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Theft and Loss of Electricity in an Indian State

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Abstract

Utilizing data from the power corporation of Uttar Pradesh, India's most populous state, we study the politics of electricity theft over a ten year period (2000–09). Our results show that electricity theft is substantial in magnitude. The extent of theft varies with the electoral cycle of the state. In years when elections to the State Assembly are held, electricity theft is significantly greater than in other years. Theft is increasing with the intensity of tubewells, suggesting that it is linked to unmetered electricity use by farmers. Incumbent legislative members of the state assembly are more likely to be reelected as power theft in their locality increases. Our interpretation of these various results is that power theft exhibits characteristics consistent with the political capture of public service delivery by local elites. Our results fail to substantiate that theft is linked either to political criminality or is the product of weak institutions.

1 Introduction

In many poor countries economic growth is hampered by inadequate and irregular supplies of electricity. Indian firms ranked electricity problems as the number one issue facing their businesses in the 2006 World Bank Enterprise Survey. The scarcity and unpredictable supply of electricity are in part results of widespread theft, as well as lack of adequate generating capacity. Given its high value, the relative ease with which it is diverted, and the difficulty of identifying individual offenders, theft of electrical power is easily accomplished as well as useful to enterprises and individuals. As a result, it is widespread across much of the developing world. Power theft leads to lost government revenues, reducing the ability of the public sector to pay for the maintenance of existing facilities or to invest in new power generation; it places unexpected strains on already taxed and often inadequate infrastructure, increasing the risk and frequency of power shortages; and it reduces the availability of electricity to paying businesses and consumers. Where power is scarce, firms and agricultural enterprises may offer bribes to government officials to divert electricity illegally, or they may opt out of public sector energy delivery and install their own power generators. The former potentially establishes persistent collusive and illicit ties between businesses and government officials, whereas the latter reduces the stream of revenue to government. If it is extensive, collusion between government, industry and agriculture provides a political incentive to keep electricity supplies inadequate so that government officials may continue to collect bribes. Estimating the extent of electricity theft, the nature of any illicit ties between politicians, power sector bureaucrats, and users, and the political, sectoral and geographic characteristics of users involved in theft is thus one step towards identifying strategies that will ultimately reduce it to manageable levels.

We report results of an analysis of electricity theft in Uttar Pradesh (UP), India's most populous state. Using local data on power generation and payment receipts over a ten year period from the Uttar Pradesh Power Corporation Ltd. (UPPCL), the state's electricity provider, we analyze the politics of where and when power theft occurs, who is involved, and whether it appears linked to other criminal activities.

Our analysis is guided by considerations of political economy. We want to know whether power theft is affected by elections, political parties, and the criminal status of state legislators. The reasoning behind our analysis is that the political system controls the institutions that ultimately prevent (or permit) the occurrence of large-scale power theft. In some settings, institutions appear to be relatively effective in preventing such abuses. For instance, widespread power theft is neither a known and noticeable problem in North America or western Europe, nor in some developing countries. In these environments, power use is metered down to the individual household, it is difficult to tap into an electricity line illegally, and bills are regularly issued for power used. Moreover, bills that remain unpaid result in a suspension of service. For the interactions of the power corporation and consumers to be vastly different, as is the case in India, things must be different at multiple points in the process. We seek to identify the specific aspects of the system of energy transmission and bill collection that are vulnerable to malfeasance or leakage.

The most visible indication of energy theft occurs when users illegally tap into the public supply. Throughout the less developed world, users without access to electricity tap illegally into existing lines, as illustrated in the photograph displayed in Figure 1. Unsanctioned connections to the grid are probably the numerically most frequent way that electricity is stolen. These illegal connections are common and easily detached when monitors or bill collectors arrive, although in some cases they are allowed to remain for indefinite periods.

But although they are highly visible and very frequent, illegal hookups are unlikely to be the largest source of energy loss. This instead stems from the two other main ways that energy is sent out but not paid for: meter fraud and unmetered use. One way that

Figure 1: Illegally Tapping into the Power Line

Source: <http://news.bbc.co.uk/2/hi/business/4802248.stm>.
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meter fraud occurs is when the public utility meter reader is bribed to report an inaccurate number, thereby effectively providing unpaid power to a consumer. This type of fraud is apparently common in settings generally characterized by high levels of bureaucratic corruption, although as far as we are aware, there are no accurate estimates of its frequency. Meter tampering is a second type of meter fraud that allows users more power than is paid for. Standard electro-mechanical meters use a slowly spinning disk to record the amount of power that is being drawn. The rotation of the disks can be slowed using magnets or by impeding the disk mechanism with foreign objects — depositing spiders and spider eggs to encourage web buildup is one known technique. Disk rotation can be stopped completely by inserting small rocks, gum, or other obstructions. However, complete obstruction of a meter is more likely to attract attention.

The third way that energy is lost is through excess unmetered use of electricity. Power is unmetered in various settings. In urban areas, individual apartments may be unmetered, with only a single meter serving a multifamily dwelling. Unmetered use is even more common in rural settings, where it may be difficult and expensive to install individual meters and even more problematic to ensure that they are regularly and accurately read. As a result, as Varshney (1998, p. 171) contends, ”agricultural consumers ... account for approximately 25 percent of total electricity consumption ... and are responsible for the bulk of the power sector’s financial losses.” More recently, others have deepened the criticism, arguing that “thanks to perverse subsidies under its flat system of electricity pricing, India’s booming groundwater irrigation economy has wrecked its energy economy” (Shah, Giordano & Wang 2004, p. 3452).

India deliberately abandoned metering the power supply for agricultural irrigation in the 1970s, as part of the Green Revolution strategy of switching to new high-yield crops, which required regular water supplies. The provision of subsidized power to farmers was considered a critical investment for improving the productivity of the agricultural sector.

Since the 1970s, Indian agricultural irrigation has involved flat rate connections with tariffs set at the state level depending on the type of energy-utilizing equipment in place. In the absence of technical enforcement mechanisms, the temptation to overdraw electrical power beyond the contracted flat rate level can be high.

In the agricultural sector, electricity is used to power irrigation pumpsets or tubewells to extract groundwater for crop watering. In many parts of the country that cannot rely on rainfed crops, including Uttar Pradesh, low cost power represents one of the most significant — and expensive — subsidies to the farming sector. Part of the subsidy is effected through the pricing schemes adopted by government, but another part occurs when electricity is sent out to irrigation equipment that encourages farmers to use more than the maximum amounts they are allocated. In South Asia, some 14 million electric tubewells pump water mainly for irrigation purposes without being metered (Shah, Scott, Kishore & Sharma 2004, p. vi). Hence, the basic features of the environment that we study in UP are exceedingly common to the region.

The main results of our analysis are as follows. First, we corroborate the common perception that power theft in India in large in magnitude (Transparency International India 2005). We document that in UP, theft is greatest in periods immediately prior to state elections. Extending this line of argument, we document that incumbent members of the state assembly are more likely to be reelected in areas where power theft is more extensive. Power theft, we show, is most intense in the state's most agricultural localities, suggesting that theft is largely due to unmetered agricultural use. The natural interpretation is that farmers simply exceed their allotted maximums when more energy is supplied. Perhaps as a result, power theft is not related to specific markers of political criminality. We find little in our data suggestive of persistent collusive illegal networks linking politicians and users. While we know that individual meter readers accept bribes to underreport the amount of electricity used, the aggregate effects of this appear relatively small. Instead, our findings are consistent with the view that relatively well-off farmers — those who own electric tubewells — comprise a powerful interest group to whose interests democratically elected state legislators are particularly sensitive. As those farmers with the wealth to own tubewells comprise a rural elite, our results are consistent with a literature that argues that public service provision is liable to political capture by local elites (Bardhan & Mookherjee 2000).

Our paper proceeds in seven parts. First, we briefly review related literature. Second, we present four sets of hypotheses that we study. Third, we describe some basic characteristics of electricity use in Uttar Pradesh and, fourth, we describe our dataset. A fifth section provides descriptive statistics and a sixth, the results of statistical estimations of our four sets of hypotheses. A final section offers concluding thoughts.

2 Related Literature

Our paper is related to studies of the political business cycle in subnational units (examples include Baleiras & Costa (2004), Drazen & Eslava (2005), Mouriuen (2007)), which grew out of studies of the political business cycle at the national level (Nordhaus 1975, Tufte 1980). Various papers show that municipal level elected officials manipulate aspects of the local political economy prior to elections in order to improve their chances of reelection. Of particular relevance is Khemani (2004), which documents state-level electorally sensitive targeting of advantage to special interests in India. Also important for our purposes is Shi & Svensson (2006), which finds that the political business cycle is larger in less developed than in developed countries, suggesting that elected officials are under greater pressure to manipulate the economy prior to elections in poorer countries. This may take forms that would not be encountered in developed economies. Burgess, Hansen, Olken, Potapov & Sieber (2011) identity “political logging cycles“ in Indonesia, where illegal logging increases substantially in the years prior to local elections.

A large related literature on political corruption is also relevant (Rose-Ackerman 1999, Johnston 2006, Treisman 2007), especially studies that document that corruption rises or declines according to the reelection incentives of local politicians (Ferraz 2006). The only study of which we are aware that specifically studies energy theft as a problem of corruption is Smith (2004). This cross-national study of transmission and distribution (T&D) losses in energy transmission finds that the extent of such losses is highly correlated with corruption in general, as well as weaknesses in accountability and institutional performance.

Our study draws on a large literature on the politics of public goods provision, as well as a small literature that studies the political economy of electricity provision in particular. The former is exceedingly vast; for a relevant review, see Golden & Min (Forthcoming 2012). The main result of the distributive politics literature is to underscore that public officials use electoral criteria in the allocation of public and government goods and services rather than utilizing strictly welfare maximizing criteria. There is considerable national and local variation in how this occurs, however, in part because features of electoral competition differ. As regards electricity provision, Brown & Mobarak (2009) show that in poorer countries, democratic political institutions shift electricity provision from the industrial sector to households, whereas authoritarian institutions favor industry. Min (2010) documents partisan effects in electricity provision in Uttar Pradesh. Other studies, including Bernard, Gordon & Tremblay (1997), show that electricity prices may be politically manipulated for electoral ends, in line with the general distributive politics theme. In a paper especially related to this one, Badiani & Jessoe (2011) show that the well-known price subsidies to Indian agriculture for electricity are partially due to political capture; subsidies increase significantly in the year prior to an election.

Finally, our study is informed by a theoretical literature on policy distortions due to capture by special interests (Grossman & Helpman 2002, Bardhan & Mookherjee 2000).

3 Hypotheses Explored in the Study

We seek to understand variations in line loss across sectors, geographic units, and years in Uttar Pradesh. Drawing on existing literature for our hypotheses, we use a variety of statistical techniques to study the following four questions:

1. Does line loss increase in electoral periods?
2. Is line loss greater for important socio-economic interests, especially agriculture?
3. Is line loss electorally beneficial to state assembly members?
4. Is line loss greater in geographic areas whose elected representatives are under self-reported criminal indictment?

We provide details about the specific estimation techniques used for each of these later in the paper.

4 Electricity in Uttar Pradesh

Uttar Pradesh is India's largest state, with a population of 190 million people in an area about half the size of California. If it were a country, it would have the fifth largest population in the world. According to World Bank estimates, it is home to 8 percent of the world's poor. As the map presented in Figure 2 shows, UP sits in the center of northern India.

All electricity transmissions and distribution in the state is controlled by the Uttar Pradesh Power Corporation (UPPCL). The UPPCL was formed in 2000 as a result of power

Figure 2: The State of Uttar Pradesh in India

sector reforms and the unbundling of the state electricity boards across India. However, UPPCL remains a state-owned entity. Its workers are state employees and its key leadership positions are filled by political appointees. The managing director of UPPCL is drawn from the Indian Administrative Service.

Compared to a baseline estimated demand of between 7.5 and 9 gigawatts (GW), UPPCL is capable of providing up to about 6 GW of power at any point in time. For comparison, this is roughly the level of electricity consumption of the state of Connecticut, whose population is about 2 percent that of the population of Uttar Pradesh. Electrical power is distributed through an intricate network of generating plants, substations, transformers, and thousands of miles of power lines. To manage the surplus demand and protect the fragile power grid, electrical power has to be rationed and massive blackouts sweep across the state every day of the year. At any given time, one-fifth of users are typically without power. Standard guidelines exist for the scheduling of blackouts. For instance, urban areas are supposed to get 20 hours of power a day and villages, 12. However, these guidelines are not always met, especially during seasons of high demand. The UPPCL in fact exercises considerable discretion in the transmission of electricity to localities, and is under constant pressure from consumers (and elected officials) to provide power when supply is inevitably inadequate.

For the UPPCL, consumers are distinguished by sector. In 2008, there were 10 million consumers registered with the UPPCL. Of these, 81 percent were domestic, 10 percent commercial, 1.5 percent industrial, and 8 percent agricultural. However consumers vary greatly in their intensity of use. In terms of connected load going to each sector, 55 percent went to domestic users, 9 percent to commercial users, 16 percent to industry, and 17 percent to agriculture. Thus, the average agricultural connection was connected to three times the load of a typical domestic consumer.

The composition of billing for electricity use varies yet again because of differences in tariffs across sectors. In the same year, domestic users accounted for 29 percent of the total amount billed, 12 percent went to commercial customers, 45 percent of bills went to industry, and a mere 5 percent of billing went to agricultural users. As these figures show, agricultural users enjoy a subsidy, paying for 5 percent of total electricity while accounting for 17 percent of the total electrical load. Industrial users, while connected to a similar share of total load as agriculture, pay 45 percent of the total amount of electricity billed.

At least in part, tariff regimes are subject to political manipulation and can be targeted in order to secure the electoral support of different constituencies. In mid-2006, the ruling Samajwadi Party (SP) government announced a lower flat rage tariff structure for power looms by weavers in the state. The new rates were 65 Rupees ($1.44) per horsepower in urban areas and 37.5 Rupees ($0.83) per horsepower in rural areas, providing weavers access to power at the same low tariffs as the powerful farming sector.[1] The decision was notable for how finely targeted the beneficiaries were: there are only about 300,000 power looms in the state, concentrated in the districts of Mau, Varanasi, Ambedkar Nagar, Meerut and Jhansi. The timing of the decision also appeared to be politically motivated, announced just months before the 2007 state elections. Finally, many weavers are of the Kori caste, among the Scheduled Castes who form a critical element in the core support base of the opposition BSP party. It would not be implausible to hypothesize that the SP's subsidy was an attempt to wrest from the BSP the electoral support of voters who owned power looms.

[1]"Power at flat rate to U.P. weavers," *The Hindu*, 21 June 2006. http://www.hindu.com/2006/06/21/stories/2006062107500400.htm

5 The Data

We collected administrative data on electricity use from the Uttar Pradesh Power Corporation Ltd. from 2000 to 2009.[2] The availability of data is the main reason that we selected UP for analysis, although its large size makes it a prominent and important case. Moreover, it is worth noting that, according to Transparency International India's ranking of corruption across 20 major Indian states, UP falls right in the middle (Transparency International India 2005, table 1.5, p. 10), making it broadly representative of the country as a whole. In India, public electricity providers, which are state-specific, are widely viewed by the public as corrupt (Transparency International India 2005, p. 49).

Our primary outcome variable is line losses, measured as the share of electrical power that is distributed from the power station but not billed for. In many contexts, line loss is known as transmission and distribution (T&D) losses. Some line losses unavoidably result from technical factors. Over long distances, power inevitably degrades due to physical factors inherent to the transmission process. Such technical losses range from 1–2 percent in efficient systems to as high as 9–12 percent of total power output in less efficient systems (according to Smith (2004, p. 2070)). Line losses in India are much larger than this, on the order of 30 percent. As we noted above, the larger share results from meter tampering, bypassing of meters via illegal connections, and unauthorized excess usage by flat rate customers. We call the share of power that is used but unpaid for, "theft," although part of this comprises genuine T&D losses. But even if we allow that as much as 12 percent of line loss may stem from technical features of India's inefficient power system, theft itself comprises a total amount that is fifty percent greater than this.

Line losses are not the only losses experienced by the UPPCL. Even when bills are sent to customers, many go unpaid, aggravating the power company's revenue shortfalls. Bills

[2] The data are recorded monthly, though we focus on annual fiscal year totals in this paper.

go unpaid for numerous reasons, only some of which might be related to corruption by corporation officials or to deliberate consumer malfeasance. Bureaucratic inefficiencies might prevent the collection of bills. Even for those willing to pay, making payments in India can be difficult. Because it has not been possible until extremely recently to pay electricity bills electronically, consumers must pay in person at a UPPCL office. In remote rural areas, customers must often travel long distances to pay their bills. Because we believe that much of the non-payment of bills is due to factors such as these (but we have no way to estimate the proportion), we do not use non-payment as a proxy for electricity theft, even though the result of non-payment is effectively such.

The power company collects and reports data at the level of the geographic service division, which are units specific to the UPPCL. The state of Uttar Pradesh was divided into 179 divisions at the end of 2009. When the number of customers within a division gets too large, the division is split. As a result, the number of divisions at the beginning of our time frame is smaller than in 2009. In our analysis, we aggregate divisions that were split back to their 2000 boundaries in order to create a uniform series.

Additional administrative data records the number of consumers, the total connected load, and total billing, broken down by sector (residential, commercial, industrial, and agricultural, among others) and by division. Note that the true usage by different consumers is not known, only the total supply delivered from each power substation and the total amount that is billed for. The gap between power that is delivered and power that is billed for represents line losses.

This data enables us to describe the composition of consumers within each division, thus identifying areas whose intensity of energy use is more agricultural or more industrial, for example. However, line losses can only be estimated at the division level and cannot be further disaggregated by sector; that is, we do not have the information to report the precise proportion of line loss due to agriculture, industry, households, or commerce.

Because we are interested in the possible political correlates of power theft, we collect data on a number of potentially relevant political factors. The first are state assembly elections. Electricity provision is a state-level responsibility in India's federal structure, power company officials are state employees, and key appointments to the power company leadership are made by elected state leaders. Village leaders have limited ability to influence the provision of electricity to their localities. Thus state assembly elections are the most salient level for political analysis, more than federal parliamentary elections or local village council elections. Uttar Pradesh has 403 single-member state assembly constituencies and elections to the Vidhan Sabha, its lower house, were held in 2002 and 2007.

The 1990s was a period of intense electoral competition and fragile coalition governments formed between new parties that had helped crack and supplant the Congress Party from its decades-long grip on power in both the national capital and UP's state capital, Lucknow. Prior to the 2002 election, the Chief Minister's office (equivalent to a state governor in the United States) was held by the Bharatiya Janata Party (BJP), a conservative Hindu nationalist party with strong support from upper caste and middle-class urban voters. The BJP was in the process of strengthening its claim as the most powerful party in post-Congress India. However, the 2002 UP state elections dealt a severe blow to the BJP's upward trajectory, as it won fewer seats than both the Bahujan Samaj Party (BSP) and the Samajwadi Party. The BSP's core support came from Scheduled Castes — comprised of groups who historically occupied the very lowest rungs of India's social hierarchy — while the SP enjoyed the support of many Other Backward Class (OBC) and Muslim voters.

In the 2007 elections, the BSP won an outright majority of seats in the state house, the first time in two decades that coalition rule was not required. The success of a party that championed the interests of UP's poorest and most marginalized citizens was both a stunning and unexpected achievement. Our data track this period of deep political and social transformation in Uttar Pradesh.

A second political factor that we incorporate into our work is the self-reported criminal status of candidates to the UP State Assembly in 2007. In 2003, the Indian courts issued a ruling requiring that all federal and state level legislative candidates provide sworn affidavits in which they reported, among other things, whether they were currently under criminal indictment or had been convicted of criminal malfeasance. The timing of the court ruling is such that this information is unavailable for candidates to the 2002 State Assembly. However, the information is available for the 2007 elections. We utilize it for the 403 assembly constituencies, which saw just over 6,000 candidates run, or an average of 15 per constituency. Of these, approximately 11 percent of candidates were either convicted criminals or had criminal charges pending against them. However, of the 403 legislators elected in 2007, fully 25 percent were either under criminal indictment when elected or had previously been convicted of criminal malfeasance. Although we do not have information on the nature of the charges, it is reasonable to investigate whether power theft is greater where legislators with criminal records or facing indictment hold the seat.

There is no way to directly map the 403 assembly constituencies to the 170 geographic service divisions, since boundaries of the UPPCL service divisions are not published. Each assembly constituency and UPPCL service division can, however, be precisely located within a single administrative district, which is a unit roughly comparable to a U.S. county. We can thus aggregate data from both other levels to the administrative district level, of which there are 70 in Uttar Pradesh. In addition, census data (from 2001) are available at the level of the administrative districts. We therefore are able to merge into our dataset a range of relevant control variables at the level of administrative districts.

Given the mismatch in the geographic levels between our power theft variables and our political variables, there is no single optimal way to merge the data together for analysis. One option is to aggregate all the data into larger units, computing averages and totals at the level of the 70 administrative districts. However, we lose a lot of information doing this.

We can also create a separate dataset at the assembly constituency level (but with imputed electricity data drawn from the district) and another at the UPPCL service division level (but with imputed electoral data from the district). These alternatives lead us to construct three datasets, one at the administrative district level ($n = 70$), a second at the UPPCL service division level ($n = 170$), and a third at the assembly constituency level ($n = 403$). We utilize each of these for different parts of the analysis.

The UPPCL division level dataset allows us to describe characteristics of power use and theft at the most detailed level, while estimating political effects from electoral constituency data aggregated to the larger district in which the division is located. We use this dataset to examine where power theft is greatest and the characteristics of politicians elected in the districts in which the division is located.

The assembly constituency level dataset is most appropriate for exploring determinants of election outcomes as well as the criminal status of assembly candidates. With these variables, we can examine whether politicians are more likely to win when their constituency is in a district with higher rates of power theft and whether tainted candidates appear more often in constituencies with more power theft.

Finally, we use the administrative district dataset, which contains the most aggregated data, to evaluate the robustness of our findings.

6 Descriptive Analysis

Nearly a third of all electrical power in Uttar Pradesh is unaccounted for. In other words, adding up all the meter readings from all consumers in the state only results in bills that amount to two-thirds of the power sent out by UP's power stations. The remaining power cannot be tracked and is assumed lost to ordinary T&D losses as well as to theft, meter tampering, and excess usage by flat rate customers. The proportion of power that is lost in UP is approximately the same as the national average (Narendranath, Shankari & Rajendra Reddy 2005, table 3, p. 5566).

6.1 Geographic Variations

There is wide variation in electrical line losses across Uttar Pradesh. In 2005, for example, a stunning 66 percent of all power in the Mainpuri district was not billed for. Meanwhile, in that same year, line losses were lowest (just under 13 percent) in the Sonbhadra district.[3] Line loss is, as we observe from the data depicted in the upper panel of Figure 3, greatest in the western part of the state and generally less farther east. This difference coincides with the differential distribution of tubewells in the state, whose irrigation coverage is 27 percent greater in western than in eastern UP (authors' calculations from 1998–99 figures reported in Pant (2004, p. 3464, Table 1)).

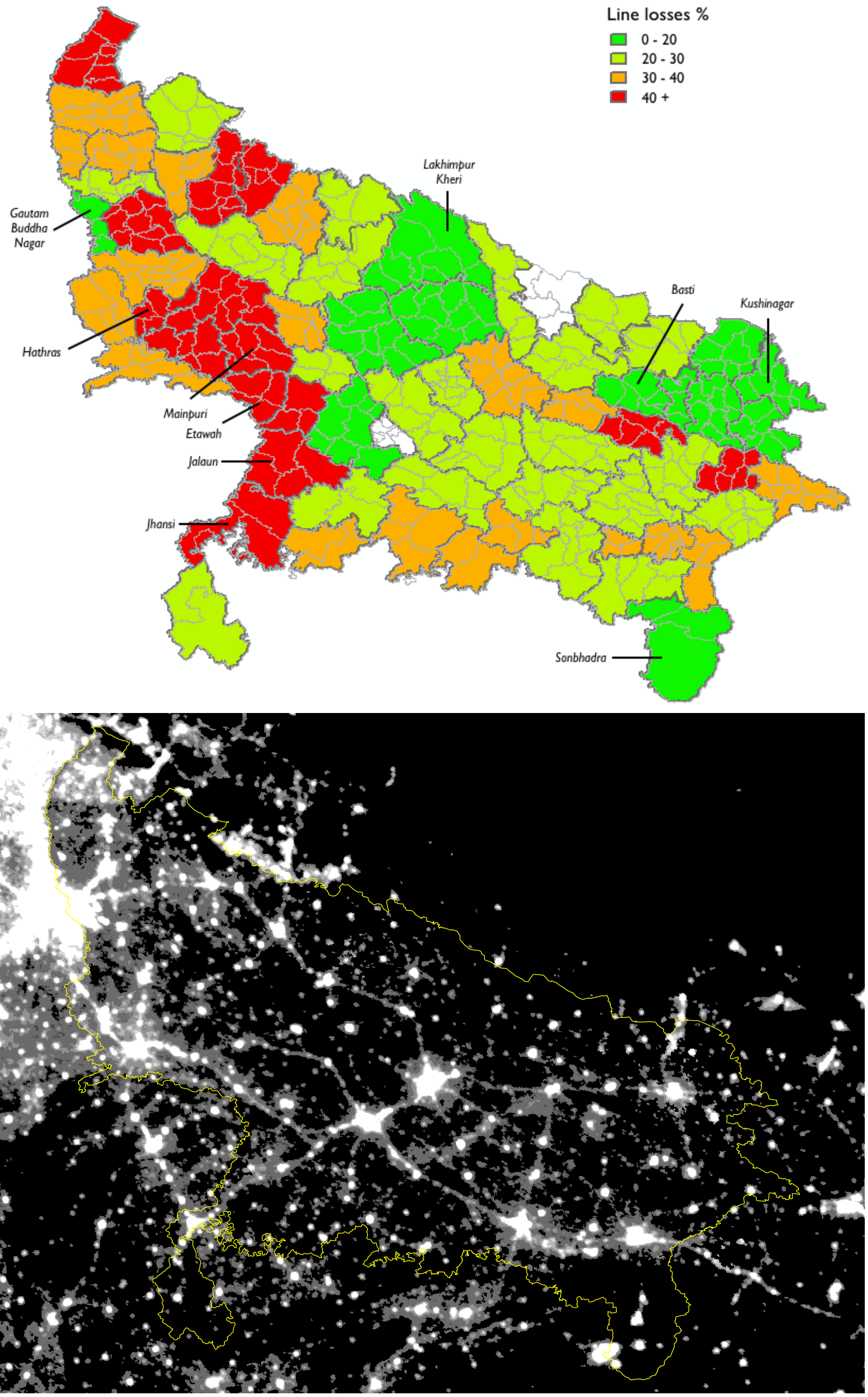
For comparison, the lower panel of the figure shows a satellite-based image of night-time light output, which depicts variations in the availability of power and intensity of use (Min 2010).[4] The image is a composite of all satellite imagery captured of Uttar Pradesh between 8:00PM and 9:30PM local time across the calendar year. Further processing excludes images shrouded by cloud cover and other digital noise. The composite image shows no obvious correlation between overall electricity use and the rate of line losses. This supports the view that most line loss is due to factors other than merely technical features of the transmission and distribution of electricity.

Table 1 lists the districts with the highest average line losses between 2000 and 2009. On average, half of all power supplied in the Hathras district (now known as Mahamaya Nagar) could not be accounted for, higher than any other district in the state. Among the other leading districts, Etawah is the home of Mulayam Singh Yadav, leader of the

[3] Sonbhadra is sparsely populated and home to several of India's largest coal-based thermal power plants.

[4] Analysis in Min (2010) shows that nighttime light output and electricity consumption at the district-level are very highly correlated in Uttar Pradesh.

Figure 3: Linelosses and Nighttime Lights Across Uttar Pradesh



Note: Line losses in districts in fiscal year 2005. Average evening hour nighttime light output from 2003. Sources: UP Power Corp, US Air Force Weather Agency, and NOAA-NGDC.

Table 1: Highest Line Losses by District, 2000–09 Average

District	Line losses (%)	Energy Supplied (MU)	Energy Billed (MU)
Hathras	49.9	472.5	192.7
Mainpuri	49.9	241.7	118.5
Jhansi	45.8	662.2	364.8
Jalaun	45.7	419.2	231.9
Etawah	45.4	321.8	173.5
Bulandshahr	43.8	933.0	526.5
Saharanpur	42.8	1233.9	709.4
Firozabad	42.5	675.5	395.7
Rampur	42.3	370.7	216.6
Moradabad	40.5	964.1	573.2

Table 2: Lowest Line Losses by District, 2000–09 Average

District	Line losses (%)	Energy Supplied (MU)	Energy Billed (MU)
Gautam Buddha Nagar	13.6	1370.0	1197.0
Sonbhadra	16.4	259.7	218.1
Lakhimpur Kheri	19.5	218.2	174.8
Basti	19.8	196.7	157.4
Kushinagar	20.0	142.2	113.1
Maharajganj	20.3	120.7	95.8
Deoria	20.7	211.2	166.5
Hardoi	21.9	252.4	195.6
Sitapur	22.6	211.8	163.2
Hamirpur	22.8	275.9	213.3

Samajwadi Party and Chief Minister of the state from 2003 to 2007. Mainpuri is home to his brother and a stronghold of the Singh Yadav family.

The districts with the lowest line losses on average during our study period are listed in Table 2. At the top of the list is Gautam Buddha Nagar, home to the bustling outsourcing hub of Noida, just east of New Delhi. The efficiency of collections in this district may reflect a greater willingness to bill commercial customers, including many foreign-owned entities.

Table 3: Average Line Loss by Year Across UPPCL Divisions, 2000–09

Fiscal year	Obs	Average %Lineloss	Std. Dev.	Min	Max
2000	154	37.02	12.42	3.97	65.32
2001	153	35.26	12.15	2.26	63.38
2002	146	36.85	9.98	13.33	62.51
2003	149	28.51	11.39	5.74	59.13
2004	158	35.33	11.67	14.70	69.00
2005	169	31.14	11.42	10.53	65.77
2006	170	31.25	10.56	9.60	64.08
2007	179	31.90	10.04	8.42	65.79
2008	190	29.89	9.46	8.19	63.72
2009	193	24.83	7.84	5.45	50.87

6.2 Variations in Line Loss Over Time

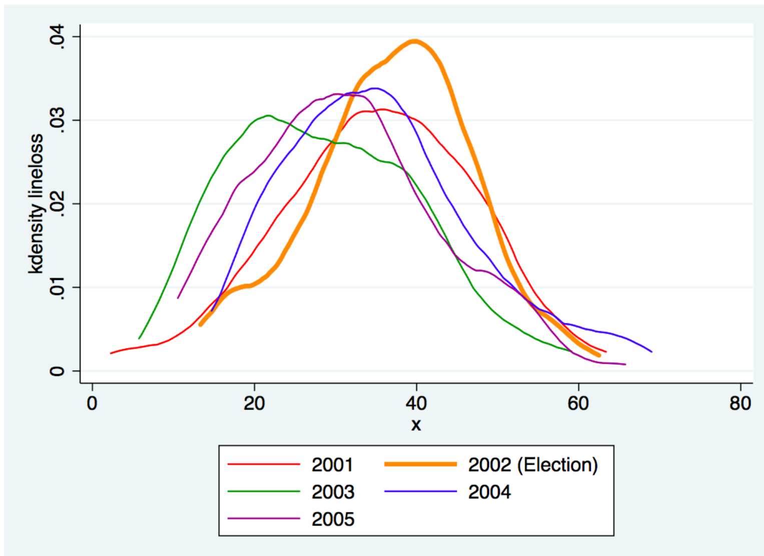
Line losses have been decreasing over time, as documented in Table 3. From a rate of 37 percent in 2000, total line losses has declined steadily to just under 25 percent in 2009. Two modest peaks in the downward trend occur in 2002 and 2007, which correspond to election years.[5]

The higher averages in election years seem to result from higher losses in UPPCL divisions all across the state and do not appear geographically concentrated. In Figure 4, we draw kernel density plots showing the distribution of line losses across all geographic observations in each year. The election year lines are shifted towards the right, indicating broad-based increases in losses.

7 Statistical Analyses

Thus far, we have identified two patterns in our data of potential theoretical importance. First, line losses are geographically concentrated in western UP, where more tubewells

[5]The UPPCL fiscal year runs from April to March. Elections were held in May 2002 and February 2007.



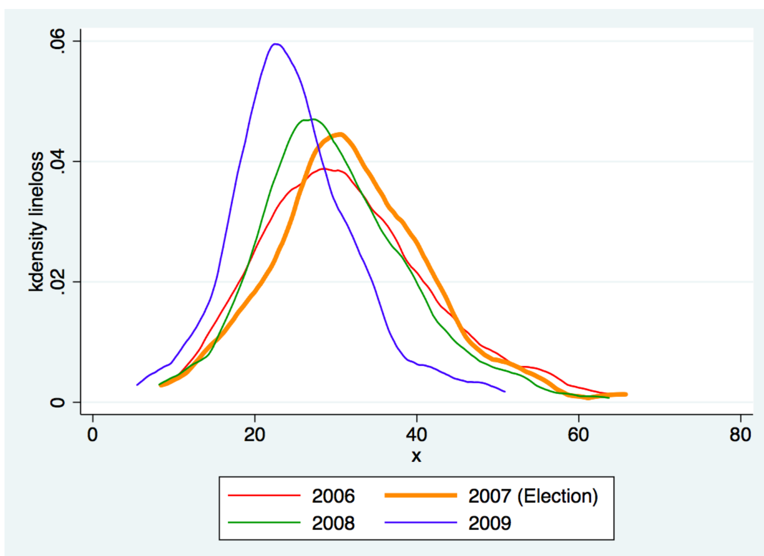


Figure 4: Kernel Density Plots of Linelosses by Year

drawing irrigation water are located. Second, although losses have fallen over the period examined, they appear greater in years of state elections than other years.

We now study these patterns using more systematic methods. As already indicated, we investigate four questions: (1) whether power theft is affected by the occurrence of an election to the State Assembly; that is, whether we observe a "political business cycle" to line loss; (2) whether theft occurs across all groups in society or whether some appear to engage in more power theft; (3) whether theft pays politically; that is, whether political incumbents benefit electorally from power theft; and (4) whether the geographic areas with more power theft exhibit other symptoms of political criminality.

7.1 Electoral Cycles

The annual data just reviewed suggests that electoral effects in line loss may be present. Confirming this, we find strong statistical effects for an electoral cycle in line losses. The t-test reported in Table 4 shows that line losses are nearly 3 percentage points higher in election years than other years and the difference is highly statistically significant.

Table 4: UP Line Losses in Election and Non-Election Years, 2000–09

	Division-Year Observations	Mean	Std. Dev.
Election Year	325	34.1	10.3
Non-Election Year	1,336	31.4	11.5
Difference		+2.7***	

$^{***}p \leq 0.001$

To investigate how robust these results are, we conduct regression analysis. As we document in the results reported in Table 5, the election year effect is slightly larger in fixed effects regressions that study line loss with election years as regressors and that include indicator variables for each division to control for time-invariant division characteristics.

These results provide circumstantial evidence that the provision of electricity is subject to political manipulation. Moreover, constituents appear to benefit from reduced efforts by the state to monitor electricity use in periods prior to elections.

Table 5: Fixed Effects OLS: Testing for Electoral Cycles in UP Line Loss

Variable	Coefficient	(Std. Err.)
Election Year	2.847**	(0.391)
Division Fixed Effects	Yes	
Intercept	30.972**	(1.554)
N	1661	
R^2	0.675	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

7.2 Who Steals: Sectoral Analysis

The UPPCL geographic divisions vary in the share of power that goes to different sectors, including the domestic, industrial, commercial, and agricultural sectors. Given the relative economic and political importance of these varying constituencies, we examine how line losses varies with the sectoral mix of customers within each geographic zone. Our data permits us to describe whether line losses are higher in places with more domestic customers, more industry, or more agriculture. (Recall that the data do not permit us to identify sectoral line losses per se.) Since we are interested in whether politicians sanction energy theft for electoral gain, identifying who is allowed to steal is relevant.

Figure 5 plots line losses in 2007 compared to the proportion of energy load going to different sectors. Each point represents a geographic service division. The most notable pattern is that line losses are increasing in private tubewells, but flat or decreasing in the other three sectors that we depict (domestic users, industry, and commerce). This means that as the proportion of electricity to private tubewells increases, the proportion of energy lost out of the total sent rises. Hence, where agriculture is a more concentrated interest, there is more power loss. In addition to the fact that private tubewells are by and large used for agricultural irrigation, we note that they are markers of relatively wealthy agricultural interests, since only relatively well off farmers are able to afford the financial burden of installing and maintaining a tubewell.

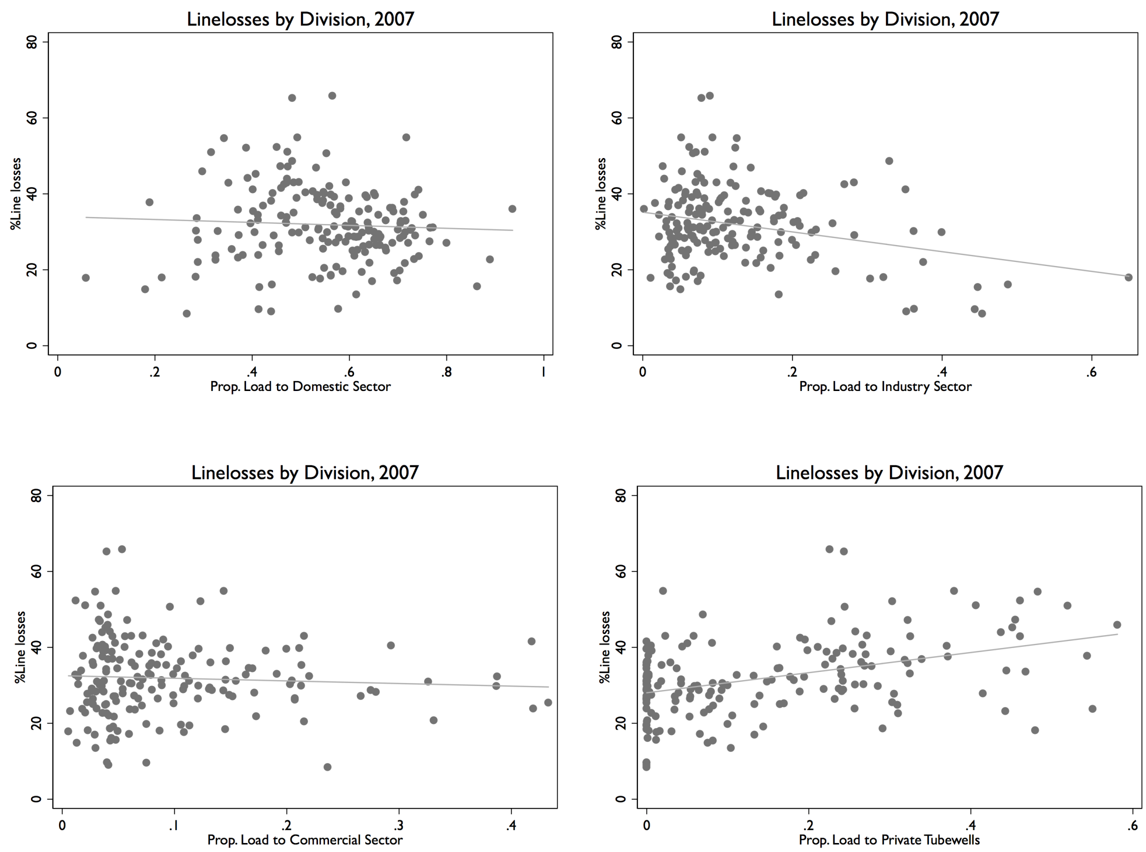


Figure 5: UP Line Losses by Sector

Why are line losses higher in more agricultural areas? Agriculture is the largest economic activity in Uttar Pradesh, accounting for nearly half of gross state product in 1991 and employing three-quarters of the labor force. Farmers are among the most important of electoral constituencies in the state. We interpret this result as indicating the tacit willingness of the state government to ignore electricity theft by relatively wealthy farmers, especially in election years.

We also compare the slopes of the best-fit line for private tubewells in 2007 with the year before and after; our results are presented in Figure 6. The slope is higher for the election year, which is again suggestive that political intervention to enable or disregard theft is occurring. (A similar analysis, not reported here, for 2002 found no election year effect, however.)

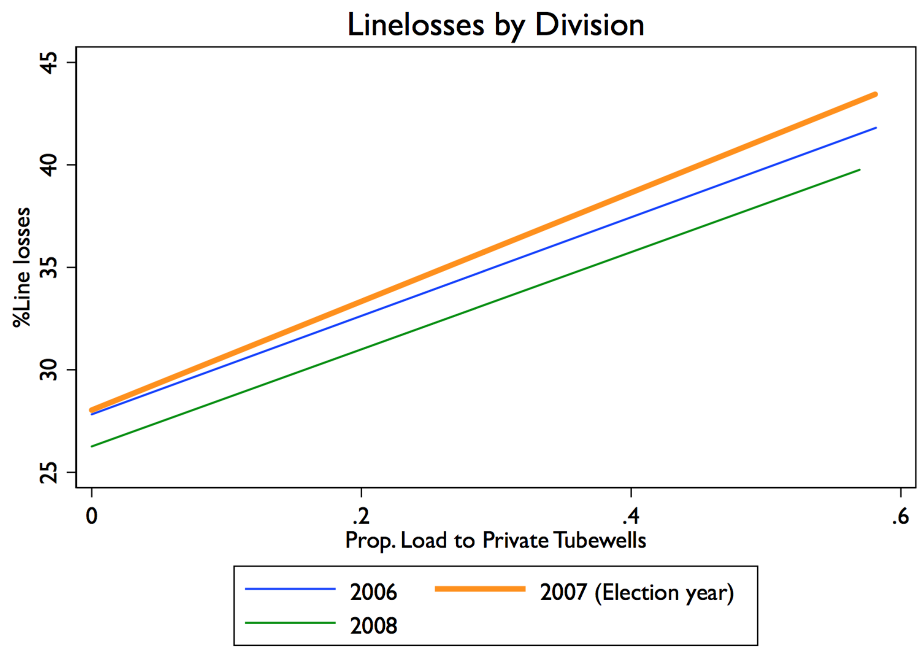


Figure 6: Linelosses in Agriculture, by Year

7.3 Incumbency Effects

A third pattern that is consistently strong in the data we analyze is the relationship between reelection and line losses. Previous research has documented a significant incumbency disadvantage for Indian state legislators (Uppal 2009). The February 2007 elections appear consistent with this expectation: across UP's 403 state assembly constituencies, only 146 of the winners were incumbents who had served in the same seat in the prior legislature.

Notably, the rate of line losses was for these incumbents was 33.0 percent compared to 30.8 percent for all other legislative constituencies. At first glance, it does appear that incumbents may benefit electorally from higher line losses within their constituencies.

We explore whether this difference in line losses could help explain variations in re-election rates. Since incumbency re-election is a function of several factors, we run a logistic regression on whether an incumbent was re-elected in the February 2007 elections. The main theoretically relevant independent variable is the measure of line loss in the assembly constituency in fiscal year 2007 (April 2006 – March 2007), most months of which occurred prior to the election. We also include as control variables whether the constituency seat is reserved for a member of a Scheduled Caste, three measures of economic welfare from the UP Human Development Index (average income, education, and health), the size of the electorate, the turnout rate, and controls for which party controlled the seat in the prior period.

In the logistic regression results reported in Table 6, The results document a positive effect and marginally significant effect of line loss on the probability of being reelected.[6] One possible interpretation of our results is that when incumbent MLA's allow high rates of power theft, they are more likely to be rewarded by voters and be reelected.

7.4 Criminal Environments

With a quarter of the members of the UP state assembly reporting that they are either under criminal indictment or have previously been convinced on criminal charges, there is evidence of criminal intrusion into state politics. In this section, we study whether line losses are significantly greater in assembly constituencies with candidates or elected representatives who report criminal records compared with constituencies with no candidates or no representative reporting criminal malfeasance.

[6] Again, we observe no similar electoral effect in 2002.

Table 6: Logit Regression Predicting Incumbency Reelection
February 2007 UP State Assembly Elections

Variable	Coefficient	(Std. Err.)
Line losses, FY 2007	0.028†	(0.016)
Criminal charges	0.056	(0.286)
Reserved SC seat	-0.137	(0.311)
HDI	6.138*	(2.933)
Number of voters	-6.446*	(3.176)
Voter turnout	-4.535*	(2.102)
Win margin, last election	8.172**	(1.839)
Seat previously held by SP	1.882**	(0.546)
Seat previously held by BSP	3.564**	(0.573)
Seat previously held by BJP	1.433*	(0.573)
Seat previously held by INC	1.180	(0.780)
Intercept	-3.713†	(2.175)
N	392	
Log-likelihood	-202.285	
$\chi^2_{(11)}$	104.011	

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%

All candidates in the 2007 election were required to file affidavits stating whether they faced any pending criminal charges. We analyzed data for 6,055 candidates across the state. Of these, 645, or nearly 11 percent of candidates reported criminal charges. Criminal candidates competed in 288 of the 403 constituencies, with a criminal candidate winning in 103 of these seats.

Overall, we find no confirmatory evidence that line losses differ substantially in areas with criminal candidates. Figure 7 compares criminality against line losses at the district level in 2007. The x-axis shows the proportion of candidates facing criminal charges in each district while the y-axis shows line losses in the district. No apparent relationship emerges between line losses and environments that attract criminal candidates.

We examine the relationship more closely with a regression that adds several district-level controls including level of development (HDI index), population, proportion SC, and

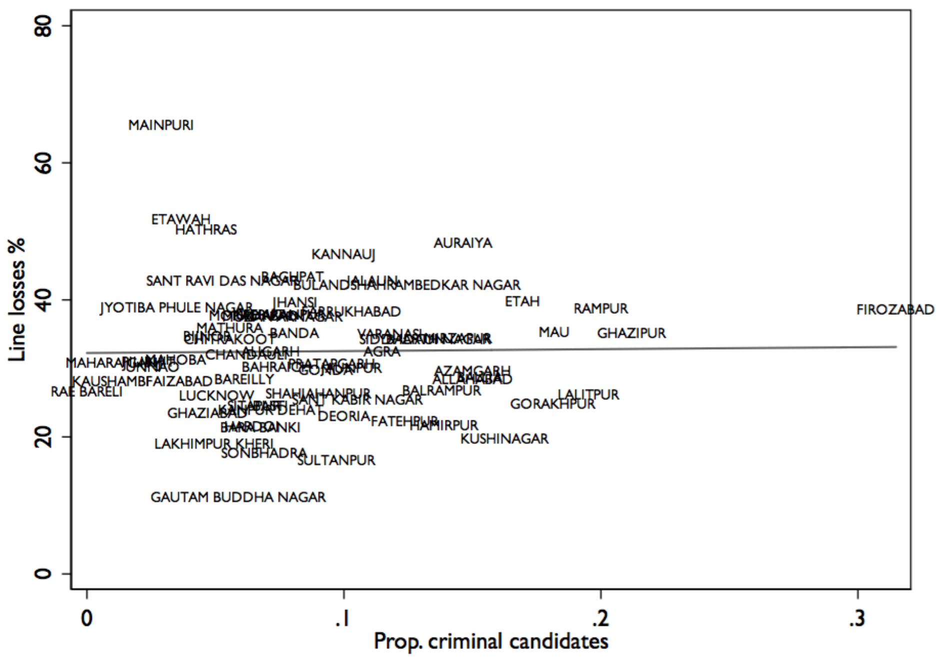


Figure 7: Linelosses and Criminality of State Assembly Candidates, Districts in 2007

proportion urban. The results, shown in Table 7, confirm the lack of a relationship between criminal candidates and line losses. By contrast, line losses are lower in district with larger populations, and more Scheduled Castes. The results are unchanged if we look only at the share of *winning* candidates that are criminals in each district (not reported). One interpretation of these results is that self-reported criminal politicians are not linked in systematic ways to line loss. If they were, we might suspect that they were accepting kickbacks from users in order to permit power theft. That instead they are not suggests instead that power theft, although of clear electoral benefit to incumbent MLA's, is not part of persistent illicit criminal networks linking elected politicians and users.

However, as displayed in Figure 8, realized revenue, which is a measure of bills collected relative to bills issued, are substantially higher in clean constituencies. This trend is confirmed in the multivariate regression reported in Table 8. The model predicts that a 10 percent increase in the share of criminal candidates is associated with a 5.4 percent

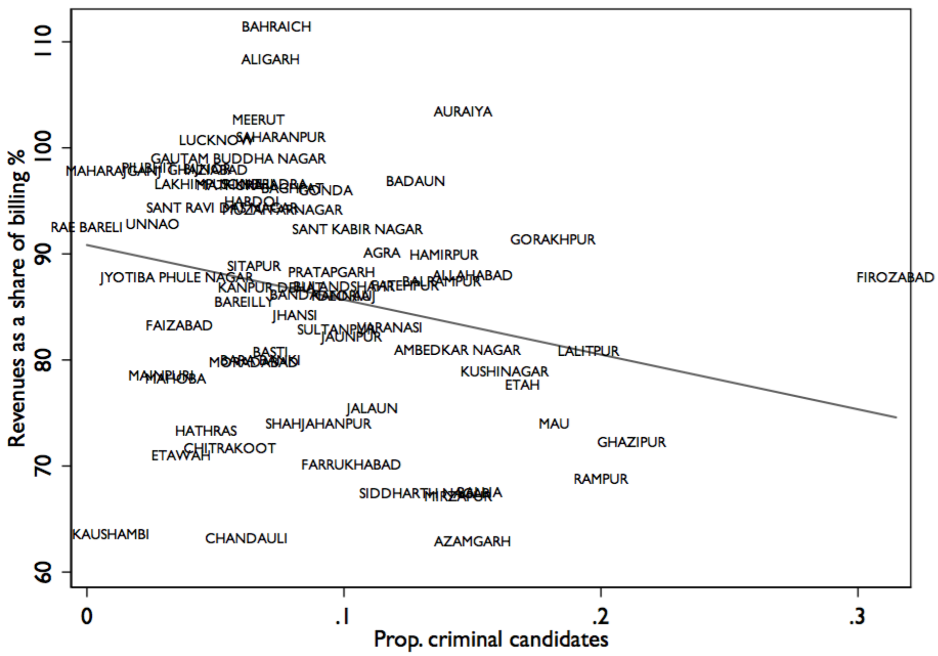


Figure 8: Realized Revenue and Criminality of State Assembly Candidates, Districts in 2007

Table 7: OLS Regression on District-level Line Losses, 2007

Variable	Coefficient	(Std. Err.)
Prop. Criminal Candidates	3.581	(19.408)
Level of Development (HDI)	45.681	(28.661)
Population	-2.618*	(1.239)
Prop. Scheduled Caste	-37.712†	(20.266)
Prop. Urban	-2.337	(12.517)
Intercept	21.356	(15.612)
N	68	
R^2	0.175	
$F_{(5,62)}$	2.634	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table 8: OLS Regression on District-level Realized Revenues, 2007

Variable	Coefficient	(Std. Err.)
Prop. Criminal Candidates	-54.014*	(23.870)
Level of Development (HDI)	-29.100	(35.250)
Population	1.334	(1.524)
Prop. Scheduled Caste	-13.114	(24.925)
Prop. Urban	31.478*	(15.394)
Intercept	101.151**	(19.201)
N	68	
R^2	0.189	
$F_{(5,62)}$	2.89	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

decrease in realized revenues. In other words, places where people do not pay their bills appear to attract state assembly candidates with criminal records. This result is not subject to unambiguous interpretation. It may indicate an environment of generally high criminality, or both high line loss and high rates of criminal candidates may instead reflect other phenomena, such as a tight connection between the ownership of private tubewells and social groups that are tolerant of criminal charges against their elected representatives.

8 Conclusions

Power theft is widespread in developing countries and important economically as well as politically. Using data from one very large Indian state, we provide evidence that power theft is politically correlated. It occurs more often around election time when well-off farmers are allowed to exceed their allotted usage for private tubewells, and this proves electorally advantageous to the incumbent member of the legislative assembly. But although power theft is linked to state assembly elections, both in the magnitude of theft that occurs in election years and in the electoral benefit it provides incumbent MLA's, power theft does not appear to represent a component of persistent criminal linkages between politicians and landowners.

Our results underscore that power theft has become bound up with the intense electoral competition that now occurs in Uttar Pradesh. It does not, by contrast, appear to be an outcome of poor governance as such, if by that we mean government institutions that lack the capacity to fulfill their mission. Our analysis documents that power theft is part of deliberate political strategy and not a by-product of weak institutions.

Many questions remain. Can we say how many incumbents were reelected in 2007 thanks to power theft? That is, can we estimate the overall political significance of the phenomenon? Second, how much energy are farmers using beyond their allotted maximum and can we calculate the aggregate economic effect of this additional energy use?

Reducing power theft to more moderate levels would require at least three policy changes. First, power company officials need to be sheltered from political influence so that incumbent legislators cannot pressure them in election years to supply more power to particular categories of users than allocated or than is equitable. Second, the state government needs to adopt a policy of metering agricultural energy use so that owners of private tubewells pay for the electricity they use. Third, the latter should occur in the context of a general policy study of the overall costs and benefits of the current electricity pricing scheme, which subsidizes agricultural users.

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