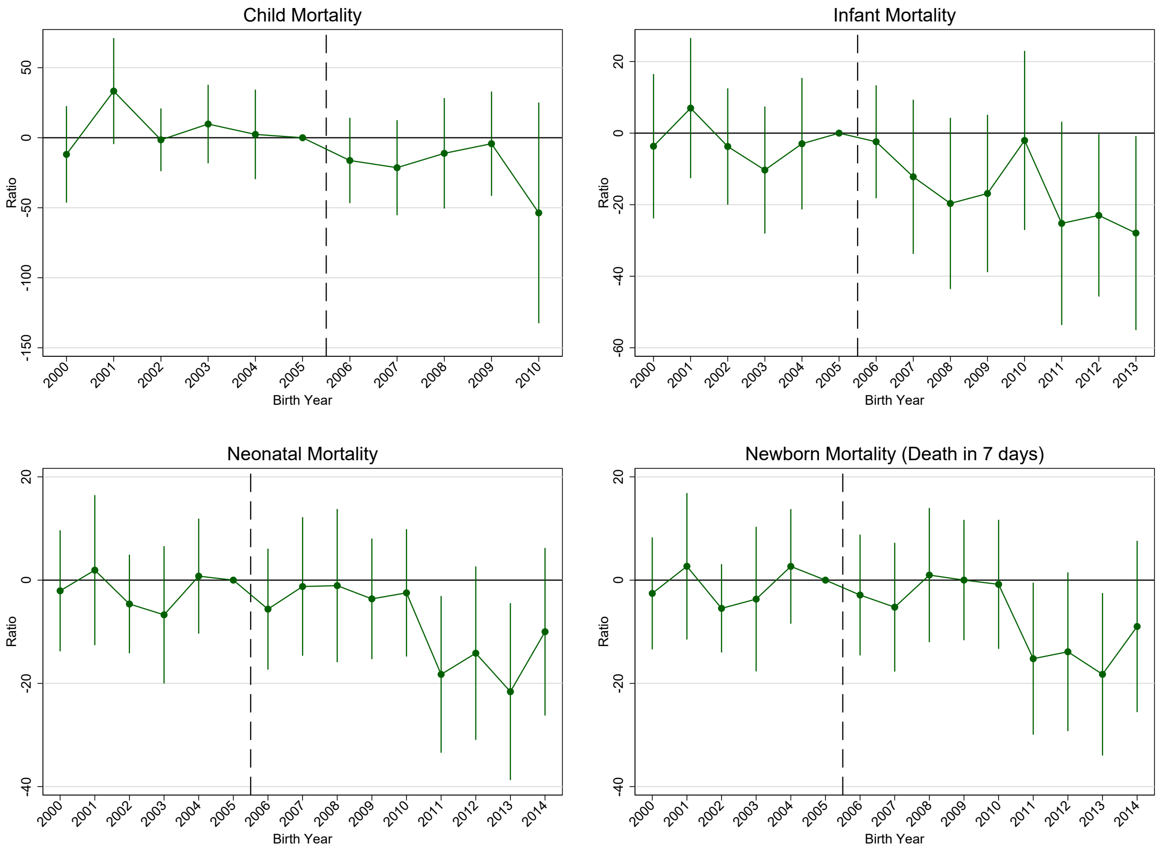
Appendix Figures

Figure A.1: Impact on Facility-Based Delivery and Prenatal Care, Event Study Framework



Note: This figure shows the treatment effect on FBD and prenatal care utilization with the event study framework with the preferred specification. I replace $\beta Low\ FBD_d \times \mathbb{1}(t \geq 2006)$ with $\sum_{k \neq 2005} \beta_k Low\ FBD_d \times \mathbb{1}(t = k)$ in Equation 1 and plot the β_k's with their 95% confidence intervals. Controls are as same in Table 3. See the notes of Table 3 for further information. Standard errors are clustered by the proper district.

Figure A.2: Impact on Mortality Rates, Event Study Framework



Note: This figure shows the treatment effect on the mortality rates. Other specifications are the same in Figure A.1.

Appendix Tables

Table A.1: Subsample Analysis

	Outside Capital (1)	Rural (2)	Education Less than Primary (3)	Wealth Quintile <4th (4)
Panel A. FBD and ANC				
Facility-Based Delivery	0.0968***	0.0791***	0.0771***	0.0626***
	(0.0173)	(0.0183)	(0.0171)	(0.0192)
Number of ANC	0.1175***	0.1046**	0.1290***	0.1192***
	(0.0406)	(0.0441)	(0.0427)	(0.0458)
Month at the First ANC	-0.1337*	-0.1298*	-0.1473*	-0.1340*
	(0.0749)	(0.0783)	(0.0755)	(0.0778)
Panel B. Mortality Rates				
Child Mortality (5 years)	-25.9307**	-26.6560**	-25.8736**	-24.2503**
	(11.6541)	(12.3714)	(11.2575)	(11.8805)
Infant Mortality (1 year)	-9.6823	-12.1180*	-11.6104*	-8.4835
	(6.5543)	(6.9817)	(6.7196)	(7.0083)
Neonatal Mortality (30 days)	-4.7484	-5.3596	-5.3256	-4.1088
	(3.4859)	(3.5780)	(3.6326)	(3.8931)
Newborn Mortality (7 days)	-4.378	-5.0992	-5.1154	-4.9567
	(3.3019)	(3.4644)	(3.3032)	(3.7173)

Note: This table shows the treatment effect with subsamples. The samples are presented at the top of each column: Households living outside of the capital (Kigali), living in rural areas, whose mother's education is less than primary completion, and whose household wealth is under or equal to the 4th quintile. Controls are as same in Table 3. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). The differences between the two groups are presented with the p-value. Panel A shows the effect on FBD and ANC and B shows the mortality. Controls are as same in Table 3. See the notes of Table 3 for further information. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table A.2: Heterogeneity by Travel Time to Health Centers

	Travel Time		P-value of
	Short	Long	the Difference
	(1)	(2)	(3)
Panel A. FBD and ANC			
Facility-Based Delivery	0.1040***	0.0909***	0.6965
	(0.0267)	(0.0211)	
Number of ANC	0.0505	0.2143***	0.0392**
	(0.0424)	(0.0681)	
Month at the First ANC	-0.0004	-0.3321***	0.0284**
	(0.0977)	(0.1175)	
Panel B. Mortality Rates			
Child Mortality (5 years)	-18.0272	-25.083	0.7468
	(13.0510)	(17.7415)	
Infant Mortality (1 year)	-14.7434	-1.0081	0.2991
	(8.9824)	(9.7987)	
Neonatal Mortality (30 days)	-8.0611	-2.4248	0.3924
	(5.1525)	(4.1284)	
Newborn Mortality (7 days)	-7.7374	-1.2832	0.329
	(5.5990)	(3.5744)	

Note: This table shows the heterogeneity in the treatment effect by travel time to health centers. I use the average travel time to the closest health center by district constructed using 2005 EICV. I divide the sample into two groups using the median travel time, 68 minutes. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). The differences between the two groups are presented with the p-value. Panel A shows the effect on FBD and ANC and B shows the mortality. Controls are as same in Table 3. See the notes of Table 3 for further information. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table A.3: Effect on Other Facility Utilization

	Facility Visit	Family Plan	HIV Test	Contraceptive
	(1)	(2)	(3)	(4)
Low FBD District	0.0715***	0.0240	0.0851***	0.0230
× Post	(0.0223)	(0.0171)	(0.0212)	(0.0159)
Observation	22,703	22,703	22,703	22,703

Note: This table shows the treatment effect on the mother's other health facility utilization. Dependent variables are presented at the top of each column. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). Visited Facility and Family Plan is one when the mother had visited a facility and family plan within 12 months, respectively. HIV Test is one when women ever got HIV tested. Contraceptive is one when the mother uses modern contraceptive methods. Controls are as same in Table 3. See the notes of Table 3 for further information. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table A.4: Treatment Effect of Insurance Coverage on FBD, ANC, and Mortality

		ANC		Mortality Rates			
	FBD	Frequency	First Month	CMR	IMR	NMR	NMR7
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Low baseline Insurance	0.0120	-0.0309	-0.0613	5.087	5.488	2.358	3.102
× Post	(0.0171)	(0.0415)	(0.0672)	(9.139)	(4.423)	(3.400)	(3.151)
Observations	19,924	19,924	19,924	28,628	52,989	58,660	58,660

Note: This table shows the treatment effect of expansion of CBHI on FBD, ANC, and childhood mortality rates. Dependent variables are presented at the column title. Each cell presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). Low insurance coverage means the insurance coverage of district was lower than the 75th percentile in 2005. I use 75th percentile here as the threshold because baseline insurance coverage was more skewed than FBD. Controls are as same in Table 3. See the notes of Table 3 for further information. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.