Power and the Vote

Elections and Electricity in the Developing World

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Democracy and Light

Introduction

For decades, political scientists have debated whether democracies are more likely than other regime types to provide valuable public goods to their citizens. Basic public goods such as clean water, sanitation, and electricity are critical because they are foundations for poverty alleviation and economic growth. Such public goods are often undersupplied by private markets, especially in the developing world, and governments must decide whether and how to address these market failures. Liberal theorists argue that free and open elections are the key to effective and responsive states. Elections create powerful incentives for politicians to pursue the preferences of the citizenry, despite the constraints that may otherwise exist within a country. Because voters have the ability to reward and punish the performance of their leaders, democratic politicians are more likely to channel a state's resources toward welfare-enhancing outcomes. Without elections, voters lack the ability to control and direct their politicians.

Yet, if democracies are supposed to be responsive to their citizens, why do so many more people in democratic India lack electricity compared to autocratic China? In an opinion piece in *The New York Times*, Amartya Sen laments, "The far greater gap between India and China is in the provision of essential public services... China has done far more than India to raise life expectancy, expand general education and secure health care for its people."[1] Across the world, more than half of the 1.3 billion people who lack electricity reside in democratic states. And within many developing democracies, glaring inequalities in public service provision challenge the norm of universalism, equality, and fairness many presume to be key features of democracy.[2]

[1] Sen, Amartya. "Why India Trails China." *New York Times*. 20 June 2013.

[2] See, for example, discussions of the norm of universalism observed within democratic legislatures such as the US Congress (Weingast, Shepsle, and Johnsen 1981; Collie 1988; Groseclose and Snyder 1996).

Using satellite imagery of the earth at night to develop new estimates of electricity access across every corner of the world, this chapter presents compelling evidence that democracies provide significantly broader levels of electricity to their citizens than do nondemocratic governments. This is not only because democratic leaders respond to citizens' preferences for public goods: democracies have an added incentive to provide public goods because of the political externalities created by their creation and distribution. Although access to electricity is proclaimed to the masses as a pure public good with universal benefits, democratic politicians can capture additional electoral payoffs because of the discretion they exert over the delivery and implementation of electrification projects.

Importantly, the higher levels of electricity access in democracies persist across all levels of income, including in the world's poorest regions. The results strongly affirm the power of competitive elections to induce more extensive public service delivery, even in contexts where state capacity may be low. Moreover, I demonstrate that the positive effect of democracy cannot be replicated using "official" statistics on electrification. This suggests that official data collected from state agencies can be unreliable, perhaps helping to explain the wide variation in reported results about the performance of democracies across the developing world.

The chapter proceeds as follows. In the next section, I argue that political externalities explain why democracies provide broader access to public goods than do nondemocracies. I then describe my method of estimating electrification rates by tracking populations in lit and unlit areas for all countries of the world. Using regression analysis, I next present cross-national evidence showing that democracy is associated with a significant and substantial increase in electrification rates.

Democracy and Light

At least three types of mechanisms have been proposed to explain why democracies will provide more public goods than nondemocracies: preference matching, performance accountability, and cost efficiency. The first mechanism is laid out most influentially by Meltzer and Richard (1981), who argue that under democracy, public policies are more likely to match the preferences of the median voter. Because the median voter is typically poor, policy outcomes should better reflect the preferences of poorer citizens, including preferences for more public goods and services that the poor value highly.

A second argument suggests that democracy induces more public goods provision because leaders are held accountable for their performance (Manin, Przeworski, and Stokes 1999; Przeworski et al. 2000). Because voters value economic development and welfare, politicians will focus on efforts that visibly improve economic outcomes, such as investments in public goods and services (Mani and Mukand 2007). A closely related claim is made by Harding and Stasavage (2014), who show that democratic politicians will concentrate more on policies with verifiable outcomes, because voters are more likely to judge their leaders for things they can control, such as abolishing school fees, and less for outcomes that are indirectly affected by politicians, such as local school quality.

The third argument expects democracies to systematically favor the provision of public goods because they are the most cost-effective way to secure the support of multitudes of voters. This argument, from Bueno de Mesquita et al. (2003), suggests that in systems in which the number of beneficiaries required to sustain political support is large, public goods are more efficient at securing broad support than private goods, which are effective only when the needed winning coalition is small.

Although these arguments have been highly influential, scholars have struggled to validate their theoretical predictions against the uneven record of public goods provision by democracies in the real world. Many cross-national studies find that even if democracies do spend more on public-facing services and social expenditures, these funds rarely reach the poorest or most vulnerable segments of society (Ross 2006). Keefer and Khemani (2005, 2) observe that "policymakers in poor democracies regularly divert spending away from areas that most benefit the poor or fail to implement policies that improve the services that are known to disproportionately benefit poor people." One reason is that graft and political manipulation of funds might actually be more likely to occur with programs designed to aid the poor. Schady (2000) notes that "the kind of targeted poverty-alleviation programs which have become increasingly widespread in Latin America and elsewhere may be particularly vulnerable to political interference" (291).

Such failures seemingly contradict the expectations of the median voter theorem, and the theory has become increasingly maligned by critics. For one, the median voter theorem assumes that candidates and voters are aligned only along a single policy dimension, a modeling conjecture that does not hold in most situations. Moreover, the standard median voter result emerges only in a setting with two candidates. By contrast, elections typically feature multiple candidates, especially in the developing world, where weak party systems can lead to a proliferation of choices for voters (Gallagher and Mitchell 2005; Golder 2005). In such multiparty settings, the policy space can become fragmented as parties seek to capture groups of supporters, resulting in a preference for goods that can be strategically targeted rather than those providing broad-based benefits (Chhibber and Nooruddin 2004).[3]

Another explanation for why democracies fail to meet the needs of the poor is that the repeated nature of elections makes governments vulnerable to

[3] Relatedly, Milesi-Ferretti, Perotti, and Rostagno (2002) show that in proportional representation systems, politicians prefer spending that can be targeted towards groups of voters while majoritarian systems will induce a preference for spending that can be targeted geographically.

"political failures," in which leaders fail to enact economically desirable policies that may reduce their likelihood of reelection, for example, by empowering the poor and thereby changing the income distribution (Besley and Coate 1998; Acemoglu and Robinson 2006a). Besley and Burgess (2002, 1415) also suggest that "the poor and vulnerable may not obtain the full attention of politicians even in a democracy where they have numerical strength," especially if they lack access to information on government performance and are unable to distinguish between high- and low-quality candidates.

Existing theories provide an incomplete account of how political institutions affect public goods delivery. I argue that democracies lean toward public goods provision for deeper reasons than just their cost effectiveness at winning support and because so many citizens value them. Under democracy, electorally minded politicians are motivated to provide public goods because of their strategic usefulness. In the hands of skilled politicians, the same public goods projects are on the one hand trumpeted as universal resources to benefit the nation, while on the other, they are used to entice supporters with promises of improved personal welfare, jobs, and other localized benefits. It is not only that public goods are an economical way to secure large numbers of votes; it is that such goods are also malleable, offering politicians fluid means of using the public purse to seek out and maximize electoral payoffs.

Unlike the reproach and censure that can result from explicit pandering to groups or outright vote buying, broad-based promises to electrify the masses, improve education, or enhance public safety reflect a veneer of universalism that masks the tartan patchwork of benefits that politicians can shape and target. Electorally minded politicians enjoy myriad opportunities to influence the timing, siting, and mode by which public goods are delivered to their constituents. When it comes to electricity, its plausibility as a pure public good despite its private good properties, and its high salience and value to voters, create an electoral payoff in its provision. This political externality provides added incentives for democratic politicians to expand access to electricity in ways that do not exist in nondemocratic settings. This implies that electricity policy is driven not merely by technical and feasibility constraints, but also by a logic of political exigency.

If this argument is correct, we should find that more citizens enjoy the benefits of electrification in democratic regimes with competitive elections, and that the positive benefits of democracy should compound over time as elected leaders continually seek out votes through the provision of public goods such as electricity. Indeed, this is the pattern I find and that I describe in the rest of the chapter.

Data and Methods

This chapter introduces a new method of estimating how many people in a country have access to electricity. Specifically, I calculate the proportion of a country's population living in areas that are consistently and brightly lit at night, indicating both the presence of electrical infrastructure and the ongoing provision of stable electricity supply. This approach relies on a systematic comparison of high-resolution data of nighttime light output and population distribution across all countries of the world.

To identify populated regions, I draw on the 2006 LandScan population count map produced by the Oak Ridge National Laboratory (see Figure 4.2). Drawing on subnational census data, the map is produced by apportioning populations onto a 30-arcsecond grid (roughly 1 square kilometre at the Equator) using country-specific likelihood coefficients based on proximity to roads, slope, land cover, and other information (Dobson et al. 2000). The LandScan population maps have been thoroughly vetted and are widely used by the United Nations, World Health Organization, and Food and Agricultural Organization. LandScan uses satellite-based inputs to create the map, including high-resolution daytime imagery and land cover databases. It does not use night lights images, resulting in a data source that is independent of the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS) night lights data.

A direct comparison of the raw LandScan and 2003 DMSP-OLS data reveals a very large number of populated cells with no light output. While this may reflect the lack of electricity, it could also be because electrified areas with very low population counts may not generate a sufficient concentration of outdoor light to be seen from space. Thus a direct comparison of these data sources will not yield an accurate count of people living in electrified areas. To better estimate the electrification rate, we need to focus on areas where we can reliably infer that lighting would be detectable *if it were present.* I do so by identifying what the typical population counts look like in the most dimly lit parts of each country. For example, it may be that in a given country, the only villages detectable in nighttime satellite imagery have at least 100 people. Since this affirms that electricity use for villages with at least 100 people are visible from space, I then assume that villages that meet this threshold but look dark at night can be reliably classified as lacking electricity. Because lighting technology, norms of streetlight density, and cultural preferences for outdoor illumination vary across the world, I conduct this procedure separately for each country. Practically speaking, I identify the median population count in the most dimly lit cells within each country individually. I then sum the population in all unlit cells of a country whose population exceeds the country-specific threshold. This provides a relatively conservative estimate of how many people live in unlit areas that presumably would appear lit if electricity were available. I then calculate the electrification rate accordingly.

To illustrate, here is how the method works in the case of India. India is home to 1.1 billion people as of 2003 and is the second most populous country and largest democracy in the world. The DMSP satellite image of India for 2003 is composed of 4 million pixels at 30-arcsecond resolution with a mean light output of 2.2 (4.9 excluding unlit cells) on the 0–63 scale. The median

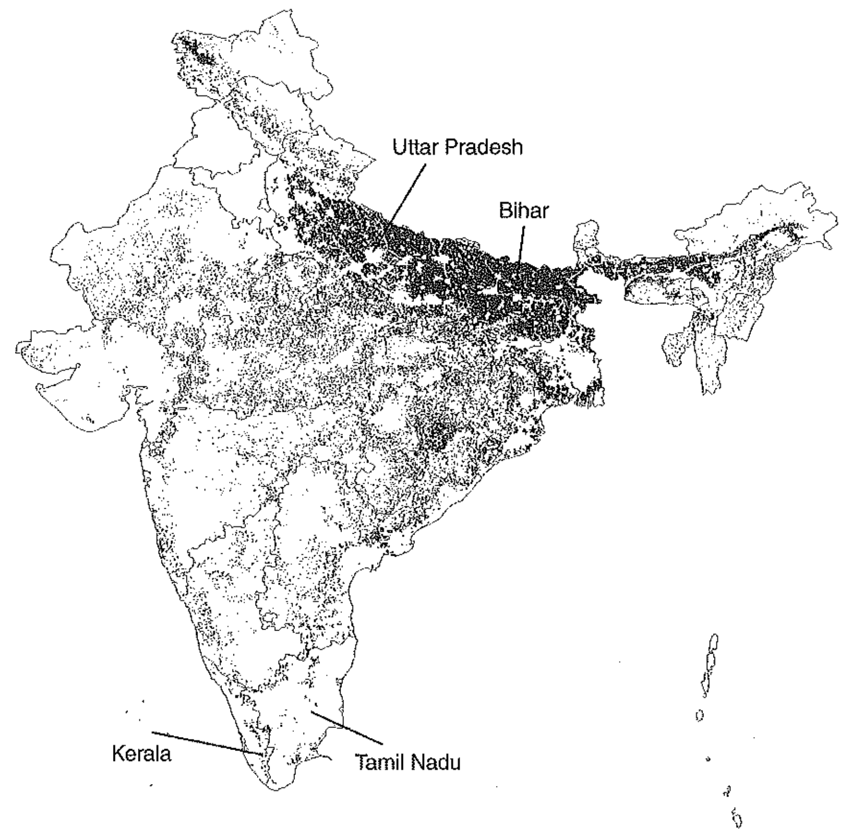


FIGURE 5.1. Estimated unlit populations in India, 2003. Darker areas have more people living in unlit areas. Each dot represents a populated 30-arcsecond cell with no detectable light output. Estimated using DMSP F152003 and LandScan 2006 data.

population count of the most dimly lit cells is 58, providing observational evidence that in India, outdoor lighting technology is detectable for cells with at least 58 people. Of the more than 2 million unlit cells in which no stable light is detected in the annual composite, about 690,000 have a population of at least 58. Summing the population counts across these unlit cells with at least 58 people yields a total estimate of about 275 million Indians living in unlit areas. Given that India has a population of 1.1 billion, using this procedure reveals that 75 percent of the country has access to electricity.[4]

The distribution of populations living in unlit areas in India is plotted in Figure 5.1, with each dot indicating an unlit settlement and darker dots

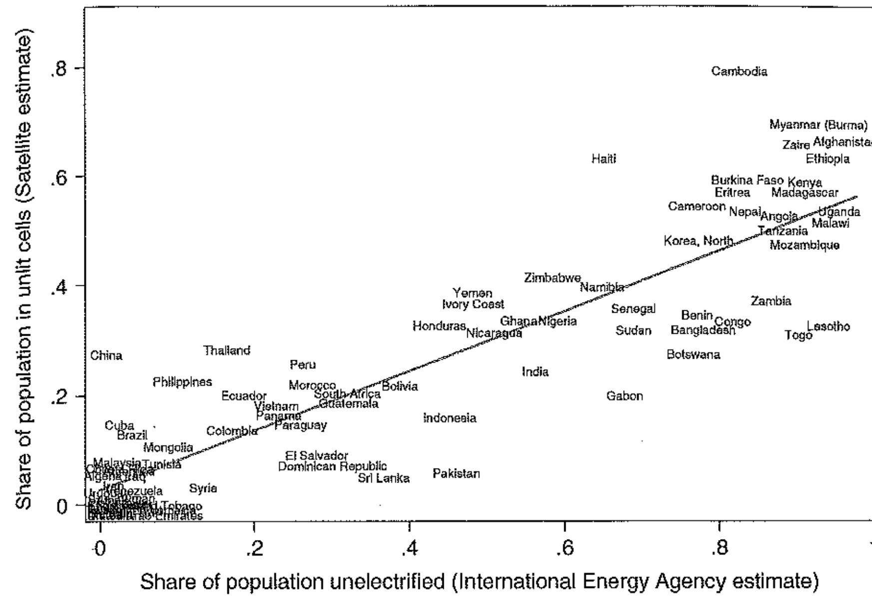
[4] By comparison, IEA (2002) estimates 440 million unelectrified homes in India, but many of these are in electrified cities and towns. The population living in unelectrified villages, which my measure most closely resembles, is not reported.

TABLE 5.1. *Estimated electrification rate using nighttime satellite images, 2003*

Region	Total Population (millions)	Unlit Population (millions)	Access to Electricity Rate (%)
Western democracies and Japan	778	7	99.1
North Africa and Middle East	414	34	91.9
Eastern Europe	405	35	91.5
Latin and Central America	546	71	87.1
Asia	3,450	895	74.1
Sub-Saharan Africa	746	349	53.2
Other	88	2	97.9
WORLD	6,427	1,391	78.4

indicating higher population counts. The highest concentrations of populations in dark areas lie across India's northern region, spanning two of India's poorest states, Uttar Pradesh and Bihar. Note that even in these impoverished regions, urban cores are white, including the state capitals Lucknow and Patna, indicating the prevalence of electrical infrastructure in urban areas. In comparison, Kerala and Tamil Nadu, on the southern tip of the Indian peninsula, have only a scattering of unelectrified communities. Indeed, India's Ministry of Power estimates that 42 percent of villages in Uttar Pradesh and 51 percent in Bihar lacked electricity in 2005. Meanwhile, the estimated rates for Kerala and Tamil Nadu were 3 percent and 0 percent, respectively. Meanwhile, the satellite-based method estimates that 37 percent of the people in Uttar Pradesh and 64 percent of those in Bihar lived in unlit areas, compared to 3 percent in Kerala and 1 percent in Tamil Nadu.

Applying the method described above, I estimate that 1.4 billion people, or 22 percent of the global population, lived in unlit areas of the world in 2003. Regional breakdowns are presented in Table 5.1 and country totals are listed in the book's appendix. This global estimate compares reasonably well with the International Energy Agency (IEA) projection of 1.6 billion people living without electricity in 2002, a number that includes the urban unelectrified (International Energy Agency 2002). Figure 5.2 plots the satellite estimates of the proportion unlit against the IEA's estimates of the proportion unelectrified, derived from official government and UN statistics. Among the 86 countries for which IEA data exist, there are some notable outliers, including China which looks far darker by satellite than official data would suggest. Overall, the satellite method yields lower estimates of electrification access than the IEA data. This is not surprising since the indicators measure different things. My satellite method identifies populations that live in electrified areas that appear lit at night, focusing on whether the public goods nature of electrification is



N = 86. Correlation coefficient = 0.89

FIGURE 5.2. Comparison of satellite and official estimates of electrification.
Sources: DMSP-OLS F152003, LandScan 2006, World Energy Outlook 2002.

available in a community. By contrast, IEA data focus on variations in household electrification, which can depend on a household's private income as much as on whether the government has chosen to provide electricity to a community. Still, the overall correlation between the satellite and IEA estimates is high, with a correlation coefficient of 0.89.[5]

Unlike the self-reported government data that are used in most widely used datasets, the accuracy of satellite-derived data is not affected by political motivations to embellish performance, economic circumstances that make proper record-keeping difficult, or definitional variations that make estimates incomparable across cases. The satellite estimates provide instead unbiased and objective estimates of lit and unlit populations, whose measurement errors are unlikely to be correlated with political variables. Furthermore, the satellite images provide spatially disaggregated information at the subnational and local levels, offering opportunities for more detailed analysis that are not possible using official country data alone (see Chapters 6 and 7).

[5] I show elsewhere that variations between the satellite estimates and the government-reported IEA estimates are not random and are systematically predicted by levels of development and bureaucratic capacity. If the IEA-reported totals include systematic measurement error, regressions using the reported data are likely to be biased and inconsistent.

Some plausible objections exist that outdoor lights might not be an accurate indicator of publicly funded electrification. If electrified areas do not have substantial outdoor lighting, they will be incorrectly classified as unelectrified by my procedure. Although this certainly is a concern, reports and anecdotal evidence suggest that outdoor lighting is among the most highly desired benefits of electricity, especially at night. Many rural electrification agencies incorporate public outdoor lighting as part of every village electrification plan.[6] Attaching an outdoor lamp to a preexisting electric utility pole is of low marginal cost but delivers large public benefits. For politicians seeking to win the favor of a community, ensuring that there is outdoor lighting is a very public and visible way to demonstrate the success of an electrification project.

A different concern is that the presence of outdoor lighting will not be a reliable indicator of government public goods provision if electricity is provided privately. In many parts of the developing world, privately owned diesel and kerosene power generators can provide electricity absent the state. However, it is unlikely that private generators are widely used to provide the kind of outdoor lighting detected by the satellite sensor. The cost of electricity produced by a generator can be several times the cost of grid electricity, depending on the price of fuel. As a result, business owners are unlikely to shine light into public spaces at their own expense because they have no way of charging the public for these benefits. It is more likely that generators are used primarily to power indoor lighting and other devices unlikely to be visible from space.

Nevertheless, the effect of these concerns will not bias inferences about the effects of democracy, unless they are correlated with political regime type. Nonsystematic measurement error on the dependent variable does not bias the slope coefficient but leads to larger standard errors, which would make it more difficult to find a statistically significant effect of democracy. On the other hand, systematic errors on the dependent variable will bias coefficient estimates toward zero when the errors are correlated with the predictor variables, which should make it more difficult to identify a democracy effect if the concerns raised earlier are valid.

Electrification and Regime Type

If voters hold their politicians accountable for the provision of electrification, then democratic leaders should face a more compelling incentive to deliver electricity to their citizens than leaders in autocracies. To assess the influence of democratic elections on electrification rates, I construct a measure of *Democratic history* that calculates the number of years between 1946 and 2002 that a country has had democratic and competitive elections. I use the

[6] For example, in Senegal, the Agence Sénégalaise d'Electrification Rurale (ASER) provides public outdoor lighting as part of every new village electrification effort. Engineers report that such outdoor lighting is among the most highly prioritized benefits of electricity in villages (Min et al. 2013).

dichotomous coding of democracy, originally attributable to Przeworski et al. (2000) and updated by Cheibub and Gandhi (2004) and Cheibub, Gandhi, and Vreeland (2010). Their definition of democracy is clear cut: executives must be elected, there must be competition between more than one party, and there must be alternation of power between different parties. The definition is particularly appropriate because it places primacy on the competitiveness of elections, which is the mechanism that leads to the political externalities that are central to this book's argument. Certainly, other features of democracy are valuable and important in their own right, from the presence of checks and balances on executive power, to freedom of expression, or to a normative preference for liberty and equality. Yet my analysis shows that the presence of competitive elections alone is sufficient to motivate a broader distribution of public goods.[7]

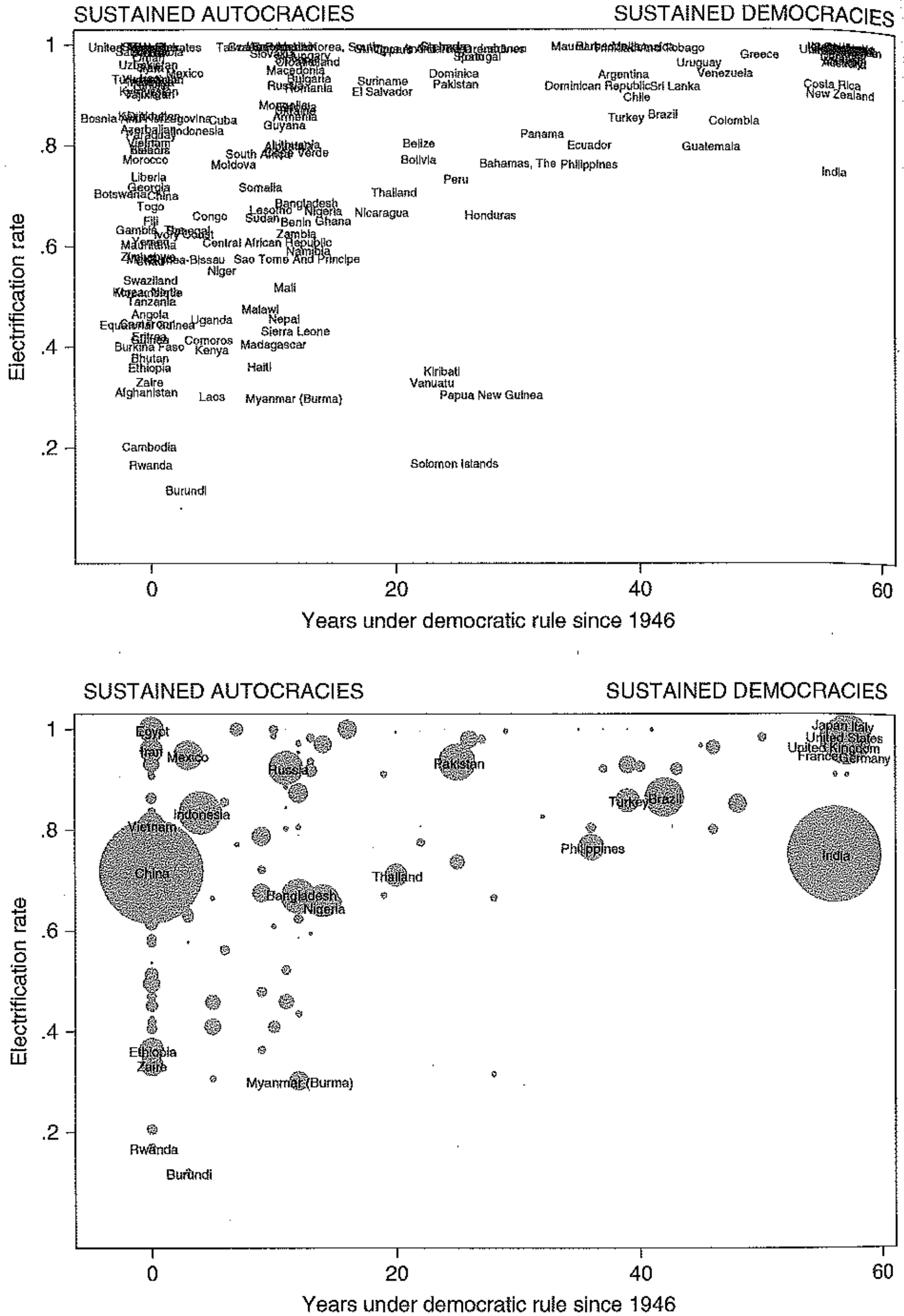
It is important to account for history because electrical infrastructure observed in 2003 is a *stock* measurement, reflecting the current extent of the grid built up through the *flow* of investments over years and decades. Looking only at the current level of democratization might yield incorrect inferences because the extent of the power grid in 2003 depends on investments made in the past, perhaps under a different regime type. That said, almost half of the countries in the dataset have not changed regime type at any point during the postwar period: 52 countries have always been autocratic while 31 have stayed democratic.

Figure 5.3a shows satellite-based electrification rates for 183 countries at all levels of democratic history (the sample size is limited only by the availability of regime-type data). Among sustained democracies, the provision of electrification is impressively uniform. In these 21 countries, only about 2 out of every 100 people live in unlit areas, with India appearing as a notable outlier. Among authoritarian regimes, the variance in electrification rates is much wider. In Rwanda and Burundi, more than three-quarters of the population live in the dark compared to less than 1 percent in Egypt and Jordan. Some of these differences are likely to be linked to oil wealth, but variation persists even among dictatorships without oil.[8]

In the middle region of the figure lie almost half of the world's countries that have experienced some mix of democratic and autocratic rule since 1946. The pattern here remains consistent with theoretical expectations: countries

[7] To evaluate robustness, I also compare my results using other widely used democracy measures constructed from Polity and Freedom House data (see later). Although these measures are highly correlated with the dichotomous scores of Cheibub, Gandhi, and Vreeland (2010), I focus less on those measures as they incorporate other dimensions of democracy that are outside the scope of my theory.

[8] Nighttime lights in oil producing countries may lead to an overestimate of the distribution of electrification: gas flares on oil wells and rigs generate high levels of outdoor light visible in the satellite images. Gas flaring is known to be particularly pronounced in Nigeria, Russia, Iran, Algeria, Mexico, Venezuela, and Indonesia (Elvidge et al. 2009).



Markers scaled to country population. $N = 184$.

FIGURE 5.3. Satellite estimates of electrification rates by history of democratic rule. *Sources*: Author calculations based on data from DMSP-OLS F152003, LandScan 2006; Cheibub and Gandhi (2004).

with a longer history of democratic rule have higher rates of electrification. In addition, variation in electrification rates appears to decrease with longer experience under democracy.

Figure 5.3b shows the same scatterplot but uses markers weighted by the population size of each country. Dominating the plot are the large markers associated with China and India. In stark contrast to the official electrification estimates reported by the IEA that claim nearly complete electrification in China but dismally low access in India, the shares of populations living in lit areas are surprisingly similar for China and India using the satellite-based methodology. In fact, a full quarter of China's population live in areas that emit no stable light output at night, with most concentrated in the poorer central provinces of Sichuan, Yunnan, and Guizhou. Meanwhile, the IEA reports a 98% electrification rate in China, an incredible rate that may reflect widely recognized reliability limitations with China's official energy statistics (Sinton 2001).[9]

Partially obscured in both figures is the large number of countries that are effectively fully electrified: 43 countries have less than 1 percent of their population in unlit cells and 64 countries have less than 5 percent in dark areas. Many of these countries are wealthy (e.g., Norway, Saudi Arabia), have small territories (e.g., Jamaica, Lebanon), or both (e.g. Kuwait, Israel). The majority are democracies though about a quarter are autocracies.

To what extent does this pattern simply reflect differences in development between the (mostly) wealthy democratic West and the (mostly) autocratic developing world? Even comparing countries at similar levels of development reveals that differences in democratic history matter. Among the poorest half of the world's countries with incomes below $4,589 per capita in 2002, those with no history of democratic rule had 63 percent of their populations in electrified areas. Among democracies below that income level with at least 10 years of democratic history, the electrification rate was 68 percent, a small but nevertheless important difference.

Many scholars have asserted that the choice of government may not be relevant in the very poorest states. As Przeworski et al. (2000, 163) write, "Poor countries cannot afford a strong state, and when the state is weak, the kind of regime matters little for everyday life." But satellite images of the earth at night show otherwise. Even among states with income levels in the bottom quartile – below $1,534 per capita – 59 percent of citizens in democracies with at least 10 years of democratic history live in electrified areas, compared to 48 percent

[9] Barry Naughton, in his influential textbook, *The Chinese Economy*, reports: "There have been serious problems with Chinese energy data in recent years. According to official Chinese data, after decades of sustained growth total energy production began a sharp decline in 1996, and by 2000 it was 19.3 percent below the 1996 peak; the entire decline was accounted for by coal production, which supposedly declined 29%, while GDP officially grew 36%. These figures are preposterous. Of all the data problems mentioned in this text, this is the most flagrant and egregious case" (2007, 335).

in countries that have always been autocracies. For the average country in this group, this translates into 2.3 million more people living with access to electricity in democracy versus autocracy. The difference is significant at the $p = 0.04$ level. These results suggest that even at low levels of development, more citizens benefit from electrification in democracies than in nondemocracies. Still, these highly suggestive results might be caused by other factors unrelated to but correlated with democratic rule, such as differences in geography or demography. I explore these concerns using regression analysis.

Cross-National Analysis of Unlit Populations

To evaluate the effects of democracy on the provision of electrification, I conduct cross-national regressions on the electrification rate as measured by satellite. The dependent variable is the electrification rate, calculated from the proportion of a country's population living in lit and unlit areas as of 2003. My key independent variable is a count of the number of years between 1946 and 2002 during which a country was a democracy in which elections were competitive.

Because my dependent variable is a proportion bounded at 0 and 1, ordinary least squares (OLS) regression is problematic because it will generate predicted values outside of this range. Instead, I use a fractional logit model following Papke and Wooldridge (1996) and Wooldridge (2002, 661). In the fractional logit model, the dependent variable, y is assumed to be a proportion generated by the logistic function:

$$E(y|x) = \exp(x\beta)/[1 + \exp(x\beta)] \tag{5.1}$$

The β's are easily estimated by specifying a generalized linear model with a binomial distribution and logit link function. The partial effects of a change in an independent variable in a fractional logit model are roughly comparable to changes estimated based on the coefficients of an OLS model.[10]

Among nonpolitical variables, other important determinants of electrification are a country's level of industrialization and the distribution of its population. The level of industrialization indicates a country's ability to afford the provision of electrification. Moreover, the more advanced an economy, the higher the demand for electrical power. I estimate the level of industrialization using the log of a country's *GDP per capita* in 2002. These data come from the Penn World Table 6.2 and are denominated in thousands of 2000 US dollars. A country's *Population density* will also affect the feasibility of electrification because sparsely populated countries must absorb higher per capita costs to electrify remote areas.

[10] An alternative would be to use the log-odds transformation, $\log[y/(1 - y)]$, as the dependent variable, since $\log[y/(1-y)]$ ranges over all real values while y is strictly bounded between 0 and 1. However, the log-odds transformation fails when y takes on the boundary values of 0 and 1 where the transformation is undefined.

I use the log of the population density, which is counted in people per square kilometer and is computed from LandScan 2006 population numbers and World Development Indicators data on surface area. To account for differences in urbanization across countries, I also control for a country's *Rural population*, calculated as the percent of the population living in rural areas in 2002 as defined by national governments and recorded in the World Development Indicators.

I include several other control variables. Violent civil wars and conflicts can quickly destroy infrastructure that might have taken years to build. As a result, countries that have suffered from a higher *Number of civil armed conflicts* might have lower levels of electrification. This variable, derived from the Peace Research Institute Oslo's (PRIO) Armed Conflicts Dataset 3.0, counts the total number of internal conflicts with at least 25 battle-related deaths from 1946 to 2002. Many scholars have found a relationship between ethnic diversity and public goods provision. I include a measure of *Ethno-linguistic fractionalization* that comes from Fearon and Laitin (2003). The physical geography of a country might make it more difficult for a government to provide rural electrification. For example, the presence of rough and *Mountainous terrain* increases construction and maintenance costs for electrical infrastructure. This measure also comes from Fearon and Laitin (2003). Geography may also affect the underlying demand for electricity. Places at a higher *Absolute latitude* have more variation in sunlight and colder temperatures. I use the latitude of a country's capital city as coded by Gleditsch (2003).

Access to natural resources such as oil might affect the incentives of governments to electrify their rural populations, both by diverting state resources toward resource extraction activities and by diminishing the accountability of governments toward their populations. I include a measure of *Oil production per capita* in barrels as recorded for 2002, derived from Humphreys (2005) and BP's *Statistical Review of World Energy 2007*.

Table 5.2 presents fractional logit regression results to test the effects of democratic rule on the electrification rate. I run all models using the Huber–White sandwich estimator to correct for heteroscedasticity. Model 1 shows the bivariate relationship between years of democratic rule and electrification. As the dependent variable is the share of the population living in lit areas, the democratic coefficient should have a positive sign, as seen here. Going from fully sustained autocratic rule to fully sustained democratic rule is linked with a 25 percent increase in the lit population. Although this is a large effect, it might be generated by other confounding factors not included in the model but correlated with democracy. Moreover, we know from Figure 5.3 that because there is so much variance among autocracies, regime type alone is a relatively poor predictor of electrification levels absent other information. What we would like to know is whether autocracies and democracies with similar levels of income and population densities provide different levels of electrification. I account for these and other potential factors in the next model. Model 2 shows that

TABLE 5.2. *Fractional logit analysis of electrification rate*

	All Countries		Excluding OECD	Less Developed Countries Only[a]
	(1)	(2)	(3)	(4)
Democratic history[b]	0.0355**	0.0170**	0.0176**	0.0149*
	(0.0053)	(0.0053)	(0.0062)	(0.0071)
log (GDP/capita)[c]		0.3206**	0.2595*	0.3290
		(0.1230)	(0.1203)	(0.1696)
log (Population density)[c]		0.1017	0.0902	0.0515
		(0.0619)	(0.0615)	(0.0684)
Rural population (%)[c]		−0.0215**	−0.0210**	−0.0219**
		(0.0053)	(0.0053)	(0.0067)
Absolute latitude of capital		0.0278**	0.0274**	0.0323**
		(0.0066)	(0.0070)	(0.0077)
Civil armed conflicts[b]		−0.0195	−0.0179	−0.0184
		(0.0457)	(0.0456)	(0.0456)
Ethno-linguistic fractionalization		0.1203	0.1457	0.2320
		(0.3283)	(0.3244)	(0.3632)
log (Mountainous terrain)		−0.0753	−0.0617	−0.1107*
		(0.0467)	(0.0489)	(0.0506)
Oil production per capita[c]		0.0891*	0.1214*	0.0786
		(0.0416)	(0.0476)	(0.1008)
Constant	−0.8255**	−1.5993	−1.1714	−1.3531
	(0.1175)	(1.1597)	(1.1395)	(1.6002)
Observations	184	147	119	88

The dependent variable is the share of country population in lit areas, 2003. Huber–White robust standard errors in parentheses.

$^{**}p$-value ≤ 0.01; $^{*}p$-value ≤ 0.05.

[a] GDP per capita < $6,500.

[b] From 1946 to 2002.

[c] As of 2002.

the effect of democratic rule is substantial even after controlling for a wide range of country-level differences. When comparing two countries with similar mean levels of all variables except that one has been democratic over the entire post–World War II period and the other has stayed autocratic, the results show that the democratic state provides electrification to 10 percent more of its citizens than the dictatorship. This is a sizeable difference, given that 29 percent of the population lived in the dark in the average autocracy. Put another way,

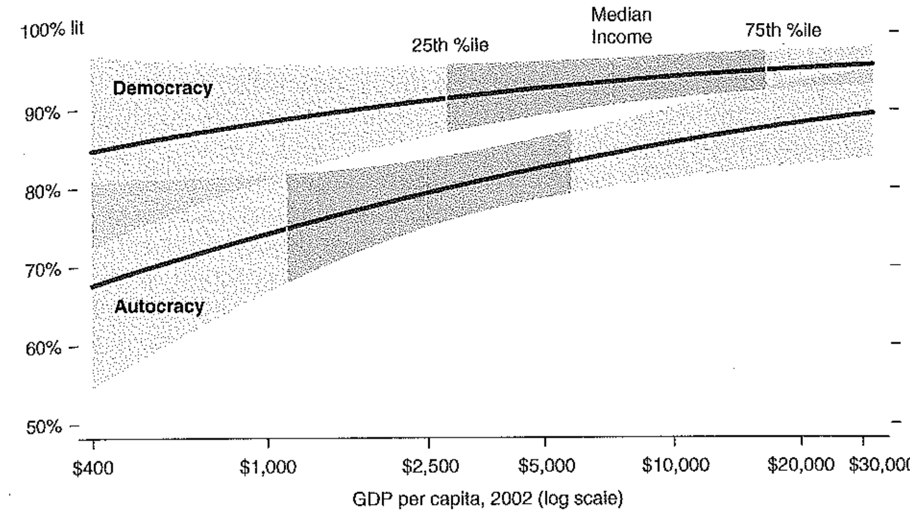


FIGURE 5.4. Predicted electrification rates by regime type and income level.

Note: Predicted values based on Table 5.2, Model 2 with bootstrapped 95% confidence intervals. Autocracy is a country with no history of democratic rule, while Democracy is a country with sustained democratic rule from 1946 to 2002 (i.e., 57 years). All other variables are held at their mean or modal values. Darker regions show interquartile range of observed per capita income values in 2002 among autocracies and democracies.

in a typical autocracy with 35 million citizens, an alternate history of sustained democratic rule would have provided electrification for an additional 3.5 million residents.

The population and income variables are highly significant, as expected. Wealthier countries provide more electricity: an increase of $1,000 in per capita income from the observed mean is associated with a 1.1 percent gain in the electrification rate. The population density result has a positive sign as expected, suggesting that more densely populated countries are likely to have greater access to electricity. With these factors taken into account, a country's war history and ethnic diversity do not predict electricity provision. Countries with more rugged terrain have fewer people in electrified areas, though the coefficient misses standard levels of significance. Finally, higher levels of oil production are linked with more widespread electrification, perhaps because some oil-rich states use diesel to generate electricity.

The effects of regime type and income are plotted in Figure 5.4, based on the equation in model 2. At every level of development, democracies are predicted to have a higher proportion of their population living in lit areas than autocracies. The difference is statistically significant, except at very low levels of income (where there are few democracies) and high levels of income (where there are few autocracies).

To what extent is the positive effect of democratic rule driven by the wealthy Western democracies? To evaluate this possibility, model 3 excludes the highly developed Organisation for Economic Co-operation and Development (OECD) nations; it yields nearly identical results. Model 4 focuses the analysis on the developing world, excluding countries with per capita income greater than $6,500.[11] The results are again nearly identical, suggesting that even poor and middle-income democracies provide electrification to more citizens than their autocratic counterparts. Drawing on codings from the Polity IV and Freedom House projects allows us to see that the results are also robust to alternative measures of democratic history. The coefficients on these measures of democratic history, presented in Tables 5.3 and 5.4, are consistent in size and significance to the main results.[12]

Table 5.5 evaluates the robustness of the main results to different model specifications. Model 1 includes only the sample of sustained democracies and autocracies to obviate the concern that existing electrification rates might have been the result of previous regimes. The size and sign of the democratic history coefficient remain similar to the results for the full country sample. Model 2 runs a population weighted regression to see whether the cross-sectional results might be driven by a handful of small countries. The largest country in my sample (China) has a population three orders of magnitude larger than the smallest (Trinidad and Tobago). The size and significance of the democratic history variable is reduced, though the sign remains positive as before. Model 3 shows that the inclusion of region fixed effects has no effect on the democratic history coefficient. Model 4 explores several potential interaction effects. For example, it might be that democracies are just more efficient at translating economic wealth into public goods provision. To ease the interpretation of interactions between two continuous variables, I center the democratic history, per capita income, and population density variables. Although the interaction effects between democratic history and income, democratic history and population density, and income and population density are all significant, the independent effect of democratic rule remains as strong as before. These results

[11] The $6,500 cutoff is arbitrary, though results are robust to a wide range of cutoff levels. Interestingly, Przeworski et al. (2000, 98) note that no democracy has fallen since World War II in a country with a per capita income higher than that of Argentina in 1975, $6,055.

[12] The different democratic history measures are:

- Years Polity>0: number of years from 1946 to 2002 in which Polity score is positive.
- Years Polity≥6: number of years in which Polity score surpasses Polity's recommended threshold for "democracy."
- Years with competitive elections: number of years in which the chief executive is chosen through competitive elections (i.e., Executive Recruitment Concept 8 in the Polity data).
- Σ Polity: the sum of the annual Polity scores (from −10 to + 10), scaled to a 0–100 score.
- Years Free: number of years since 1972 (the earliest year available) a country has been coded as "Free" by Freedom House.

TABLE 5.3. *Robustness checks: Fractional logit analysis of electrification rate using alternative democracy measures (all countries)*

All Countries	(1) Years Polity >0	(2) Years Polity ≥6	(3) Years with Competitive Elections	(4) Σ Polity
Democratic history, 1946–2002	0.0142* (0.0056)	0.0162** (0.0059)	0.0150** (0.0057)	0.0193** (0.0068)
log (GDP/capita), 2002	0.3214* (0.1292)	0.3407** (0.1282)	0.3289** (0.1272)	0.3020* (0.1282)
log (Population density), 2002	0.1057 (0.0643)	0.1217 (0.0646)	0.1051 (0.0646)	0.1114 (0.0647)
Rural population (%), 2002	−0.0220** (0.0052)	−0.0230** (0.0053)	−0.0223** (0.0053)	−0.0221** (0.0053)
Absolute latitude of capital city	0.0273** (0.0065)	0.0252** (0.0064)	0.0266** (0.0062)	0.0272** (0.0064)
Civil armed conflicts, 1946–2002	−0.0210 (0.0439)	−0.0284 (0.0456)	−0.0224 (0.0449)	−0.0214 (0.0448)
Ethno-linguistic fractionalization	0.0461 (0.3327)	0.1336 (0.3273)	0.0635 (0.3290)	0.0779 (0.3325)
log (Mountainous terrain)	−0.0630 (0.0475)	−0.0570 (0.0471)	−0.0589 (0.0469)	−0.0618 (0.0472)
Oil production per capita, 2002	0.0894* (0.0424)	0.0794* (0.0393)	0.0829* (0.0400)	0.0898* (0.0413)
Constant	−1.5935 (1.1844)	−1.7133 (1.1889)	−1.5888 (1.1783)	−1.4860 (1.1769)
Observations	147	147	147	147

The dependent variable is the share of country population in lit areas, 2003. Huber–White robust standard errors in parentheses.
**p-value ≤ 0.01; *p-value ≤ 0.05.

are nearly identical for the reduced sample that excludes the OECD countries (Table 5.6).

Finally, I evaluate whether we could have reached the same conclusions by relying on existing measures of electrification rates. It is by now well known that missing data, inconsistent definitions, and variable data collection practices across states impair many traditional cross-national data sources. In fact, the best available data on electrification rates suffer from many of these limitations. The IEA's World Energy Outlook volume reports electrification rates for 86 countries compiled from various sources including government self-reports, private research notes, and OECD and World Bank estimates.

TABLE 5.4. *Robustness checks: Fractional logit analysis of electrification rate using alternative democracy measures (excluding OECD)*

Excluding OECD	(5) Years Polity >0	(6) Years Polity >6	(7) Years with Competitive Elections	(8) Σ Polity
Democratic history, 1946–2002	0.0153*	0.0169*	0.0150*	0.0210*
	(0.0062)	(0.0073)	(0.0065)	(0.0082)
log (GDP/capita), 2002	0.2434	0.2782*	0.2672*	0.2323
	(0.1254)	(0.1250)	(0.1240)	(0.1245)
log (Population density), 2002	0.0944	0.1119	0.0940	0.0999
	(0.0636)	(0.0644)	(0.0642)	(0.0645)
Rural population (%), 2002	−0.0215**	−0.0228**	−0.0218**	−0.0217**
	(0.0052)	(0.0052)	(0.0052)	(0.0052)
Absolute latitude of capital city	0.0269**	0.0247**	0.0259**	0.0271**
	(0.0067)	(0.0067)	(0.0065)	(0.0068)
Civil armed conflicts, 1946–2002	−0.0199	−0.0276	−0.0202	−0.0207
	(0.0440)	(0.0462)	(0.0449)	(0.0452)
Ethno-linguistic fractionalization	0.0675	0.1651	0.0864	0.1037
	(0.3271)	(0.3248)	(0.3243)	(0.3284)
log (Mountainous terrain)	−0.0454	−0.0400	−0.0433	−0.0453
	(0.0491)	(0.0488)	(0.0484)	(0.0488)
Oil production per capita, 2002	0.1247**	0.1101*	0.1144*	0.1232**
	(0.0483)	(0.0456)	(0.0466)	(0.0463)
Constant	−1.0475	−1.2719	−1.1442	−0.9991
	(1.1533)	(1.1627)	(1.1487)	(1.1468)
Observations	119	119	119	119

The dependent variable is the share of country population in lit areas, 2003. Huber–White robust standard errors in parentheses.
$^{**}p$-value ≤ 0.01; $^{*}p$-value ≤ 0.05.

Affirming the difficulty of compiling reliable data from such diverse sources, IEA researchers made adjustments to country estimates in at least a dozen cases: "Where country data appeared contradictory, outdated or unreliable, the IEA Secretariat made estimates based on cross-country comparisons, earlier surveys, information from other international organizations, annual statistical bulletins, publications and journals." In addition, there are a large number of missing observations in the IEA data, which will exacerbate bias if the pattern of unavailable data is not random (King et al. 2002; Groves 2006).

As reported earlier, the IEA data on electrification rates correlate at 0.89 with my satellite-derived estimates of population proportions that are lit. Yet

TABLE 5.5. *Robustness checks: Fractional logit analysis of electrification rate using alternative model specifications (all countries)*

	All Countries			
	Sustained Autocracies & Democracies Only	Population Weighted	Region Fixed Effects	Interactions
	(1)	(2)	(3)	(4)
Democratic history, 1946–2002	0.0164	0.0096	0.0189**	0.0128*
	(0.0092)	(0.0057)	(0.0069)	(0.0050)
log (GDP/capita), 2002	0.2999	0.6523**	0.3060**	0.3380*
	(0.2442)	(0.1732)	(0.1044)	(0.1381)
log (Population density), 2002	0.0927	0.1477	0.0690	0.2166**
	(0.0902)	(0.0814)	(0.0665)	(0.0720)
Rural population (%), 2002	−0.0234*	−0.0149*	−0.0175**	−0.0209**
	(0.0115)	(0.0069)	(0.0055)	(0.0050)
Absolute latitude of capital	0.0356**	0.0160	0.0135	0.0268**
	(0.0120)	(0.0083)	(0.0098)	(0.0061)
Civil conflicts, 1946–2002	0.0146	−0.0826	−0.0081	−0.0389
	(0.0782)	(0.0440)	(0.0450)	(0.0379)
Ethno-linguistic fractionalization	0.1945	0.7783*	0.2243	0.1783
	(0.5267)	(0.3841)	(0.3536)	(0.2873)
log (Mountainous terrain)	−0.0447	−0.0818	−0.0983	−0.0510
	(0.0939)	(0.0722)	(0.0513)	(0.0444)
Oil production per capita, 2002	0.0696	0.2319*	0.0466	0.1253**
	(0.0388)	(0.0968)	(0.0334)	(0.0429)
Latin America and Caribbean			−0.9803*	
			(0.4376)	
Eastern Europe and former Soviet Union			−0.4041	
			(0.4479)	
Asia			−1.1571*	
			(0.4729)	
Sub-Saharan Africa			−1.1662*	
			(0.5252)	
North Africa and Middle East			0.1133	
			(0.5438)	
Democratic history × log (GDP/capita)				0.0103*
				(0.0044)
Democratic history × log (Population density)				0.0028
				(0.0038)
log (GDP/capita) × log (Population density)				0.2494**
				(0.0490)
Constant	−1.5400	−4.7575**	−0.3228	1.7336**
	(2.5572)	(1.4080)	(1.2991)	(0.3530)
Observations	67	147	147	147

The dependent variable is the share of country population in lit areas, 2003. Huber–White robust standard errors in parentheses.
$^{**}p$-value ≤ 0.01; $^{*}p$-value ≤ 0.05.

TABLE 5.6. *Robustness checks: Fractional logit analysis of electrification rate using alternative model specifications (excluding OECD)*

	Excluding OECD		
	Population Weighted	Region Fixed Effects	Interactions
	(5)	(6)	(7)
Democratic history, 1946–2002	0.0072	0.0234**	0.0111*
	(0.0064)	(0.0075)	(0.0055)
log (GDP/capita), 2002	0.5593**	0.2507*	0.3148*
	(0.1642)	(0.1016)	(0.1392)
log (Population density), 2002	0.1416	0.0476	0.1980*
	(0.0776)	(0.0685)	(0.0773)
Rural population (%), 2002	−0.0139*	−0.0161**	−0.0219**
	(0.0066)	(0.0055)	(0.0050)
Absolute latitude of capital	0.0157	0.0142	0.0258**
	(0.0087)	(0.0102)	(0.0064)
Civil conflicts, 1946–2002	−0.0605	−0.0090	−0.0485
	(0.0516)	(0.0467)	(0.0403)
Ethno-linguistic fractionalization	0.6977	0.2747	0.1359
	(0.3714)	(0.3508)	(0.2909)
log (Mountainous terrain)	−0.0774	−0.0900	−0.0292
	(0.0760)	(0.0511)	(0.0477)
Oil production per capita, 2002	0.2526**	0.0669	0.1430**
	(0.0919)	(0.0353)	(0.0415)
Latin America and Caribbean		−1.2942**	
		(0.4456)	
Eastern Europe and former Soviet Union		−0.6912	
		(0.3799)	
Asia		−1.4571**	
Sub-Saharan Africa		(0.3994)	
North Africa and Middle East		−1.4545**	
		(0.4116)	
Democratic history × log (GDP/capita)			0.0062
			(0.0060)
Democratic history × log (Population density)			0.0068
			(0.0046)
log (GDP/capita) × log (Population density)			0.2708**
			(0.0536)
Constant	−4.0866**	0.3201	1.7605**
	(1.2777)	(1.1397)	(0.3836)
Observations	119	119	119

The dependent variable is the share of country population in lit areas, 2003. Huber–White robust standard errors in parentheses.
** p-value ≤ 0.01; * p-value ≤ 0.05.

TABLE 5.7. *Comparing results using satellite and official data*

	Satellite Data	IEA Data
	(1)	(2)
Democratic history, 1946–2002	0.0168**	0.0103
	(0.0062)	(0.0078)
log (GDP/capita), 2002	0.5028**	0.6872**
	(0.1401)	(0.2165)
log (Population density), 2002	0.1840*	0.2261
	(0.0847)	(0.1375)
Rural population (%), 2002	−0.0152*	−0.0255**
	(0.0063)	(0.0091)
Absolute latitude of capital city	0.0295**	0.0302*
	(0.0089)	(0.0135)
Civil armed conflicts, 1946–2002	−0.0565	−0.0334
	(0.0450)	(0.0736)
Ethno-linguistic fractionalization	0.2452	−0.1274
	(0.3287)	(0.4495)
log (Mountainous terrain)	−0.0946	0.0085
	(0.0487)	(0.0879)
Oil production per capita, 2002	0.1160*	0.0373
	(0.0464)	(0.0442)
Constant	−3.9120**	−5.7301**
	(1.2622)	(1.7972)
Observations	80	80

The dependent variable is the share of country population in unlit areas, 2003. Huber–White robust standard errors in parentheses.
** p-value ≤ 0.01; * p-value ≤ 0.05.

running the same exact statistical test on the same sample of countries produces different results (Table 5.7). Although democratic history continues to have a statistically significant effect on the rate of electrification observed by satellite (model 1), democracy is insignificant if one uses the IEA data (model 2). In other words, we would have mistakenly concluded that democracy has no effect on electrification if we used official IEA data.

This inconsistency demonstrates the potential perils of measurement problems in cross-national analysis (Treier and Jackman 2008). When the dependent variable is measured with random error, then coefficient estimates on the independent variables will be biased toward zero. But regression estimates can be biased if the measurement error in the dependent variable is systematically related to one or more explanatory variables. Moreover, if there are systematic errors in the recording of any independent variable, then regression results will be attenuated on that variable while other coefficients will be biased and inconsistent in unknown direction and magnitude (Wooldridge 2002, 70–76).

Taken together, these findings support the claim that electoral incentives induce higher public goods provision in democracies. Across a range of samples and model specifications, democratic leaders provide substantially broader levels of electrification than do autocrats, even after controlling for differences in wealth, population density, and other factors. Nevertheless, the results should be interpreted with some caution. Recent work has challenged the use of standard cross-sectional research methods in comparing democracies and dictatorships (Przeworski et al. 2000; Keefer and Khemani 2005; Ross 2006). Because the causal factors that lead countries to democratize might also be correlated with the outcomes we seek to evaluate, inferences about the effects of democracy might be weakened by selection bias. Some of this concern is mitigated by my measure of democratic history, which takes period under democratic rule and not just the current level of democracy into account. However, it is still possible that observed electrification levels are not causally linked to democracy. For example, a country that transitions to democracy might already have had high levels of electrification, and inferring that it was democracy that led to the provision of lighting would be incorrect. One way of mitigating this concern is to compare only the subsample of states that have not experienced a regime transition during the postwar period. Within this group, the average electrification rate was 26 percent lower in the 51 fully sustained autocracies compared to the 17 sustained democracies.

Competitive Elections or State Capacity?

The findings in the preceding text argue that there is broader public goods provision in democracies than in nondemocracies. But is it the presence of free and open elections that induces this effect? Or could the effect be due to higher state capacity, in which the occurrence of elections is simply a confounding factor that tends to exist in many states with high capacity?

Theories stressing the importance of state capacity extend at least as far back as Weber, who argued that states were defined by their ability to maintain a monopoly on violence and manage a bureaucracy capable of effectively implementing policy. According to Weber's many followers, a state's capacity determines the effectiveness with which it can enact and enforce policies and laws, whereas its absence is reflected in mismanagement, corruption, and disorder (Huntington 1968; Geddes 1996; Bates 2008). Without a strong and functional state apparatus, rules about how to select leaders to fill national offices are largely inconsequential. Indeed, states vary widely in their ability to meet the needs of their citizens:

> Efficacious states simply have more power at their disposal than less efficacious ones... Some states are simply more purposive and better organized than others. Some states also choose to work closely with their dominant classes, whereas others, facing a variety of pressures, maintain some distance. (Kohli 2004, 20–21)

Geddes (1996) defines the most important feature of the state as its capacity to translate preferences into actions:

> Preferences matter very little if officials cannot carry out the policies they choose. The capacity to implement state-initiated policies depends on the ability to tax, coerce, shape the incentives facing private actors, and make effective bureaucratic decisions during the course of implementation. (14)

According to this view, a state's institutional capacity is more important for many outcomes than the electoral rules that decide how its leaders are chosen. For Huntington (1968), highly institutionalized states are more adaptable, complex, impervious to outside interference, and unified. Strong states, he says, have the ability to "command the loyalties of their citizens and thus have the capacity to tax resources, to conscript manpower, and to innovate and to execute policy" (1). Without such capacity, elections matter very little to a country's people. Consistent with this view, Lipset (1959) argued, "Only in a wealthy society in which relatively few citizens live at the level of real poverty could there be a situation in which the mass of the population intelligently participate in politics and develop the self-restraint necessary to avoid succumbing to the appeals of irresponsible demagogues" (75). Democracy may thus be of limited benefit then when states are too poor to implement policies. More recently, Barro (1996) stated that democracy is "a sort of luxury good. Rich places consume more democracy because this good is desirable for its own sake" (24).

Are states characterized by high capacity – competent bureaucracies, civil order, and the fiscal and organizational ability to implement policy – better at providing basic public services to their citizens? Or do democratic states, led by political leaders who must win elections, perform better? A stylized dichotomy places the competing expectations of these two perspectives in stark relief. Functionalists expect higher levels of state capacity to improve outcomes regardless of regime type. Institutionalists expect that at any level of state capacity, democracy will improve outcomes. The juxtaposition of these claims results in sharply divergent expectations regarding the distribution of public goods by governments around the world. On the one hand, democracy is expected to improve outcomes regardless of a state's capacity. On the other hand, state capacity is argued to lead to better outcomes irrespective of regime type. Yet empirical research has yielded little consensus on how state capacity and regime type influence the welfare of the world's citizens.

Although the analysis that follows will not provide a definitive answer, it is a first step in comparing the effects of elections against the role of efficacious state institutions in enabling the provision of electricity. I use several measures to account for state capacity. The most widely used indicator may be tax revenues, without which governments cannot finance their activities (Tilly 1990; Lieberman 2002; Brownlee 2004; Brautigam, Fjeldstad, and Moore 2008; Besley and Persson 2009; Hendrix 2010). As Herbst (2000, 113) writes, "There is no better measure of a state's reach than its ability to collect taxes."

TABLE 5.8. *Democracy or state capacity? Fractional logit analysis of electrification rate*

	(1)	(2)	(3)	(4)	(5)	(6)
Democratic History[a]	0.0118*	0.0167**	0.0150**	0.0135*	0.0147**	0.0168**
	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)
log (GDP/capita)[b]	0.3813*	0.3610**	0.2159	0.2357	0.2003	0.3159*
	(0.151)	(0.119)	(0.135)	(0.124)	(0.123)	(0.123)
log (Population density)[b]	0.2664**	0.0973*	0.1021	0.1017	0.1425*	0.1021
	(0.080)	(0.050)	(0.061)	(0.063)	(0.060)	(0.062)
Rural population (%)[b]	−0.0260**	−0.0199**	−0.0229**	−0.0232**	−0.0237**	−0.0215**
	(0.007)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Absolute latitude of capital	0.0181**	0.0285**	0.0272**	0.0257**	0.0306**	0.0276**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Civil conflicts[a]	−0.0822	−0.0195	−0.0126	−0.0012	−0.0461	−0.0181
	(0.045)	(0.042)	(0.044)	(0.045)	(0.046)	(0.047)
Ethno-linguistic fractionalization	0.0137	0.1942	0.0881	0.0819	−0.0991	0.1191
	(0.349)	(0.298)	(0.329)	(0.335)	(0.342)	(0.327)
log (Mountainous terrain)	0.0186	−0.0531	−0.0603	−0.0517	−0.0379	−0.0740
	(0.056)	(0.048)	(0.048)	(0.047)	(0.057)	(0.049)
Oil production per capita[b]	0.1118	0.0940*	0.1010*	0.0962*	0.0920	0.0895*
	(0.080)	(0.046)	(0.049)	(0.049)	(0.047)	(0.042)
Tax revenues (% of GDP)[c]	0.0032					
	(0.011)					
Central government Expenditures (% of GDP)[c]		−0.0040				
		(0.008)				
Government effectiveness			0.2074			
			(0.158)			
Rule of law				0.2513		
				(0.136)		
ln (Homicides/100,000)[d]					−0.0150	
					(0.075)	
State fragility index[e]						−0.0008
						(0.006)
Constant	−2.6788*	−1.9797	−0.5916	−0.6686	−0.6327	−1.5021
	(1.326)	(1.069)	(1.294)	(1.205)	(1.211)	(1.291)
Observations	103	138	147	147	128	147

The dependent variable is the share of country population in lit areas, 2003. Huber–White robust standard errors in parentheses.
**p-value ≤ 0.01; *p-value ≤ 0.05.
[a] From 1946 to 2002.
[b] Measured in 2002.
[c] Average, 2001–2005.
[d] Measured in 1998.
[e] Average, 2005–2008.

Tax revenue is measured as tax revenue of the state as a percent of GDP, averaged from 2001–2005. A related indicator is *Central government expenditure*, recorded as a percent of GDP, averaged from 1998 to 2005. Both measures are from the World Bank.

State capacity may also be reflected in the quality of a state's governance. From the Worldwide Governance Indicators project (Kaufmann, Kraay, and Mastruzzi 2005), I use the two measures that most clearly reflect the capacity of a state's bureaucratic and governing institutions to carry out policy: *Government effectiveness*, which measures the competence of the bureaucracy and the quality of public service delivery; and *Rule of law*, which measures the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence.

Measures of internal security and violence may also reflect the strength of a state. As indicators of a state's domestic capacity to control violence and security, I use data on the *Homicide rate*, measured as the log number of homicides per 100,000 people in 1995 (Neumayer 2003) and a composite measure of *State fragility*, averaged over the first years of data collection, 2005–2008 (Fund for Peace 2008).

The results are presented in Table 5.8. In every single case, the effect of competitive elections is far more important than the capacity of a state's institutions in predicting access to electricity. Thus although the ability to collect taxes, govern effectively, and maintain peace and domestic security are important characteristics of a strong state, they do not override the importance of democratic and competitive elections in motivating politicians to ensure broad access to critical public goods.

Conclusion

This chapter demonstrates that democracies provide electrification to many more of their citizens than autocracies. Drawing on new estimates of electrification whose reliability and validity are not sensitive to endogeneity with the political institutions we want to evaluate, I show a positive link between democratic rule and electrification that is robust to differences in development, demographics, and geography.

These results affirm the central theoretical claim of this book: that public goods provision is especially attractive to democratic leaders because of the political benefits they can capture during elections. In countries with longer histories of democratic rule, the ongoing pursuit of votes results in broader access to electricity. The results hold across all levels of income, affirming the power of democratic elections in inducing higher public service delivery, even in contexts where state capacity appears to be low.

6

Lighting the Poor

Introduction

In the previous chapter, I demonstrated that democracies across the world provide electricity to a larger share of their populations than do autocracies. This is an especially important result for the developing world, where many wonder whether democracy is effective in contexts of high poverty and low state capacity. Although the results from the last chapter show that democracy leads to greater electricity provision in *poor countries*, does democracy actually benefit *poor people*? This chapter evaluates this question by comparing electricity provision in the poorest areas of countries across the developing world.

Poverty has long been a central concern of states. Charles Booth, who coined the idea of a poverty line in his groundbreaking 1889 study of poverty in London, defined the poor as those "living under a struggle to obtain the necessaries of life and make both ends meet, while the 'very poor' live in a state of chronic want." For Booth, the persistence of abject poverty demanded public action by the state, and he was among the first proponents of a publicly funded social safety net. More than a century later, poverty alleviation efforts continue to accentuate the role of the state in providing public goods that communities and markets fail to deliver. Besley and Burgess (2002) argue that in poor countries where markets are weak, "vulnerable populations rely in large measure on state action for their survival" (1415). This means that the poor depend heavily on the state for basic public goods such as electricity, education, and health services.

Despite the high demand for public goods among the poor, it is far from obvious that the state will supply such goods to them. Clearly, poor areas have the highest need and greatest demand for public goods. However, the poor lack economic clout, contribute little to state revenues, and participate less actively in the political process. In many advanced democracies, they are less likely to vote than better off groups (Powell 1986; Schlozman and Brady 1995).

Moreover, the votes of the poor are thought to be easily captured, whether by vague promises made by co-ethnics (Chandra 2004; Dunning and Nilekani 2013) or the fear of retribution (Stokes 2005; Stokes et al. 2013). Yet the poor also represent a powerful resource for democratic politicians. They are numerous and constitute the majority of voters. Moreover, many among them are nonaligned voters, with shorter histories of electoral participation and thus potentially weaker partisan attachments. It is precisely in this context of numerically large groups of marginal voters where political entrepreneurs may have the greatest opportunity to reshape the coalitions that define the political landscape. Given the high demand for basic public goods and services among the poor, strategic efforts to market and distribute such goods can offer lucrative opportunities for democratic politicians as they seek to win large numbers of votes. Such electoral incentives do not exist in autocracies.

Drawing on a new subnational dataset constructed at the 1-degree latitude by 1-degree longitude level across the developing world, I compare rates of electrification in the poorest areas of a country, and show that democracies provide consistently higher rates of access in these economically disadvantaged regions than do non-democracies.

Although this pattern is consistent with the theoretical expectations of Meltzer and Richard (1981), Bueno de Mesquita et al. (2003), and Lake and Baum (2001), my results go further than these models. Prevailing theories emphasize that democracies provide more public goods because they satisfy the preferences of the median voter, they are a cost-effective means of securing mass support, or because leaders are held accountable if they withhold them in favor of rents. Although these accounts predict that democracies will provide higher levels of public goods, my theory helps explain *how* such public goods will be distributed and targeted. I argue that the institutional preference for public goods under democracy emerges from their extraordinary political usefulness. Because demand for public goods is high, and because political leaders enjoy influence over their supply, their provision results in political externalities that, in the context of elections, result in valuable electoral payoffs. Consequently, democratic leaders can be expected not only to provide more public goods, but also to exploit them and distribute their benefits in ways that yield political advantages.

Affirming this expectation and exploiting the disaggregated nature of my data, I show that the distribution of electricity within poor areas reflects an electoral logic: especially where poor voters are more concentrated, democracies provide more public services. By contrast, in autocracies, the spatial distribution of citizens has no systematic effect on the provision of electricity. Taken together, the patterns revealed in this chapter bolster the evidence that democracies favor public goods because of their electoral value.

My research strategy seeks to overcome several barriers obstructing previous research. First, I exploit the advantages of nighttime satellite imagery to construct measures of electricity provision in the world's poorest regions where traditional data are sparse and unreliable. The use of a common data source for the subnational estimates in this chapter and the national estimates in the previous one ensures decomposability and alleviates concerns about aggregation bias and ecological inference problems. Second, I draw on subnational data to construct a new dataset of cells at the 1-degree latitude by 1-degree longitude level. For all developing countries (i.e., non–Organisation for Economic Co-operation and Development [OECD]), I identify the cells in which the poorest quartile of citizens reside. Given the difficulties associated with assessing poverty, I construct separate measures to discern where the poor reside within each country, the first using subnational infant mortality rates, the second using disaggregated economic output data, and the third a combined measure that identifies areas with both the highest infant mortality rates and the lowest income levels.

Identifying the Poor

Identifying where the poor reside in the developing world is no easy task. My strategy draws inspiration from the use of poverty mapping and small-area estimations of poverty. In this approach, scholars use household surveys to estimate the relationship between poverty and household characteristics and then apply this relationship to similar households across a country using census data, generating maps that show the spatial distribution of poverty as opposed to simple national headcounts of the poor (Henninger and Snel 2002; Hentschel et al. 2000; Minot 2007). However, because comprehensive household surveys and census data are not available for all developing countries, I adopt a more feasible approach, combining spatial data on average infant mortality rates as well as disaggregated estimates of economic output with population maps to identify a country's poorest areas.[1] I focus only on non-OECD states and organize all of my data into cells at a resolution of 1-degree latitude by 1-degree longitude (roughly 100 km × 100 km at the equator), which is the smallest common unit across my subnational data sources.

Infant mortality is considered by many to be a highly reliable measure of social welfare in poor settings (Ross 2006; McGuire 2010; Diaz-Cayeros, Magaloni, and Estévez forthcoming). Death rates are usually similarly defined and well recorded, even in the developing world. Moreover, high rates of childhood death are likely to indicate conditions of impoverishment. The data come from the Global Subnational Infant Mortality Rates (GSIMR) project, which estimates the number of children who die before their first birthday for every

[1] Given the lack of household or other lower-level data for most developing countries, I do not have the data, for example, to estimate the proportion of people who are poor in each cell.

10,000 live births in the year 2000. Data are available for more than 10,000 national and subnational units.[2]

To complement the infant mortality–based poverty measure, I also create estimates following a more traditional approach that relies on economic output data. The most comprehensive source for spatially disaggregated economic data is the G-Econ project, which estimates total economic output for sub-national cells at the 1-degree latitude by 1-degree longitude level (Nordhaus et al. 2006). This provides an unparalleled perspective on subnational variation in economic activity. However, the data may underestimate poverty since the total economic output of a cell may be dominated by point source industrial output or resource extraction which reflect little about the welfare of typical households. Still, cells with the lowest economic output within a country should reflect areas that are relatively poorer.

I organize all the subnational data in cells at the same 1-degree latitude by 1-degree longitude level as the G-Econ data. When a cell lies across a national border, it is divided into smaller country-specific cells. Because cells are not uniform in size, I control for *area* in the regressions. There are a total of about 27,000 terrestrial cells in the subnational dataset; 21,000 once you exclude Antarctica. Russia, the world's largest territory, is composed of 3,448 cells; China has 1,092 cells; India comprises 363 cells.

The G-Econ dataset also provides additional geographic variables that describe variations in climate and terrain (Hood 2005). I include measures of the average *Precipitation*, *Temperature*, *Elevation*, and *Roughness* of each cell. These data are derived from the Climate Research Unit Average Climatology 10-arcminute datasets (New et al. 2002). Precipitation and temperature are long-term monthly averages from 1961 to 1990.

For my dependent variable I compute the *Population in lit areas* as a proportion of each cell's population. The proportion lit for each cell is computed based on the underlying 30-arcsecond pixel data using the same 2003 night lights imagery and LandScan population map as in Chapter 5. Using the same data sources to construct both the earlier national and these new subnational estimates of lit populations ensures decomposability, a desirable feature not common to most measures of public service provision. The global distribution of electricity access by cell is presented in Figure 6.1. The map reveals variations at the national level, and for the first time, large variations at the subnational level. An analysis of variance (ANOVA) reveals that almost half of the variation in the proportion lit variable is between countries and half within countries. This highlights the potential magnitude of variation that goes unexplained in traditional cross-national studies that rely only on national-level averages.

[2] The level of subnational detail varies substantially by country and includes as few as one data point for the entire country, as in Chad, and more than 2,000 county-level observations for China. See http://sedac.ciesin.columbia.edu/povmap/.

FIGURE 6.1. Electrification rates by 1-degree × 1-degree cell, 2003. Lighter cells have a higher proportion of the population living in lit areas. OECD countries excluded.

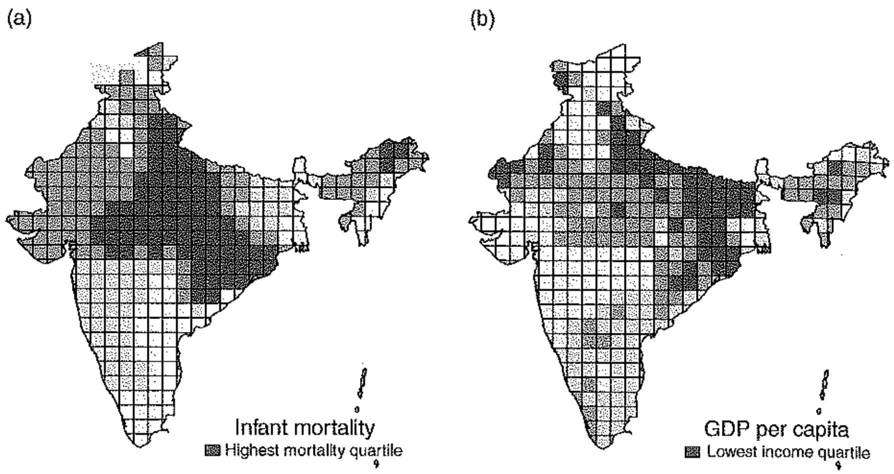


FIGURE 6.2. Mapping India's poor.
Sources: Global Subnational Infant Mortality Rates Project, G-Econ Project.

To identify population counts in poor areas, I rely on the Gridded Population of the World (GPW) dataset from Columbia's Earth Institute, because this is the data source used by both the GSIMR and G-Econ projects. For the measures of both infant mortality and per capita income, I overlay their distributions against the GPW population map to identify the cells that make up the poorest population quartiles using both measures. For example, for the infant mortality data, I locate the cells in which the quarter of the population with the highest infant mortality rates reside.

After identifying the cells that are home to the poorest quartiles, I then look at nighttime satellite imagery and compare rates of electricity provision within these poorest areas. Consider India and China, the world's largest democracy and autocracy, respectively. In India, stark inequalities exist in wealth and social welfare across its population of 1.2 billion. From the bustling information technology hubs of Bangalore and Hyderabad to the impoverished farmlands across Bihar and Uttar Pradesh, levels of development vary widely across regions, with some evidence of divergence in welfare across states during the 1990s (Deaton and Drèze 2002). Applying the mapping methods described previously, Figure 6.2 shows two perspectives on where India's poorest quartile lives, identified by the darkest cells. Infant mortality rates are highest in India's north, including the states of Uttar Pradesh, Madhya Pradesh, Chhattisgarh, and Orissa. The quartile of India's population with the highest infant mortality is spread across 84 cells. Per capita income is also lower in the north, with the poorest quartile living in 71 cells across Bihar, Orissa, and some parts of Uttar Pradesh.

Electricity provision across India is plotted in Figure 6.3, showing much higher rates of unlit populations in the northeast than in the south and around

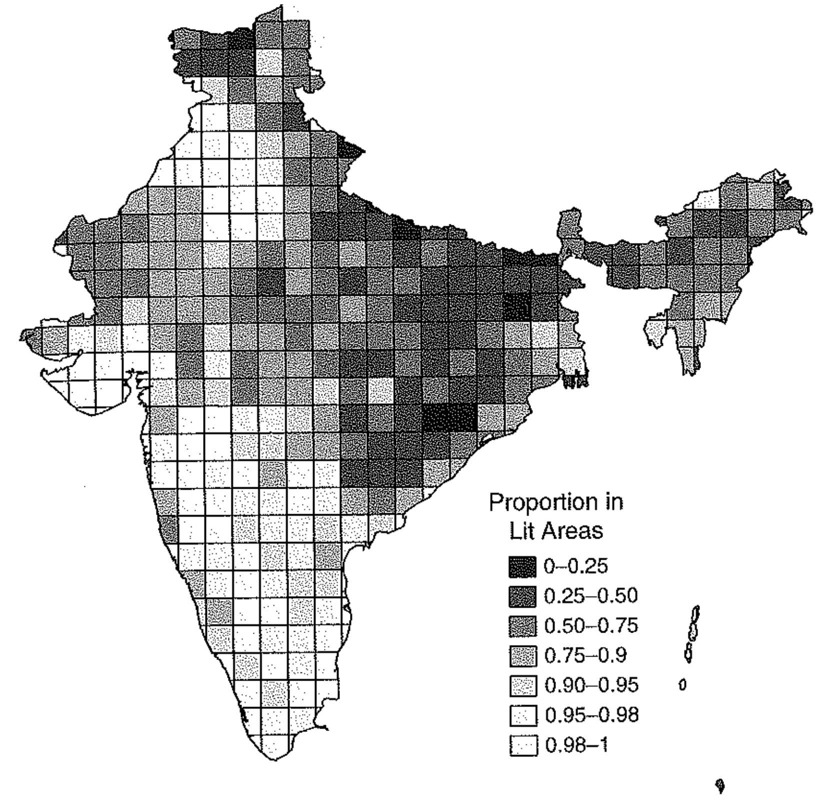


FIGURE 6.3. India's lit population.
Sources: DMSP F152003, LandScan 2005.

the New Delhi capital region. Visually comparing the maps, one observes that the proportion lit is low in many of the cells where Indians with the highest rates of infant mortality and lowest incomes live. Notably, rates of electrification are exceedingly low in cells identified as poor across both poverty measures, such as in Orissa.

Inequality is also high in neighboring China. Figure 6.4 shows China's 1,092 cells, home to 1.3 billion people. Although infant mortality rates in some eastern areas (80 deaths per 10,000) are as low as in some industrialized nations, rates are 8.5 times higher in the 525 cells that are home to the highest infant mortality quartile. These include the western province of Xizang (Tibet) and the central provinces of Sichuan, Yunnan, and Guizhou. Meanwhile, income levels are lowest in the central region, with the bottom quartile located in 169 cells, including Sichuan province. Interestingly, many western provinces that look underdeveloped when observing infant mortality rates nevertheless appear to have impressive rates of economic output. One driver for this has been the

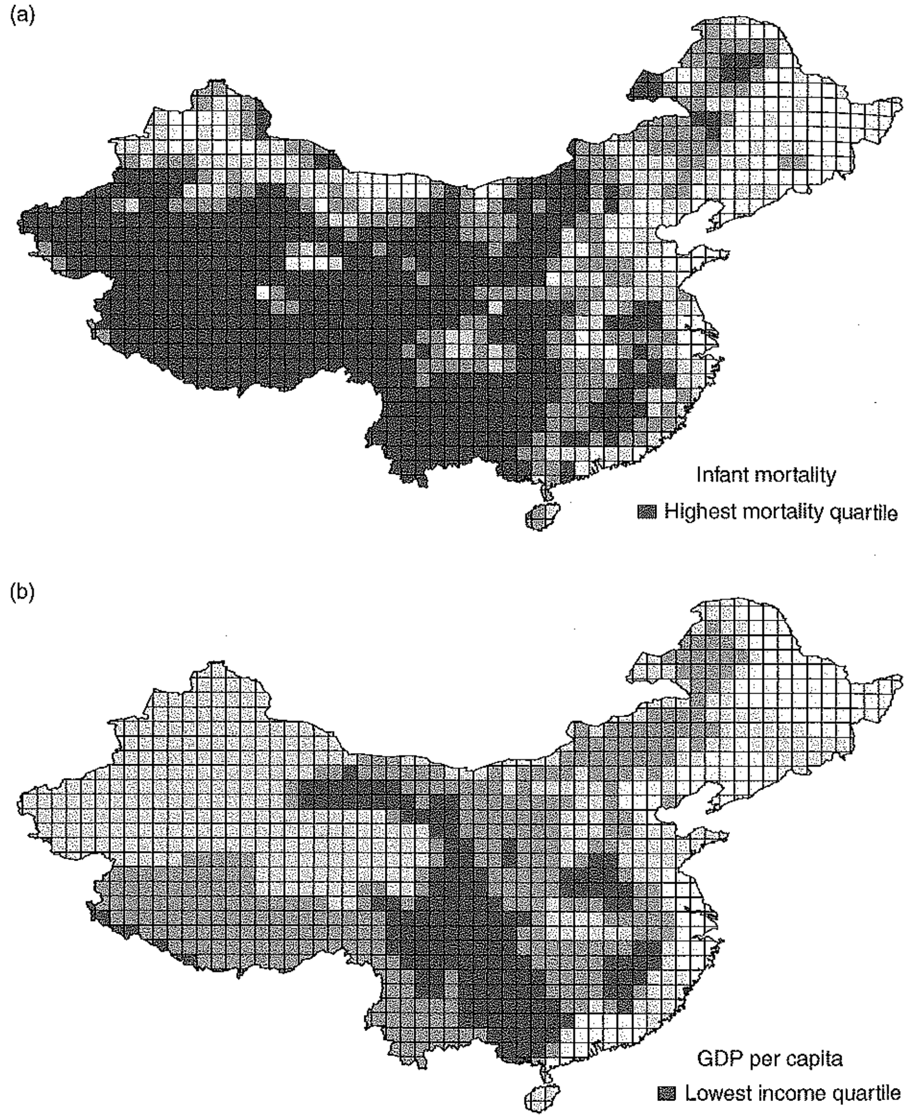


FIGURE 6.4. Mapping China's poor.
Sources: Global Subnational Infant Mortality Rates Project, G-Econ Project.

implementation of China's "Western Development" policy since 1999, which has resulted in billions of dollars of investment in infrastructure and industrial development to secure growth and sustain political stability. However, to date, these sizable expenditures appear to have only had limited impacts on

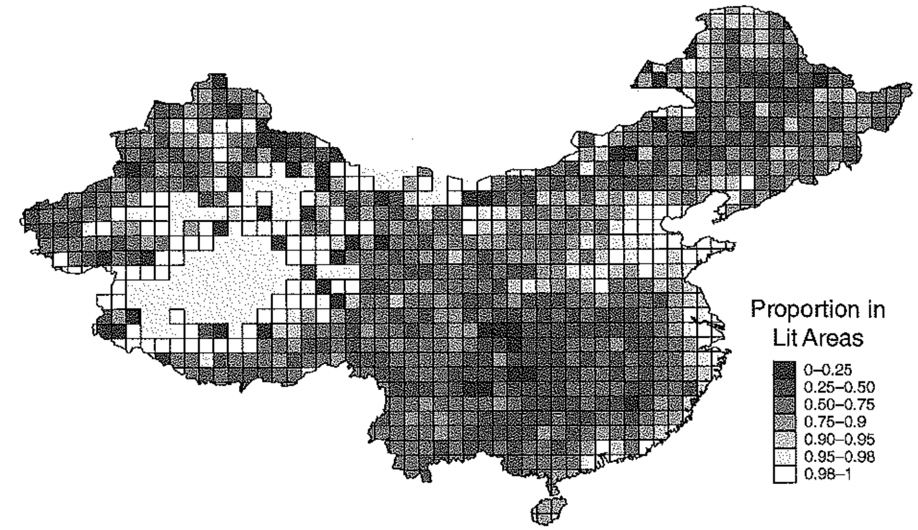


FIGURE 6.5. China's lit population.
Sources: DMSP F152003, LandScan 2005.

improving social welfare, at least partly due to corruption and misappropriation of funds (Lai 2002; Démurger et al. 2002).

Figure 6.5 shows the proportion of people living in electrified areas in China. Many cells in the Tibetan Plateau show no data, as I do not compute lit populations in areas with very low population counts (see discussion in Chapter 5). As with India, the maps show that in many of China's cells with the highest rates of poverty, electricity provision is low.

How do India and China differ in the rates of electricity provision to their poorest citizens? To compare, Figure 6.6 shows kernel density plots of the distribution of proportion lit per cell in the poorest quartiles. Higher densities toward the right of the plot mean more poor cells are highly electrified and have fewer people living in the dark. Higher densities toward the left suggest instead that most living in these poor cells lack electricity.

These distributional plots show a somewhat mixed picture. Electricity provision to the disadvantaged is higher in democratic India when the poor are identified by infant mortality rates (Figure 6.6a). However, when looking at poor areas identified by relatively lower per capita incomes, electricity provision appears slightly higher in autocratic China (Figure 6.6b). That these patterns are similar at all is in itself surprising, given the widespread belief that China has outpaced India in the delivery of electricity. In fact, the results here suggest that India has done as well, and maybe even better, than China, at providing electricity to its poorest citizens. Although India and China represent

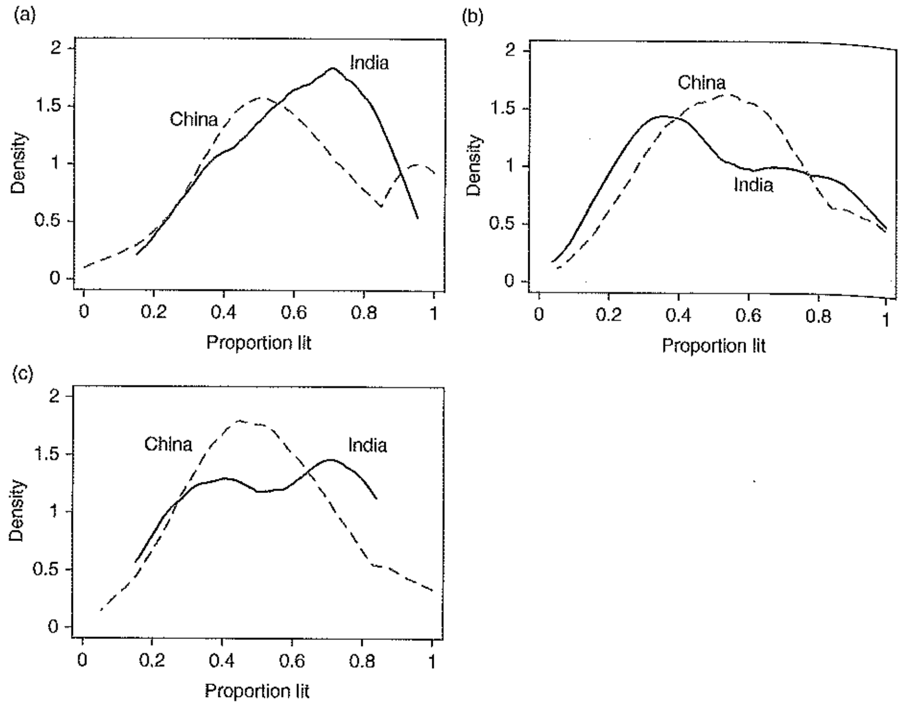


FIGURE 6.6. Electricity provision in India and China's poorest regions.
Note: Kernel density plots using the Epanechnikov kernel.

an important paired comparison, what systematic patterns hold across the broader developing world? I turn to this global comparison next.

Global Patterns of Electricity Provision to the Poor

Do regimes differ systematically in whether they provide electricity to their poorest citizens? In autocracies, the poor have little oversight or authority over their governments. By contrast, the impoverished in democracies can wield their ballots to demand that elected leaders be responsive to their basic needs.

Figure 6.7 provides a global perspective of where the poorest quartile reside as identified by the highest infant mortality rates. Similarly, Figure 6.8 shows areas with the lowest per capita incomes from the G-Econ data in all countries of the developing world. By comparing electrification rates within these poorest quartile cells (see Figure 6.1), I find that for those living in a country's poorest areas, the likelihood of being electrified is substantially higher in a democracy than in an autocracy.

Figure 6.9 presents kernel density plots showing the distribution of electrification in the poorest regions of developing democracies and autocracies.

FIGURE 6.7. Highest infant mortality areas per country.
Sources: Global Subnational Infant Mortality Rates (GSIMR) and LandScan projects. OECD countries excluded.

FIGURE 6.8. Lowest income areas per country.
Sources: G-Econ and LandScan projects. OECD countries excluded.

The top graph, identifying the poorest quartile using infant mortality rates, contrasts electricity provision in 23 developing democracies over 1,561 cells versus 33 developing autocracies over 1,042 cells.[3] The next graph uses lowest per capita income to identify the poorest quartile. Here, the density plot traces electricity provision across 1,122 cells in 38 developing democracies and 1,274 cells in 56 developing autocracies.[4] Both of these perspectives on poverty provide the same finding: poor areas are more likely to be electrified in democracies than in autocracies.

Among the highest infant mortality quartile areas, 84 percent of the population was lit in countries that were democratic and had at least 10 years of democratic rule in their recent history. By contrast, 70 percent of the population was lit in autocratic states. When using income to identify the poor, the difference is 79 percent lit in democracies versus 72 percent in autocracies.

Although these results are suggestive, they show only bivariate comparisons among large pooled samples of diverse countries and cells. One concern about these patterns is that poor areas in democracies like India might differ in important respects from poor areas in autocracies like China. For example, there might be higher geographic barriers such as more mountainous terrain and higher elevations in poor parts of China than in India. If such factors can influence the ability of governments to provide electricity, *and* these factors are correlated with regime type, then it is important to account for such differences.

To account for such effects, I run fractional logit regressions controlling for several potential confounders. I include country-level controls for GDP per capita and population density. I also include cell-level measures of infant mortality, income per capita, and population density. I also add cell-level

[3] The developing democracies in the high infant mortality sample are Argentina, Armenia, Bangladesh, Benin, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, India, Mali, Mongolia, Namibia, Nicaragua, Philippines, Russia, Thailand, Uruguay, Venezuela, and Zambia. The developing autocracies are Algeria, Angola, Botswana, Burkina Faso, Cambodia, Cameroon, China, Cuba, Egypt, Eritrea, Ethiopia, Gabon, Gambia, Guinea, Iran, Jordan, Kazakhstan, Lebanon, Mauritania, Morocco, Mozambique, Paraguay, Rwanda, Somalia, Sudan, Tanzania, Togo, Turkmenistan, Uganda, Uzbekistan, Vietnam, Yemen, and Zimbabwe.

[4] The developing democracies in the low-income sample are Albania, Argentina, Armenia, Bangladesh, Benin, Bolivia, Brazil, Bulgaria, Chile, Colombia, Costa Rica, Croatia, Dominican Republic, Estonia, Guatemala, Honduras, India, Israel, Jamaica, Latvia, Lithuania, Macedonia, Mali, Mongolia, Namibia, Nicaragua, Panama, Papua New Guinea, Philippines, Romania, Russia, Slovenia, Sri Lanka, Thailand, Ukraine, Uruguay, Venezuela, and Zambia. The developing autocracies are Afghanistan, Algeria, Angola, Azerbaijan, Belarus, Bosnia and Herzegovina, Botswana, Burkina Faso, Cambodia, Cameroon, Chad, China, Democratic Republic of Congo, Cuba, Egypt, Eritrea, Ethiopia, Gabon, Gambia, Georgia, Guinea, Iran, Iraq, Jordan, Kazakhstan, North Korea, Kyrgyzstan, Laos, Lebanon, Liberia, Libya, Malaysia, Mauritania, Morocco, Mozambique, Myanmar, Oman, Paraguay, Rwanda, Saudi Arabia, Serbia and Montenegro, Somalia, Sudan, Swaziland, Syria, Tajikistan, Tanzania, Togo, Tunisia, Turkmenistan, Uganda, United Arab Emirates, Uzbekistan, Vietnam, Yemen, and Zimbabwe.

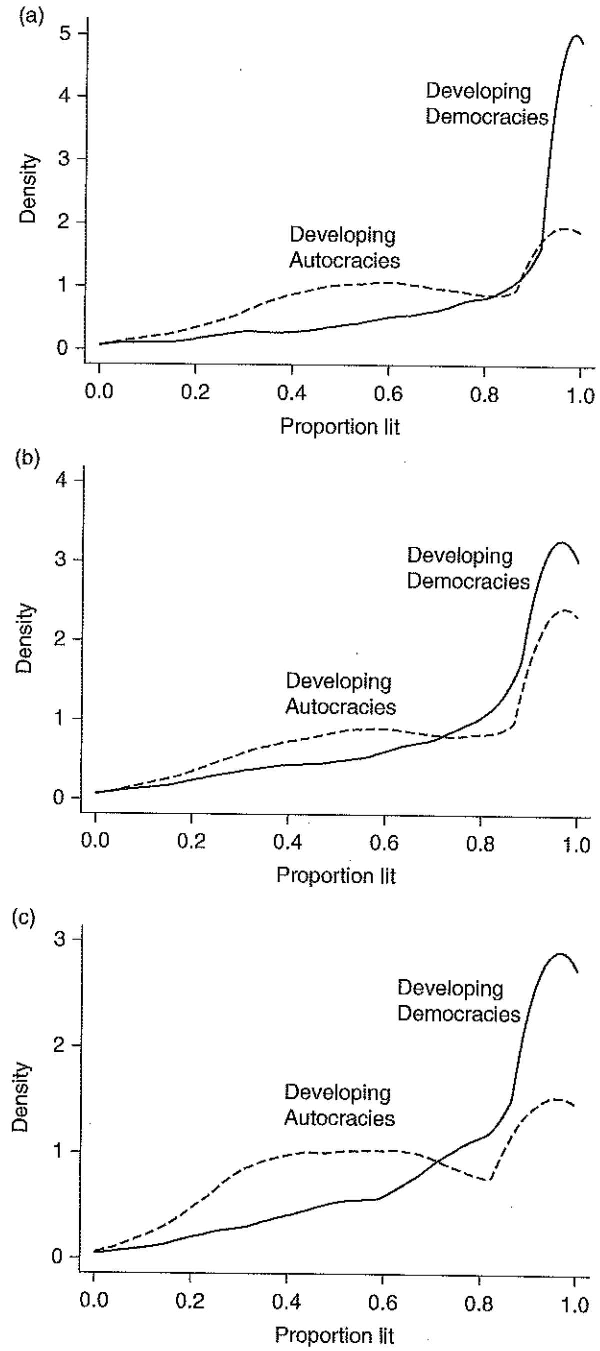


FIGURE 6.9. Electricity provision in the poorest regions of developing states.
Note: Kernel density plots using the Epanechnikov kernel.

controls to account for differences in geography, including average roughness, elevation, precipitation, temperature, latitude, and area. The results are presented in Table 6.1. I run three models using different samples: (1) highest infant mortality quartile cells, (2) lowest per capita income quartile cells, and (3) cells that are both in the highest mortality and lowest income cells. In models 1 and 2, democracy is associated with higher lit populations, though the coefficients just miss standard levels of statistical significance ($p = 0.087$ and $p = 0.064$). For the cells identified as most poor in model 3, democracy is significant ($p = 0.038$).

In the next section, I use matching to identify cells that are essentially identical along a wide range of cell-level variables but that differ in whether they are governed by a democracy or an autocracy.

Matching

To address concerns of selection bias and reduce the dependence of results on model specification and parametric assumptions, I use matching in an effort to achieve the highest level of balance across all observed covariates between democratic and nondemocratic cases. Matching seeks to make the treatment group look as similar as possible to the control group, allowing analysis that is less sensitive to choices of functional form and model selection. By achieving balance, matching reduces model dependence and reduces bias and variance (Ho et al. 2007).

The goal is to identify cells that are as similar as possible across all potentially relevant aspects except for their regime type. One way to think of this is to consider areas that lie along opposing sides of national borders that share similar geography, access to natural resources, and settlement patterns, but that differ in their political institutions (Posner 2004; Miguel 2004). China and India, for example, share a common border extending over 2,000 miles. Today, the Tibetan population is divided by this border in Xizang province in China and the Indian state of Himachal Pradesh. There are numerous cultural and geographic similarities across these areas, yet a clear difference in political institutions. The impact of political differences can be stark. One newspaper account described how in another area straddling the India–China border to the southeast, Indians living in unelectrified villages in Arunachal Pradesh would gaze in frustration at the twinkling lights of lit villages across the Chinese border.[5] The 38th parallel dividing the Korean peninsula provides another well-known example. While South Korea is bathed in light, North Korea is almost completely dark except for lights in the capital city and in a few isolated pockets, including the area around the Yongbyon nuclear facility.

[5] Rao, Raghvendra. "Shining China in Sight, Villages to Finally Get Power." *The Indian Express*, December 25, 2007.

TABLE 6.1. *Regime type and electricity provision in the poorest quartiles*

	Highest Infant Mortality Quartile (1)	Lowest Per Capita Income Quartile (2)	Most Poor (Highest Mortality and Lowest Income) (3)
Democracy	0.3336	0.3493	0.4316*
	(0.195)	(0.189)	(0.208)
GDP per capita (country)	0.0194	0.0091	−0.0047
	(0.049)	(0.039)	(0.069)
Population density (country)	−0.0030**	−0.0042**	−0.0056**
	(0.001)	(0.001)	(0.001)
Infant mortality rate (cell)[a]	−0.0130	−0.0716**	−0.0496*
	(0.020)	(0.025)	(0.024)
Gross cell product per capita (cell)[a,b]	0.1456**	0.1618*	0.2006*
	(0.049)	(0.073)	(0.080)
Population density (cell)[a]	−0.0000	0.0006*	0.0004
	(0.001)	(0.000)	(0.001)
Cell-level controls			
Roughness	−0.6008	0.2530	0.3215
	(0.424)	(0.305)	(0.300)
Elevation, average	0.0003	0.0001	0.0003**
	(0.000)	(0.000)	(0.000)
Precipitation, average	−0.0019	−0.0059**	−0.0038**
	(0.001)	(0.001)	(0.001)
Temperature, average	0.0611**	0.0459*	0.0871**
	(0.021)	(0.023)	(0.019)
Latitude, absolute	0.0302*	0.0055	0.0303*
	(0.012)	(0.011)	(0.015)
Area (10^3 km^2)	−0.0136	−0.0270	−0.0299
	(0.019)	(0.017)	(0.022)
Constant	−0.9244	0.8572	−0.8992
	(0.826)	(0.812)	(0.746)
Cell observations	2,557	1,971	689

Huber–White robust standard errors, clustered on country, in parentheses.
**p-value ≤ 0.01; *p-value ≤ 0.05.
[a] Estimate for 2000.
[b] In 1995 purchasing power parity (PPP) US dollars.

Borders are not the only places where similar cases can be found. Using the language of counterfactual analysis, Haber and Menaldo (2011) match cases of countries that discovered oil against similar neighbors that did not to estimate the effect of resource wealth on political development. They note, "If one wanted, for example, to specify the counterfactual path that would have been followed by oil- and gas-rich Kazakhstan had it not discovered those resources,

the best approximation would be the other Central Asian Republics that have not emerged as major resource producers (e.g., Uzbekistan) – but that share Kazakhstan's history of repeated invasions and occupations, as well as broad geographic and cultural characteristics" (3).

A similar logic underpins the Przeworski et al. (2000) landmark study of democracy and development. To identify the impact of regime type on the growth of, say, authoritarian Chile in 1985, one would want to observe how much a democratic Chile would have grown in that year. This is not possible. Still, they say, "There seems to be a way out: We could look for some case that was exactly like 1985 Chile in all respects other than its regime and, perhaps, its rate of growth, and we could match this country with Chile. We could then compare the growth of dictatorial Chile in 1985 with the performance of its democratic match and draw a conclusion" (8).

Following standard notation of the Rubin causal model, the causal effect is the difference in potential outcomes under treatment and control, only one of which is observed for each observation. Let Y_{i_1} denote the electrification level for cell i that is under democratic rule and Y_{i_0} be the electrification level for a cell under autocratic rule. Treatment is denoted T_i, equaling 1 when i is in the treatment regime and 0 otherwise. The observed outcome for i is $Y_i = T_i Y_{i_1} + (1 - T_i) Y_{i_0}$ and thus the treatment effect for i is $\tau_i = Y_{i_1} - Y_{i_0}$. In experimental settings with perfect randomization, individuals in both treatment and control groups are equally as likely to receive treatment and so estimation of the treatment effect is simply the mean difference in observed outcomes between the treatment and control groups. However, in observational settings like the one under consideration, treatment is not randomly assigned, and the treatment and control groups are likely to differ along multiple dimensions. If we assume that selection into the treated group depends only on observable covariates X_i, we can estimate the average treatment effect on the treated, or ATT:[6]

$$\tau \,|(T = 1) = E\{E(Y_i|X_i, T_i = 1) - E(Y_i|X_i, T_i = 0)|T_i = 1\} \qquad (6.1)$$

In other words, I identify the effect of democratic rule as the expected difference in electrification status between a cell that is under democratic rule and the expected status of that cell had it not been under democratic governance, conditional on a set of covariates, X.

To identify matches, I use the genetic search algorithm, GenMatch (Sekhon 2011), which is particularly well suited to optimizing balance in contexts in which the dimensionality of covariates is large. The algorithm uses one-to-one matching with replacement where the estimand is the average treatment effect on the treated (ATT).

[6] The model assumes strong ignorability in which, conditional on X, treatment assignment is unconfounded, $Y_0, Y_1 \perp T \,|X$. Overlap is also assumed, $0 < Pr(T = 1|X) < 1$ (Rosenbaum and Rubin 1983).

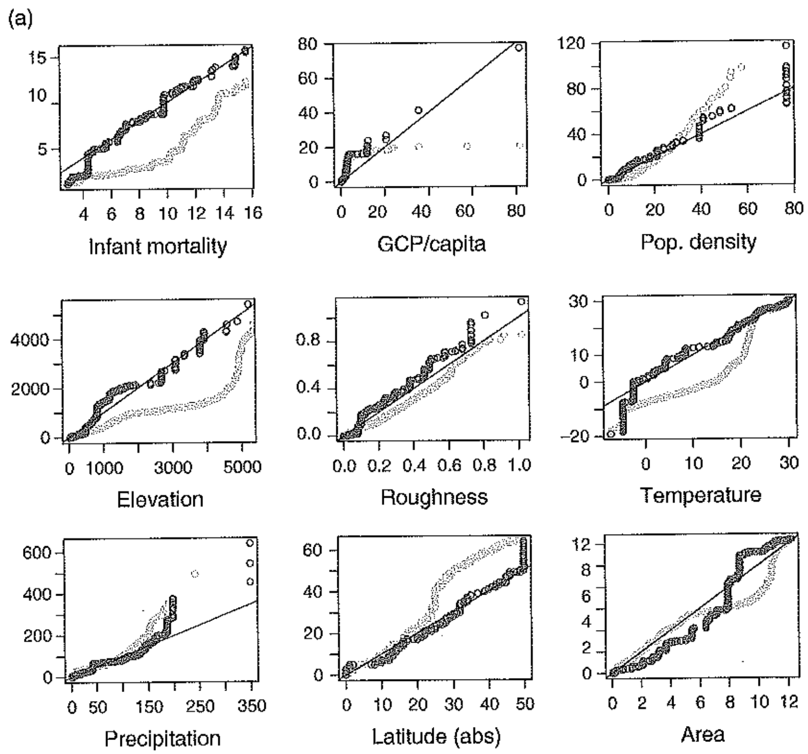


FIGURE 6.10. Balance checks for poorest areas, before and after matching.

I matched on the following nine cell-level variables: infant mortality rate, per capita income, population density, roughness, elevation, precipitation, temperate, latitude, and area. I attempted to match on additional country-level variables as well, but because the number of developing countries is small (for the purposes of matching), this proved intractable. As a result the estimates here need to be interpreted with some caution: the matched samples look very similar across cell-level characteristics but do not reflect national-level differences.

To evaluate balance, I present quantile–quantile plots comparing the distribution of variables among democracies and autocracies. The plots show the distribution before and after matching, where balance is better when observations lie closer to the 45-degree line. Balance plots for the highest infant mortality quartile are shown in Figure 6.10a and for the lowest income quartile in Figure 6.10b. Before matching, there are significant differences between regime types, most notably in infant mortality rates, which are lower in poor areas of democracies. There are geographic differences as well: average temperatures are lower in poor areas of democracies, while elevation is also generally lower

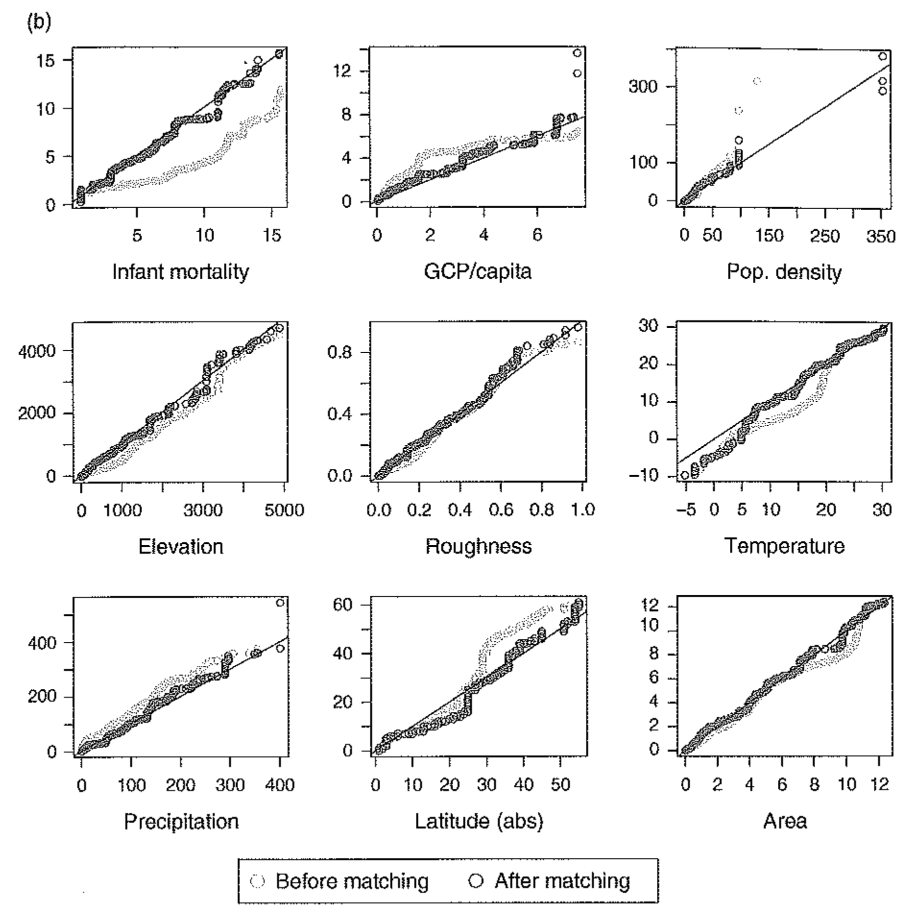


FIGURE 6.10. (*continued*)

and precipitation higher in democracies in Figure 6.10a. For both sets of samples, balance has improved substantially after matching.

Based on the matched samples, I compare differences in electrification rates to estimate the effect of democracy in Table 6.2. The analysis of matched samples confirms the powerful effect of democracy on increasing electricity provision to the poor. In the poorest areas as defined by infant mortality rates, 14 percent more of the population live in electrified areas in democracies. In the lowest per capita income areas, 8 percent more benefit from electricity. These effects are large, affecting millions of people, and statistically significant. The results are also consistent with the full sample regression analysis presented earlier, demonstrating that electricity is provided to more of the poor in democracies than in nondemocracies.

TABLE 6.2. *ATT estimates for effect of democracy on electricity provision in the poorest quartile*

	Highest Infant Mortality Quartile	Lowest Per Capita Income Quartile	Most Poor (Highest Mortality and Lowest Income)
ATT estimate	0.140	0.078	0.045
Standard error	0.062	0.030	0.035
p-value	0.026	0.009	0.21
Observations	1,558	1,080	402

Elections and the Targeting of Voters

The evidence in the preceding text suggests that developing democracies do indeed provide more electricity to their poorest citizens. Why do they do this? I have argued it is because democratic politicians have unique incentives that drive them to distribute public goods more broadly than in autocracies. In the presence of elections, politicians seek out electoral benefits that accrue from directing public goods and services to those who value them the most, particularly among the poor.

One way of validating this expectation is to look more closely for differences in how public goods are distributed *within* the poorest areas of both regime types. If democratic leaders are conditioned to seek out votes, then all else equal, we should see that democracies pay more attention to areas with larger numbers of citizens (i.e., voters), because the aggregation of per capita benefits flowing from electrification will be higher in dense areas. Meanwhile, in autocracies, no consistent relationship is expected between population density and public goods access.

Figure 6.11 provides a first test of this expectation across regime types. Each panel compares rates of electricity access as a function of population density, looking only at cells that comprise the poorest areas of developing states, measured by infant mortality on top and by income on the bottom. Overall, there is a negative correlation between electrification and population density in both regime types. Part of this pattern reflects the increased technical complexity and economic costs associated with electrifying densely populated areas. Given that each cell corresponds roughly to a 100 km × 100 km area, providing full electrification to a cell in which there are only a few villages is far less challenging than doing the same for a cell with more than 10 million residents such as the cell encompassing the industrial city of Kanpur and its impoverished environs in northern India.

In addition, the negative trend is partially an artifact of pooling observations from very diverse countries, resulting in a comparison of cases between low-density and high-density countries. Although cells from 71 countries are represented in the top panel, only 11 countries contribute observations with

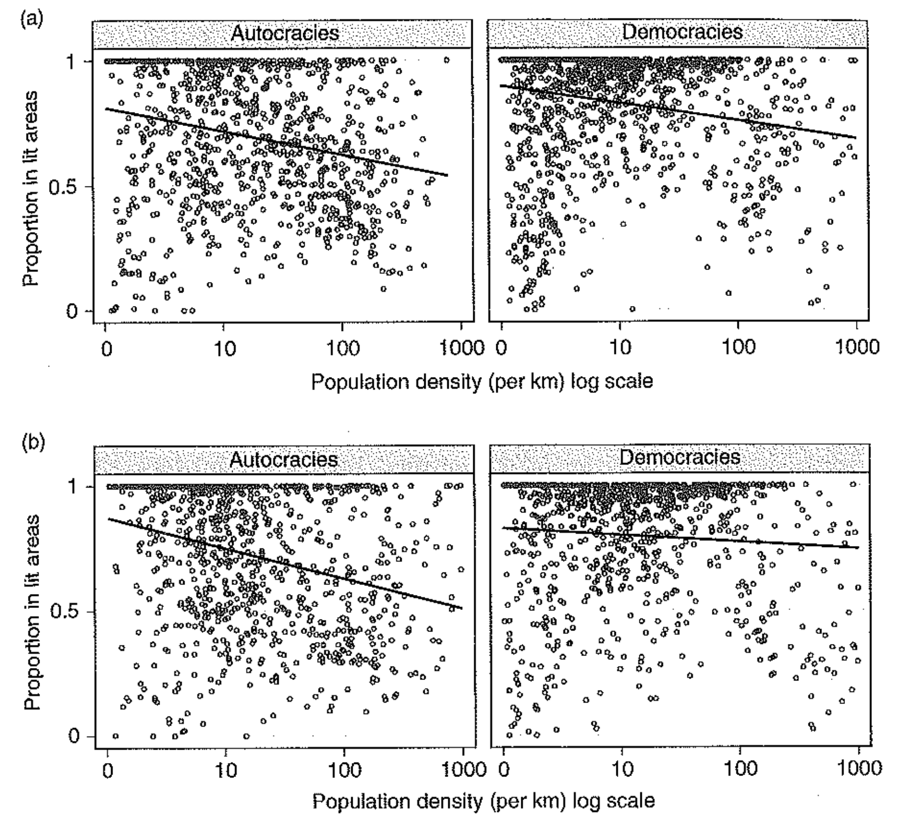


FIGURE 6.11. Democracies respond to population density in the poorest regions of developing states. Top panel shows poorest quartile cells identified by highest infant mortality rates, bottom panel by lowest per capita incomes.

population densities higher than 400 people per square kilometer, including countries such as India, Brazil, and Indonesia.

Nevertheless, the figures show that in democracies, the provision of public goods to poor areas with more people is systematically higher than in autocracies where targeting the poor offers few immediate political payoffs. Still, these visual patterns do not reveal whether it is actually democracy that is causing the apparent differences in electrification across regime types. Democracies and autocracies differ on nonpolitical dimensions that may be important drivers of electrification. In 2002, the average developing democracy was wealthier, more populous, geographically larger, and less mountainous than the typical autocracy, and so the correlations documented previously could be caused by other confounding factors. To examine more rigorously how patterns of distribution vary within countries, I conduct regressions to account for other factors that might affect the apparent relationship observed in the scatterplots.

Country fixed effects are included to help account for country-specific factors that can influence the provision of electrification. The fixed effects absorb all *between*-country variation and enable a focus on factors that shape *within*-country variation in access to electricity. This allows for a more direct evaluation of the claim that within poor areas of their countries, democracies are likely to target areas with more voters while no such pattern is expected to exist among autocracies.

Since country fixed effects are correlated with whether a country is a democracy or not, I conduct subsample analysis, presenting results for developing democracies in models 1 to 3 of Table 6.3 and developing autocracies in models 4 to 6. Direct comparison of coefficients across different subsamples can be misleading. Yet, the results affirm the overall expectation that population density is a significant and positive determinant of electricity provision within democracies, but seemingly has no consistent effect in autocracies. This shows that democratic leaders respond to electoral incentives, directing electricity provision to areas with the greatest voter densities, even among the poorest regions of their countries. An increase of one standard deviation in population density, from 8 to 43 people/km^2, is associated with a 3.1 percent increase in electricity access. Interestingly, differences in the level of economic output across poor areas seem to have little effect, except in model 1. If a strategy of poverty alleviation were at work, we might expect a more consistent relationship between economic output and public goods provision.

Meanwhile, in autocracies, population density is an insignificant predictor of electricity provision as expected, given the lack of electoral incentives that compel leaders to provide public goods broadly to their citizenry. Meanwhile, there is some evidence that within the poorest regions, autocratic governments provide less access to electricity in areas with higher economic output (models 5 and 6). Overall, the inconsistent effects of population and economic measures on electricity provision within autocratic regimes reflect the idiosyncratic preferences and priorities that vary across such states.

Conclusion

The findings of this chapter show that democracies provide broader levels of electricity provision to their poorest citizens. These results are consistent with the expectations of institutional theories in which electoral incentives motivate democratic leaders to provide more public services to their citizens. However, the finding that democracies are effective at serving the poorest quartile of their citizenry is surprising given the many concerns about the lackluster performance of democratic governments in low income settings.

The results also challenge the expectations of clientelism theory, in which the influence of the poor on public policy is discounted because their votes are so easily swayed by promises and threats or by token gifts or handouts. When poor voters are fearful that politicians will withdraw even these small benefits,

TABLE 6.3. *Electricity provision in poor areas: Fractional logit analysis of electrification rates with country fixed effects*

	Poorest Quartile by Infant Mortality	Poorest Quartile by Per Capita Income	Most Poor (Highest Mortality and Lowest Income)	Poorest Quartile by Infant Mortality	Poorest Quartile by Per Capita Income	Most Poor (Highest Mortality and Lowest Income)
	(1)	(2)	(3)	(4)	(5)	(6)
Population density[a]	0.1611^{+}	0.2610**	0.2851**	−0.0843^{+}	−0.0522	0.0231
	(0.083)	(0.087)	(0.107)	(0.047)	(0.076)	(0.069)
Gross cell product[a,b]	0.5078**	−0.0501	−0.2935*	−0.0237	−0.4778^{+}	−1.2524**
	(0.133)	(0.134)	(0.147)	(0.115)	(0.271)	(0.209)
Roughness	0.4526	0.0326	0.1101	−0.9273**	0.3843	−0.5238^{+}
	(0.433)	(0.293)	(0.755)	(0.207)	(0.320)	(0.298)
Elevation, avg.	−0.0001	0.0005**	0.0004**	0.0003^{+}	0.0000	0.0004*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Precipitation, avg.	−0.0004	−0.0009	−0.0012	−0.0036	−0.0047**	−0.0009
	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)	(0.003)
Temperature, avg.	0.0096	0.0697**	0.0772**	0.0470	0.0327	0.0412
	(0.048)	(0.016)	(0.022)	(0.031)	(0.024)	(0.048)
Absolute latitude	0.0709*	0.0580**	0.1033*	0.0199	0.0385*	0.0422
	(0.032)	(0.015)	(0.045)	(0.035)	(0.019)	(0.048)
Area	0.0037	0.0019	−0.0150	−0.0299	−0.0457**	−0.0005
	(0.017)	(0.016)	(0.023)	(0.020)	(0.011)	(0.031)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−1.9502	−3.9640**	−4.2173**	−0.2159	3.1126**	−2.1632
	(1.205)	(0.538)	(1.152)	(1.802)	(1.003)	(2.207)
Observations	1,558	1,142	402	999	949	287

The dependent variable is the share of cell population in lit areas, 2003. Huber–White robust standard errors, clustered by country, in parentheses.
$^{**}p$-value ≤ 0.01; $^{*}p$-value ≤ 0.05; ^{+}p-value ≤ 0.10.
[a] Logged values, 2000.
[b] In 1995 purchasing power parity (PPP) US dollars.

a perverse accountability arises in which voters are accountable to their elected leaders and are not willing to vote according to their true preferences (Stokes 2005). Yet, I find evidence of higher rates of electricity provision even in areas where clientelism may be most pernicious.

My explanation is that irrespective of the extent of clientelistic practice in the developing world, competitive elections in democracies generate powerful institutional incentives for public service provision. For democratic leaders, the delivery of a broad-based public service such as electricity is a cost-effective means of garnering political support, especially in areas where the poor have few outside alternatives and thus place a high value on provision by the state.

Inductively, patterns of broader electricity provision in poor democratic areas can also be interpreted as evidence of an equilibrium in which democratic leaders steer public services toward poor areas exactly because poor voters are receptive to these investments. The way elections induce a correspondence between political demand and supply is an important mechanism in electorally competitive settings that does not apply in nondemocratic settings.

The evidence in this chapter and the previous one shows that democracies provide greater levels and broader distributions of electricity to their citizens than in autocracies. But how does this happen? To pursue this question, the next chapter explores how electoral competition shapes the distribution of scarce electrical power within the context of democratic India.

7

Electrifying India

Introduction

In the developing world, whether or not one has access to public goods such as electricity, clean water, or education is largely determined first, by the decision of governments to provide them, and second, by the strategies employed by political actors in delivering them. Chapters 5 and 6 have underscored the broader provision of public goods to the less advantaged in democratic settings, showing that democracies provide broader access to electricity, even among the poorest segments of their countries. This chapter seeks to better illuminate the process by which public goods, which are often wrapped in a universalist veneer when they are proposed, are manipulated by political actors who shape their delivery in the pursuit of electoral payoffs.

More people in India lack electricity than in any other country in the world, and nowhere more so than in the state of Uttar Pradesh (UP), where an estimated 60 million people have no electrical connection at home. Electricity is desired everywhere because it improves quality of life and enables economic development. Yet Uttar Pradesh lacks the electricity supply to provide to all who need or want it, and thus its distribution must be heavily rationed through ubiquitous power cuts that impose steep costs on both citizens and businesses.

Using evidence from satellite imagery over time, I demonstrate that governments in India are motivated by political incentives to manipulate the distribution of electricity. In a context where access to electricity is fundamentally supply constrained, I use detailed local-level evidence collected over nearly two decades to show that electricity provision follows a cycle in which more villages enjoy stable access to electricity in periods around elections than during nonelection periods.[1]

[1] In closely related work, Baskaran, Min, and Uppal (2015) use data from across India to show that constituencies are brighter due to elections, looking specifically at special elections whose

These election period effects are highest in areas represented by parties whose platforms and ideological commitments are credibly served by targeting public services to poor and rural areas.

The analysis draws on annual composite imagery of the earth at night that enable detection of electricity availability to all 98,000 villages in UP in each year from 1992 to 2010. The timeframe captures a period of dramatic political change in UP, particularly due to the emergence of the low-caste Bahujan Samaj Party (BSP), whose core support lies primarily among poor and rural Scheduled Caste (SC) voters. Drawing on the full set of village observations and controlling for village- and constituency-level factors using multilevel models, I show that villages were significantly more likely to benefit from stable electricity service in election periods than in non-election periods, and that these effects were strongest among constituencies represented by the BSP.

Although the observational data reveal important electoral patterns, these do not necessarily imply a causal effect, as that requires the evaluation of a counterfactual. Would a village's electrification status have been different if it had been represented by a party other than the BSP? I attempt to uncover the causal effect of BSP representation by focusing on a subset of villages around the pivotal 2002 state election in which political power shifted from the right-wing Bharatiya Janata Party (BJP) to the low-caste BSP. Exploiting the abundance of data, I use matching techniques to identify similar villages that differ only on whether they were to be represented by the BSP or the BJP in the state legislature. Based on the matched samples, I show a strong positive treatment effect of BSP representation on the probability of new village electrification.

The data provide an unusually fine-grained perspective on how universal public goods schemes are transformed into vehicles that deliver discrete benefits to electorally critical regions and voters. Unlike official government data sources and survey-based studies, the satellite data provide complete geographical coverage with no missing data, and are measured repeatedly over time enabling the tracking of light signatures over individual villages across multiple election cycles. Moreover, the satellite-derived data are tracked using a consistent and automated process and thus are not impacted by potential biases imparted by human record collectors. As a result, the data avoid some common empirical challenges that constrain research on service delivery in the developing world.

timings are exogenous to economic conditions because they are held following the death of incumbent legislators. Min and Golden (2014) show that rates of electricity line loss – power that is distributed but not paid for presumably due to theft and other irregularities – also increase in election years, benefiting incumbents who are more likely to win re-election in areas with higher line losses.

Electoral Competition and Distribution in Uttar Pradesh

Uttar Pradesh (UP) is the most populous state in India. Home to some 200 million people in an area about half the size of California, it has more people than every country in the world except China, India itself, the United States, and Indonesia. Spanning the fertile plains of the Ganges River, the densely populated state remains predominantly rural, with 80 percent of the people living in the countryside in some 98,000 villages. With tens of millions of farmers plowing fields of cereal crops like wheat, rice, and millet, agriculture is the largest economic activity in UP, accounting for nearly half of the state product in 1991 and employing nearly three-quarters of the workers.

Many of India's eminent political leaders have their roots in UP, including 8 of its 15 prime ministers. The state controls 80 out of 543 seats in the national parliament, nearly double the contingent of the next largest state. Yet despite its size and progeny, UP remains among India's poorest states. It ranks at or near the bottom across a range of socioeconomic indicators, including per capita income, infant mortality rates, literacy levels, and access to electricity (Uttar Pradesh Planning Department 2006). The World Bank estimates that 8 percent of the world's poor live in UP alone (World Bank 2002).

In the first four decades after independence, the Indian National Congress party enjoyed nearly uninterrupted control of UP's parliamentary seats as well as its *Vidhan Sabha* (Legislative Assembly). Congress often used pro-poor slogans to mobilize its supporters, especially in the rural villages where 70 percent of Indians live. Indira Gandhi's rallying cry of "Garibi Hatao" [abolish poverty] was a rhetorical success but a practical failure (Rath 1985). According to Kohli, "While socialist rhetoric was used to try to build political capital, policies in favor of the poor were seldom pursued vigorously" (Kohli 2004, 258). By the late 1980s, frustrations among the poor cracked Congress's base of popular support, and its hegemony in Uttar Pradesh deteriorated (Brass 1994; Hasan 2002).

The decline of Congress was hastened by the emergence of new political parties with more targeted bases of support. In UP, the significant size of both low- and high-caste groups – 21 percent of the population are Scheduled Castes and 10 percent are Brahmin, high proportions relative to those of other Indian states – made them electorally significant voting blocs that the new parties have courted. Among the entrants were two lower-caste parties, the BSP, drawing on the support of Scheduled Castes, and the Samajwadi Party (SP), supported by many Other Backward Class (OBC) and Muslim voters (Duncan 1999; Varshney 2000; Pai 2002; Jaffrelot 2003; Chandra 2004). In addition, the BJP, a conservative Hindu nationalist party, popular among upper-caste and middle-class voters, emerged as a powerful force (Hansen 1999; Thachil 2014). After Congress lost control of the UP state assembly in the 1989 elections, the BJP, BSP, and SP emerged as the most powerful parties in the state, jockeying for power amidst intense competition and fragile power-sharing coalitions. As the parties increasingly targeted their platforms to social groups, citizens aligned their votes accordingly, reinforcing the polarization of politics along caste lines (Banerjee and Pande 2007).

In her rich and nuanced account, Chandra (2004) describes UP as a patronage democracy in which access to public services such as water, roads, and electricity, is monopolized by elected officials. As a consequence, citizens cast their votes according to beliefs about which parties are most likely to deliver benefits to them and their communities. Responding to and nourishing the mobilization of the rural poor, the BSP and its leader, Mayawati Kumari, launched efforts to expand welfare programs and improve public services in historically underprivileged communities. Several projects targeted predominantly SC villages and Dalit *bastis* (neighborhoods). As Chief Minister in the late-1990s, Mayawati initiated the Ambedkar Village Programme, promising to provide more than 11,000 of the poorest villages with electrification, roads, and irrigation.

The BSP enjoyed increasing electoral success in the 1990s. Its share of assembly seats rose from 12 out of 425 seats in the 1991 elections to 67, 66, and 98 seats in the 1993, 1996, and 2002 elections, respectively.[2] In the 1996 state elections, the BSP won 62 percent of the Dalit vote, increasing to 69 percent in the 2002 election.[3] The landmark 2002 election was an inflection point in UP politics as the BSP secured more seats than the incumbent BJP, which had governed both UP and the national government in Delhi. In 2007, the BSP secured an outright majority of seats, the first time a party had achieved that feat since Congress won a majority in 1985.

Electricity and Party Politics

Although electoral competition has been vibrant in UP, this has not resulted in notable improvements in access to public services relative to the rest of India (Kohli 1987; Varshney 1995; Chandra 2004; Chhibber and Nooruddin 2004). As Drèze and Gazdar (1996) observe, "Whether we look at health care provisions, or at educational facilities, or at the public distribution system, or indeed at almost any essential public services for which relevant data are available, Uttar Pradesh stands out as a case of resilient government inertia as far as public provisioning is concerned" (53). The disparity is especially severe in terms of access to electricity, a critical public service that is primarily a state-level responsibility within India's federal structure (Modi 2005; Kale 2014). According to official Ministry of Power data, fewer than 60 percent of UP's villages were electrified in 2005 compared with well over 90 percent of villages in the neighboring states of Rajasthan and Madhya Pradesh (see Figure 7.1).

[2] The number of assembly seats in UP was reduced to 403 after the state was partitioned in 2000.
[3] Data from 2002 Uttar Pradesh Assembly Election Study, Center for the Study of Developing Societies.

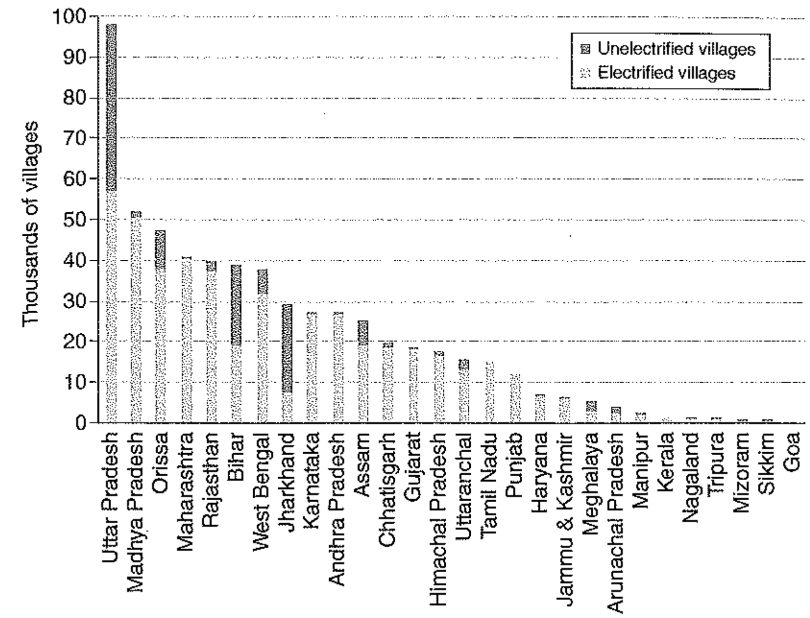


FIGURE 7.1. Village electrification rates in Indian states, 2005.
Source: Government of India, Ministry of Power.

All electricity transmission, distribution, and supply within the state is managed by the government-owned and government-operated Uttar Pradesh Power Corporation Limited (UPPCL). Against a typical available supply of 6 gigawatts (GW) in 2008, the baseline demand for power in UP hovered around 7.5 GW, peaking at 9 GW during the hottest months or around major festivals. This chronic supply shortage means that roughly a quarter of demand must go unmet, requiring massive and relentless power cuts that black out swaths of the state every day of the year. To protect the grid from catastrophic failures, cuts are scheduled following formal load-shedding guidelines as well as informal daily exceptions and adjustments. Critical decisions regarding how, when, and where power is delivered across the state are centrally made and executed from within a single UPPCL office, the Central Load Dispatching Station (CLDS). The CLDS monitors the grid and coordinates the allocation of electricity via directives to four regional Area Load Dispatch Stations (ALDS) located in Sarnath, Panki, Moradabad, and Meerut. The ALDS, in turn, make allocations from their limited supply to regional and local electric utilities. Local utilities can make further allocation decisions as necessary: for example, they may begin or end power cuts to neighborhoods or villages within their jurisdiction.

Load shedding affects almost everyone in the state. Official policy dictates anywhere from 4 hours of daily power cuts in the largest cities to 12 hours of cuts for rural villages. In Kanpur, the state's largest industrial center, daily cuts from 9 AM to 1 PM choke production, shut down businesses, and leave schools without light and homes without fans or refrigeration. Power cuts are often more frequent or last longer than scheduled, especially during the hot months. Those who can afford it run diesel generators and use power inverters that store up battery power, but these alternatives are expensive and unavailable to most poor rural residents.

A few privileged areas are designated by the government as load shed-free zones and enjoy uninterrupted power supply. These include the capital city of Lucknow, where power is deemed necessary for the government to function; the important tourist destination of Agra; the campuses of prestigious universities; the railways; and specially designated industrial zones. Occasionally, "VIP" districts are declared exempt from power cuts, with announcements often occurring right after elections, like the Noida district containing Mayawati's hometown in 2007, and the SP strongholds of Etawah and Mainpuri following the SP's victory in the 2012 election.[4] Temporary exceptions to the standard load-shedding schedule are made daily. Special allowances are often made for local holidays and festivals, typically as a result of petitions from local leaders. Protection from power cuts is also granted to the chief minister, whose travel schedule is communicated to the CLDS. A common joke says one can tell when the chief minister is in town because the power will be working.

Given that electricity is a key input to economic activity, access to electrical power is an important issue for voters. In a 2007 preelection survey in UP, nearly four in ten voters noted that development issues including electricity, road, and water concerns were their most important considerations in deciding for whom to vote.[5] Indeed, it is often said that Indian politics centers around *bijli, sadak, paani* (electricity, roads, water). In the World Bank Enterprise Survey of Indian businesses in 2006, more firms cited access to reliable electricity as the number one obstacle facing their business (35 percent) than any other concern, including taxes (25 percent) and corruption (11 percent). Firms estimated losing 6.6 percent of sales as a result of power outages.

Engineers at CLDS describe an intricate balancing act in which they must manage competing requests from elected leaders across the state. In one memorable account, a state assemblyman who had negotiated power cut exemptions from the chief minister threatened to shoot the engineer who had turned off the power to his constituency. Anecdotal evidence suggests that politicians routinely interfere in the operation of the state electricity board through patronage transfers of employees; interventions in the selection of villages for electrification projects; and the assertion of influence on when, where, and how, power cuts are timed and distributed. In a government audit of the Ambedkar Village Programme, numerous villages were found to have been electrified despite

[4] "24-hour power to VIP districts in Uttar Pradesh upsets court." NDTV.com, September 11, 2012.
[5] Lokniti, *Uttar Pradesh Pre-poll 2007*.

failing to meet qualification guidelines. Others were electrified following the intervention of the energy minister, contrary to the required procedure. Overall, a third of program spending, or $US 50 million, could not be accounted for, presumably lost to kickbacks and fraud.[6]

In another investigation, the Kaul Committee diagnosed a culture of political interference in the day-to-day operations of the power company. It found that the board was heavily packed by "political bosses" and that "the State Government appears to be exercising unbridled power of interference in the day to day working of the Electricity Board. This interference in transfers and postings with political patronage has totally destroyed the autonomous nature of the electricity board."[7] Bureaucrats must be responsive to politicians because their careers depend on the favor of their political bosses. Bardhan explains, "Headships of public sector units, particularly under the State Governments, are indiscriminately used as political sinecures. Efficient managers who fail to satisfy the Minister's political clients are often arbitrarily transferred" (Bardhan 1984, 69–70). In his study of corruption in India, Das concludes, "From the evidence available, it is clear that the present bureaucracy in India is used as the personal instrument of ruling politicians" (Das 2001, 219).

Because the provision of electrical power is mediated by public officials whose careers depend on the support of elected state leaders, I argue that the allocation of scarce electrical power across the state reflects the influence of competing political interests. This claim implies that the distribution of electricity should vary across time and space as a function of changes in the political environment. Media reports provide plenty of corroborating evidence of how this occurs. Saifai, the home village of SP leader Mulayam Singh Yadav, has benefited from numerous public works projects, including new highways, a stadium, and a dedicated power substation. According to one account, the village of 4,500 has enjoyed protection against load shedding: "While all districts in the state, including Lucknow, face severe power cuts, Saifai has been spared. 'We thank the chief minister for uninterrupted power supply,' says Amar Yadav."[8] A similar story emerged in Badalpur, the home village of BSP leader Mayawati (often referred to as Behenji by her followers). Following the BSP's majority victory in 2007, the village chief declared, "We get just 7 to 8 hours electricity. All of it will change now," while the area's newly elected BSP MLA announced, "We will give 24-hour electricity supply to the village as in the previous Behenji regime. All projects announced by Behenji earlier for the village will be revived."[9]

The ability of politicians to pressure power company officials to redirect power supply can also be discerned from space. In October 1997, Naresh

[6] Comptroller and Auditor General of India, *Report on Uttar Pradesh*, 2002, p. 46.
[7] Suresh Chandra Sharma vs Chairman, UPSEB & Ors. RD-SC 20 (January 13, 1998).
[8] Chakraborty, Tapas, "Air and star power for CM village." *The Telegraph*, September 5, 2004.
[9] Sharma, Aman, "Maya magic sweeps Noida." *Indian Express*, May 13, 2007.

Agarwal defected from the Congress party and transferred his support and that of his followers to the BJP, enabling it to take over the reins of UP's state government. In return, Agarwal was granted the plum position of Energy Minister. Figure 7.2 reveals the effects of his ascendancy in his constituency, Hardoi. From 1998 onwards, lights in Hardoi increased in intensity and extent as "blackout-free electricity reached even the most rustic areas of [Agarwal's] constituency."[10] Then in August 2001, Agarwal was removed from his cabinet post for disloyalty. With no further influence on UP's electricity supply, Hardoi experienced a massive decline in power provision, as revealed by satellite imagery, with the 2002 image showing a reversion almost back to the levels before Agarwal's promotion.

Less prominent legislators can also influence the provision of electricity. As part of the Ambedkar Village Programme, MLAs and upper state house members were each entitled to recommend up to five villages per year for new electrification.[11] Elected MLAs also have access to roughly $US 400,000 per year in local area development funds (Keefer and Khemani 2009), which can be directed toward electrification projects. MLAs can use their local clout to aid their constituents in many other ways, including by pressuring the utility company to speed up electrification projects or defer power outages.

These anecdotes support the claim that politicians can distort access to basic public services such as electricity down to the local level. Given this expectation, we should observe that the distribution of electricity varies across time and space, with the most notable improvements in periods when access to electricity is most politically salient, in places where citizens have few alternatives to public provision, and by elected leaders who can most effectively use improved electricity provision as a credible signal of their commitment to their supporters. In the remainder of the chapter, I examine satellite data from the last two decades to show that, consistent with these expectations, improvements in electricity access are most notable during election periods, especially in areas represented by the BSP as compared to those represented by other parties with less credible commitments to the poor.

Research Design and Data

To evaluate how the delivery of electricity varies as a function of electoral politics, I construct a dataset of all 98,000 villages in UP, structured in village-constituency-year format, with annual indicators of electricity service availability from 1992 to 2010. Villages are located within 403 state assembly constituencies, and state elections were held in 1993, 1996, 2002,

[10] "Caste Adrift in India." *The Economist*, February 7, 2002.

[11] Comptroller and Auditor General of India, *Report on Uttar Pradesh*, 2002, p. 45.

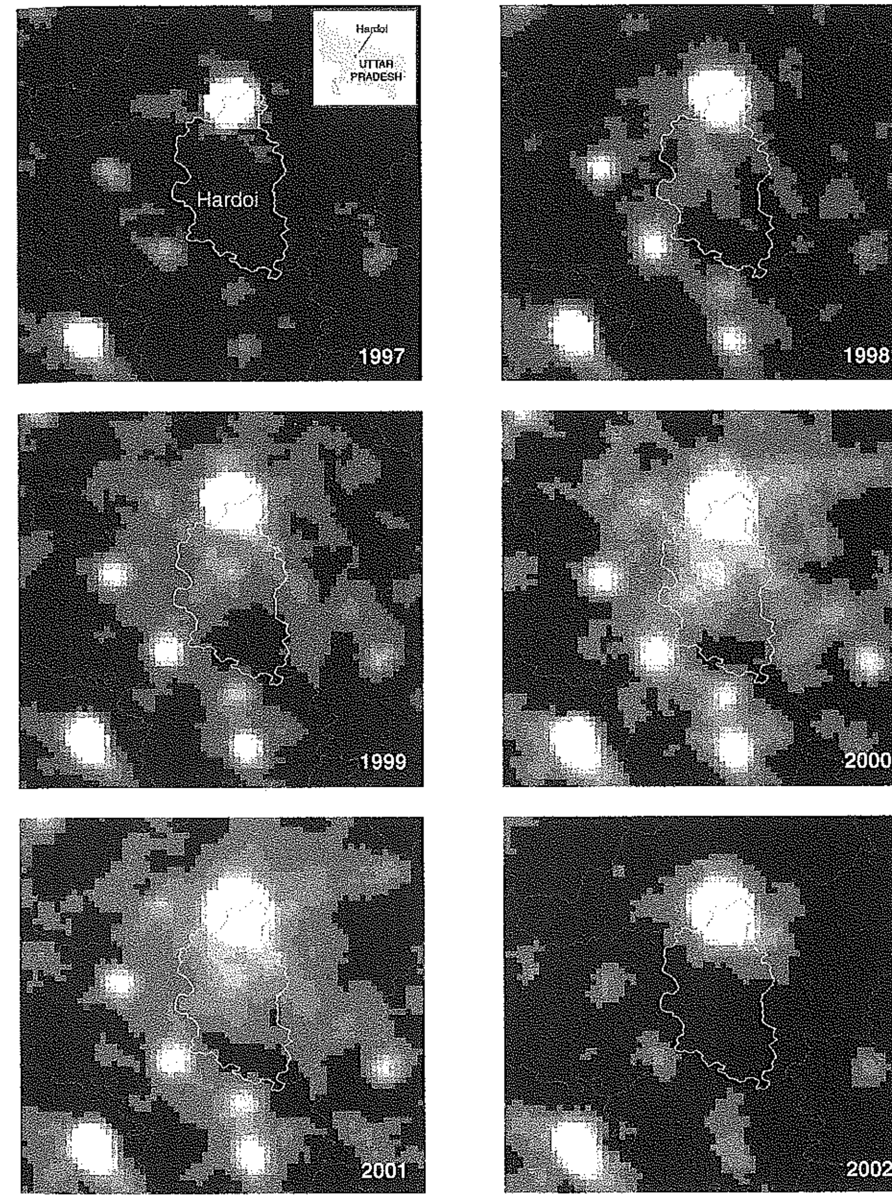


FIGURE 7.2. Nighttime light output in Hardoi constituency, 1997–2002.
Source: NOAA National Geophysical Data Center and US Air Force Weather Agency.

and 2007. I conduct two broad sets of analyses. The first evaluates party effects using time-series cross-sectional data of nearly two million observations tracking all villages over 19 years to see whether electricity service is higher in election years than non-election years. Moreover, I estimate the conditional probability that a village will be lit in constituencies that voted for the BSP versus in those that did not elect the BSP. However, observational data will not necessarily identify a causal effect of BSP representation. To estimate the causal effect of party treatment requires the evaluation of a counterfactual: Would a village's access to electricity have been different had it been represented by another party? If villages could be randomly assigned to BSP treatment, then estimating the causal effect of BSP rule would be easy. Because that is not possible, in the second analysis, I use matching techniques to more reliably estimate the causal effect of BSP representation on a village's access to electricity.

It is important to note that while the unit of analysis is the village, the key treatment regarding election of state legislators occurs at the assembly constituency level. The data are therefore structured as hierarchical or multilevel data in which individual observations are clustered within groups and the key treatment is applied at the group level. An alternative design could aggregate the village observations into constituency-level totals and means (which I do as a robustness check). However, using village-level data efficiently uses all the available data, enables the detection of heterogeneous effects within constituencies, and helps avoid aggregation problems of ecological inference and the related modifiable areal unit problem. To account for the grouped nature of the village data, I employ multilevel models using fixed effects at the constituency level and cluster the standard errors by constituency.

An additional form of nonindependence may also exist among geographically proximate villages. Because electrification is a networked phenomenon, a village may be more likely to be electrified where the grid is dense and other nearby villages have power. If there is spatial autocorrelation, it needs to be taken into account to derive correct standard errors. However, standard methods for controlling for spatial dependence are not tractable for networks as large as those observed here. Spatial lag models with binary dependent variables do not have closed-form solutions and are difficult to estimate (Ward and Gleditsch 2002). A more primitive strategy adopted here is to include controls that relate directly to the extent and density of the electrical grid, namely a village's distance from the nearest town (because all towns are connected to the grid). The inclusion of fixed effects will also help account for unmeasured regional variations in the power grid by allowing the intercepts to vary across constituencies. A shortcoming of these approaches is that unlike spatial lag models, which allow the degree of similarity to be measured continuously across all villages, varying-intercept models can only control for fixed spatial autocorrelation across constituencies and not within each constituency.

Dependent Variable: Lit Villages

To estimate the availability of electricity in individual villages, I rely on satellite imagery of the earth at night. As described in Chapter 4, the imagery comes from the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS), a set of US military weather satellites that have been flying in polar orbit since 1970 recording high-resolution images of the earth each night, typically between 7PM and 10PM local time. Captured at an altitude of 830 km, these images reveal concentrations of outdoor lights, fires, and gas flares at a fine resolution of 0.56 km and a smoothed resolution of 2.7 km. Beginning in 1992, all DMSP-OLS images were digitized, facilitating their analysis and use by the scientific community. Annual composite images are created by overlaying all images captured during a calendar year, dropping images where lights are shrouded by cloud cover or overpowered by the aurora or solar glare (near the poles), and removing ephemeral lights such as fires and other noise. The result is a series of images of time-stable night lights covering the globe for each year from 1992 to 2010 (Elvidge et al. 1997a; Imhoff et al. 1997; Elvidge et al. 2001). Images are scaled onto a georeferenced 30-arcsecond grid (approximately 1 km^2). Each pixel is encoded with a measure of its annual average brightness on a 6-bit scale from 0 to 63. Figure 7.3a shows an image of 2002 time-stable night lights in UP. The state's largest cities are brightly lit, including the capital Lucknow, and the manufacturing center Kanpur. But given that 80 percent of UP's population is rural, the image also reveals vast areas of darkness. This is not simply because the satellite cannot detect very low levels of light: in fact, thousands of small villages emit discernible levels of light. The fact that some villages appear lit while many otherwise similar villages are dark suggests instead that access to electricity varies widely across the state.

Compared with traditional data on energy production and consumption, the satellite images explicitly reveal the geographic distribution of electrical power, providing a clearer and more dynamic picture of who benefits from electricity than could be gained from maps of static electrical infrastructure.

By comparing composite images from different years, trends in light output can be visualized. The two maps in Figure 7.3b contrast light output from satellite images in 1992/1993 against those from 2009/2010. On the left, the dark grey areas identify pixels that have become newly lit over that timespan. Many newly lit areas correspond to zones of urban expansion and grid extensions, including around the Agra area, which has benefited from many infrastructure improvements. On the right, dark grey pixels show areas that have gone *dark* over this timespan: these are areas where lights were once visible in 1992 and 1993 but are no longer consistently detectable by satellite sensors. These newly dark areas are heavily concentrated in the impoverished eastern region. These patterns reflect the decay of infrastructure, lack of maintenance including the replacement of streetlight bulbs, and increasingly frequent power outages. The

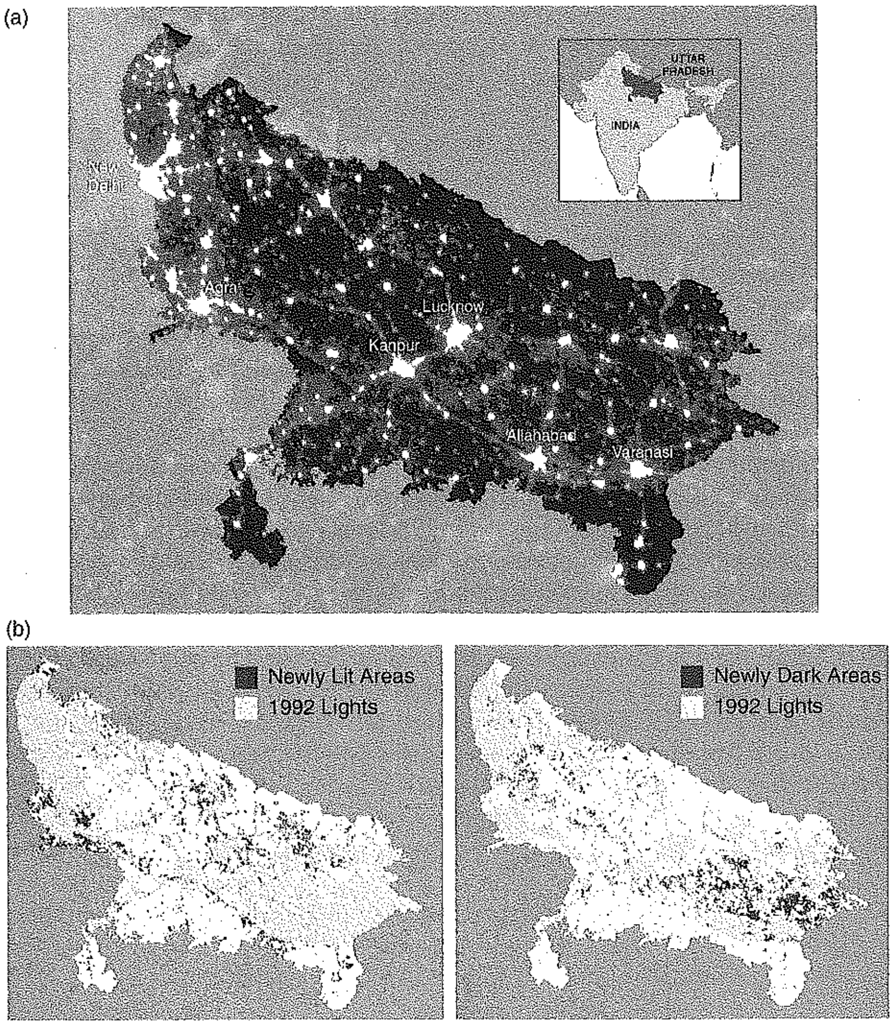


FIGURE 7.3. Nighttime lights in Uttar Pradesh. (a) Average annual stable lights, 2002, (b) Change detection, 1992/93 versus 2009/2010.

Source: Satellite data from NOAA National Geophysical Data Center and US Air Force Weather Agency.

change detection image illustrates the dynamic nature of electrical service and the reality that its provision can both improve and worsen over time.

The primary dependent variable is a dichotomous measure of whether a village benefits from stable electricity supply or not in each year, by which I mean whether a village center appears lit in the relevant annual composite

stable lights image. The data extractions are performed using GIS software to spatially match village locations to the satellite imagery.[12] The emission of light at night reveals both the presence of electrical infrastructure *and* the regular flow of electrical power converted into outdoor lighting at night. Outdoor lighting is meaningful because it is a useful application of electricity with broad public benefits and suggests wider availability of electricity to residences and businesses. Indeed, electric poles and wires are irrelevant if the supply of power is inconsistent or unreliable. As one upset villager in a newly "electrified" village reported, "We have only had a few hours of power since the men came to install the poles. It is worse now. Now we get a bill even though there is still no electricity!"

Independent Variables

The primary independent variables of interest are an indicator variable for election years, indicators for the party of the MLA representing each constituency, and the set of interaction terms between these variables. Several control variables account for factors that might make a village more likely to be electrified for nonpolitical reasons that might nevertheless be confounded with the party variables. *Village population* identifies the number of potential consumers of electricity, with larger villages more likely to be targeted. The presence of complementary infrastructure such as a *School*, *Medical facility*, or a *Paved approach road* may induce a higher local demand for electricity. A village's *Literacy rate* may reflect a latent factor associated with the ability of local residents to secure government projects in their village. *Distance to nearest town* is measured in kilometers and provides an upper bound on distance to the electrical grid, since all towns are electrified.

Data at the assembly constituency level include *Constituency population* and *Number of villages*. The variable *Scheduled Caste population* codes the proportion of the population classified as Scheduled Caste according to the 2001 Indian Census. Given the very high rates of support for the BSP among SC voters, this variable serves as a proxy for BSP core voters. I create an interaction term *BSP × SC population share* to explore heterogeneous effects of BSP MLA representation depending on the proportion of core voters within a village. Some assembly constituency seats are *Reserved* for Scheduled Caste candidates.

To account for variations in the level of industrialization and development across the state, *Income index* is calculated based on adjusted district per capita income, scaled on an index between 0 and 1 (Uttar Pradesh Planning Department 2006). District-level income data are available for 1991, 2001, and 2005 for all 70 districts and are the most disaggregated estimates of income of which I am aware.

[12] The village location data are from ML Infomap.

The UPPCL reports the *Total available power supply* in the state in each year. This is important because it is easier to distribute electricity more broadly when greater supply is available. Reflecting the greater priority the state's leaders have put on managing the *distribution* of electricity rather than making more costly and less visible investments in increasing its supply, UP's power generation totaled 21 terawatt-hours in 2010, a figure no higher than it was in 1995. Meanwhile, UP has artfully increased the availability of electricity by importing from the central grid, which now accounts for up to two-thirds of total power in the state. The flexibility to import more power from its neighbors when needed, despite the generally high cost, is what enables temporary increases in electricity provision in critical periods such as those around elections.

Over the timespan of the study, night lights data were recorded from six distinct DMSP satellites: F10, F12, F14, F15, F16, and F18. To account for differences in the characteristics of each sensor, I code separate satellite dummy variables, which function in the models as satellite fixed effects. Moreover, sensors are known to degrade over time. To account for these effects, I create sensor-specific variables that count the number of years for which that sensor has provided DMSP-OLS data. For example, F10, which provided data in the first two years of the series, is coded as 1 in 1992, 2 in 1993, and 0 in all other years. Finally, I include a year counter variable that tracks the progression of calendar time. The inclusion of these sensor age and year counter variables helps account for period-specific factors that affect all villages.

Results and Analysis

Descriptive Trends

Figure 7.4 plots the proportion of villages appearing lit in satellite imagery with thin lines depicting smoothed trends in individual constituencies and the dark line showing the overall state average (see also Tables 7.6–7.9 in the chapter's Appendix). The noisy figure reveals high variation, both across constituencies and over time. Only in a few constituencies around large cities are villages fully lit in each year. In the rest of the state, there has been little improvement in the rate of lit villages over the last two decades, with just over half of the state's villages appearing lit at both the starting and ending points. This slow pace of change is consistent with expert observations. According to one report, "Power is the most critical bottleneck the state is currently facing. There has been practically no addition to generation capacity in the state since 1990, while the demand has been increasing. The distribution network is obsolete and overloaded resulting in frequent breakdowns" (Singh 2009, 6). Nevertheless, the overall statewide pattern reveals a cyclical pattern in which more villages are generally lit around elections than in nonelection periods.

Table 7.1 presents logit regressions to more formally evaluate the impact of elections. The results show consistently that villages are more likely to be lit in years when an election is held. Model 1 shows the impact of election

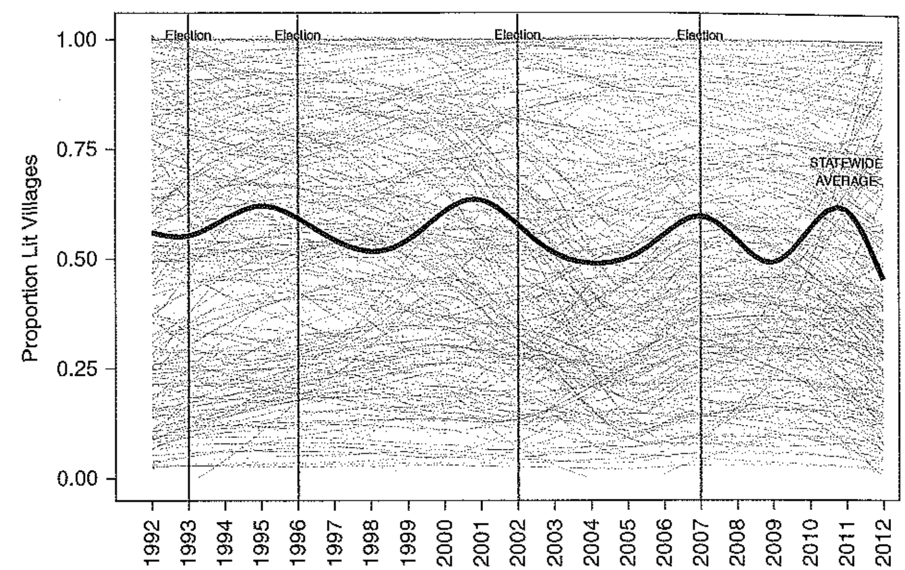


FIGURE 7.4. Proportion of villages lit by constituency, 1992–2010. Individual lines represent smoothed averages for each of Uttar Pradesh's 403 assembly constituencies.

years versus nonelection years on all pooled village observations with a control accounting for the total power supply available in the state in each year. Models 2 and 3 add additional dummies to estimate the effect in years immediately prior to and following election years. In all cases, the election year effect is large and significant. Models 4 to 6 add village fixed effects, estimating a separate intercept for each individual village to help account for fixed characteristics that may make it more or less likely that a village will be electrified, such as size, level of economic activity, or proximity to larger towns. These results show an even larger effect of elections. Although one cannot make causal claims based on these results, it is important to note that the effect is substantively large: based on model 4, the probability that a village is lit is 51 percent in election years versus 40 percent for the same village in nonelection years.

Focusing on some key constituencies further reveals the influence of individual politicians and the significance of elections when it comes to the distribution of electricity. The first plot in Figure 7.5 shows the proportion of villages lit in Hardoi constituency, tracking the rise and fall of Naresh Aggarwal discussed previously and shown in Figure 7.2. Amethi is the seat of power of India's Nehru–Gandhi clan. Its close association with the Congress party has been both a blessing and curse to its residents. The steep decline in electricity provision following the 2002 election reflects a shifting of the political winds toward the BSP and SP, with Congress declining to historic lows, winning only 25 and 22 seats in 2002 and 2007, respectively.

TABLE 7.1. *Election year effects on village lit or not, 1992–2010 logit regressions*

Dependent Variable: Village lit	(1)	(2)	(3)	(4)	(5)	(6)
Years since election: −2			0.2741**			0.5770**
			(0.004)			(0.008)
Years since election: −1		−0.0950**	−0.0023		−0.2002**	−0.0106
		(0.003)	(0.003)		(0.006)	(0.007)
Years since election: 0	0.2244**	0.2904**	0.4691**	0.4485**	0.5977**	0.9893**
	(0.002)	(0.003)	(0.004)	(0.005)	(0.006)	(0.009)
Years since election: +1		0.3519**	0.4153**		0.7238**	0.8735**
		(0.003)	(0.004)		(0.007)	(0.008)
Years since election: +2			0.1976**			0.4210**
			(0.004)			(0.008)
Total power supply	−0.0049**	−0.0147**	−0.0054**	−0.0099**	−0.0309**	−0.0117**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Village fixed effects	No	No	No	Yes	Yes	Yes
Constant	0.1750**	0.4805**	−0.0314*			
	(0.009)	(0.011)	(0.015)			
Observations	1,874,065	1,676,795	1,479,525	1,333,629	1,161,185	984,480

Robust standard errors clustered on villages in parentheses.
$^{**}p \leq 0.01$, $^{*}p \leq 0.05$.

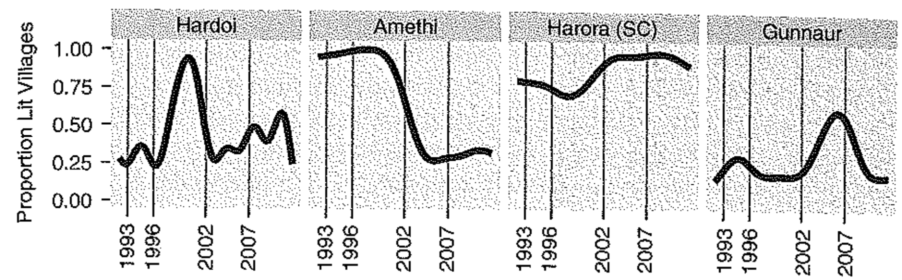


FIGURE 7.5. Villages lit in politically significant constituencies, 1992–2010.
Source: Satellite data from NOAA National Geophysical Data Center and US Air Force Weather Agency.

Yet the Gandhi clan continues to retain influence: media reports in summer 2012 reported that Sonia Gandhi had secured a promise of uninterrupted power supply to Amethi from the new incoming chief minister.[13]

Mayawati, on her rise to leadership of the BSP, first served as MLA of Harora constituency from October 1996 to October 1998, a period when the BSP was a weak player in state politics. When the BSP won enough seats in 2002 for Mayawati to secure the chief minister's post, access to electricity in Harora reflected her growing political power and influence. Following the collapse of her coalition government in 2003, Mulayam Singh Yadav became chief minister in September 2003. Following constitutional requirements that the chief minister also hold a seat in the state legislature, Yadav was elected MLA of Gunnaur constituency in a February 2004 by-election. The constituency benefited immediately from its new and powerful representative. In the village of Chhabilpur, a schoolmaster marveled, "We get electricity for almost 20 hours a day, a distant dream three years ago when this village didn't even have electricity poles."[14] Yet when Yadav lost his post as CM in 2007 (to Mayawati), many villages in Gunnaur, including Chhabilpur, were once again plunged into darkness.

Because the satellite data represent averages over the calendar year, there is no straightforward way to use this data to investigate whether light output peaks in the weeks and months prior to an election or in the period afterward. The cases above suggest, however, that both can occur, as some leaders persuade power company officials to increase power leading up to elections when voters are most attuned to their performance, while later, newly elected leaders shake up the status quo by advocating for new distributional allocations favoring their critical constituents. In the next subsection, I examine whether the impact of elections on electricity provision can be generalized beyond these anecdotal cases in a statistical framework that accounts for confounding factors.

[13] "A word from Sonia Gandhi ensures uninterrupted power supply in Rae Bareli, Amethi." *Times of India*, August 29, 2012.

[14] "Mulayam as MLA changes face of Gunnaur." *Indian Express*, March 18, 2007.

Time-Series Cross-Sectional Analysis

Table 7.2 shows a set of logit regressions to evaluate election and party effects on the likelihood that a village will be lit in the satellite imagery. The models include fixed effects for all 403 constituencies to help account for unobserved factors that may be associated with patterns of electrification such as geography or economic potential. To help account for nonindependence of village observations within the same constituency, standard errors are clustered at the constituency level.

Across all models, the coefficient on election year is positive and significant, indicating that a village's probability of being lit is higher in those years than in nonelection years. To evaluate whether the election year effects vary by party, model 1 includes party dummies, interactions of each party dummy with the election year dummy, and the measure of total available electrical power in the state. The upper-caste BJP is the omitted reference category. None of the main party effects are significant, suggesting that the party of the MLA makes no difference to the likelihood that a village will be lit in nonelection years. But in election years, parties matter. The interaction term (Election year × BSP MLA) is positive and significant, meaning that villages in BSP constituencies are more likely to be lit in election years than those in BJP constituencies. Controlling for differences in district-level income and a wide range of village-level covariates in model 2 does not change the positive effect of election years and the (Election year × BSP MLA) interaction term.

One possible explanation for the BSP-election year effects is that they are actually driven by differences in political participation and competitiveness. In model 3, I add political variables that control for the win margin, the turnout rate, and the number of registered voters, and whether the incumbent party won in the most recent election. The results show that the likelihood of villages being lit is lower in areas with lower turnout and with reelected incumbents. This may suggest that elected representatives are more likely to be complacent when voter participation is lower. Yet these effects do not meaningfully change the coefficients on election years or the (Election year × BSP) interaction.

Models 4 and 5 add variables identifying the party of the chief minister, and interaction terms between the chief minister's party and the MLA party. The results show interestingly that compared to years with a BJP chief minister (1992, 1998–2001), electricity provision was significantly worse under all other chief ministers and in periods of *President's rule* (in which no ruling coalition emerged, necessitating direct federal rule). Moreover, the (BSP CM × BSP MLA) interaction term shows that electricity provision in BSP-represented constituencies was even worse when there was a co-partisan BSP chief minister than it was in the omitted category of BJP-represented constituencies. Although this result is somewhat unexpected, it affirms how strategic senior political leaders can be in their allocation of political resources. The result suggests in particular that the BSP chief minister may have been more focused on directing

TABLE 7.2. *Fixed effects logit regressions on village lit or not, 1992–2010*

Dependent variable: Village lit	(1)	(2)	(3)	(4)	(5)
Election year	0.1630**	0.1747**	0.2533**	0.4441**	0.4673**
	(0.054)	(0.058)	(0.065)	(0.069)	(0.103)
BSP MLA	−0.0582	−0.0626	−0.0835	0.0039	0.1556
	(0.068)	(0.074)	(0.075)	(0.075)	(0.095)
INC MLA	−0.0609	−0.0658	−0.0927	−0.1047	0.0463
	(0.084)	(0.091)	(0.092)	(0.090)	(0.126)
Other MLA	−0.1487	−0.1640	−0.1940	−0.1774	−0.3152*
	(0.095)	(0.104)	(0.106)	(0.107)	(0.134)
SP MLA	−0.0237	−0.0263	−0.0333	0.0276	−0.0027
	(0.062)	(0.068)	(0.069)	(0.069)	(0.097)
Election year × BSP MLA	0.3423**	0.3722**	0.3061**	0.1751*	0.1677
	(0.076)	(0.083)	(0.083)	(0.084)	(0.117)
Election year × INC MLA	−0.0473	−0.0537	−0.0809	−0.1108	−0.0996
	(0.108)	(0.118)	(0.120)	(0.118)	(0.167)
Election year × Other MLA	0.2292*	0.2504*	0.2204*	0.1664	0.1138
	(0.095)	(0.102)	(0.104)	(0.104)	(0.161)
Election year × SP MLA	0.0686	0.0753	0.0379	−0.0263	−0.0457
	(0.062)	(0.067)	(0.067)	(0.067)	(0.121)
BSP CM				−0.5922**	−0.4835**
				(0.055)	(0.087)
President's rule				−1.2944**	−1.4442**
				(0.120)	(0.154)
SP CM				−0.7759**	−0.8279**
				(0.065)	(0.109)
BSP MLA × BSP CM					−0.3712**
					(0.134)
(All other MLA party × CM party interactions)					Yes
Win margin			0.0061	0.0057	0.0061
			(0.003)	(0.003)	(0.003)
Turnout			−0.0212**	−0.0006	0.0007
			(0.005)	(0.006)	(0.006)
Electors			−0.0038	0.0002	0.0008
			(0.002)	(0.002)	(0.002)
Incumbent wins			−0.1087*	−0.0801	−0.0772
			(0.054)	(0.053)	(0.052)
Income (district level)		0.4208	0.1998	2.2540*	2.2371*
		(0.648)	(0.741)	(1.003)	(0.994)

(*continued*)

TABLE 7.2. (*continued*)

Dependent variable: Village lit	(1)	(2)	(3)	(4)	(5)
Total power supply in state	0.0088	0.0096	0.0014	−0.0082	−0.0067
	(0.005)	(0.005)	(0.006)	(0.007)	(0.007)
Constituency fixed effects	Yes	Yes	Yes	Yes	Yes
Village controls[a]	No	Yes	Yes	Yes	Yes
Satellite sensor-age	Yes	Yes	Yes	Yes	Yes
Year trend	Yes	Yes	Yes	Yes	Yes
Constant	0.7588**	0.6670**	3.2318**	0.5116	0.2479
	(0.111)	(0.235)	(0.657)	(0.785)	(0.769)
Observations	1,865,667	1,852,690	1,849,081	1,849,081	1,849,081

Robust standard errors clustered on assembly constituency in parentheses. BSP, Bahujan Samaj Party; CM, chief minister; INC, Indian National Congress Party; MLA, member of the legislative assembly; SP, Samajwadi Party.

$^{**}p \leq 0.01$, $^{*}p \leq 0.05$.

[a] Village controls include population; proportion Scheduled Caste; proportion literate; presence of a school, a medical facility, a paved road; and distance to nearest town (km).

electricity supply toward constituencies of marginal support than to areas of core support. Still, even after accounting for these effects, the main finding on the election year variable remains robust and positive, and the (Election year × BSP MLA) coefficient remains positive though it now just misses standard levels of statistical significance.

These results are notable given the claims in India that, on the one hand, access to state resources depends entirely on who you vote for, and on the other hand, that all parties are equally ineffective in addressing the needs of the poor. When it comes to village electrification, the differences across parties are substantial but only in election years, with the largest effects occurring in villages located in BSP constituencies.

These findings are robust to different estimation strategies and codings of the dependent variable. The chapter's appendix reports models that include a lagged dependent variable rather than a fixed effects specification (Appendix Table 7.7). The same positive effect of election years and interactions between election years and BSP legislators persists. The findings are also unchanged when recoding the dependent variable to look for light output in a larger area than just the village center (using bilinear interpolation of the 2 × 2 pixel area) (Appendix Table 7.8). Finally, to be sure that the results are not artificially driven by the large number of observations in the multilevel dataset, I collapse the data into a constituency-level dataset where the dependent variable is the fraction of villages in a constituency that are lit. Using fractional logit (Papke and Wooldridge 1996) and regressing a comparable set of explanatory

variables on this outcome, I find again the same positive effect of election years and their interaction with BSP representation (Appendix Table 7.9).

That said, we cannot easily conclude that these patterns reflect a true causal effect of BSP representation, as these findings could be biased by unobserved factors associated with both BSP electoral success *and* higher electrification rates. Although the inclusion of constituency fixed effects should absorb time-invariant factors that matter within constituencies, and the satellite sensor-age variables should account for broad temporal trends affecting the whole state, these statistical adjustments provide only a partial response to such concerns. In the next section, I focus on a smaller subset of villages and use matching techniques to derive a more compelling estimate of the causal effect of BSP representation.

Deriving Causal Estimates of BSP Representation on Village Electrification

The 2002 election marked an inflection point in the ascendancy of the BSP when it secured 98 seats to surpass the upper caste BJP whose seat share dropped from 157 to 88. For the BSP, the election was an impressive and surprising achievement. Replacing the BJP leader Rajnath Singh, the BSP's Mayawati was named chief minister and served in that post for 16 months from May 2002 through August 2003. Given the dramatic transition in power from BJP to BSP rule during this timeframe, I focus on the period immediately prior to and following the 2002 election to evaluate party effects on changes in village electrification rates.

To define my sphere of analysis, I begin with the 157 assembly constituencies that were represented by the BJP prior to the 2002 election. In the election, 37 switched their support to the BSP while 52 retained BJP representation. Based on this study sample, I ask whether unlit villages in constituencies that switched to BSP representation (the "treatment" group) were more likely to become lit than if they had retained the BJP (the "control" group). Constituencies that have no unlit villages (mostly urban areas) are excluded from the analysis. This results in a sample that comprises a treatment group of 2,679 villages in 29 constituencies that switched from BJP to the BSP, and a control group of 3,223 villages in 29 seats that retained the BJP. The contingency table in Table 7.3 presents a first comparison of the data. Within the treatment group, 10 percent of unlit villages that switched to BSP representation now appeared lit in 2003. That rate is more than twice as high as the rate for unlit villages that retained their BJP representatives.

To address selection bias further and reduce the dependence of results on model specification and parametric assumptions, I use matching in an effort to achieve a higher level of balance across covariates between the treatment and control groups. Matching seeks to make the characteristics of the treated group look similar to those of the control group, allowing analysis that is less sensitive to choices of functional form and model selection (see discussion in Chapter 6).

TABLE 7.3. *Comparing changes in village electrification, 2001–2003*

	Retains BJP BJP, 2001 → BJP, 2003	Switches To BSP BJP, 2001 → BSP, 2003	Total
Unlit 2001 → Lit 2003	4.8% 154 villages	10.1% 272 villages	7.2% 426 villages
Unlit 2001 → Unlit 2003	95.2% 3,069	89.8% 2,407	92.8% 5,476
Total	100% 3,223	100% 2,679	100% 5,902

By improving balance, matching reduces model dependence and reduces bias and variance (Ho et al. 2007). Using GenMatch to conduct one-to-one matching with replacement, I match on the seven village and four constituency-level covariates listed in Table 7.4. Empirical-QQ plots of all continuous variables in Figure 7.6 show improvement in balance after matching, especially on the village-level covariates.

If matching achieved perfect balance across all covariates, the treatment effect could be estimated by comparing the mean outcomes across treatment and control groups. However, some differences remain even after matching. As a result, I continue the analysis on the matched sample, conditioning on covariates by estimating multilevel models using random effects logistic regression. The multilevel approach for dealing with grouped data is preferable to the clustering of standard errors used in the preceding text and allows us to estimate the effects of constituency-level factors that are not possible in a fixed effects framework. Specifically, the model estimates

$$\Pr(y_i = 1) = \operatorname{logit}^{-1}(X_i\beta + \alpha_{j[i]}), \text{ for } i = 1, \ldots, n \qquad (7.1)$$

$$\alpha^j \sim N(U_j\gamma, \sigma^2_\alpha), \text{ for } j = 1, \ldots, 403, \qquad (7.2)$$

where **X** is a matrix of village-level covariates and $j[i]$ is an index indicating the constituency in which village i is located. At the constituency level, U is a matrix of constituency-level predictors, γ is the vector of coefficients for the predictors, and σ^2_α is the variance of the constituency-level errors. An important assumption of the model is that the random effects and errors are assumed to be normally distributed with constant mean and variance in each constituency, j (Gelman and Hill 2007). The multilevel model estimates both equations at the same time, thus avoiding collinearity problems, while accounting for both village- and constituency-level variations in estimating the key constituency-level coefficient of BSP representation.

Table 7.5 presents the main results on the matched sample and evaluates whether unlit villages that switched to BSP representation were more likely to

TABLE 7.4. *Characteristics of unlit villages in study group, 2001*

	Retains BJP In 2002 Election BJP 2001 → BJP 2003 3,223 Villages in 29 Assembly Constituencies				Switches To BSP In 2002 Election BJP 2001 → BSP 2003 2,679 Villages in 29 Assembly Constituencies			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Village-level variables								
Proportion Scheduled Caste	0.23	0.19	0	1	0.29	0.22	0	1
Population (thousands)	1.31	1.26	0.001	11.61	1.39	1.51	0.001	15.54
Literacy rate	0.35	0.13	0	1	0.40	0.13	0	1
School	0.71	0.45	0	1	0.75	0.43	0	1
Medical facility	0.27	0.44	0	1	0.25	0.44	0	1
Paved approach road	0.52	0.50	0	1	0.51	0.50	0	1
Dist. to town (km)	11.90	9.31	0	105	12.14	10.26	0	99
Assembly constituency-level variables								
Income index (district)	0.40	0.04	0.35	0.50	0.43	0.04	0.37	0.65
2001 total light output (log)	7.17	0.71	5.44	8.65	7.54	0.54	6.56	9.09
Reserved seat	0.23	0.42	0	1	0.20	0.40	0	1
Proportion Scheduled Caste	0.22	0.07	0.10	0.40	0.26	0.05	0.14	0.34

be lit than those that stayed with the BJP.[15] The coefficient on the BSP treatment indicator is positive and statistically significant in both the reduced (model 1) and full specifications (model 2). The fact that BSP legislators are effective at improving access to electricity to villages is notable because electrification is a targeted action that requires active coordination on the part of numerous officials. Against the backdrop of endemic power blackouts, the emergence of new lights is a noteworthy and visible signal of political effort to court voters. The positive BSP coefficient suggests that new BSP legislators have more aggressively pursued efforts to improve village electrification than their BJP counterparts, consistent with differences in the respective parties' ideological commitments to the rural poor.

[15] Appendix Table 7.10 shows results of the analysis on the unmatched samples.

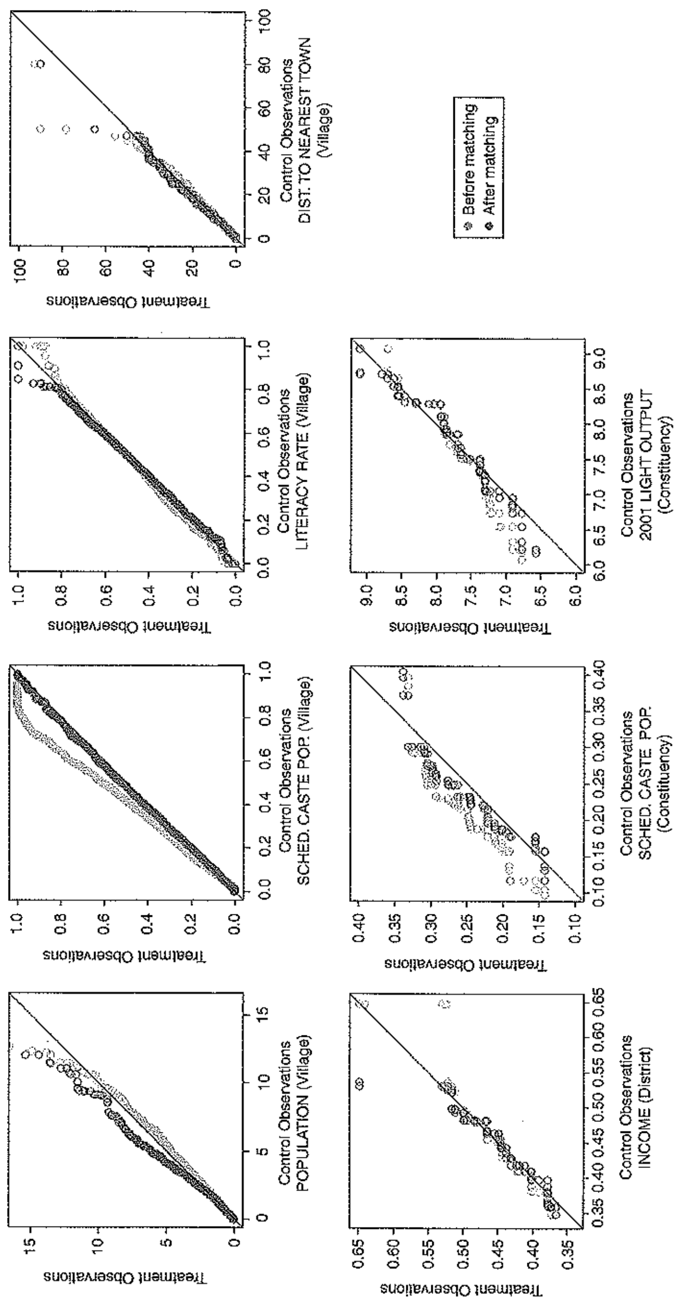


FIGURE 7.6. Empirical-QQ plots of key covariates, before and after matching.

TABLE 7.5. *Evaluating BSP treatment effects on village electrification random effects logistic regressions on matched sample*

	Outcome: Newly Lit in 2003	
	(1)	(2)
BSP treatment	1.6680*	1.9314*
	(0.7663)	(0.7910)
Scheduled Caste population share		1.3190**
		(0.4435)
BSP treatment × SC population share		−1.7844**
		(0.5930)
Village-level controls		
Village population (thousands)		−0.0527
		(0.0477)
Literacy rate in village		2.3317**
		(0.5875)
School in village		−0.3617*
		(0.1663)
Medical facility in village		0.0299
		(0.1295)
Paved approach road to village		0.5063**
		(0.1203)
Distance to nearest town (km)		−0.0368**
		(0.0090)
Constituency-level controls		
Income index	12.0242*	6.4064
	(5.7739)	(6.1200)
2001 Nighttime light output (log)		1.0654
		(0.6189)
Reserved constituency		−0.2551
		(0.9561)
Scheduled Caste population share		−0.5918
		(6.8396)
Constant	−9.3191**	−15.5634**
	(2.4363)	(4.6062)
Observations	5358	5358
Constituencies in sample	56	56

Standard errors in parentheses.
**p-value ≤ 0.01; *p-value ≤ 0.05.

Although the positive impact of BSP representation is validated here, it is also the case that the overall number of impacted villages remains small. Absent any meaningful increase in the overall supply of electrical power, any improvement in electricity provision to one constituency is difficult to sustain over time. Visual analysis of these BSP constituencies suggests that even the limited improvements dissipated rapidly in the years that followed, as outcomes reverted to the status quo. Although empowered legislators may use their influence to impel the power company to enhance electricity delivery at critical moments, such deviations cannot be sustained in the face of the state's chronic power shortages. Overall, these results support and strengthen the descriptive and time-series findings given earlier. Electricity access can indeed be shaped by opportunistic legislators and parties, but given resource constraints and awareness that such manipulations will only have short-term effects, such efforts will be concentrated during only the most politically important junctures.

Conclusion

This chapter uses satellite imagery of the earth at night to study variations in the provision of electrical power across Uttar Pradesh. By examining a period of substantial political change in one of India's poorest states, I show that many villages have benefited from the rise of the lower caste BSP over the last two decades. Using annual data on village electrification from 1992 to 2010, I show that the probability of receiving electricity is substantially and significantly higher in constituencies represented by the BSP, especially in election years. Using matching techniques to evaluate similar villages that differ only on whether they switched to BSP representation in the critical 2002 elections, I also show a positive BSP treatment effect.

This chapter shows that while the electrical grid is often conceived of as a public good imparting nonrival and nonexcludable benefits, in practice, the actual service that it delivers – the flow of useful electrical power – is far from static. Because the distribution of electricity is controlled by political actors, its benefits can be provided and taken away in accordance with political priorities and strategic considerations. The results illustrate the dangers of conflating the provision of infrastructure with service delivery, a problem that afflicts the study of many public goods such as education and health services, given that the presence of buildings or the expenditure of budgets do not necessarily imply the actual delivery of services (Chaudhury et al. 2006). Moreover, the account of UP shows that although many politicians campaign to improve access to public goods, whether or not they can do so depends on the credibility of their parties to such commitments and their ability to persuade officials to respond to their demands.

Appendix

TABLE 7.6. *Summary statistics*

Outcome Variables	Observations	Mean	Std. Dev.	Min.	Max.
All Villages, 1992–2010					
Lit in annual composite satellite image	1,860,898	0.503	0.500	0	1
Average annual light output (0–63 scale)	1,860,898	2.986	5.057	0	63
Village-level characteristics[a]					
Population of village	97,942	1.344	1.475	0.001	99.51
Proportion Scheduled Caste (SC) in village	97,942	0.244	0.208	0	1
Proportion literate in village	97,942	0.422	0.132	0	1
School in village	97,926	0.703	0.457	0	1
Clinic in village	97,926	0.265	0.441	0	1
Paved road to village	97,926	0.594	0.491	0	1
Distance to nearest town (km)	97,942	8.725	4.865	0.003	49.6
Assembly constituency-level characteristics[b]					
Population (thousands)	403	412.401	251.390	0.634	2731
Number of villages	403	242.993	150.799	3	1190
Average proportion of SC	403	0.233	0.071	0.034	0.572
Proportion of villages with school	403	0.755	0.138	0.333	1
Proportion of villages with paved road	403	0.633	0.152	0.326	1
Proportion of villages with clinic	403	0.317	0.169	0.041	1
Reserved constituency	403	0.221	0.415	0	1
District-level characteristics[c]					
Income index, 1991	70	0.321	0.056	0.208	0.517
Income index, 2001	70	0.440	0.058	0.349	0.648
Income index, 2005	70	0.439	0.061	0.326	0.643

(continued)

TABLE 7.6. *(continued)*

Outcome Variables	Observations	Mean	Std. Dev.	Min.	Max.
Education index, 1991	70	0.403	0.089	0.227	0.640
Education index, 2001	70	0.560	0.091	0.338	0.744
Education index, 2005	70	0.596	0.098	0.344	0.775
Health index, 1991	70	0.560	0.128	0.284	0.853
Health index, 2001	70	0.592	0.052	0.483	0.750
Health index, 2005	70	0.643	0.046	0.545	0.783
State-level characteristic					
Annual total power supply (TWh)[d]	19	40.223	9.149	28.563	61.21
State assembly election results[e]		*1993*	*1996*	*2002*	*2007*
Seats won by					
Bahujan Samaj Party (BSP)		67	66	98	206
Samajwadi Party (SP)		135	114	143	97
Bharatiya Janata Party (BJP)		164	157	88	51
Indian National Congress Party (INC)		22	33	25	22
Other party		15	33	49	27
Total seats		403	403	403	403
Average win margin (%)		10.1	9.6	8.1	7.3
Turnout (%)		57.4	56.3	54.5	46.5
Incumbent party reelected (%)		33.5	35.1	37.2	32.5
Registered voters (thousands)		213.1	238.9	247.5	281.8

[a] Data from 2001 Census of India.
[b] Estimates based on 2001 Census data and spatial joins of village locations to constituencies.
[c] Data from *Uttar Pradesh Human Development Report* 2006, background tables.
[d] Available electrical power at all station busbars in terawatt-hours. Data from UPPCL Annual Reports.
[e] Excludes constituencies in the northwestern districts that were separated into the new state of Uttaranchal in 2000.

TABLE 7.7. *Logit regressions on villages lit or not, 1992–2010 with lagged dependent variable*

Dependent Variable (DV): Village Lit	(1)	(2)	(3)	(4)	(5)
L.lit (lagged DV)	2.9474**	2.7043**	2.6491**	2.7607**	2.7569**
	(0.061)	(0.055)	(0.054)	(0.052)	(0.052)
Election year	−0.1368*	−0.1138	−0.1983**	0.2351**	0.2837*
	(0.068)	(0.071)	(0.072)	(0.078)	(0.130)
BSP MLA	−0.1591*	−0.1599*	−0.1700*	−0.0866	−0.0833
	(0.075)	(0.072)	(0.069)	(0.064)	(0.115)
INC MLA	−0.1811	−0.1185	−0.1910*	−0.1779	−0.2394
	(0.098)	(0.098)	(0.088)	(0.091)	(0.147)
Other MLA	0.1138	0.0499	−0.0253	0.0689	−0.2234
	(0.109)	(0.098)	(0.101)	(0.102)	(0.164)
SP MLA	−0.1780*	−0.1406*	−0.1168	−0.0377	−0.1607
	(0.071)	(0.071)	(0.066)	(0.066)	(0.099)
Election year × BSP MLA	0.4597**	0.4645**	0.4038**	0.1089	0.0236
	(0.085)	(0.089)	(0.090)	(0.087)	(0.158)
Election year × INC MLA	0.1603	0.1353	0.1171	0.0929	0.1146
	(0.136)	(0.140)	(0.144)	(0.124)	(0.222)
Election year × Other MLA	0.3065**	0.3180**	0.3298**	0.1936	0.1234
	(0.101)	(0.108)	(0.109)	(0.105)	(0.203)
Election year × SP MLA	0.1333	0.1264	0.1086	−0.0223	−0.0476
	(0.070)	(0.072)	(0.073)	(0.072)	(0.156)
BSP CM				−0.9984**	−1.0634**
				(0.059)	(0.089)
Pres Rule CM				−3.6040**	−3.8106**
				(0.133)	(0.197)

(continued)

TABLE 7.7. *(continued)*

Dependent Variable (DV): Village Lit	(1)	(2)	(3)	(4)	(5)
SP CM				−1.5294**	−1.7013**
				(0.089)	(0.124)
BSP MLA × BSP CM					−0.0563
					(0.136)
Win margin			0.0088**	0.0080**	0.0081**
			(0.002)	(0.002)	(0.002)
Turnout			−0.0193**	−0.0158**	−0.0153**
			(0.005)	(0.005)	(0.005)
Electors			0.0064**	0.0065**	0.0066**
			(0.001)	(0.001)	(0.001)
Incumbent wins			−0.0648	−0.0285	−0.0229
			(0.049)	(0.048)	(0.048)
Income (district level)		1.1902*	2.1692**	3.2102**	3.2824**
		(0.528)	(0.645)	(0.739)	(0.730)
Total power supply in state	−0.0293**	−0.0264**	−0.0443**	−0.0778**	−0.0780**
	(0.004)	(0.004)	(0.005)	(0.007)	(0.007)
Constituency fixed effects	No	No	No	No	No
Village controls	No	Yes	Yes	Yes	Yes
Satellite sensor-age	Yes	Yes	Yes	Yes	Yes
Year trend	Yes	Yes	Yes	Yes	Yes
Constant	−0.8616**	−1.2339**	−1.2108*	−0.6520	−0.6533
	(0.128)	(0.239)	(0.539)	(0.552)	(0.549)
Observations	1,775,430	1,762,668	1,760,157	1,760,157	1,760,157

Robust standard errors clustered on assembly constituency in parentheses. BSP, Bahujan Samaj Party; CM, chief minister; INC, Indian National Congress Party; MLA, member of the legislative assembly; SP, Samajwadi Party.

$^{**}p \le 0.01$; $^{*}p \le 0.05$.

TABLE 7.8. *Logit regressions on villages lit or not, 1992–2010 using interpolated light values*

Dependent Variable: Village Lit (Using Bilinear Interpolation)	(1)	(2)	(3)	(4)	(5)
Election year	0.1999**	0.2170**	0.3035**	0.5238**	0.5292**
	(0.053)	(0.057)	(0.065)	(0.069)	(0.102)
BSP MLA	−0.0713	−0.0788	−0.0992	−0.0132	0.1588
	(0.068)	(0.073)	(0.074)	(0.073)	(0.095)
INC MLA	−0.0580	−0.0620	−0.0876	−0.1036	0.0328
	(0.080)	(0.087)	(0.088)	(0.088)	(0.124)
Other MLA	−0.1700	−0.1851	−0.2140*	−0.2027	−0.3399*
	(0.096)	(0.105)	(0.108)	(0.108)	(0.135)
SP MLA	−0.0239	−0.0267	−0.0317	0.0283	−0.0109
	(0.062)	(0.067)	(0.068)	(0.068)	(0.096)
Election year × BSP MLA	0.3433**	0.3749**	0.3070**	0.1776*	0.1940
	(0.075)	(0.082)	(0.082)	(0.084)	(0.118)
Election year × INC MLA	−0.0500	−0.0555	−0.0846	−0.1126	−0.0534
	(0.108)	(0.118)	(0.120)	(0.117)	(0.179)
Election year × Other MLA	0.2341*	0.2574*	0.2273*	0.1758	0.1251
	(0.101)	(0.109)	(0.110)	(0.110)	(0.167)
Election year × SP MLA	0.0639	0.0703	0.0306	−0.0354	−0.0386
	(0.061)	(0.066)	(0.067)	(0.066)	(0.122)
BSP CM				−0.6456**	−0.5400**
				(0.055)	(0.085)
Pres Rule CM				−1.3188**	−1.4416**
				(0.118)	(0.153)
SP CM				−0.7566**	−0.8101**
				(0.066)	(0.110)

(continued)

TABLE 7.8. *(continued)*

Dependent Variable: Village Lit (Using Bilinear Interpolation)	(1)	(2)	(3)	(4)	(5)
BSP MLA × BSP CM					−0.3880**
					(0.133)
All other MLA × CM interactions					Yes
Win margin			0.0061	0.0055	0.0059
			(0.003)	(0.003)	(0.003)
Turnout			−0.0216**	−0.0013	−0.0001
			(0.005)	(0.006)	(0.006)
Electors			−0.0043*	0.0002	0.0007
			(0.002)	(0.002)	(0.002)
Incumbent wins			−0.1120*	−0.0842	−0.0813
			(0.053)	(0.052)	(0.051)
Income (district level)		−0.0781	−0.3490	1.3928	1.3714
		(0.644)	(0.743)	(1.000)	(0.994)
Total power supply in state	0.0136**	0.0149**	0.0070	0.0019	0.0035
	(0.005)	(0.005)	(0.006)	(0.007)	(0.007)
Constituency fixed effects	Yes	Yes	Yes	Yes	Yes
Village controls	No	Yes	Yes	Yes	Yes
Satellite sensor-age	Yes	Yes	Yes	Yes	Yes
Year trend	Yes	Yes	Yes	Yes	Yes
Constant	1.0136**	1.0877**	3.7977**	1.0029	0.7522
	(0.112)	(0.234)	(0.655)	(0.784)	(0.772)
Observations	1,863,330	1,850,486	1,846,877	1,846,877	1,846,877

Robust standard errors clustered on assembly constituency in parentheses. BSP, Bahujan Samaj Party; CM, chief minister; INC, Indian National Congress Party; MLA, member of the legislative assembly; SP, Samajwadi Party.
$^{**}p \le 0.01$; $^{*}p \le 0.05$.

TABLE 7.9. *Fractional logit regressions on proportion of villages lit in constituency, 1992–2010*

Dependent Variable: Proportion Villages Lit	(1)	(2)	(3)	(4)	(5)
Election year	0.2048**	0.2029**	0.2574**	0.4676**	0.5221**
	(0.051)	(0.051)	(0.059)	(0.063)	(0.095)
BSP MLA	−0.0103	−0.0079	−0.0207	0.0559	0.1829*
	(0.066)	(0.067)	(0.068)	(0.068)	(0.093)
INC MLA	−0.0609	−0.0614	−0.0837	−0.0902	0.0734
	(0.087)	(0.087)	(0.089)	(0.087)	(0.109)
Other MLA	−0.0860	−0.0895	−0.1228	−0.0967	−0.1776
	(0.090)	(0.090)	(0.093)	(0.093)	(0.111)
SP MLA	−0.0225	−0.0227	−0.0251	0.0380	−0.0214
	(0.056)	(0.056)	(0.058)	(0.059)	(0.080)
Election year × BSP MLA	0.2998**	0.2971**	0.2410**	0.1164	0.0519
	(0.068)	(0.069)	(0.069)	(0.069)	(0.105)
Election year × INC MLA	−0.0645	−0.0659	−0.0884	−0.1202	−0.1895
	(0.108)	(0.108)	(0.109)	(0.109)	(0.145)
Election year × Other MLA	0.2318*	0.2305*	0.2080*	0.1520	0.0921
	(0.091)	(0.091)	(0.092)	(0.092)	(0.137)
Election year × SP MLA	0.0100	0.0095	−0.0193	−0.0826	−0.1326
	(0.058)	(0.058)	(0.058)	(0.058)	(0.106)
BSP CM				−0.5734**	−0.5191**
				(0.046)	(0.075)
Pres Rule CM				−1.1983**	−1.3472**
				(0.097)	(0.134)
SP CM				−0.6695**	−0.6937**
				(0.054)	(0.090)

(continued)

TABLE 7.9. *(continued)*

Dependent Variable: Proportion Villages Lit	(1)	(2)	(3)	(4)	(5)
BSP MLA × BSP CM					−0.2461*
					(0.119)
All other MLA × CM interactions					Yes
Win margin			0.0066*	0.0060*	0.0064*
			(0.003)	(0.003)	(0.003)
Turnout			−0.0173**	−0.0006	0.0006
			(0.004)	(0.005)	(0.005)
Electors			−0.0026	0.0011	0.0016
			(0.002)	(0.002)	(0.002)
Incumbent wins			−0.0461	−0.0222	−0.0251
			(0.048)	(0.048)	(0.048)
Income (district level)		0.6039	0.4864	1.9563*	1.9645*
		(0.553)	(0.611)	(0.814)	(0.811)
Total power supply in state	0.0060	0.0060	−0.0012	−0.0063	−0.0059
	(0.004)	(0.004)	(0.005)	(0.006)	(0.006)
Constituency fixed effects	Yes	Yes	Yes	Yes	Yes
Village controls	No	Yes	Yes	Yes	Yes
Satellite sensor-age	Yes	Yes	Yes	Yes	Yes
Year trend	Yes	Yes	Yes	Yes	Yes
Constant	0.7924**	9.1591**	11.3101**	8.3195**	7.9917**
	(0.098)	(0.371)	(1.017)	(1.151)	(1.146)
Observations	7,657	7,657	7,634	7,634	7,634

Robust standard errors clustered on assembly constituency in parentheses. BSP, Bahujan Samaj Party; CM, chief minister; INC, Indian National Congress Party; MLA, member of the legislative assembly; SP, Samajwadi Party.
$^{**}p \le 0.01$, $^{*}p \le 0.05$.

TABLE 7.10. *BSP effects on unmatched sample*

	Outcome: Newly Lit in 2003	
	(1)	(2)
Bahujan Samaj Party (BSP) treatment	1.0236	0.9037
	(0.6084)	(0.6305)
Scheduled Caste (SC) population share		−0.4696
		(0.6558)
BSP treatment × SC population share		−0.0997
		(0.7565)
Village-level controls		
Village population (thousands)		2.5873**
		(0.5593)
Literacy rate in village		0.0705
		(0.1628)
School in village		−0.2326
		(0.1460)
Medical facility in village		0.2097
		(0.1306)
Paved approach road to village		−0.0287**
		(0.0091)
Distance to nearest town (km)		12.8120*
		(5.4762)
Constituency-level controls		
Income index	16.6825**	0.0140
	(5.2632)	(0.5251)
Nighttime light output, 2001 (log)		0.7046
		(0.4454)
Reserved constituency		0.0527
		(0.0477)
SC population share		−2.5379
		(5.4108)
Constant	−10.7466	−14.5531**
	(2.2399)	(3.3334)
Observations	5902	5902
Assembly constituencies in sample	58	58

Standard errors in parentheses. $^{**}p$-value ≤ 0.01; $^{*}p$-value ≤ 0.05.