Power Outages, Power Externalities, and Baby Booms

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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 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. The fact that a large fertility increase is observed in communities with very low levels of electricity suggests that the outage affected the fertility of households not connected to the grid through some spillover effect. 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 rural populations that have little exposure to it.

Keywords: Africa, Blackouts, Electricity, Fertility, Infrastructure Development.

1 Introduction

Electrification brings many benefits to rural communities in developing countries, including raising employment, allowing industrialization, and introducing new technologies for home and market production (Dinkelman, 2011, Rud, 2012). However, the electricity that arrives in developing countries is often rationed, unstable, and erratic. According to the World Bank, a typical firm in Africa can expect 9 outages a month, each lasting an average of 7 hours, causing losses of 7% in sales (World Bank, 2013). By contrast, in OECD countries, a typical firm can expect less than one outage a month, lasting an average of 3 hours. Power outages also cause disruptions outside of work: for those who use it at home, the sudden lack of electric power reduces recreational activities, makes chores harder to complete, and makes studying harder for students. When communities go dark, social activities are also affected, as public meeting places cannot be illuminated, public televisions remain turned off, and people's perception of security is reduced.

This paper shows that the unintended consequences of such events include increases in fertility. The evidence comes from a month-long power outage affecting the entire island of Zanzibar, Tanzania, between May and June of 2008. To document the implications of this event, I use a panel database of community-level births constructed from maternity ward birth records covering a period of two and half years. The identification relies on the timing of birth, with children born eight to ten months after the blackout likely to have been conceived during the event. Since not all areas of Zanzibar have electricity, a second source of identification is the location of the mother's residence, with mothers in villages with no electricity being unlikely to be affected by the blackout. Using a difference in difference strategy, I show that the affected communities in the sample experienced an increase in maternity ward births eight to ten months after the event. Additionally, I show that the increase in births happened only in communities that had *some* electricity: villages without electricity did not experience a baby boom.

Having established a fertility response to the power outage, the paper shows that the estimated impact was remarkably similar across communities, regardless of their level of electrification. Consequently, villages with low levels of electrification (below 10%) experienced as significant increases in births as other communities with higher electricity levels. This finding is important because in communities where most people lack access to electricity, many of the births are occurring in households that are not connected to the grid. This indicates that the blackout affects households through an externality effect that operates through the community.

To provide further insights on how the blackout affected fertility, I use data from a time use survey carried out five months after the event to show how time use patterns were changed. The blackout caused an average increase in the amount of time spent inside the home for both men and women. 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 fully driven by changes in the allocation of time, but by other factors not captured in the survey such as boredom.

The idea that procreation increases when the lights go out is a widely held belief that has rarely been empirically examined.[1] However, it is unfortunately not possible to establish whether power instability increases births temporarily (through a "harvesting effect" where planned pregnancies are anticipated) or causes an increase in the total population. This remains a particularly important question for developing countries, where there is frequent power instability and low levels of contraceptive use. To the extent that mothers do not adjust their subsequent fertility plan, it is possible that at least some of the baby boom will translate to permanent increases in the population.[2] Even if long term effects to the population are absent, short-run increases in births could strain health and neonatal services, and lead to adverse perinatal outcomes by reducing birth spacing among some mothers. If blackouts increase births, even an isolated and short lived event–like the two day blackout that affected 600 million people in India in July 2012–could have significant population implications simply by the sheer number of individuals involved (BBC, 2012).

In addition to finding an overall fertility effect of blackouts, this paper contributes to our understanding of the importance of electricity as a public good in areas with almost-zero levels of electrification. In those areas, which are often rural, the spread of electricity takes time: after electric poles are erected and connected to the grid, dwellings and businesses must make significant investments to connect to the electric wires; the electrification rate statistics might show only marginal improvements over time. While electricity as a private good may remain underutilized, electricity has an immediate effect as a public good: meeting points such as stores or mosques are illuminated, electric water pumps are installed at public wells, public televisions are turned on. The strong fertility response to the blackout shows that this

[1] The 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).

[2] In 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.

"public good effect" can be large and important. While there is no hard data to measure the extent of power failures in rural areas, they likely happen with some frequency: In 2008, for instance, local newspapers reported a 3 week long blackout in the Mtwara region on Tanzania. In early 2010, Zanzibar 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.[3]

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.[4] Moreover, because it contains household-level data on time use, it provides additional insights on the possible reasons for a fertility increase, including the effect of changes in time spent at home. The paper also contributes to the the larger literature on the social impacts of infrastructure (such as Pande and Duflo, 2007, Dinkelman, 2011, Rud, 2012), although it does not directly address an important question in this literature–the causal relationship between electrification (as opposed to blackouts) on fertility.

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

[3]In 2009, for instance, then Uganda Planning Minister Ephraim Kamuntu commented that the frequency of electricity shortages was causing too many births (BBC, 2009)

[4]Within the development literature on blackouts, see Adenikinju (2003) for its effects on firm-level outcomes in Nigeria.

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, with similar improvements in electrification (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.[5] Thus, electrification has 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.[6]

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 Appendix A). 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

[5]See Winther (2008) for a rich and very enjoyable anthropological study of the impact of electricity in rural communities in Zanzibar.

[6]It 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.

reported a steep drop in earnings and hours worked, and birth weights of children conceived before or around the blackout fell significantly (Burlando, 2012).[7] 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.

Use of petrol-run generators was limited before the blackout (as electricity provision had been quite stable previously) and remained so throughout the period. The price of generators shot up two- to ten-fold due to restricted supply, and remained high throughout. Moreover, running costs were also very high–reportedly in the order of 35-40 US dollars a day (BBC, 2008). A household survey collected five months after the blackout suggests that 7.2% of workers reported using generators during the blackout.

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. A first possible response to the blackout is to migrate from the stricken island. The evidence from the post-event household survey indicate that this was not a common response: only 3.1% of respondents left the island during the blackout.[8] Since most remained in the island, their time use was influenced by the blackout.

In principle, it is likely that both "quality" (i.e., boredom) and quantity of disposable time changed during this period. One 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, a 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 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.[9]

[7] Burlando (2012) also discusses some aggregate fertility effects, and does not study the impact of village electricity on fertility.

[8] This statistic excludes those who permanently left Zanzibar since they could not answer the questionnaire. It is unlikely that this group was large.

[9] Aside for their monetary value, domestic electric appliances have the added value of conferring social

In addition to these direct effects, 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, I use some data from a time use survey that documented the changes in time use during the blackout (the data is described in appendix B) on 664 individuals living in parts of Zanzibar with varying degrees of electrification. In the survey, I 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. Figure 3 plots the average changes in domestic time use by the percentage of the village with an electricity connection at the time of the 2002 census (described below), for women and men separately. While there is significant dispersion of hours across communities, at least two patterns are noticeable. First, time spent at home is generally increasing in the electrification rate for men, but not necessarily for women (where the relationship seems to be inverse-U shaped). Second, changes in time use for both men and women are more closely bunched around zero at very low levels of electrification, suggesting smaller changes in time use there.

These two patterns would be interesting if indeed they are driven by the rate of electrification in the community, and not by some other variable. For additional insight, 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, $\triangle(\log l_{iv})$, is:

$$\triangle(\log l_{iv}) = \alpha_1 DE_{iv} + \alpha_2 WE_{iv} + \alpha_3 VE_v + \alpha_4 VE_v^2 + X_{iv}\beta + \omega_{iv} \tag{1}$$

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.

The model here measures whether individuals connected to the grid (having domestic electricity, DE) or whose jobs depend on electricity (WE) responded differently to the blackout relative to the rest. The variable VE measures the percentage of the village with an electricity connection. Absent other unobservable characteristics, the coefficients α_3 and α_4 should jointly capture the (nonlinear) net spillover effect of the electrification rate on time use. In practice, however, this coefficient might also capture the effect of other confounding variables that are correlated with the electrification rate.[10] 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 7 estimates only the coefficients α_1 and α_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 8 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. To further explore the relationship between own leisure time and the degree of electricity in the community, columns 3 and 9 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 $\frac{x_{-i}+x_1}{11}$. 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. Columns 4 and 10 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 estimated coefficients much from the previous two specifications. Finally, columns 5-6 and 11-12 include the quadratic term of VE_v. This term is insignificant for men and strongly significant for

[10]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.

women. Thus, the pattern of time use is linear for men, quadratic for women, and close to zero for both groups in areas with low levels of electrification.[11]

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; I introduce these other elements in the conceptual framework below.

3 Conceptual framework

How should one expect blackouts to affect pregnancy rates? In general, blackouts are transitory and have no impact on future employment, wages, life expectancy, or other long-term household or child characteristics. If fertility is fully determined by these characteristics, power failures would 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:

$$C_{iv} = c(t(e_i, E_v), q(e_i, E_v); \xi_i, \xi_v). \tag{2}$$

It is thus assumed 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 family planning, as well as other community-level characteristics (such as social norms, the extent of alternative leisure activities, or availability of contraceptives). I summarize these observed and unobserved variables with the terms ξ_i and ξ_v, and for simplicity I assume that they do not influence the shape of the functions t and q.[12]

[11] The regressions are robust to outliers and higher order polynomials in VE.

[12] Alternatively, I could write t_{iv} and q_{iv}.

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 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, the effect of this shock on fertility is estimated by differentiating the C function with respect to E_v:

$$\frac{\partial C_i}{\partial E_v} = \frac{\partial c}{\partial t}\left\{\frac{\partial t}{\partial E_v} + \frac{\partial t}{\partial e_i}\frac{\partial e_i}{\partial E_v}\right\} + \frac{\partial c}{\partial q}\left\{\frac{\partial q}{\partial E_v} + \frac{\partial q}{\partial e_i}\frac{\partial e_i}{\partial E_v}\right\}. \tag{3}$$

The first term in equation (3), $\partial c/\partial t_i$, is the effect of time spent at home on fertility. This term is not directly observed; 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. 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. These terms cannot be empirically observed; 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, I get that

$$\begin{aligned}\frac{\partial C_v/\partial E_v}{N_v} &= \left[\frac{\partial c}{\partial t}\frac{\partial t}{\partial e_i} + \frac{\partial c}{\partial q}\frac{\partial q}{\partial e_i}\right]E_v + \frac{\partial c}{\partial t}\frac{\partial t}{\partial E_v} + \frac{\partial c}{\partial q}\frac{\partial q}{\partial E_v} \\ &= \alpha_1 E_v + \alpha_2(E_v),\end{aligned} \tag{4}$$

that is, the short term increase in the fertility rate is a function of direct effects (summarized by α_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 ξ_i and ξ_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

I 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).[13] 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 six public and private maternity wards in the island.

Using the name of the home *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. I 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 is only an

[13] Records from preceding years were missing, and the data for June 2009 was not yet ready at the time of collection.

approximation of the true village average.[14] 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. I 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: 26% of villages did not have any electricity (close to the census average), are slightly ahead in terms of asset ownership (with an index value of 0.39 relative to the census average 0.17) and had a similar rate of citizens connected to the electricity grid (29% relative to the census average of 25%–38.9% among villages with some positive level of electricity). 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 4 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 I present in the next section should be able to account for this.

[14] 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.

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 in electrified *shehias* between May 21 and June 18, 2008 to other cohorts, 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

$$y_{vt} = \delta_t + \alpha_v + \beta_1 BB_{vt} + \epsilon_{vt}, \tag{5}$$

where BB_{vt} is a dummy variable for whether the births occurred among the "blackout baby" cohort of children (a) conceived during the blackout and (b) conceived in villages with electricity, β_1 measures the percentage change of births per week, and α_v and δ_t are village fixed effects and month and year fixed effects respectively. Since Zanzibar is a small island of 640 squared miles located close to the Equator, there are no large differences in weather patterns across *shehias* and the location-invariant fixed effects, δ_t, should capture seasonality quite well. Provided that the fixed effects correctly capture any time invariant heterogeneity across *shehias*, that fertility rates comove similarly across villages over time, and that across-*shehia* spillover effects from the blackout were small, the coefficient β_1 correctly captures the "difference in difference" effect of the blackout on the fertility of couples exposed to the blackout. Since different villages may be growing at different rates, I also provide estimates using a more rigorous set of village-specific time trends in addition to the seasonality controls. To more formally test that the blackout was the sole cause of the fertility increase, I next consider the following:

$$y_{vt} = \delta_t + \alpha_v + \beta_1 BB_{vt} + \beta_2 NE_{vt} + \epsilon_{vt}, \tag{6}$$

where NE_{vt} identifies those cohorts that were conceived during the blackout in villages with No Electricity. Here, the coefficient β_2 indicates the degree to which *shehias* that were not electrified experienced an increase in births. To the extent that the blackout was not felt in these areas, and to the extent that all seasonality has been captured by time fixed effects, this coefficient should be zero.[15] A positive coefficient on NE_{vt}, on the other hand, would suggest that the identification strategy is suspect–either because time-varying controls do

[15]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.

not correctly capture all seasonality, or because there are cross village spillover effects.

Performing the above analysis is impeded by two limits to the data. First, it would be ideal to determine whether a village had electricity in 2008, when the blackout happened. Lacking this information, I rely on data from the 2002 census and (as a further check) on the more limited 2007 LFS data. Second, I do not observe the date of conception but only the date of birth. 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 during the blackout. This measure, which is described in detail in appendix C, 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 and interpret 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 β-estimates are interpreted as percentage changes. Second, errors are likely to be non-standard. To correct for possible autocorrelation in the errors, all poisson regressions report bootstrapped standard errors. Third, records cover only births occurring at the specific facility, and therefore exclude a large fraction of home and other hospital deliveries.[16] If the amount of deliveries performed at a hospital is seasonal and varies from village to village, the time fixed effects and village-specific time trends will account for these. 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. It is therefore cautious to interpret the magnitude of the coefficients as an upper bound of the overall fertility effect.

[16] I 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).

Heterogeneity and externalities I 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, I test the implications of equation (4). The baseline model is given by

$$y_{vt} = \delta_t + \alpha_v + \beta_1 BB_{vt} + \beta_2 VE_v \times BB_{vt} + \epsilon_{vt}, \tag{7}$$

where the continuous variable VE_v (village electricity) indicates the estimated fraction of residences that use electricity. Now, β_1 identifies the effect of the blackout on those electrified villages that have a "close to zero" electrification rate. That is, β_1 identifies the parameter $\alpha_2(0)$ from equation (4), the externality effect of the blackout when $VE_v \to 0$. β_2 estimates the additional impact of electricity coverage on fertility; that is, it identifies the linear average effect of the direct and indirect blackout effects, $\alpha_1 + \alpha'_{2VE}(VE_v)$.

6 Results

6.1 Blackouts and births

Average fertility effects Table 2 reports the difference in difference estimates of the impact of the blackout on the blackout baby cohort size. Column 1 through 3 reports β_1 from equation 1 for the sample of villages matched to the census using an increasingly complete set of control variables. The difference in difference coefficient is 18.4% for the baseline specification, falling to 15.7% when quadratic time trends are included in column 2. In column 3, *shehia*-specific time trends are added to control for differences in population growth rates across communities. The coefficient does not change significantly, remaining close to 0.17. The latter coefficient thus indicates that the exposed cohort of children born 8-10 months later was 17% larger than expected. While these estimates seem large, the estimated population increase is not. A 17% increase corresponds to an average of 0.25 additional maternity ward births per week across villages with electricity, which translates to 0.25 x 11 weeks = 2.75 more children per electrified *shehia* born at the facility. In other words, the estimated size of the baby boom in the health facility is 2.75 x 92 = 253 births (where 92 is the total number of electrified *shehias* in the sample).[17]

Column 4 separately identifies affected cohort sizes for those born in villages with and without electricity coverage in 2002. The coefficient β_2 should be zero if the regression controls correctly capture seasonality and if spillovers from electrified villages to non-electrified

[17] 253 is also the lowest bound of the estimated total increase in births, assuming that all blackout babies were born at Mnazi Mmoja. Assuming that only 25% of blackout births per village were at Mnazi Mmoja (which might be considered an upper bound), the total population increase is of 1,012, or approximately 0.84‰ of the 1.2 million Zanzibar population.

villages are small or nil. The coefficient β_2 is estimated at a small and statistically insignificant 0.022, meaning that villages with no reported electricity in 2002 did not experience an increase in fertility. The coefficient β_1 is a smaller but significant 0.15.

In order to use more recent electrification data, columns 5 through 8 repeat the exercise for the sample of villages that were matched to the 2007 LFS. The coefficient in (5) indicates a similar increase of 15.9% in cohort size, which again corresponds to approximately 0.28 more births per week. This estimate falls to 12.7 when I include quadratic time trends (column 6) and *shehia* time trends (column 7). Finally, column 8 again splits the cohort born 8-10 months later between those born in villages with and without electricity; as in column 4, there is no evidence that fertility increased in places with no electricity. This gives confidence that the regression is indeed capturing the effect of the blackout and not some other extemporaneous or cyclical event. However, the difference in difference coefficient loses statistical significance (p-value 0.20).

Appendix table 1 replicates the results by disaggregating the affected cohort into three four-week periods: early, middle, and late. Most of the gain in births is concentrated among those born 9 or 10 months later, although some coefficients lack precision.

Robustness tests and other outcomes An important concern of the analysis above is that the difference in difference regression is capturing some other unobserved factor, such as differential growth in birth numbers across *shehias* with and without electricity that is not controlled for by the time period fixed effects or time trends. Figure 5 plots the coefficient estimates from equation (6) where the exposed cohorts are those conceived before the blackout.[18] All the coefficients are close to zero, indicating that, in any twelve week period before the birth of the cohort under analysis, the growth rates in births across *shehias* with and without electricity were similar. To the extent that the short time span available is representative, this validates the "parallel assumption" of the difference in difference specification.

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

[18] More precisely, I replicate column 4 of table 2 where the exposed cohort is not the "blackout baby" cohort, but the cohort of children born in a twelve-week period starting with the sixth week of 2007. Thus, the first coefficient identifies the difference in difference estimate on children born between 6 and 18 weeks from the start of 2007, the second identifies those born between the 19 and 30 weeks, and so on.

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 columns thus study the compositional differences across cohorts.

Column 1 reports the effect of the blackout on the number of births from first-time mothers, and shows that births among this group increased 22%. It also means that women at first pregnancy were over-represented among the baby boom cohort. This could potentially indicate that women become pregnant earlier. To further study this issue, column 2 regresses the average age of all women from village v giving birth in week t on whether the birth belonged to the affected cohort, while column 3 reports the same for first time pregnant women. On average, affected mothers skew marginally younger, but this result is small and statistically insignificant. In addition, first time mothers are not younger and in fact they are on average marginally older (column 3). Column 4 considers directly the number of births from teenage mothers. As with first pregnancies, it is quite clear that teenagers were particularly affected by the blackout, with births increasing 22.6% for this group. It is quite possible that many of these teenage pregnancies might not have happened if electricity remained; however, it is hard to speculate whether these young women will end up having more children as a result of this early pregnancy.

An alternative way to address the concern of a permanent fertility increase is to check birth increases at the other end of the age distribution, among women over the age of 40. Among this category of women, unplanned births are more likely to represent an unplanned increase in total fertility. Column 6 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)). I start by looking at the census sample in column 1. 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. I find that this coefficient is a large and statistically significant 0.21. This externality effect thus seems large and important. Looking at the estimated β_2, I see that the level of electrification has no statistically significant effect on the size of the fertility increase; if anything, the coefficient suggests that increasing electrification somewhat *reduces* the increase in births. 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. Column 2 reports the model (7) using the more recent 2007 village electrification data. The coefficient β_1 closely follows those found in the difference in difference model reported in table 2, but now β_1 is insignificant. Given that there are very few villages with electrification levels of between 0 and 5 or 10%, the insignificance is probably driven by lack of power rather than lack of effect. In addition, as for with the census sample, the fertility effect does not vary significantly with the amount of electricity in a given community, so that the fertility effect is similar across electrification rates.

In columns 3 and 4, I check whether there is heterogeneity in estimated effects through mechanisms other than the rate of electricity coverage. I 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.[19] 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. These alternative regressors are not predictive, as none of the coefficients are significant. The coefficient on the interaction with television or work are positive, but statistically insignificant.

Taken together, the evidence from table 4 suggests that the pattern of births in villages with electricity differed during the blackout, but that electricity *coverage* did not matter. Figure 6 provides a visual and nonlinear confirmation of this. The figure plots the estimated coefficient on the exposed BB cohort from equation (5) when 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 and in the estimated coefficient those births from 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. Table 5 estimates cohort sizes for villages with different levels of electrification in a single regression. Across the various specifications reported, the highest coefficients are found among *shehias* with little electricity use, and are generally lower among those with high coverage. Nonetheless, these differences are statistically insignificant, and every coefficient being statistically indistinguishable from any other.[20] Thus, the fertility increase was indeed strikingly uniform across the (electrified) portions of the island.

[19]These sectors are defined as employing managers, professionals, technicians, clerks, plant and machine operators.

[20]A table with data restricted to the LFS provides similar results–table available from the author upon request.

The most important result from table 4 and 5 is that births increased significantly in areas where private connections to the electric grid are few and where most exposure is (presumably) through public electricity use. The estimated indirect (externality) effect of the blackout at somewhere between 0.20 and 0.25. Taking the conceptual framework presented in section 5 seriously, this externality effect appears in equation (4) as $\alpha_2(0)$ and is the combination of two effects: the effect of the blackout on fertility through domestic time use, and through the quality of time. If the estimated impact of the blackout on domestic time use from figure 3 and appendix table 1 is correct– that is, it is close to zero in areas with little electricity– we could conclude that, in these areas at least, the fertility effect operated mostly through its impact on the *quality* of time.

The second result from table 4 and 5–an absence of a fertility gradient across electrification areas– can be explained through many different and mutually exclusive mechanisms, and they cannot be separately identified with the data at hand. For instance, it may be that fertility is not driven the quantity and quality of time spent at home. More plausibly, it is possible that fertility increases with time spent at home, but the larger expected increase in births in areas with more electricity was counterbalanced by an opposing mechanism, such as a decline in the importance of the public externality effect ($\alpha_2(E_v)$), or the presence of other unobservable characteristics of the community (such as access to modern forms of contraception or a lower desire for children).

Finally, it is important to highlight that the coefficients in table 4 and 5 and in figure 6 may 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, I would be overestimating $\alpha_2(0)$. However, the coefficient on electrification rate 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 β_1 and β_2 could be downward biased; this might mean that the externality effect is, in fact, 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 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. Most importantly, the paper shows that health facility births increased significantly in villages with few private connections to the grid. These villages are characterized by a “public” use of electricity (through public televisions, illumination in front of public spaces). The increase in births in these areas is indicative of important externalities of electricity on fertility in areas with little private use of electric power.

A The Blackout

The Zanzibar blackout started on May 21, 2008 at approximately 10 p.m. and lasted until June 18, 2008. The cause was the rupture of the undersea cable that connects the Zanzibar island substation with the electricity generators on mainland Tanzania. Why the cable broke at that time is the subject of speculation, although it happened a few minutes before halftime during an important international soccer match–the Champion's League final that pitted Chelsea against Manchester United. The biggest soccer event of the year featured the two most followed teams on the island (*pace* Liverpool). Crowds gathered in traditional meeting places where home televisions were set up, and most televisions were tuned to the match in Moscow. It has been suggested, perhaps mischievously, that the staff at the utility company were among those watching the game. Without paying much attention to the aging machinery, they did not shut the system down during a power surge originating on the mainland. Even allowing for staff negligence, interviews with Zanzibar Electricity Corporation (ZECO) officials clearly point to underinvestment in maintenance as the ultimate culprit. The relaying system, designed and built under Norwegian financing, had never been upgraded in the thirty years since it was installed, and had exceeded its expected lifetime.

It took just a few days before it became clear that the problem was serious, and the blackout was likely to be long (BBC, 2008). On June 3—two weeks into the power cut—a Norwegian technician arrived to assess the damage, propose a solution, and indicate a possible resumption date. The technician's assessment was the cause of much confusion: the morning after, one newspaper reported an estimated resumption of power in July (The Guardian, 2008), whereas another reported the date to be September (Citizen, 2008). In a radio address, the President of Zanzibar encouraged citizens to get used to candlelight dinners, which he admitted he found quite romantic. Disillusioned Zanzibaris believed that the situation would not improve before Ramadan in September.

On June 17th, the government announced the imminent restoration of power. The following day, electricity was flowing.[21] The restoration took many people by surprise, since the government had been careful to play down expectations of a quick solution. The event was the longest recorded time without power in Zanzibar's history, although shorter unexpected blackouts were not unusual. Since Zanzibar is an important tourist destination, it is also worth noting that this power outage stroke during the low season, a period where few visitors come and most resorts are closed. The same cannot be said for the blackout of 2009-2010, which hit the tourism sector hard (O'Connor 2010).

B 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

[21] A limited number of rural areas reported a continuation of the blackout for a number of days after restoration. Only a small proportion of the population was affected.

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 provided 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.

C Calculation of exposed cohort dates

Birth records do not contain the information required to determine the date of conception. I 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, I 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).

Finally, appendix table 1 disaggregates the blackout baby cohort in three four week periods. The early cohort runs from January 22 to February 18; the middle cohort from February 19 to March 18; and the late cohort from March 19 until April 15.

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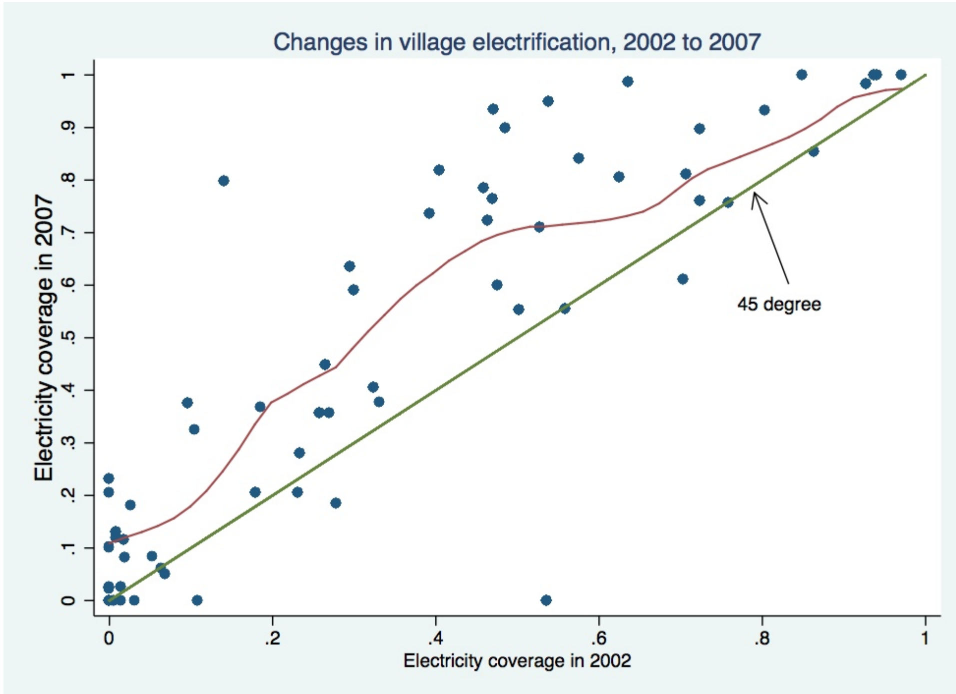

Figure 1: Changes in village electrification rates, selected villages

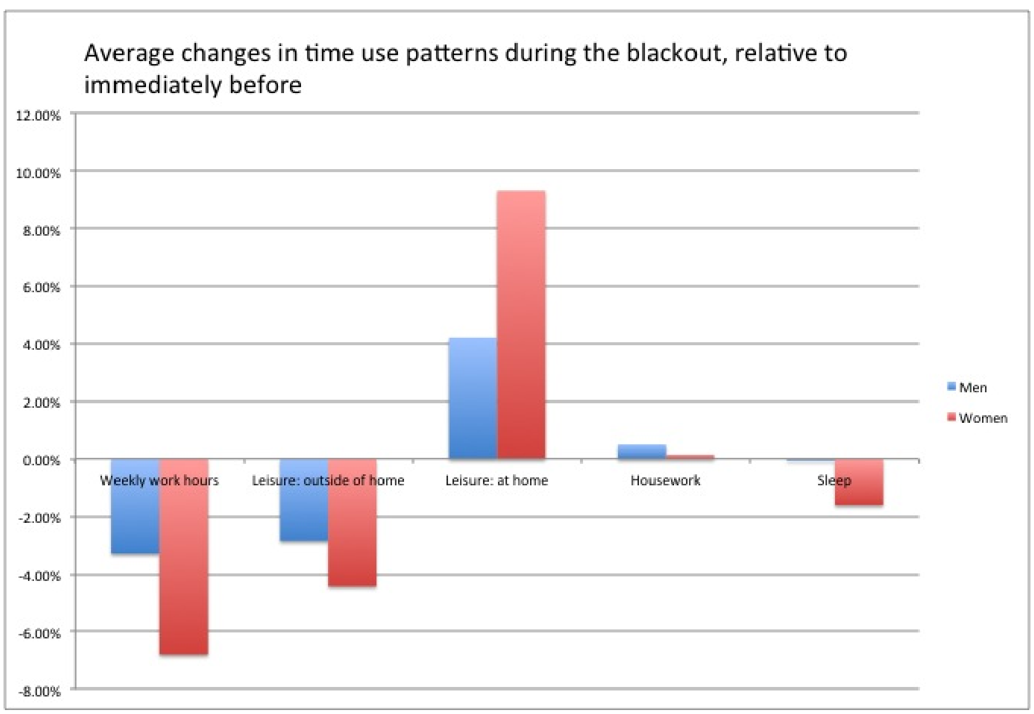

Figure 2: Changes in time use during the blackout

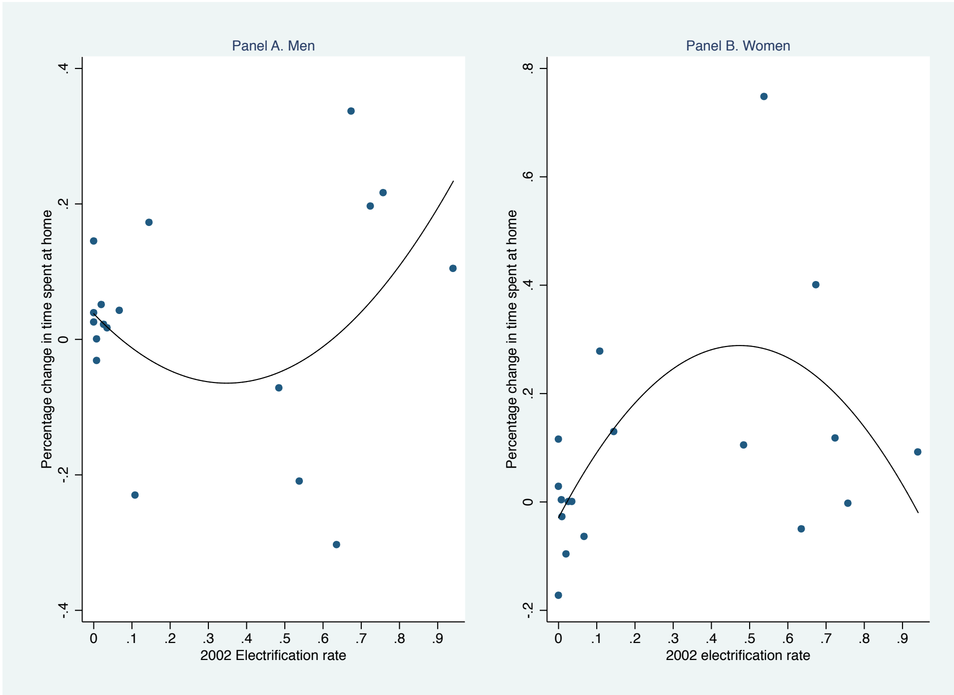

Figure 3: Average changes in time use during the blackout, by electrification rate

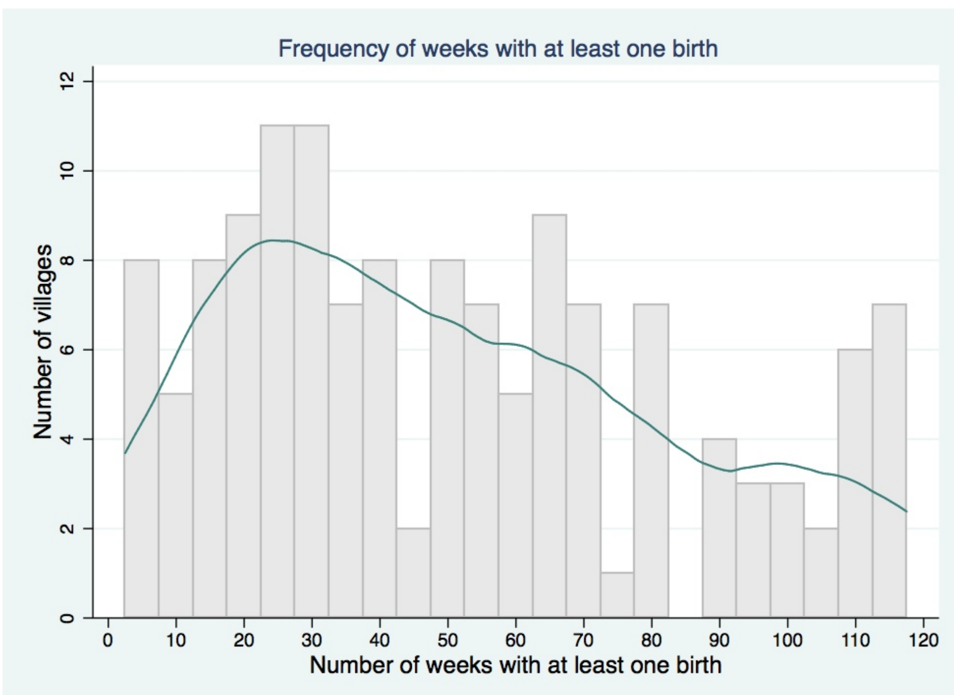

Figure 4: Frequency of *shehia* birth events

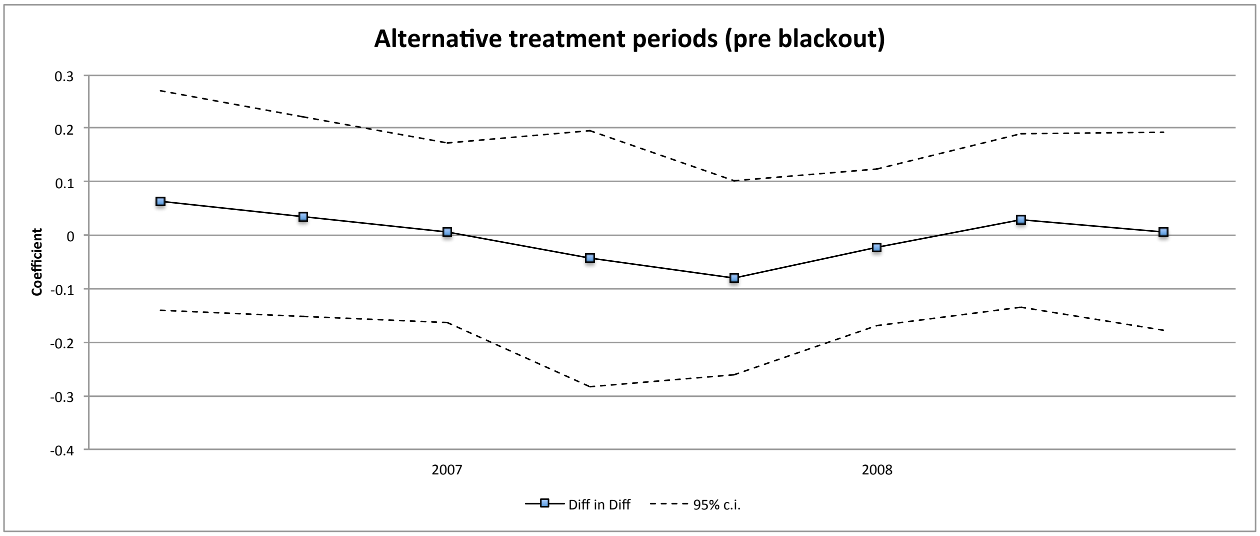

Figure 5: Falsification test: Difference in difference coefficients on pre-blackout cohorts

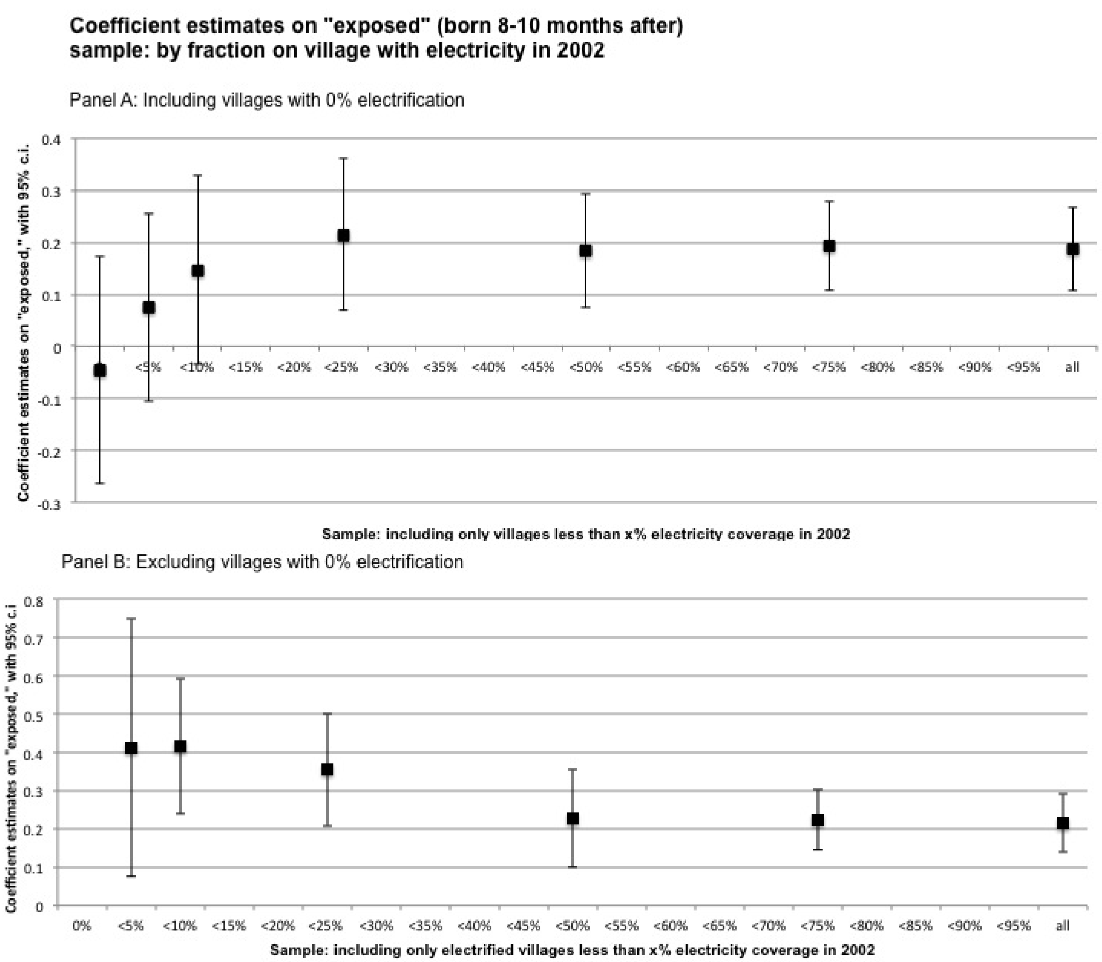

Figure 6: Estimated fertility effect, by fraction of village with electricity

Appendix table 1: Change in log leisure hours spent during the blackout

Panel A: Leisure spent at home	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Men						Women					
Dwelling has electricity	0.249**	0.173*	0.185*	0.209	0.182*	0.209	0.055	0.070	0.058	0.064	0.070	0.053
	(0.092)	(0.094)	(0.104)	(0.123)	(0.104)	(0.124)	(0.088)	(0.105)	(0.114)	(0.142)	(0.110)	(0.138)
Person works with electricity	-0.041	-0.063	-0.062	-0.022	-0.064	-0.022	0.025	0.033	0.042	0.054	0.061	0.072
	(0.105)	(0.102)	(0.105)	(0.108)	(0.105)	(0.108)	(0.090)	(0.085)	(0.085)	(0.088)	(0.075)	(0.081)
Percentage village		0.283**	0.387**	0.395**	0.161	0.404		-0.052	-0.149	-0.173	0.965**	0.989***
electrified in 2002		(0.112)	(0.151)	(0.182)	(0.458)	(0.439)		(0.120)	(0.248)	(0.303)	(0.358)	(0.316)
Percentage immediate			-0.143	-0.130	-0.120	-0.131			0.131	0.089	0.026	-0.020
neighborhood with electricity			(0.138)	(0.163)	(0.155)	(0.167)			(0.293)	(0.318)	(0.240)	(0.262)
Squared of percentage village					0.246	-0.009					-1.242**	-1.229**
electrified in 2002					(0.463)	(0.455)					(0.517)	(0.484)
Household has radio	0.087**	0.112**	0.115**	0.136**	0.116**	0.136**	-0.018	-0.021	-0.020	-0.006	-0.019	-0.000
	(0.033)	(0.040)	(0.042)	(0.059)	(0.041)	(0.059)	(0.047)	(0.045)	(0.045)	(0.059)	(0.048)	(0.062)
Participates in Rosca	-0.082	-0.042	-0.038	-0.177	-0.044	-0.177	0.074	0.070	0.066	0.103	0.060	0.093
	(0.090)	(0.098)	(0.100)	(0.134)	(0.098)	(0.135)	(0.055)	(0.054)	(0.049)	(0.060)	(0.048)	(0.059)
Participates in other	0.073	0.083	0.086	0.087	0.083	0.087	-0.059	-0.062	-0.059	-0.067	-0.059	-0.072
community organization	(0.082)	(0.082)	(0.080)	(0.117)	(0.079)	(0.115)	(0.061)	(0.066)	(0.070)	(0.096)	(0.071)	(0.095)
Fasts regularly	0.096	0.091	0.095	0.165	0.091	0.165	-0.019	-0.023	-0.022	0.007	-0.003	0.019
	(0.102)	(0.097)	(0.097)	(0.120)	(0.101)	(0.121)	(0.057)	(0.053)	(0.053)	(0.047)	(0.055)	(0.051)
Household assets	-0.054**	-0.063**	-0.058**	-0.058**	-0.056**	-0.058**	0.042*	0.043*	0.038*	0.043*	0.029	0.034
	(0.025)	(0.023)	(0.023)	(0.024)	(0.022)	(0.023)	(0.022)	(0.022)	(0.021)	(0.022)	(0.018)	(0.019)
Demographic Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Sample	Full	Full	Full	Restricted	Full	Restricted	Full	Full	Full	Restricted	Full	Restricted
Observations	330	330	325	266	325	266	334	334	332	273	332	273
R-squared	0.038	0.053	0.052	0.070	0.052	0.070	0.121	0.121	0.124	0.133	0.150	0.156

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

Appendix table 2: Difference in Difference estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Data source:	2002 Census				2007 Labor force survey			
Early cohort	0.152***	0.095**	0.107	0.079	0.140**	0.078	0.077	0.019
	(0.051)	(0.044)	(0.066)	(0.139)	(0.055)	(0.057)	(0.059)	(0.159)
Middle cohort	0.187**	0.158***	0.171***	0.146	0.151**	0.118	0.117*	0.311
	(0.075)	(0.050)	(0.054)	(0.178)	(0.066)	(0.072)	(0.064)	(0.273)
Late cohort	0.210***	0.207***	0.220***	0.223	0.182***	0.179***	0.178***	0.199
	(0.057)	(0.051)	(0.063)	(0.161)	(0.053)	(0.062)	(0.061)	(0.252)
Early cohort n				0.031				0.055
				(0.124)				(0.155)
Middle cohort not exposed				0.028				-0.199
				(0.169)				(0.251)
Late cohort not exposed				-0.002				-0.025
				(0.152)				(0.245)
Observations	14,500	14,500	14,500	14,500	8,120	8,120	8,120	8,120
Month and yea	YES	YES	YES	YES	YES	YES	YES	YES
Village f.e.	YES	YES	YES	YES	YES	YES	YES	YES
Quadratic time	NO	YES	YES	YES	NO	YES	YES	YES
Village time tre	NO	NO	YES	YES	NO	NO	YES	YES
Number of vill	125	125	125	125	70	70	70	70

Notes:
See notes on table 2 for details. Early, middle and late cohort are composed of those born in the first four weeks, middle four weeks, or last four weeks of the exposed cohort.
Bootstrapped errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 1: Summary Statistics

Merged birth records/survey data	2002 (Census) Mean	2002 (Census) Standard Deviation	2007 (Labor force Survey) Mean	2007 (Labor force Survey) Standard Deviation
Births per week per village:				
All villages	1.208	2.180	1.574	2.435
Villages with electricity	1.469	2.441	1.705	2.554
Villages with electricity, blackout cohort	1.760	2.815	1.759	2.815
Village has no electricity	0.264	0.441	0.157	0.364
Percentage of village with electricity	0.286	0.319	0.426	0.361
Average household size in village (2002)	4.937	0.423	5.006	0.471
Average wealth index (2002)	0.391	1.650	0.625	1.580
Average television ownership	-	-	0.340	0.297
Average working in electricity sectors	-	-	0.130	0.086
Number of villages	125		70	
Number of observations	14,500		8,120	

Table 2: Difference in Difference estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Data source:	2002 Census				2007 Labor force survey			
Blackout baby cohort	0.184***	0.157***	0.169***	0.150**	0.159***	0.128**	0.127***	0.170
	(0.039)	(0.036)	(0.042)	-0.065	(0.043)	(0.052)	(0.048)	(0.134)
Not exposed				0.022				-0.046
				-0.076				(0.149)
Observations	14,500	14,500	14,500	14,500	8,120	8,120	8,120	8,120
Month and year f.e.	YES	YES	YES	YES	YES	YES	YES	YES
Village f.e.	YES	YES	YES	YES	YES	YES	YES	YES
Quadratic time trends	NO	YES	YES	YES	NO	YES	YES	YES
Village time trends	NO	NO	YES	YES	NO	NO	YES	YES
Number of villages	125	125	125	125	70	70	70	70

Notes:
Poisson regressions on weekly number of births per village matched to the 2002 Census. Blackout baby cohort is composed of children born 8-10 months after the blackout in electrified villages (see appendix). Not exposed are children born 8-10 months after the blackout in villages with no electricity. Sample in columns 5 - 8 restricted to villages sampled by the 2007 labor force survey. Bootstrapped errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Characteristics of mothers of affected cohort

	(1)	(2)	(3)	(4)	(5)
Estimation method	Poisson	OLS	OLS	Poisson	Poisson
Sample	Restricted to observations with births-Full Census				
Outcome variable	Births from first time mothers	Average age, all mothers	Average age, only first-time mothers	Births from teenage mothers	Births from mothers over 40
Blackout baby cohort	0.226***	-0.333	0.265	0.226**	0.189
	(0.058)	(0.320)	(0.324)	(0.110)	(0.219)
Month and year f.e.	YES	YES	YES	YES	YES
Village f.e.	YES	YES	YES	YES	YES
Quadratic time trends	YES	YES	YES	YES	YES
Village time trends	YES	YES	YES	YES	YES
Average dep. var.	0.50	26.5	22.5	0.14	0.04
Observations	14,500	6,742	4,389	14,500	14,500
Number of villages	125	125	125	125	125

Notes:
Regressions from equation (5). Bootstrapped errors in column 1; errors clustered at the *shehia* level for the remaining columns.
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Heterogeneous effects of blackout on number of births per week

	(1)	(2)	(3)	(4)
Data source:	2002 Census	2007 Labor Force Survey		
Village electricity measure:	fraction with domestic electricity (2002)	fraction with domestic electricity (2007)	fraction with tv (2007)	fraction working in electricity-using sectors (2007)
Blackout baby cohort	0.214***	0.133	0.062	0.065
	(0.074)	(0.097)	(0.097)	(0.090)
Blackout baby cohort x Village electricity measure	-0.902	-0.010	0.133	0.369
	(2.069)	(0.141)	(0.164)	(0.412)
Observations	14,500	8120	8,120	8,120
Average electricity measure	0.29	0.43	0.34	0.13
Month and year f.e.	YES	YES	YES	YES
Village f.e.	YES	YES	YES	YES
Quadratic time trends	YES	YES	YES	YES
Village time trends	YES	YES	YES	YES
Number of villages	125	70	70	70

Notes:
Poisson regressions on weekly number of births per village matched to the 2002 Census.
Sample in columns 2-4 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

Table 5: Differential impact of electrification on births

Dep var: number of births Census sample	(1)	(2)	(3)	(4)
Blackout baby cohort by rate of electrification (2002)				
(0, 0.05)	0.270**	0.243	0.269**	0.250
	(0.129)	(0.180)	(0.127)	(0.176)
[0.05, 0.10)	0.304**	0.277*	0.257	0.238
	(0.128)	(0.150)	(0.156)	(0.190)
[0.10, 0.25)	0.311***	0.284***	0.283***	0.264**
	(0.098)	(0.094)	(0.091)	(0.117)
[0.25, 0.50)	0.149***	0.122**	0.110**	0.091
	(0.050)	(0.055)	(0.053)	(0.101)
[0.50, 0.75)	0.138**	0.111*	0.159***	0.140
	(0.062)	(0.059)	(0.058)	(0.093)
[0.75, 1]	0.187	0.160	0.192**	0.173
	(0.124)	(0.126)	(0.092)	(0.116)
Not exposed				0.021
				(0.094)
Month and year f.e.	YES	YES	YES	YES
Village f.e.	YES	YES	YES	YES
Quadratic time trends	NO	YES	YES	YES
Village time trends	NO	NO	YES	YES
Observations	14,500	14,500	14,500	14,500
Number of villages	125	125	125	125

Poisson regressions--See notes from table 2 for details. Bootsrapped standard errors.
*** p<0.01, ** p<0.05, * p<0.1