Abstract

Determining whether power outages have significant fertility effects is an important policy question in developing countries, where blackouts are common and modern forms of family planning scarce. Using birth records from Zanzibar, this paper shows that a 2008 month-long blackout caused a significant, 20% increase in the number of births eight to ten months later. The increase is similar across villages that had electricity, regardless of the level of electrification, while villages with no electricity connections saw no changes in birth numbers. Household surveys confirm that people were more likely to consume their leisure inside the home during the blackout, but time use shifts are unlikely to be the sole drivers of the fertility change. While it is unclear whether the baby boom is likely to translate to a permanent increase in the population, the paper highlights an important hidden consequence of power instability in developing countries. It also shows evidence that electricity imposes significant externality effects on those populations that have little exposure to it.

JEL Classification: J13, J22, O15.

Keywords: Africa, Blackouts, Electricity, Fertility.

Mji hapa sasa! (Now there’s a town here!)

-Hija’s response to the street lighting in Uroa, as recounted by Tanja Winthers (Winthers, 2008)

1 Introduction

In rural communities in Africa and elsewhere, electricity can be transformational. Aside for the many economic and social benefits (Dinkelman, 2011), it allows for light bulbs to illuminate a street, or a television to be turned on in the main square; the possibilities for
nighttime activities outside the house grow in scope and number. Yet, often it goes hand in hand with power instability and frequent blackouts. Those lucky enough to have access to electricity often find that access rationed, unstable and erratic. For those who rely on electricity for work, outages and rationing create uncertainty and income loss. In addition, as this paper demonstrates, when outages happen they can also lead to more births.

The idea that procreation increases when the lights go out is a widely held belief that has rarely been empirically examined. It is a particularly important and relevant question within developing countries where there is more frequent power instability and significant barriers to accessing contraception. In Africa, low rates of contraceptive use make it more likely that unexpected, blackout-induced sexual activity translates to additional births. These short-run increases in births could strain some health and neonatal services, and might even translate to permanent increases in the population if mothers do not adjust their subsequent fertility plan. Yet, an opposite argument can be made. In parts of Africa where few have electricity connections, few are directly impacted, so power outages should have only small fertility effects.

In this paper, we provide evidence that power outages do increase short-run fertility, even in areas where few have electricity. The evidence comes from a particular blackout—a month-long power outage affecting the entire island of Zanzibar in Tanzania, between May and June of 2008. To document the implications of this event, we constructed a panel database of community-level births from maternity ward birth records for most villages and towns of Zanzibar, covering a period of two and half years. Using this data, we show that the communities in the sample experienced a remarkable 20% increase eight to ten months after the event. In addition, we further show that the increase in births happened, as expected, only in communities that had some electricity. In other words, villages that were not electrified did not experience a baby boom. Surprisingly, however, the increase was remarkably similar across all levels of electrification. Such a result can be accounted for in the presence of significant externalities from the blackout, affecting the fertility outcomes of women who do not have electricity at home.

To provide further insights on the mechanism, we use data from a time use survey carried out five months after the event to suggest that the blackout affected time use patterns. In particular, the blackout caused an average increase in the amount of time spent inside the

---

1The idea gained traction in the United States after a one-day blackout hit the northeast in 1965 and several hospitals reported more births nine months later (Udry, 1970). The same questions arose following the New York City blackout of 1975 and the northeast blackout of 2003 (Pollack, 2004).

2In sub-Saharan Africa, lifetime fertility is influenced by delays in first pregnancy and birth spacing (United Nations, 2009); anticipating a birth without adjusting birth spacing could thus lead to one more child in a woman’s reproductive lifetime.
home. A simple descriptive regression of time use indicates that the pre-existing amount of electricity in the community was correlated with time use changes, with men spending more time at home the higher the electricity coverage. Interestingly, those living in villages with little electricity did not change their routines. Given that the fertility shock was equally felt in areas with little electricity, this suggests that the effect may not be driven by changes in the allocation of time, but other factors such as boredom or other changes in the perceived quality of that time.

Power instability is a significant problem in sub-Saharan African and elsewhere. Cities like Lagos in Nigeria have constant power cuts, and even places where service has historically been considered reliable have been in the news for intermittent power or power outages lasting weeks or months, including Addis Ababa, Nairobi, Dar es Salaam, and Johannesburg. If blackouts increase births, even an isolated and short lived event—like the two day blackout that affect 600 million Indians in July 2012—could have significant population implications simply by the sheer number of impacted individuals (BBC, 2012). Importantly, while blackouts in capital cities make news, a significant amount of power outages are taking place in rural areas where a small fraction of the population is connected to the grid and where electricity is imported from a single single power line. While there is no hard data to measure the extent of power failures in rural areas, they might happen with some frequency: In 2008, for instance, local newspapers reported a 3 week long blackout in the Mtwarra region on Tanzania. In early 2010, Zanzibar reportedly fell into a new and even more serious blackout that lasted three months. While marginal from the point of view of electricity consumption, blackouts in these areas have as severe of a consequence for births as blackouts in more central areas—a point that is not necessarily lost among Africans.

In addition to contributing to the literature on the social impacts of infrastructure (such as Pande and Duflo, 2007, and Dinkelman, 2011), the paper contributes to the study of fertility responses to aggregate shocks. The existing literature focuses on natural events: Pörtner (2008) studies the effects of hurricanes on fertility in Guatemala; he finds that hurricane risk increases fertility, while hurricane events diminish it. Evans, Hu and Zhao (2010) also studied the effect of hurricanes on fertility, finding that the response varied depending on the severity of the hurricane advisory. They hypothesize that hurricanes affect the opportunity cost of procreation, possibly through the allocation of time at home. In contrast, this paper shows the effect of man-made shocks. Moreover, because it contains household-level data on time use, it provides additional insights on the possible reasons for

3In 2009, for instance, then Uganda Planning Minister Ephraim Kamuntu commented that the frequency of electricity shortages was causing too many births (BBC, 2009)
4Within the development literature on blackouts, see Adenkinji (2003) for its effects on firm-level outcomes in Nigeria.
a fertility increase, including the effect of changes in time spent at home.

The rest of the paper proceeds as follows. Section 2 provides some background information, with a brief overview of the blackout in subsection 2.2 and a discussion of the effects on time use in subsection 2.3. Sections 3 to 5 provide a conceptual framework, a description of the data, and the estimation strategy. Results are presented in section 6, and section 7 provides the concluding remarks.

2 Background information

2.1 Leisure and electricity in Zanzibar

Like many other places in the developing world, electricity coverage in Zanzibar is quite uneven, with some areas having high coverage, and other areas with low or no coverage. In part this is driven by the slow process of electrification in rural areas: The Rural Electrification Project (RUREL) began in 1984, with sixty four villages electrified between 1984 and 1991. A second phase, completed by 2006, added 77 villages, both in Zanzibar and the secondary island of Pemba. Once a community has access to power, private households need to be able to pay for a hookup to their dwelling. This can be difficult or costly for those dwelling further away from the electric lines, and so the process of village electrification is gradual and often slow.

Figure 1 provides a scatterplot of the estimated electricity coverage in 2002 and 2007 for communities surveyed both in the 2002 census and the 2007 Labor Force Survey (described below). Between these two dates most locations improved their electricity coverage, with several rural villages receiving electricity for the first time. The figure also overlays a frequency weighted local polynomial smoothed regression. Clearly, most villages either maintained or improved their coverage of electricity; the regression line has an average slope that is very close to 45 degrees, which implies that average improvements in electrification are similar (approximately 14%) for villages at all levels of 2002 coverage.

Electricity plays an important but complicated role in Zanzibari society. Aside from its impact to households who are able to add a television set, an electric lightbulb, or some other appliance, electrification dramatically changes the set of amenities available in public spaces. Electric lights are often installed on meeting places (baraza) where adults meet after dusk; outdoor televisions appear in those public places, and are then switched on for the screening of evening news, soccer matches, or soap operas.

5See Winther (2008) for a rich and very enjoyable anthropological study of the impact of electricity in rural communities in Zanzibar.
substantial externality effects on the quality of leisure time available, even among those who do not have it installed at home. As the proportion of citizens with a private provision of electricity increases and people acquire private televisions, some of the outdoor activities move back to the private sphere.  

2.2 The 2008 blackout

The Zanzibar blackout started on May 21, 2008 at approximately 10 p.m. and lasted until June 18; it was caused by an accidental break in the undersea cable that connects the Zanzibar island substation with the electricity generators on mainland Tanzania (for more details on the blackout, see Burlando [2012]). The event was the longest recorded time without power in Zanzibar’s history to that point. The event caused economic damage: those employed in occupations using electricity reported a steep drop in earnings and hours worked, and birth weights of children conceived before or around the blackout fell significantly (Burlando, 2012). The power outage only marginally affected other aspects of daily life: it had no impact on work and earnings of households engaged in activities not relying on electricity, little to no effect on consumer good prices, did not cause significant public health problems, and –given that the great majority of the population does not make significant use of electric cookers, fridges, air conditioners, and other domestic electric appliances–it had little impact on cooking patterns.

2.3 Blackouts effects on time use

Since time use seems to be an important factor in short-term fluctuations in fertility (Evans et al, 2010), it is useful to see how the blackout affected leisure activities. In principle, it is likely that both quality and quantity of disposable time increased during this period. We would expect some variation in the response that depends on whether a household is directly affected by the blackout (if work depends on electricity, or if the home is connected to the grid). For those workers temporarily displaced by the blackout, the decrease in work hours would have caused an increase of time spent at home, other things equal. For those with domestic electricity, the reduction in domestic amenities–for instance, the sudden lack of television programming–might lead them to find alternative activities elsewhere. On the

---

6It should be noted that there is an extensive literature on the impact of televisions on fertility. Jensen and Oster (2010) and La Ferrara et al. (2012) provide some evidence that television programming reduce fertility. They both suggest that television programming provides information about outside social norms, including smaller family sizes.

7Burlando (2012) also discusses some aggregate fertility effects, and does not study the impact of village electricity on fertility.
other hand, the lack of outdoor lighting in the evenings heightened fears of thieves and home intrusions, and the usual response in those cases is to remain inside the home to protect valuable assets such as electric appliances from theft, or to avoid interactions with the rest of the community at a time of distress. In addition, every member of a community is potentially subject to an indirect effect. Lacking private or public sources of lighting, darkness enveloped towns immediately after dusk, at approximately 6 in the afternoon; together with the darkening of television screens, this discouraged public gatherings. It is reasonable to presume that this indirect or externality effect is more pronounced in places where public gatherings are important, that is in communities where few have televisions or electric connections.

To make some sense of the possible effects on time utilization, we use some data from a time use survey that documented the changes in time use during the blackout (the data is described in appendix A) on 664 individuals living in parts of Zanzibar with varying degrees of electrification. In the survey, we observe time use for each respondent in two periods: the month before the blackout, and during the blackout. Figure 2 shows the average percentage change in time use for five broad categories of time use: work, leisure outside the home, leisure at home, housework, and sleep. On average, work hours (which is often an outside of home activity) declined, and so did time spent outside of the home. Domestic leisure, on the other hand, increased by an average of 4% for men and over 9% for women. Sleep and housework patterns did not vary much for either group. The time use evidence is thus consistent with more time at home, as a possible source of a fertility increase. The blackout caused a reduction of time spent outside the domestic domain, and an increase in time spent in the domestic domain.

To see how these changes in habits depend on the direct and indirect exposure, appendix table 1 regresses the change in leisure on various measures of electricity. Let the amount of leisure time spent at home (net of sleeping or housework) for person \(i\) in community or village \(v\) be \(l_{tic}\). The effect of exposure to the blackout on the change in log leisure hours during the blackout period for person \(i\), \(\Delta(\log l_{iv})\), is:

\[
\Delta(\log l_{iv}) = \alpha_1 D_E{iv} + \alpha_2 W_E{iv} + \alpha_3 V_E{v} + X_{iv} \beta + \omega_{ic} \tag{1}
\]

The model here measures whether individuals connected to the grid (having domestic electricity, \(D_E\)) or whose jobs depend on electricity (\(W_E\)) responded differently to the blackout relative to the rest. The variable \(V_E\) measures the percentage of the village with

\[8\text{Aside for their monetary value, domestic electric appliances have the added value of conferring social status to a family in rural Zanzibar (Withers, 2008); as valuable assets, they are owned by the husband and are often received as wedding gifts.}\]
an electricity connection at the time of the 2002 census (described below). Absent other unobservable characteristics, the coefficient $\alpha_3$ should capture the net spillover effect of the electrification rate on time use. In practice, this coefficient might capture the effect of other confounding variables that are correlated with the electrification rate. The matrix $X_{iv}$ includes other possible work/leisure shifters, including ownership of domestic leisure substitutes (such as radios, which are generally battery-powered), participation in social and religious activities (participation in ROSCAS, in other community groups, and regular fasting), and other household and individual characteristics which could be correlated with the shape of the utility function with respect to leisure (age, education, family size, wealth).

Columns 1 and 5 estimates only the coefficients $\alpha_1$ and $\alpha_2$ for men and women separately. Those connected to the electric grid report a larger increase in their time spent at home, with the effect being statistically significant for men only. Perhaps surprisingly, controlling for domestic electricity use, there is no additional effect of working with electricity for neither men nor women.

Columns 2 and 6 introduce the percentage of the village that had electricity at the time of the 2002 census. The coefficient on overall village electricity is substantially correlated with men’s leisure time. Thus, either the lack of electricity exhibits externality effects that increase with the electrification rate, or communities with more electricity are different for other reasons. This effect is not present for women, whose domestic time use does not vary consistently with electricity. As a caveat, the sample size of communities is small, as only 19 communities were part of the sample.

To further explore the relationship between own leisure time and the degree of electricity in the community, columns 3 and 7 introduce a measure of electricity presence in the immediate neighborhood. Each household in the questionnaire was asked how many of the 10 closest neighbors had electricity; denoting by $x_{-i}$ the answer to this question and by $x_i$ whether the respondent has electricity, the measure “percentage immediate neighborhood with electricity” is computed as $\frac{x_{-i} + x_i}{11}$. The addition of this measure does not change the main results: what seems to matter is the overall level of electrification of the community for men, while for women there is no effect. Finally, columns 4 and 8 drops observations from villages without electricity. While these absorb the village electrification variable and help increase the amount of variance explained by the regression, they do not change the

---

9 As a clarifying example, suppose that the amount of electricity is correlated with social capital in the community, with more electrified communities having a lower level of social capital. These communities may be less likely to “come together”, with more people deciding to stay at home during the crisis.

10 In light of cultural practices, this might not be too surprising. Men have more leeway in deciding how to allocate their leisure time, and thus might be more sensitive to the quality of out-of-home leisure activities. Women’s time is more centered around the home, with time spent outside often needing to be justified to the spouse.
estimated coefficients much from the previous two specifications.

The patterns of time use changes reveal that a possible pathway between power outages and fertility is the increase in domestic leisure. However, other aspects (quality of time use, boredom, preferences over fertility, etc.) could also play a role; we introduce these other elements in the conceptual framework below.

3 Conceptual framework

How should we expect blackouts to affect pregnancy rates? In general, blackouts are transitory and have no impact on future employment, wages, child survival, or other long-term household or child characteristics. If fertility is fully determined by these characteristics, we would expect power failures to have an impact on births through a “harvesting effect”, in which planned future births are brought forward in time without changing lifetime fertility rates. Alternatively, blackouts could also increase unplanned pregnancies by increasing the rate of unprotected sex in the population. This would require that blackouts reduce the opportunity cost of procreation—perhaps by increasing the amount of time available for sex, or by decreasing the overall quality of time devoted to alternative activities.

Assuming that these short term effects are present, it still remains to be explained how they should be correlated with electricity coverage in a community. The answer depends in part on the extent to which spillovers from the blackout affect pregnancies. To fix ideas, suppose that the short-term probability of a pregnancy that results in a child $C$ from a couple $i$ living in village or community $v$ (with a total $N_v$ couples) is a function of quantity and quality of time, and let that function be the following reduced form equation:

$$C_{iv} = c(t(e_i, E_v), q(e_i, E_v); \xi_i, \xi_v).$$

(2)

We thus assume that the procreation function $c(t, q)$ is a function of time spent at home, $t$, and the overall quality of non-work time $q$. This probability is also a function of many other observed and unobserved characteristics of the couple, such as their preferences over children and access to family planning, as well as other community-level characteristics (such as social norms or the extent of alternative leisure activities). We summarize these observed and unobserved variables with the terms $\xi_i$ and $\xi_v$, and for simplicity we assume that they do not influence the shape of the functions $t$ and $q$.\[^{11}\]

The blackout affects the quantity and quality of time in two ways. First, it affects the household through their direct exposure to electricity, $e_i \in \{0, 1\}$. This exposure originates

\[^{11}\]Alternatively, we could write $t_{iv}$ and $q_{iv}$.
in households whose dwellings or whose jobs depend on electricity \((e = 1)\), and is absent for those who do not have electricity at home or work \((e = 0)\). Second, it affects all households through the spillover effect from all those with electricity to the rest of the community, \(E_v = \sum_j e_j\). These spillover effects include the shutting down of power in common areas, the darkening of streets, the heightened fear of theft, or just the reduction in economic activity in the community. A blackout is a shock that, in the simplest terms, eliminates electricity, i.e. \(E_v = e_i = 0\). With a slight abuse of notation, we estimate the effect of this shock on fertility by differentiating the \(C\) function with respect to \(E_v\):

\[
\frac{\partial C_i}{\partial E_v} = \frac{\partial c}{\partial t} + \frac{\partial c}{\partial q} \left\{ \frac{\partial q}{\partial E_v} + \frac{\partial q}{\partial e_i} \frac{\partial e_i}{\partial E_v} \right\}.
\]

(3)

The first term in equation (3), \(\partial c/\partial t_i\), is the effect of time spent at home on fertility. We do not get to observe this term directly; presumably, it is either positive or (if time at home does not affect frequency of unprotected sex) zero. Inside the parenthesis is the effect of the direct and indirect electricity shock on time use; from the discussion in section 2.3, the coefficient should be negative; that is, a reduction in electricity leads to an increase in domestic time use. From this channel, then, we expect a non-negative response of fertility to the blackout. The last term in equation (3) indicates the effect of quality of time on procreation, multiplied by the effect of the blackout on this quality of time. We cannot empirically observe these terms; however, as explained in the previous section, the blackout did worsen the quality of time. In that case, this (unobserved) term would indicate that the fertility effect through the quality channel is positive if boredom aids procreation, and negative if it hinders it.

To bring this model to the data, totally differentiate the community-level birth function \(C_v = \sum_{i=1}^{N_v} C_{iv}\). After applying (3) and manipulating the equation, we get that

\[
\frac{\partial C_v/\partial E_v}{N_v} = \left[ \frac{\partial c}{\partial t} + \frac{\partial c}{\partial q} \right] E_v + \frac{\partial c}{\partial t} \frac{\partial E_v}{\partial e_i} + \frac{\partial c}{\partial q} \frac{\partial E_v}{\partial e_i} = \alpha_1 E_v + \alpha_2(E_v),
\]

(4)

that is, the short term increase in the fertility rate is a function of direct effects (summarized by \(\alpha_1\)) and indirect spillover effects (summarized by \(\alpha_2(E_v)\)). Note that the direct effect is an increasing function of the village electrification rate if \(\partial c/\partial t\) or \(\partial c/\partial q\) are nonnegative, whereas the indirect effect has a (possibly nonlinear) relationship, which is equal to zero if there are no spillover effects from electrification.

Equation (4) generates one testable prediction: as \(E_v \to 0\), the predicted increase in fertility is given by \(\alpha_2(0)\). That is, a (local) externality effect can be measured by looking at
the fertility increase in villages with very low levels of electricity. As $E_v$ increases (through work or domestic use of electricity), the direct effect becomes more important, while arguably the indirect effect $\alpha_2(E_v)$ has a reduced impact on procreation, as the externality effect may be less important.

Finally, the shape of the function $C$ might be affected by unobserved characteristics $\xi_i$ and $\xi_v$, which might systematically vary by the degree of electrification in a community. For instance, residents of areas with higher electricity coverage might have better access to family planning, or have a lower demand for children.

4 Data

We estimate community-level fertility rates through birth records from the Mnazi Mmoja maternity ward in Zanzibar, which delivers approximately 25% of all births in the island. Records from the maternity ward were collected in July 2009, and cover the period between January 2007 (one year and 4 months prior to the blackout) until May 2009 (11 months after the end of the event). The records include the date of birth (but not date of conception) of the child, and the name, home town (known as shehia), number of prior pregnancies, age and admission date of all expectant mothers. Only children born in the facility were included in the database; a large fraction of (especially rural) children are born at home, and a smaller minority attend one of the other 6 public and private maternity wards in the island.

Using the name of the hometown shehia, records were matched to the 2002 census data and the 2007 Zanzibar Labor Force Survey. The 2002 census administered a short-form questionnaire which collected demographic information for every household of Zanzibar. One of every four enumeration areas (EAs) was also selected to receive an expanded (or long-form) questionnaire component that collected household-level information on basic asset ownership and house dwelling characteristic on all EA residents, including whether the residence had a source of electricity. Thus, the census collected asset ownership information for approximately one quarter of all households. For this paper, the census bureau made available to us the long-form micro data, but not the short form one. We used this micro data to derive the percentage of the village connected to the electric grid, the average village wealth (as measured by a household level index of asset ownership), and the average size of the household (which was also reported in the data file). Since the long form survey is representative only at the district level and not at the village level, the constructed average

\footnote{Records from preceding years were missing, and the data for June 2009 was not yet ready at the time of collection.}
is only an approximation of the true village average.\footnote{There is no reason to expect that the lack of representativeness is correlated with the number of births during the blackout in a way that would bias the analysis. Lacking access to the short survey, it is not possible to construct a measure of village population size, or even determine the proportion of village residents that answered the long-form questionnaire.} While the information covered by the census is limited and, by the time the blackout happened, somewhat outdated, it has the benefit of covering almost all villages in Zanzibar.

The 2007 Labor Force Survey (LFS) is a more recent, complete description of household and worker characteristics, but because it was implemented on few enumeration areas, it covers fewer and less representative communities. We followed a similar procedure to the one outlined above to derive average household characteristics by village and then matched these characteristics to each community. In total, 76 LFS communities were successfully matched.

Table 1 provides some summary statistics from the two matched datasets. Villages sampled from the census are fairly representative, with a similar rate of villages having electricity (26%, close to the census average) but slightly ahead in terms of asset ownership (with an index value of 0.39 relative to the census average 0.17) and in terms of the rate of citizens connected to the electricity grid (29% relative to the census average of 25%). On the other hand, the characteristics of the village matched to the LFS are systematically different, with these villages being larger (as can be guessed by looking at the higher birth rates) and generally much higher levels of wealth (as measured in 2002). Thus while this sample provides a more recent set of village covariates, it is also less representative of the average community.

The final data has been reformatted so each observation is a village-week, and the main outcome variable of interest is the number of births in a week in a village. After dropping incomplete birth records and villages with four positive birth weeks or less, there are 14,500 usable observations, with 70 villages matched to the LFS and 125 matched to the census.

As a final observation, it should be noted that many shehias are represented in the data through a limited number of births. Figure 3 shows how often shehias have at least one birth per week, and finds that shehias with relatively few birth events are more common than villages with many birth events. Such shehias are likely to be somewhat remote, or have a small population to begin with, while shehias with a significant presence in the facility are more likely to be urban and located near the maternity ward. To the extent that the relative frequency of maternity ward attendance is time invariant, the econometric methods we present in the next section should be able to account for this.
5 Econometric strategy

Fertility effects The first objective of the paper is to estimate the impact of the blackout on the number of births of children conceived during the blackout. The strategy for accomplishing this objective is to compare the cohort size of those conceived between May 21 and June 18, 2008 to other cohorts conceived before or after, once factors such as seasonality and population growth have been taken into account. Denoting the log of the number of births reported by a town or village \( v \) during week \( t \) by \( y_{vt} \), the baseline regression is

\[
y_{vt} = \delta_t + \alpha_v + \beta_1 BB_t + \epsilon_{vt},
\]

where \( BB_t \) is a dummy variable for whether the births occurred among the “blackout baby” cohort of children conceived during the blackout, \( \beta_1 \) measures the percentage change of births per week, and \( \alpha_v \) and \( \delta_t \) are village fixed effects and month and year fixed effects respectively.

While the blackout affected the entire island of Zanzibar, not every village is connected to the grid. To account for that fact, we next estimate a difference in difference model:

\[
y_{vt} = \delta_t + \alpha_v + \beta_1 BB_t + \beta_2 NE_v^s \times BB_t + \epsilon_{vt},
\]

In this model, the dichotomous variable \( NE_v^s \) indicates whether the village was not electrified in survey year \( s = 2002 \) or 2007. The coefficient \( \beta_1 \) estimates the common impact of the blackout on the number of births per week on villages that had electricity in the survey year, thus capturing the average effect of the blackout on an electrified village. The difference \( \beta_1 - \beta_2 \) is the impact of the blackout on villages that lacked electricity. To the extent that the blackout was not felt in these areas, and to the extent that most of these areas remain without electricity, we would expect this difference to be zero\(^{14}\).

Performing the above analysis is impeded by the fact that birth records contain the date of birth, but not the estimated date of conception. One solution is to replace the date of conception with the expected date of conception, and thus consider any child born 40 weeks after any date in which the blackout was ongoing as “exposed” to the blackout. This measure might under-report the actual fertility effect if the blackout also affected the rate of premature or delayed births. An alternative measure, which is adopted here, attributes any birth occurring eight to ten months after the blackout being the result of a conception

\(^{14}\)It is important to note that even non-electrified rural villages could have felt the effects of the blackout, provided, for instance, that it disrupted the work pattern of residents. This channel is likely to be minor in the study communities: the blackout disrupted jobs that depended on electricity directly, and few rural residents hold these types of jobs.
during the blackout. This measure captures premature and delayed births, and (to the extent that it captures births that were not affected by the blackout) it provides a lower estimate of the true effect.

To properly regress the above equations, several econometric issues need to be considered. First, the underlying outcome of interest—number of births per week per village—is measured in non-negative integers and has a large number of zero values. An improvement over the standard linear regression would involve estimating the model using a Poisson regression, and this is the method adopted here. Having assumed a log-normal model, the $\beta$-estimates are interpreted as percentage changes.

Second, records cover only births occurring at the specific facility, and therefore exclude a large fraction of home and other hospital deliveries. If the amount of deliveries performed at a hospital is seasonal, the time fixed effects will account for this. However, to the extent that the fertility response to the blackout is not independent of the choice of delivery location, the above results are to be understood as the blackout effect on the sub-population that is likely to deliver at a hospital. If fertility outcomes for this sub-population are more responsive to the blackout, the regressions overestimate the overall fertility effect for the population at large.

Third, errors are likely to be non-standard. To correct for possible autocorrelation in the errors, all poisson regressions report bootstrapped standard errors.

**Heterogeneity and externalities** We next modify the difference in difference model to study the effect of externalities and account for the heterogeneity in electrification rates across villages; that is, we test the implications of equation (4). The model is given by

$$ y_{vt} = \delta_t + \alpha_v + \beta_1 BB_t + (\beta_2 NE_{v}^s + \beta_3 VE_{v}^s) \times BB_t + \epsilon_{vt}, $$

where the continuous variable $VE_{v}^s$ (village electricity) indicates the estimated fraction of residences that use electricity. The coefficient $\beta_1 - \beta_2$ again identifies the effect of the blackout on those villages with no electricity during survey year $s$ has the same interpretation as above, while $\beta_1$ identifies the effect of the blackout on those electrified villages that have a "close to zero" electrification rate. That is, $\beta_1$ identifies the parameter $\alpha_2(0)$, the externality effect of the blackout. Finally, $\beta_3$ estimates the additional impact of electricity coverage on fertility; that is, it identifies the linear average effect of the direct and indirect blackout

---

15See the appendix for a more precise description of the determination of this cohort.

16I estimate that approximately 25% of total births occur at Mnazi Mmoja. The ward delivers 500-900 children per month, representing 48% of all children born in health facilities (according to facilities data from the Ministry of Health). It is estimated that 61% of all children in Zanzibar are born at a health facility (NBS 2011).
effects, $\alpha_1 + \alpha_{2VE}'(VE_v)$. A positive coefficient is consistent with the hypothesis that direct and indirect personal exposure to the blackout affects fertility.

## 6 Results

### 6.1 Blackouts and births

**Average fertility effects** Table 2 reports the simple difference and the difference in difference estimates of the impact of the blackout on the blackout baby cohort size. Column 1 regresses equation 1 for the sample of villages matched to the census. The coefficient on the exposed cohort of children born 8-10 months later was 0.195, meaning that the cohort was 19% larger than expected. This corresponds to an average of 0.23 additional maternity ward births per week across all villages, which translates to $0.23 \times 11$ weeks $= 2.5$ more children per village born at the facility.

Column 2 reports the difference in difference results by comparing villages connected and unconnected to the grid in 2002. The cohort size of children with in villages with some electricity in 2002 is 20% larger, with the coefficient estimate being strongly significant. Villages with no electricity in 2002 had a much smaller increase, with a coefficient $\beta_1 - \beta_2 = 0.102$ being not different from zero. This is suggestive that the true fertility increase took place only on those villages that were connected to the grid. However, $\beta_2$ is measured with imprecision: many villages were connected to the grid between 2002 and 2008, and it is possible that these villages did experience an increase in fertility. As a consequence, we cannot reject the hypothesis that villages with electricity in 2002 had a different fertility response to the blackout than villages without electricity.

In order to use more recent electrification data, columns 3 and 4 repeat the exercise for the sample of villages that were matched to the 2007 LFS. The coefficient indicates a more measured increase of 9.7% in cohort size, which again corresponds to approximately 0.28 more births per week. The difference in difference estimates in column 4 indicate a 10.6% increase in births for villages with electricity, and a 0.033% decrease in other villages, with the latter not statistically different from zero. In addition, we can reject the hypothesis that the increase in fertility across the two types of villages is the same (p-value of Chi test is 0.016).

---

17 It is not advisable to extrapolate these numbers to the entire population; extrapolating these numbers to the entire population in 159 villages, one can calculate that the entire blackout baby cohort falls somewhere between 275 births (assuming that all blackout babies were born at Mnazi Mmoja) and $0.23 \times 0.25 \times 11 \times 159 = 1,608$ births (assuming that only 25% of blackout births per village were at Mnazi Mmoja). The upper bound is approximately 1.3‰ of the 1.2 million Zanzibar population.
Robustness tests and other outcomes  Table 3 returns to the difference in difference model to provide some robustness tests and additional results. A first concern is that the blackout effect observed is capturing some other unobserved factor, such as residual growth in birth numbers that is not controlled for by the time period fixed effects. In the first column, we thus run a falsification test on the difference in difference model by letting the exposed cohort to be the one born 11 or 12 months after the blackout. As expected, the coefficients on these cohorts are very small and statistically insignificant. Second, one could be concerned that the increase in births might have been an isolated event to a few locations. Column 2 provides some evidence that the birth boom was felt across villages: the column reports the result of a logit regression on a dummy variable that is equal to one if a village reported any birth that week. If the fertility increase was widespread, then we should expect that the likelihood of a village reporting a birth is higher for the affected cohort. This is confirmed by a positive and almost significant coefficient (p-value: 0.10). In column 3, we also report the coefficients from the same regression estimated using a linear probability model, which estimates that the probability of a village reporting a blackout birth is a marginally insignificant 3.2% higher than expected.

Perhaps the most important issue that remains unsolved is whether the baby boom is likely to translate to a permanent increase in population. A definitive assessment of this would require analyzing fertility some years into the future—something that, with the data available, is not possible. One way to make some headway on this issue is to explore the age and fertility structure of the affected cohort of women. Under the assumption that total fertility increases if either (i) birth spacing falls, or (ii) women become pregnant earlier, the concern that the increase in population is permanent is heightened if the composition of women giving birth eight to ten months later is younger. The remaining two columns of table 4 report the effect of the blackout on the age structure of those giving birth. Column 4 regresses the average age at birth for women in the sample on the explanatory variables, and column 5 regresses the average age at birth for those women who were at their first pregnancy. The coefficient estimates on “exposed cohort” are negative, suggesting that the composition skews younger—but the standard errors are large. Columns 6 consider directly the number of births from teenage mothers. These increased by a third over the predicted value, which makes it indeed possible that fertility was started earlier than expected for this group. Finally, column 7 looks at the other end of the fertility distribution by measuring the change in births among women at the end of their fertility. It finds no evidence that the number of births increased for this group. The evidence is thus inconclusive.
**Heterogeneity and externality** Having established that the blackout is associated with a sizable increase in population, table 4 explores the correlation between the rate of electrification and the population increase (equation (7)). We start by looking at the census sample in columns 1 and 2. The first coefficient now describes the effect of the blackout on villages with “close to zero” electrification, and is our measure of the externality effect of the blackout. We find that this coefficient is a large and statistically significant 0.25-0.28 (depending on controls). This externality effect thus seems large and important.

Looking at the other two coefficients, we see that increasing the level of electrification somewhat reduces the increase in births (coefficient $\beta_3$); however, coefficients are statistically insignificant. On the other hand, as before we find that villages with no electricity had no statistically detectable change in their fertility patterns. Overall, this suggests that what matters for the fertility response is the presence of *any* electricity, rather than the amount of electricity present.

The remaining regressions limit the sample size to just the 70 villages surveyed by the LFS. Columns 3 and 4 run the model (7), with and without village controls and using the more recent 2007 village data. The coefficients $\beta_1$ and $\beta_2$ closely mimic those of columns 3 and 4 of table 2, but now $\beta_1$ is marginally insignificant, possibly a result of the sample of villages with low electricity levels being particularly small. However, the result is consistent with the one from the full sample: The fertility effect does not seem to vary significantly with the amount of electricity in a given community, so that the fertility effect is similar across electrification rates.

In columns 5 and 6, we check whether there is heterogeneity in estimated effects through mechanisms other than the rate of electricity coverage. We replace electricity coverage in the regression with two alternative variables: the fraction of the population that reported owning a television, and the fraction of the population working in sectors that use electricity. These should more directly capture the effect on quality of leisure (through having a television at home that is not functioning) and the loss of work. The coefficient on the interaction with television is now positive (column 5), but small and statistically insignificant. A similar story holds for the interaction with work, whose coefficient is positive but still insignificant.

Taken together, the evidence from table 4 suggests that the pattern of births in villages with no electricity differs from those that have some electricity, but that electricity coverage does not matter. Figure [4] provides a visual and nonlinear confirmation of this. The figure plots the estimated coefficient on the exposed $BB$ cohort from equation (5) when

---

18 These sectors are defined as employing managers, professionals, technicians, clerks, plant and machine operators.
the sample is restricted to villages below a certain rate of electrification. As one moves left to right, the estimated coefficient includes villages with higher levels of electricity. Panel A includes in the sample villages with no electricity in 2002. The coefficient is centered at zero when electrified villages are excluded, with a wide standard error. As one increases the level of electrification, the coefficient raises sharply, and quickly stabilizes around 0.20. Clearly, small levels of electrification are having a large impact on the estimated coefficients. An alternative view of the data is given in panel B, which excludes all villages that were not electrified. The estimated coefficients start with a large value and large standard errors (due to small sample sizes), then decline slightly at higher levels of electrification.

The coefficients in table 3 and in figure 4 are likely to suffer from two biases. The first bias is the result of changes in electrification rates. Many villages that help estimate \( \alpha_2(0) \) at low levels of electricity are likely to have a higher electrification rate by 2008. If electrification rate had a significant positive impact on fertility, we would be overestimating \( \alpha_2(0) \). However, the coefficient on electrification rate \( \beta_3 \) is negative or null, suggesting that this source of bias is likely small. The second possible source of bias originates from women in the shiehias with low electrification rates being more likely to deliver at home. Then, the coefficients \( \beta_1 \) and \( \beta_3 \) could be downward biased and the externality effect underestimated.

7 Conclusion

This paper provides evidence that blackouts can indeed produce baby booms. Using a particularly well-defined and long power outage in the island of Zanzibar, Tanzania, the paper shows that blackout babies born 8-10 months later were 20% more numerous than expected. The blackout provides also important and policy-relevant insights over the distribution of fertility effects: large increases in the number of births were found on villages with electricity, regardless of the degree of electrification; in contrast, birth numbers did not change in areas not served by the electricity network. Such pattern is consistent with the blackout causing a common village shock that reduces the quality of leisure time to all.
A  Post-blackout Time-use surveys

The second source of data is a time-use survey collected five months after the event to gather information on household responses to the blackout. The sample consists of 366 randomly selected households in 19 villages and towns selected from high, medium and low electricity coverage villages and neighborhoods. 12 survey locations are rural or semi-rural villages from the North, East, and South of the island, and have electricity coverage varying from 0 to 40% of sampled households. The remaining seven areas are urban and peri-urban neighborhoods of the main town, where between 70% and 100% of sampled households are connected to the grid. The percentage of electricity coverage from the 2002 census was also matched to each community. (Not all communities were represented in the LFS survey, so communities were not matched with more recent electricity coverage estimates.)

In each visited household, both head and spouse were then asked specific information about their work in general, and around the period of the blackout in particular. The questionnaire reports whether electricity is a critical input for each one of at most three income-generating activities undertaken by the respondent. The person is then coded as “working with electricity” if any activity uses electricity. In addition, one of the two respondents provided information on a family structure, asset ownership, income levels, education, religious practices, and use of electricity in their own home.

The two respondents were also asked to assess how many daily hours they spent in four different categories of time use during the “usual weekday”: leisure hours spent at home, leisure hours spent outside of home, time spent doing house chores, and working hours. To help estimating time use as accurately as possible, enumerators played a simple game with respondents. They first determined the amount of time available during the day by estimating the time respondents go to sleep and wake up in the morning. Having thus determined how many hours were available during the day, they provided an equal number of pebbles to the enumerators, and the enumerator then proceeded to allocate those pebbles on a board with four quadrants representing the four time use categories. The enumerator then prodded and questioned the respondent until they were both satisfied that the board represented a fair assessment of their time use. This process was carried out first to determine the usual hours spent before the blackout; in the second stage, they were asked to update the board by moving the pebbles to reflect changes to time use during the blackout.

B  Calculation of exposed cohort dates

Birth records do not contain the information required to determine the date of conception. We thus need to use a measure of expected conception that takes into account that births occurs on average after 266 days, but canals occur before or after that date. The strategy adopted here is to attribute any birth occurring eight to ten months after the blackout being the result of a conception during
the blackout.

Thus, the oldest children born under the blackout should be those born 8 months after the beginning date of the blackout; that is, those born on or after January 21, 2009. The youngest blackout babies should instead be those born 10 months after June 18, which marked the end of the blackout: that is, those born before or on April 18, 2009.

The one technical difficulty to consider here is that the data is formatted by week. Thus, we consider the start of the blackout baby cohort to be the fourth week of the year (January 22-28) and the end to be the 15th week of the year (April 9-15).

References


Figure 1: Changes in village electrification rates, selected villages

Figure 2: Changes in time use during the blackout
Figure 3: Frequency of *shehia* birth events
Figure 4: Estimated fertility effect, by fraction of village with electricity
<table>
<thead>
<tr>
<th>Merged birth records/survey data</th>
<th>2002 (Census)</th>
<th>2007 (Labor force Survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Births per week per village</td>
<td>1.208</td>
<td>2.180</td>
</tr>
<tr>
<td>Births per week per village, blackout cohort</td>
<td>1.398</td>
<td>2.431</td>
</tr>
<tr>
<td>Village has any electricity</td>
<td>0.264</td>
<td>0.441</td>
</tr>
<tr>
<td>Percentage of village with electricity</td>
<td>0.286</td>
<td>0.319</td>
</tr>
<tr>
<td>Average household size in village (2002)</td>
<td>4.937</td>
<td>0.423</td>
</tr>
<tr>
<td>Average wealth index (2002)</td>
<td>0.391</td>
<td>1.650</td>
</tr>
<tr>
<td>Average television ownership</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Average working in electricity sectors</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Number of villages</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Number of observations</td>
<td>14,500</td>
<td></td>
</tr>
</tbody>
</table>
**Table 2: Difference in Difference estimates**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data source:</strong></td>
<td>2002 Census</td>
<td>2007 Labor force survey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed (β₁)</td>
<td>0.194***</td>
<td>0.204***</td>
<td>0.097*</td>
<td>0.106**</td>
</tr>
<tr>
<td>(born 8-10 months later)</td>
<td>(0.036)</td>
<td>(0.036)</td>
<td>(0.051)</td>
<td>(0.050)</td>
</tr>
<tr>
<td>Exposed x</td>
<td>-0.102</td>
<td>-0.139</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not electrified in survey year (β₂)</td>
<td>(0.080)</td>
<td>(0.102)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>14,500</td>
<td>14,500</td>
<td>4,442</td>
<td>4,442</td>
</tr>
<tr>
<td><strong>Month and year f.e.</strong></td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Village f.e.</strong></td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Number of villages</strong></td>
<td>125</td>
<td>125</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>β₁-β₂</td>
<td>0.102</td>
<td>-0.033</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P-value of Chi-test: Exposed in non-electrified villages =0</strong></td>
<td>0.21</td>
<td>0.78</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bootstrapped errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes:
Poisson regressions on weekly number of births per village matched to the 2002 Census.
Sample in columns 3 - 4 restricted to villages sampled by the 2007 labor force survey.
Table 3: Other fertility outcomes

<table>
<thead>
<tr>
<th>Estimation method</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Poisson</td>
<td>Logit</td>
<td>LPM</td>
<td>OLS</td>
<td>OLS</td>
<td>Poisson</td>
<td>Poisson</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample</th>
<th>Full 2002 Census</th>
<th>Restricted to observations with births-Full Census</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Outcome variable</th>
<th>Births (Delayed cohort)</th>
<th>Dummy: any birth in week</th>
<th>Average age, Births from only first-time teenage mothers</th>
<th>Births from mothers over 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed cohort</td>
<td>-0.008</td>
<td>0.204</td>
<td>0.032</td>
<td>-0.456</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td>(0.125)</td>
<td>(0.02)</td>
<td>(0.370)</td>
</tr>
<tr>
<td>Exposed x</td>
<td>0.045</td>
<td>-0.028</td>
<td>0.003</td>
<td>1.150**</td>
</tr>
<tr>
<td>Not electrified in 2002</td>
<td>(0.114)</td>
<td>(0.172)</td>
<td>(0.032)</td>
<td>(0.573)</td>
</tr>
<tr>
<td>Month and year f.e.</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Village f.e.</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Village controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Average dep. var.</td>
<td>1.11</td>
<td>0.44</td>
<td>0.44</td>
<td>26.5</td>
</tr>
<tr>
<td>Observations</td>
<td>14,500</td>
<td>14,036</td>
<td>14,500</td>
<td>6,742</td>
</tr>
<tr>
<td>Number of shehiaid</td>
<td>125</td>
<td>121</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>P-value of test: Exposed in non-electrified villages=0</td>
<td>0.75</td>
<td>0.3</td>
<td>0.24</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Robust errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Table 4: Heterogeneous effects of blackout on number of births per week

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed (β1)</td>
<td>0.280***</td>
<td>0.246***</td>
<td>0.137</td>
<td>0.119</td>
<td>0.081</td>
<td>0.171*</td>
</tr>
<tr>
<td>(born 8-10 months later)</td>
<td>(0.063)</td>
<td>(0.092)</td>
<td>(0.083)</td>
<td>(0.093)</td>
<td>(0.086)</td>
<td>(0.088)</td>
</tr>
<tr>
<td>Exposed x</td>
<td>-0.185*</td>
<td>-0.162*</td>
<td>-0.207*</td>
<td>-0.198*</td>
<td>-0.186*</td>
<td>-0.222**</td>
</tr>
<tr>
<td>Not electrified in survey year (β2)</td>
<td>(0.104)</td>
<td>(0.096)</td>
<td>(0.110)</td>
<td>(0.110)</td>
<td>(0.107)</td>
<td>(0.106)</td>
</tr>
<tr>
<td>Exposed x</td>
<td>-0.194</td>
<td>-0.107</td>
<td>-0.020</td>
<td>0.024</td>
<td>0.153</td>
<td>-0.352</td>
</tr>
<tr>
<td>Electricity measure (β3)</td>
<td>(0.127)</td>
<td>(0.286)</td>
<td>(0.106)</td>
<td>(0.167)</td>
<td>(0.198)</td>
<td>(0.518)</td>
</tr>
</tbody>
</table>

Observations | 14,500 | 14,500 | 4,442 | 4,442 | 4,442 | 4,442 |

Month and year f.e. | YES | YES | YES | YES | YES | YES |

Village f.e. | YES | YES | YES | YES | YES | YES |

Village controls x Exposed | NO | YES | NO | YES | YES | YES |

Number of villages | 125 | 125 | 70 | 70 | 70 | 70 |

β1-β2 | 0.102 | 0.109 | -0.070 | -0.079 | -0.105 | 0.051 |

P-value of Chi-test: Exposed in non-electrified villages =0 | 0.16 | 0.32 | 0.43 | 0.43 | 0.21 | 0.64 |

Notes:
Poison regressions on weekly number of births per village matched to the 2002 Census. Controls include village wealth and average number of household members. Village wealth is the village average of an index of 13 items or dwelling characteristics collected in the 2002 census. Both wealth and number of household member have mean zero. Sample in columns 4-8 restricted to villages sampled by the 2007 labor force survey. Fraction working in electricity using sectors: managers, professionals, technicians, clerks, plant and machine operators.

Bootstrapped errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
## Appendix table 1: Change in log leisure hours spent during the blackout

<table>
<thead>
<tr>
<th>Panel A: Leisure spent at home</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwelling has electricity</td>
<td>0.249**</td>
<td>0.173*</td>
<td>0.185*</td>
<td>0.209</td>
<td>0.055</td>
<td>0.070</td>
<td>0.058</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>(0.092)</td>
<td>(0.094)</td>
<td>(0.104)</td>
<td>(0.123)</td>
<td>(0.088)</td>
<td>(0.105)</td>
<td>(0.114)</td>
<td>(0.142)</td>
</tr>
<tr>
<td>Person works with electricity</td>
<td>-0.041</td>
<td>-0.063</td>
<td>-0.062</td>
<td>-0.022</td>
<td>0.025</td>
<td>0.033</td>
<td>0.042</td>
<td>0.054</td>
</tr>
<tr>
<td></td>
<td>(0.105)</td>
<td>(0.102)</td>
<td>(0.105)</td>
<td>(0.108)</td>
<td>(0.090)</td>
<td>(0.085)</td>
<td>(0.085)</td>
<td>(0.088)</td>
</tr>
<tr>
<td>Percentage village electrified in 2002</td>
<td>0.283**</td>
<td>0.387**</td>
<td>0.395**</td>
<td>-0.052</td>
<td>-0.149</td>
<td>-0.173</td>
<td>-0.052</td>
<td>-0.149</td>
</tr>
<tr>
<td></td>
<td>(0.112)</td>
<td>(0.151)</td>
<td>(0.182)</td>
<td>(0.120)</td>
<td>(0.248)</td>
<td>(0.303)</td>
<td>(0.120)</td>
<td>(0.248)</td>
</tr>
<tr>
<td>Percentage immediate neighborhood with electricity</td>
<td>-0.143</td>
<td>-0.130</td>
<td>0.131</td>
<td>0.089</td>
<td>-0.143</td>
<td>-0.130</td>
<td>0.131</td>
<td>0.089</td>
</tr>
<tr>
<td></td>
<td>(0.138)</td>
<td>(0.163)</td>
<td>(0.293)</td>
<td>(0.318)</td>
<td>(0.138)</td>
<td>(0.163)</td>
<td>(0.293)</td>
<td>(0.318)</td>
</tr>
<tr>
<td>Household has radio</td>
<td>0.087**</td>
<td>0.112**</td>
<td>0.115**</td>
<td>0.136**</td>
<td>-0.018</td>
<td>-0.021</td>
<td>-0.020</td>
<td>-0.006</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.040)</td>
<td>(0.042)</td>
<td>(0.059)</td>
<td>(0.047)</td>
<td>(0.045)</td>
<td>(0.045)</td>
<td>(0.059)</td>
</tr>
<tr>
<td>Participates in Rosca</td>
<td>-0.082</td>
<td>-0.042</td>
<td>-0.038</td>
<td>-0.177</td>
<td>0.074</td>
<td>0.070</td>
<td>0.066</td>
<td>0.103</td>
</tr>
<tr>
<td></td>
<td>(0.090)</td>
<td>(0.098)</td>
<td>(0.100)</td>
<td>(0.134)</td>
<td>(0.055)</td>
<td>(0.054)</td>
<td>(0.049)</td>
<td>(0.060)</td>
</tr>
<tr>
<td>Participates in other community organization</td>
<td>0.073</td>
<td>0.083</td>
<td>0.086</td>
<td>0.087</td>
<td>-0.059</td>
<td>-0.062</td>
<td>-0.059</td>
<td>-0.067</td>
</tr>
<tr>
<td></td>
<td>(0.082)</td>
<td>(0.082)</td>
<td>(0.080)</td>
<td>(0.117)</td>
<td>(0.061)</td>
<td>(0.066)</td>
<td>(0.070)</td>
<td>(0.096)</td>
</tr>
<tr>
<td>Fasts regularly</td>
<td>0.096</td>
<td>0.091</td>
<td>0.095</td>
<td>0.165</td>
<td>-0.019</td>
<td>-0.023</td>
<td>-0.022</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>(0.102)</td>
<td>(0.097)</td>
<td>(0.097)</td>
<td>(0.120)</td>
<td>(0.057)</td>
<td>(0.053)</td>
<td>(0.053)</td>
<td>(0.047)</td>
</tr>
<tr>
<td>Household assets</td>
<td>-0.054**</td>
<td>-0.063**</td>
<td>-0.058**</td>
<td>-0.058**</td>
<td>0.042*</td>
<td>0.043*</td>
<td>0.038*</td>
<td>0.043*</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.023)</td>
<td>(0.023)</td>
<td>(0.024)</td>
<td>(0.022)</td>
<td>(0.022)</td>
<td>(0.021)</td>
<td>(0.022)</td>
</tr>
</tbody>
</table>

Demographic controls include age, age squared, schooling, and size of household. Restricted sample excludes villages that were unconnected to the grid in 2002. Errors clustered at the village level in parentheses.

*** p<0.01, ** p<0.05, * p<0.1