The impact of access to health facilities on maternal care use, travel patterns and health status: Evidence from longitudinal data from Uganda

Fredrick Manang [*] Chikako Yamauchi [†‡]

June 2018

Abstract

This paper investigates whether new health facilities affect maternal care use, maternal/child health and travel patterns to facilities. In order to deal with possibly endogenous facility placement, we apply community- and mother-level fixed effects models to the decade-long panel data from Uganda. Several robustness checks support the validity of our results. We find that large facilities and small clinics play differential roles. While openings of large facilities increase the probability of delivery at formal facilities, new clinics increase regular antenatal care usage. The openings of both types of facilities are accompanied by an increased use of less expensive yet more time-consuming transportation modes such as walking, leaving the time to facilities unchanged but reducing the monetary costs of care use. Our heterogeneity analysis further indicates the first facility of each type drives the effects on maternal care use, and the impact of a large facility is found only in areas which initially had clinics. These results imply that clinics play special roles in linking mothers with the national health system. They also suggest the importance of universal coverage of health facilities which ensures each locality to have at least one facility suitable for its population size.

JEL classification: I10 ; I18 ; D12
Keywords: health facility; maternal health; infant health; skilled birth attendance; antenatal care; Uganda

[*]Dodoma University; phd09005@grips.ac.jp
[†]National Graduate Institute for Policy Studies (GRIPS), Tokyo; c-yamauchi@grips.ac.jp
[‡]This work was supported by Japan Society for the Promotion of Science (JSPS) KAKENHI Grant Number 25101002. We appreciate comments from Will Dow, Tomoya Matsumoto, Alistair Munro, Tetsushi Sonobe, two anonymous reviewers and participants at the International Health Economics Association conference (IHEA), Australian Development Economics Workshop (ADEW), Japan Health Economics Association conference (JHEA), the 85th Meeting of the Osaka Workshop on Economics of Institutions and Organizations: Tokyo Conference, Osaka University Machikaneyama Seminar and Tokyo Labor Economics Workshop. Any remaining errors are our own.

1 Introduction

Maternal death poses a serious risk to women of reproductive age. In 2013, 289,000 mothers lost their lives during their pregnancy or within 42 days after that. Ninety-nine percent of these deaths occurred in developing countries and 62 percent in sub-Saharan Africa (WHO, 2014). In order to reduce maternal mortality, it is considered most crucial that women deliver at a formal facility, attended by skilled health practitioners such as midwives (Campbell and Graham, 2006; Filippi et al., 2006).[1] Most complications cannot be predicted or prevented (Ronsmans and Graham, 2006), and if a complication happens without the presence of a skilled practitioner, delay in the diagnosis and referral of the complication could result in maternal mortality or morbidity.[2] Reflecting this importance, deliveries attended by a skilled birth attendant (SBA) has been one of the Millennium and Sustainable Development Goal indicators. However, the average rate of utilization is still low in developing countries. Only 53 percent of pregnant women deliver with the help of a skilled attendant (WHO, 1999). One of the major causes of poor use of SBA is physical accessibility to health facilities. They are considered to be too far for mothers to walk to in many Sub-Saharan African countries (Sabine and Oona, 2009; Thaddeus and Maine, 1994).

This paper investigates how improved access to health facilities can affect maternal health care utilization, measured by delivery at formal facilities, SBA usage and regular antenatal care visits in every trimester, as well as maternal and child health status, measured by the number of complications during delivery and birth weight. As we discuss later, while many studies examine the cross-sectional

[1] A skilled attendant refers to individuals with midwifery skills who have been trained to manage normal pregnancies, childbirth and the immediate postnatal period, as well as to identify and refer complications in women and newborns. They include a midwife, doctor and nurse (WHO, 2004). While home deliveries attended by a skilled practitioner might be another option (or the only option in some areas), home conditions can be extremely basic and the skilled attendant will not have the support of other skilled practitioners or equipment in the case of complications (Campbell and Graham, 2006).

[2] In addition to antenatal and delivery care, reducing the number of unwanted pregnancies and lowering the costs of safe abortion are alternative ways to improve maternal health because unsafe abortion is one of the causes of maternal deaths. In fact, new clinics offering family planning services are found to have modestly reduced fertility in Iran (Hashemi and Salehi-Isfahani, 2013) and openings of legal abortion centers are shown to have decreased the probability of live birth given conception in Nepal (Valente, 2014). While these services are for women in general or pregnant women who prefer abortion, this paper focuses on services for pregnant women who prefer giving birth.

relationship between maternal health care utilization and access to health facilities, rigorous evidence is limited for the causal relationship between them. Few available panel studies are also based on the data spanning for a relatively short time period. More importantly, it is not well understood how health facility of differing types (such as community-based clinics and hospitals covering a whole district) play different roles in influencing maternal health care demand. It has also not yet been comprehensively studied how the expansion of health infrastructure affects transportation patterns and maternal/infant health status. We fill these gaps in the literature. More specifically, the contribution of our study is three-fold: First, we show evidence on the impact of new openings of health facilities on maternal health care usage, using the new, decade-long panel data on health facilities between 2002 and 2012 for Uganda. Second, we explore the differential roles played by large facilities and small clinics by exploiting the data which distinguishes the level of health facilities. Heterogeneity in the impact of facilities is also investigated by the initial availability of different types of facilities. Third, we shed light on the mechanism through which the expansion of health infrastructure improves access to health facility by examining the impact on transportation patterns. In order to address the endogenous placement of health facilities, we employ the community- and mother-fixed effects models, controlling for the district-specific year effects as well as various time-variant characteristics. Several robustness checks support that our results are driven by neither the supply of health facilities that follow demand growth nor measurement errors in the availability of health facilities.

Results show that the increase in the availability of health facilities enhances maternal care utilization, and they further reveal that large and small facilities play different roles. One one hand, the opening in a sub-county of a large, higher-level facility, which provides comprehensive maternal care, increases delivery with SBA at a formal facility by 7 percentage points, or 13 percent compared to the mean of 56 percent. On the other hand, the opening of a small, lower-level facility, which does

not provide delivery care or detailed antenatal care, increases the probability of regularly receiving antenatal care in every trimester by 3 percentage points, or 7 percent relative to the mean of 44 percent. These results suggest that new higher-level facilities increase the medically recommended delivery practices. An interpretation for the results for lower-level facilities is that they increase the chance for pregnant women of receiving information on higher-level facilities where the majority of antenatal care is provided as well as the needs and importance of regular antenatal care visits during pregnancy. Interestingly, the openings of both types of health facilities are not found to be accompanied by a decrease in travel time; instead, they are accompanied by an increased use of inexpensive yet more time-consuming transportation modes such as walking, leaving the travel time to facilities unchanged but reducing the monetary costs of maternal care use. This suggests that pregnant mothers choose to save the monetary costs of maternal care utilization as a new facility can reduce the distance to the nearest facility. While the results suggest no evidence for new health facilities improving maternal or infant health, this might be merely due to the limitation of our data on health, which is smaller than the data for the other outcomes. Finally, our heterogeneity analysis indicates that the effects of higher- and lower-level facilities are driven by sub-counties which did not initially have a higher- and lower-level facility, respectively. The impact of a higher-level facility is also strong in sub-counties which initially had lower-level facilities. These results imply the importance of universal coverage of health facilities which ensures each locality to have at least one facility suitable for its population size (such as a clinic in each community and a hospital in each district). They further underscore the essential roles that lower-level facilities play in linking pregnant mothers with the national health service network.

Our study contributes to the literature on the impact of the proximity to health facilities on access to health facilities, health care utilization and health status by providing the first evidence from developing countries. It is of significant importance to provide evidence for developing countries,

which suffer from significantly higher mortalities compared to developed countries. Many developing countries are also in need of the knowledge on the relative importance and different roles of various types of health facilities such as basic clinics and well-equipped hospitals because many of them are in the process of expanding their national health systems. An efficient public investment in the system necessitates a firm understanding of the roles played by health facilities of varying levels. Regardless of this importance, the literature has been mainly based on the evidence from developed countries where hospital closures, rather than openings, are the major source of variation. Empirical evidence generally points to the negative effects of hospital closures/consolidations or increased distance to the nearest hospital on preventative health care utilization (Currie and Reagan, 2003; Lu and Slusky, 2016) and the probability of survival following accidents or illness requiring speedy treatment (Avdic, 2016; Bindman et al., 1990; Buchmueller et al., 2006).[3] Hospital closures are also found to increase travel distance for hospital visitors (Bazzoli et al., 2012), and distance in turn is found to cause delay in reaching care and raises mortality (Wilde, 2013). Our results are in line with the overall findings of this literature. Namely, while the closure of hospitals has been shown to negatively affect health care usage and access, we show that openings of health facilities improve access (in terms of monetary costs of travel) and maternal heath care utilization.

For developing countries, as reviewed in Vieira1 et al. (2012), there are many cross-sectional studies which report positive association between the availability of, or proximity to, health facilities and maternal care use and maternal health outcomes (for example, Do (2009); Gage and Calixte (2006); Overbosch et al. (2004); Yanagisawa et al. (2006)). However, it is unclear whether their estimates are free from a possible bias due to endogenous placement of health facilities. For example, public facilities might target areas with worse outcomes, which creates a negative bias in the OLS

[3]The methodology used in the literature is similar to that used in this paper. For instance, Buchmueller et al. (2006) and Lu and Slusky (2016) use the ZIP code fixed effects model, while Currie and Reagan (2003) employs mother fixed effects model. Avdic (2016) uses hospital fixed effects model.

estimates (Rosenzweig and Wolpin (1982), Pitt et al. (1993) and Frankenberg et al. (2005)).[4] On the other hand, remote areas might not be able to attract a health facility due to high construction costs and preferences of health practitioners. If those areas also have individuals of poorer health, OLS estimates are likely to be positively biased.

The available few rigorous studies for developing countries that are related to the impact of the access to health facility on maternal health are Frankenberg et al. (2009), Joshi and Schultz (2007), Chaudhuri (2008), and Fauveau et al. (1991). These studies provide the evidence on the impact of posting midwives at the village level. First, Frankenberg et al. (2009) assesses the effect of the presence of village midwives in Indonesia, using the panel data with two waves in 1993 and 1997. Their findings based on the mother fixed effects model suggest that an increase in the number of midwives significantly increased the probability for pregnant mothers of receiving iron tablets during pregnancy.[5] While this study informs us of the roles played by midwives, the impact is still unknown of health facilities which come with health practitioners, medical supplies, and testing and operating equipment. Their data also do not allow the examination of long-term changes in maternal care use and health status. Another set of available studies, Chaudhuri (2008), Joshi and Schultz (2007), and Fauveau et al. (1991), are based on the experiment launched in 1977 in Matlab, Bangladesh, where a package of family planning, and later maternal and child services, were provided through home visits by midwives. By comparing the experiment villages with the villages with similar pre-program observable characteristics, improvement has been found for a wide range of outcomes including maternal mortality (Fauveau et al., 1991), children's height (Chaudhuri, 2008), and various indicators for maternal and child well-being (Joshi and Schultz, 2007). However, it is likely to be difficult to replicate this type of intensive service package in sparsely populated, remote and low-

[4]For instance, Rosenzweig and Wolpin (1982) finds that an additional family planning clinic increased child height by 12 percent in India using the child fixed effect model. However, their 'naive' cross-sectional estimates suggest no significant impact.

[5]Separate studies also show that the same program improved the health status of women of reproductive age and children (Frankenberg et al., 2005; Frankenberg and Thomas, 2001)

income areas. On the other hand, the development of public health system, usually consisting of the network of well-equipped hospitals and far-reaching clinics, is a widely shared policy objective. It is therefore of significant importance to quantify the impact of additional health facilities on the health of the population, particularly the most vulnerable such as infants and pregnant mothers. By showing evidence on the impact of health facility of different types, we provide implications which contribute to the policy discussion on the efficient formulation of a national health system.

The rest of the paper is organized as follows: The next section presents the institutional background in Uganda, followed by the description of the data used in our analysis. The empirical models are illustrated in section four. Section five presents the estimation results and robustness checks. Finally, section six concludes.

2 Background

While it is one of the low-income countries, Uganda has appreciably improved its public health system and advanced the health status of the population in the recent decade or two. The infant mortality rate decreased from 88 to 54 deaths per 1000 live births, and the maternal mortality ratio declined from 524 to 438 deaths per 100,000 live births between 2000-01 and 2011 (UDHS, 2012). The expansion of the health system followed the governmental plans, which put forward the improvement of the access to health services as one of the major objectives. The first national health policy stipulated in 1999 that national health infrastructure would be expanded in order to bring health care closer to the public and improve the utilization of health services. For this end, emphasis was placed on the provision of community-based health facilities (Ministry of Health, 1999).[6]

The national health policy also specified the target population size and geographic unit that is

[6] After the political insecurity during the 1970s and 1980s, the government of Uganda started to base the development of the health sector on the 10-year national health policy plans (Ministry of Health, 1999, 2010b) and the associated five-year sectoral plans (Ministry of Health, 2000, 2005, 2010a). This framework has been formulated within the context of the provisions of the 1995 Constitution and the 1997 Local Governments Act, which decentralised governance and service delivery.

to be served by each level of facility. For example, a village is supposed to have Health Center I (HCI), which is to cover 1,000 individuals. A parish, which includes several villages, is supposed to have a Health Center II (HCII) covering 5,000 individuals. A HCI comprises of a team of community health workers who provide community-based health care services. Therefore, the health facility of the lowest administration level with a physical establishment is a HCII. This level of facility provides simple preventive and curative care as well as outreach services to promote a healthy lifestyle. It is not supposed to provide delivery care or comprehensive antenatal care, though sometimes a HCII may receive emergency cases and provide partial antenatal care, which does not require laboratory testing.[7] The lowest level of facilities which provide delivery and comprehensive antenatal care is a Health Center III (HCIII), which is expected to serve 20,000 individuals. Every sub-county is supposed to have one HCIII. All the facilities of levels higher than HCIII provide comprehensive maternal care. They include a Health Center IV, which should be built in every county, and a Health Center V (or hospital) for every district, serving 100,000 and 500,000 individuals, respectively. On top of these levels, there are regional referral hospitals, which are expected to cover 2 million individuals and the national referral hospital in the capital city (Ministry of Health, 2000). In the analysis, we distinguish HCIIs and the facilities above HCIIs as the latter provides comprehensive maternal care. We refer HCIIs and facilities above HCIIs as "lower-level facilities" and "higher-level facilities," respectively.

These goals for the availability of health services were far from being met initially. For instance, in 1999-2000, there were only 746 HCIIs, while it was considered that 3624 were needed. Accordingly, it was expected that priority would be placed on the construction of lower-level facilities. Since it was recommended that every parish has one HCII and also good access to health facilities was considered to be living within 5 km of a facility, priority was placed on locations which did not have

[7] A HCII does not have a laboratory, and thus cannot conduct the tests required in comprehensive antenatal care such as urine and blood tests. However, health workers at a HCII can examine body size and blood pressure, and provide those with existing diseases with drugs and treatment.

a facility initially (Ministry of Health, 2000). This means the initial availability of health facilities affects the probability of acquiring a new facility during the analysis period. In order to take this into account, we control for sub-county fixed effects, which allow different localities to have different levels of outcomes such as maternal care use and health status due to sub-county-level time-invariant factors, including the initial availability of health facilities.

3 Data

Our analysis draws on the Research on Poverty, Environment and Agricultural Technologies (RePEAT) survey for 2003, 2005, 2008 and 2012 as well as the Uganda health facility inventory for 2002, 2004, 2006, 2008, 2010, 2011, and 2012.[8] The RePEAT survey is the longitudinal survey of about 940 households from 94 communities (or *Local Council 1*) in Uganda.[9] In the initial year, ten households were randomly sampled from each of the 94 communities, which are scattered in three regions (Central, East and West) as shown in Figure 1. The attrition rate has been low at 6 percent between 2003 and 2012, leaving 889 out of the original 940 households.[10] The main outcomes for this study, maternal care utilization, maternal/child health and travel patterns, are measured in the retrospective questions on past pregnancies, which were collected in the second (2005) and fourth (2012) waves.

In 2005, each household was asked whether there was a woman who became pregnant in the past five years, including cases of miscarriage, abortion and still births. For those households reporting a pregnancy, detailed questions on care utilization and travel patterns were asked on each pregnancy

[8]The administrative data was collected once in two years between 2002 and 2010, and annually from 2010 onwards.

[9]It is a subset of a stratified random sample collected for the study on Policies for Improved Land Management by the IFPRI. As its main research goal was to investigate agricultural productivity and livelihoods, strata were defined based on the factors influencing agricultural practices: agro-climate conditions, elevation, access to market and population density. Using these indicators, 32 districts in Southern Uganda were divided into 18 strata, excluding parts of the northern region which had security concerns around 1999. The RePEAT further excluded three districts which had aggravated insecurity when the survey started in 2003 (Ruecker et al., 2003a,b; Yamano et al., 2004).

[10]Attrition is not related to either the initial level of the availability of health facilities or changes in the availability over the analysis period, as shown in Appendix Table A1.

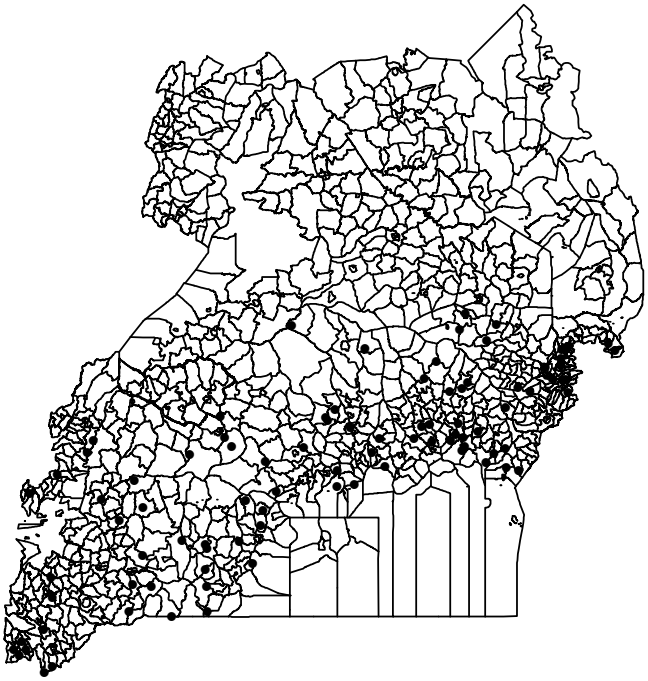
for each woman. In 2012, the presence of a woman aged 15-56 (women ages 50-56 were included as they were aged 49 or below in 2005) was asked first, and then the number of pregnancies was asked. For women who provided pregnancy information in 2005, pregnancy experience between 2005 and 2012 was asked for update, while women who did not provide pregnancy information in 2005 were asked about pregnancy experience between 2001 and 2012.[11] Out of the original 940 households, 893 remained in the second wave, of which 539 had at least one pregnancy in the past five years reported by 609 women. Eighty-two percent of these women were re-interviewed in the fourth wave, providing the full pregnancy history between 2001 and 2012. The remainder of women attrit between the second and fourth waves, but their pregnancy histories between 2001 and 2005 are used for our analysis. In addition to these 609 women, in the fourth wave, 335 women who joined the sample households or became of reproductive age reported pregnancies between 2001 and 2012. Altogether, these 944 women reported 2410 pregnancies. Of these, 2084 cases occurred in or after 2002, for which the health facility data is available. After further excluding the cases with missing values in the outcomes or pregnancy-, mother- and household-level characteristics, 1860 observations are used for the analysis.

Since data on pregnancy details were collected retrospectively, one might be concerned about possible measurement errors. According to Beckett et al. (2001), however, there is unlikely to be a large measurement error in reports of important events such as whether pregnancy resulted in a live birth or still birth. On the other hand, detailed information such as the choice of antenatal care providers and the amount of medical fees could suffer from some measurement errors. In order to address this concern, we use dichotomous indicators for less salient outcomes such as transportation costs (for example, whether she paid for it or not, rather than the actual amount of payment). We have also tested the robustness of our results by excluding data on pregnancies which were reported

[11] When there were more than two women per household who reported pregnancy in the relevant years, we randomly selected two women and recorded all the pregnancy cases for them. However, there were only seven households bound by this constraint.

after more than 5 years have past, but our findings did not change qualitatively.[12]

Figure 1: Location of RePEAT survey communities (local council 1) and the 2002 sub-county boundaries in Uganda



Source: Author's calculation.

Together with the RePEAT survey data, we use the health facility inventory for 2002, 2004, 2006, 2008 and 2010-2012. This is an administrative list of health facilities for the whole Uganda. For each facility, the list indicates its level (such as HCI and HCII), ownership (public, private or non-governmental-not-for-profit organization (NGO)) and status (whether or not it is operational). We count the number of operating facilities for each year and sub-county by level and type. A sub-county is likely to approximate the area individuals travel to antenatal care. As discussed in the previous section, every sub-county is supposed to have one HCIII, which is the most basic level of facility providing comprehensive antenatal care. Also, a sub-county is not too large with the average population size being 25,261 in 2002 (UBOS, 2006). We count public and non-public

[12]This is likely to reflect the fact that there are few women who provided information on pregnancies which occurred more than 5 years ago because those who were newly interviewed in 2012 (who were supposed to be asked about their pregnancy experience from 2001) were mostly young girls who became 15 years or older or women who were married into the sample households between 2005 and 2012.

facilities separately, but do not distinguish private and NGO facilities, which are both included in the group of "non-public facilities." This is because there are too few of them in our sample areas. In order to improve the precision of the estimates, therefore, these two types of facilities are combined into one group, including both higher-level and lower-level facilities.[13] This health facility inventory data was merged across years using sub-county names as in 2002.[14]

As Figure 2 indicates, there has been a massive increase in the number of health facilities in Uganda. Between 2002 and 2012, the total number of facilities has increased by more than two folds from about 2500 to 5000. Consistent with the governmental focus on the investment in HCII, this change has by large been driven by an increase in the number of HCIIs. On the other hand, while the growth rate looks less drastic, the number of higher-level facilities has also increased. Since one higher-level facility can cover a far greater number of persons (20,000-500,000 for HCIII-V as opposed to 5,000 for HCII), even the moderate increase in the availability of higher-level facilities can bring about large changes in maternal health care behavior.

After we divide the number of health facilities by the number of parishes as in 2002[15] and limit the sample to the RePEAT survey areas, the number of health facilities per parish still shows an increasing trend (Figure 3). The top panel indicates the number of public facilities by level. It depicts that the average number of lower-level facilities per parish doubled from about 0.2 in 2002 to 0.4 in 2012. The higher-level facilities also became more available. We examine how this massive investment in health infrastructure has affected a range of maternal care utilization outcomes and

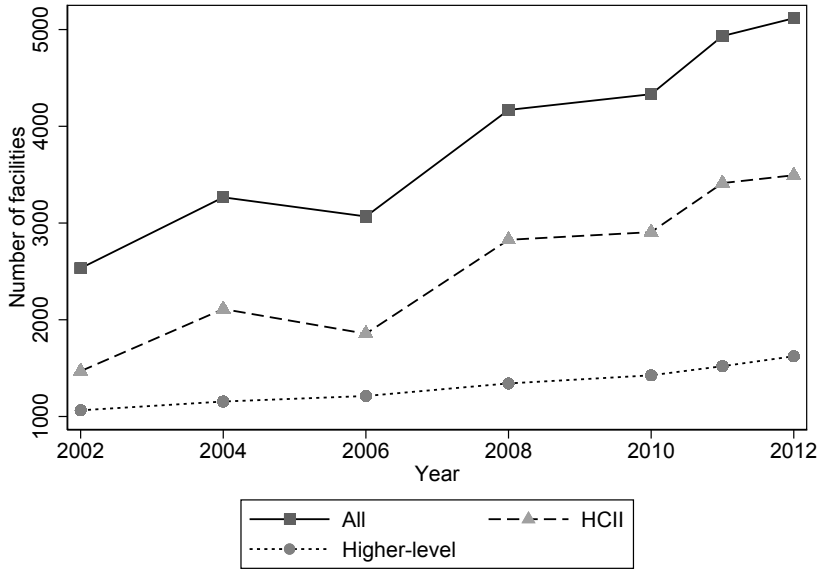
[13] In particular, only one sub-county had private health facilities functioning by 2012 in the RePEAT sub-counties.

[14] Between the analysis period of 2001-2012, some administrative areas split into multiple new administrative areas, some parishes were promoted to become sub-counties, and some parishes were assigned to new sub-counties. We traced the names of the parishes and their sub-counties over the years, using the crosswalk data provided from the Uganda Bureau of Statistics (UBOS). The resulting data are organized in the way that the same parishes that are identified within one sub-county as in 2002 are contained in that sub-county throughout the analysis period.

[15] Ideally, we would like to adjust our measure of facility availability for population size. However, unfortunately data on population at the sub-county level is unavailable. Since the number of parishes in a sub-county is proportional to the population size of the sub-county, this is likely to approximate the availability of health facilities adjusting for population size at the initial period. We use the initial number of parishes so that the indicator for access captures the availability adjusting for population size, but not affected by population changes motivated by new openings of health facilities.

health status. In doing so, we control for the availability of non-public health facilities in order to disentangle the effect of the availability of public health infrastructure from the effect of the availability of alternative health care providers, which are mostly not-for-profit organizations in the RePEAT survey areas. The number of non-public facilities is shown in the bottom panel in Figure 3. It suggests that there are significantly fewer non-public facilities and they did not increase as much as public facilities. As discussed above, this limited availability and variation precludes us from separately controlling for lower-level and higher-level non-public facilities. Thus, we control for the availability of all the non-public facilities regardless of their levels. The results do not differ much even when we exclude this control variable from the analysis.

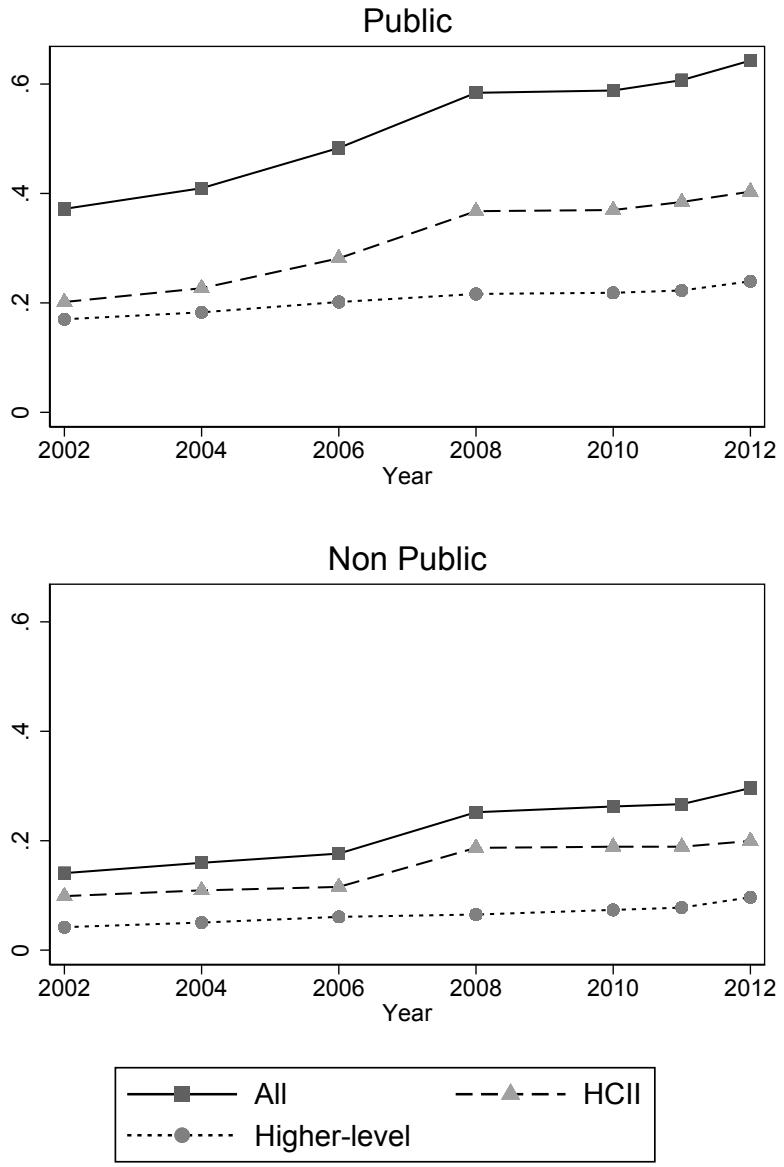
Figure 2: The total number of health facilities in Uganda by level: 2002-2012



Source: The Health Facility Inventory 2002, 2004, 2006, 2008, 2010, 2011 and 2012
Notes:
1) Facilities are divided into Health Center II (HCII) and the rest of the facilities including Health Centers III, IV, and V. HCII is expected to cover a parish, while HCIII is to cover a sub-county. HCIV and HCV cover a county and district, respectively. While HCII does not provide full maternity care, all the other types of HCs provide it.
2) There is a slight decline between 2004 and 2006. Our interviews with officials at the Ministry of Health suggest that this was mainly due to the campaign to close private facilities that either failed to renew the permits to operate, or did not have permit to operate at all. Since these facilities were generally located in Kampala, the capital city, once it is excluded, Figure A1 in the appendix shows a consistent upward trend.

According to the 2005 and 2012 RePEAT data, access to health facilities was the most cited reason

Figure 3: The number of health facilities per parish by type and level in the RePEAT Study areas: 2002-2012



Source: The Health Facility Inventory 2002, 2004, 2006, 2008, 2010, 2011 and 2012
Notes:
1) The figures show the number of Health Center II (HCII) and higher-level health centers separately by ownership (public and non-public) in the areas covered by the RePEAT study. The governmental investment in health infrastructure mainly affected the construction of public facilities. Thus, we focus on these facilities in the analysis.
2) In the RePEAT study areas, non-public facilities are mostly not-for-profit facilities, with a very small number of private facilities. Since the number of non-public facilities is small, we cannot separate lower- and higher-level facilities. Therefore, the number of non-public facilities (including both lower- and higher-level facilities) is included as a control variable.
3) The higher-level health facilities include Health Centers III, IV, and V. All these facilities provide full maternal care. On the other hand, HCII provide only limited antenatal care and no delivery care. HCII is expected to cover a parish, while HCIII is to cover a sub-county. HCIV and HCV cover a county and district, respectively.

Table 1: The reason for choosing a particular place for maternal care

Panel A: Antenatal care	Public lower-level		Public higher-level		Non-public		TBA	
Reason	N	Share	N	Share	N	Share	N	Share
Better access	275	0.78	730	0.55	192	0.49	8	0.03
Cheaper	25	0.07	198	0.15	12	0.03	17	0.07
Good quality of service	53	0.15	399	0.30	174	0.45	4	0.02
Less waiting time	1	0.00	1	0.00	10	0.03	0	0.00
Easy to get recommendation if necessary for referral	0	0.00	5	0.00	0	0.00	0	0.00
Total	354	1.00	1333	1.00	388	1.00	29	1.00

Panel B: Delivery care	Home		Public lower-level		Public higher-level		Non-public		TBA	
Reason	N	Share	N	Share	N	Share	N	Share	N	Share
Better access	81	0.22	64	0.68	245	0.48	92	0.38	26	0.53
Cheaper	31	0.08	7	0.07	70	0.14	7	0.03	9	0.18
Good quality of service	5	0.01	21	0.22	193	0.37	127	0.53	10	0.20
Less waiting time	158	0.43	2	0.02	7	0.01	13	0.05	1	0.02
No need (was confident that everything was fine)	64	0.17	0	0.00	0	0.00	0	0.00	3	0.06
Lack of transport	9	0.02	0	0.00	0	0.00	0	0.00	0	0.00
Harassment by medical personnel	13	0.04	0	0.00	0	0.00	0	0.00	0	0.00
Medical attendant nearby	10	0.03	0	0.00	0	0.00	0	0.00	0	0.00
Government health centers rejects mothers who have had many pregnancies before	0	0.00	0	0.00	0	0.00	2	0.01	0	0.00
Total	371	1.00	94	1.00	515	1.00	241	1.00	49	1.00

Source: RePEAT Survey 2005 and 2012

Notes:

1) The table shows the reason for choosing a particular facility/care provider separately for those who visited public lower-level, public higher-level, and non-public facilities, as well as Traditional Birth Attendants (TBA). In the case of delivery care (Panel B), the reasons cited by those who stayed at home are separately listed.

2) "Public lower-level" means public Health Center II, while "public higher-level" includes public Health Center III, IV, and V (hospital). "Non-public" includes private or not-for-private NGO health facilities. TBAs are not certified medical practitioners but traditionally take care of delivery in their local areas.

3) Panel A is based on the responses from women who received antenatal care, who were asked "why did ... choose to go there?" Panel B is based on the responses from women who received delivery care or treatment for miscarriage, and these women were asked "what factors led you to choose this delivery site/attendant?"

4) The number of observations is smaller in Panel B because the question on the reason for choosing the place for delivery care was asked only in the 2012 survey, while the question on the reason for choosing the place for antenatal care was asked in the 2005 nd 2012 surveys.

for choosing a particular facility for delivery. Table 1 shows the reasons for choosing a particular place for maternal care by the place of care, separately for antenatal and delivery care in Panels A and B, respectively. For instance, better access is the most cited reason for women who visited formal facilities for antenatal care regardless of the selected type (public or non-public) or level (higher or lower) of facilities (Panel A). Women who gave birth at public facilities also suggest most frequently that better access is the reason for choosing the facilities (Panel B). This implies the improvement in access to health facilities is likely to promote maternal care utilization.

In order to measure this impact, we define four dummy variables indicating maternal care usage. One is for delivery at formal facilities, which takes the value of one if a mother chooses to deliver at any formal facility, regardless of its level (lower/higher) and type (public/non-public). Those pregnancy cases where mothers delivered at home (either alone or with family members) and at the place of a traditional birth attendant (TBA) are included in the data, taking the value of zero. The second dummy variable is for Skilled Birth Attendant (SBA) use, which takes the value of one if delivery is attended by a medical practitioner (midwife, nurse or doctor) regardless of the place of delivery, and zero otherwise. This variables takes the value of zero when mothers are attended by no one, a TBA, relative, or Village Health Team (VHT, or HCI). The third dummy variable is the combination of these two dummy variables. It takes the value of one if a mother delivers at a formal facility and is attended by a medical practitioner.[16] The final dummy variable captures frequent and timely antenatal care usage. It takes the value of one if a mother visits a formal facility for antenatal care regardless of its level or type at least once in each trimester.[17] We can also look at whether a mother receives formal antenatal care at least once, but this share is very high and not

[16]We created this indicator of skilled birth attendance at formal facility (SBA at a facility) because a small proportion of mothers reached health facilities but were not assisted by skilled attendants. While delivery at facilities only reflects the demand-side behavior, the difference between facility delivery and SBA at a facility is likely to be due to the absence of health practitioners.

[17]Regular antenatal care is recommended by the WHO and Ministry of Health of Uganda. This variable can be defined only for pregnancies terminated between 2005 and 2012.

affected by the availability of health facilities during the analysis period. Thus, we mainly use the four above-mentioned dummy variables as the indicators for maternal care usage.

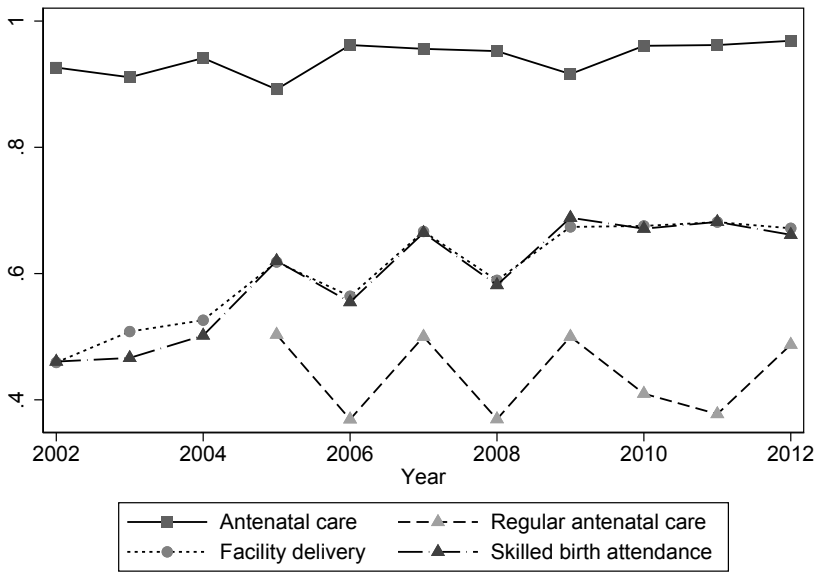
These outcome variables indicate an increasing trend over the analysis period (Figure 4). It suggests that the increase in the availability of health facilities was indeed accompanied by the increase in the number of the sample mothers delivering at formal facilities using SBA during the 2000s. Both the share of cases delivered at formal facilities and attended by SBA increased from 46 to 67 percent between 2002 and 2012.[18] Antenatal care utilization remains high around 93 percent throughout the period. However, regular antenatal care usage, which is defined as the pregnancy cases in which the mother made at least one antenatal care visit in every trimester, is much lower averaging at 44 percent. There is also no indication of improvement over time. The summary statistics of these outcomes and control variables are provided in Table 2.

In order to merge the RePEAT data and the facility data for each sub-county and year, we filled missing values in the facility data in 2003, 2005, 2007 and 2009 using the interpolation based on the simple mean between the two closest years for which data are available. For example, the mean availability over 2002 and 2004 is assigned to 2003, and the mean availability over 2004 and 2006 is assigned to 2005. Table 3 provides the summary statistics for the availability of health facilities. While the interpolated data can be incorrect, in our case they turn out to be correct values for 71 (61) percent of sub-counties for upper(lower)-level health facilities, respectively, because they did not experience a gain in the availability of those facilities between the two years before and after the four years with no original data. Nevertheless, for the rest of the sub-counties, the interpolated values overestimate the availability of health facilities if true availability increased after the year with no data, and underestimate it if true availability increased in the year with no data.

In order to see the robustness of our results against the use of the interpolated data, we analyze

[18] SBA at a facility is not included in Figure 4 because its trend almost coincides with the trends of SBA and facility delivery.

Figure 4: Maternal care utilization: 2002-2012



Source: RePEAT Study 2005 and 2012.
Notes: Regular care is defined as receiving antenatal care at least once in every trimester. Facility delivery includes delivery at formal facilities regardless of their level (lower/higher) or type (public/non-public). Women who delivered at home or attended by a traditional birth attendant (TBA) are included in the data and considered not to have used formal facilities. Skilled birth attendants include a midwife, nurse, or doctor, but excludes a TBA, relative, and Village Health Team (VHT, or HCI).

the impact of health infrastructure excluding the four years (while this comes with the disadvantage of reducing the sample size significantly). We also repeat the same estimation exercise using two alternative datasets: one fills in the missing values with their pre-determined values and the other fills in the missing values with the nearest available future values from the same sub-county (e.g., for 2003, the pre-determined values are the 2002 data while the future values are the 2004 data). These two alternative datasets are based on two extreme assumptions that, for sub-counties which experienced changes in the availability of health facilities, all the new openings occurred in the year before the year with no data (when we use the pre-determined values such as the 2002 data for 2003) and that all the new openings occurred in the year with no data (when we use the future values such as the 2004 data for 2003). The amount of underestimation of the availability of health facilities is largest in the data with the pre-determined values, while the amount of overestimation is largest in the data with the future values. Thus, the results based on these two datasets are likely to provide upper- and lower-bounds.[19] Finally, while our data do not include 2000 and 2001, this is unlikely to matter much because many new health centers were constructed after 2002. The number of planned construction of HCII was 20 and 65 for 2001 and 2002, but 250, 250 and 300 for 2003, 2004 and 2005 (Ministry of Health, 2000).

4 Empirical model

The increasing trends in both access to health facilities and maternal care usage suggest that maternal health investment might be partly explained by the improvement in the access to facilities. In order to more rigorously investigate this possibility, we employ sub-county fixed effects model and mother

[19] We appreciate one of the referees for suggesting these robustness checks.

Table 2: Summary statistics: outcomes and pregnancy-, mother- and household-level variables

Variable	Obs	Mean	Std. Dev.
A. Outcomes			
1 if at least one antenatal care visit	1860	0.93	0.25
1 if at least one antenatal care visit in every trimester* (regular antenatal care)	1081	0.44	0.5
1 if delivered at a facility	1860	0.59	0.49
1 if delivery was attended by a skilled birth attendant (SBA)	1860	0.58	0.49
1 if delivered at a facility with a SBA	1860	0.56	0.5
1 if complication happened during delivery*	1063	0.15	0.36
1 if baby weight was measured*	1063	0.6	0.49
Baby's birth weight (Kg)*	559	3.46	0.82
1 if birth weight < 2.5Kg*	559	0.07	0.26
1 if baby was perceived to be bigger than other babies*	1063	0.48	0.5
1 if walked to the place for antenatal care	1813	0.47	0.50
1 if used an own bicycle to the place for antenatal care	1813	0.19	0.39
1 if used a bodaboda to the place for antenatal care	1813	0.21	0.41
1 if used a bus to the place for antenatal care	1813	0.11	0.31
1 if used other modes to the place for antenatal care	1813	0.03	0.16
1 if walked to the place for delivery care	1037	0.23	0.42
1 if used an own bicycle to the place for delivery care	1037	0.21	0.40
1 if used a bodaboda to the place for delivery care	1037	0.38	0.49
1 if used a bus to the place for delivery care	1037	0.09	0.29
1 if used other modes to the place for delivery care	1037	0.09	0.29
Travel time for antenatal care (minutes)	1813	49.67	43.54
Travel time for delivery (minutes)	1037	37.6	41.76
1 if paid for transport for antenatal care	1813	0.33	0.47
1 if paid for transport for delivery	1037	0.54	0.5
B. Pregnancy characteristics			
Age at pregnancy	1860	28.63	7.33
1 if parity is 2-5	1860	0.45	0.5
1 if parity is 6-9	1860	0.34	0.47
1 if parity is 10 or over	1860	0.1	0.29
1 if household owns some land	1860	0.82	0.39
log of per capita land holdings (acre)	1860	7.86	3.84
1 if household owns some livestock	1860	0.82	0.39
log of per capita value of livestock	1860	8.27	4.19
1 if household owns some assets	1860	0.88	0.33
log of per capita value of assets	1860	8.6	3.35
B. Household and mother characteristics			
Altitude of household location (1000 meters)	695	1.3	0.28
1 if mother completed some primary education	848	0.47	0.5
1 if mother completed primary education	848	0.20	0.4
1 if mother completed more than primary education	848	0.18	0.39

Sources: The RePEAT study 2003, 2005, 2009 and 2012.

Notes:

1) A formal facility includes both governmental and private facilities. Delivery at home or attended by a traditional birth attendant (TBA) is not included in the delivery at facility.

2) Skilled birth attendants include a midwife, nurse, or doctor, but excludes a TBA, relative, or Village Health Team (VHT, or HCI).

3) Regular care refers to receiving antenatal care at least once in every trimester.

4) Information on the value of assets and livestock is available for the survey years. The interpolated values are assigned to non-survey years.

5) Information on household land size is available for each year because the RePEAT asked the year in which each of the household land parcels was purchased or sold. We use this information to construct household land size in each year.

6) The number of households is shown for altitude, and the number of mothers is shown for the dummies for education attainment.

7) The variables with asterisk are measured only in 2012 for pregnancies between 2005 and 2012. Travel-related outcome variables are measured only for mothers who used formal antenatal or delivery care.

Table 3: Summary statistics: sub-county- and village-level variables

Variable	Obs	Mean	Std. Dev.
Number of public higher-level facilities per parish	796	.23	.16
Number of public lower-level facilities per parish	796	.31	.31
Number of private facilities per parish	796	.18	.22
1 if driving time from village to the nearest district town is less than median in 2005	282	0.52	0.5
1 if subcounty had at least one higher-level facility in 2002	85	0.85	0.36
1 if subcounty had at least one lower-level facility in 2002	85	0.59	0.5

Sources: Uganda health facility inventory data and the RePEAT study 2003, 2005, 2009 and 2012.
Notes:
1) Theoretically, the number of observations for the number of health facilities per parish is 85 sub-counties * 11 years (2002-2012)=935. However, the number of observations above is smaller than that because some sub-counties do not provide pregnancy observations in each year. The mean and standard deviation of the availability of health facilities do not differ much when we do not restrict the sample to those with pregnancy information.
2) The number of villages (282) is shown for the indicator for villages with short driving time to the district town in 2005. The number of sub-counties (85) is shown for the dummy variable for sub-counties with at least one higher- or lower-level facility in 2002.

fixed effects model. First, sub-county fixed effects model is formalized as follows:

$$M_{ijhkt} = \beta_1 * Access_{kt} + \beta_2 * Z_{jhkt} + \mu_k + \lambda_{rt} + \nu_{ijhkt} \tag{4.1}$$

M_{ijhkt} indicates the outcome of interest for pregnancy i of woman j in household h, living in sub-county k in district or region r in year t. $Access_{kt}$ is the vector of three variables which indicate the per-parish availability of the three types of health facilities (public higher-level, public lower-level, and non-public) within sub-county k in year t. μ_k represents unobserved time-invariant characteristics of sub-county k. According to the governmental plan, sub-counties with many parishes which did not have HCII were more likely to receive a new HCII. While sub-counties with many and few such parishes might be different in terms of unobserved characteristics which affect health investment behavior and outcomes, sub-county fixed effects take into account any additive differences in those outcomes. Also, sub-counties in remote and rugged areas are less likely to receive a health facility, and might also have residents suffering from poor health. However, to the extent such unobserved characteristics do not change in the short run, it is also likely to be captured by the sub-county fixed

effects.

λ_{rt} is a set of dummy variables defined for each district and year (year dummies and district-year interactions) which controls for the annual nation- and district-wide shocks/events that might have affected the availability of health facilities and utilization of health care. These include natural calamities such as floods, outbreak of diseases and varying trends in public investment in health. Also, they include possible changes in the average awareness of women, which might have happened due to increased information exposure to younger cohorts.

In addition to these district-specific year effects, a set of control variables, Z_{jhkt}, is included. These consist of: maternal age at delivery, the age squared, and a set of three dummy variables indicating parity. Furthermore, we control for household wealth by including: log of per capita size of landholdings, log of per capita values of assets and livestock, and the three dummy variables indicating whether households hold any land, assets and livestock. These are likely to control for the income effect on maternal care usage and health status. For instance, if economic booms increase the average income of households in the areas, both maternal care utilization and health outcomes might improve. If new openings of health facilities coincide with these economic booms, we might falsely attribute such improvement to the health facilities. We capture this income effect at the household level. In addition, the altitude of household location and three dummy variables indicating maternal education are controlled. The altitude of a household is likely to capture its remoteness, which can vary even within a village. Table 2 contains the summary statistics for these variables. Finally, ν_{ijhkt} is the idiosyncratic standard errors clustered at the sub-county level. Clustering corrects the standard errors for potential correlation of outcomes for women within a sub-county over time, including those with repeated births (Bertrand et al., 2001).

The sub-county fixed effects model assumes that, controlling for the district-specific year effects as well as pregnancy-, mother- and household-level characteristics, there is no unobserved hetero-

geneity that affects growth in outcomes and changes in the access to health facilities. However, the composition of mothers could change over time within a sub-county. For instance, mothers who delivered in later years in the analysis period might have been more aware of the importance of maternal care than mothers who delivered in earlier years. If this tendency is particularly strong in areas that gained a new facility, it could positively bias the impact of the availability of health facilities on maternal care utilization.

In order to assess whether this issue matters, we also utilize the mother fixed effects model, which replaces the sub-county fixed effects with mother fixed effects as follows:

$$M_{ijhkt} = \beta_1 * Access_{kt} + \beta_2 * Z_{jhkt} + \mu_i + \lambda_{rt} + \nu_{ijhkt} \tag{4.2}$$

This specification controls for mother-specific unobserved characteristics such as innate health and preferences towards transportation and health care. Thus, the mother fixed effects model is our preferred specification for internal validity. However, in terms of external validity, there is a drawback since those women who experienced only one pregnancy during the analysis period are dropped from the analysis. The proportion of these women is small when we use all the years between 2002 and 2012.[20] However, when we exclude the years for which health facility data are unavailable for robustness check, quite many women drop out of the analysis sample. Nevertheless, the availability of health facilities does not differ systematically between those observations included and excluded in the mother fixed effects model estimation. Therefore, the mother fixed effects model is likely to provide the most reliable results. This model assumes that, controlling for the district-specific year effects, maternal time-invariant differences, pregnancy- and household-level time-variant characteristics, there is no unobserved change that affects growth in outcomes and changes in the

[20]For example, 18 percent of the sample drop in Table 4 in Columns 2-4 where data from all the years are used for estimation.

availability of health facilities. That is, pregnant women in a sub-county which gained a health facility would not have changed unobserved factors disproportionately compared to pregnant women in other sub-counties which experienced no change in access to health facility. This is likely to hold as we allow general attitudinal changes affecting the outcomes at the district level,[21] and also control for the effect of economic development at the household level.

The linear probability model (LPM) is used to estimate equations 4.1 and 4.2. While some of the outcome variables are discrete, the fixed effects logit model does not allow the estimation of the partial effects on the response probabilities without making assumptions on the values of the fixed effects. As the results based on the fixed effects logit model are generally similar to the findings based on the LPM, in this paper we mainly discuss the LPM results.

5 Results

5.1 Impact on maternal health care use

Table 4 shows the results for maternal care utilization. For comparison, we start with the OLS estimates, which are reported in Panel A. They suggest that sub-counties with relatively many more public higher-level facilities have more pregnant women who deliver at formal facilities, attended by skilled birth attendants (Column 3). On the other hand, sub-counties do not differ much in terms of maternal care use by the availability of public lower-level facilities. The results are somewhat different once sub-county fixed effects are included. The results in Panel B indicate that areas experiencing a gain in access to public higher-level facilities exhibit an increase in the probability of facility delivery and SBA (Columns 2-4). These results suggest the OLS estimates slightly underestimate the impact of access to public higher-level health facilities on the utilization of facility delivery and SBA. This is

[21] When we estimate the mother fixed effects estimates for the impact on the outcomes with a smaller sample size (those measured only for pregnancies in or after 2005), a set of dummy variables defined for each region (instead of district) and year is used.

consistent with the previous studies which do not find significant effect of health programs in cross sectional estimates but do find a significant impact in community fixed effects models (Frankenberg et al., 2005; Pitt et al., 1993; Rosenzweig and Wolpin, 1982). It is likely that the government's guideline to target unserved areas causes a downward bias in the OLS estimates.

The sub-county fixed effects results however may still be biased if the composition of mothers changed within sob-counties. However, even after mother fixed effects are taken into account, the results in Panel C depict a robust relationship between maternal care utilization and public higher-level facilities. That is, given the same woman, a delivery which occurred after the opening of a new higher-level facility is more likely to take place at a formal facility with SBA (Columns 2-4). The estimated coefficient for the use of SBA at facility implies that, an additional higher-level facility in a sub-county induces a 7-percentage-point increase in the probability of SBA at facility. This is equivalent to a 13-percent increment compared to the mean.[22]

Interestingly, the mother fixed effects results also show that improved access to public *lower-level* facilities increases regular antenatal care, though these facilities do not provide full maternal care. The estimates imply that an additional public lower-level facility leads to a 7-percent increase in regular antenatal care. A possible explanation for the differences between the sub-county and mother fixed effects models is that relatively developed sub-counties which are unlikely to have gained lower-level facility experienced disproportionate changes in unobserved factors affecting regular antenatal care, such as willingness to regularly check their pregnancies, possibly due to the exposure of young cohorts to media. If such improvement in awareness happened due to cohort changes only in areas not gaining access to facilities, while both young and old women kept traditional attitude in more rural areas (which gained access to facilities), it can cause an underestimation of the impact of access to

[22] A new higher-level facility in a sub-county is equivalent to about a one-sixth increase in the number of those facilities per parish, as there are about six parishes on average. This can be a newly established facility or upgrading of an existing lower-level facility. It leads to a $1/6 \times 0.44 = 7$-percentage-point increase in the outcome, or a 13-percent increase relative to the mean ($0.0733 \div 0.5618$).

Table 4: Impact of access to health facilities on maternal care utilization in Uganda: 2002-2012

Panel A: OLS model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	0.20	0.23	0.26*	0.23
	(0.11)	(0.11)	(0.07)	(0.14)
Number of public lower-level facilities per parish	0.03	-0.08	-0.08	-0.11
	(0.71)	(0.30)	(0.35)	(0.16)
Observations	1,081	1,860	1,860	1,860
R-squared	0.22	0.29	0.26	0.26

Panel B: Sub-county fixed effects model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	0.00	0.38**	0.33*	0.33*
	(1.00)	(0.02)	(0.06)	(0.08)
Number of public lower-level facilities per parish	0.07	-0.06	-0.10	-0.09
	(0.56)	(0.49)	(0.29)	(0.32)
Observations	1,081	1,860	1,860	1,860
R-squared	0.051	0.028	0.028	0.034
Number of sub-counties	82	84	84	84

Panel C: Mother fixed effects model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	0.07	0.43**	0.44**	0.43**
	(0.66)	(0.02)	(0.02)	(0.02)
Number of public lower-level facilities per parish	0.19*	0.04	0.05	0.07
	(0.05)	(0.69)	(0.62)	(0.43)
Observations	888	1,531	1,531	1,531
R-squared	0.031	0.028	0.027	0.029
Number of mothers	321	489	489	489

Notes:

1) Robust p-values in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

2) All regressions control for age, age squared, parity dummies, dummies indicating the possession of land, livestock, and durables. For those households which have non-zero landholdings, livestock and/or durables, the amount of landholdings and/or the values of livestock and durables are included as well. The sub-county fixed effects models also control for the three dummies for maternal education, the altitude of household location, and district-year interactions. The mother fixed effects models also control for district-year interactions (Columns 2-4) or region-year interactions (Column 1).

3) A facility includes both public and non-public facilities. Delivery at home or attended by a traditional birth attendant (TBA) is not included in the delivery at (formal) facility.

4) SBA indicates a skilled birth attendant, which includes a midwife, nurse, and doctor, but excludes a TBA, relative, and Village Health Team (VHT, or HCI).

5) Regular care refers to receiving antenatal care at least once in every trimester. This outcome is measured only for pregnancies which happened in or after 2005. This makes the number of observations smaller in Column 1.

6) Lower-level facilities include Health Center II (HCII), which does not provide either full antenatal care or delivery service. Higher-level facilities include the rest of the facilities, which provide full antenatal care and delivery care.

health facilities in the sub-county fixed effects model. Altogether, these results suggest that improved access to health infrastructure promotes regular antenatal care visits and delivery at a formal facility with a skilled birth attendant.

The estimated coefficients for the control variables (not shown) suggest the usage of SBAs and delivery at facilities are associated with parity. For example, the results based on the mother fixed effects model suggest that women of higher parities are less likely to use facilities or be attended by SBA. Under the sub-county fixed effects model, it is found that mothers from households with increased values of livestock are more likely to use facilities for delivery, while women from households with larger landholding are more likely to regularly use antenatal care. In terms of time-invariant correlates, altitude and the level of education do not indicate a systematic association with the place of delivery or use of SBAs.

5.2 Impact on travel and expenditure patterns

The results in the previous section indicate that improved access to lower-level health infrastructure promotes regular antenatal care visits and better access to higher-level health facilities enhances delivery at a formal facility with a skilled birth attendant. In order to see if these advantages are in fact due to better access to health facilities, we now examine the effects on travel mode, time and expenses. It is important to note the affordability of *health care* is not addressed in this study, though it is shown to matter in determining the demand for health care (Lagarde et al., 2007; Nguyen et al., 2012; Powell-Jackson and Hanson, 2012). In the case of Uganda, user fees in public health facilities were mostly abolished in 2001.[23] Some preventative care including antenatal visits had been free even before the 2001 reform (Burnham et al., 2004). However, unofficial fees in the public sector has been reported (Ministry of Health, 2010a). More relevant to this study is that users still pay for transportation and face the opportunity costs for the time taken to reach facilities and receive care.

[23] User fees in public facilities remained in private wings of public hospitals (Ministry of Health, 2010a).

In this context, changes in the physical proximity to health facilities are still likely to affect the total cost of health care usage.

On one hand, if a new facility reduces the distance to the nearest facility, it can reduce both the time to reach a facility and travel costs, given the mode of transportation remains unchanged. On the other hand, if a mother stops choosing a relatively expensive mode of transportation such as a motorcycle and bus, and starts choosing a less expensive mode such as walking, transportation costs will decrease, but the impact on travel time is unclear. The data on the major transportation mode, total travelling time and transportation costs are available in the 2005 and 2012 RePEAT data for mothers who used some antenatal or delivery care. We use the pregnancy cases which experienced at least one antenatal care visit to a formal facility in order to study the patterns of travel for antenatal care. Since the probability of having at least one antenatal care is very high (Table 2), the sample for this analysis includes almost all observations used for the analysis for maternal care use. However, in the case of the travel for delivery care, the sample size is largely reduced as delivery took place outside formal facilities for about 35 percent of the cases.[24] Furthermore, since this analysis compares travel experiences among mothers who delivered at facilities, if there is no mother delivering at facilities before and after new openings of facilities, those sub-counties do not contribute to sub-county fixed effects estimation. Similarly, if mothers did not deliver at facilities more than once before and after new openings of facilities, those mothers do not contribute to the estimation of the mother fixed effects model.[25]

The results for the travel patterns associated with antenatal care and delivery care are provided in Tables 5 and 6, respectively. In each table, Panels A and B indicate the results based on the

[24]If more than one transport mode was used, the mode and cost for the most expensive one were asked. This is likely to underestimate the total cost for individuals who travel a long distance. To the extent those individuals are more likely to experience an improvement in access to health facilities, its estimated impact is likely to be underestimated, thereby serving as a lower bound.

[25]We have also estimated the impact on travel time and costs separately for those cases choosing one of the three major modes of transportation (walking, cycling, and bodaboda) by the mode of transportation. The results however suggest no significant impact (results not shown).

sub-county and mother fixed effects models, respectively. For antenatal care visits, the mother fixed effects estimates in Panel B, Table 5 suggest that a new higher-level public facility in every parish (which increases our measure of per-parish availability by one) reduces the probability for expecting mothers of paying for transportation to antenatal care places by 24 percentage points (Column 7, Panel B).[26] This is accompanied by a decrease in the probability of taking the transportation modes which require monetary costs: a boda boda (motorcycle taxi) and bus (Columns 3 and 4), though these coefficients are not statistically significant. These results seem to suggest that mothers became to choose less expensive modes of transportation as higher-level facilities became closer to them. It is also consistent that they respond to changes in the availability of higher-, rather than lower-, level facilities as the majority of mothers receive antenatal care at higher-level facilities (Table 1) where full antenatal care service is rendered. Table 5 also indicates that a new lower-level public facility reduces the probability for expecting mothers of using bicycles to travel to the place of antenatal care (Column 2, Panel A), but this estimate becomes insignificant once mother fixed effects are taken into account (Panel B).

Turning to transportation to delivery care, the mother fixed effects model results suggests that mothers became to walk to health facilities for delivery after the opening of a new higher-level facility (Column 1, Panel B, Table 6). At the same time, they are less likely to use bicycles and buses, and also less likely to pay for transportation to delivery places (Columns 4, 5 and 7), while these changes are not statistically significant. Since the sample size is relatively small for the analysis of delivery care, and the mother fixed effects model can incorporate only the region-specific year effects, these results can be taken as weak evidence for the change in transportation modes influenced by better access to higher-level health facilities. Altogether, these results for the transportation outcomes imply that mothers took advantage of an increase in the availability of health facilities to reduce

[26] We prefer to use the dummy variable for paying for transportation rather than the actual amount of expense because it is known that a measurement error issue is less severe in the dichotomous variable (Beckett et al., 2001).

Table 5: Impact of access to health facilities on the mode, time and cost of transportation to antenatal care (ANC) in Uganda: 2002-2012

Panel A: Sub-county fixed effects model	(1) 1 if walk to ANC	(2) 1 if cycle to ANC	(3) 1 if use boda to ANC	(4) 1 if use mini bus to ANC	(5) Travel time to ANC	(6) 1 if paid for transport to ANC
Number of public higher-level facilities per parish	0.07	-0.10	-0.09	0.08	-25.17	-0.07
	(0.76)	(0.34)	(0.68)	(0.39)	(0.17)	(0.77)
Number of public lower-level facilities per parish	0.11	-0.15*	-0.03	0.08	-21.95	-0.03
	(0.34)	(0.06)	(0.71)	(0.27)	(0.17)	(0.82)
Observations	1,813	1,813	1,813	1,813	1,813	1,813
R-squared	0.0226	0.0156	0.0230	0.0121	0.0298	0.0295
N Subcounties	85	85	85	85	85	85

Panel B: Mother fixed effects model	(1) 1 if walk to ANC	(2) 1 if cycle to ANC	(3) 1 if use boda to ANC	(4) 1 if use mini bus to ANC	(5) Travel time to ANC	(6) 1 if paid for transport to ANC
Number of public higher-level facilities per parish	0.07	0.05	-0.14	-0.08	22.38	-0.24*
	(0.57)	(0.66)	(0.24)	(0.28)	(0.16)	(0.10)
Number of public lower-level facilities per parish	0.01	-0.09	0.01	0.04	-4.78	0.01
	(0.92)	(0.18)	(0.94)	(0.43)	(0.70)	(0.93)
Observations	1,496	1,496	1,496	1,496	1,496	1,496
R-squared	0.0164	0.0205	0.0218	0.0251	0.0299	0.0194
N Mothers	476	476	476	476	476	476

Notes:

1) Robust p-value in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

2) All regressions control for district-year interactions, age, age squared, parity dummies, dummies indicating the posession of land, livestock, and durables as well as the amount of landholdings and the values of livestock and durables for those households which have non-zero landholdings, livestock or durables. The sub-county fixed effects models also control for the three dummies for maternal education and altitude of the household location.

3) The mode of transportation is examined for the pregnancy cases where mothers visited formal health facilities for antenatal care. The cases where mothers did not seek care, stayed at home and visited a traditional birth attendant are excluded from analysis.

4) *Boda* (or *Boda boda*) is a motorcycle which functions as a taxi. It gives ride to a user for a fee which is negotiated between the user and the boda rider.

5) Mini bus is a ban which accommodates about 15-20 passengers which functions as a bus, providing transportation between large town centers.

6) Lower-level facilities include Health Center II (HCII), which does not provide full antenatal care nor delivery service. Higher-level facilities include the rest of the facilities which provide full antenatal care and delivery care.

travel expenses by selecting a less expensive mode of transportation for maternal care. As a result, no clear pattern emerged significantly for the time taken to reach antenatal and delivery care places.

5.3 Impact on maternal and child health

Thus far, we have demonstrated that new openings of health facilities increase demand for maternal care, induce the choice of a less expensive mode of transportation, thereby reducing the monetary costs of transportation of maternal care. A natural next question is whether this increase in maternal care utilization also influences maternal and child health outcomes. In order to address this issue, we now examine the impact on the incidence of complications mothers experience during delivery, as well as the birth weight of their children. The 2012 RePEAT asked whether a woman experienced any complication or health problems during child birth, and some problems happened for 15 percent of the pregnancies. Common responses include severe bleeding and being labor for more than a day.[27] The 2012 RePEAT also asked mothers whether they thought their babies were bigger, smaller, or similar in size compared to other infants. It further asked whether their weights were measured right after birth, and if so, how many kilograms they were.[28] While these outcome variables provide reasonable measures for maternal and child health, their information is available only for pregnancies terminated in or after 2005. Thus, the sample size is somewhat limited and in the mother fixed effects model, only region-, rather than district-specific year effects can be incorporated.

The results are shown in Table 7 based on the sub-county fixed effects model (Panel A) and mother fixed effects model (Panel B). They suggest that, even though usage is increased by the openings of higher-level health facilities, they do not seem to affect the risk of complications for mothers during childbirth (Column 1). However, given the data limitations, this finding does not

[27]The common complications that can be life-threatening include severe bleeding and infections (particularly after childbirth), high blood pressure during pregnancy (which can lead to pre-eclampsia and eclampsia), and other indirect causes due to worsening medical disorders.

[28]The data on infant and maternal deaths are available, but unfortunately sample size is too small to conduct a reliable study on the impact on these rare events.

Table 6: Impact of access to health facilities on the mode, time and cost of transportation to delivery care (DC) in Uganda: 2002-2012

Panel A: Sub-county fixed effects model	(1) 1 if walk to DC	(2) 1 if cycle to DC	(3) 1 if use boda to DC	(4) 1 if use mini bus to DC	(5) Travel time to DC	(6) 1 if paid for transport to DC
Number of public higher-level facilities per parish	0.27	-0.16	-0.20	0.05	34.16	-0.26
	(0.45)	(0.42)	(0.50)	(0.75)	(0.14)	(0.49)
Number of public lower-level facilities per parish	0.01	-0.10	-0.08	0.04	-17.77	-0.02
	(0.91)	(0.36)	(0.53)	(0.46)	(0.16)	(0.91)
Observations	1,037	1,037	1,037	1,037	1,037	1,037
R-squared	0.0613	0.0512	0.0212	0.0180	0.0303	0.0270
N Subcounties	80	80	80	80	80	80

Panel B: Mother fixed effects model	(1) 1 if walk to DC	(2) 1 if cycle to DC	(3) 1 if use boda to DC	(4) 1 if use mini bus to DC	(5) Travel time to DC	(6) 1 if paid for transport to DC
Number of public higher-level facilities per parish	0.26*	-0.07	0.01	-0.10	28.12	-0.24
	(0.10)	(0.71)	(0.97)	(0.51)	(0.23)	(0.32)
Number of public lower-level facilities per parish	0.03	-0.03	0.04	-0.07	5.00	0.01
	(0.71)	(0.65)	(0.68)	(0.37)	(0.44)	(0.91)
Observations	817	817	817	817	817	817
R-squared	0.0428	0.0304	0.0128	0.0183	0.0416	0.0163
N Mothers	286	286	286	286	286	286

Notes:

1) Robust p-value in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

2) All regressions control for age, age squared, parity dummies, dummies indicating the posession of land, livestock, and durables as well as the amount of landholdings and the values of livestock and durables for those households which have non-zero landholdings, livestock or durables. The sub-county fixed effects models also control for the three dummies for maternal education, the altitude of the household location, and district-year interactions. The mother fixed effects models also control for region-year interactions.

3) The mode of transportation is examined for the pregnancy cases where mothers visited formal health facilities for delivery care. The cases where mothers did not seek care, stayed at home and visited a traditional birth attendant are excluded from analysis.

4) *Boda* (or *Boda boda*) is a motorcycle which functions as a taxi. It gives ride to a user for a fee which is negotiated between the user and the boda rider.

5) Mini bus is a ban which accommodates about 15-20 passengers which functions as a bus, providing transportation between large town centers.

6) Lower-level facilities include Health Center II (HCII), which does not provide full antenatal care nor delivery service. Higher-level facilities include the rest of the facilities which provide full antenatal care and delivery care.

Table 7: Impact of access to health facility on maternal and child health outcomes in Uganda: 2001-2012

Panel A: Sub-county fixed effects model	(1) 1 if complication during delivery	(2) 1 if baby weight was measured	(3) Birth weight (Kg)	(4) 1 if birth weight < 2.5Kg	(5) 1 if mother thinks baby is big
Number of public higher-level facilities per parish	-0.16	0.37	-0.35	0.35	-0.06
	(0.49)	(0.22)	(0.67)	(0.28)	(0.85)
Number of public lower-level facilities per parish	-0.01	-0.17	-1.00***	0.12	0.04
	(0.94)	(0.20)	(0.00)	(0.53)	(0.74)
Observations	1,063	1,063	559	559	1,063
R-squared	0.021	0.046	0.066	0.028	0.026
Number of sub-counties	81	81	71	71	81

Panel B: mother fixed effects model	(1) 1 if complication during delivery	(2) 1 if baby weight was measured	(3) Birth weight (Kg)	(4) 1 if birth weight < 2.5Kg	(5) 1 if mother thinks baby is big
Number of public higher-level facilities per parish	-0.00	0.13	-2.14***	0.42	-0.07
	(1.00)	(0.55)	(0.00)	(0.13)	(0.83)
Number of public lower-level facilities per parish	0.02	-0.11	-0.62*	0.15	-0.03
	(0.78)	(0.13)	(0.09)	(0.23)	(0.79)
Observations	869	869	412	412	869
R-squared	0.0174	0.0179	0.117	0.0764	0.0164
N Mothers	317	317	157	157	317

Notes:

1) Robust p-values in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

2) All regressions control for age, age squared, parity dummies, dummies indicating the possession of land, livestock, and durables. For those households which have non-zero landholdings, livestock and/or durables, the amount of landholdings and/or the values of livestock and durables are included as well. The sub-county fixed effects models also control for the three dummies for maternal education, the altitude of household location, and district-year interactions. The mother fixed effects models also control for region-year interactions.

3) A complication during delivery is self-reported. Common responses include severe bleeding and being labor for more than a day. The common complications that can be life-threatening include severe bleeding and infections (particularly after childbirth), high blood pressure during pregnancy (which can lead to pre-eclampsia and eclampsia), and other indirect causes due to worsening medical disorders.

4) Lower-level facilities include Health Center II (HCII), which does not provide full antenatal care nor delivery service. Higher-level facilities include the rest of the facilities which provide full antenatal care and delivery care.

5) The number of observations is smaller in Columns 3 and 4 because the outcomes are available only for babies whose birth weight was measured.

preclude all the possibilities that health facilities help pregnant mothers to avoid complications. For example, the measurement of complication is based on self-reported symptoms, which may not be precise enough to detect the impact on the incidence of true, serious complications. The incidence of complications is also relatively low, and thus the data from 2005 and onwards may not be large enough to detect any effect.

The results for child health outcomes also suggest a limited impact of new health infrastructure. First, they indicate the openings of public higher-level facilities do not alter the probability for babies of being weighted right after birth (Column 2). This might be puzzling, given the weights of newborn babies are supposed to be measured at birth at higher-level facilities. The absence of a significant effect on the probability might be due to the failure of facilities or mothers to follow the protocol of postnatal care. For instance, the RePEAT data indicates that 16 percent of babies delivered at facilities were not immediately weighted after birth. It might also be due to memory loss among mothers. Seven percent of babies were reported to have been weighted right after birth, even though they were born outside a facility. Among those babies who were weighed, an increase in the number of lower-level public facilities leads to a reduction in the birth weight (Column 3). However, this does not lead to the significant increase in the incidence of low birth weight infants with the weight less than 2.5kg (Column 4). Furthermore, no negative effect is found on the subjective size of children, which was evaluated by their mothers regardless of whether they were weighed or not (Column 5). Coupled with the small sample size, these results suggest that the estimates in Columns 3 and 4 need to be taken with some caution. One possible explanation might be that mothers become to have their babies weighed at an earlier point in time once their sub-county receives a lower-level health facility. Some of the answers to birth weight, which is supposed to have been measured "right after birth," exceed 5kg, which is more likely to be true if babies were weighed a few weeks or months after birth. If birth weight was actually measured at different ages in weeks or months, the opening of a

lower-level facility might have induced mothers who deliver at home to bring their newborn babies to the facility earlier, thereby reducing the mean weight.

In sum, the results for health outcomes do not provide evidence for improvement, except for the weak indication that babies might have been taken to weight measurement at an earlier stage in their lives. However, our small sample size does not allow us to conclude that there is no impact of access to health facilities on maternal and child health outcomes. The results suggest the need for further investigation with larger data with more accuracy.

5.4 Robustness check

We have demonstrated that demand for maternal care responds to new openings of health infrastructure, which might have resulted in an early measurement of the weight of new-born babies. However, one might be concerned that these results reflect the fact that facilities are built in places with growing demand. That is, the results might be biased due to reverse causality. Also, another concern might be related to a possible bias stemming from the fact that the data on access to health facilities are interpolated because the original data were collected only once in two years between 2002 and 2010. In this section, we address these concerns. In order to see whether the results are driven by reverse causality, we augmented the base model with the future availability of health facilities. If the results thus far capture the demand-side response, it should react to current, not future, availability of health facilities. On the other hand, if supply chases demand, a high level of current utilization can give rise to new health facilities, thereby producing the correlation with the future availability of health facilities.[29] Table 8 shows the results of estimating the augmented model for maternal care use outcomes.[30] The results show that the future availability indicators are all insignificant (Columns 1,

[29]We thank one of the referees for suggesting this robustness check. The future availability of health facilities is defined to be the number of facilities two years later, as the original data was collected once in two years between 2002 and 2010. This reduces the sample period from 2002-2012 to 2002-2010.

[30]For this exercise, we focus on these outcomes which provide large enough sample even after the sample period is limited to 2002-2010.

3, 5 and 7). While the estimates for the effects of current availability of higher-level facilities become also insignificant most likely due to the smaller sample size, the point estimates are comparable to the results in Table 4, ranging between 0.21-0.39 in Panels A and B. The estimates for the effect of lower-level facilities on regular antenatal care are also marginally significant but consistent with those in Table 4. For comparison, the results without the future availability indicators are included for this sample period in Columns 2, 4, 6, and 8. They show the estimates are not altered by the additional inclusion of the future availability indicators. While the sub-county fixed effects model results indicate the negative effects of facilities (Panel A), once mother fixed effects are incorporated, these effects become largely insignificant (Panel B).[31] These results provide suggestive evidence that what is estimated in the analysis so far reflects the demand-side response to changes in the supply of health facilities.

Next, in order to address the concern that the use of interpolated availability indicators may cause measurement errors which bias the results, we repeat the analysis of Table 4 without including the years for which the original inventory data is unavailable. The results are shown in Table 9. Since four out of 11 years drop from the sample, the number of observations reduces by about 40 percent for the OLS and the sub-county fixed effects model. For the mother fixed effects model, it reduces by about a half because mothers whose pregnancies occurred in one of those four years are excluded if they do not have multiple remaining pregnancies occurring in the 7 years for which the health facility inventory data was collected. Nevertheless, the results indicate qualitatively similar findings as Table 4. Those based on the sub-county fixed effects model suggests the positive and significant impact of higher-level facilities on delivery care utilization. In addition, the mother fixed effects model estimates imply the positive and significant effect of lower-level facilities on regular antenatal care. The mother fixed effects model also provides positive estimates for the impact of higher-level

[31]The negative effect of lower-level facilities on the probability of delivering at any facility is still significant. This might be because a new lower-level facility induces mothers to choose to deliver at home, thinking that it does not take a long time to reach the lower-level facility even if they decide to go there after something happens.

Table 8: Impact of current and future access to health facilities on maternal care utilization in Uganda: 2002-2010
Robustness test including access to health facilities two years later

Panel A: Sub-county fixed effects model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1 if regular antenatal care		1 if delivery at a facility		1 if SBA at a facility		1 if SBA	
Future number of public higher-level facilities per parish	0.28		0.09		0.13		0.09	
	(0.55)		(0.73)		(0.61)		(0.71)	
Future number of public lower-level facilities per parish	-0.11		0.07		0.10		0.05	
	(0.60)		(0.53)		(0.41)		(0.66)	
Current number of public higher-level facilities per parish	-1.10***	-1.05***	0.29	0.34	0.21	0.28	0.23	0.28
	(0.00)	(0.01)	(0.36)	(0.16)	(0.52)	(0.28)	(0.51)	(0.32)
Current number of public lower-level facilities per parish	0.14	0.13	-0.23*	-0.19*	-0.29**	-0.23*	-0.24*	-0.21*
	(0.45)	(0.47)	(0.05)	(0.09)	(0.05)	(0.07)	(0.08)	(0.09)
Observations	821	821	1,590	1,590	1,590	1,590	1,590	1,590
R-squared	0.0578	0.0568	0.0315	0.0310	0.0317	0.0308	0.0358	0.0355
Number of sub-counties	80	80	84	84	84	84	84	84
Panel B: Mother fixed effects model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1 if regular antenatal care		1 if delivery at a facility		1 if SBA at a facility		1 if SBA	
Future number of public higher-level facilities per parish	0.32		0.06		0.12		-0.01	
	(0.28)		(0.77)		(0.56)		(0.95)	
Future number of public lower-level facilities per parish	-0.11		0.11		0.05		-0.00	
	(0.49)		(0.36)		(0.63)		(0.97)	
Current number of public higher-level facilities per parish	-0.12	-0.06	0.24	0.26	0.30	0.35	0.39	0.38
	(0.56)	(0.78)	(0.37)	(0.28)	(0.26)	(0.16)	(0.17)	(0.14)
Current number of public lower-level facilities per parish	0.21	0.17	-0.24**	-0.17	-0.15	-0.11	-0.06	-0.06
	(0.10)	(0.23)	(0.02)	(0.19)	(0.21)	(0.41)	(0.62)	(0.65)
Observations	642	642	1,263	1,263	1,263	1,263	1,263	1,263
R-squared	0.0348	0.0266	0.0383	0.0358	0.0344	0.0326	0.0346	0.0339
Number of mothers	268	268	446	446	446	446	446	446

Notes:
1) Robust p-values in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.
2) All regressions control for age, age squared, parity dummies, dummies indicating the possession of land, livestock, and durables. For those households which have non-zero landholdings, livestock and/or durables, the amount of landholdings and/or the values of livestock and durables are included as well. The sub-county fixed effects models also control for the three dummies for maternal education, the altitude of household location, and district-year interactions. The mother fixed effects models also control for district-year interactions (Columns 2-4) or region-year interactions (Column 1).
3) See notes for Table 4 for the definition of the outcome variables and the number of observations.
4) Lower-level facilities include Health Center II (HCII), which does not provide full antenatal care nor delivery service. Higher-level facilities include the rest of the facilities which provide full antenatal care and delivery care.

facilities on delivery care utilization, though they are of marginal significance. This exercise is also repeated using the two different variants of the access data: one fills the missing values (due to no data collection) with pre-determined values and the other fills them with future values. These results (Appendix Tables A2 and A3) are again qualitatively similar to those in Table 4. Altogether, these results appear to indicate that the use of interpolated data is not the driving factor of the main findings, and the use of interpolated data enables us to utilize all the pregnancy cases reported between 2002 and 2012.[32]

5.5 Heterogeneity in the impact of access to health facility

The analysis so far has assumed the impact of access to health facilities is homogeneous across all the groups of different characteristics. However, the response to changes in service availability can vary depending on the constraints which restrict maternal care use. This section explores the heterogeneity in the impact of access to health facilities by three factors: 1) the condition of the road connecting the local village and the closest district town, 2) the initial availability of higher-level heath facilities and 3) the initial availability of lower-level health facilities. For this exercise, we focus on the impact on delivery care usage as the data for the other outcomes are too small to provide reliable estimates for heterogeneity analysis. We have also investigated heterogeneity by maternal education. The results suggest that only less educated mothers show significant responses, which however are not significantly different from the effects for more educated mothers (not shown for brevity).

Regarding road connectivity, it is possible that a new facility benefits communities with good road conditions particularly for the higher-level facilities because they are usually located in towns. As discussed earlier, HCIII is supposed to be built in every sub-county, HCVI in every county and a

[32]Lastly, we have also examined the long-term impact of having a new health facility on maternal care use in later years using the lagged variables of the three measures of access to health facility. While we added a set of one-year lags for the access measures, a set of three-year lags and a set of five-year lags, and so on, the results indicate that demand responds quite sharply once a new facility opens up, and thus no lagged take-up increase is observed (results not shown).

Table 9: Impact of access to health facilities on maternal care utilization in Uganda: 2002-2012
Robustness test excluding the years for which access data are unavailable

Panel A: OLS model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	0.22	0.36***	0.40***	0.38***
	(0.14)	(0.00)	(0.00)	(0.01)
Number of public lower-level facilities per parish	-0.01	-0.08	-0.05	-0.07
	(0.87)	(0.32)	(0.52)	(0.41)
Observations	682	1,202	1,202	1,202
R-squared	0.21	0.29	0.26	0.26
Panel B: Sub-county fixed effects model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	-0.03	0.40**	0.38**	0.41**
	(0.96)	(0.01)	(0.03)	(0.02)
Number of public lower-level facilities per parish	0.04	-0.06	-0.08	-0.06
	(0.86)	(0.47)	(0.42)	(0.47)
Observations	680	1,202	1,202	1,202
R-squared	0.0243	0.0270	0.0310	0.0331
Number of sub-counties	78	84	84	84
Panel C: Mother fixed effects model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	0.06	0.27	0.33	0.34
	(0.81)	(0.27)	(0.17)	(0.13)
Number of public lower-level facilities per parish	0.32**	0.05	0.09	0.11
	(0.01)	(0.67)	(0.46)	(0.34)
Observations	449	839	839	839
R-squared	0.0695	0.0607	0.0652	0.0643
Number of mothers	189	314	314	314

Notes:
1) Robust p-values in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.
2) All regressions control for age, age squared, parity dummies, dummies indicating the possession of land, livestock, and durables. For those households which have non-zero landholdings, livestock and/or durables, the amount of landholdings and/or the values of livestock and durables are included as well. The sub-county fixed effects models also control for the three dummies for maternal education, the altitude of household location, and district-year interactions. The mother fixed effects models also control for district-year interactions (Columns 2-4) or region-year interactions (Column 1).
3) See notes for Table 4 for the definition of the outcome variables and the number of observations.
4) Lower-level facilities include Health Center II (HCII), which does not provide full antenatal care nor delivery service. Higher-level facilities include the rest of the facilities which provide full antenatal care and delivery care.

hospital (HC V) in every district. For many of the villages, the roads leading to the district town also include the roads to the sub-county town and other towns. Thus, the condition of the roads to the district town roughly measures whether individuals living in a village can easily reach a new higher-level facility built in the sub-county. If the local roads are not passable, even if the new higher-level facility is built in the adjacent town, women in the village may not be able to use it. In order to measure the condition of roads, we use the travel time to the nearest district town in the dry season in 2005-the year that is about the middle of the analysis period. This is based on the following two questions: "Can one drive to the nearest district town in a dry season?" and "If so, how long does it take to get there?" Since most villages answered "Yes" to the first question, we define the villages with better road connectivity to be those that take less than the median driving time to the nearest district town. This dummy variable indicating villages with better road connectivity takes the value of zero for the few villages that answered "No" to the first question.[33]

Table 10 shows the results of estimating the augmented sub-county and mother fixed effects models in Panels A and B, respectively, which include the interaction terms between the indicators for access to health facilities and the dummy variable indicating villages with the less-than-median driving time to the nearest district town. As expected, the results show that the positive effects of higher-level facilities on facility delivery and skilled birth attendance, which was found in Table 4, are concentrated in villages with better access to district towns (Columns 1-3). On the other hand, those villages which do not have easy access to the district town fail to benefit from new higher-level facilities, as indicated by the insignificant coefficient for the uninteracted indicator for access to those facilities. For instance, in Column 2 in Panel A, the estimated coefficient of the availability of higher-level facilities for villages without better road connectivity is 0.03, which is insignificant.

[33]While these questions were asked in each survey year of 2003, 2005, 2009 and 2012, the nearest district town changed for some villages due to district splits. In these cases, the driving time can change even the condition of roads does not change at all. Thus, we could not use changes in the driving time as the indicator for changes in road connectivity. The results based on the condition during a rainy season are qualitatively unchanged. We use the condition during a dry season, which is likely to be answered with more accuracy given that the survey was conducted in a dry season.

This indicates that the availability of higher-level facility does not alter the probability of delivery at formal facilities, most likely because mothers in villages without better road connectivity still have difficulty in accessing new higher-level facilities. On the other hand, the estimate for villages with better road connectivity is 0.508 (=0.03+0.47). This is significant as indicated by the p-value for the test for this estimate given at the bottom of the panel. This implies that an additional new higher-level facility in these villages increases the probability of facility delivery by 8.5 (=0.508/6) percentage points.[34] The gap between the estimates for the two groups of villages is also statistically significant. The estimates based on the mother fixed effects model (Panel B) depict a very similar picture. These results suggest that neither having a good road only nor gaining a new facility only enhances delivery care utilization. In other words, road infrastructure and health facility network have an important complementary effect on maternal care demand. However, no such heterogeneous effect is found for the lower-level facility, which is not surprising as these basic clinics are likely to be built in every parish, and mothers can reach them without using the main roads.

Secondly, the heterogeneity in the impact of health facilities is analyzed by the initial availability of facilities. Since the government prioritized areas which did not have the level of health facilities specified under the guideline (such as at least one HCII in each parish and HCIII in each sub-county), it is likely to have provided relatively remote areas with the very first health facility of a certain level. Given that the distance to health facility is considered to be one of the major obstacles in utilizing maternal care (Table 1), it is likely that the impact of the first facility of a certain level is particularly large. However, if those remote areas also have relatively low demand for maternal care, the impact of the first facility might not be very large. In order to investigate this issue, we use the dummy variable indicating whether a sub-county had at least one public higher-level facility in 2002 - the initial year of the analysis period. The results are shown in Table 11, which clearly indicates the

[34] As discussed earlier, a new facility in a sub-county means one in six parishes. Thus, the number of facility per parish increases by 1/6 when a new facility opens. This leads to 0.085 (=0.508/6) percentage point increase in the outcome.

Table 10: Heterogeneity in the impact of access to health facilities on maternal care utilization in Uganda by road conditions: 2002-2012

Panel A: Sub-county fixed effects model	(1) 1 if delivery at a facility	(2) 1 if SBA at a facility	(3) 1 if SBA
Number of public higher-level facilities per parish	0.03	0.04	0.04
	(0.83)	(0.83)	(0.85)
Number of public lower-level facilities per parish	0.01	-0.04	-0.02
	(0.93)	(0.73)	(0.82)
Number of public higher-level facilities per parish	0.47**	0.36	0.35
× 1 if in village with better access to district town	(0.03)	(0.12)	(0.17)
Number of public lower-level facilities per parish	-0.21	-0.22	-0.24
× 1 if in village with better access to district town	(0.19)	(0.23)	(0.22)
Observations	1,860	1,860	1,860
R-squared	0.0320	0.0311	0.0367
Number of sub-counties	84	84	84
Effect of higher-level facilities in village with better access to district town	0.508	0.403	0.389
P-value	0.00656	0.0786	0.0946
Effect of lower-level facilities in village with better access to district town	-0.202	-0.262	-0.258
P-value	0.182	0.186	0.195

Panel B: Mother fixed effects model	(1) 1 if delivery at a facility	(2) 1 if SBA at a facility	(3) 1 if SBA
Number of public higher-level facilities per parish	0.08	0.15	0.13
	(0.61)	(0.38)	(0.40)
Number of public lower-level facilities per parish	0.10	0.11	0.14
	(0.36)	(0.34)	(0.18)
Number of public higher-level facilities per parish	0.40*	0.31*	0.27
× 1 if in village with better access to district town	(0.06)	(0.08)	(0.14)
Number of public lower-level facilities per parish	-0.20	-0.19	-0.24
× 1 if in village with better access to district town	(0.13)	(0.14)	(0.10)
Observations	1,531	1,531	1,531
R-squared	0.0346	0.0322	0.0362
Number of mothers	489	489	489
Effect of higher-level facilities in village with better access to district town	0.483	0.456	0.406
P-value	0.0168	0.0201	0.0456
Effect of lower-level facilities in village with better access to district town	-0.100	-0.0856	-0.100
P-value	0.391	0.516	0.474

Notes:
1) Robust p-values in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.
2) All regressions control for district-year interactions, age, age squared, parity dummies, dummies indicating the possession of land, livestock, and durables. For those households which have non-zero landholdings, livestock and/or durables, the amount of landholdings and/or the values of livestock and durables are included as well. The sub-county fixed effects models also control for the three dummies for maternal education and the altitude of household location.
3) See notes for Table 4 for the definition of the outcome variables and the number of observations.
4) Lower-level facilities include Health Center II (HCII), which does not provide full antenatal care nor delivery service. Higher-level facilities include the rest of the facilities which provide full antenatal care and delivery care.
5) Villages with better access to district town is defined as those villages where one can drive to the nearest district town in a dry season with less than the median time to get there. See the main text for details.

positive effect of higher-level facilities is concentrated in sub-counties which did *not* initially have that level of facilities (Columns 1-3). The coefficients for the uninteracted term are significant and comparable in magnitude to the results in Table 4. On the other hand, these effects are completely offset by the interacted term, resulting in the insignificant effects for sub-counties which initially had higher-level facilities (shown at the bottom of each panel). These results altogether suggest a substantial marginal effect of the very first higher-level facility. On the other hand, the impact of lower-level facilities is negative in those sub-counties which did not initially had a higher-level facility. It might be that mothers feel less need to travel to higher-level facilities (which are outside the sub-county) when a new lower-level facility starts operating nearby, even though it is not equipped enough to handle complication cases. This negative effect on delivery care use is not found in sub-counties that initially had a higher-level facility.

Thirdly, we have conducted a similar heterogeneity analysis by the initial availability of public lower-level health facilities. The results reveal a strong complementary effect on delivery care usage between pre-existing lower-level facilities and a new higher-level facility. The results based on the mother fixed effects model (Panel B, Table 12) indicates the positive effects of higher-level facilities are found only in the sub-counties which initially had a lower-level facility. The magnitude of the coefficient suggests, for instance, the probability of delivery at facilities increases by 9 percentage points (0.87 =0.522/6) when a new higher-level facility starts operating in sub-counties which initially had a lower-level facility. One possible interpretation is that existing lower-level facilities recommend local pregnant mothers, particularly those who are considered to have some risk of developing complications, to deliver at newly established higher-level facilities. On the other hand, sub-counties which did not have a lower-level facility does not indicate a significant change in the outcomes when a new higher-level facility opens. The results based on the sub-county fixed effects model (Panel A) are qualitatively similar.

Table 11: Heterogeneity in the impact of access to health facilities on maternal care utilization in Uganda by initial availability of higher-level facilities: 2002-2012

Panel A: Sub-county fixed effects model	(1) 1 if delivery at a facility	(2) 1 if SBA at a facility	(3) 1 if SBA
Number of public higher-level facilities per parish	0.46**	0.42**	0.41**
	(0.02)	(0.03)	(0.04)
Number of public lower-level facilities per parish	-0.25	-0.31*	-0.34**
	(0.17)	(0.07)	(0.05)
Number of public higher-level facilities per parish	-0.40	-0.44	-0.48*
× 1 if in sub-counties which initially had a higher-level facility	(0.15)	(0.10)	(0.08)
Number of public lower-level facilities per parish	0.22	0.24	0.30*
× 1 if in sub-counties which initially had a higher-level facility	(0.20)	(0.14)	(0.08)
Observations	1,860	1,860	1,860
R-squared	0.0305	0.0306	0.0371
Number of sub-counties	84	84	84
Effect of higher-level facilities in sub-counties which initially had a higher-level facility	0.0665	-0.0200	-0.0687
P-value	0.740	0.492	0.626
Effect of lower-level facilities in sub-counties which initially had a higher-level facility	-0.0282	-0.0676	-0.0453
P-value	0.749	0.927	0.753

Panel B: Mother fixed effects model	(1) 1 if delivery at a facility	(2) 1 if SBA at a facility	(3) 1 if SBA
Number of public higher-level facilities per parish	0.45**	0.47***	0.38**
	(0.02)	(0.01)	(0.02)
Number of public lower-level facilities per parish	-0.19	-0.19	-0.27**
	(0.22)	(0.21)	(0.04)
Number of public higher-level facilities per parish	-0.38	-0.41*	-0.34
× 1 if in sub-counties which initially had a higher-level facility	(0.13)	(0.10)	(0.15)
Number of public lower-level facilities per parish	0.27*	0.28**	0.39***
× 1 if in sub-counties which initially had a higher-level facility	(0.05)	(0.02)	(0.00)
Observations	1,531	1,531	1,531
R-squared	0.0326	0.0327	0.0375
Number of mothers	489	489	489
Effect of higher-level facilities in sub-counties which initially had a higher-level facility	0.0747	0.0607	0.0414
P-value	0.728	0.786	0.844
Effect of lower-level facilities in sub-counties which initially had a higher-level facility	0.0764	0.0892	0.123
P-value	0.438	0.382	0.196

Notes:
1) Robust p-values in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.
2) All regressions control for district-year interactions, age, age squared, parity dummies, dummies indicating the posession of land, livestock, and durables as well as the amount of landholdings and the values of livestock and durables for those households which have non-zero landholdings, livestock or durables. The sub-county fixed effects models also control for the three dummies for maternal education and altitude of the household location.
3) See notes for Table 4 for the definition of the outcome variables and the number of observations.
4) Lower-level facilities include Health Center II (HCII), which does not provide full antenatal care nor delivery service. Higher-level facilities include the rest of the facilities which provide full antenatal care and delivery care.
5) The initial availability of higher-level facilities is measured by whether a sub-county had at least one higher-level facility as in 2002, which is the initial year of the analysis period.

Turning to the results for the impact of lower-level facilities, the estimates again suggest the first facility in the locality matters. For example, based on the mother fixed effects model estimates (Panel B), a new lower-level facility increases the probability of delivery at facilities by 3.3 (=0.20/6) percentage points in sub-counties which did not initially have a lower-level facility, while there is no significant impact in sub-counties which had a lower-level facility (the effect is -0.0168 with the p-value of 0.862). The gap in the coefficients, -0.22, is also statistically significant. While lower-level facilities are not supposed to provide delivery service themselves, an interpretation for these results is that the first lower-level facility in a sub-county can provide information on nearby higher-level facilities and recommends mothers to deliver at formal facilities. The results for skilled birth attendance are qualitatively similar though the effects are less precisely estimated (Columns 2 and 3). This evidence for the large marginal effect of the first lower-level facility, coupled with the complementary effect between lower- and higher-level facilities, suggest that lower-level facilities play special roles in linking mothers with the national health system. In turn, the results underscore the importance of providing at least one facility suitable for the size of population, such as a clinic at a community level and a larger clinic or hospital at a larger administrative level.

6 Conclusion

This paper has investigated how the expansion of the national health facility network affects maternal care use, the patterns of travel to maternal care and the health of mothers and infants. Applying the sub-county and mother fixed effects models to the decade-long panel data from Uganda, we have demonstrated the improvement in access to public health facilities leads to increased maternal care use. In particular, an additional higher-level public health facility in a sub-county brings about a 7-percentage-point (13 percent) increase in the probability of delivery with SBA at a formal facility, instead of delivering at home surrounded by no medical professional. This is accompanied by

Table 12: Heterogeneity in the impact of access to health facilities on maternal care utilization in Uganda by initial availability of lower-level facilities: 2002-2012

Panel A: Sub-county fixed effects model	(1) 1 if delivery at a facility	(2) 1 if SBA at a facility	(3) 1 if SBA
Number of public higher-level facilities per parish	0.10	0.12	0.09
	(0.68)	(0.66)	(0.74)
Number of public lower-level facilities per parish	0.07	-0.00	0.01
	(0.57)	(0.98)	(0.92)
Number of public higher-level facilities per parish	0.33	0.25	0.29
× 1 if in sub-counties which initially had a lower-level facility	(0.31)	(0.43)	(0.36)
Number of public lower-level facilities per parish	-0.18	-0.14	-0.14
× 1 if in sub-counties which initially had a lower-level facility	(0.14)	(0.30)	(0.32)
Observations	1,860	1,860	1,860
R-squared	0.0305	0.0293	0.0351
Number of sub-counties	84	84	84
Effect of higher-level facilities in sub-counties which initially had a lower-level facility	0.433	0.375	0.384
P-value	0.0250	0.0925	0.102
Effect of lower-level facilities in sub-counties which initially had a lower-level facility	-0.113	-0.140	-0.125
P-value	0.158	0.0503	0.0534

Panel B: Mother fixed effects model	(1) 1 if delivery at a facility	(2) 1 if SBA at a facility	(3) 1 if SBA
Number of public higher-level facilities per parish	-0.18	-0.13	-0.22
	(0.48)	(0.66)	(0.47)
Number of public lower-level facilities per parish	0.20*	0.17	0.20
	(0.06)	(0.17)	(0.13)
Number of public higher-level facilities per parish	0.70***	0.66***	0.78***
× 1 if in sub-counties which initially had a lower-level facility	(0.01)	(0.01)	(0.00)
Number of public lower-level facilities per parish	-0.22**	-0.15	-0.14
× 1 if in sub-counties which initially had a lower-level facility	(0.02)	(0.16)	(0.22)
Observations	1,531	1,531	1,531
R-squared	0.0415	0.0369	0.0406
Number of mothers	489	489	489
Effect of higher-level facilities in sub-counties which initially had a lower-level facility	0.522	0.533	0.559
P-value	0.00340	0.845	0.558
Effect of lower-level facilities in sub-counties which initially had a lower-level facility	-0.0168	0.0190	0.0522
P-value	0.862	0.00135	0.000340

Notes:
1) Robust p-value in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.
2) All regressions control for district-year interactions, age, age squared, parity dummies, dummies indicating the posession of land, livestock, and durables as well as the amount of landholdings and the values of livestock and durables for those households which have non-zero landholdings, livestock or durables. The sub-county fixed effects models also control for the three dummies for maternal education and altitude of the household location.
3) See notes for Table 4 for the definition of the outcome variables and the number of observations.
4) Lower-level facilities include Health Center II (HCII), which does not provide full antenatal care nor delivery service. Higher-level facilities include the rest of the facilities which provide full antenatal care and delivery care.
5) The initial availability of higher-level facilities is measured by whether a sub-county had at least one lower-level facility as in 2002, which is the initial year of the analysis period.

an increase in the proportion of mothers who walk to delivery places, which cost less than other transportation modes such as a bus and a motorcycle taxi. Similarly, an additional lower-level public health facility raises the probability of regular antenatal care in every trimester, which is accompanied by the reduction in the probability of paying for transportation to antenatal care places. These results suggest the opening of new facilities induce mothers to use maternal care more often as they can reach facilities at lower travel costs than before within the same amount of time.

Furthermore, our heterogeneity analysis reveals the first facility of each level matters the most. That is, the effects of higher-level facilities on delivery at facilities and SBA use are concentrated in villages which did not have a higher-level facility in 2002, the initial year of the analysis period. Similarly, the openings of lower-level facilities significantly increase the probability of delivery at facilities only in villages which did not have a lower-level facility in 2002. Our heterogeneity analysis also demonstrate the complementary effect between lower- and higher-level facilities. That is, the effects of higher-level facilities on the delivery-related outcomes are particularly large in villages which initially had a lower-level facility. It is worth noting that lower-level facilities (clinics) neither provide full antenatal care nor handle deliveries. Therefore, the complementary effect of higher- and lower-level facilities and the large impact of the first lower-level facility on delivery-related outcomes suggest that lower-level facilities provide information on higher-level facilities and/or induce pregnant mothers, particularly those with the risk of complications, to deliver there.

These findings demonstrate differential roles played by community-based clinics and more equipped facilities. Namely, accessible higher-level facilities increases the utilization of professional delivery services, which is suggested by the medical literature to reduce maternal mortality. On the other hand, accessible community-level facilities function as the place to have regular contact with health practitioners and connect pregnant mothers and higher-level facilities. These results in turn underscore the importance of universal coverage of health facilities which ensures each locality to have at least

one facility suitable for its population size (such as a clinic in each community and a hospital in each district). They further highlight the critical roles that lower-level facilities play in linking pregnant mothers with the national health service network. Since the effects of higher-level facilities are limited in areas which did not initially had a lower-level facility, it implies that it is important for those areas to disseminate information on new higher-level facilities in order to promote the utilization of the facilities. Lastly, the complementary effects are also found between health and road infrastructure. As higher-level facilities are likely to be located outside rural villages, their effects on the delivery-related outcomes are limited to villages with good road connections to the nearest district towns. This suggests the importance of road infrastructure in making existing or new health facilities accessible to rural populations.

Our study however is not free from limitations. Most likely due to small sample size and limited data, we do not find a robust and meaningful effect of health facilities on maternal (measured by the probability of complications during delivery) and infant health (the subjectively evaluated body size and birth weight). Investigating the impact of facilities on maternal and infant health using a larger and more objective indicators would be a fruitful future study. Furthermore, it would deepen our knowledge on the benefits of the national health facility network if the impact of the proximity to health facilities is further examined based on the data on the distance to the nearest facility, instead of the availability of health facilities within a local administrative area.

References

Avdic, D. (2016). Improving efficiency or impairing access? health care consolidationand quality of care: Evidence from emergency hospital closures in sweden. *Journal of Health Economics*, 48:44–60.

Bazzoli, G. J., Lee, W., Hsieh, H.-M., and Mobley, L. R. (2012). The effects of safety nethospital closures and conversions on patient travel distance tohospital services. *Health Services Research*, 47(1):129–150.

Beckett, M., Vanzo, J. D., Sastry, N., Panis, C., and Peterson, C. (2001). The quality of retrospective data: An examination of long-term recall in a developing country. *Journal of Human Resources*, 36(3):593–625.

Bertrand, M., Duflo, E., and Mullainathan, S. (2001). How much should we trust differences-in-differences estimates? *Quarterly Journal of Economics*, 119(1):249–275.

Bindman, A. B., Keane, D., and Lurie, N. (1990). Public hospital closes: Impact on patients' access to care and health status. *Journal of American Medical Association*, 264(22):2899–2904.

Buchmueller, T. C., Jacobson, M., and Wold, C. (2006). How far to the hospital?: The effect of hospital closures on access to care. *Journal of Health Economics*, 25(4):740 – 761.

Burnham, G. M., Pariyo, G., Galiwango, E., and Wabwire-Mangen, F. (2004). Discontinuation of cost sharing in uganda. *Bulletin of the World Health Organization*, 82(3):187–195.

Campbell, O. M. R. and Graham, W. J. (2006). Strategies for reducing maternal mortality: getting on with what works. *Lancet*, 368:1284–99.

Chaudhuri, A. (2008). Revisiting the impact of a reproductive health intervention on children's height-for-age with evidence from rural bangladesh. *Economic Development and Cultural Change*, 56(3):619–659.

Currie, J. and Reagan, P. B. (2003). Distance to hospital and children's use of preventive care: Is being closer better, and for whom? *Economic Inquiry*, 41(3):378–391.

Do, M. (2009). Utilization of skilled birth attendants in public and private sectors in vietnam. *J.Biosoc*, 41(3):289–308.

Fauveau, V., Stewart, K., Khan, S., and Chakraborty, J. (1991). Effect on mortality of community-based maternity-care programme in rural bangladesh. *Lancet*, 9.

Filippi, V., Ronsmans, C., Campbell, O. M. R., Graham, W. J., Mills, A., Borghi, J., Koblinsky, M., and Osrin, D. (2006). Maternal health in poor countries: the broader context and a call for action. *Lancet*, 368:153541.

Frankenberg, E., Buttenheim, A., Sikoki, B., and Suriastini, W. (2009). Do Women Increase Their Use of Reproductive Health Care When It Becomes More Available? Evidence from Indonesia. *Studies in Family Planning*, 40(1):27–38.

Frankenberg, E., Suriastini, W., and Thomas, D. (2005). Can expanding access to basic healthcare improve children's health status? lessons from indonesia's 'midwife in the village' programme. *Population Studies*, 59(1):5–19.

Frankenberg, E. and Thomas, D. (2001). Women's health and pregnancy outcomes: Do services make a difference? *Demography*, 38(2):253–265.

Gage, A. J. and Calixte, M. G. (2006). Effects of the physical accessibility of maternal health services on their use in rural haiti. *Population Studies*, 60(3):271–288.

Hashemi, A. and Salehi-Isfahani, D. (2013). From health service delivery to family planning: The changing impact of health clinics on fertility in rural iran. *Economic Development and Cultural Change*, 61(2):281 – 309.

Joshi, S. and Schultz, P. (2007). Family planning as an investment in development: Evaluation of a programs consequences in matlab, bangladesh. *Yale University Economic Growth Center Discussion Paper*, 951.

Lagarde, M., Haines, A., and Palmer, N. (2007). Conditional cash transfers for improving uptake of health interventions in low- and middle-income countries: A systematic review. *Journal of American Medical Association*, 298(16):1900–1910.

Lu, Y. and Slusky, D. J. G. (2016). The impact of womens health clinic closures on preventive care. *American Economic Journal: Applied Economics*, 8(3):100124.

Ministry of Health (1999). The national health policy. Uganda.

Ministry of Health (2000). Health sector strategic plan: 2000/01 2004/05. The Republic of Uganda.

Ministry of Health (2005). Health sector strategic plan ii: 2005/06 2009/2010, vol.1. The Republic of Uganda.

Ministry of Health (2010a). Health sector strategic plan iii: 2010/11-2014/15. The Government of Uganda.

Ministry of Health (2010b). The second national health policy: Promoting people's health to enhance socio-economic development. Uganda.

Nguyen, H. T., Hatt, L., Islam, M., Sloan, N. L., Chowdhury, J., Schmidt, J.-O., Hossain, A., and Wang, H. (2012). Encouraging maternal health service utilization: An evaluation of the bangladesh voucher program. *Social Science and Medicine*, 74:989–996.

Overbosch, G., N.N.N. Nsowah-Nuamah, G.J.M. Van den Boom, and Damnyag, L. (2004). Determinants of antenatal care use in ghana. *Journal of African Economies*, 13(02):277–301.

Pitt, M. M., Rosenzweig, M. R., and Gibbons, D. M. (1993). The determinants and consequences of the placement of government programs in indonesia. *The World Bank Economic Review*, 7(3):319–348.

Powell-Jackson, T. and Hanson, K. (2012). Financial incentives for maternal health: Impact of a national programme in nepal. *Journal of Health Economics*, 31:271 284.

Ronsmans, C. and Graham, W. J. (2006). Maternal mortality: who, when, where, and why. *Lancet*, 368:1189–200.

Rosenzweig, M. R. and Wolpin, K. I. (1982). Governmental interventions and household behavior in a developing country: Anticipating the unanticipated consequences of social programs. *Journal of Development Economics*, 10(2):209–225.

Ruecker, G., Park, S., Ssali, H., and Pender, J. (2003a). Community resource mapping for regional land quality assessment in uganda: A methodology documentation paper. *ZEF-Documentation of Research*, 1.

Ruecker, G., Park, S., Ssali, H., and Pender, J. (2003b). Strategic targeting of development policies to a complex region: A gis-based stratification applied to uganda. *ZEF-Discussion Papers On Development Policy*, 69.

Sabine, G. and Oona, C. (2009). Still too far to walk literature review of the determinants of delivery service use. *BMC Pregnancy & Childbirth*, 9(34).

Thaddeus, S. and Maine, D. (1994). Too far to walk: maternal mortality in context. *Social Science & Medicine*, 38(8):1091–1110.

UDHS (2012). Uganda Demographic and Health Survey 2011.

Valente, C. (2014). Access to abortion, investments in neonatal health, and sex-selection: Evidence from nepal. *Journal of Development Economics*, 107(0):225 – 243.

Vieira1, C., Portela, A., Miller, T., Coast, E., Leone, T., and Marston, C. (2012). Increasing the use of skilled health personnel where traditional birth attendants were providers of childbirth care: A systematic review. *PLoS ONE*, 7(10):e47946.

WHO (1999). Reduction of maternal mortality a joint who unfpa unicef world bank statement. Geneva.

WHO (2004). Making pregnancy safer : the critical role of the skilled attendant : a joint statement by WHO, ICM and FIGO. Geneva.

WHO (2014). Trends in maternal mortality: 1990 to 2013, estimates by who, unicef, unfpa, the world bank and the united nations population division, executive summary.

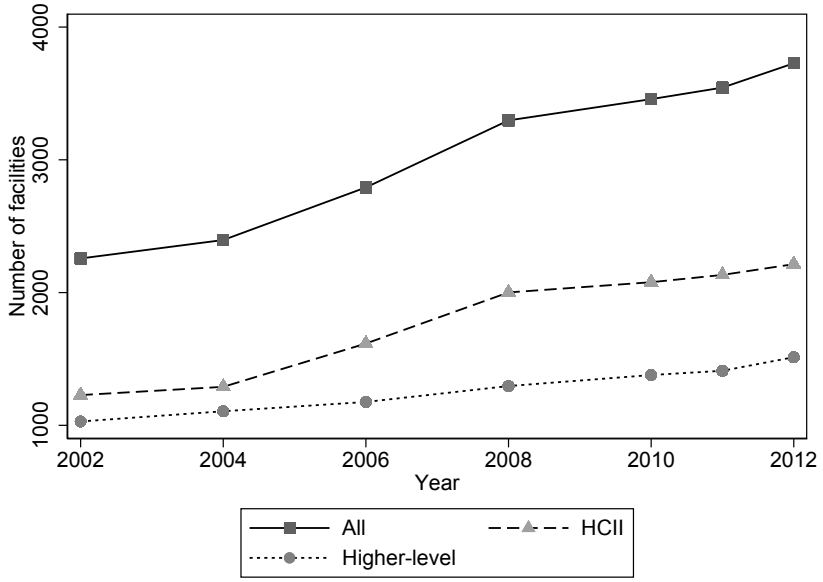
Wilde, E. T. (2013). Do emergency medical system response times matter for health outcomes? *Health Economics*, 22:790806.

Yamano, T., Sserunkuuma, D., Otsuka, K., Omiat, G., Ainembabazi, J. H., and Shimamura, Y. (2004). The 2003 repeat survey in uganda: Results. *FASID Development Database*.

Yanagisawa, S., Oum, S., and Wakai, S. (2006). Determinants of skilled birth attendance in rural cambodia. *Tropical Medicine & International Health*, 11(2):238–251.

Appendix

Figure A1: The total number of health facilities in Uganda excluding the capital city (Kampala): 2002-2012



Source: The Health Facility Inventory 2002, 2004, 2006, 2008, 2010, 2011 and 2012
Notes: Facilities are divided into Health Center II (HCII) and the rest of the facilities including Health Centers III, IV, and V. HCII is expected to cover a parish, while HCIII is to cover a sub-county. HCIV and HCV cover a county and district, respectively. While HCII does not provide full maternity care, all the other types of HCs provide it.

Table A1: Correlation between attrition and the level and changes in the number of health facilities in Uganda (2002-2012)

	(1) Number of higher-level facilities per parish in 2002	(2) Number of lower-level facilities per parish in 2002	(3) Change in the number of higher-level facilities per parish between 2002 & 2012	(4) Change in the number of lower-level facilities per parish between 2002 & 2012
1 if attrit	-0.00	0.02	-0.01	-0.04
	(0.01)	(0.02)	(0.01)	(0.03)
Constant	0.20***	0.19***	0.08***	0.26***
	(0.01)	(0.02)	(0.01)	(0.02)
Number of mothers	605	605	605	605
R-squared	0.00	0.00	0.00	0.00

Notes:
1). Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
2). The attrition indicator takes the value of one if a woman found in the 2005 survey is not found in the 2012 survey. Changes in the number of health facilities per parish is the changes between 2002 and 2012.

Table A2: Impact of access to health facilities on maternal care utilization in Uganda: 2002-2012
Robustness test with the missing access values filled with pre-determined data

Panel A: OLS model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	0.17	0.24*	0.26*	0.22
	(0.15)	(0.09)	(0.06)	(0.12)
Number of public lower-level facilities per parish	0.03	-0.08	-0.07	-0.10
	(0.68)	(0.32)	(0.36)	(0.16)
Observations	1,081	1,860	1,860	1,860
R-squared	0.22	0.29	0.26	0.26
Panel B: Sub-county fixed effects model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	-0.08	0.35**	0.30*	0.31*
	(0.76)	(0.05)	(0.09)	(0.09)
Number of public lower-level facilities per parish	0.05	-0.09	-0.11	-0.09
	(0.62)	(0.28)	(0.20)	(0.28)
Observations	1,081	1,860	1,860	1,860
R-squared	0.0507	0.0289	0.0283	0.0335
Number of sub-counties	82	84	84	84
Panel C: Mother fixed effects model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	0.02	0.48***	0.46***	0.48***
	(0.87)	(0.01)	(0.00)	(0.00)
Number of public lower-level facilities per parish	0.17**	0.03	0.04	0.08
	(0.05)	(0.73)	(0.65)	(0.34)
Observations	888	1,531	1,531	1,531
R-squared	0.0326	0.0310	0.0289	0.0301
Number of Mothers	321	489	489	489

Notes:
1). Robust t-statistics in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.
2). All regressions control for age, age squared, parity dummies, dummies indicating the possession of land, livestock, and durables. For those households which have non-zero landholdings, livestock and/or durables, the amount of landholdings and/or the values of livestock and durables are included as well. The sub-county fixed effects models also control for the three dummies for maternal education, the altitude of household location, and district-year interactions. The mother fixed effects models also control for district-year interactions (Columns 2-4) or region-year interactions (Column 1).
3). See the notes for Table 4 for the definition of the variables.

Table A3: Impact of access to health facilities on maternal care utilization in Uganda: 2002-2012
Robustness test with the missing access values filled with future data

Panel A: OLS model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	0.21*	0.21	0.24*	0.21
	(0.08)	(0.16)	(0.10)	(0.17)
Number of public lower-level facilities per parish	0.02	-0.08	-0.07	-0.10
	(0.74)	(0.29)	(0.36)	(0.16)
Observations	1,081	1,860	1,860	1,860
R-squared	0.22	0.29	0.26	0.26
Panel B: Sub-county fixed effects model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	0.18	0.31***	0.28*	0.26*
	(0.67)	(0.01)	(0.05)	(0.10)
Number of public lower-level facilities per parish	0.05	-0.02	-0.07	-0.07
	(0.63)	(0.76)	(0.41)	(0.38)
Observations	1,081	1,860	1,860	1,860
R-squared	0.0504	0.0270	0.0271	0.0330
Number of sub-counties	82	84	84	84
Panel C: Mother fixed effects model	(1) 1 if regular antenatal care	(2) 1 if delivery at a facility	(3) 1 if SBA at a facility	(4) 1 if SBA
Number of public higher-level facilities per parish	0.25	0.23	0.27*	0.24
	(0.20)	(0.11)	(0.09)	(0.14)
Number of public lower-level facilities per parish	0.14	0.03	0.04	0.05
	(0.11)	(0.70)	(0.65)	(0.57)
Observations	888	1,531	1,531	1,531
R-squared	0.0286	0.0231	0.0236	0.0263
Number of mothers	321	489	489	489

Notes:
1). Robust t-statistics in parentheses. Standard errors clustered at sub-county level. Significance level: *** p<0.01, ** p<0.05, * p<0.1.
2). All regressions control for age, age squared, parity dummies, dummies indicating the possession of land, livestock, and durables. For those households which have non-zero landholdings, livestock and/or durables, the amount of landholdings and/or the values of livestock and durables are included as well. The sub-county fixed effects models also control for the three dummies for maternal education, the altitude of household location, and district-year interactions. The mother fixed effects models also control for district-year interactions (Columns 2-4) or region-year interactions (Column 1).
3). See the notes for Table 4 for the definition of the variables.