ISSN 2042-2695

CENTRE for ECONOMIC PERFORMANCE

CEP Discussion Paper No 1247

November 2013

An Urban Legend?! Power Rationing, Fertility and its Effects on Mothers

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E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Abstract

This paper answers the question whether extreme power rationing can induce changes in human fertility and thus, generate “mini baby booms”. We study a period of extensive power rationing in Colombia that lasted for most of 1992 and see whether this has increased births in the subsequent year, exploiting variation from a newly constructed measure of the extent of power rationing. We find that power rationing increased the probability that a mother had a baby by 4 percent and establish that this effect is permanent as mothers who had a black out baby were not able to adjust their total long-run fertility. Exploiting this variation, we show that women who had a black-out baby find themselves in worse socio-economic conditions more than a decade later, highlighting potential social costs of unplanned motherhood.

Keywords: Fertility, infrastructure, blackouts, unplanned parenthood
JEL Classifications: J13, J16, O18, H41

This paper was produced as part of the Centre’s Communities Programme. The Centre for Economic Performance is financed by the Economic and Social Research Council.

Acknowledgements

The first author acknowledges financial support from the Kondard-Adenauer Foundation.

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Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

The national blackout might have another surprise as well - a Kenyan baby boom nine months from now... take advantage of a great opportunity to say: "Hey baby, how you doing?"

1 Introduction

Power outages or blackouts are a recurrent feature in many developing countries across the world. Anecdotal evidence has suggested increased fertility rates resulting 9 months after the blackout as peoples' procreation increases when lights go out. The idea of baby booms following a blackout has been a subject of contention for a long time. It first came into prominence in popular culture after the great New York blackout of 1965 which left over 30 million people without electricity for 13 hours. However, the seminal work by Udry (1970) concluded that there was no significant impact of the great NY blackout on fertility 9 months later. Since then, the theory has been termed as an "urban legend" by the President of the Population Association of America .

Unlike the New York blackout or indeed most power outages in the developed world, which are limited in time and space, developing countries in recent years have been experiencing great power uncertainty. Many states in Africa experience rolling blackouts that last weeks if not months and for several hours a day. Thus, though the evidence may lack in support of baby booms after a black out in developed countries, the frequency of blackouts over a longer period of time make it more plausible to causally link blackouts in developing countries to baby booms 9 months later. Rather, the question may be of greater importance to policy makers and planners in developing countries who have burgeoning populations and high rates of urbanization. Understanding the impact of electricity shocks on fertility behavior is important to economists, demographers, and policy makers in general because it illuminates how individual fertility decisions are influenced by changes in expectations about the costs and benefits of child rearing in the future. This question is also of great importance, in particular, to policy makers in areas that experience power cuts at a regular frequency or even in isolated and short lived events like the two day blackout that affected 600 million Indians in July 2012 for its implications by the sheer number of impacted individuals.[1] Further, blackouts may play a bigger role in developing countries, as there

[1] See `http://www.bbc.co.uk/news/world-asia-india-19071383`, accessed on 20.06.2013.

are significant barriers to access to effective family planning tools, which increase the likelihood that unexpected, blackout-induced sexual activity translates to additional births. Additionally, in presence of market failures, the same lack of family planning use increases the likelihood that any temporary increase in fertility could translate to a permanent increase in the population. We would also expect that if a woman is at a critical development stage such as the teen years or early adulthood having an unplanned birth could halt educational attainment, career development, or even romantic relationships, therefore leading her to be out of sync with her peers, being detrimental above and beyond the challenges of unintended births.

Our paper makes two main contributions. First, we provide evidence that there is a causal effect of power outages on short and long run fertility. We examine a particular black out in Colombia caused by the El-Nino droughts in 1992, leading to a period of almost 12 months of daily rationing of electricity. The blackout had some appealing features: because it was caused by an unforeseen climate change phenomenon, it was completely unexpected; it lasted for one year, long enough for sufficient statistical power to detect the impact on fertility and long run family size; and, since it affected the country, it was very clearly delimited in time and space. In order to identify the effect of the rolling blackout, we construct two novel datasets. First we use the IPUMS micro sample for the 2005 population census of Colombia to construct a retrospective mother level birth history by linking mothers to children within the household. We combine this dataset with municipality level variation in night lights as measured by satellites images for the period 1992/1993 to construct a variable of treatment intensity to the power crisis. We document an increase of 0.005 percentage points in the probability of having a child in 1993. When evaluated at the mean probability of having a child in any given year, this results into an increase in having a birth by 4 percent. In terms of the total number of additional children born, if the whole of Colombia was to lose power for one year, an additional 27,000 children would be born due to a complete blackout. We also identify heterogenous effects by age cohorts, with almost all of the effect being driven by women between the ages of 15 and 30 in 1992. Finally, we show that women who gave birth due to the blackout have a permanent increase in total number of children 13 years later. Our second key contribution is to use the black-out intensity as an instrument for total fertility, to study the effect of the fertility shock on economic outcomes of young mothers. We provide evidence that women who had an unplanned birth following the black-out ended up with worse-education levels and they were more likely to be single-mothers living in poorer housing conditions. These findings suggest that there may have been significant welfare-consequences through longterm persistence of the shock, contrary to lifecycle theory.

The rest of the paper proceeds as follows. Section 2 provides a brief background on the institutional features of the 1992 black out in Colombia. In Section 3, we describe the data and how we constructed our main dependent variables. Section 4 provides the empirical strategy and the key results. The conclusion follows in Section 5.

2 Context and Existing Literature

This paper contributes to several strands of literature. First, it contributes to a limited but growing empirical literature on examining the impact of electricity infrastructure in developing countries (see Dinkelman (2011); Rud (2012); Burlando (2012)). In particular, it provides evidence on the influence of infrastructure on fertility behavior, thus shedding light on the role of long run effects of infrastructure investment so far as there exist state dependency within households. Mostly closely tied to our work is by Burlando (2012) who looks at the impact of a month long power outage in Zanzibar on village level fertility outcomes. He finds a mini baby boom 9 months after the blackout with an increase in village level births by 20%. Second, it contributes to understanding fertility response to aggregate shocks Evans et al. (2008) and and Pörtner (2008). Studies of natural disasters and in particular hurricanes have found a negative relationship between hurricane advisories and baby booms 9 months after the event. As the type of advisory goes from least severe to most severe, the fertility effect of the specific advisory type decreases monotonically from positive to negative. In comparison, our paper is similar in treatment to the least severe advisory given that power blackouts do not have any physical stress associated to them, while at the same time provides a better experiment than Udry (1970) whose treatment only lasted a period of 10 hours. Third, we speak to a broad literature of the role of culture and leisure on fertility (Ferrara et al. (2012); Jensen and Oster (2009)). Both the studies have linked the role of television programing in influencing fertility behavior, including smaller family sizes. To the extent that television programing and other social activities require electricity, we would expect persistent power outages to change cultural norms and thus effect fertility behavior. Finally, we also provide evidence on the long-run consequences of unwanted pregnancies and the effect of children on their mothers labour market and socio-economic outcomes (Angrist and Evans (1998) and Jacobsen et al. (2007)). In the Colombian context, this is particularly worrying as unwanted pregnancies and too-early childbearing are common in Latin America and the Caribbean. According to Koontz and Conly (Koontz and Conly), women who begin childbearing as teenagers are estimated to have two to three more children than women who delay their first birth until their twenties or later. This problem is even more acute in Latin America where improving health care during the 90s meant that young women are now more likely to have a child during adolescence than were teens during the 1970s Gutmacher Institute (1997). Finally, not only does early motherhood lead to more children in the future, but high adolescent fertility rates are linked to low educational attainment and poverty Koontz and Conly (Koontz and Conly). In developed countries the findings are similar, where early motherhood leads to lower education outcomes, worst housing condition and labor market outcomes Levine and Painter (2003), Ashcraft and Lang (2006) and Kaplan et al. (2004). For a review of the literature on unintended pregnancies on parental and child health the reader is referred to Gipson et al. (2008).

Our paper is, to our knowledge, the first paper to look at mother level impact of an aggregate shock like power outages on short and long run fertility outcomes.

This represents a potential improvement over previous studies, which have used twins- and siblings to study the impact on mothers' labour market outcomes. Our paper is broader and thus contributes regarding external validity concerns that these other approaches suffer from.

We also make significant contributions on the methodological front by combining aggregate night light data to micro data sets. Finally, we present evidence on how in practice, families may overshoot or undershoot their optimal fertility contrary to the lifecycle hypothesis of fertility behavior.

We now turn to discussing the data and the methods used in this study, before presenting the specification and our key results.

3 Data

3.1 Detecting Power Outages from Remote Sensing

In 1992 Colombia derived roughly 80 % of its electricity consumption from hydroelectric.[2] Most of this energy is produced in fourteen hydro-electric power plants that are located mainly in the Caldas and Antioquia departments of central Colombia. These are located to the north and east of Medellin, where the Mountain ranges of the Andes typically provide ample rainfall runoff water that may be used for hydroelectric power generation. However, data of power generation and consumption at municipality level is not available. Thats why we use variation in remote-sensing derived luminosity data to obtain a measure of the treatment intensity of different municipalities across Colombia.

Satellite derived Night lights data has been used by economist to map economic activity (see Doll (2008)) and economic growth (Henderson et al. (2012)) for some time. The data has the advantage of being available, where reliable GDP statistics do not exist. Furthermore, they allow the study of the geography of urbanisation. Other recent applications have been in the sphere of political economy, to map the relationship between electoral success and the provision of public goods (see Min (2008)), again in contexts where data on the provision of these public goods is not available.

However, to the best of the knowledge of the authors, the night lights data has not been exploited to study abnormal variation in night-light intensity, which may be caused by power outages. In that way, the paper breaks methodological ground as we show that the night light data can be used to obtain measures of the extent to which areas were exposed to power outages.

We study the Colombian context where power rationing was in place from February 1992 to March 1993. This power rationing was caused by insufficient rainfalls due to the El Nino phenomena. This lead to low water levels in the reservoirs of hydroelectric dams and resulted in significantly less power being generated. There are no country-wide figures available, as even for some departments, no power production or consumption data is available. However, one of the biggest energy firms at that time

[2] See `http://www.tebsa.com.co/history.htm`. Since the power crisis in 1992 a lot of investment in thermal power plants have reduced the reliance on hydro power. According to `https://www.cia.gov/library/publications/the-world-factbook/geos/co.html`, the share of hydroelectric power is now only 67%.

estimated that throughout the year there was a shortfall equivalent to roughly 20% of the annual production of 1991.[3] Colombians refer to the period from 1992 to 1993 simply as the "Black Out".

We exploit luminosity data to map the geographic heterogeneity of the extent to which there was indeed a black-out. There are good reasons to believe why this effect varied across the regions. There are a lot of reasons why potentially, there was heterogeneity in the extent of power rationing. One source of heterogeneity may be geographic distance to the nearest power generating facility, or whether alternatives for power generating were available (such as geothermal power generated mainly in the North of Colombia). A second reason for heterogeneity may be a political economy channel - namely, municipalities that were well-connected to the ruling party, may have been able to lobby for less extensive rationing in their municipality. All of these points suggest that the effect of power rationing was indeed heterogeneous.

Figure 2 highlights our approach to measure this heterogeneity indirectly, using night-lights luminosity data available from US run Defense Metrological Satellite Program (DMSP).

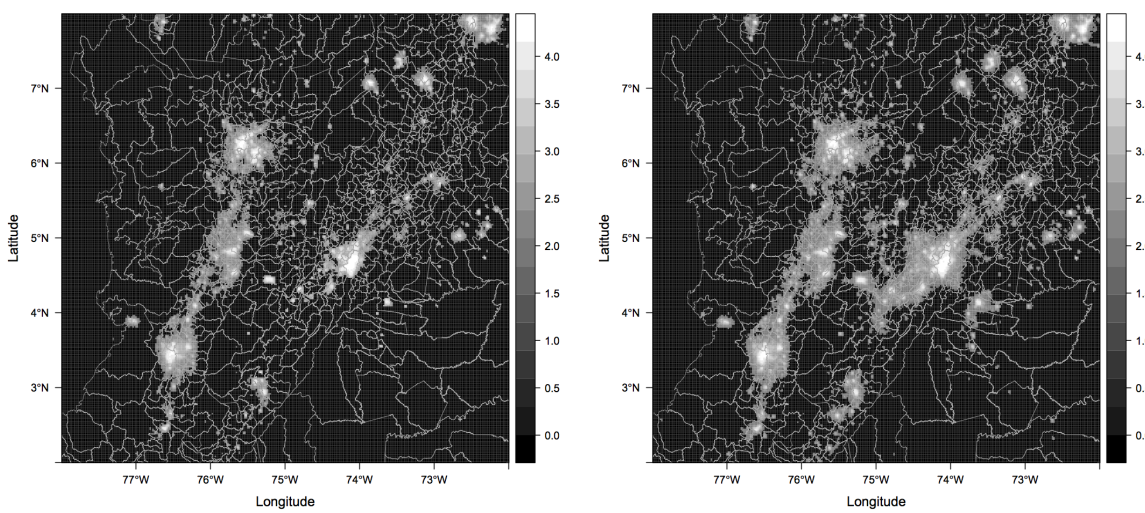

Figure 1: This graph depicts the light intensity in 1992 (left) and 1993 (right)

The figures depict the luminosity variable around three main urban centres in Colombia in 1992 (left) and 1993 (right). The northern area is the Medellin metropoli-

[3]See http://www.tebsa.com.co/history.htm, accessed on 20.06.2013.

tan area, while in the south is Colombia's second biggest city Cali. The light-blob to the right is the metropolitan area of Bogota. The differences in the pictures are dramatic. Especially around Bogota, the broader geographic area appeared to be completely dark in 1992, while it is lighted in 1993.

Note that the night-light data series is only available from 1992 onwards. Hence, we can not compare the lighting intensity in the year 1992 (the year of the outage) with preceding years, as this data simply does not exist. However, we may be able to compare the 1992 lighting intensity with the intensity in 1993 or 1994. This measure will, of course, be subject to measurement error since the 1993 luminosity is an outcome variable in itself. However, as we are studying micro-level data, it is hard to believe that the micro-variation has a direct effect on 1993 luminosity. In fact in appendix B we also show the luminosity for 1994 - it is difficult to argue that the year-on-year variation between 1992 and 1993 is capturing something other than the power-outage, since the pictures for 1993 and 1994 look almost identical.

We construct the power outage intensity variable at municipality level as being essentially the ratio of the average population-weighted municipality luminosity in 1992 over that measure for 1993, i.e. it is constructed as:

$$O_m = 100 \times (1 - \frac{Lights_{1992}}{Lights_{1993}})$$

The weighting by population becomes necessary as the IPUMS data merges several municipalities that have population sizes less than 20,000 to ensure that users of the data are not able to reverse-engineer who the individuals in the sample were. This makes the treatment intensity construction more tedious and less clean, but does not represent a significant issue.[4] Before turning to the empirical specification and the main results, we discuss the census data that is used throughout the paper.

3.2 Census Data

For outcomes we use the 10 per cent of the 2005 micro sample census of Colombia provided by IPUMS. The sample census covers 10% of the population at the time

[4] Our results are robust to not using weights or weighting by the geographic size of municipalities. Note that the measure may actually take on negative values, indicating that there are places that were more luminous in 1992 then in 1993; however, the bulk of the municipalities exhibit a positive measure.

and was hailed to be the most successfully conducted population census.[5] For the short run outcomes, we construct a retrospective panel of mothers using the matched mother to children data for the period 1990 to 1995. The panel structure of the data allows us to identify the effect of the blackout by exploiting within-mother variation in the timing of birth of babies, instead of cross-region or within-region variation. This gives us a total number of 540,737 mothers with 68,673 number of children born in this period. For the long run outcomes, we exploit the the exogenous timing of the blackout caused by El-Nino rainfall shortages and take advantage of the timing of births, giving us a quasi-experiments where mothers were not treated by the blackout due to biological constraints. We restrict our analysis to comparing women who gave birth in 1993 to women who gave birth in 1992 and 1991. This leaves us with 67,240, 59,635 and 57,511 women in the sample respectively.

We now proceed to detail the empirical strategy and present the main results.

4 Empirical Strategy and Main Results

We separate the empirical analysis into three steps. First, we look at the short run implications of the power outages on mother-level fertility behaviour. Secondly, we show that these effects persisted - i.e. that the power outage is associated with a life-time increase in fertility. In the third section we ask how this long-run effect correlates with economic outcomes for the mothers, thus highlighting the possibility of there being welfare consequences.

4.1 Short Run Fertility Effects

4.1.1 Method

Our dependent variable is a dummy variable $B_{imt} = 1$, if mother i from municipality m gave birth in year t. We estimate the following linear probability model specification

$$Pr(B_{imt} = 1) = a_i + b_t + \theta \times O_m + \zeta \times T_{imt} + O_{mt} \times T_{it}\gamma + \epsilon_{imt} \qquad (1)$$

where we include mother fixed effects a_i and time fixed-effects b_t. We add the sub-index m for municipality, since the treatment intensity is fixed at municipality

[5] See http://unstats.un.org/unsd/censuskb20/KnowledgebaseArticle10236.aspx, accessed 20.06.2013.

level. The treatment assignment is $T_{it} = 1$ for the year 1993, i.e. the year in which babies conceived in 1992 are being born.[6] Note that T_{it} is perfectly collinear with the time-fixed effects and the power outage measure O_m is invariant at municipality level, thus perfectly collinear with the mother fixed effects a_i.

Although there is no a priori association between the power outage intensity and the likelihood that female babies or twins are born, controlling for these exogenous characteristics of babies reduces the error variance, and thus increases the precision of estimation of coefficients of interest. Standard errors are clustered at the municipality level to take into account any arbitrary correlations of the error term ϵ_{imt} across babies born in municipality m in year t and over time in municipality m.

Hence, the estimating equation becomes:

$$Pr(B_{imt} = 1) = a_i + b_t + O_m \times T_{it}\gamma + \epsilon_{imt} \tag{2}$$

The coefficient of interest is γ, which measures the average difference in the mean probability of giving birth born to the same mother over time between municipalities with varying degree of power-outage intensity measured by O_m. Under the assumption that, after controlling for mother fixed effects and exogenous covariates, changes in probability of birth in municipalities which experienced lower power-outage treatment provide a counterfactual for municipalities, which were hit by high power-outage treatment (i.e change in birth probability that would occur if there were no power-outage), represents the effect of power-outage intensity on birth probability. Possible sourced of violations in equation 1 can be municipality unobserved characteristics. Unobservable time-invariant characteristics of municipalities such as geography, history and culture are not the source of violation of the identifying assumption represented by model 2 because the set of mother fixed effects in each municipality captures such municipality fixed effects. On the other hand, we are worried to a lesser degree regarding time varying unobserved factors, which may be correlated with the intensity of power-outage and probability of birth due to the short time frame we consider for the analysis (1990-1995).

[6] It is clear that this is an Intention to Treat design, as we do not actually observer fertility and mating behaviour around the time, i.e. we can not rule out that some women who were assigned treatment did actually receive treatment.

4.1.2 Results

Table 1 reports estimated coefficients on the variable of interest γ by adding controls one by one. γ, the coefficient on power-outage intensity O_{mt} interacted with treatment year T_{it} is positive and significantly different from zero. In column (2) we add time fixed effects, in column (3) we add municipality fixed effects and in column (4) we replace municipality fixed effects with mother fixed effects. At first, it may seem surprising that the coefficient remains very stable and does not change when adding the mother fixed effects. However, we may see this exercise as evidence that the treatment was quasi random, as adding the fixed effects does not change the estimated coefficient, but only services to increase the precision of the estimates - which is what we would expect if treatment was quasi random. A 100% increase in power-outage intensity (i.e complete blackout relative to previous year) increases the probability of having a birth by 0.005 percentage points. A 0.005 percentage point increase is an increase of 4% in the probability of giving a birth in a given year for the sample period in consideration. At the mean power-outage intensity of 31.5%, we estimate the additional number of children born due to the power-outage to be 8,517 - a 95% confidence bound suggests that between 2,310 and 14,502 children were born due to the blackout.[7] How does this compare to the total expected number of children being born in this period? Given a mean probability of giving birth of 12.3%, on average, 209,508 babies would have been born. Hence, we can estimate that between 1.1% and 6.9% of the babies born were "power outage babies".

Column (5) presents evidence on heterogenous treatment effect. There is strong support for differential cohort effects. Most of the impact of the power-outage is being driven by the younger cohort who were aged between 15 and 30 in 1992.[8]

[7]We arrive at these upper- and lower bounds by scaling up the point estimate times the mean black-out intensity of 0.315, by the number of women in the estimation sample multiplied by the point estimate. This implies, given our point estimate of 0.005, that there are $0.005 \times 0.315 \times 540,737 \times 10 = 8,517$. We multiply by 10, since the micro-data pertains to only 10% of the population.

[8]Note that the coefficient for women aged above 30 has a p-value of .151. Using finer age-cohorts, some older age groups yield significant results as well, however, there is not enough variation to estimate differences in the mean effects precisely. These results are shown in the Appendix **??**.

Table 1: The Impact of Power Outage Intensity on Birth Probability

	Different Fixed Effects				Age Specific Effect
	(1)	(2)	(3)	(4)	(5)
Outage Intensity x Treated	0.525***	0.525***	0.525***	0.525***	
	(0.182)	(0.182)	(0.182)	(0.182)	
Outage Intensity x Treated x Younger than 30					0.530**
					(0.256)
Outage Intensity x Treated x Older than 30					0.397
					(0.262)
Mother FE	No	No	No	Yes	Yes
Time FE	No	Yes	Yes	Yes	Yes
Municipality FE	No	No	Yes	.	.
Mean Birth Probability	.123	.123	.123	.123	.123
Observations	3187164	3187164	3187164	3187164	3187164
Number of Groups				531194	531194

Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. Standard errors in the parentheses are clustered at the municipality-type level. Outage x Intensity measures the proportional change in municipality-level luminosity between 1992 and 1993. The dependent variable is an indicator variable equal to one, in case the mother experiences a birth.

We consider a few robustness checks to ensure the validity of our results. Column (1) of table 2 presents the preferred specification from from table 1. Since the census sample was conducted in 2005, a major concern with our results is that mothers may have moved across municipalities since 1993, thus biasing our power-outage intensity assignment. If this is due to pure randomness, we would expect our measure to be noise and thus lead to attunation bias. On the other hand if the re-location choice of the mother is correlated with some unobserved characteristic of the municipality in 1993, we would have biased estimates for the effect of power-outage on probability of birth. In order to address this, we restrict our sample to women who are born in the same municipality and have lived there all their lives. In column (2), we present the results of the sub sample and re-assuringly, we do not find any change in the point estimate. In column (3) we carry out a placebo test by re-assigning the treatment year to be 1992, reflecting children born who were conceived in 1991. Since 1991 was a normal year with respect to electricity provision, we would not expect any differential impact of power-outage intensity for children born in 1992. Indeed we find a coefficient that is close to zero and statistically insignificant. In column (4) we use an unweighted measure of the power-outage intensity and find that the point estimate for γ remains robust to the alternative measure of power-outage intensity.

Columns (5) and (6) explore some asset ownership interactions; as these are measured in 2005, they are likely endogenous and it becomes clear that no pattern emerges.

We now turn to the study of the persistent effects of the power outage on total fertility, thus, trying to shed light on the life-cycle hypothesis of fertility behaviour.

Table 2: Robustness of the Short-Run Fertility Effect of Power Outages

	Robustness Measures and Specification				Heterogeneity	
	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	Non-movers	Placebo	Unweighted	Refrigerator	Electricity
Outage Intensity x Treated	0.494***	0.459**			0.220	-0.290
	(0.182)	(0.224)			(0.305)	(0.661)
Outage Intensity x Treated (Placebo)			0.110			
			(0.204)			
Outage Intensity (Unweighted) x Treated				0.485**		
				(0.197)		
Outage Intensity x Treated x Refrigerator					0.374	
					(0.418)	
Outage Intensity x Treated x Electricity						0.859
						(0.696)
Mother FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Mean Birth Probability	.123	.127	.123	.123	.124	.123
Observations	3244422	1869534	3244422	3254166	3162210	3244422
Number of Groups	540737	311589	540737	542361	527035	540737

Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. Standard errors in the parentheses are clustered at the municipality-type level. Outage x Intensity measures the proportional change in municipality-level luminosity between 1992 and 1993. The dependent variable the total number of children of a mother in 2005.

4.2 Long-run Fertility Outcomes

4.2.1 Method

The simple theoretical framework suggested that there may be dynamic adjustment of fertility behaviour after an induced shock. If this is the case, then we would not expect there to be any persistent effects of fertility shocks due to the power outage. In particular, we would not expect there to be an effect on the total number of children that are being born in the lifetime of a women that was affected by the power outage as increased fertility behaviour during the blackout is compensated with less fertility behaviour in later years. Furthermore, we want to study what is the effect of unexpected children on the mothers.[9]

We first turn to studying, whether women who experienced a fertility shock were adjusting their fertility behaviour later on in life. The key difficulty for this exercise is to find an adequate treatment- and control-group for which a difference-in-difference methodology can be applied on the cross-sectional data on the number of children per women that comes from the census.

This is not straightforward as cohorts in different age-groups may be differing in many ways, such that it is difficult to verify a common trends assumption. Furthermore, selecting a good counterfactual cohort may help us address issues regarding the *underlying mechanisms*. In particular, it is possible that the power outage had a direct effect on incomes and through that affected long-run outcomes at the mother-level. This would lead to a violation of the exclusion restriction for our later instrumental variables exercise. A second concern is that the power-outage may have shifted copulation forward in time. This would suggest that a woman would become mother at an earlier age. Since these women are sexually active for a longer period of time, we would expect them to have in total, more children. Again, it has been shown that early motherhood has been found to adversely affect the mother (see e.g. Ashcraft et al. (2013)), which would lead to yet another violation of the exclusion restriction for our exercise.

We will choose our treatment and control group to get the closest possible definition to highlight the unplanned motherhood mechanism. In particular, we choose our control group, such that both treatment and control were exposed to the power outage (and thus, a possible income shock), but only the treatment group could *physically*

[9] Since in 2005, most of these children were only 13 years old, we are not yet able to study consequences on the "power outage babies" themselves.

receive the treatment. Secondly, we constrain our sample to women both the control and treatment groups to mothers who had given birth at least once before 1992 and 1993 respectively. This implies that the channel of early motherhood affecting socio-economic outcomes has been shut out.

With this in mind, we construct our control group as women who gave birth during 1992, the period in which the blackout did occur, and had given birth at least once already prior to 1992. These women were, if anything, only partially treated. Post-delivery, the likelihood of having another child immediately is very low as post natal care takes up a large chunk of the mothers time. As per the sample census, of the women who gave birth in 1992 or 1993, only 3.7 per cent of the women gave birth in both years. Clearly, a women who gave birth in 1992 would not be treated for the months she was pregnant during the blackout for obvious reasons. Given that women who gave birth in 1992 were less treated than otherwise, they can constitute a control group for women who gave birth in 1993 and had given birth already at least once before 1993.

This sample of women constitutes a very good counterfactual, as their age-profiles and thus, their physiological fertility profiles are very similar since they reproduced around the same period of time. Furthermore, the choice of treatment- and control group helps us to rule out alternative mechanisms that could violate our instrumental variables identification strategy for the effects of unplanned motherhood on socio-economic outcomes of the mother.

The specification we estimate is a difference in difference specification. This allows us to test the impact of the blackout on total number of children 13 years onwards, comparing women who gave birth in 1993 to women who gave birth in 1992.

In particular, we estimate:

$$tch_{ami} = b_{ma} + \beta_1 T_{mi} + \beta_2 O_m + \beta_3 T_{mi} \times O_m + \mathbf{X_{im}}'\pi + \epsilon_{ami} \tag{3}$$

where b_{ma} is a set of municipality-age-fixed effects. These control for common shocks to women of the same age in a municipality. These fixed-effects are very demanding, but take out a lot of age specific heterogeneity that could be due to age or time-specific events at municipality level. Note that in this setup, we can not control for mother-fixed effects, as there is only cross-sectional variation in the dependent variable. The variable O_m measures, as before, the intensity of the power outage in 1992. Treatment is assigned to mothers i in municipality m that gave birth in 1993, while this variable is set to zero for mothers in municipality m who gave birth in 1992. $\mathbf{X_{im}}$ contains other time-invariant controls fixed at the mother level.[10] We present the results from this regression in table 3.

4.2.2 Results

Column (1) is a simple difference in difference regression without any controls. The coefficient on the interaction term is positive and highly significant. This means that the mothers who gave birth due to the power outage were unable to fully compensate by having fewer future children relative to mothers who gave birth just a year prior to the power outage. In columns (2) and (3) add municipality age fixed effects and in mother level controls respectively. Our point estimate increases slightly in size and become more precisely estimated. Column (5) suggests that if a municipality was exposed to 100% blackout in 1993, then every 10th mother in the treatment group within the municipality is likely to have one more child compared to the control group. Evaluated at the mean power-outage intensity, this results in 2,308 additional number of children 12 years later. Column (4) and (5) report some robustness checks to ensure our results are indeed meaningful and do not simply capture differential trends between the cohorts. In column (4) we look at the long run outcome by age cohorts. Since the short run shock was observed to only effect mothers below the age of 30, we would not expect there to be any differential treatment effect for mothers above the age of 30 12 years later. Indeed we find that the coefficient on the triple interaction with mothers aged above 30 in 1992 is mont significantly different from 0. On the other hand, the difference in total number of children is once again being fully driven by mothers who were young in 1992. In column (5) we present a natural placebo check. We present is to perform the same exercise comparing women who gave birth in 1992 to women who gave birth in 1991. Since there were no power outages in either of the two years, there is no reason to believe that the blackout should have any significant impact on the long run total number of children for these two groups of women. Indeed the difference in difference estimator is close to 0 and insignificant.

It becomes evident that the power outage had a significant effect on the number of children born for the treated cohort. We take these results now one step further, by asking what are the impacts on the mother who had a potentially unplanned child?

[10]These include an indicator variable for the ethnicity status (mainly to control for indigenous populations) at the mother-level and some indicator of whether the location of the mother within the municipality is a population centre,a head-town or dispersed population.

Table 3: The Persistent Effects of Power Outage Intensity of Total Number of Children

	(1) Base	(2) Adding FE	(3) Adding Controls	(4) Cohort Effect	(5) Placebo
Treatment x Outage Intensity	9.704**	10.614**	10.115**		
	(4.671)	(4.120)	(3.953)		
Older than 30 x Treatment x Outage Intensity				14.005	
				(11.506)	
Younger than 30 x Treatment x Outage Intensity				8.965**	
				(4.070)	
Treatment (Placebo)					0.028
					(0.018)
Treatment (Placebo) x Outage Intensity					-1.516
					(4.788)
Treatment	-0.039**	0.063***	0.052***		
	(0.019)	(0.018)	(0.017)		
Muncipality x Age FE	No	Yes	Yes	Yes	Yes
Mother Controlls	No	No	Yes	Yes	No
Mean Number of Children	4.12	4.12	4.1	4.12	4.14
Observations	125451	125451	121609	125451	115861

Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. Standard errors in the parentheses are clustered at the municipality-type level. Outage x Intensity measures the proportional change in municipality-level luminosity between 1992 and 1993. The dependent variable is given in the column head.

4.3 Long Run Impacts on the Mother

We can now turn to the third pillar of the analysis - namely, we want to shed light into whether the fertility shock had some long-lasting effects on the lives of the mother or the family environment in which mothers live. We can exploit the variation in long-run number of children as an instrument for a set of family characteristics to shed light on possible mechanisms through which unplanned children may have an effect on the lives of the mother and the family, in which children are brought up. This is key as the existing labour economics literature has highlighted the role of the family environment for long-term outcomes.

We have already established that the power outage had persistent effects on the number of children born to a mother i. We now want to use this variation to explore other margins through which a mother i was affected through having a "power outage baby". We proceed with an IV estimation strategy, whereby we exploit the arguably exogenous variation in power-outage intensity that resulted in more babies being born. These additional children may affect women, as they may have to give up e.g. further education. They also may have had to enter the workforce at a younger age, which allowed them to build up assets earlier, even though their lifetime earnings prospects may be significantly lower. As we expect this to be particularly relevant for younger mothers, we constrain the sample to women who in 1992 were younger than 30. Restricting the sample to this cohort is further supported by the previous section, where we found that the effect on total fertility is mostly driven by women who in 1992 were between 20 and 30 years old.

The relevance of our instrument has been demonstrated in the previous section. The exclusion restriction requires that there is no other channel through which the exposure to the power outage intensity O_{im} had an effect on some outcome $y_{mai}$for a women $i$of age $a$living in municipality m. We will explore some falsification exercises that suggest that the excludability of the instrument is indeed satisfied. The first stage for our Instrumental Variable specification is simply specification 3 from the previous section. We use the first-stage to generate fitted values for the total number of children and then estimate:

$$y_{mai} = b_{ma} + t\hat{ch}_{mai}\gamma + \eta_1 T_{mi} + \eta_2 O_m + \mathbf{X'_{im}}\mu + \nu_{dami} \tag{4}$$

The results from this exercise are presented in table 4.

Women who were subject to the power-outage induced fertility shock were in 2005, more likely to be single-mothers, possibly reflecting the social cost of having unwatned babies. They were also less likely to have completed higher secondary schooling and less likley to have graduated from university. We do not find any effect of an extra child on the likelyhood of employment.

However, we see that they were more likely to own the accommodation they live in, but this accommodation tends to be of low quality. The quality of the accommodation is an index that takes a maximum value of three if the accommodation has dirt-floors, no solid walls and no access to running water.

The last column serves as a placebo check. Here we see whether the total number of children had an effect on the mother's primary school educational attainment. As this was predetermined before the mother was in child-bearing age, it is reassuring that the total number of children appear not to have an effect on this covariate. It is important to highlight that the IV strategy provides some distinct results, compared to the simple OLS estimation of the above specifications.

These results taken together paint a very interesting picture. It suggests that there were persistent effects on women, who had more children in total due to the power outage. These women are living in less stable family situations, as they are more likely to be single mothers. This could be because the child was born into an unstable relationship and was not planned. There are also repercussions on the educational attainment, with women not taking higher education. However: there are also some more positive results. Women may have had to enter the labour force at a younger age due to having a baby. This makes it more likely that these women can accumulate assets.

5 Conclusion

This paper set out to analyse the impact of vast power rationing in Colombia in the early 1990's on fertility behaviour. This is the first paper to evaluate the impact of power rationing on population dynamics, going beyond the question whether power outages may cause "mini baby booms".

Such research was not possible, because we lacked good data on electricity consumption. However, we highlight that the satellite based night lights measures may be a good measure to identify places, which were subject to power rationing and the extent thereof.

We use this measure to show that women who live in areas in which the power rationing was more severe, were more likely to give birth in the year following the rationing period. This suggests that there are indeed "mini baby booms". However, we take these results further to answer the question whether fertility behaviour dynamically adjusts over time.

We find that there is significant persistence as women do not fully adjust their overall fertility. Finally, we show that the power-outage induced baby boom had long run consequences on the mothers. This suggests that there may be significant "hidden cost" to variable or low quality infrastructure.

In order to equip policy makers in developing countries, that face periods of severe power rationing, further research needs to be carried out to understand the timing of load shedding and its effect on fertility, so as to minimise the hidden social cost of power rationing.

Table 4: The Persistent Effects of Power Outage Intensity on Socio-Economic Status of Mother

	(1) Children	(2) House	(3) Low Quality Housing	(4) Single Mother	(5) Self-employed	(6) Secondary School	(7) Placebo
IV							
Treatment x Outage Intensity	0.110***						
	(0.038)						
Total Number of Children Born		0.240*	0.672**	0.190*	0.073	-0.188*	-0.067
		(0.131)	(0.301)	(0.097)	(0.105)	(0.112)	(0.109)
Reduced Form							
Treatment x Outage Intensity		0.027**	0.074***	0.021***	0.008	-0.020*	-0.007
		(0.012)	(0.023)	(0.008)	(0.010)	(0.011)	(0.012)
OLS							
Total Number of Children Born		-0.008***	0.123***	-0.000	-0.024***	-0.063***	-0.076***
		(0.002)	(0.005)	(0.001)	(0.001)	(0.002)	(0.001)
Municipality x Age Group FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variable	3.62	.575	1.07	.12	.282	.212	.63
Observations	85897	85746	85746	85746	84871	84838	84838

Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. Standard errors in the parentheses are clustered at the municipality-type level. Treatment indicates mothers who gave birth in 1993 and had already given birth at least once before 1993, while control group constitutes of women who gave birth in 1992 and have given birth at least once before 1992. Intensity measures the proportional change in municipality-level luminosity between 1992 and 1993. The dependent variable is given in the column head and are various socio-economic variables of the mother measured in 2005.

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A Summary Statistics

Table 5: Summary statistics for Short Run Analysis

Variable	Mean	Std. Dev.	N
Birth (dummy)	0.123	0.329	3278532
Outage Intensity	0.297	0.265	3244422
Outage Intensity (Unweighted)	0.297	0.268	3254166
TV ownership (dummy)	0.717	0.45	3176124
Electricity (dummy)	0.916	0.278	3278532
Refrigerator (dummy)	0.608	0.488	3192228
Women Younger than 30 (dummy)	0.591	0.492	3278532
Women Older than 30 (dummy)	0.409	0.492	3278532

Table 6: Summary statistics for Long-Run Data

Variable	Mean	Std. Dev.	N
Power Outage Intensity	0.314	0.275	171631
Indigenuous	0.171	0.376	173023
Not Indigenuous	0.825	0.38	173023
Unknown Ethnicity	0.004	0.064	173023
Mother's Age	39.335	6.569	173023
Total Children Born	4.077	2.376	173023
Single Mom (dummy)	0.126	0.332	173023
Cheap Housing	1.072	1.3	173023
House Ownership (dummy)	0.609	0.488	173023
Primary School Completion (dummy)	0.594	0.491	170927
Years of Schooling	5.834	4.309	170910
Self Employed (dummy)	0.218	0.413	49800
Employment Status (dummy)	0.284	0.451	171014
University Degree (dummy)	0.046	0.209	173023

B Luminosity for 1994

As mentioned in the text, we lack luminosity data for the period before 1991, which would be the adequate control-year for the construction of the power-outage intensity. However, the night light data is only available from 1992 onwards. Thats why we had to compare the 1992 luminosity to the 1993 luminosity to construct the outage intensity variable. The following graphs depict the luminosity also for the year 1994 on the same scale. This highlights that the changes in luminosity from 1992 to 1993 is far from any "normal" year on year variation in luminosity, suggesting that we are really capturing the effect of the power outage through that variable correctly.

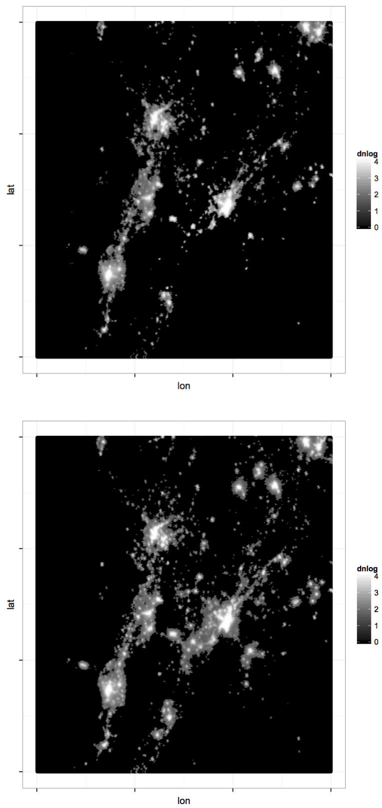

Figure 2: Night Light Intensity in Central Colombia in 1992 (top left) , 1993 (top right) and 1994 (bottom left)

C Further Tables and Robustness Checks

Table 7: The Persistent Effects of Power Outage Intensity on Socio-Economic Status of Mother (unrestricted sample)

	(1) Children	(2) House	(3) Low Quality Housing	(4) Single Mother	(5) Self-employed	(6) University degree	(7) Placebo
Treatment x Outage Intensity	10.339***						
	(3.796)						
Total Number of Children Born		0.225*	0.706**	0.182*	0.084	-0.085*	-0.063
		(0.134)	(0.321)	(0.098)	(0.109)	(0.047)	(0.112)
Municipality x Age Group FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variable	3.59	.573	1.05	.119	.285	.0372	.636
Observations	89644	89491	89491	89491	88603	89491	88572

Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. Standard errors in the parentheses are clustered at the municipality-type level. Treatment indicates mothers who gave birth in 1993, while control group constitutes of women who gave birth in 1992. Intensity measures the proportional change in municipality-level luminosity between 1992 and 1993. The dependent variable is given in the column head and are various socio-economic variables of the mother measured in 2005.

Table 8: The Persistent Effects of Power Outage Intensity on Socio-Economic Status of Mother (unrestricted sample, including age of first birth)

	(1) Children	(2) House	(3) Low Quality Housing	(4) Single Mother	(5) Self-employed	(6) University degree	(7) Placebo
IV							
Treatment x Outage Intensity	0.074**						
	(0.030)						
Age at first birth	-0.142***	0.047	0.142*	0.038*	0.026	-0.005	0.003
	(0.002)	(0.029)	(0.074)	(0.021)	(0.022)	(0.010)	(0.023)
Total Number of Children Born		0.350*	1.090**	0.253*	0.140	-0.099	-0.099
		(0.201)	(0.522)	(0.148)	(0.151)	(0.071)	(0.161)
Municipality x Age Group FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variable	3.59	.573	1.05	.119	.208	.0372	.636
Observations	89644	89491	89491	89491	25805	89491	88572

Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. Standard errors in the parentheses are clustered at the municipality-type level. Intensity measures the proportional change in municipality-level luminosity between 1992 and 1993. Treatment indicates mothers who gave birth in 1993, while control group constitutes of women who gave birth in 1992. Age of first birth measures the age at which the women gave first birth. The dependent variable is given in the column head and are various socio-economic variables of the mother measured in 2005.

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