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Does Electrification Spur the Fertility Transition? Evidence from Indonesia

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ABSTRACT

Does Electrification Spur the Fertility Transition? Evidence from Indonesia[*]

We analyse various pathways through which access to electricity affects fertility, using a pseudo-panel of Indonesian districts covering the period 1993-2010. Identification of causal effects relies on a district-fixed effects approach and controlling for local economic development. The electrification rate increased by about 65 percent over the study period and our results suggest that the subsequent effects on fertility account for about 18 to 24 percent of the overall decline in the fertility rate, depending on the specification. A key channel through which electrification affects fertility is increased exposure to TV, explaining about a quarter of the total fertility effect. Using in addition several waves of Demographic and Health Surveys, we find suggestive evidence that increased exposure to TV affects in particular fertility preferences and increases the effective use of contraception. Reduced child mortality seems to be another important pathway linking access to electricity and fertility. We find no evidence that changes to direct and indirect costs of children play a role. Overall, the results suggest that electrification contributes substantially to the fertility decline. In a context in which family planning policy still plays an important role this second order effect should be taken into account in cost benefit analyses of publicly funded grid expansion policies.

JEL Classification: H43, H54, J13, J22, O18, Q40

Keywords: fertility, fertility transition, electrification, family planning, television, infrastructure, child mortality

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1. Introduction

Electric power went out in New York City and much of the Northeast in the late afternoon of November 9, 1965, and stayed out for up to ten hours. Nine months later, births went up in several large hospitals in the same region. This convinced many people that electricity, or more precisely light, has an effect on fertility. The idea is old, already Friedrich Wilhelm III of Prussia (1797-1840) used to send music bands to villages to wake up peasants when it was still too early to go out and work in the fields and too late to go back to sleep hoping that this would help him to double the size of the Prussian army (Simon, 1955). Although a few years after the New York blackout Udry (1970) showed that what had happened in New York was not necessarily a causal effect, but rather within the usual boundaries of statistical variation, there are theoretically many potential channels through which electricity more broadly could indeed affect fertility. Besides the effect of light on human interaction, electricity may affect fertility via information transmitted through radio and television, via the changes in the direct and indirect costs of children and via improved survival chances of both mothers and their new-borns (see also Harbison and Robinson, 1985). The role of media received recently particular attention. La Ferrara *et al.* (2012) showed that the exposure to soap operas, in particular of women of lower socio-economic status, lowered fertility through the role models that were portrayed. Jensen and Oster (2009) found similar effects for India. Modern media may also enable couples to close the gap between desired and actual fertility by providing information about modern contraception, which in turn helps to reduce unwanted fertility (Bongaarts, 1993). Watching television and radio might also be associated with less social interaction (Olken, 2009) and physical intimacy.

In developing countries fertility is declining almost everywhere, albeit at different paces within and across countries. Understanding the causes and channels of that decline is important to advice policy. For example, the effect of family planning is in reality often lower than commonly thought, as these programs may only affect unwanted fertility, but not fertility preferences, unless these are large scale comprehensive programs that include campaigns promoting smaller families.[1] If access to electricity affects fertility preferences as well as the demand and supply side of fertility through different channels than this factor needs to be taken into account in population policies and policies of reproductive health.

The objective of this paper is to investigate the net effect of electrification on fertility and to shed light on some of the transmission channels suggested by the theoretical literature. We consider the case of Indonesia which is one of the largest and most diverse countries in the world. Indonesia introduced family planning programs in 1970, expanding rapidly throughout the country accompanied by an intense family planning campaign diffused through radio and television and, more recently, other modern media (Hull and Hull, 2005). In the decade that followed the total fertility rate declined by 22 percent, from 5.6 in 1970 to 4.1 in 1980, and then by another 23 percent in the following five years,

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[1] A case in point is the Matlab project in Bangladesh (Pritchett, 1994).

reaching 3.2 in 1985 (BPS, 1998).[2] This decline is often attributed to the dramatic rise in contraceptive use and an associated increase in the age of marriage. The proportion of women using contraception rose from 27 percent in 1980 to 47 percent in 1987 and the average age of marriage went from 19.3 in 1971 to 21.1 in 1985 (Adioetomo et al., 1990; Hull and Hatmadji 1990). However, a number of studies also highlight the effects of expanding women's education and labour market opportunities, which may have been more important drivers of fertility decline than family planning (Hull et al., 1977; McNicoll and Singarimbun, 1983; Hull and Hatmadji, 1990; World Bank, 1990, Pitt et al., 1993; Gertler and Molynaux, 1994; Molynaux and Gertler, 2000; Angeles et al., 2005). The share of households with an electricity connection also increased substantially over this period; between 1993 and 2010 alone from 58 to 95 percent and this may have influenced fertility through enhanced diffusion of contraceptive knowledge and norms as well as a driver of economic development. In both cases electrification would imply second order effects that might easily be overseen in a standard cost benefit analysis of publicly funded electricity grid expansion.

The effect of electrification on fertility has so far received little attention in the literature. In general, the existing empirical studies find a negative correlation between fertility and electrification (Cornwell and Robinson, 1988; Herrin, 1979; Hardison and Robinson, 1985). However, only a few studies look at causal effects. Potter, Schmertmann and Cavenaghi (2002) and Bailey and Collins (2011) confirm the negative effects of expanding electricity connection on fertility in Brazil from 1960 to 1990 and in the US from 1940 to 1960, respectively. Both studies identify causal effects by exploiting geographic variation over time in a fixed-effects analysis. Burlando (2013) exploits the effect of a months-long power outage across electrified and non-electrified villages in Zanzibar and finds a strong positive effect on fertility. Similar results have been obtained by Fetzer et al. (2013) who examine periods of power rationing in Colombia. Peters and Vance (2011) find contrasting patterns for urban and rural areas of Côte d'Ivoire, based on a cross sectional analysis, as electrification is associated with a decrease in fertility for rural households but an increase in fertility for urban households.

Our results are largely in line with these previous empirical studies, as we find that the increase in the electrification rate contributes substantially to the fertility decline between 1993 and 2010. Increased exposure to TV and reduced child mortality rates appear to be key pathways through which access to electricity affects fertility.

We use a unique data set combining annually repeated cross section household survey data with village census information to construct a pseudo-panel for 261 districts, covering the period 1993 to 2010. The district pseudo-panel allows for a district level analysis of the causal relationship between regional expansion of the electricity grid and

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[2] The total fertility rate (TFR) of a population is the average number of children that would be born to a woman over her lifetime if she were to experience the exact current age-specific fertility rates through her lifetime, and she were to survive from birth through the end of her reproductive life. It is obtained by summing the single-year age-specific rates at a given time.

lagged changes in the fertility rate, as well as the transmission channels, while controlling for district and time fixed effects. In addition, the data includes a large set of variables that capture socio-demographic change, and economic and infrastructure development in districts. Finally, we apply an instrumental variables strategy, exploiting variation over time and across districts in the proximity of power plants. The fixed effects estimates are robust to including the control variables as well as the IV approach, suggesting that unobserved time-dependent and district specific shocks are unlikely to drive the results.

The remainder of the paper is organized as follows. Section 2 presents the theoretical framework guiding our empirical analysis. Section 3 describes the data base and the Indonesian context. Section 4 shows the empirical specifications. Section 5 presents and discusses our results. Section 6 concludes.

2. Theoretical framework

As we have argued above there are various channels by which electrification could potentially affect fertility decisions and fertility outcomes. We use a simple theoretical framework that accounts for these various effects, to guide our subsequent empirical analysis. We start from a standard Beckerian model of the demand for children (see e.g. Becker and Lewis, 1973; Willis, 1973; Becker, 1981). We assume that each family maximizes a utility function over the quantity (or number) of children that survive to adulthood, n, and the consumed quantity of an aggregate commodity, Z, i.e.

$$U = U(n,Z) \qquad \text{with} \quad n, Z \geq 0. \tag{1}$$

The budget constraint is given by

$$Y = p_z Z + p_n n, \tag{2}$$

where p_z is the price of the aggregate commodity and p_n is the fixed cost of raising a child to adulthood. This includes direct costs such as food and clothes, but also indirect costs such as the opportunity costs of mothers' time.[3] Children may also directly contribute to family income, Y, for instance by providing labour on the family farm. This can be interpreted as a net reduction in the price p_n, which then becomes endogenous.

Families may value n directly, i.e. for pure altruistic reasons, or because of the children's possible contribution to income. For simplicity we will ignore the issue of old-age support, and only consider a one period model. We also ignore a possible trade-off that

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[3] Assuming that in most societies mothers still provide the bulk of the time needed to raise children.

may exist between the quantity and the quality of children, as we do not want to focus on a possible interaction between access to electricity and returns to investment in education (Becker, 1981).

Given p_n, p_z and Y, and excluding that children contribute to Y, the optimal quantities of n and Z are determined by the budget constraint and the usual marginal utility condition (Becker, 1981)

$$\frac{\partial U}{\partial n} \Big/ \frac{\partial U}{\partial Z} = \frac{p_n}{p_Z}. \tag{3}$$

If children do contribute to household income, p_n depends in turn on the children's marginal productivity. Condition (3) implies a demand function for children n^d of the form

$$n^d = d_n(p_Z, p_n, Y). \tag{4}$$

Hence the demand for children depends on the price of raising children, the price of the aggregate commodity and on income. For example, the demand for children should increase with fathers' income and decrease with the prices p_n and p_Z assuming that both n and Z are normal goods and not too close substitutes.

We now extend the basic demand framework by two elements. First, we allow preferences, U, to vary, for instance in response to the exposure of parents to new role models or to family planning messages. Second, we add exogenous supply side factors to the analysis, such as the quality of available health care that may affect the survival chances of unborn children and infants (Easterlin and Crimmins, 1985). To account for the first effect, we simply rewrite the demand for children as being conditioned by the marginal utility of n for a given set of prices and income, i.e.

$$n^d = d_n(p_Z, p_n, Y \mid \partial U/\partial n_{\mid p_Z, p_n, Y}). \tag{5}$$

To account for the second effect, we write n, the actual number of children that have survived to adulthood, as a function of demand n^d and survival chances s, i.e.

$$n = f(n^d(s), s). \tag{6}$$

Survival chances *s* may also have a direct effect on n^d, for instance if parents are risk averse and anticipate that a certain fraction of their children will die. In this case n^d must be higher in order to make sure that *n* is at least as high as n^d (Schultz, 1997).

We now have all ingredients to illustrate how electricity may have an effect on n^d and *n*. First, access to electricity, *e*, may influence the (shadow) price of children by affecting both the direct and indirect cost of raising children. The direct costs increase as electricity improves the productivity on the labour market of the main caregiver and hence the opportunity cost of time for raising children. But electricity also affects the productivity of child labour and, subsequently, the indirect cost of raising children. Thus we can rewrite (5) as follows

$$n^d = d_n(p_Z, \ p_n(e), Y \mid \partial U/\partial n_{\mid pZ,pn,Y}). \tag{7}$$

The direction of the effect of $p_n(e)$ on *n* depends on the net effect resulting from the direct and indirect effects on the price of children. Empirically this implies investigating the effect of access to electricity on fertility directly and on male, female and children's labour market participation and wages. For South-Africa, Dinkelman (2011) finds relatively strong effects of household electrification on women's labour market participation. Barron and Torero (2013) find somewhat smaller effects for El Salvador. Access to electricity may of course also have a direct effect on the price of *Z*, if this reduces the production costs of *Z* or the transactions costs of acquiring *Z*.[4] Electrification may also increase income directly and by this increase fertility. This could happen if electrification opens up new business opportunities or increases the productivity of existing businesses. Such effects have been recently shown by van de Walle et al. (2013), Lipscomb et al. (2013), Khandker et al. (2013) and Chakravorty (2013). However, overall the evidence is mixed (Bernard, 2012).

Second, electricity may affect $\partial U/\partial n_{\mid pZ,pn,Y}$ through the exposure to television and other electronic media that portray new role models which may alter fertility preferences

$$\partial U/\partial n_{\mid pZ,pn,Y} = f(e). \tag{8}$$

Obviously, even if the desired number of children is not affected, the exposure to new media may still affect the actual number of children if more information about family planning services helps to reduce unwanted births by reducing the cost of not having a child (which is equivalent to an increase in p_n). In this case we are back to the channel illustrated in Equation (7), i.e. a change in the direct cost of children. Modern media may also have an effect on the opportunity cost of time, if the availability of television

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[4] Access to electricity may improve the information about prices and the availability of certain goods on certain markets, thereby reducing the transactions costs of getting *Z*.

increases the costs of time spent on physical intimacy and, subsequently, also the cost of producing a child. This would further increase p_n.

Finally, if electrification improves the quality and accessibility of health care, because new technologies can be used or simply because standard treatments can also be undertaken in the absence of daylight, then we can write survival chances as a function of access to electricity

$$n = f(n^d, s(e)). \qquad (9)$$

Assuming that the increase in survival chances is unrelated to income, prices and preferences, the resulting increase in surviving children that parents will experience can be interpreted as an exogenous shift in the biological supply of children (Schultz, 1997). This shift reduces the cost of producing a survivor, while it also reduces the number of births needed to have a survivor. If parents' demand for surviving children is price inelastic and the cost per surviving child decreases in proportion to the increase in the survival rate, then theoretically parents should respond by reducing the number of births, since they need fewer births to attain a given number of survivors (Sah, 1991; Schultz, 1997). If, in addition, parents are risk averse, the need for hoarding declines as well, which will further reduce the number of births (Schultz, 1997). In this case n^d becomes a direct function of $s(e)$, i.e.

$$n^d = f(s(e)). \qquad (10)$$

In the next section we present the data that will allow us to test some of these channels empirically and provide more information about the context. The empirical specifications that derive from our theoretical framework are then introduced in Section 4. Besides the reduced form analysis of the direct effects of access to electricity on actual fertility, we will investigate the effect of access to electricity on fertility through various forms of media exposure, the use of contraceptives and on women's and children's labour market participation.

3. Data and context

In this paper we use four different sources of data. The core of our analysis draws on the annual Indonesian national socioeconomic household survey (Susenas) from 1993 to 2010. In addition, we use data from the village census (Podes) which was conducted in 1996, 2000, 2003, 2006 and 2008 and data from the Indonesian Demographic and Health Surveys (DHS) which was conducted in 1991, 1994, 1997, 2002/03 and 2007. Finally, we use a dataset containing information on all power plants with a capacity of more than

1MW, their exact location, the date they started operation and, if applicable, the date the plant was shut down. Between 1993 and 2010 there were in total 133 power plants of that size in operation.

The annual cross section data that can be drawn from the Susenas is representative at the district level and can be used to construct a district pseudo panel, yielding a balanced panel of 261 districts for 16 years. We had to drop the districts in the provinces of Aceh, Papua and the Maluku Islands, which were not included in the survey in some years due to violent conflicts. Other than that, all districts are represented in each year. Due to a number of districts splitting up over time, in particular after 2001, we apply a geographic definition of districts that is consistent over time. To this end, we use the 1993 districts definition for all years, combining districts that split up to form the original parent district.[5]

The Susenas includes a question on the source of lighting for the household, which we use as indication of electricity connection. This question is included in the questionnaire in all years, except in 2005. Based on this information we construct a variable measuring the district-specific share of households reporting electricity as the main source of lighting. Information on fertility is based on questions to women aged 10 years and older, regarding the number of biological children. We construct fertility rates as the average number of live births per women. Given that the number of children a woman has depends strongly on age, we control in all our regressions for the district-specific age composition. Moreover, we also estimate the main regressions separately for different age groups to see whether our results differ across age (or cohorts). A problem with our fertility measure could arise if electrification affects the timing of birth, i.e. if electrification leads woman to have their children later without altering the total number of children they have. In this case we would overestimate the effect of electrification on completed fertility. However, we do see no particular reason why electrification should just affect the timing of births.

The survey further includes an array of socioeconomic variables, including education (highest level completed), use of contraceptives, labour market participation, and detailed household spending. We use these household expenditures as a proxy for income in the analysis. For the years 1993 to 1998 the questionnaire also included a module on mass media, asking respondents whether they have watched TV, listened to radio or read a newspaper in the previous week, allowing testing whether electrification affects fertility through the exposure to new media.

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[5] Districts splits followed almost entirely sub-district boundaries within the relevant district, and did not affect borders with neighboring districts. See Fitrani, Hofman and Kaiser (2005) for a more complete account of this process. Statistics Indonesia maintains a full list of district codes over time (see http://www.bps.go.id/mstkab/mfkab_03_09.pdf).

The Podes village census covers all villages (*desa*) and urban precincts (*kelurahan*) in Indonesia, collecting information from the village or precinct head. The village census is aggregated at the district level using village population weights and then merged to the Susenas district pseudo-panel. The Podes village census provides information on infrastructure and economic development. We found consistent questions across Podes waves regarding economic structure (agriculture as the main activity), presence of a market with a (semi-) permanent building or larger shopping complex, the quality of roads (whether the majority of traffic uses an asphalt road), source of clean drinking water (pump or piped water), health care providers (maternity clinic/hospitals, health centers and village maternity posts) and schools in the village.

The DHS data is used to probe the hypotheses regarding desired fertility and child mortality that cannot be tested with the Susenas data. To collect information on desired fertility, the DHS survey asks all women aged 15 to 49 "if they could start afresh, how many children in all they would want". Interpretation of answers to this kind of questions has been subject of controversy. The main point of criticism is that the response may reflect the preferences of the current context women live in and the associated social pressure, rather than intrinsic fertility preferences. However, BPS[6] and Macro International (2008) argue that this criticism may not be relevant for Indonesia, where family planning is widely supported and used, and social pressure is likely to be less of an issue. The main drawback of the DHS data is that it is not suitable for building a district pseudo-panel as the sample is not representative at the district level. Hence, we cannot claim to identify causal effects for the analysis based on the DHS data.

Descriptive statistics for the variables at the district level are presented in Table 1. The electrification rate has increased strongly from 1993 to 2010, in particularly during the 1990s. Based on the Susenas data, Table 2 shows that the share of the population with access to electricity increased from 57.6 percent in 1993 to 94.9 percent in 2010. Most electricity connections are to the national electricity grid of the state utility PLN (PT Perusahaan Listrik Negara), with only 2 to 4 percent of household having a connection to an alternative source. Alternative sources include for instance diesel generators, car batteries and solar panels. The temporal roll out of access to electricity across the archipelago is illustrated in Figure 1, showing that in 1993 the electrification rate was highest on Java and relatively low on most other islands. By 2001, the electrification rate exceeded 50% on almost all islands, with North Sumatra and East Kalimantan exceeding 80%. By 2010 all districts except a few other remote rural areas on Sumatra, West and Central Kalimantan and Sulawesi realised electrification rates of at least 80%.

[insert Tables 1, 2, 3; Figure 1]

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[6] *Badan Pusat Statistik* (Statistics Indonesia).

Both the level and rate of change in access to electricity also varies greatly by income level. Using per capita expenditure as a proxy for income and ranking the population into per capita expenditure quintiles, Table 3 shows that in 1993 only a third of the poorest quintile had access to electricity, against 86.4 percent for the richest quintile. But the expansion of the PLN grid over the following 16 years has led to a more than proportional increase for the poorest. By 2008, households in the richest quintile have close to universal access (98.5 percent), while the poorest have almost caught up (88.0 percent).

The increase in electrification coincides with a gradual decrease in the fertility rate. The trends in the fertility rate are shown in Table 4. Over the period 1993 to 2008, the average number of live births per women aged 15 to 49 has decreased from 2.1 to 1.8. The temporary rise of fertility in 2001 most likely reflects a post-crisis catch-up effect. The small increase of fertility visible after 2005 might be due to the reversal of the trend in the average age at marriage. Hull (2013) shows that in 2005 the age at marriage started to decline again after a long rise.

The general trend is similar to what DHS data reveals, although the level is clearly different, since we do not focus on completed fertility but on age-specific fertility. Another difference is that the Susenas data includes all women between 15 and 49 years old, whereas the DHS focuses only on married women. This leads to a significant overestimation of women's fertility in the DHS data (Hull, 2008). In 1994 the DHS based total fertility rate stood at 2.9 and in 2007 at 2.6, suggesting that fertility declined by about 9 percent (Measure DHS, 2008). Our data yields a quite similar negative growth rate of 12.4 percent over the same period. Moreover, if we condition on married, divorced and widowed women aged 15 to 49, we find 2.854 children per woman for 1994 and 2.413 children per women for 2007 which is relatively close to the DHS figures.

[insert Table 4]

Figure 2 shows that the aggregate time series of electrification and fertility[7] are strongly correlated. Particularly striking is the strong increase in electrification and decline in fertility between 1993 and 2000. After 2000 the rate of change slows down for both variables. But while the electrification rate maintains a steady increase until 2010, fertility shows strong fluctuations around a slight declining trend. The main empirical challenge in this study will be to discern the causal relationship from this correlation.

[insert Figure 2]

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[7] Note that in this figure the decline in the fertility rate includes both a general decline in fertility and changes in the age composition over time.

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4. Empirical specifications

4.1 Fertility and electrification

We model the fertility rate in a district i at time t as a linear function of the electrification rate e_i in that district and a set of time variant district characteristics x_i

$$fr_{it} = \alpha + \beta e_{it-1} + \gamma x_{it-1} + \eta_i + \delta_t + \varepsilon_{it}. \tag{11}$$

We further include district fixed effects η_i and time dummy variables δ_t, with the error term ε_{it} assumed to be a random disturbance. The electrification rate and control variables are lagged by one year, given that fertility decisions and conception occur at least nine months prior to the timing of the household survey. Since the number of reported live births depends on the age of the woman, x_i includes in all regressions the district-specific age composition of women. Note that fr_{it} is rather a measure of n than of n^d, since fr_{it} is based on live births. However, using the DHS data we will also investigate the determinants desired fertility, which is a good proxy for n^d. The control variables x_i also include the rural population share in the district, the average education levels of women aged 15 to 59, the use of modern and traditional contraceptives, and average per capita household expenditure.

The empirical relationship between fertility and the electrification rate is prone to several sources of bias. There may be simultaneity bias, as an expanding population is likely to increase the demand for electricity and energy in general. By taking up lagged values of e_i and x_i, any bias due to direct reverse causality should be eliminated. Omitted variables are another source of bias. Time invariant characteristics, such as cultural and institutional determined factors, are controlled for by including district fixed-effects. Time variant characteristics are more difficult to deal with, as we may expect potentially confounding trends in wealth, and economic and infrastructural development in districts, that could simultaneously affect PLN grid expansion and fertility preferences. First, average district wealth is captured by average per capita household expenditure, lagged by one year. Second, we use data from the Podes village census on economic and infrastructural development characteristics of villages, to conduct a sensitivity analysis for the subset of years in which the Podes was fielded. If the results are biased due to confounding economic and infrastructural development, then we would expect the estimates to be sensitive to adding Podes village variables. Third, the problem of omitted time-variant factors is reduced by the fact that due to the time lag between the district averages of fertility and electrification both variables are not computed over the same sample of women since the Susenas draws a new sample of households every year.

Finally, to further assess the robustness of our fixed effects estimates, we take an instrumental variable approach (following the empirical strategy suggested by Van de

Walle et al. (2013)), where we instrument the district electrification rate by the presence of at least one power plant in the same (p_{it}) or a neighbouring district (pn_{it}). In this case the first stage equation is given by

$$e_{it} = \phi + \chi p_{it} + \kappa\, pn_{it} + \lambda x_{it} + \varphi_i + \vartheta_t + \omega_{it}\,, \tag{12}$$

where all other variables have the same notation as above. The key identifying assumption is that the location of power plants determines village access to electricity but does not have any direct effect on fertility other than through the supply of electricity. For instance it could be that unobserved preferences simultaneously determine fertility outcomes in a village and the connection of that same village to the electricity grid. We assume that the placement of a power plant in the district where the village is located, or a neighbouring district, is exogenous to these preferences after controlling for district fixed effects. This assumption might be violated in the short term if the location of power plants is influenced by local economic development; within the fixed effects setup, however, the assumption is more credible when it concerns the location of older power plants. We therefore apply two alternative specifications: (i) using all power plants operational in year t as instruments and (ii) using only those power plants that have been in operation for at least five years.

4.2 Transmission channels

Guided by our theoretical framework, we assess the role of three potential transmission channels through which electrification may affect fertility: (i) children's and women's labour market participation, (ii) media exposure and (iii) child mortality. We apply a similar fixed effects specification as in equation (10), except that we do not take a lagged specification throughout (as the nine months pregnancy argument is not relevant and we would expect an immediate effect). Apart from income (approximated by per capita expenditure) all other variables we focus on are observed in the current period. To explore the relevance of a particular channel, we first always test whether electrification has a significant effect on the channel variable under study. If this is the case, we then test whether the channel variable has a significant effect on fertility. Finally, we test whether (i) the direct effect of electricity is altered if the channel variable is included in the fertility equation and (ii) if the channel variable is statistically significant. If the latter is the case, we take this as suggestive evidence that this particular channel is empirically relevant.

5. Results

5.1 Does electrification affect fertility?

Table 5 summarizes the results estimating Equation (11) with the district level data for different specifications. Columns (1) and (2) show a simple random and fixed effects

model, respectively, in which we do not control for any time-variable effects except for year dummy variables. In both cases electricity is highly significant, but the district fixed effects appear to explain part of the correlation captured by the random effects model. The within estimator suggests that an increase in the district coverage by ten percentage points is associated with a reduction of the (district-level) average number of live births per women aged 15 to 49 in the following year by 0.027 children or by 1.3 percent. As more control variables are added the size of the electricity effect decreases somewhat, but stays negative and statistically significantly different from zero (column (3)). The electricity effect also persists if the sample is divided into rural and urban households and the model is estimated separately. To place these results in perspective, when we compare the estimated coefficients to the total change in the average number of live births over the observation period of 16.5 percent, then electricity is in fact explaining a large part of it. The reduced form point estimate in column (3) implies that over the period 1993 to 2010 electrification alone reduced the number of live births per women by 0.084 (0.2245×0.3731), corresponding to about 24 percent of the total change in fertility over the same period (0.084/0.350).[8] This seems a sizeable effect, especially if we compare this to factors that have traditionally been credited for decreasing fertility, such increased female education (see e.g. Molynaux and Gertler, 2000), for which we estimate the contribution to be about 27 percent.

[insert Table 5]

All coefficients associated with the control variables have the expected signs.[9] A higher urbanisation and a higher education are both associated with lower fertility. The effect of the share of women using modern contraceptives is also negative and highly significant. As we will examine in more detail below, the use of modern contraception is a possible pathway for the effect of electrification on fertility, hence this variable may capture parts of the electricity effect. The use of traditional contraceptives does not have any effect. We find a positive income effect, which may seem counterintuitive but is in line with theoretical predictions; as long as children are considered a normal good, the pure income effect should be positive if urbanisation, education, hoarding and price effects - in particular the opportunity cost of time – are controlled for. The statistically significant positive income effect is also observed for rural areas (columns (4)) but diminishes and loses precision for urban areas (columns (5)). This supports the view that children have a different value in urban as compared to rural areas, where relatively wealthier parents tend to have fewer but rather better educated children, possibly because the return to education may exceed the return to child labour.

Columns (6) to (8) in Table 5 present estimates of the effects of electrification by age group, showing that the effect of electricity is always statistically significant and

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[8] The average electrification rate increased from 57.6 percent in 1993 to 94.9 percent in 2010 (see Table 2), and the average number of live births per woman declined from 2.118 in 1993 to 1.768 in 2010 (Table 4).
[9] The coefficients for the control variables are not shown here, but the complete estimation results are reported in the supplemental appendix.

negative. The order of magnitude for the age group 25 to 34 is comparable to that for the overall female population of reproductive age, but for older and younger age groups the effects appear smaller.

Although the effect of electricity coverage on fertility is quite robust across these different specifications, it cannot be excluded that time-varying district-specific shocks or confounding unobserved economic development still lead to an omitted variable bias. To assess this potential bias, we add time-varying village characteristics from the village census (Podes) to the set of control variables. A summary of the results is presented in Table 6. These Podes variables are all listed in Table 1 and primarily relate to the availability of infrastructure, including water and education. Given the fact that Podes data is not available in all years, the benchmark specification taken from column (3) in Table 5 is re-estimated on the reduced sample of observations, yielding a coefficient of -0.18 (Table 6, column (1)). The estimates do not seem sensitive to adding the Podes characteristics, as the electrification coefficient decreases only slightly to -0.17 (Table 6, column (2)), even though some of the Podes variables do appear statistically significant. This result is also not dependent on the inclusion or exclusion of certain subsets of Podes variables, which could be the case if the Podes variables were highly co-linear.[10] Finally, the effect also holds if, instead of the district electrification rate, the district-average of village electrification is used as explanatory variable, where village electrification is defined as at least one household in the village reporting the use electricity as the main source of lighting. This should further reduce a possible endogeneity problem as the focus is then more on potential than actual access.[11] Obviously, with this specification we lose some variation at the lower end reducing the estimated coefficient, but at least for the entire sample the effect is still significantly negative. Overall, this robustness suggests that the estimated effect of electrification on fertility is not driven by unobserved economic development or modernity, and can therefore be interpreted as causal effects. If these unobservables did account for part of the estimated effect of electrification, then we would expect this estimate to be sensitive. Nevertheless, in the remainder of the analysis we will stick to the conservative estimates and include the Podes variables where possible. Among the Podes characteristics that can be associated with a better education supply and with modernity (such as the existence of a shopping complex), we find a negative sign, while public health facilities for maternity care have a positive effect on fertility.

[insert Table 6]

To further document the robustness of our findings, we conduct a few more sensitivity checks. First, we re-estimate the model on either only those districts where in 1993 the electrification rate was below 50% (roughly the median) or above 50% to see whether the

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[10] This is shown in Table A6 of the supplemental appendix.
[11] These results are shown in Table A7 of the supplemental appendix.

initial electrification level matters.[12] The estimated effects are very similar to the corresponding estimates shown in Table 5 and 6.

Finally, we re-estimate the model controlling for the presence of a power plant in the same or neighbouring district and alternatively using the presence of a power plant in the same and a neighbouring district as an instrument for the electrification rate. The results are presented in Table 7. If we just control for the presence of power plants (column (2)), the electricity effect is not different from the previous estimates (reproduced in column (1)). This is also the case if we consider only those power plants that have been in operation for at least five years (column (3)). If we use the instrumental variables, the electricity effect remains negative and statistically significant but increases in its absolute size. This could indicate a weak instrument problem, although at least in column (4) the *F*-statistics suggest that the instruments are strong. The over-identifying restrictions tests do not reject the validity of the instrumental variables. Hence, although we are inclined to interpret the more conservative fixed effects estimates as preferred results, the instrumental variables estimates underline the robustness of our findings.

[insert Table 7]

5.2 How does electrification affect fertility? – Understanding the relevant transmission channels

Guided by our theoretical framework introduced in Section 2, we now explore in more detail the channels through which electricity may affect fertility.

5.2.1 Does electrification affect fertility through changes in children's and women's labour market participation?

As we set out above, access to electricity may influence the (shadow) price of children by affecting both the direct and indirect cost of raising children. The direct costs increase as electricity improves the productivity on the labour market of the main caregiver and hence the opportunity cost of time for raising children. But electricity also affects the productivity of child labour and, subsequently, the indirect cost of raising children. If electricity is a substitute to child labour, the cost of children increases and hence fertility is further reduced through this channel. If electricity and children are complements the opposite must be expected. In practice, cases of complementarity and substitution will both occur, with the net effect remaining an empirical issue. Nevertheless, we expect the substitution effect to dominate in Indonesia given that more than two thirds of child labour in the age group 10 to 15 years takes place in agriculture (Kis-Katos and Sparrow, 2011) where a technological development is likely to substitute labour.

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[12] These results are shown in Table A8 of the supplemental appendix.

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Table 8 shows that child labour indeed decreases with electricity coverage. In a district that is electrified the share of children working decreases on average by 6 percentage points. If child labour is introduced in the fertility equation the coefficient of child labour is not statistically significant. Overall, this suggests that electricity does reduce child labour, which is in it-self an interesting finding, but changes in child labour do not seem to cause changes in fertility.

[insert Table 8]

Electricity coverage also lowers female labour market participation roughly by the same extent it lowers child labour. This may surprise as electricity may open up new labour market opportunities. Similar to child labour, we find no effects of female labour participation on fertility. We also control for the district-specific share of men working to account for the complete allocation of time within the household. The share of men working is associated with fertility decline, but these effects are difficult to interpret as they just account for time allocation and do not capture wage or income effects. The absence of an effect of electrification on female labour market participation is in contrast with the findings by Dinkelman (2011) for South Africa. Dinkelman (2011) finds a significant positive effect of household electrification on female employment and argues that this increase stems from a release of women from home production and from the creation of new micro-enterprises. Van de Walle et al. (2013), in turn, find for India also only moderate effects. They observe an increase in female casual work, but not for regular wage work.

5.2.2 Does electrification affect fertility through increased the exposure to modern media, altered fertility preferences and an increased use of contraception?

Media exposure is another possible channel linking electricity and fertility. Following Equation (8), media exposure may change the fertility preferences through the promotion of specific role models or by providing information on modern contraception. This may reduce fertility through a more efficient prevention of unwanted births, by reducing the price of not having a child and thus increasing p_n.

The results in Table 9, columns (1) and (2), suggest that electricity coverage increases exposure to television, while simultaneously decreasing the exposure to newspapers, suggesting that the former is a substitute to the latter.[13] Column (3) explores directly the effect of TV exposure on the use of modern contraception. The results suggest that exposure to television increases the use of modern contraception by about 12 percentage points. There is no effect on the use of traditional contraception. This is what we would

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[13] Since the media variables are only available in the Susenas surveys from 1993 to 1998, the number of observations smaller than those reported in Table 5. For this period we have PODES data only for 1996, therefore PODES variables are not included as controls in the fixed effects regressions.

expect, since the Government in Indonesia uses television to promote *modern* family planning and rather discourages *traditional* methods (Dewi et al., 2013).

TV exposure enters negatively and statistically significant in the fertility equation. When it is introduced together with electricity, the effect of TV exposure is still statistically significant while the effect of electricity is slightly lower and less precise compared to a regression in which TV exposure is excluded, suggesting that TV exposure is indeed a relevant transmission channel linking electricity and fertility. The point estimate implies that an increase of the share of women exposed to TV by one standard deviation, i.e. 43 percent, reduces the average number of live births per woman by 0.022, i.e. by about 1.2 percent. This means that the TV effect explains about a quarter of the total reduction in fertility that can be attributed to the increase in electrification. Our point estimate is comparable to the effect identified by La Ferrara et al. (2012). For Brazil they found that the exposure to the signal of cable TV showing soap operas reduced the average number of live births per woman by 0.027 with an only slightly higher overall mean in their dependant variable.[14]

[insert Table 9]

To further assess the effects on desired fertility, we turn to the DHS data. We re-emphasize that we need to be cautious when interpreting the results based on the DHS, nevertheless it can still provide us an interesting insight. Moreover, when replicating the analysis of electrification on fertility, we find qualitatively similar results to those based on the district pseudo panel.[15] Table 10 shows the average desired number of children by age group and year. The reported ideal number of children decreases over time suggesting that next to the use of family planning devices, and hence a reduction in unwanted births, a reduction in the number of wanted births is a major driver of Indonesia's fertility decline. The preferred number of children increases with age, mainly reflecting cohort effects but also the fact that respondents ex-post tend to accept actual fertility, i.e. older women may over-report the children they would have preferred at the beginning of their fertility cycle. In other words, as parity increases, the ideal number of children also increases because women tend to rationalize their actual family size to be their ideal family size (BPS and Macro International, 2008).

[insert Table 10]

We apply a Poisson regression with the number of desired children as dependent variable and dummy variables indicating the availability of electricity and whether the household

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[14] Jensen and Oster (2009) estimated for India that exposure to cable TV reduced the probability of a woman being pregnant at the time of the survey by 4 to 7 percent.

[15] To further check the robustness of our results, we re-estimated Equation (11) with the five rounds of pooled DHS data (1991, 1994, 1997, 2002/03 and 2007). These estimates provide results consistent to those obtained through the district panel. The full results are reported in the supplemental appendix (Table A11).

has a TV set as main explanatory variables. The control variables include age, a dummy for living in a rural area, education, asset ownership and DHS wave indicators.

Column (1) of Table 11 presents the reduced form showing that electricity is negatively correlated with desired fertility. Women in households with electricity report an ideal number of children that is lower by roughly 5% or 0.15 children (marginal effect computed at the sample mean) compared to the reported ideal number by women in households without electricity. When TV is also introduced (column (2)), both variables have a negative effect. The effect associated with TV exposure implies a reduction in the number of desired children by about 2.5 percent, possibly through new information, new role models and so forth. The effect associated with electricity is roughly unchanged. The upshot from these regressions is that electricity has an effect on actual and desired fertility (or fertility demand) that is independent of TV exposure.

[insert Table 11]

5.2.3 Does electrification affect fertility through reduced child mortality?

Finally, we examine whether electrification also affects child mortality, for example by improved quality of health care supply, including better conditions of maternal care and attended births. We also examine whether child mortality affects actual and desired fertility. If risk-averse parents that aim for a certain number of children that survive until adulthood expect higher survival chances for their offspring they may reduce the number of desired and actual pregnancies. The estimation in column (1) in Table 12 shows that electricity per se, as expected, significantly reduces child mortality. Furthermore, child mortality, here approximated by the average mortality in a woman's cluster,[16] increases actual fertility (column (2)), i.e. parents seem to anticipate that some of their children may die and hence they compensate. When cluster-specific mortality is introduced, the electricity effect decreases, suggesting that the electricity effect passes at least partly through reduced mortality (compare column (2) in Table 12 with column (2) in Table A11). The same holds for desired fertility (compare column (3) in Table 12 with column (1) in Table 11).

[insert Table 12]

6. Conclusion

Theoretically, there are multiple pathways by which the availability and use of electricity may affect fertility. This paper empirically examines several of these pathways. The reduced form estimates suggest that expanding electrification in Indonesia can explain about 18 to 24 percent of the overall decline in the fertility rate between 1993 and 2010,

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[16] Note that this average is computed without taking into account the experienced child mortality of the mother under study. A cluster contains on average 124 households in the Indonesian DHS.

depending on the specification. This seems a sizeable effect, especially if we compare this to factors that have traditionally been credited for decreasing fertility, such increased female education, for which we estimate the contribution to be about 27 percent. The estimate is robust to a large number of robustness checks including an IV estimator. The key identification assumption of the IV is that the location of power plants determines village access to electricity but does not have any direct effect on fertility other than through the supply of electricity to households.

We also made an attempt to unpack the net effect to further understand how electricity affects fertility. Our results are summarized in Table A2. Although electricity does seem to reduce women's and children's labour market participation, it does not affect fertility through this channel. However, we find evidence that the availability of electricity increases exposure to TV and by this channel reduces fertility. The point estimate implies that an increase of the share of women exposed to TV by one standard deviation, i.e. 43 percent, reduces the average number of live births per woman by 0.022 i.e. by about 1.2 percent. TV can explain about a quarter of the total fertility effect. Further analysis suggests that this is partly explained by changes in desired fertility and a more effective use of modern contraception. But we think it is also plausible to assume that watching television simply reduces the time spent on physical intimacy. At least anecdotic evidence seems to suggest that this effect is important, not only in Indonesia but for example also in India or China (Dewi et al., 2013; Johnson, 2001). Finally we find that electricity seems to reduce child mortality and by this channel also fertility. However, given that the latter results are based on pooled cross-sectional DHS data, they are more vulnerable to omitted variable bias and require caution to be interpreted as causal effects. Nevertheless, these results are informative and consistent with the other results.

Overall the results suggest that the expansion of the electricity grid contributes substantially to the fertility decline. In a context in which family planning policy still plays an important role and in which the societal objective is to further reduce the birth rate, these benefits need to be taken into account when costs of electricity roll out are compared to its benefits. These findings are potentially important for many countries in Sub-Saharan Africa where fertility is still high, often much higher than in Indonesia today and grid electricity in rural areas is still rare.

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Tables and figures

Table 1 Descriptive statistics district panel, 261 districts[1], 1993-2010

Variable	Obs	Mean	Std. Dev
Susenas			
Age	4697	27.95	2.82
Female share	4697	0.50	0.01
Household size	4697	4.89	0.53
Rural share	4697	0.61	0.32
Electricity coverage [2]	4436	0.79	0.23
PLN	4436	0.75	0.25
Other source	4436	0.04	0.07
Composition of female population			
Share aged 15-19	4697	0.18	0.03
Share aged 20-24	4697	0.16	0.03
Share aged 25-29	4697	0.16	0.02
Share aged 30-34	4697	0.15	0.02
Share aged 35-39	4697	0.14	0.02
Share aged 40-44	4697	0.12	0.02
Share aged 45-49	4697	0.10	0.02
Fertility rate (average number of live births)			
Women aged 15-49	4697	1.88	0.34
Women aged 15-24	4697	0.29	0.11
Women aged 25-34	4697	1.81	0.40
Women aged 35-49	4697	3.49	0.74
Contraceptives used	4697	0.38	0.11
Traditional contraceptives used	4697	0.005	0.01
Real monthly per capita expenditure (Rupiah)	4697	287964	263325
Child work	4697	0.10	0.08
Female work	4697	0.50	0.13
Media exposure in previous week (1993-1998 only)			
TV	1566	0.61	0.26
Radio	1566	0.51	0.21
Newspaper	1566	0.19	0.15
Highest education completed by women aged 15-49			
None	4697	0.34	0.14
Primary	4697	0.31	0.08
Junior secondary	4697	0.17	0.07
Senior secondary	4697	0.13	0.08
Higher	4697	0.05	0.05
Podes [3]			
Agriculture main activity in village	1296	0.69	0.32
Market with (semi-) permanent building in village	1296	0.29	0.17
Shopping complex in village	1296	0.27	0.21
Majority of traffic on asphalt road in village	1296	0.73	0.22

Drinking water piped/pump in village	1296	0.33	0.29
Nr. of primary schools in village	1296	4.32	2.72
Nr. of junior secondary schools in village	1296	1.01	0.87
Nr. of senior secondary schools in village	1296	0.59	0.67
Nr. of maternity clinics/hospitals in village	1296	0.16	0.18
Nr. of health centers in village	1296	0.24	0.17
Nr. of village maternity posts in village	1296	0.33	0.25

Note: [1] The panel is balanced for all years except 2006, for which $N = 260$. The provinces of Aceh, Maluku and Papua are excluded throughout.
[2] Electrification rate missing for 2005.
[3] Podes data is only available for 1996, 2000, 2003, 2006 and 2008.
Source: Susenas household surveys.

Table 2 Electrification rate 1993 to 2010 (percent of population)

Year	PLN connection	Other source	Total connected
1993	53.84	3.75	57.59
1994	59.26	3.67	62.93
1995	64.68	3.84	68.52
1996	70.48	3.80	74.28
1997	74.93	3.81	78.74
1998	79.38	2.87	82.25
1999	82.63	2.15	84.78
2000	84.22	2.45	86.67
2001	83.91	2.76	86.67
2002	85.11	2.30	87.40
2003	85.71	2.97	88.68
2004	87.32	2.47	89.79
2005	.	.	.
2006	88.60	2.88	91.48
2007	88.96	3.15	92.11
2008	90.05	3.38	93.43
2009	89.88	4.35	94.23
2010	90.17	4.73	94.90

Source: Susenas household surveys, based on households reporting electricity as main source of lighting. The electrification rate is missing for 2005.

Figure 1 Roll out of the electricity grid across space
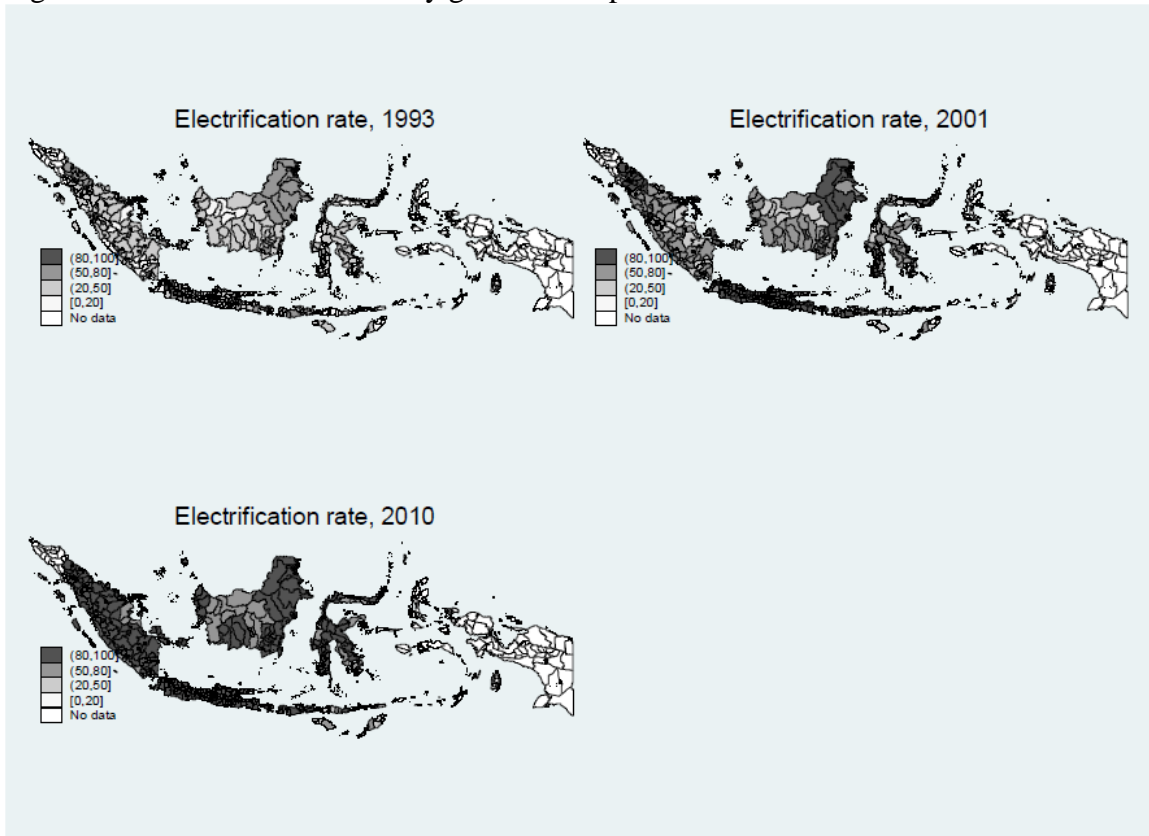
Source: Susenas household surveys, own representation.

Table 3 Electrification (percent coverage) by per capita consumption quintile

Quintile	1993	1996	1999	2002	2004	2006	2008	2009	2010
1	33.37	53.89	72.23	74.17	78.48	85.27	87.97	88.80	89.93
2	45.33	65.72	81.24	84.33	87.04	89.11	92.38	92.80	93.65
3	55.35	74.75	85.54	88.43	91.04	91.41	92.82	94.56	95.07
4	67.44	83.26	89.53	92.71	94.71	94.23	95.52	96.53	97.01
5	86.44	93.77	95.35	97.38	97.69	97.38	98.46	98.48	98.85

Source: Susenas household surveys, based on households reporting electricity as main source of lighting.

Table 4 Fertility rate 1993 to 2010 by age group (average number of live births)

Year	15 - 49	15 - 24	25 - 34	35 - 49
1993	2.118	0.341	2.239	4.128
1994	2.043	0.318	2.097	4.009
1995	2.055	0.336	2.093	3.981
1996	2.029	0.311	2.024	3.912
1997	1.944	0.306	1.923	3.741
1998	1.906	0.290	1.854	3.649
1999	1.833	0.264	1.780	3.542
2000	1.763	0.260	1.684	3.339
2001	1.850	0.308	1.759	3.471
2002	1.790	0.275	1.685	3.330
2003	1.779	0.271	1.659	3.254
2004	1.726	0.282	1.632	3.110
2005	1.711	0.261	1.595	3.057
2006	1.759	0.250	1.617	3.118
2007	1.790	0.280	1.619	3.126
2008	1.766	0.270	1.593	3.051
2009	1.749	0.267	1.570	2.996
2010	1.768	0.286	1.637	3.061

Source: Susenas household surveys.

Figure 2: Electrification rate (percent) and fertility (average number of live births per woman 15 to 49) over time, Indonesia
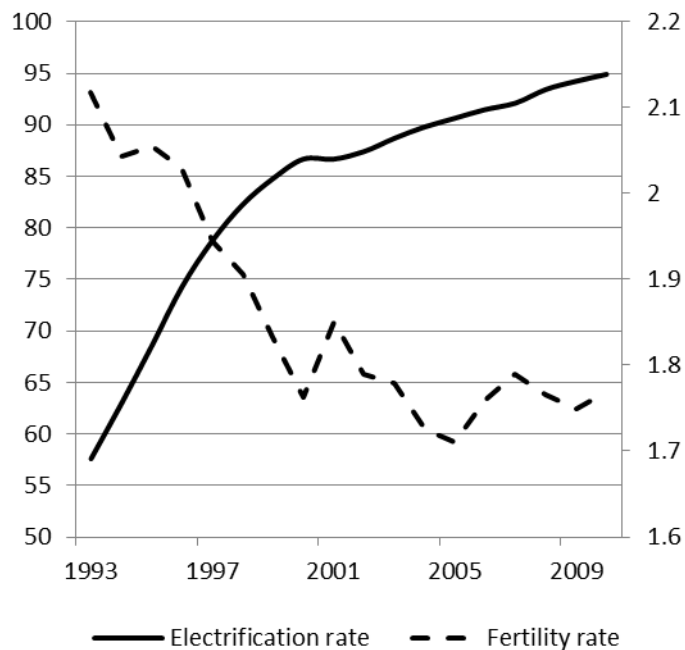
Source: Susenas household surveys (left axis: electrification;
(right axis: fertility).

Table 5 Impact of electrification on fertility (average number of live births), women 15 to 49, 1993-2010

	All	All	All	Rural	Urban	Age 15-24	Age 25-34	Age 35-49
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Electricity coverage	-0. 3227**	-0.2695**	-0.2245**	-0.1648**	-0.1806*	-0.0696**	-0.1917**	-0.1306
	[0.0390]	[0.0395]	[0.0409]	[0.0499]	[0.0851]	[0.0169]	[0.0595]	[0.0806]
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4175	4175	4175	3820	4146	4175	4175	4175
Number of districts	261	261	261	251	261	261	261	261
R-squared (within)	0.56	0.56	0.58	0.41	0.21	0.13	0.63	0.78

Note: Control variables are lagged by one year and include rural population share, age composition of the female population, education shares, contraceptive use, and log per capita expenditure. Robust standard errors in brackets, clustered at districts level. Full results are reported in Tables A3 and A4.

Statistical significance: + 10%, * 5%, ** 1%.

Source: Susenas household surveys.

Table 6 Robustness of impact of electrification on fertility to including village economic and infrastructure variables, women 15 to 49, Podes years only

	(1)	(2)
Electricity coverage	-0.1803**	-0.1725*
	[0.0663]	[0.0678]
Year dummies	Yes	Yes
District fixed effects	Yes	Yes
Control variables	Yes	Yes
Podes variables	No	Yes
Observations	1304	1296
Number of districts	261	261
R-squared (within)	0.50	0.52

Note: Podes years are 1996, 2000, 2003, 2006 and 2008. Control variables are lagged by one year and include rural population share, age composition of the female population, education shares, contraceptive use, and log per capita expenditure. Robust standard errors in brackets, clustered at districts level. Full results are reported in Table A5.
Statistical significance: + 10%, * 5%, ** 1%.
Source: Susenas household surveys and Podes village census.

Table 7 Impact of electrification on fertility (average number of live births), women 15 to 49, 1993-2010, IV estimates

	Results Table 5	Power plants as control variables		Power plants as instrumental variables	
		All plants	> 5 years	All plants	> 5 years
Electricity coverage	-0.2245**	-0.2170**	-0.2228**	-0.4591**	-0.3306+
	[0.0409]	[0.0414]	[0.0407]	[0.1402]	[0.1953]
Power plants district		-0.0017	0.0077		
		[0.0247]	[0.0246]		
Power plants neighbour		-0.0226	-0.0103		
		[0.0170]	[0.0195]		
First stage IV					
Power plants district				0.0318**	0.0359**
				[0.0105]	[0.0104]
Power plants neighbour				0.0836**	0.0508**
				[0.0085]	[0.0076]
Joint significance instruments					
F-statistic (clustered standard errors)				13.6	5.9
F-statistic (non-clustered standard errors)				62.0	30.9
Over-identifying restrictions test					
$\chi^2(1)$ test statistic				0.0135	0.0799
p-value				0.9075	0.7774
Year dummies	Yes	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes	Yes
Susenas control variables	Yes	Yes	Yes	Yes	Yes
Observations	4175	4175	4175	4175	4175
Number of districts	261	261	261	261	261
R-squared (within)	0.58	0.58	0.58	0.57	0.58

Note: Control variables are lagged by one year and include rural population share, age composition of the female population, education shares, contraceptive use, and log per capita expenditure. Standard errors in brackets.
Statistical significance: + 10%, * 5%, ** 1%.
Source: Susenas household surveys.

Table 8 Impact of electrification on fertility, and the role of child and female labour, 1993-2010, Podes years only

	Child works	Female works	Fertility (age 15 – 49)
	(1)	(2)	(3)
Electricity coverage	-0.0637**	-0.0698*	-0.1766*
	[0.0244]	[0.0294]	[0.0705]
Child works (age 10-15)			0.1389
			[0.1215]
Female works			-0.0266
			[0.0801]
Male works			-0.3097+
			[0.1846]
Year dummies	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes
Control variables	Yes	Yes	Yes
Podes variables	Yes	Yes	Yes
Observations	1296	1296	1296
Number of districts	261	261	261
R-squared (within)	0.47	0.46	0.52

Note: Podes years are 1996, 2000, 2003, 2006 and 2008. Control variables are lagged by one year and include rural population share, age composition of the female population, education shares, contraceptive use, and log per capita expenditure. Robust standard errors in brackets, clustered at districts level. Full results are reported in Table A9.
Statistical significance: + 10%, * 5%, ** 1%.
Source: Susenas household surveys.

Table 9 Impact of electrification on fertility, and the role of media, 1993-1998

			Contraception used			Fertility	
	TV	Newspaper	All	Traditional		(age 15 – 49)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Electricity coverage	0.1848** [0.0400]	-0.0518* [0.0222]	0.0161 [0.0187]	-0.0039 [0.0030]		-0.1030+ [0.0578]	-0.1227* [0.0597]
Watch TV			0.1176** [0.0150]	0.0033 [0.0021]	-0.0948* [0.0455]	-0.0739+ [0.0440]	
Listen to radio			-0.0165 [0.0143]	-0.0013 [0.0027]	0.0914* [0.0582]	0.0878 [0.0571]	
Read newspaper			-0.1496** [0.0273]	-0.0013 [0.0037]	-0.0868 [0.0833]	-0.0964 [0.0831]	
Contraceptives used					-0.1031 [0.0894]	-0.1042 [0.0888]	-0.1183 [0.0877]
Traditional contraceptives used					0.0126 [0.5689]	-0.0268 [0.5702]	-0.0710 [0.5765]
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Podes variables	No	No	No	No	No	No	No
Observations	1305	1305	1305	1305	1566	1566	1566
Number of districts	261	261	261	261	261	261	261
R-squared (within)	0.91	0.64	0.78	0.09	0.41	0.41	0.41

Note: Control variables are lagged by one year and include rural population share, age composition of the female population, education shares, contraceptive use, and log per capita expenditure. Robust standard errors in brackets, clustered at districts level. Full results are reported in Table A10.
Statistical significance: + 10%, * 5%, ** 1%.
Source: Susenas household surveys.

Table 10 Desired number of children 1991 to 2007 by age group

Year	15 - 49	15 - 24	25 - 34	35-49
1991	3.16	2.67	3.05	3.56
1994	2.97	2.56	2.87	3.27
1997	2.96	2.54	2.83	3.24
2002-03	2.91	2.59	2.74	3.15
2007	2.82	2.56	2.72	2.95

Source: DHS, various years.

Table 11 Impact of electrification on fertility preferences and the role of media, 1991-2007, DHS data, Poisson model

	Number of desired children	
	(1)	(2)
Electricity coverage	-0.047***	-0.053***
	[0.005]	[0.005]
Watch TV		-0.024***
		[0.005]
DHS wave	Yes	Yes
Control variables	Yes	Yes
Observations	107,137	107,137

Note: Control variables include age, education, an asset index and a dummy variable for rural areas. Robust standard errors, i.e. corrected for intra-cluster correlation, in brackets. Full results are reported in Table A12.
Statistical significance: + 10%, * 5%, ** 1%.
Source: DHS, various years.

Table 12 Impact of electrification on fertility and fertility preferences, and the role of child mortality, 1991-2007, DHS data, Poisson model

	Mortality	Fertility	Desired fertility
	(1)	(2)	(3)
Electricity coverage	-0.089***	-0.008	-0.031***
	[0.009]	[0.006]	[0.004]
Average cluster mortality		0.456***	0.393***
		[0.005]	[0.006]
DHS wave	Yes	Yes	Yes
Control variables	Yes	Yes	Yes
Observation	131,409	131,409	107,137

Note: Control variables include age, education, an asset index and a dummy variable for rural areas. Robust standard errors, i.e. corrected for intra-cluster correlation, in brackets. Full results are reported in Table A13.
Statistical significance: + 10%, * 5%, ** 1%.
Source: DHS, various years.

Appendix

Table A1 Used data sources

Name of data source	Observation unit (raw data)	Unit of analysis	N	Years
Susenas	Households and women 15 to 49 years living in these households	Districts	261 districts (260 in 2006)	1993 to 2010 (annually)
Podes	Rural villages and urban precincts	Districts	261 districts (260 in 2006)	1996, 2000, 2003, 2006, 2008
Demographic and Health Survey (DHS)	Women 15 to 49 years	Women 15 to 49 years	131,409 (pooled)	1991, 19994, 1997, 2002/03, 2007
Power plants	Power plant	Power plants	133	1993-2010 (annually)

Source: Own representation.

Table A2 Synthesis of results

	Demand		Supply	
	Desired fertility [b]	Use of modern contraception	Survival chances [b]	Actual fertility
Electricity	---		+++	--
Transmission channels (effect of electricity through)[a]				
Children's labour supply (--)				n.s.
Women's labour supply (--)				n.s.
TV exposure (++)	---	++		-
Child mortality [b] (---)	+++			+++

Note: [a] In parentheses direction of effect of electricity on corresponding channel variable. "-" ("+") negative (positive) effect significant at 10%, "--" ("++") negative (positive) effect significant at 5%, "---"("+++") negative (positive) effect significant at 1%. n.s. stands for "not significant". [b] These channels have been analysed with the DHS data and hence cannot necessarily be interpreted as causal. Channels with empty fields have not been analysed.
Source: Own representation.

Supplemental Appendix

Table A3 Impact of electrification on fertility (average number of live births), women 15 to 49, all *lagged* explanatory variables, 1993-2010

	Random effects		Fixed effects			
	All HH		All HH		Rural HH	Urban HH
	(1)	(2)	(3)	(4)	(6)	(7)
Electricity coverage	-0. 3227**	-0.2695**	-0.2140**	-0.2245**	-0.1648**	-0.1806*
	[0.0390]	[0.0395]	[0.0416]	[0.0409]	[0.0499]	[0.0851]
Rural population share			0.1661**	0.1806**		
			[0.0562]	[0.0547]		
Composition of female population (ref: share aged 15-19)						
Share aged 20-24			-0.3183*	-0.2697+	0.0897	0.3453*
			[0.1530]	[0.1517]	[0.3016]	[0.1550]
Share aged 25-29			-0.1966	-0.1005	-0.0716	0.3159*
			[0.1398]	[0.1431]	[0.2826]	[0.1388]
Share aged 30-34			0.1602	0.2137	0.3316	0.2150
			[0.1625]	[0.1641]	[0.2055]	[0.1504]
Share aged 35-39			0.3716+	0.4176*	0.3099	0.3620+
			[0.1970]	[0.1956]	[0.2797]	[0.1929]
Share aged 40-44			0.1620	0.1854	-0.1686	0.3727+
			[0.2039]	[0.1976]	[0.3582]	[0.1955]
Share aged 45-49			0.1239	0.1821	-0.1079	0.3046
			[0.2013]	[0.1969]	[0.2937]	[0.1949]
Highest education completed by women aged 15-49 (ref: none)						
Primary			-0.3593**	-0.3360**	-0.2040	-0.2202*
			[0.0814]	[0.0798]	[0.1283]	[0.0859]
Junior secondary			-0.3381**	-0.4003**	-0.3589*	-0.2333*

			[0.0802]	[0.0828]	[0.1414]	[0.0972]
Senior secondary			-0.4447**	-0.5149**	-0.3576*	-0.2309**
			[0.0924]	[0.0948]	[0.1569]	[0.0797]
Higher			-0.3902**	-0.4173**	-0.1642	-0.0387
			[0.1425]	[0.1433]	[0.2325]	[0.1347]
Contraceptives used				-0.1716**	-0.1239	-0.0414
				[0.0605]	[0.0768]	[0.0748]
Traditional contraceptives used				-0.1020	0.5317	-0.0397
				[0.3804]	[0.5395]	[0.3859]
Log per capita expenditure				0.1075**	0.1230**	0.0202
				[0.0210]	[0.0383]	[0.0249]
Constant	2.2693**	2.0521**	2.1419**	0.6803*	1.0645*	1.7401**
	[0.0307]	[0.0354]	[0.1422]	[0.2965]	[0.4618]	[0.2647]
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4175	4175	4175	4175	3820	4146
Number of districts	261	261	261	261	251	261
R-squared (within)	0.56	0.56	0.57	0.58	0.41	0.21

Note: Robust standard errors in brackets, clustered at districts level.

Statistical significance: + 10%, * 5%, ** 1%.

Source: Susenas household surveys.

Table A4 Impact of electrification on fertility (average number of live births) by age group, all *lagged* explanatory variables, 1993-2010, fixed effects regressions

| | 15 - 24 | 25 - 34 | 35 - 49 |
	(1)	(2)	(3)
Electricity coverage	-0.0696**	-0.1917**	-0.1306
	[0.0169]	[0.0595]	[0.0806]
Rural population share	0.0768**	0.2124*	0.3317**
	[0.0213]	[0.0849]	[0.1073]
Composition of female population (ref: share aged 15-19)			
Share aged 20-24	0.1538*	-0.6647**	-0.7516*
	[0.0748]	[0.2142]	[0.3059]
Share aged 25-29	0.3295**	-0.1387	-1.2180**
	[0.0804]	[0.1981]	[0.2833]
Share aged 30-34	0.1179	0.2080	-0.9056**
	[0.0862]	[0.2156]	[0.3235]
Share aged 35-39	0.0836	0.2400	-0.6768+
	[0.0903]	[0.2495]	[0.3754]
Share aged 40-44	0.0417	-0.1138	-1.1505**
	[0.0974]	[0.2607]	[0.3949]
Share aged 45-49	0.0608	-0.3749	-0.7177
	[0.0971]	[0.2596]	[0.4386]
Highest education completed by women aged 15-49 (ref: none)			
Primary	-0.1085**	-0.3421**	-0.4814**
	[0.0374]	[0.1037]	[0.1579]
Junior secondary	-0.0613	-0.6037**	-0.5086**
	[0.0436]	[0.1026]	[0.1562]
Senior secondary	-0.0806+	-0.6831**	-0.6864**
	[0.0412]	[0.1333]	[0.1845]
Higher	0.0765	-0.2894	-1.2940**
	[0.0677]	[0.1984]	[0.2687]
Contraceptives used	0.0044	-0.3331**	-0.2356*
	[0.0365]	[0.0880]	[0.1132]
Traditional contraceptives used	-0.0930	0.4696	0.0620
	[0.1699]	[0.5416]	[0.7574]
Log per capita expenditure	0.0325**	0.1279**	0.1707**
	[0.0113]	[0.0282]	[0.0398]
Constant	-0.2025	0.5186	1.9701**
	[0.1722]	[0.3960]	[0.5840]
Year dummies	Yes	Yes	Yes
Observations	4175	4175	4175
Number of districts	261	261	261
R-squared (within)	0.13	0.63	0.78

Note: Robust standard errors in brackets, clustered at districts level.
Statistical significance: + 10%, * 5%, ** 1%. *Source:* Susenas household surveys.

Table A5 Robustness of impact of electrification on fertility to including village economic and infrastructure variables, all *lagged* explanatory variables, 1993-2010, women 15 to 49, fixed effects regressions

	All years	Podes years	
	(1)	(2)	(3)
Electricity coverage	-0.2245**	-0.1803**	-0.1725*
	[0.0409]	[0.0663]	[0.0678]
Rural population share	0.1806**	0.2955**	0.2778**
	[0.0547]	[0.0921]	[0.0891]
Composition of female population (ref: share aged 15-19)			
Share aged 20-24	-0.2697+	-0.4540+	-0.4722+
	[0.1517]	[0.2459]	[0.2513]
Share aged 25-29	-0.1005	-0.1801	-0.1962
	[0.1431]	[0.2875]	[0.2819]
Share aged 30-34	0.2137	-0.0821	-0.0762
	[0.1641]	[0.3081]	[0.3001]
Share aged 35-39	0.4176*	0.1767	0.1677
	[0.1956]	[0.3191]	[0.3142]
Share aged 40-44	0.1854	0.0495	0.1331
	[0.1976]	[0.3077]	[0.3119]
Share aged 45-49	0.1821	0.1998	0.2788
	[0.1969]	[0.3145]	[0.3201]
Highest education completed by women aged 15-49 (ref: none)			
Primary	-0.3360**	-0.4468**	-0.4646**
	[0.0798]	[0.1043]	[0.1075]
Junior secondary	-0.4003**	-0.2589*	-0.2110+
	[0.0828]	[0.1226]	[0.1195]
Senior secondary	-0.5149**	-0.4594**	-0.4638**
	[0.0948]	[0.1578]	[0.1504]
Higher	-0.4173**	-0.5876**	-0.5149*
	[0.1433]	[0.2083]	[0.2053]
Contraceptives used	-0.1716**	-0.0871	-0.0627
	[0.0605]	[0.0991]	[0.1003]
Traditional contraceptives used	-0.1020	-1.3129+	-1.2461+
	[0.3804]	[0.6950]	[0.7034]
Log per capita expenditure	0.1075**	0.0593+	0.0610+
	[0.0210]	[0.0319]	[0.0347]
Villages Characteristics (Podes)			
Agriculture main activity			0.0691
			[0.0578]
Market with (semi-)permanent building			0.1169**
			[0.0438]
Shopping complex			-0.0796
			[0.0487]

Majority of traffic on asphalt road			-0.0058
			[0.0366]
Drinking water piped/pump			0.0122
			[0.0435]
Nr. of primary schools			-0.0131*
			[0.0055]
Nr. of junior secondary schools			0.0254
			[0.0197]
Nr. of senior secondary schools			-0.0019
			[0.0184]
Nr. of maternity clinics/hospitals			0.0475
			[0.0378]
Nr. of village health centers			-0.0497
			[0.0591]
Nr. of village maternity posts			0.0373*
			[0.0148]
Constant	0.6803*	1.3702**	1.2795*
	[0.2965]	[0.4780]	[0.5170]
Year dummies	Yes	Yes	Yes
Observations	4175	1304	1296
Number of districts	261	261	261
R-squared (within)	0.58	0.50	0.52

Note: Robust standard errors in brackets, clustered at districts level. Podes years are 1996, 2000, 2003, 2006 and 2008.
Statistical significance: + 10%, * 5%, ** 1%.
Source: Susenas household surveys and Podes village census.

Table A6 Sensitivity of the results with respect to the inclusion and exclusion of Podes controls

	(1)	(2)	(3)	(4)
Electrification rate	-0.1725*	-0.1892**	-0.1653*	-0.1659*
	[0.0678]	[0.0656]	[0.0673]	[0.0664]
Villages Characteristics (Podes)				
Agriculture main activity	0.0691	0.0589		
	[0.0578]	[0.0573]		
Market with (semi-)permanent building	0.1169**	0.0796+		
	[0.0438]	[0.0447]		
Shopping complex	-0.0796	-0.0905+		
	[0.0487]	[0.0487]		
Majority of traffic on asphalt road	-0.0058	-0.0025		
	[0.0366]	[0.0362]		
Drinking water piped/pump	0.0122	0.0173		
	[0.0435]	[0.0439]		
Nr. of primary schools	-0.0131*		-0.0109*	
	[0.0055]		[0.0054]	
Nr. of junior secondary schools	0.0254		0.0202	
	[0.0197]		[0.0201]	
Nr. of senior secondary schools	-0.0019		-0.0011	
	[0.0184]		[0.0183]	
Nr. of maternity clinics/hospitals	0.0475			0.0227
	[0.0378]			[0.0385]
Nr. of village health centers	-0.0497			-0.0830
	[0.0591]			[0.0556]
Nr. of village maternity posts	0.0373*			0.0376*
	[0.0148]			[0.0147]
Year dummies	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes
Susenas controls	Yes	Yes	Yes	Yes
Observations	1296	1296	1296	1296
Number of districts	261	261	261	261
R-squared	0.52	0.51	0.51	0.51

Note: Robust standard errors in brackets, clustered at districts level.
Statistical significance: + 10%, * 5%, ** 1%.
Source: Susenas household surveys.

Table A7 Impact of electrification on fertility using village level connection (at least one sampled household in the village is connected) instead of household level connection

	(1)	(2)
Village electrification rate	-0.0898*	-0.0131
	[0.0448]	[0.0768]
Year dummies	Yes	Yes
District fixed effects	Yes	Yes
Susenas controls	Yes	Yes
Podes controls	No	Yes
Observations	4175	1296
Number of districts	261	261
R-squared	0.57	0.51

Note: Robust standard errors in brackets, clustered at districts level.
Statistical significance: + 10%, * 5%, ** 1%.
Source: Susenas household surveys.

Table A8 Impact of electrification on fertility by initial electrification rate

	(1)	(2)	(3)	(4)
	Elec 1993 <.5	Elec 1993 >=.5	Elec 1993 <.5	Elec 1993 >=.5
Electrification rate	-0.1984**	-0.2784**	-0.1438	-0.2060
	[0.0611]	[0.0721]	[0.1044]	[0.1415]
Year dummies	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes
Susenas controls	Yes	Yes	Yes	Yes
Podes controls	No	No	Yes	Yes
Observations	2064	2111	640	656
Number of districts	129	132	129	132
R-squared	0.58	0.60	0.54	0.52

Note: Robust standard errors in brackets, clustered at districts level.
Statistical significance: + 10%, * 5%, ** 1%.
Source: Susenas household surveys.

Table A9 Impact of electrification on fertility, and the role of child and female labour, 1993-2010, fixed effects regressions

	Child works (1)	Female works (2)	Fertility [1] (3)
Electricity coverage	-0.0637**	-0.0698*	-0.1766*
	[0.0244]	[0.0294]	[0.0705]
Child works (age 10-15)			0.1389
			[0.1215]
Female works			-0.0266
			[0.0801]
Male works			-0.3097+
			[0.1846]
Rural population share	0.0712*	0.0452	0.2836**
	[0.0309]	[0.0364]	[0.0901]
Composition of female population (ref: share aged 15-19)			
Share aged 20-24	0.3715**	0.3702**	-0.4814+
	[0.0817]	[0.1092]	[0.2511]
Share aged 25-29	0.2804**	0.1796	-0.1652
	[0.0848]	[0.1122]	[0.2800]
Share aged 30-34	0.1799*	0.3282**	-0.0498
	[0.0843]	[0.1148]	[0.2977]
Share aged 35-39	0.1489	0.0974	0.1712
	[0.1124]	[0.1281]	[0.3128]
Share aged 40-44	0.0878	0.1935	0.1424
	[0.0913]	[0.1334]	[0.3139]
Share aged 45-49	-0.0837	0.0122	0.3039
	[0.0996]	[0.1210]	[0.3194]
Highest education completed by women aged 15-49 (ref: none)			
Primary	-0.2003**	-0.1435**	-0.4622**
	[0.0471]	[0.0457]	[0.1103]
Junior secondary	-0.1817**	-0.2847**	-0.2443*
	[0.0447]	[0.0591]	[0.1231]
Senior secondary	-0.1799**	-0.2219**	-0.5039**
	[0.0502]	[0.0736]	[0.1555]
Higher	-0.0437	0.0775	-0.5075*
	[0.0728]	[0.1065]	[0.2015]
Contraceptive used			-0.0734
			[0.0987]
Traditional contraceptives used			-1.2436+
			[0.7158]
Log per cap. exp. (t-1)	-0.0123	-0.0003	0.0630+
	[0.0092]	[0.0131]	[0.0347]
Villages Characteristics (Podes)			

Agriculture main activity	-0.0156	0.0160	0.0735
	[0.0161]	[0.0246]	[0.0571]
Market with (semi-)permanent building	0.0177	0.0220	0.1156**
	[0.0162]	[0.0223]	[0.0439]
Shopping complex	-0.0120	-0.0059	-0.0773
	[0.0141]	[0.0226]	[0.0487]
Majority of traffic on asphalt road	0.0185	0.0051	-0.0059
	[0.0147]	[0.0153]	[0.0365]
Drinking water piped/pump	0.0118	0.0174	0.0134
	[0.0130]	[0.0162]	[0.0431]
Nr. of primary schools	-0.0021	-0.0057*	-0.0126*
	[0.0014]	[0.0025]	[0.0055]
Nr. of junior secondary schools	0.0019	0.0134+	0.0261
	[0.0058]	[0.0081]	[0.0197]
Nr. of senior secondary schools	0.0049	0.0122	-0.0048
	[0.0063]	[0.0078]	[0.0185]
Nr. of maternity clinics/hospitals	-0.0039	0.0064	0.0470
	[0.0122]	[0.0176]	[0.0380]
Nr. of village health centers	0.0020	-0.0394+	-0.0505
	[0.0171]	[0.0231]	[0.0589]
Nr. of village maternity posts	-0.0243**	-0.0154*	0.0379*
	[0.0047]	[0.0066]	[0.0150]
Constant	0.2458+	0.5375**	1.5216**
	[0.1293]	[0.2025]	[0.5620]
Year dummies	Yes	Yes	Yes
Observations	1296	1296	1296
Number of districts	261	261	261
R-squared (within)	0.47	0.46	0.52

Note: Robust standard errors in brackets, clustered at districts level.
[1] Age 15 – 49. All *lagged* explanatory variables.
Statistical significance: + 10%, * 5%, ** 1%.
Source: *Susenas* household surveys.

Table A10 Impact of electrification on fertility, and the role of media, 1993-1998, fixed effects regressions

| | TV | Newspaper | Contraception used | | | Fertility [1] (age 15 – 49) | |
| | | | All | Traditional | | | |
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Electricity coverage	0.1848**	-0.0518*	0.0161	-0.0039		-0.1030+	-0.1227*
	[0.0400]	[0.0222]	[0.0187]	[0.0030]		[0.0578]	[0.0597]
Watch TV			0.1176**	0.0033	-0.0948*	-0.0739+	
			[0.0150]	[0.0021]	[0.0455]	[0.0440]	
Listen to radio			-0.0165	-0.0013	0.0914	0.0878	
			[0.0143]	[0.0027]	[0.0582]	[0.0571]	
Read newspaper			-0.1496**	-0.0013	-0.0868	-0.0964	
			[0.0273]	[0.0037]	[0.0833]	[0.0831]	
Contraceptives used					-0.1031	-0.1042	-0.1183
					[0.0894]	[0.0888]	[0.0877]
Traditional contraceptives used					0.0126	-0.0268	-0.0710
					[0.5689]	[0.5702]	[0.5765]
Rural population share	0.1564+	0.0872	-0.0664+	-0.0002	0.3282**	0.3017**	0.3048**
	[0.0853]	[0.0780]	[0.0351]	[0.0039]	[0.0740]	[0.0734]	[0.0732]
Composition of female pop. (ref: share aged 15-19)							
Share aged 20-24	-0.2494	0.0672	0.2268*	-0.0179	0.0979	0.0774	0.1000
	[0.1821]	[0.1211]	[0.0997]	[0.0132]	[0.2227]	[0.2234]	[0.2242]
Share aged 25-29	-0.2207	0.0599	0.5087**	-0.0115	0.1773	0.1373	0.1484
	[0.1805]	[0.0990]	[0.0844]	[0.0105]	[0.2345]	[0.2326]	[0.2300]
Share aged 30-34	-0.3105+	-0.0115	0.5347**	-0.0029	0.1264	0.1339	0.1351
	[0.1860]	[0.1164]	[0.0937]	[0.0128]	[0.2228]	[0.2231]	[0.2217]
Share aged 35-39	-0.5027*	0.0325	0.4281**	-0.0002	0.1339	0.1043	0.1429
	[0.2378]	[0.1310]	[0.1051]	[0.0131]	[0.2730]	[0.2673]	[0.2720]
Share aged 40-44	0.0507	0.0876	0.4755**	-0.0159	0.2951	0.2656	0.2660
	[0.2247]	[0.1434]	[0.1152]	[0.0165]	[0.3112]	[0.3067]	[0.3094]
Share aged 45-49	-0.6268*	-0.2466+	0.3792**	0.0078	-0.2358	-0.2649	-0.2153

	[0.2664]	[0.1335]	[0.1187]	[0.0145]	[0.3022]	[0.3011]	[0.3025]
Highest education completed by women aged 15-49 (ref: none)							
Primary	0.1091	-0.1390**	0.1186**	0.0120	-0.0624	-0.0345	-0.0285
	[0.0888]	[0.0510]	[0.0358]	[0.0073]	[0.1194]	[0.1207]	[0.1217]
Junior secondary	0.5119**	0.3693**	0.1224+	0.0018	-0.1454	-0.0868	-0.1589
	[0.1447]	[0.1144]	[0.0707]	[0.0106]	[0.1914]	[0.1938]	[0.2039]
Senior secondary	0.3933*	0.6495**	-0.0389	0.0008	0.1559	0.1723	0.1099
	[0.1543]	[0.1293]	[0.0691]	[0.0145]	[0.1719]	[0.1727]	[0.1662]
Higher	0.9112*	1.0205**	-0.2048	0.0248	0.7915+	0.6813	0.5960
	[0.3920]	[0.2740]	[0.1687]	[0.0224]	[0.4288]	[0.4327]	[0.4485]
Log per cap. exp. (t-1)	0.0603*	0.0187	0.0046	0.0018	0.0032	0.0161	0.0098
	[0.0287]	[0.0186]	[0.0132]	[0.0017]	[0.0359]	[0.0356]	[0.0351]
Constant	-0.0920	-0.1175	-0.0953	-0.0128	1.8028**	1.7350**	1.8014**
	[0.3669]	[0.2417]	[0.1714]	[0.0202]	[0.4313]	[0.4281]	[0.4209]
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1305	1305	1305	1305	1566	1566	1566
Number of districts	261	261	261	261	261	261	261
R-squared (within)	0.91	0.64	0.78	0.09	0.41	0.41	0.41

Note: Robust standard errors in brackets, clustered at districts level.

[1] All *lagged* explanatory variables.

Statistical significance: + 10%, * 5%, ** 1%.

Source: *Susenas* household surveys.

Table A11 Impact of electrification on fertility (average number of live births), women 15 to 49, DHS, 1991-2007, Poisson model

	Fertility	Fertility
	(1)	(2)
Electricity coverage	-0.092***	-0.025***
	[0.006]	[0.005]
Composition of female population (ref: share aged 15-19)		
Share aged 20-24		0.247***
		[0.012]
Share aged 25-29		0.626***
		[0.012]
Share aged 30-34		0.950***
		[0.012]
Share aged 35-39		1.176***
		[0.012]
Share aged 40-44		1.327***
		[0.013]
Share aged 45-49		1.431***
		[0.013]
Highest education completed by women aged 15-49 (ref: none)		
Primary education		0.029***
		[0.007]
Secondary education		-0.054***
		[0.008]
Education higher than secondary		-0.224***
		[0.011]
Contraception used		-0.069***
		[0.004]
Traditional contraceptive used		0.021***
		[0.010]
Asset index		-0.067***
		[0.002]
Rural area		-0.055***
		[0.005]
Constant	1.069***	0.118***
	[0.004]	[0.015]
DHS wave	No	Yes
Observation	131,409	131,409

Note: Robust standard errors, i.e. corrected for intra-cluster correlation, in brackets.
Statistical significance: + 10%, * 5%, **, 1%.
Source: DHS, various years.

Table A12 Impact of electrification on fertility preferences and the role of media, 1991-2007, DHS, Poisson model

	Number of desired children	
	(1)	(2)
Electricity coverage	-0.047***	-0.053***
	[0.005]	[0.0052]
Watch TV		-0.024***
		[0.0047]
Composition of female population (ref: share aged 15-19)		
Share aged 20-24	0.039***	0.038***
	[0.0126]	[0.0128]
Share aged 25-29	0.110***	0.109***
	[0.0127]	[0.0126]
Share aged 30-34	0.176***	0.175***
	[0.0127]	[0.0127]
Share aged 35-39	0.229***	0.228***
	[0.0129]	[0.0129]
Share aged 40-44	0.276***	0.274***
	[0.0132]	[0.0132]
Share aged 45-49	0.321***	0.319***
	[0.0134]	[0.0134]
Hh living in rural areas	-0.0146*	-0.014***
	[0.0044]	[0.0044]
Highest education completed by women aged 15-49 (ref: none)		
Primary education	-0.039***	-0.041***
	[0.0070]	[0.0070]
Secondary education	-0.065***	-0.068***
	[0.0077]	[0.0077]
Higher	-0.084***	-0.086***
	[0.0110]	[0.0109]
Asset index	-0.065***	-0.069***
	[0.0023]	[0.0025]
Constant	1.053***	1.050***
	[0.0148]	[-0.0149]
DHS wave	Yes	Yes
Observation	107,137	107,137

Note: Robust standard errors, i.e. corrected for intra-cluster correlation, in brackets.
Statistical significance: + 10%, * 5%, ** 1%.
Source: DHS, various years.

Table A13 Impact of electrification on fertility and fertility preferences, and the role of child mortality, 1991-2007, DHS, Poisson model

	Mortality (1)	Fertility (2)	Desired fertility (3)
Electricity coverage	-0.089***	-0.008	-0.031***
	[0.009]	[0.006]	[0.004]
Average cluster mortality		0.456***	0.393***
		[0.005]	[0.006]
Composition of female population (ref: share aged 15-19)			
Share aged 15-24	0.056***	0.257***	0.041***
	[0.011]	[0.012]	[0.012]
Share aged 25-29	-0.060	0.623***	0.110***
	[0.011]	[0.012]	[0.012]
Share aged 30-34	-0.302***	0.949***	0.178***
	[0.013]	[0.012]	[0.012]
Share aged 35-39	-0.655***	1.189***	0.236***
	[0.015]	[0.012]	[0.012]
Share aged 40-44	-1.345***	1.344***	0.290***
	[0.024]	[0.013]	[0.012]
Share aged 45-49	-2.573***	1.464***	0.345***
	[0.044]	[0.013]	[0.013]
Hh living in rural areas	-0.087***	-0.039***	0.002
	[0.009]	[0.005]	[0.004]
Highest education completed by women aged 15-49 (ref: none)			
Primary education	0.031	0.026***	-0.040***
	[0.0166]	[0.007]	[0.006]
Secondary education	0.190***	-0.069***	-0.077***
	[0.009]	[0.008]	[0.007]
Education higher than secondary	0.190***	-0.252***	-0.109***
	[0.017]	[0.011]	[0.010]
Contraception used		0.095***	
		[0.004]	
Traditional contraceptive used		-0.001	
		[0.010]	
Asset index	-0.137***	-0.042***	-0.041***
	[0.004]	[0.002]	[0.002]
DHS year	Yes	Yes	Yes
Observation	131,409	131,409	107,137
Constant	0.194***	-0.262***	0.730***
	[0.021]	[0.016]	[0.015]

Note: Robust standard errors, i.e. corrected for intra-cluster correlation, in brackets. Statistical significance: + 10%, * 5%, ** 1%. *Source*: DHS, various years.