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An equity analysis of performance-based financing in Rwanda: are services reaching the poorest women?

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Maternal health services continue to favour the wealthiest in lower and middle income countries. Debate about the potential of performance-based financing (PBF) to address these disparities continues. As PBF is adopted by countries, it is critical to understand the equity effects for maternal services. The aim of this study is to examine the effects of PBF on equity in maternal health service use when no specific provisions target the poorest in the population. In Rwanda, PBF was designed to increase health service use, which was universally low. Paired districts were randomly assigned to intervention and control for PBF implementation. Using Rwanda's Demographic Health Survey data from 2005 (pre-intervention) and 2007–8 (post-intervention), a cluster-level panel dataset of 7899 women 15–49 years of age from intervention (4477) and control districts (3422) was created. The impact of PBF on reported use of facility deliveries, antenatal care (ANC) and modern contraceptive use was estimated using a difference-in-differences model with community fixed effects. Interaction terms between wealth quintiles and PBF were estimated to identify the differential effect of PBF among poorer women. The probability of a facility delivery increased by 10 percentage points in the intervention when compared with the control districts ($P = 0.014$), while no significant effects were noted for ANC visits or modern contraceptive use. Service use increased for intervention and control populations and across all wealth quintiles from 2005 to 2007, with no evidence that PBF was a pro-poor or a pro-rich strategy. Insurance remained a positive predictor of service use. This research suggests that if service use is uniformly low then a PBF programme that incentivizes select services, such as facility deliveries, may improve service use overall. However, if the equity gap is extreme, then a PBF programme without equity targets will do little to alleviate disparities.

Keywords Performance-based financing, equity, maternal health services, Rwanda

KEY MESSAGES

- Maternal health service utilization has substantially increased in Rwanda from 2005 to 2007 across all economic strata.
- Performance-based financing was found to be neither a pro-poor nor pro-rich strategy for increasing use of services. If service use is uniformly low then a programme with standard performance targets that are well reimbursed improves service use overall. However, if the equity gap is extreme or service use is sub-optimal among the poorer populations, then a non-targeted programme will do little to alleviate disparities.

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Introduction

Over the past several years, results-based financing strategies have gained support among lower and middle income countries as tools to increase the use of primary maternal and child health services. Broadly speaking, these strategies include demand-side incentives, such as vouchers or conditional cash transfers that encourage more care-seeking behaviour from the consumer, and supply-side incentives that reward providers and health systems for improved performance. Performance-based financing (PBF) is a type of results-based financing that uses only supply-side financial incentives to motivate healthcare providers to improve the delivery of health services (Musgrove 2011). Advocates hail PBF as a potential reform strategy that may profoundly influence the provision of health care through greater local provider autonomy under strong national oversight (Meessen *et al.* 2011), praise it as a flexible financing strategy that is responsive to country context and evolving health priorities (Basinga *et al.* 2011*b*; Soeters *et al.* 2011) and promote it as an effective strategy for increasing service use (Schwartz and Bhushan 2005; Eichler *et al.* 2009; Basinga *et al.* 2011*a*). Critics, on the other hand, raise concerns regarding the limited empirical evidence for PBF, specifically the effect on equity of service use, on health outcomes, not just service outputs, on the potential adverse effects for non-incentivized services and on the long-term impact and sustainability of this approach (Gwatkin 2009; Ireland *et al.* 2011; Montagu and Yamey 2011; Witter *et al.* 2012). Recognizing the legitimacy of these concerns, the building of an evidence base for PBF in lower and middle income countries remains a priority. This study examines the question of whether a PBF programme can help close the equity gap in use of maternal health services when there are no specific provisions to target the poorest in the population.

Primary maternal health services continue to favour wealthier households in lower and middle income countries (Houweling *et al.* 2007; Creanga *et al.* 2011). Victora *et al.* (2000) suggest that health services benefit those who least need them and will not trickle down to the poorest in the population until the wealthiest have maximized the potential of the intervention. The poorer among the population often face limited choices for services, require more education about the value of services and face other economic priorities that compete for their limited time and resources. Even programmes developed specifically to reach the poorest populations, such as oral rehydration therapy, were still more likely to reach those with greater economic resources, albeit in a less pro-rich manner than general health services (Gwatkin 2000, 2001). In an analysis of 54 countries, Boerma *et al.* (2008) calculated that the largest absolute difference in service use between the least poor and the poorest quintiles was for skilled delivery and antenatal care (ANC): a 34 and 21 percentage-point difference, respectively. In Rwanda in 2005, the wealthiest, on average, used health services at a rate 16.3% higher than the poorest (Boerma *et al.* 2008).

Suggested means of reaching the poor through PBF strategies include targeting services geographically as seen in Guatemala (Danel and La Forgia 2005), paying directly for services provided to identified poor patients as seen in Bangladesh (Iqbal *et al.* 2009) and contracting with equity targets, as seen in Cambodia (Schwartz and Bhushan 2004; Gwatkin 2009). Data from Guatemala suggests that service use increased in the targeted underserved districts; however, baseline survey data were not collected, limiting the extent of conclusions drawn (Danel and La Forgia 2005). In Bangladesh, vouchers were provided by skilled birth attendants (SBAs) to pregnant women from the poorest 40% of households. SBAs were paid per voucher redeemed for services. Iqbal *et al.* (2009) concluded that SBAs contributed to an increased use of maternal services; however, no counterfactual was studied. In Cambodia, using a quasi-experimental design with pre- and post-intervention measures, Schwartz and Bhushan (2004) found that children from the poorest households in contracted districts had a higher probability of being fully immunized compared with the poorest in control districts. These examples provide weight to the plausibility of improved outcomes among the targeted poor, but what about PBF programmes that do not specifically target the poor? Can a non-targeted supply-side financing strategy close the gap in service use or are pro-poor programme provisions needed to close the equity gap?

Rwanda has produced remarkable improvements in maternal health service use over the past several years. The latest Rwanda Demographic and Health Survey (RDHS) reports an improvement in facility deliveries from 28% in 2005 to 69% in 2010 (National Institute of Statistics of Rwanda *et al.* 2012). Similarly modern contraceptive use among married women increased dramatically from 10% in 2005 to 45% in 2010 (National Institute of Statistics of Rwanda *et al.* 2012). The equity gap in maternal service use has also improved from a 50 percentage-point difference in facility deliveries between the poorest and least poor wealth quintile in 2005 to a 29 percentage-point gap in 2007 (National Institute of Statistics of Rwanda *et al.* 2009). A parallel trend was seen for modern contraceptive use with only a 7 percentage-point gap in 2007, down from 21 percentage points in 2005 (National Institute of Statistics of Rwanda *et al.* 2009). Efforts that contributed to the narrowing of the equity gap have been suggested but not rigorously examined.

Rwanda's PBF experience provides an opportunity to examine the effects of supply-side financing on improving equity in maternal health service utilization. In 2005, the Government of Rwanda formally adopted PBF as a health financing strategy designed to motivate health providers to increase service output and improve quality of care. Fourteen indicators monitored the quantity of maternal and child primary care services, including but not limited to ANC use, delivery in a facility, modern contraceptive use, immunizations, growth monitoring and appropriate treatment and referrals. Nine quality indicators were evaluated through quarterly site visits. Payment was based on service outputs with varying rates per service, then the total payment was weighted per facility quality score. Health facilities apportioned these funds at their discretion. Typically, three-quarters of the funds were directed to health providers, resulting in an average 38% salary top-off; the remainder used for infrastructure and supplies (Kinoti 2011). (For details see Rusa *et al*. 2009 or Basinga *et al*. 2011*a*).

Previous PBF studies in Rwanda reported dramatic increases in facility deliveries and receipt of tetanus toxoid and contraceptive use in pilot sites (Meessen *et al.* 2006), and an increase in facility deliveries following national implementation in 2005

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(Rusa *et al.* 2009). However, both these prior studies relied on convenience sampling for comparison groups and the facilities' routine health information systems. In one of the most extensive impact evaluations of PBF in Rwanda, Basinga *et al.* (2011a) randomly assigned districts to intervention and control groups. Population-based survey data were collected from households within facility catchment areas pre- and post-implementation. Results supported earlier findings for facility deliveries, a 23% increase in use of facility deliveries, yet no differences were found in number of ANC visits; modern contraceptive use was not evaluated. Moreover, the effect of PBF among the poorest women was not examined, despite the potential inequitable implementation by providers who may differentially target women from wealthier households, those perceived as 'low hanging fruit'.

The aim of this study was to examine the effects of PBF on equity in maternal health service use. Specifically, in the absence of provisions targeting the poor, does PBF increase service use differentially among the poorest women?

Methods

Study design

A phased implementation plan for PBF included an experimental design to allow for robust programme evaluation. Prior to national PBF scale-up, administrative districts not involved in earlier PBF pilot projects were matched on population density, rainfall and livelihood. Matched districts were randomly assigned to early implementation between January 2006 and November 2007, or delayed implementation beginning in April 2008 (Basinga *et al.* 2011*a*). This experimental design allows for comparisons over time between the early implementers or intervention districts and delayed implementers or control districts. National household survey data from 2005 to 2007–8 provide pre- and post-implementation measures for selected maternal health outcomes.

Data

Data from the Rwanda DHS 2005 (henceforth 2005) and Rwanda Interim DHS 2007–8 (henceforth 2007) provide individual and household socio-demographic characteristics and health indicators for maternal health, including ANC, birthing practices and family planning. The 2005 survey sampled 463 clusters representative of the 12 former provinces, stratified by rural and urban residence (National Institute of Statistics of Rwanda and Macro International Inc. 2006). In 2007, 250 of these clusters were resampled for the interim survey (National Institute of Statistics of Rwanda *et al.* 2009). Geographic coordinates were available for 246 of the clusters, facilitating the creation of a panel dataset of matched clusters from 2005 and 2007; 86 clusters located in the 12 intervention districts and 64 clusters in the seven control districts. Ninety-six clusters from the 11 pilot districts, including the three districts surrounding Kigali, were excluded due to non-random assignment to early implementation. Using DHS data is advantageous because it allows one to look at the effect in the population rather than relying on data from facilities that are incentivized to improve reporting. Three factors facilitate the use of DHS data for this evaluation: (1) the random assignment of programme implementation at the district level, (2) the close match between district boundaries and facility catchment areas post-decentralization and (3) the timing of the two DHSs, book-ending the implementation for intervention districts.

The panel dataset included 7899 women 15–49 years of age who lived in an intervention (4477) or control district (3422): 3611 women from the 2005 survey and 4288 from 2007. Three pregnancy-related outcomes were studied: early initiation of ANC, four or more ANC visits during pregnancy and delivery in a health facility. The window of analysis for these outcomes was limited to deliveries in the previous 18 months to isolate the effects of PBF. The final dataset for pregnancy-related outcomes included 2044 women: 1170 from intervention districts and 874 from control districts. The fourth outcome studied was use of modern contraceptives among married women. This final dataset included 4121 currently married women: 2328 from intervention districts and 1793 from control districts.

The four dependent variables, early initiation of ANC, four or more ANC visits during pregnancy, delivery in a health facility and use of modern contraceptives, were collected in each DHS. For this evaluation, receipt of formal ANC services includes women who reported receiving prenatal care from a trained medical provider in a public or private health facility. WHO recommends four or more ANC visits and early initiation of care, defined as any visit before the fourth month of pregnancy (World Health Organization 2007). Facility deliveries include delivery in any public or private health facility, and are promoted worldwide as a key strategy to reduce maternal mortality. Modern contraception was limited to use of the pill, injectables, implants or intrauterine device (IUD), as these methods were specifically promoted under PBF. Each of these outcomes is incentivized through PBF, although the payment rate varies by service with the highest monetary incentive for a facility delivery.

The key independent variables are residence in a PBF district and household wealth. Assignment to a PBF intervention district was based on the district in which the survey cluster was located; hence, all women from the same cluster were assigned the same PBF status. Household wealth scores based on asset ownership and housing characteristics were created separately for the 2005 and 2007 study samples. Polychoric principal component analysis (PCA) was used to calculate a wealth score. Polychoric PCA ranks the categorical responses to maintain the relative position of responses and wealth. This avoids generating dummy variables as is the norm with standard PCA, which may create spurious negative correlations and underestimate the explained variance (Kolenikov and Angeles 2009). The choice of assets for the wealth score was based on the economic context in Rwanda and data availability. Assets for 2005 included television, radio, telephone, bicycle and land ownership; housing characteristics included electricity, drinking water, toilet facility, cooking fuel and flooring material. Three assets were excluded as a result of perfect prediction with other assets: refrigerator, motorcycle and car. For 2007, land ownership data were not collected, car and motorcycle ownership were combined as a single variable and refrigerator was excluded, again for reasons of perfect prediction. The first component of the polychoric PCA was used to create the wealth

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index score, explaining 59% of the variance for 2005 and 57% for 2007. Households were divided into quintiles based on their wealth index score; the new wealth quintile was assigned to each woman living in the household.

Statistical analysis

Bivariate descriptive analyses for each outcome variable by year and wealth quintile were completed. Concentration curves plotting the cumulative outcome variables by the cumulative percentage of women ranked by wealth were created to graphically illustrate inequity in service use by wealth status (O'Donnell *et al.* 2008).

A difference-in-differences (DD) estimation strategy was used to evaluate the impact of PBF on the use of maternal health services. The DD estimator calculates the change in outcome for the intervention and control groups over time and takes the difference between the groups to determine the effect of PBF, written as:

$$\mathrm{DD} = (Y_{\mathrm{PBF07}} - Y_{\mathrm{PBF05}}) - (Y_{\mathrm{Non-PBF07}} - Y_{\mathrm{Non-PBF05}}) \qquad (1)$$

A linear probability model (LPM), with cluster-robust standard errors and individual and household covariates included to reduce residual variance and improve the efficiency of the estimates, was estimated for each outcome. Community fixed effects were subsequently included to control for time-invariant unobserved community differences. The DD with community fixed effects specification is written as:

$$Y_{ijt} = \beta_0 + \beta_1 X_{ijt} + \beta_2 \mathrm{Y07}_t + \beta_3 (\mathrm{PBF}_j * \mathrm{Y07}_t) + \mu_j + \varepsilon_{ijt}, \qquad (2)$$

where subscripted indexes are defined as i = individual, j = community or cluster and t = time. Terms in the model include the vector of covariates (X), a dummy variable for time period 2007/8 (Y07 = 1 for post-implementation) and a dummy programme variable for clusters located in districts with PBF (PBF = 1 for intervention district). The primary coefficient of interest is β_3, which captures the effect of the PBF programme on the outcomes of interest. By subtracting the differences over time between programme areas, the unobserved time-invariant community fixed effects (μ_j) will be differenced out. Unobserved time-varying community variables (μ_{jt}) are excluded from the model because community characteristics are unlikely to change dramatically during the short 2- to 3-year interval and the fixed community differences will be differenced out already. Individual unobserved time-invariant fixed effects (μ_i) are also excluded because any potential bias due to omitted variables might arise at the community level where the programme intervention was assigned rather than the individual level.

Interaction terms between wealth quintiles and the PBF intervention were then estimated to identify the differential effect of PBF among women from poorer families. The model specification shown below is written with only one set of wealth interaction terms to illustrate the inclusion of the interactions.

$$\begin{aligned} Y_{ijt} = {} & \beta_0 + \beta_1 X_{ijt} + \beta_2 \mathrm{Y07}_t + \beta_3 (\mathrm{Y07}_t * \mathrm{PBF}_j) + \beta_4 (\mathrm{Wealth1}_{ijt}) \\ & + \beta_5 (\mathrm{PBF}_j * \mathrm{Wealth1}_{ijt}) + \beta_6 (\mathrm{Y07}_t * \mathrm{Wealth1}_{ijt}) \\ & + \beta_7 (\mathrm{Y07}_t * \mathrm{PBF}_j * \mathrm{Wealth1}_{ijt}) + \mu_j + \varepsilon_{ijt}, \end{aligned} \qquad (3)$$

where subscripted indexes are defined as i = individual, j = community and t = time. Dummy variables for the wealth quintiles were added. Wealth1 represents the poorest 20% of households, additional terms for Wealth2, Wealth3 and Wealth4 were also included (not shown), and the least poor, Wealth5, was the referent group. The primary coefficient of interest is for the triple interaction (β_7), which captures the effect of the PBF programme on the probability of the outcome among women from the poorest households compared with the probability of the outcome among women from the least poor households, relative to women living in control districts. Interaction terms between insurance status and PBF residence and insurance with wealth quintiles were tested but not included due to insignificance.

Finally, the models were stratified by residence to identify any difference in programme effect in rural vs urban settings that were not revealed in the full model when residence was differenced out by the community fixed effects specification. However, due to the minimal number of urban clusters ($n = 22$) and the allowance for intracluster correlation, correct cluster-robust standard errors are not produced with more than 21 variables in the model. Hence, the number of covariates was restricted for the stratified models to those considered most influential as noted in the results.

The study was reviewed and approved by the University of North Carolina Institutional Review Board. All analyses were completed in Stata SE 11.2. (StataCorp, College Station, TX, USA)

Results

Comparison of the intervention and control study populations at baseline indicates that the random assignment of districts to intervention phase created comparable populations with no significant differences (Table 1).

The concentration curves (Figures 1–4) plot the cumulative share in service use by wealth status for 2005 and 2007. Women by wealth quintile are plotted on the x-axis with the poorest women located in the lower left. The cumulative outcome variable is plotted on the y-axis. The line of equity is achieved when use of the service is equal across wealth quintiles. Plotting below the line of equity indicates the outcome has lower values among the poorer women in the population. The equity gap in 2005 is most evident for modern contraceptive use, with 60% of the poorest women reporting <40% of the share of modern contraceptive use (Figure 4). Likewise, facility deliveries were more often reported among the wealthier in 2005 (Figure 3). By 2007, the gap in equity for all four outcomes narrowed.

The absolute change in service use improved from 2005 to 2007 for all four outcomes (Table 2). The most dramatic improvements were measured for facility deliveries among the intervention and control groups, 36.0 and 19.9 percentage-point changes, respectively. For ANC visits and contraceptive use, average service use improved ~14 percentage points from 2005 to 2007.

Looking at disparities, the inequity of facility deliveries seen in 2005 between the least poor 20% of the population compared with the poorer 80% of the population is substantial for the intervention and control groups. By 2007, improved use by the middle income groups narrowed this gap in facility deliveries.

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Table 1 Comparison of individual woman and household characteristics between the intervention and control samples at baseline: 2005 Rwanda DHS weighted data

Characteristics	Total		Intervention		Control		Difference	*P*-value
	$n = 3613$	%	$n = 2227$	%	$n = 1386$	%		
Age								
<20 years	743	20.6	469	21.1	274	19.8	1.29	0.368
≥35 years	359	9.9	218	9.8	141	10.2	−0.38	0.704
Primary school	618	17.1	375	16.8	243	17.5	−0.69	0.760
Married	1832	50.7	1124	50.5	707	51.0	−0.54	0.825
Parity: no births	1309	36.2	815	36.6	495	35.7	0.88	0.659
Parity: more than 5	774	21.4	481	21.6	293	21.1	0.46	0.776
Wealth status								
Poorest	737	20.4	476	21.4	262	18.9	2.47	0.310
Poorer	775	21.5	442	19.8	333	24.0	−4.18	0.115
Middle	678	18.8	414	18.6	264	19.0	−0.46	0.814
Less poor	718	19.9	452	20.3	265	19.1	1.18	0.597
Least poor	704	19.5	442	19.8	262	18.9	0.94	0.799
Health insurance	1768	48.9	1051	47.2	717	51.7	−4.54	0.248
Rural residence	3302	91.4	2051	92.1	1251	90.3	1.84	0.653
Prior facility delivery	203	5.6	121	5.4	83	6.0	−0.56	0.521

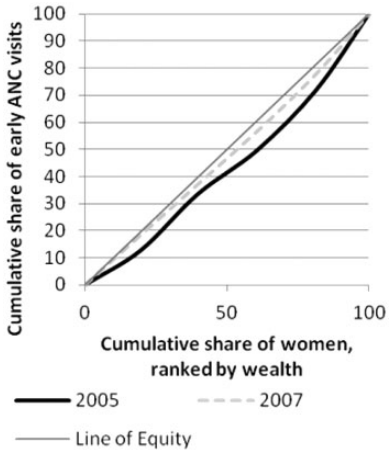

Figure 1 Concentration curves for early ANC initiation.

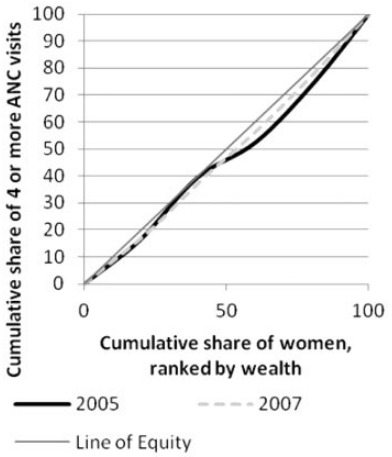

Figure 2 Concentration curves for four or more ANC visits.

A similar pattern is seen for modern contraceptive use in 2005 where use doubles among the least poor population quintile compared with the poorer 80%. This disparity by wealth is much less evident for early ANC initiation and nearly non-existent for meeting the recommended number of ANC visits.

Modern contraceptive use was twice as high among urban vs rural residents in 2005, a pattern seen also for facility deliveries. In absolute terms, the improvements between 2005 and 2007 for urban and rural residents were similar for modern contraceptives and facility deliveries. By 2007, approximately one-quarter of the women reported early ANC and adequate number of ANC visits, with no clear differences between rural and urban communities.

Comparisons of absolute changes between PBF intervention and control groups between 2005 and 2007 suggest that PBF may have positively influenced the increased use of facility deliveries. However, no consistent patterns of higher service use are evident for intervention vs control populations for ANC visits or modern contraceptive use. Further analyses using econometric techniques provide an opportunity to control for unmeasured influences or programmes that may have contributed to the changes seen, hence offering insights into the effect of PBF particularly among the poor.

Results from the LPM were used to obtain the DD estimator for the effect of PBF on maternal health services (Table 3). The probability of a facility delivery increased by 0.100 in the intervention districts compared with the control districts ($P = 0.014$), while no significant PBF effects were noted for ANC visits or modern contraceptive use.

Our primary question, however, was whether PBF reached the poorest of the population, that is did PBF help to close the gap

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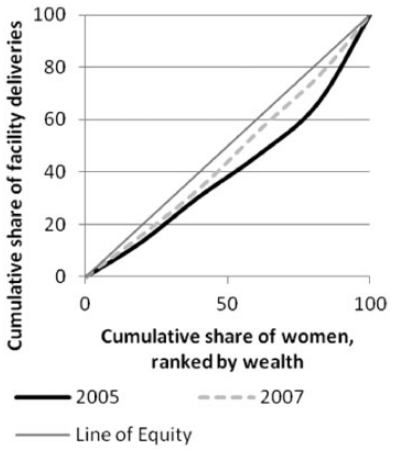

Figure 3 Concentration curves for facility delivery.

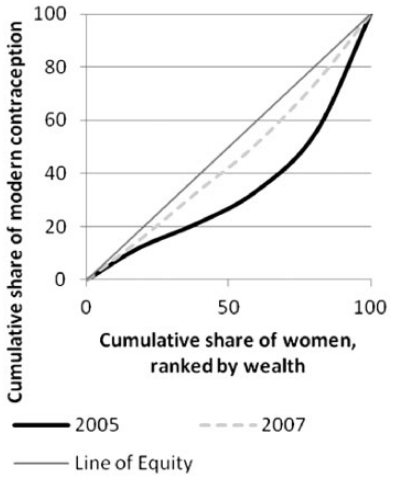

Figure 4 Concentration curves for modern contraceptive use.

in service use between the least poor and poorest women in Rwanda. Interactions between programme effect and wealth quintile found no statistically significant differences based on wealth status (Table 4). For facility deliveries, no consistent pattern in use relative to household wealth status was found. The strongest predictors of facility delivery after controlling for PBF remain parity ($\beta = 0.408$, $P < 0.001$), prior facility delivery ($\beta = 0.368$, $P < 0.001$) and any ANC visits during index pregnancy ($\beta = 0.193$, $P < 0.001$), while health insurance contributed modestly ($\beta = 0.056$, $P = 0.012$) (data from full models are given in Tables A1 and A2). Receipt of four or more ANC visits trends positively among the poorer 80% of the population compared with the least poor, particularly for women in the middle ($\beta = 0.197$, $P = 0.102$) and the richer ($\beta = 0.139$, $P = 0.217$) wealth quintiles, although the results are not significant. No clear patterns emerge for either early ANC initiation or modern contraceptive use by wealth group.

Finally, the impact of PBF by wealth was estimated separately for rural and urban residence. First, a DD model interacting with rural residence rather than wealth quintiles was run for each outcome (data not shown). No differences in programme impact were found for rural vs urban residents for the four outcomes studied. Next, the primary DD with wealth interaction terms was run for stratified rural and urban samples (Table 5). No clear patterns emerge in the stratified analysis, leading to the conclusion that PBF did not influence service use differentially by wealth or residence, although this absence of differential effect may reflect a sample size that limits our ability to detect an effect size <20% by wealth group even before stratification by residence.

Discussion

To combat the pervasive low use of maternal health services in Rwanda in the early 2000s, the Government of Rwanda promoted both supply-side and demand-side financing strategies. PBF was scaled up nationally to increase the supply of health services through an incentive programme for providers and health facilities. Supporters for PBF recognized that increasing and improving service performance was not solely an issue of lack of provider knowledge or skills (Rowe *et al.* 2005), rather the government needed to target multiple facets of provider motivation to increase service output. Serneels and Lievens (2008) propose four institutional factors that influence health worker performance in Rwanda: incentives, monitoring arrangements, professional norms and intrinsic motivations (Serneels and Lievens 2008). PBF, through a set of monetary incentives and increased supervision and monitoring, directly addresses the first two factors. Indirectly, PBF may improve the professional norms or culture of a facility as colleagues begin to work together towards higher outputs and subsequently intrinsic motivations may improve as one takes pride in the improved performance of the facility. Basinga *et al.* (2011*a*) found that the monetary incentives of PBF increased the probability of facility deliveries by 8.1 percentage points for women in intervention sites after controlling for the increase in absolute health expenditures (~22%), yet no effect was found for ANC use. Our analysis of national data confirmed the increase in facility deliveries; women living in intervention districts were 10.0 percentage points more likely to deliver in a health facility compared with women in control districts, a 42.7% increase in facility deliveries attributable to PBF. Likewise, no effect on early ANC initiation or number of ANC visits was found. These effects suggest that a supply-side incentive will not adequately increase service use unless the incentive is large.

This study took a step further and looked at whether PBF was an effective pro-poor strategy, increasing the use of maternal services among the poorest women in the population. No evidence was found that PBF is pro-poor in Rwanda, likewise we found no evidence that PBF is pro-rich. The increase in facility deliveries was seen across all wealth groups ranging from 26 to 45 percentage-point increases among the intervention group compared with 8–30 percentage-point increases among the controls (Table 2), yet interaction terms between wealth, year and PBF programme found no differential effect of the programme by wealth quintile. While the equity gap in service use for facility deliveries and modern contraceptive use decreased from 2005 to 2007, we cannot conclude that PBF was responsible for these improvements.

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Table 2 Percent of women reporting key outcomes by study sample and year

Key outcome	Intervention group			Control group		
	2005	2007	Absolute change[a]	2005	2007	Absolute change[a]
First trimester ANC[b]	7.2	23.8	16.6***	6.6	20.0	13.4***
Wealth						
Poorest	6.2	20.0	13.8	1.2	22.1	20.9**
Poorer	8.8	17.5	8.7	5.0	25.4	20.4**
Middle	5.4	25.6	20.2***	5.3	13.6	8.3
Less poor	6.1	25.0	18.9***	10.2	19.8	9.6
Least poor	10.5	31.7	21.2	10.7	18.3	7.6
Residence						
Rural	6.6	23.4	16.8***	6.9	19.5	12.6***
Urban	16.5	28.6	12.1	4.3	25.1	20.8**
Four or more ANC[b]	13.3	24.6	11.3***	10.0	22.8	12.8***
Wealth						
Poorest	11.1	20.4	9.3	7.8	20.5	12.7*
Poorer	18.7	26.2	7.5	7.2	22.1	14.9**
Middle	7.2	23.5	16.3**	8.8	21.0	12.2*
Less poor	14.2	27.6	13.4*	11.2	22.4	11.2*
Least poor	16.5	26.2	9.7	15.3	29.2	13.9
Residence						
Rural	13.1	24.6	11.5**	10.2	22.8	12.6***
Urban	16.6	25.2	8.6	8.8	22.3	13.5
Facility delivery[b]	23.4	59.4	36.0***	28.8	48.7	19.9***
Wealth						
Poorest	17.7	44.2	26.5	16.0	45.6	29.6**
Poorer	19.8	53.4	33.6***	24.3	43.7	19.4*
Middle	18.8	64.2	45.4***	20.3	50.0	29.7***
Less poor	21.0	61.6	40.6***	29.1	44.6	15.5
Least poor	42.1	77.1	35.0	53.5	62.3	8.8
Residence						
Rural	22.1	57.8	35.7***	27.9	47.6	19.7**
Urban	44.0	79.3	35.3*	35.3	61.4	26.1
Modern contraception[b,c]	6.1	22.0	15.9***	6.8	23.3	16.5***
Wealth						
Poorest	3.8	18.4	14.6***	4.9	18.1	13.2**
Poorer	2.3	18.0	15.7***	3.5	23.0	19.5***
Middle	3.1	20.3	17.2***	4.9	17.7	12.8**
Less poor	6.7	23.9	17.2***	6.6	25.5	18.9***
Least poor	14.9	29.0	14.1**	14.4	31.7	17.3**
Residence						
Rural	5.6	21.2	15.6***	6.2	22.6	16.4***
Urban	12.6	33.4	20.8*	13.8	30.7	16.9*

[a]*T*-tests for differences between 2005 and 2007. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.
[b]No statistical differences found between intervention and control groups at baseline.
[c]Modern contraception includes pill, injectable, implant and IUD.

So why isn't PBF a pro-poor strategy in Rwanda? Often health facilities located in poorer communities are understaffed, poorly equipped and less well organized, resulting in health services less responsive to the needs of the population (Castro-Leal *et al.* 2000; Victora *et al.* 2003). PBF was designed specifically to increase health service output and quality for a health system chronically understaffed. Inputs included financial incentives, training, supervision and accountability through monitoring and reporting of services provided. A priori, one would anticipate improved quality of services that are more responsive to local needs, and

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subsequently an increased use of services in these facilities. Moreover, facilities had the authority to allocate incentive payments according to perceived need; provider bonuses, equipment replacement and community outreach efforts all were options exercised by local leaders. Anecdotally we know that some facilities adopted outreach strategies to encourage facility use by women from poorer households, including waiving or reducing fees, offering transportation and enlisting community health workers to refer women for services. However, there were no specific provisions in the PBF incentive structure or the programme placement that differentially targeted poorer households or communities; rather the programme was rolled out uniformly to serve all Rwandans.

Given the widespread disparities in health service use between the least poor and poorest populations in sub-Saharan Africa, a fair question is why Rwanda did not design a PBF programme that explicitly targeted poorer households. Following the war and genocide in Rwanda, maternal health indicators and service utilization were poor across the board. Estimated maternal mortality was very high, 1071 deaths per 100 000 live births from 1994 to 2000 (National Office of Population (Rwanda) and Macro International Inc 2001). Fewer than one-third of deliveries were assisted by a trained birth attendant and only 27% reported delivery in a health facility. While more than 90% of women reported at least one ANC visit during pregnancy, only 10% reported receiving the recommended four or more visits and only 4% of married women reported modern contraceptive use, resulting in a 36% estimated unmet need for family planning. With such low service statistics in 2000, a national approach to improve services universally was warranted, particularly, one could argue, if levels of use among the poorest continue to lag as long as the wealthiest do not achieve high levels of use (Victora *et al.* 2000).

Rwanda, however, did not ignore the issue of equity, rather a demand-side effort was simultaneously undertaken to reach the poorer populations. Community-based health insurance (CBHI) improved dramatically during this time, reaching estimated levels of 73% coverage by 2006 (Logie *et al.* 2008). CBHI was developed in an effort to mobilize resources locally for health centres and to reduce the financial barriers and risks families faced with unexpected medical costs. Benefits cover a standard set of MCH services, such as family planning, ANC, deliveries, consultations, laboratory work and generic drugs. Participation requires an enrolment fee and annual premium, with the poorest in the community eligible for donor subsidies (Logie *et al.* 2008). Analysis of 2005 data found that insured women were significantly less likely to deliver at home, and the odds of delivery at home significantly decreased as wealth status increased (Hong *et al.* 2011). In another small-scale study in Rwanda, outpatient visits increased significantly when insurance co-payments were waived, arguing that any point-of-service payment is a barrier to use among the poorest (Dhillon *et al.* 2012). In our analysis, additional interaction terms with health insurance (insurance and wealth, insurance and PBF, insurance and rural residence) found no evidence of insurance operating differently in PBF districts or by wealth group (data not shown). Moreover, our findings did not change with the exclusion of the insurance covariate, suggesting that the effect of PBF was not mediated by insurance uptake. The synergistic effects of PBF and health insurance by wealth, however, remain unclear. Researching the effects of PBF in a country with minimal insurance coverage may provide further insight into the relative effects of supply- and demand-side interventions.

Table 3 Estimated effects of PBF on service use (DD estimate)

Maternal health service	Difference in service use in intervention districts			
	N	Coefficient	SE	*P*-value
First trimester ANC visit[a]	1983	0.011	0.037	0.770
Four or more ANC visits[a]	1983	−0.053	0.036	0.145
Facility delivery[b]	1977	0.100*	0.040	0.014
Use of modern contraception[c]	4050	0.010	0.022	0.641

[a]Covariates include wealth, age, education, marital status, parity, insurance and prior facility birth within past 5 years.

[b]Covariates include wealth, age, education, marital status, parity, insurance, any ANC visits and prior facility birth within past 5 years.

[c]Modern contraception includes pill, injectable, implant and IUD. Covariates include wealth, age, education, marital status, parity, insurance, previous child death and prior facility birth within past 5 years.

Limitations

This study purposively used national household survey data that were collected independently of the PBF programme in an effort to reproduce findings from an earlier programme

Table 4 Estimated differential effects of PBF by wealth on service use (DD estimate with wealth interaction terms)

Effect of PBF by wealth (least poor = referent group)	First trimester ANC visit[a]	Four or more ANC visits[a]	Facility delivery[b]	Modern contraception[c]
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
PBF among poorest	−0.062 (0.104)	0.091 (0.103)	−0.040 (0.119)	0.058 (0.072)
PBF among poorer	−0.097 (0.113)	0.048 (0.122)	0.102 (0.114)	0.022 (0.072)
PBF among middle	0.029 (0.105)	0.197 (0.119)	0.045 (0.112)	0.088 (0.075)
PBF among less poor	0.051 (0.117)	0.139 (0.112)	0.020 (0.123)	0.056 (0.073)
Number of clusters	150	150	150	150
Number of women	1983	1983	1977	4050

[a]Covariates include age, education, marital status, parity, insurance and prior facility birth.

[b]Covariates include age, education, marital status, parity, insurance, prior facility births and ANC.

[c]Modern contraception includes pill, injectable, implant and IUD. Covariates include age, education, marital status, parity, insurance, prior facility birth and previous child death.

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Table 5 Estimated differential effects of PBF by wealth on service use, stratified by residence (DD estimate with wealth interaction terms)

Effect of PBF by wealth (least poor = referent group)	First trimester ANC visit[a]		Four or more ANC visits[a]		Facility delivery[b]		Modern contraception[c]	
	Rural Coefficient (SE)	Urban Coefficient (SE)	Rural Coefficient (SE)	Urban Coefficient (SE)	Rural Coefficient (SE)	Urban Coefficient (SE)	Rural Coefficient (SE)	Urban Coefficient (SE)
PBF among the poorest	−0.147 (0.111)	0.012 (0.304)	0.087 (0.121)	−0.069 (0.242)	−0.018 (0.148)	0.096 (0.300)	0.082 (0.083)	−0.031 (0.181)
PBF among the poorer	−0.178 (0.122)	0.014 (0.327)	0.080 (0.138)	−0.642 (0.327)	0.122 (0.143)	0.022 (0.337)	0.034 (0.084)	0.054 (0.196)
PBF among the middle	0.071 (0.115)	−0.573* (0.254)	0.224 (0.129)	−0.277 (0.298)	0.081 (0.151)	−0.012 (0.189)	0.114 (0.086)	0.073 (0.190)
PBF among the less poor	−0.027 (0.129)	0.167 (0.212)	0.108 (0.124)	0.290 (0.259)	0.108 (0.152)	−0.379 (0.231)	0.089 (0.088)	0.009 (0.146)
Number of clusters	128	22	128	22	128	22	128	22
Number of women	1733	302	1733	302	1682	296	3586	535

*$P < 0.10$, **$P < 0.05$.

[a]Covariates limited to marital status, parity and insurance.

[b]Covariates limited to parity, prior facility birth and any ANC visits.

[c]Modern contraception includes pill, injectable, implant and IUD. Covariates limited to parity.

evaluation and to explore different household characteristics that may not have been collected elsewhere. However, relying on national datasets means certain constraints to the analyses. First, the window between initial PBF payments for intervention districts and data collection for the 2007 survey was only 18 months; this short time period may underestimate programme effects. However, the main programme components were implemented in all districts by the time of the first payment to meet the payment requirement, which diminishes concerns of non-uniform adoption.

Another potential limitation is the structure of the panel dataset. The survey design re-sampled the 2005 clusters in 2007, but individuals were not re-interviewed. The models difference out the time-invariant unobserved community-level characteristics, but do not include individual-level fixed effects because the individuals change between surveys. Three of the individual-level control variables, health insurance, prior facility delivery and any ANC visits, are ‘choice’ variables indicative of possible underlying propensity to choose insurance or choose to use services. However, assignment of the PBF programme was random at the community level, irrespective of individual characteristics so there is no reason to suspect that PBF programme placement is correlated with individual insurance or use of services. In fact, models run with and without these choice variables produced very similar coefficients. The inclusion of these individual covariates merely improved the efficiency of the estimates.

Finally, the creation of asset-based wealth scores was limited by the questions fielded on the 2005 and 2007–8 DHS. Asset-based indices remain the standard when income and expenditure data are not available, yet more researchers are calling for separate rural and urban scales (Filmer and Pritchett 2001; Rutstein 2008; Speizer and Luseno 2010). Unfortunately, rural-specific assets, such as livestock and land ownership, were not collected in both surveys, limiting our ability to create separate scales. This prompted further stratification by residence; however, the limited number of urban clusters reduced the power to detect differences. The trend in DHS is now to collect asset information that will allow a refinement of wealth quintiles in rural areas.

Conclusion

Rwanda has produced remarkable results from their efforts to improve maternal health service utilization over the past several years, including progress in narrowing the equity gap. Countries across sub-Saharan Africa are rapidly scaling up new PBF-style financing strategies to improve health services. Implications from this research suggest that if service use is uniformly low then a PBF programme that has standard performance targets, particularly for services that are well reimbursed, such as facility deliveries, may improve service use overall. However, if the equity gap is extreme or service use is sub-optimal among the poorer populations, then a non-targeted supply-side programme like Rwanda’s will likely do little to alleviate disparities. Specific equity targeting that rewards providers based on services provided to the poorest, as piloted in Bangladesh, may improve outreach services to those most in need. Recent adoption of community-based PBF in Rwanda

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which incentivizes referrals and home services provided by community health workers warrants further study to determine benefits to equity. Finally, complementary efforts that address demand-side barriers, such as health insurance, waived fees or voucher schemes, may result in accelerated improvement among the poorest.

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Appendix

Table A1 LPMs for effect of PBF on maternal health service use, with and without community fixed effects

	Early ANC initiation		Four or more ANC visits		Facility delivery		Modern contraception	
	DD model Coefficient (SE)	DD with FE Coefficient (SE)	DD model Coefficient (SE)	DD with FE Coefficient (SE)	DD model Coefficient (SE)	DD with FE Coefficient (SE)	DD model Coefficient (SE)	DD with FE Coefficient (SE)
Year 2007	0.144*** (0.027)	0.140*** (0.027)	0.140*** (0.027)	0.136*** (0.026)	0.170*** (0.033)	0.169*** (0.033)	0.148*** (0.017)	0.148*** (0.017)
PBF district	0.015 (0.019)		0.042 (0.025)		−0.040 (0.028)		0.001 (0.013)	
2007 × PBF district	0.004 (0.036)	0.011 (0.037)	−0.052 (0.036)	−0.053 (0.036)	0.090* (0.039)	0.100* (0.040)	0.009 (0.022)	0.010 (0.022)
Wealth (ref: least poor)								
Poorest	−0.016 (0.028)	0.006 (0.028)	−0.055 (0.032)	−0.035 (0.032)	−0.120*** (0.033)	−0.091* (0.036)	−0.069** (0.021)	−0.060* (0.023)
Poorer	−0.012 (0.029)	−0.008 (0.030)	−0.027 (0.033)	−0.030 (0.033)	−0.090** (0.034)	−0.073* (0.036)	−0.081*** (0.020)	−0.073*** (0.022)
Middle	−0.023 (0.028)	−0.013 (0.028)	−0.044 (0.030)	−0.029 (0.031)	−0.060 (0.031)	−0.041 (0.032)	−0.074*** (0.019)	−0.068*** (0.019)
Less poor	−0.017 (0.028)	−0.011 (0.029)	−0.022 (0.033)	−0.017 (0.033)	−0.075 (0.031)*	−0.072* (0.032)	−0.041* (0.020)	−0.037 (0.021)
Rural residence	−0.049 (0.030)		−0.005 (0.029)		−0.052 (0.032)		−0.028 (0.027)	
Age	−0.001 (0.002)	−0.001 (0.002)	0.001 (0.002)	0.000 (0.002)	0.002 (0.002)	0.002 (0.002)	−0.006*** (0.001)	−0.006*** (0.001)
Education (ref: no school)								
Primary school	0.002 (0.020)	−0.005 (0.021)	0.010 (0.019)	−0.005 (0.020)	0.048* (0.022)	0.042 (0.022)	0.033** (0.012)	0.028* (0.012)
Secondary school	0.046 (0.042)	0.023 (0.045)	−0.016 (0.036)	−0.030 (0.037)	0.193*** (0.038)	0.169*** (0.039)	0.108*** (0.026)	0.098*** (0.027)
Married	0.047* (0.021)	0.059* (0.024)	0.072** (0.024)	0.079** (0.026)	0.026 (0.027)	0.049 (0.029)		
Parity (ref: ≥5 births)								
1 birth	0.085* (0.035)	0.088* (0.036)	0.077 (0.039)	0.072 (0.040)	0.426*** (0.039)	0.404*** (0.041)	0.131*** (0.017)	0.134*** (0.018)
2–4 births	0.026 (0.021)	0.029 (0.022)	0.028 (0.027)	0.028 (0.028)	0.053 (0.027)	0.046 (0.028)	0.255*** (0.019)	0.253*** (0.021)
≥5 births (ref: no births)							0.327*** (0.023)	0.328*** (0.024)
Health insurance	0.037* (0.016)	0.038* (0.018)	0.021 (0.017)	0.028 (0.019)	0.058** (0.020)	0.055* (0.022)	0.016 (0.011)	0.008 (0.012)
Prior facility delivery	0.006 (0.021)	−0.003 (0.022)	0.065* (0.029)	0.053 (0.029)	0.402*** (0.028)	0.367*** (0.030)	−0.055** (0.017)	−0.053** (0.017)
Any ANC visits					0.202*** (0.030)	0.192*** (0.035)		
Prior child death							−0.075*** (0.014)	−0.074*** (0.014)
Constant	0.051 (0.073)	0.001 (0.073)	0.003 (0.094)	0.038 (0.089)	−0.102 (0.092)	−0.155 (0.097)	0.094* (0.039)	0.069* (0.033)
Number of clusters	150	150	150	150	150	150	150	150
Number of women	1983	1983	1983	1983	1977	1977	4050	4050

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

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Table A2 LPMs with community fixed effects for effect of PBF on maternal health service use, differentiated by wealth and stratified by residence

	Early ANC initiation			**Four or more ANC visits**			**Facility delivery**			**Modern contraception**		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
Year 2007	0.148** (0.056)	0.099 (0.061)	0.228* (0.105)	0.212*** (0.059)	0.211** (0.072)	0.213 (0.119)	0.107 (0.064)	0.159 (0.101)	0.016 (0.051)	0.169*** (0.044)	0.169** (0.053)	0.227* (0.081)
2007 × PBF district	0.024 (0.082)	0.098 (0.089)	−0.030 (0.156)	−0.150 (0.084)	−0.135 (0.099)	−0.043 (0.153)	0.070 (0.083)	0.050 (0.118)	0.155 (0.116)	−0.033 (0.056)	−0.060 (0.070)	0.008 (0.098)
2007 × PBF × poorest	−0.062 (0.104)	−0.147 (0.111)	0.012 (0.304)	0.091 (0.103)	0.087 (0.121)	−0.069 (0.242)	−0.040 (0.119)	−0.018 (0.148)	0.096 (0.300)	0.058 (0.072)	0.082 (0.083)	−0.031 (0.181)
2007 × PBF × poorer	−0.097 (0.113)	−0.178 (0.122)	0.014 (0.327)	0.048 (0.122)	0.080 (0.138)	−0.642 (0.327)	0.102 (0.114)	0.122 (0.143)	0.022 (0.337)	0.022 (0.072)	0.034 (0.084)	0.054 (0.196)
2007 × PBF × middle	0.029 (0.106)	0.071 (0.115)	−0.573* (0.254)	0.197 (0.119)	0.224 (0.129)	−0.277 (0.298)	0.045 (0.112)	0.081 (0.151)	−0.012 (0.189)	0.088 (0.075)	0.114 (0.086)	0.073 (0.190)
2007 × PBF × less poor	0.051 (0.117)	−0.027 (0.129)	0.167 (0.212)	0.139 (0.112)	0.108 (0.124)	0.290 (0.259)	0.020 (0.123)	0.108 (0.152)	−0.379 (0.231)	0.056 (0.073)	0.089 (0.088)	0.009 (0.146)
2007 × poorest	0.044 (0.070)	0.107 (0.078)	0.075 (0.220)	−0.111 (0.077)	−0.084 (0.094)	−0.104 (0.148)	0.135 (0.090)	0.071 (0.122)	0.390* (0.148)	−0.048 (0.055)	−0.046 (0.065)	−0.131 (0.120)
2007 × poorer	0.030 (0.087)	0.093 (0.095)	−0.143 (0.169)	−0.076 (0.093)	−0.086 (0.107)	0.000 (0.185)	0.009 (0.086)	−0.030 (0.118)	0.113 (0.154)	−0.006 (0.057)	0.012 (0.064)	−0.045 (0.120)
2007 × middle	−0.040 (0.074)	−0.055 (0.083)	0.124 (0.158)	−0.097 (0.090)	−0.100 (0.095)	0.000 (0.222)	0.142 (0.092)	0.093 (0.132)	0.245* (0.093)	−0.058 (0.059)	−0.052 (0.066)	−0.159 (0.148)
2007 × less poor	−0.062 (0.087)	0.009 (0.097)	−0.249 (0.135)	−0.102 (0.086)	−0.070 (0.094)	−0.258 (0.201)	0.035 (0.091)	−0.051 (0.119)	0.313 (0.170)	−0.010 (0.055)	−0.010 (0.066)	−0.061 (0.085)
Wealth (ref: least poor)												
Poorest	−0.017 (0.043)	−0.039 (0.048)	−0.059 (0.072)	−0.004 (0.058)	0.035 (0.067)	−0.180 (0.095)	−0.158* (0.067)	−0.166* (0.083)	−0.380* (0.152)	−0.033 (0.041)	−0.019 (0.042)	−0.117 (0.136)
Poorer	0.007 (0.051)	−0.034 (0.055)	0.121 (0.112)	−0.016 (0.062)	0.008 (0.073)	−0.090 (0.104)	−0.088 (0.066)	−0.090 (0.083)	−0.251 (0.136)	−0.068* (0.033)	−0.056 (0.035)	−0.211** (0.065)
Middle	0.014 (0.045)	−0.008 (0.055)	0.006 (0.071)	0.037 (0.062)	0.062 (0.073)	−0.041 (0.098)	−0.119 (0.065)	−0.157 (0.085)	−0.126 (0.125)	−0.043 (0.034)	−0.039 (0.036)	−0.104 (0.104)
Less poor	0.035 (0.053)	0.005 (0.062)	0.076 (0.105)	0.021 (0.064)	0.051 (0.071)	−0.054 (0.144)	−0.069 (0.061)	−0.061 (0.075)	−0.243 (0.137)	−0.050 (0.038)	−0.022 (0.039)	−0.225*** (0.057)
Age	−0.001 (0.002)			0.000 (0.002)			0.001 (0.002)			−0.006*** (0.001)		
Education (ref: no school)												
Primary	−0.006 (0.021)			−0.004 (0.020)			0.039 (0.022)			0.027* (0.013)		
Secondary	0.022 (0.045)			−0.029 (0.037)			0.168*** (0.039)			0.099*** (0.027)		
Married	0.059* (0.024)	0.047 (0.027)	0.136 (0.071)	0.080** (0.026)	0.077** (0.029)	0.126 (0.083)	0.050 (0.029)					
Parity (Ref: ≥5 births)												
1 birth	0.086* (0.037)	0.076** (0.026)	0.110 (0.065)	0.070 (0.040)	0.042 (0.026)	0.036 (0.069)	0.408*** (0.041)	0.372*** (0.028)	0.450*** (0.062)	0.134*** (0.018)	0.120*** (0.017)	0.187* (0.072)
2–4 births	0.028 (0.023)			0.026 (0.029)			0.046 (0.028)			0.254*** (0.021)	0.177*** (0.016)	0.286*** (0.056)
≥5 births (Ref: no births)										0.329*** (0.024)	0.166*** (0.014)	0.253*** (0.059)
Health insurance	0.038* (0.018)	0.027 (0.018)	0.036 (0.054)	0.029 (0.019)	0.035 (0.022)	−0.001 (0.046)	0.056* (0.022)			0.008 (0.012)		
Prior facility birth	−0.002 (0.022)			0.052 (0.029)			0.368*** (0.029)	0.380*** (0.031)	0.457*** (0.074)	−0.053** (0.017)		
Any ANC visits							0.193*** (0.036)	0.197*** (0.042)	0.254* (0.090)			
Prior child death										−0.075*** (0.014)		
Constant	−0.004 (0.075)	0.027 (0.039)	−0.126 (0.090)	0.024 (0.092)	0.049 (0.048)	−0.013 (0.107)	−0.114 (0.096)	0.065 (0.053)	0.092 (0.070)	0.068* (0.034)	−0.037 (0.025)	−0.070 (0.066)
Number of clusters	150	128	22	150	128	22	150	128	22	150	128	22
Number of women	1983	1733	302	1983	1733	302	1977	1682	296	4050	3586	535

Note: Coefficients for PBF × poorest (poorer, middle and less poor) are not included in the table.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

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