Does Facility-Based Delivery Save Lives? Evidence from Rwanda

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Abstract

In 2006, Rwanda initiated Facility-Based Childbirth Policy (FBCP) to promote facility-based child delivery (FBD) and prenatal care. This paper studies the effect of this reform on FBD and prenatal care utilization, and childhood mortality rates. To identify the causal effect, I utilize the geographical variation of FBD in the baseline period and the timing of the policy in a difference-in-difference framework. My estimates suggest that the health reform increased FBD and the number of prenatal 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 has a substantial effect on infant (under one year) and child (under five years) mortality, 12 and 25 reductions per 1,000 live births, respectively. However, the overall reduction in newborn (seven days) neonatal (30 days) mortality is not statistically significant despite a large increase in FBD. The results are robust to using alternative definitions of treatment status. I show that other policy interventions like performance-based financing schemes can strengthen the treatment effect on newborn and neonatal mortality, implying the importance of multiple approaches to reduce mortality rates.

Keywords: Facility-based delivery, Child Mortality, Rwanda

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Despite the substantial reduction in the mortality rate for children in developing countries, it is still high compared to the developed world. Reducing child deaths is one of the most critical goals in developing countries. To prevent premature deaths, governments have designed various policy interventions. One of the most known programs is promoting safe birth and facility-based delivery (FBD).[1] Most developing countries have at least one public program to induce safe birth (skilled attendant at birth) and meet their Sustainable Development Goals by 2030 set by the United Nations (Doctor, Nkhana-Salimu and Abdulsalam-Anibilowo, 2018).

Sound clinical studies prove that a skilled attendant's presence during labor significantly reduces the chance of maternal and neonatal deaths provided that the quantity and quality of the birth attendants are high enough (De Bernis et al., 2003; De Brouwere, Tonglet and Van Lerberghe, 1998; Kumar et al., 2008). This is largely true for developed countries where high-quality facilities are abundant. However, it is not clear whether FBD helps reduce mortality in developing countries (Fadel et al., 2015). There are several reasons why FBD can be ineffective. First, the quality of health facilities might be poor, or they lack proficient health assistants equipped with skills to deal with emergencies during labor. Second, traveling to facilities could increase the risk of deaths if the facility is too remote or transportation is poorly prepared. Finally, being surrounded by other patients could also cause other infections that lead to death (Graham, Bell and Bullough, 2001). Therefore, whether FBD and related policies in developing countries reduce newborn mortality is an empirical question.

This paper examines the causal relationship between FBD and childhood deaths exploiting a policy intervention in Rwanda. Rwanda achieved its Millennium Development Goals of safe childbirth by increasing FBD from 30 percent in 2005 to 96 percent in 2015 after implementing a series of health policies. The most relevant policy is the Facility-Based Childbirth Policy (FBCP), which provides a full package of prenatal care and FBD for all pregnant women free of charge, in 2006. A rapid increase of FBD rate follows the policy intervention as Figure 1 shows.

To evaluate the effect of this policy, I exploit the spatial variation in the program exposure represented by the extent of FBD in the baseline period and construct a difference-in-difference estimator. The assumption is that the regions with lower baseline FBD rates have more scope to increase FBD and prenatal care utilization by the reform in 2006. I use the Rwandan Demographic and Health Survey (RDHS), which contains rich information on the

[1] Other similar intervention includes educating midwives and nurses and banning traditional midwives.

birth history and socioeconomic and demographic variables of mothers and households. I define the low FBD districts in which the historical FBD rate is relatively low and show those areas have a greater increase in FBD by 9.9 to 13 percent.

Despite a substantial increase in FBD in the treatment districts, I find weak evidence on any reduction in the newborn (death in 7 days) and neonatal (death in 30 days) mortality. The newborn and neonatal mortality rate is 5.1 and 4.9 lower per 1,000 live births in the low-FBD districts after the reform, respectively, in the most conservative specification, although they are not statistically significant. I next expand the analysis to the later mortality rates. The difference-in-difference estimator suggests that the pre-period low FBD use is associated with a decline of 12 deaths and 25 deaths lower infant (death in a year) and child (death in 5 years) per 1,000 live births, which is equivalent to 15 and 20 percent reduction, respectively. The results are robust to using alternative treatment definitions, such as using continuous treatment or adjusting the threshold of defining low FBD districts.

Next, I examine whether the treatment effect varies depending on the exposure to other health policies. The Rwandan Ministry of Health implemented universal health insurance (Community-Based Health Insurance, CBHI) and Performance-Based Financing (PBF) scheme in the similar period, which intended to improve access to and quality of health services, respectively (Bucagu et al., 2012). The treatment effect does not vary by exposure to the CBHI scheme. However, the impact on mortality rates is stronger in districts exposed longer to PBF.[2] This result implies that facilities' quality plays a vital role in increasing the impact of FBD and prenatal care.

This paper has two important contributions. First, it contributes to the scant literature investigating the causal effect of FBD on the childhood mortality rate. Because it is difficult to find an exogenous variation in FBD, very few papers attempt to identify a causal effect without a policy intervention (Fadel et al., 2015; Okeke and Chari, 2018). Most of the other previous works evaluate the impact of certain policies. 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-

[2]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

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. On the other hand, some studies find a meaningful reduction in neonatal mortality through government intervention (Feng et al., 2011; McKinnon et al., 2015). However,there are very limited studies on FBD and mortality rates beyond the neonatal period, and my paper fills this gap.

Second, this paper is one of the few papers examining FBD in Rwanda. Rwanda has experienced a surprising increase in FBD during the last decade, but its causal effect is not well-known. Thus, it is important to confirm whether the seemingly successful free FBD policy has achieved its ultimate goal of reducing mortality rates. To my knowledge, there is only one more paper studying Rwanda. Chari and Okeke (2014) use the staggered roll-out of the performance-based financing program in Rwanda, where its performance determines the budget of each facility, and also find no effect of FBD on NMR. My paper focuses on a different policy, the free FBD policy, exploiting the pre-period prevalence of FBD in each district. Also, I expand the focus to later life mortality and find an improvement in infant and child mortality rates. As not all health policies specifically target neonatal mortality, it is crucial to examine the effect on other health indexes. My paper implies that Rwanda was successful in reducing child deaths through promoting FBD and prenatal care.

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 relates the result to other health initiatives. I discuss the implications and limitation of the paper in Section VI and conclude in Section VII.

I Institutional Background

The Rwandan genocide in 1994 destroyed most of the health facilities and workforce, leading to a surge in mortality and morbidity rates. Furthermore, the health care utilization rate had severely dropped after the genocide with extreme inequality across the population. Wealthier, more educated, and urban households had a much greater propensity to pursue health care and have safe child delivery (Comfort, Peterson and Hatt, 2013)

Since 1999, at the end of the civil war, the Rwandan government had implemented a variety of health policies and public programs to improve people's health status. There are three notable policies: (1) Facility-Based Childbirth Policy (FBCP), which provides a full package of maternity care and delivery service free of charge, (2) community-based health insurance (CBHI) scheme, a universal health insurance plan eligible to the entire population,[3] and (3) performance-based financing (PBF), which determines the budget of each facility based on its performance in the previous year (Bucagu et al., 2012). Note that (1) and (2) are intended to improve access to health service while (3) is to improve the quality of the care. Table 1 shows the timeline of these events. It is noteworthy that most of the changes and expansion occurred together in 2006. While all of the three policies played a significant role in improving facility access and quality, I focus on the increase in facility-based delivery (FBD) in Rwanda induced by (1). The FBCP emphasized the benefits of FBD and provided pregnant women with free prenatal care and delivery service at health facilities regardless of insurance possession (Rwanda Ministry of Health, 2017). FBD rate had increased from 37 percent in 2005 to 95 percent in 2010 thanks to this effort (Figure 1). This increase is notable compared to other sub-Saharan African countries with similar health initiatives (Doctor, Nkhana-Salimu and Abdulsalam-Anibilowo, 2018).

Under the Rwandan health system, Health Centers handle prenatal care and normal childbirth (vaginal delivery). Complicated pregnancies are referred to the higher-level health facilities such as District Hospitals and Provincial Hospitals that are generally well equipped and capable to perform surgical procedures (Bucagu et al., 2012).[4] Most of the prenatal and normal delivery service is provided by midwives and nurses (Lundeen et al., 2019).

II Data

II.1 Data Sources

The main dataset 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

[3]The premium and co-payment varies depending on the income and wealth of the household. Poorest households are exempt from premium or co-pay, depending on the region (Bucagu et al., 2012).

[4]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).

birth happened to the respondent (woman of reproductive age, 15–49 years old) retrospectively regardless of survival. For the children who have died, the respondents provide detailed 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 prenatal 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 mortality rates: Newborn Mortality (death in seven daysNMR7), Neonatal Mortality (death in 30 days, NMR), Infant Mortality (death in one year, IMR), and Child Mortality (death in five years, CMR). Following the traditional definition, the mortality rates are scaled per 1,000 live births.

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. Fortunately, RDHS provides GPS coordinates of the primary sampling units (PSU, or clusters),[5] making it possible to identify the old district of each PSU in the later surveys. I match 2008-2014 PSUs to the 106 old districts to have a greater variation. Because the DHS 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 and total population by district and survey year that RDHS does not provide. When calculating the average insurance coverage by district, I restrict the EICV cample to women 15-45 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's characteristics, respectively. I have data on 58,660 births after removing

[5]Available from 2005 wave.

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

missing variables.

Two things are noticeable in Panel A. First, the Facility-Based Childcare Policy seems to be effective in terms of service utilization. FBD rate had increased significantly, from 31 percent to 76 percent. Prenatal care utilization did not increase substantially; however, the number of visits increased, and the month of pregnancy at the first visit decreased. Second, the overall mortality rates had declined during this period. For example, the child mortality rate (CMR, mortality under five years old) had declined the most, from 124 death to 66 death per 1,000 birth.[7]

Panel B shows that the overall socioeconomic status of the household had improved during this period. Especially, the fraction of households with piped water had increased significantly, from 17 percent to 34 percent. Furthermore, Rwandan women become more educated and literate over time, consistent with the government's effort to promote female education in most developing countries.

III Empirical Strategy

III.1 Basic Specification

To identify the causal effect of the FBCP in 2006 on facility use and mortality rates, I exploit spatial and temporal variation in the 'intensity of exposure' to the policy in a difference-in-difference framework. I use the baseline district-level home delivery rate (1-FBD rate) as the proxy for the intensity of exposure. In other words, I use the fact that districts with low FBD rates experienced a greater increase in FBD rates following the old literature.[8]

The geographic unit I use is old districts that were used until 2006. I take the districts with a low FBD rate (below median) as the treatment districts and call them low-FBD districts. Figure 2 displays how the treatment and control districts are distributed in Rwanda. Kigali area (capital) and other large cities are mostly control treatment; however, some rural areas are classified as control districts as well.

[7] When defining mortality rates, I only include the births that passed the threshold periods.For NMR and NMR7, I include births that happened at least one month before the survey. For IMR and CMR, births that occurred one year and five years before the survey date are included, respectively.

[8] Using the baseline means as exposure measures is found in previous works like Bleakley (2007); Godlonton and Okeke (2016); Osili and Long (2008).

Specifically, the main regression equation is as follows:

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

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, information on prenatal visits, and mortality rates, such as newborn (deaths within seven days) neonatal (deaths within 30 days), infant (deaths within a year), and child (deaths within five years) mortality rate. $Low\ FBD_d$ 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_{it} 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 allow province-level time trends to vary by the district 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 rest of the waves are at the new district level. Thus, I use the proper 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 outcome variables should evolve in parallel in treatment and control districts. Women and children in low-FBD districts are disadvantaged, to begin with: low FBD rate is correlated with lower SES and fewer and worse quality health facilities in the district. This discrepancy can cause a differential change in relevant variables and affect the outcome variables. Thus, it is important to examine whether the changes in other factors that could affect FBD and mortality rates are correlated with the treatment status.

In Figure 3, I display the trend of FBD and prenatal care in treatment and control districts. The pre-trends in treatment and control districts are very similar for all three variables. Especially in Panel A, there is a much larger increase in FBD rate in treatment districts, suggesting that the baseline FBD rate is a good proxy for treatment intensity.

Figure 4 graphically presents the coefficients of $Low\ FBD_d \times \mathbb{1}(t \geq 2006)$ with different outcome variables. If the point estimate is statistically significant, it indicates a differential change between 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. Whether the child is a first child and current marital status are statistically significant. I suspect that this stems from a decline in total fertility and an increase in men's survival rates. I also test mother and household SES, such as an indicator for primary school completion, living in an urban area, possession of a car or motorcycle and piped water, and wealth index, all of which are not associated with $LowFBD_d \times \mathbb{1}(t \geq 2006)$. Overall, results in Figure 4 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 Facility-Based Delivery and Prenatal Care

Table 3 presents β_1's of Equation 1 with different specifications for three outcome variables: an indicator for FBD, number of prenatal visits, and month at the first visit. In all panels, the coefficients are robust to the inclusion of birth-related controls and SES controls in columns 2 and 3. In my preferred specification, column 4, I include province-specific time trends to adjust to the differential time trend of each area. In Panel A, the coefficient means that the FBD rate had increased by 9.9 FBD districts in the preferred specification. Overall, Table 3 implicates that the policy changes effectively increased FBD. The policy was also intended to increase prenatal care at health facilities, and Panels B and C show it was effective. The number of prenatal visits increased by 0.113 times, and the month at first visit declined by 0.125 months in my preferred specification (column 4). The results in Table 6 are consistent with Figure 3.In Appendix Figure A.1, I present the results in the event study framework.

IV.2 Effect on the Mortality Rates

The previous results show that the health reform in 2006 successfully increased FBD rate and prenatal care use in Rwanda. Here, I examined whether this is associated with a reduction in mortality rates. 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 after 1999 even though the RDHS asks the full history of the birth career.[9] The primary outcome is the binary indicator for deaths. To match the standard definition of the mortality rates in developing countries (deaths per 1,000 lives), I assign 1,000 to the deaths.[10] I tested deaths in seven days (newborn death), 30 days (neonatal mortality), one year (infant mortality), and five years (child mortality).

Figure 5 presents the mortality trends in treatment and control districts. The relatively small sample size of RDHS gives the unsmoothed trend of mortality rates. Consistent with Table 2, there is an overall reduction in mortality rates in all panels. It is not clear there is a larger decline in newborn and neonatal mortality rates in treatment districts in Panels A and B. However, infant and child mortality rates in treatment and control districts seem to converge after the health reform (Panels C and D).

The difference-in-difference results with the preferred specification are presented in Table 4.[11] Each cell is from separate regressions with Equation 1, and dependent variables are described in the column title. There is an insignificant decline in the newborn and neonatal mortality rates in columns 1 and 2, respectively. Infant and child mortality rates declined by 12 and 25 deaths per 1,000 live births, corresponding to 15 and 20 percent, respectively, in low FBD districts. These point estimates are both statistically significant.

IV.3 Alternative Specification

My main specification defines low FBD districts as the districts whose baseline FBD rate is below the median (of all districts). In Table 5, I use alternative specifications to examine the robustness of my result. Overall, Table 5 shows my results are robust to using an alternative definition of the treatment.

[9] Including earlier birth can be potentially problematic for 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.

[10] This is to scale the mortality rates per 1,000 live births. This method is used in Geruso and Spears (2018).

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

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. Panel B defines the low FBD districts as districts whose FBD rate is below the top 25th percentile. 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.[12]

In Panel C, I define a composite index representing the exposure to FBD and prenatal care in the baseline period. I perform Principal Component Analysis (PCA) with district-level FBD rate, frequency of prenatal visits, and month at the first prenatal visit and take the first principal component (PC1) as the indicator.[13] Similar to the main specification, the treatment variable is one when the composite index is lower than its median (low use of prenatal care and FBD). Because I include the two 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 statistically significant.

Prenatal care and FBD may be associated with the overall use of health facilities. Areas with high utilization of health services are often areas with higher accessibility and more well-equipped facilities. Also, the free FBD program happened together with other policies like universal insurance. Thus, I test whether the results are substantially different when using an index for pre-period facility use in Panel D. Included variables are whether the respondent (mother) visited a facility within 12 months, whether she uses modern contraceptives, whether she got tested for HIV, and whether a child was taken to a facility for diarrhea or fever. I also include FBD and prenatal care variables. Similar to Panel C, I take the PC1 and define the low index status if the index is below the median. The point estimates are similar, however, more precisely estimated. This result suggests that low facility use and low FBD rate before the reform are somewhat correlated.

[12]This specification much more precisely estimates the result. 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.

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

IV.4 Impact on Other Health Services Utilization

My results show that promoting FBD successfully reduced mortality rates, although the impact on newborn and neonatal deaths is not precisely measured. Free prenatal care and FBD may induce mothers to visit health facilities for other reasons after birth, as they learn facilities are accessible and affordable. In this case, it is difficult to determine whether more frequent use of health facilities after birth or prenatal care and FBD resulted in reductions in mortality rates. In Table 6, I test whether the free FBD policy is associated with an increase in facility visits for other reasons than prenatal care and delivery.

Panel A shows little impact on children's facility visits. Interestingly, children born from cesarean section (C-section) did not increase due to the free FBD program. This result suggests that while the overall FBD rate increases, C-section does not increase accordingly. In Rwanda, C-sections are available at the district or provincial hospitals (secondary or tertiary facilities); however, this process is often not smooth (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 this free FBD program. In Panel B, there is evidence that women in treatment districts are more likely to use health services. Especially, they tend to visit any health facilities within 12 months and get an HIV test. However, there is an insignificant increase in the tendency to visit fertility planning (column 3) or use modern contraceptives (column 4) conditional to using any birth control methods. To summarize, the FBCP may have increased the overall facility use to some extent; however, it seems that it is not the primary reason for the decline in mortality rates.

V Relation to Other Health Policies

Previously I show there were three critical programs in the 2006 health reform in Rwanda. This section examines whether the treatment effect varies depending on the intensity of two other health programs: free universal insurance (community-based health insurance, or CBHI) and performance-based financing (PBF).

From 2006, insurance coverage had increased significantly in Rwanda thanks to CBHI. In 1999, the Rwandan Ministry of Health started a pilot program of CBHI in three Health Districts.[14] After the success in these three districts, the Ministry of Health decided to expand the program nationwide (Nyandekwe, Nzayirambaho and Kakoma, 2014). Even before the expansion, some districts independently offered CBHI or other public health insurance schemes and some wealthy households were able to possess their insurance. Thus, the intensity of exposure to health insurance also varied 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 EICV and estimate the insurance coverage change between 2005 and 2014 in each (new) district and use it to measure the intensity of exposure to CBHI. In columns 1 and 2 of Table 7, I compare the treatment effects on outcome variables in districts with larger vs. smaller change in insurance coverage.[15] FBD rate tended to increase much larger in districts with a larger increase in insurance coverage. However, point estimates on the rest of the outcomes are not statistically different in columns 1 and 2. Insurance may have increased access to health services and thus FBD; however, impact on mortality rates is limited.[16]

Performance-based financing (PBF) intends to improve health facilities' quality by rewarding them based on their performance in the previous year. Like CBHI, PBF also had a pilot study period in a few health districts and became nationwide in 2006 (Chari and Okeke, 2014). Districts that implemented PBF earlier (i.e., pilot districts) are more likely to have better quality facilities if PBF is effective. In columns 5 and 6, I divide the sample by the timing of PBF implementation (earlier or later). The impact on FBD and prenatal care is mixed. The treatment effect on FBD is similar; however, effects on the number of prenatal visits are statistically different in columns 5 and 6. 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, although it is significantly different only for newborn mortality. 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.[17]

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

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

[16]I test the treatment effect of CBHI using Equation 1 in Appendix Table A.2. It seems that the expansion of CBHI is not associated with a reduction in mortality rates, except for CMR.

[17]Papers like Basinga et al. (2011); Chari and Okeke (2014) finds that PBF itself increased FBD rate. However, they both did not find PBF reduced mortality rates.

VI Discussion

Despite the remarkable success in promoting FBD in Rwanda, there is limited evidence that FBD reduces newborn and neonatal mortality in this paper. It is hard to believe that FBD reduces infant and child mortality without reducing newborn and neonatal mortality rates because FBD is more directly related to earlier life deaths (Moyer, Adanu and Engmann, 2013). However, prenatal care and FBD may reduce infant and child mortality by improving the child's long-term health status. For example, prenatal cares play an essential role in promoting women's health literacy (Lori et al., 2014) and positively affect child health.

There are several possible explanations why the impact on newborn and neonatal deaths is limited. First, the quality of the facilities or the care provided may not have been sufficient enough to have a meaningful impact on newborn and neonatal mortality rates. Very basic causes of death could be prevented by primary care in the health facility. However, more resources are required to deal with complicated causes. In fact, about 84 percent of health centers did not have an ambulance in 2014. The majority of health centers own a motorcycle as the main means of transportation, not appropriate for patient transfer. Almost none of the health centers have an X-ray or anesthesia machine. Even in the provincial and district hospitals, 15 percent did not own anesthesia machine (Rwanda Ministry of Health, 2015). Although both devices may have little to do with safe delivery (especially X-rays), it implies how low the overall quality of Rwandan health facilities is. Because of the data limitation, I cannot examine the differential treatment effect based on the quality of the nearby health facility. The negative and significant estimates on the newborn and neonatal mortality rates in column 5 in Table 7 suggest the quality matters, although the coefficients are not statistically distinguishable from column 6.

Second, the increase in the use of prenatal care and family plan may have made high-risk women successfully deliver their children. In other words, without the reform, some of the children might not have been born alive, not contributing to the death rates. Alternatively, a high-risk woman who would not have been able to conceive may have got pregnant as she became healthier. Either way, the chance of high-risk children being born increases, and the overall neonatal mortality does not go down. In Figure 4, the average birth order in the treatment group increases (because the likelihood of being the first birth decreases), supporting that there has been more birth in treatment districts after the reform.

VII Conclusion

Today, still more than 2.5 million children die within a month after birth every year. Many developing countries have made enormous efforts during the last thirty years, but premature deaths are still far more frequent than their developed counterparts. Because a health professional can readily treat some causes of deaths during labor, FBD and safe delivery very important. However, several empirical studies do not support the positive impact of FBD on neonatal mortality.

Rwanda is recognized as one of the most successful countries promoting FBD. Rwanda's experience is unique in that only a few countries went through such a rapid surge in FBD. Today, most Rwandan children are now born in a health facility, and women have access to pre-and postnatal care thanks to FBCP initiated in 2006. By leveraging variation in the district-level FBD rate in the baseline period in a difference-in-difference framework, I find evidence that the policy effectively improved FBD and prenatal care utilization.

The estimates show that the policy had reduced the infant mortality rate and child mortality rate by 12 and 25 deaths per 1,000 births. I also find that newborn and neonatal mortality declined, although not statistically significant. My results are robust to using alternative treatment definitions. The size of the treatment effect of free FBD and prenatal care programs is not related to other health policies in this period, such as universal health insurance or PBF.

It seems Rwanda has a little problem with access to maternal health services. However, anecdotal evidence tells the quality of Rwandan facilities is far below the standards in developed countries. Even secondary and tertiary level facilities lack basic equipment in the developed countries' standards. For a country like Rwanda, where its quantitative success is widely known, it is time to seek qualitative improvement in the health sector.

References

Basinga, Paulin, Paul J. Gertler, Agnes Binagwaho, Agnes Lb Soucat, Jennifer Sturdy, and Christel Mj Vermeersch. 2011. “Effect on maternal and child health services in Rwanda of payment to primary health-care providers for performance: An impact evaluation.” *The Lancet*, 377(9775): 1421–1428.

Bleakley, Hoyt. 2007. “Disease and development: Evidence from hookworm eradication in the American South.” *Quarterly Journal of Economics*, 122(1): 73–117.

Bucagu, Maurice, Jean M. Kagubare, Paulin Basinga, Fidèle Ngabo, Barbara K. Timmons, and Angela C. Lee. 2012. “Impact of health systems strengthening on coverage of maternal health services in Rwanda, 2000-2010: A systematic review.” *Reproductive Health Matters*, 20(39): 50–61.

Chari, Amalavoyal V, and Edward N Okeke. 2014. “Can Institutional Deliveries Reduce Newborn Mortality? Evidence from Rwanda.”

Comfort, Alison B., Lauren A. Peterson, and Laurel E. Hatt. 2013. “Effect of health insurance on the use and provision of maternal health services and maternal and neonatal health outcomes: A systematic review.” *Journal of Health, Population and Nutrition*, 31(4 SUPPL.2).

De Bernis, Luc, Della R. Sherratt, Carla AbouZahr, and Wim Van Lerberghe. 2003. “Skilled attendants for pregnancy, childbirth and postnatal care.” *British Medical Bulletin*, 67(July): 39–57.

De Brouwere, Vincent, René Tonglet, and Wim Van Lerberghe. 1998. “Strategies for reducing maternal mortality in developing countries: What can we learn from the history of the industrialized West?” *Tropical Medicine and International Health*, 3(10): 771–782.

Doctor, Henry V., Sangwani Nkhana-Salimu, and Maryam Abdulsalam-Anibilowo. 2018. “Health facility delivery in sub-Saharan Africa: Successes, challenges, and implications for the 2030 development agenda.” *BMC Public Health*, 18(1): 1–12.

Fadel, Shaza A., Usha Ram, Shaun K. Morris, Rehana Begum, Anita Shet, Raju Jotkar, and Prabhat Jha. 2015. “Facility delivery, postnatal care and neonatal deaths in India: Nationally-representative case-control studies.” *PLoS ONE*, 10(10): 1–12.

Feng, Xing Lin, Sufang Guo, David Hipgrave, Jun Zhu, Lingli Zhang, Li Song, Qing Yang, Yan Guo, and Carine Ronsmans. 2011. "China's facility-based birth strategy and neonatal mortality: A population-based epidemiological study." *The Lancet*, 378(9801): 1493–1500.

Geruso, Michael, and Dean Spears. 2018. "Neighborhood sanitation and infant mortality." *American Economic Journal: Applied Economics*, 10(2): 125–162.

Godlonton, Susan, and Edward N. Okeke. 2016. "Does a ban on informal health providers save lives? Evidence from Malawi." *Journal of Development Economics*, 118: 112–132.

Graham, Wendy J, Jacqueline S Bell, and Colin H W Bullough. 2001. "Can skilled attendance at delivery reduce maternal mortality in developing countries ?" *Studies in HSO&P*, 17: 97–129.

Harrison, Margo S, and Robert L Goldenberg. 2016. "Cesarean section in sub-Saharan Africa." *Maternal Health, Neonatology and Perinatology*, 2(1): 6.

Kumar, Vishwajeet, Saroj Mohanty, Aarti Kumar, Rajendra P. Misra, Mathuram Santosham, Shally Awasthi, Abdullah H. Baqui, Pramod Singh, Vivek Singh, Ramesh C. Ahuja, Jai Vir Singh, Gyanendra Kumar Malik, Saifuddin Ahmed, Robert E. Black, Mahendra Bhandari, and Gary L. Darmstadt. 2008. "Effect of community-based behaviour change management on neonatal mortality in Shivgarh, Uttar Pradesh, India: a cluster-randomised controlled trial." *The Lancet*, 372(9644): 1151–1162.

Lim, Stephen S., Lalit Dandona, Joseph A. Hoisington, Spencer L. James, Margaret C. Hogan, and Emmanuela Gakidou. 2010. "India's Janani Suraksha Yojana, a conditional cash transfer programme to increase births in health facilities: an impact evaluation." *The Lancet*, 375(9730): 2009–2023.

Lori, Jody R., Chin Hwa Y. Dahlem, Jacqueline V. Ackah, and Richard M.K. Adanu. 2014. "Examining Antenatal Health Literacy in Ghana." *Journal of Nursing Scholarship*, 46(6): 432–440.

Lundeen, Tiffany, Sabine Musange, Hana Azman, David Nzeyimana, Nathalie Murindahabi, Elizabeth Butrick, and Dilys Walker. 2019. "Nurses' and midwives' experiences of providing group antenatal and postnatal care at 18 health centers in Rwanda: A mixed methods study." *PLoS ONE*, 14(7): 1–16.

McKinnon, Britt, Sam Harper, Jay S. Kaufman, and Yves Bergevin. 2015. "Removing user fees for facility-based delivery services: A difference-in-differences evaluation from ten sub-Saharan African countries." *Health Policy and Planning*, 30(4): 432–441.

Moyer, Cheryl A, Richard M K Adanu, and Cyril M Engmann. 2013. "The relationship between facility-based delivery and maternal and neonatal mortality in Sub-Saharan Africa." *International Journal of Gynecology and Obstetrics*, 122(3): 263–265.

Niyitegeka, Joseph, Georges Nshimirimana, Allison Silverstein, Jackline Odhiambo, Yihan Lin, Theoneste Nkurunziza, Robert Riviello, Stephen Rulisa, Paulin Banguti, Hema Magge, Martin Macharia, Regis Habimana, and Bethany Hedt-Gauthier. 2017. "Longer travel time to district hospital worsens neonatal outcomes: A retrospective cross-sectional study of the effect of delays in receiving emergency cesarean section in Rwanda." *BMC Pregnancy and Childbirth*, 17(1): 1–10.

Nyandekwe, Médard, Manassé Nzayirambaho, and Jean Baptiste Kakoma. 2014. "Universal health coverage in Rwanda: Dream or reality." *Pan African Medical Journal*, 17.

Okeke, Edward N., and A. V. Chari. 2018. "Health care at birth and infant mortality: Evidence from nighttime deliveries in Nigeria." *Social Science and Medicine*, 196(May 2017): 86–95.

Osili, Una Okonkwo, and Bridget Terry Long. 2008. "Does female schooling reduce fertility? Evidence from Nigeria." *Journal of Development Economics*, 87(1): 57–75.

Powell-Jackson, T, B D Neupane, S Tiwari, K Tumbahangphe, D Manandhar, and A M Costello. 2009. "The impact of Nepal's national incentive progamme to promote safe delivery in the district of Makwanpur." In *Innovations in health system finance in developing and transitional economies.* , ed. D Chernichovsky and K Hanson. Bingley:Emerald.

Powell-Jackson, Timothy, Sumit Mazumdar, and Anne Mills. 2015. "Financial incentives in health: New evidence from India's Janani Suraksha Yojana." *Journal of Health Economics*, 43: 154–169.

Randive, Bharat, Miguel San Sebastian, Ayesha De Costa, and Lars Lindholm. 2014. "Inequalities in institutional delivery uptake and maternal mortality reduction in the context of cash incentive program, Janani Suraksha Yojana: Results from nine states in India." *Social Science and Medicine*, 123: 1–6.

Rusa, Louis, and Gyuri Fritsche. 2007. "Rwanda: Performance-Based Financing in Health." In *Sourcebook on emerging good practice in managing for development results.* . 2 ed., , ed. E Ashbourne, J Ballkind and H Cooper, 105–115. OECD.

Rwanda Ministry of Health. 2009. "Rwanda Health Statistical Booklet 2008."

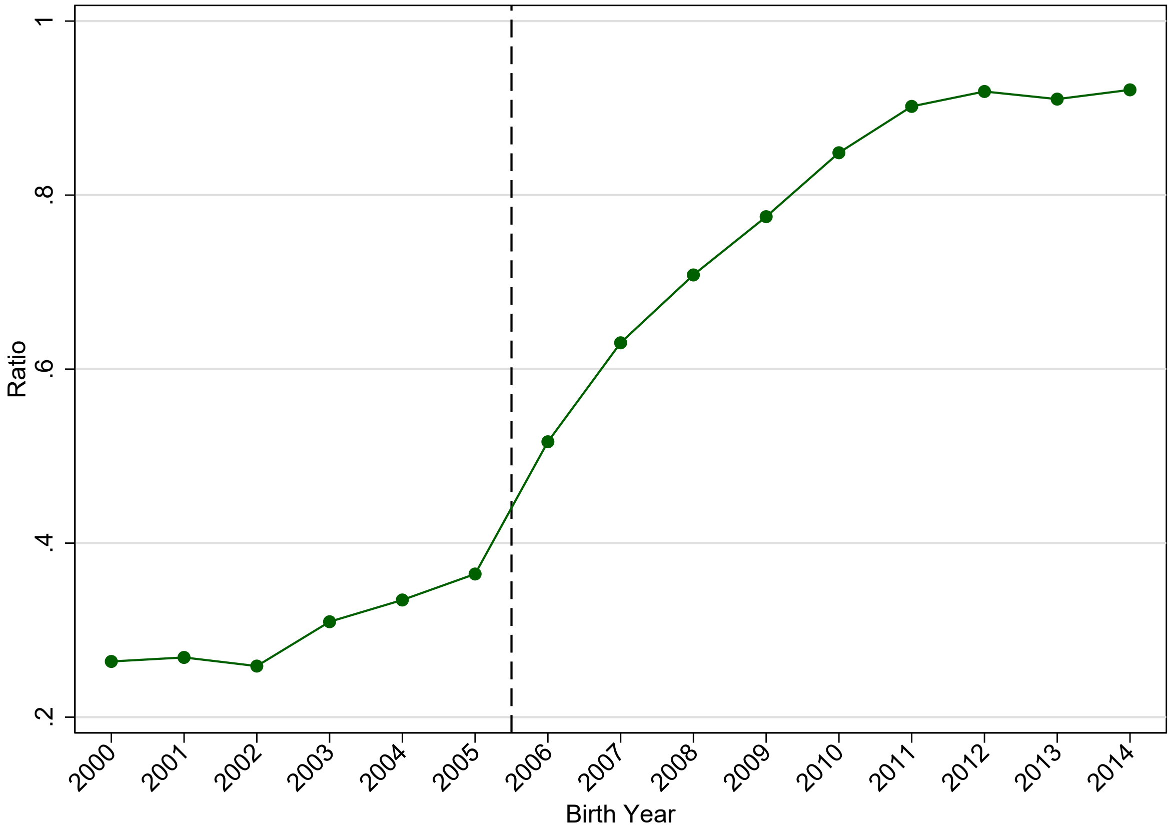
Rwanda Ministry of Health. 2015. "Rwanda Annual Health Statistics Booklet 2014."

Rwanda Ministry of Health. 2017. "Health Service Packages for Public Health Facilities in Rwanda." January.

Vyas, Seema, and Lilani Kumaranayake. 2006. "Constructing socio-economic status indices: How to use principal components analysis." *Health Policy and Planning*, 21(6): 459–468.

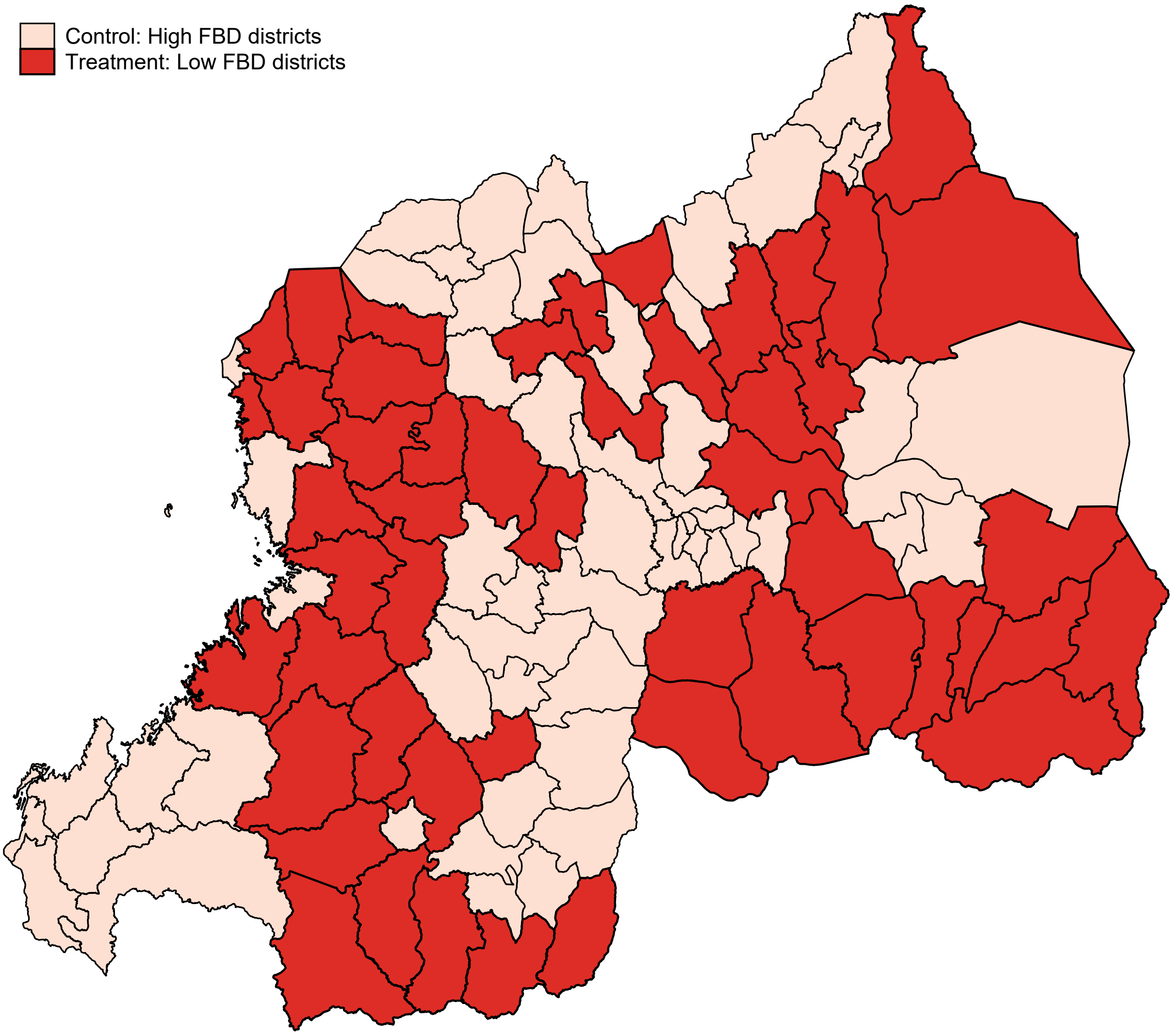
Figures

Figure 1: Trend of Facility-Based Delivery in Rwanda



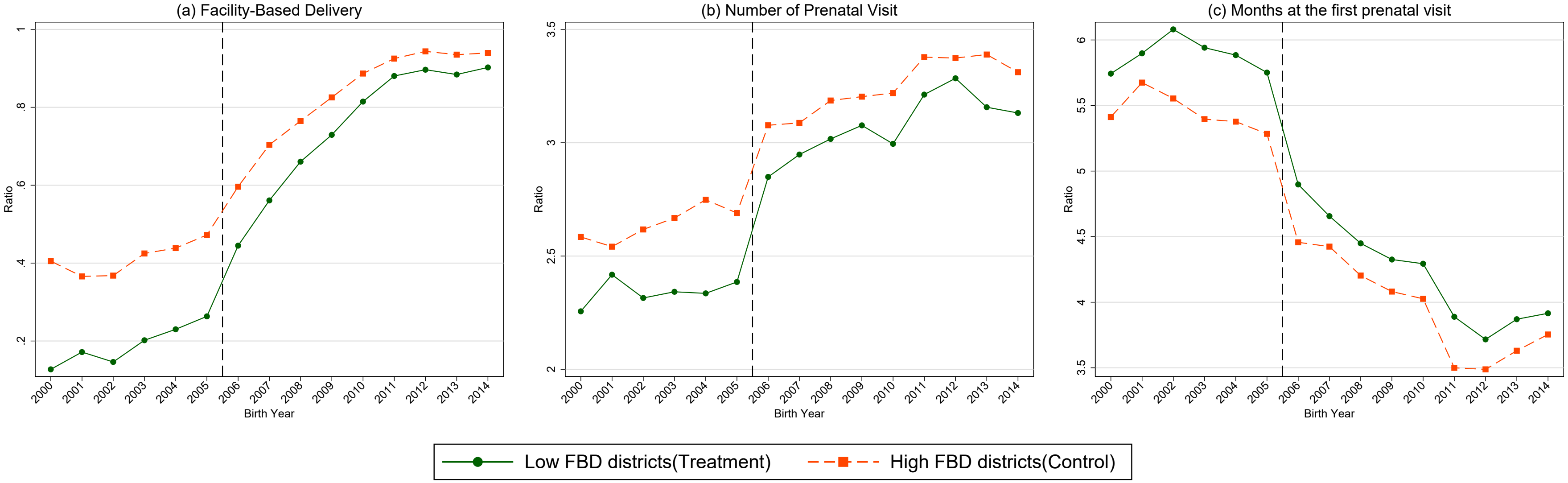
Note: Data from the Rwandan Demographic and Health Survey (RDHS). I combine multiple rounds of RDHS to show the trend of FBD. The Facility-Based Childbirth Policy (FBCP) was implemented in 2006, and the dashed line separates before and after the policy intervention. The figure presents a steep increase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

Figure 2: Treatment/Control Assignment



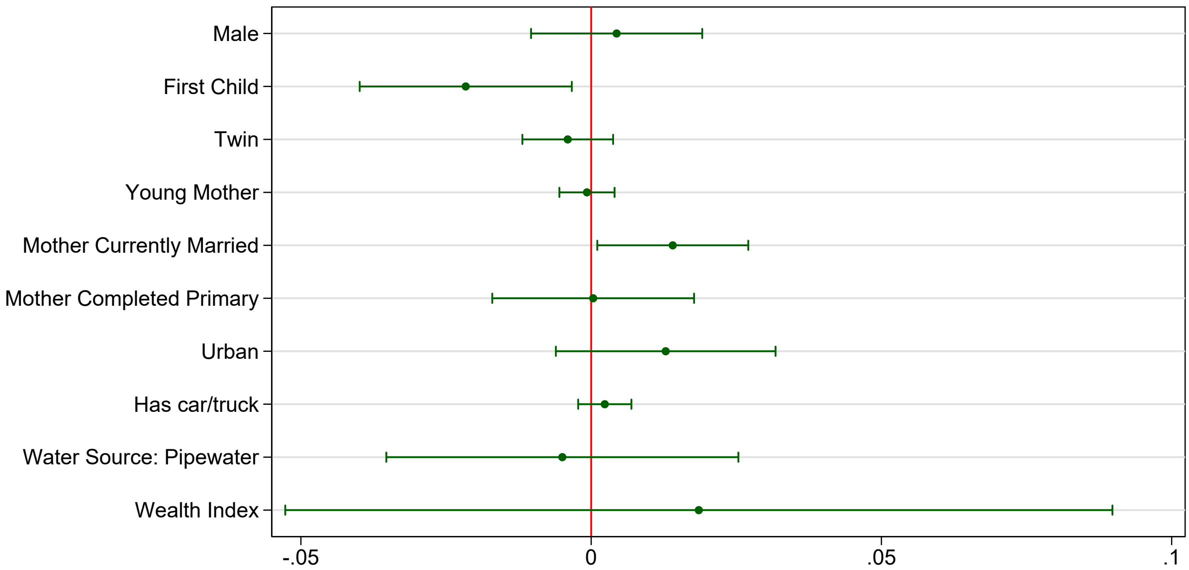
Note: This figure shows the map of Rwanda with its administrative districts in 2005. The treatment districts or the low FBD districts are depicted in the darker shade. The treatment districts are districts whose baseline average FBD rates are below the 50th percentile. High FBD or control districts are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

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



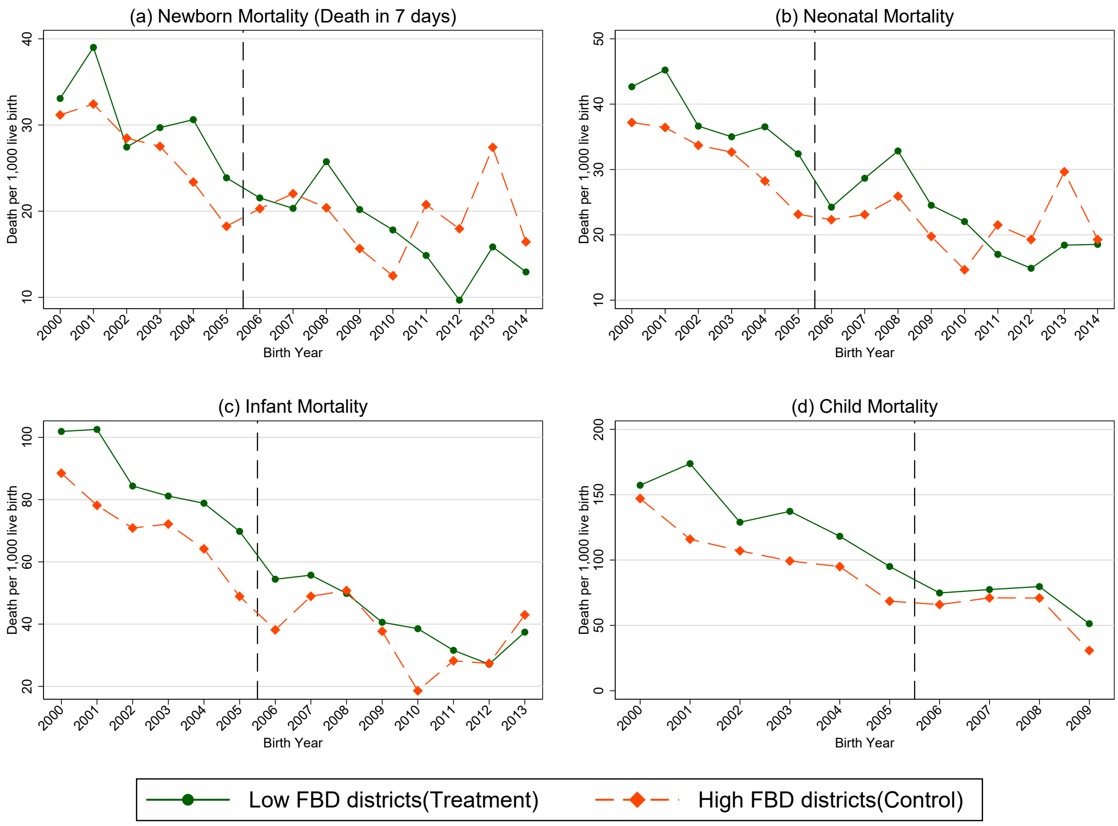
Note: This figure shows the trend of FBD (Panel A), the number of prenatal visits (Panel B), and the month at the first visit (Panel C) in treatment and control districts. Treatment and control status is defined as the same in Figure 2. The solid green line and dashed orange line represent treatment 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: 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 difference-in-difference 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.)

Figure 5: Trend of Mortality Rates



Note: This figure shows the trend of the newborn (death in seven days), neonatal (in 30 days), infant (in one year), and child (in five years) mortality rate 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. While it is not clear for the newborn (Panel A) and neonatal (Panel B) mortality rates, it seems that infant and child mortality rates relatively declined in treatment districts.

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

	Year≤2005			Year≥2006		
	Mean	SD	Observation	Mean	SD	Observation
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Birth Characteristics						
Male	0.51	0.50	33559	0.50	0.50	25363
Birth Order	3.62	2.30	33559	3.31	2.24	25363
Twin	0.03	0.17	33559	0.03	0.17	25363
FBD	0.31	0.46	11279	0.76	0.43	18778
Prenatal Care	0.95	0.22	6430	0.98	0.13	14261
Number of Prenatal Visit	2.52	1.15	6421	3.13	0.97	14257
Month at First Prenatal Visit	5.64	1.50	6096	4.15	1.48	14021
Newborn Mortality (NMR7)	28.75	167.10	33455	19.39	137.88	25205
Neonatal Mortality (NMR)	35.07	183.96	33455	23.22	150.59	25205
Infant Mortality (IMR)	79.40	270.36	31810	42.86	202.56	21179
Child Mortality (CMR)	123.60	329.13	22097	65.68	247.74	6531
Panel B. Mother and Household Characteristics						
Age at Birth	28.22	6.31	33559	28.41	6.28	25363
Currently Married	0.85	0.36	33559	0.84	0.36	25363
Some Education	0.74	0.44	33559	0.81	0.39	25363
Urban	0.13	0.34	33559	0.14	0.35	25363
Has Pipewater	0.31	0.46	33559	0.34	0.47	25363
Has Car/Truck	0.01	0.09	33559	0.01	0.10	25363

Note: This table shows the summary statistics of the entire data used. In Panel A, I present the variables related to children or births. The unit of observation is each birth. Pre- and post-policy is divided by birth year. There is a considerable variation in the observation number because some detailed birth information is only available for the births in recent five years. The place of birth (facility or not), prenatal care, and vaccination information are available for recent births only. Survival status, gender, birth order (from the same mother), twin indicator, and the mother's age at birth is available for the whole 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. Like Panel A, the unit of observation is birth, so 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. Facility Based Delivery				
Low FBD District	0.135***	0.143***	0.133***	0.0985***
× Post	(0.0156)	(0.0155)	(0.0168)	(0.0159)
Observations	30,057	30,057	30,057	30,057
Panel B. Number of Prenatal Visit				
Low FBD District	0.151***	0.157***	0.149***	0.113**
× Post	(0.0419)	(0.0417)	(0.0439)	(0.0438)
Observations	20,678	20,678	20,678	20,678
Panel C. Month at the First Prenatal Visit				
Low FBD District	-0.194**	-0.209***	-0.202**	-0.125*
× Post	(0.0769)	(0.0763)	(0.0788)	(0.0755)
Observations	20,117	20,117	20,117	20,117
Birth Controls		Yes	Yes	Yes
SES Controls			Yes	Yes
Province Time Trend				Yes

Note: This table presents the treatment effect on FBD and prenatal visits. Dependent variables are presented as the panel title. Each column 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

	NMR7	NMR	IMR	CMR
	(1)	(2)	(3)	(4)
Low FBD District	-5.121	-4.895	-12.15*	-25.06**
× Post	(3.205)	(3.401)	(6.573)	(10.98)
Observation	58,660	58,660	52,826	28,628

Note: This table shows the treatment effect on different mortality rates. Dependent variables are presented as the column title. Each column 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: Alternative Definitions of Treatment

		Prenatal Care			Mortality Rates		
	FBD	Frequency	First Month	NMR7	NMR	IMR	CMR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Continuous Home Delivery (1-FBD) Rate							
Treatment	0.472***	0.584***	-0.652**	-9.479	-10.08	-29.41*	-63.09**
× Post	(0.0488)	(0.150)	(0.261)	(9.117)	(10.08)	(16.60)	(29.97)
Panel B. Home Delivery Rate Above 25th Percentile							
Treatment	0.120***	0.166***	-0.239***	-5.392*	-6.887**	-11.94**	-23.86**
× Post	(0.0204)	(0.0513)	(0.0880)	(3.128)	(3.017)	(5.290)	(11.02)
Panel C. Composite Index of FBD and Prenatal Care							
Treatment	0.0824***	0.216***	-0.299***	-3.734	-3.584	-7.337	-20.80
× Post	(0.0165)	(0.0429)	(0.0756)	(3.502)	(3.809)	(6.642)	(12.84)
Panel D. Composite Index of Facility Use							
Treatment	0.0833***	0.165***	-0.179**	-4.824	-6.316*	-10.91**	-21.35**
× Post	(0.0162)	(0.0411)	(0.0730)	(2.958)	(3.392)	(5.301)	(9.507)
Observation	30,057	20,678	20,117	58,660	58,660	52,989	28,628

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 column 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 prenatal care utilization in Panel C. In Panel D, I add other facility utilization measures, such as whether the mother visited a facility in the last 12 month, utilizing modern contraceptive, whether got an HIV test, and whether the child got treatment for diarrhea and fever at the health facility. In Panels C and D, 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 mean. 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 6: Effect on Other Facility Utilization

	(1)	(2)	(3)	(4)
Panel A. Children				
	C-section	Postnatal care	Treated Diarrhea	Treated Fever
Low FBD District	-0.00414	-0.0258	-0.0348	0.0061
× Post	(0.00690)	(0.0228)	(0.0345)	(0.0283)
Observation	27,517	17,974	3,686	9,638
Panel B. Mothers				
	Visited Facility	HIV Test	Fertility Planing	Contraceptive
Low FBD District	0.0694***	0.0868***	0.0238	0.0310
× Post	(0.0223)	(0.0211)	(0.0172)	(0.0209)
Observation	22,772	22,744	22,764	16,700

Note: This table shows the treatment effect on children's and mother's health facility utilization. Dependent variables are presented at the top of each column. Each column presents β_1 of Equation 1 with the preferred specification (column 4 in Table 3). Panel A shows the health service utilization of children. Treated diarrhea and fever are one when the child was taken to a health facility for treatment conditional on having symptoms within a week. In Panel B, I present treatment effects on mothers' facility utilization. Visited Facility is one when the mother had visited a facility within 12 months. Contraceptive is one when the mother uses modern contraceptive methods conditional on the intention of birth control. 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: Heterogeneity by Exposure to Other Policies

	Change in Insurance Coverage		Difference		Performance-Based Finance		Difference	
	Large	Small	(1)-(2)	P-value	Earlier	Later	(5)-(6)	P-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. FBD and Prenatal Care								
Facility-Based Delivery	0.1216***	0.0489**	0.0726	0.0324**	0.1045***	0.0988***	0.0058	0.862
	(0.0240)	(0.0242)			(0.0270)	(0.0197)		
Number of Prenatal Visit	0.0914	0.0893**	0.0021	0.9794	-0.0185	0.1618***	-0.1803	0.0798*
	(0.0689)	(0.0410)			(0.0922)	(0.0488)		
Month at the First Prenatal Visit	-0.1043	-0.0256	-0.0786	0.57	-0.1722	-0.0986	-0.0736	0.6652
	(0.1078)	(0.0892)			(0.1504)	(0.0850)		
Panel B. Mortality Rates								
Newborn Mortality (7 days)	-5.0103	-4.0353	-0.975	0.8819	-15.4270***	-1.6214	-13.8057	0.0370**
	(4.1166)	(5.1760)			(5.1853)	(4.1828)		
Neonatal Mortality (30 days)	-3.6721	-4.4702	0.7981	0.9057	-11.8010**	-3.1236	-8.6774	0.2331
	(4.8196)	(4.7809)			(5.7794)	(4.4927)		
Infant Mortality (1 year)	-15.4167	-7.1691	-8.2476	0.5216	-28.9349**	-5.2105	-23.7244	0.1469
	(11.4747)	(5.9042)			(14.6791)	(7.4832)		
Child Mortality (5 years)	-22.4734	-29.4191***	6.9457	0.7608	-37.6575	-21.1826*	-16.4749	0.5615
	(20.4609)	(10.4823)			(25.7400)	(12.6050)		

Note: This table shows the heterogeneity in the treatment effect by the exposure to other related policies. In 2006, the Rwandan Ministry of Health implemented universal health insurance (CBHI) and Performance-Based Financing (PBF) nationwide. Because the government earlier started these programs as pilot programs, the exposure to the program varies by district. In columns 1 and 2, I divide the sample by districts with large and small changes in insurance coverage. The district-level insurance coverage is estimated with EICV data. 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. In columns 5 and 6, 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 districts are also in the new administrative boundaries. The differences between the two groups are presented with the p-value. Panel A shows the effect on the outcomes of children, and Panel B shows the women's outcomes. The joint-significant test is also conducted and presented with the p-value at the bottom part of the panels. 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 Heterogeneity by Distance to Health Facilities

Proximity to health facilities is an important factor in access to health services. If the health facility is too far away, it is difficult to seek care as needed. The FBCP focuses on increasing utilization by removing the financial barrier. Intuitively, the policy effect may be greater in areas with greater physical access to health facilities. The Rwandan Ministry of Health provides a complete list of the registered health facilities in the country. However, the public data only provides the most recent information.[18] In 2019, there are 48 hospitals (district, provincial, and referral hospitals) and 508 health centers in Rwanda. The geocodes are available for all of the hospitals and 465 health centers. Although the data includes the opening date of each facility, they are overall inaccurate with a lot of missing values. Hence, I ignore the opening dates and use all of the available facilities in 2019. This is potentially problematic because the new opening of health facilities is not exogenous. Nevertheless, I explore whether the treatment effect is stronger in areas with greater health service access.

Using the geocodes of the primary sampling units of RDHS, I can identify the distance to the closest facilities. Because the prenatal care and basic delivery services are provided at the health center, and complicated pregnancies are transferred to hospitals, I estimate the distance to the health center and the higher-level facility separately. The median of the minimum distance to the health center is 2.5 km and to district/provincial/referral hospital is 8.8 km. I separate the sample into two groups by the distance to the closest facility, below and above the median distance. I separately evaluate the treatment effect on the outcome variables above.

The results are presented in Table A.1. Panel A contains the impact on FBD and prenatal care utilization, and Panel B contains the mortality outcomes. Columns 1 and 2 depict the differential result by the distance to the health center, the primary level facility. Mothers are more likely to give birth in a health facility and have more prenatal visits when they live closer to the facility. The differences are 9.9 percentage points and 0.2 times for FBD and the number of prenatal visits, respectively, with a very high significance. Despite this differential effect on FBD and prenatal care, this is not leading to a larger effect on newborn and neonatal mortality in the districts with closer proximity to the facility. However, there is a large difference in infant

[18] In this study, I acquire the list of facilities in 2019.

and child mortality rates, a larger decline in areas where facilities are close. These results are largely consistent with my main results: a large decline in infant and child mortality rates, but not for newborn and neonatal mortality rates.

I find similar heterogeneity in effect when I divide the sample by the distance to the closest higher-level facility in columns 3 and 4. Although the higher-level facilities are not the place for most babies' delivery, the treatment effect is much larger in the villages where the hospital is close. This is largely coming from the correlation between the distance to the health center and the hospital. Villages in a denser area are likely to be urban, which makes them closer to everything. However, when I run the regressions only with rural villages, the overall results don't change much (result available upon request). Although not statistically significant, treatment effects are larger in districts where hospitals are close for all mortality rates. The difference in point estimates is substantial for newborn and neonatal mortality: 10.6 and 8.2, respectively. Together with results in Table 7 for PBF, it seems that the quality of the facility plays an important role in reducing mortality.

There is concern about using 2019 as the reference year because the number of health facilities has increased substantially since 2006, and thus it would not fully capture the access of health facilities in the baseline period. However, the increase in health facilities is driven mainly by health posts where the child delivery service is not provided, not health centers or district hospitals (or higher level) (Rwanda Ministry of Health, 2009, 2015). The largest increase in the number of health centers from 2008 to 2014[19] is five in Rusizi and Musanze district. Since this number is non-negligible,[20] I estimate the same regressions for the two groups according to the average travel time to the health facility in 2005 .[21] The results look very similar. The results change little when I use travel time in 2014 instead (Results available upon request). Although some mothers give birth at a private facility, the fraction is very small (less than 2 percent).

B Effect of the Expansion of Universal Health Insurance

Expansion of universal health insurance is another policy that potentially increased FBD and prenatal care utilization. This section examines how much expansion of the CBHI scheme is

[19]The information available from Rwandan Ministration of Health on the number of facilities in each district starts from 2008.

[20]The median number of health centers in each district in 2014 is 6.

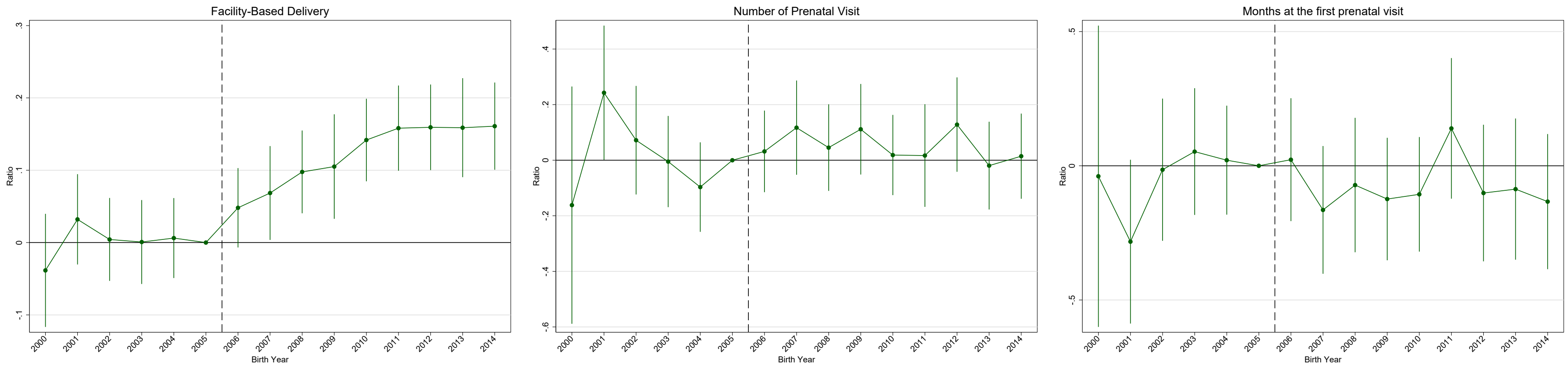
[21]This information is available in the EICV 2005 round.

associated with FBD 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.2 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 7, where an increase in insurance coverage is not associated with the treatment effect of free FBD and prenatal care policy. To summarize, Tables 7 and A.2 imply that Facility-Based Childbirth Policy was the main driver promoting FBD and prenatal care.

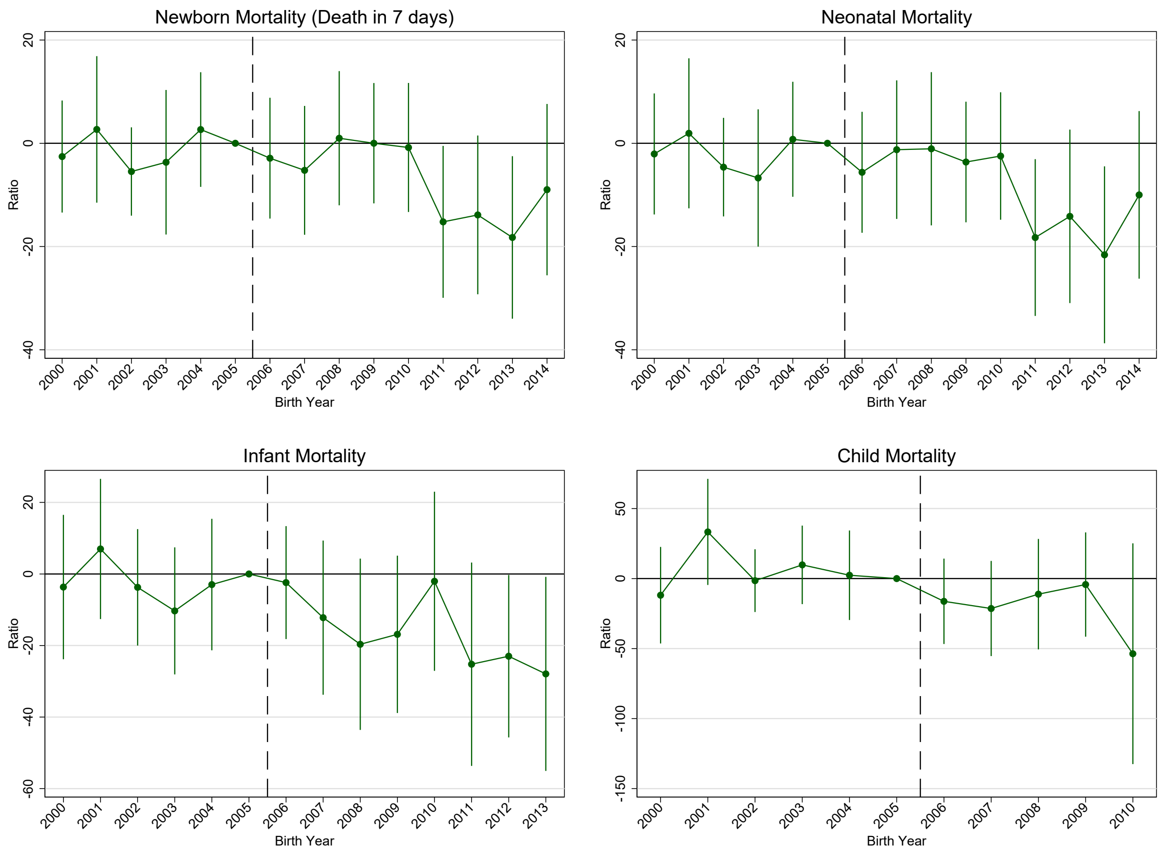
Appendix Figures

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: Heterogeneity by Distance to Health Facilities

	Primary facility		Difference		Higher facility		Difference	
	Close	Far	(1)-(2)	P-value	Close	Far	(5)-(6)	P-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. FBD and Prenatal Care								
Facility-Based Delivery	0.1455***	0.0500**	0.0955	0.0007***	0.1360***	0.0358	0.1002	0.0021***
	(0.0223)	(0.0206)			(0.0227)	(0.0238)		
Number of Prenatal Visit	0.2454***	0.0427	0.2026	0.0274**	0.0789	0.0891	-0.0102	0.8976
	(0.0737)	(0.0598)			(0.0538)	(0.0613)		
Month at the First Prenatal Visit	-0.1177	-0.1269	0.0093	0.9475	-0.0769	-0.0895	0.0126	0.9255
	(0.1078)	(0.1066)			(0.1055)	(0.0895)		
Panel B. Mortality Rates								
Newborn Mortality (7 days)	-7.5091*	-4.4298	-3.0793	0.5919	-10.7123**	-0.1203	-10.592	0.1422
	(4.3980)	(3.9913)			(5.3807)	(4.6610)		
Neonatal Mortality (30 days)	-4.9189	-6.785	1.8661	0.7718	-9.3460*	-1.1759	-8.1701	0.2665
	(4.7247)	(4.6034)			(5.4599)	(5.1528)		
Infant Mortality (1 year)	-25.9421***	-5.6041	-20.338	0.0445**	-19.2714**	-4.5328	-14.7386	0.2384
	(8.3285)	(7.9156)			(8.7207)	(9.5099)		
Child Mortality (5 years)	-50.0745***	-18.3917	-31.6828	0.1325	-30.5677***	-17.6239	-12.9438	0.6377
	(14.6058)	(14.0840)			(11.8326)	(22.6410)		

Note: This table shows the heterogeneity in the treatment effect by distance to health facilities. Because the Rwandan Ministry of Health only provides the most recent list of health facilities, I use the recent data to divide the sample (2019 data in this paper). In columns 1 and 2, I divide the sample by districts with distance to the primary facility (health center) and in columns 5 and 6, with secondary or above hospitals (district or provincial hospital). The median distance to the closest primary and secondary or above facility is 2.5 km and 8.8 km, respectively. Other specification is same with Table 7. Robust standard errors are in parentheses clustered by the proper district. * significance at 10%; ** significance at 5%; *** significance at 1%.

Table A.2: Treatment Effect of Insurance Coverage

		Prenatal Care		Mortality Rates			
	FBD	Frequency	First Month	NMR7	NMR	IMR	CMR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Low baseline Insurance	0.0304	-0.0389	-0.0263	-2.167	-2.587	-7.597	-25.95**
× Post	(0.0187)	(0.0536)	(0.0908)	(3.399)	(3.420)	(5.633)	(12.02)
Observations	30,057	20,678	20,117	58,660	58,660	52,826	28,628

Note: This table shows the treatment effect of expansion of CBHI on different outcome variables. Dependent variables are presented as the column title. Each column 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. 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%.