Electoral Cycles in Electricity Losses in India

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Abstract

A third of electricity in India is lost each year, where losses refer to power that is supplied but not billed. Utilizing data from the power corporation of Uttar Pradesh, India's most populous state, we study the politics of electricity losses. Examining annual data over four decades, we document that statewide electricity losses tend to increase in periods immediately prior to state assembly elections. Drawing upon more fine-grained and disaggregated data since 2000, we observe higher line losses leading up to the 2002 and 2007 elections, and show that the incumbent party was more likely to retain the assembly seat as line losses in the locality increased. We interpret these results as corroboration that political parties deliberately permit users to access unbilled electricity in a context of chronically inadequate supply. Political factors appear to affect line losses in ways that technical and economic factors alone cannot explain.

Keywords: Power theft, Line losses, Politics

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1. Introduction

In many developing countries, electricity theft and line losses are a costly burden on the power sector (Depuru et al., 2011). Transmission and distribution (T&D) losses are estimated to cost India's economy 1.5% of GDP each year, aggravating chronic power shortages and straining the precarious finances of its public electricity providers (Bhatia and Gulati, 2004). In India's largest state, Uttar Pradesh, 29% of all power sent out from 1970 to 2010 was never billed for, presumably lost to theft, billing irregularities, and technical losses. This cumulative loss amounts to some 300 million megawatt-hours (MWh), enough to power all of Italy or South Africa for a year. Moreover, rates of line loss in Uttar Pradesh are higher today than they were in the 1970s despite numerous policy interventions, regulatory reforms, and increased efforts to prosecute power theft.

We examine data from Uttar Pradesh to demonstrate that variations in electricity losses are related to the timing of statewide elections. The focus of our study is on line losses — electricity that is supplied but for which bills are not issued. Some of these losses are technical in nature, including resistive losses from high voltage transmission, and variations in the quality of electrical infrastructure.[1] The remaining (majority) line losses are widely assumed to reflect inefficiencies in billing, meter tampering, illegal connections, and unauthorized excess use by flat rate consumers. Yet such explanations do not fully explain why rates of line loss vary over time within the same geographic

[1]Such technical losses range from 1–2 percent in efficient systems to as high as 9–12 percent 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.

unit. We present evidence that the cyclicality of losses are consistent with patterns of political manipulation of the power sector associated with election periods. Given the scarcity of electrical power, its value to consumers, and the central role of politicians and public officials in its provision, electricity is a potentially valuable weapon in electoral competition.

We report on statewide trends from 1970 to 2010 and examine more highly disaggregated data on electrical power distribution, billing, and line losses from 2000 to 2009. The main results of our analysis are as follows. First, the data show that power theft and line losses in Uttar Pradesh are large in magnitude. Second, line losses are substantially higher in periods immediately prior to state elections. Third, we extend this line of argument and document that the incumbent political party is more likely to retain the assembly seat where power theft is more extensive. We interpret these results as corroboration of the theory that electricity is used for political gain. Our results suggest that a part of line losses can be explained by political motivations rather than only by technical and economic factors.

Our paper is related to studies of the political business cycle in subnational units (examples include Baleiras and Costa (2004), Drazen and 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 re-election. Of particular relevance is Khemani (2004), which documents state-level electorally sensitive targeting of advantage to special interests in India. In a paper especially related to this one, Badiani and Jessoe (2011) show

that the price subsidies for electricity that go to Indian agriculture increase significantly in the year prior to an election.

A large literature on political corruption is also relevant (Rose-Ackerman, 1999; Johnston, 2006; Treisman, 2007), particularly those showing that corruption rates are correlated with the reelection incentives of politicians (Ferraz, 2006). The only studies of which we are aware that study energy theft as a problem of corruption are Smith (2004) and Joseph (2010). The first is a cross-national study of T&D losses in electricity transmission linking it to corruption as well as weaknesses in accountability and institutional performance. The second reports that T&D losses across Indian states are associated with decisions by firms to establish their own power-generating capacity, exiting the state provider.[2]

2. 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. According to World Bank estimates, it is home to 8 percent of the world's poor. Electricity transmis-

[2]Our study also draws on a large literature on the politics of public goods provision and a small literature on the political economy of electricity provision. The former is exceedingly vast; for a relevant review, see Golden and Min (Forthcoming 2013). The main result of the distributive politics literature is to underscore that public officials use electoral criteria in the allocation of 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 and 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 et al. (1997), show that electricity prices may be politically manipulated for electoral ends, in line with the general distributive politics theme.

sion and distribution in the state is controlled by the Uttar Pradesh Power Corporation Ltd (UPPCL), formed in 2000 as a result of power sector reforms and the unbundling of India's state electricity boards. Electricity provision is a state-level responsibility in India's federal structure and the UPPCL is a state-owned entity. Its workers are state employees and its key leadership positions are filled by appointment by the state government. Politically, Uttar Pradesh has 403 single-member state assembly constituencies and elections are held approximately every five years.

We report trends in statewide losses from 1970 to 2010 and then focus our analysis on finer geographically disaggregated data from 2000 to 2009. Our primary outcome variable is line losses, measured as the share of electrical power that is distributed from the power substation busbar but not billed for. The power company reports connected load and billing data at the level of the geographic service division, which are units specific to the UPPCL. The state of Uttar Pradesh was divided into 193 divisions at the end of 2009. When the number of customers within a division gets sufficiently large, the division is split. As a result, the number of divisions at the beginning of our time frame is smaller than in 2009.

To investigate the political correlates of power theft, we merged data on state assembly elections with UPPCL data on electricity transmission and billing. However, there is no way to directly map the 403 assembly constituencies to UPPCL's 190+ geographic service divisions, since information on service division boundaries is not publicly available. Each assembly constituency and UPPCL service division can, however, be precisely located within a single administrative district, 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.

Given the mismatch in the geographic levels between our power loss 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 UPPCL service zone) and another at the UPPCL service division level (but with imputed electoral data from the assembly constituency). These alternative scenarios lead us to construct three datasets, one at the administrative district level ($n = 70$), a second at the UPPCL service division level ($nupto193$), and a third at the assembly constituency level ($n = 403$). We report results using these alternate data setups.

3. Descriptive Analysis

3.1. Geographic Variations in Power Loss

There is wide variation in electrical line losses across Uttar Pradesh. In 2005, for example, a staggering two-thirds 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 observed in Figure 1, greatest in the western part of the state. The western part of

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

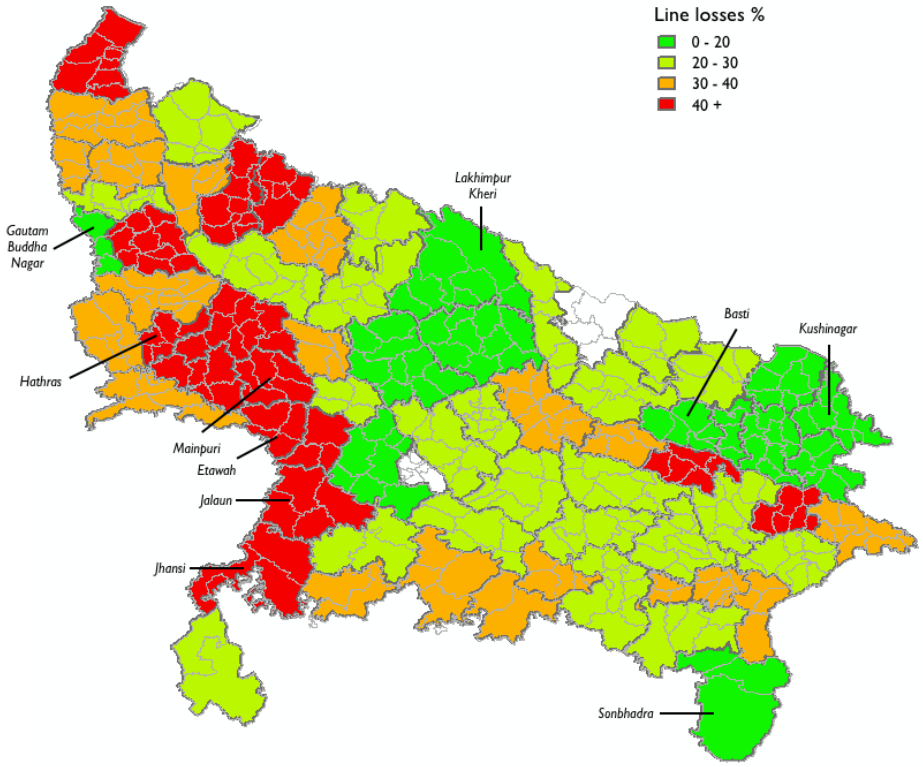


Figure 1: District-level Line Losses Across Uttar Pradesh, 2005.

Source: UP Power Corporation.

UP is more developed economically and more intensive irrigation by means of electric tubewells, a significant driver of electricity use.

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 Samajwadi Party and Chief Minister of the state from 2003 to 2007. Mainpuri, the district that ties for

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

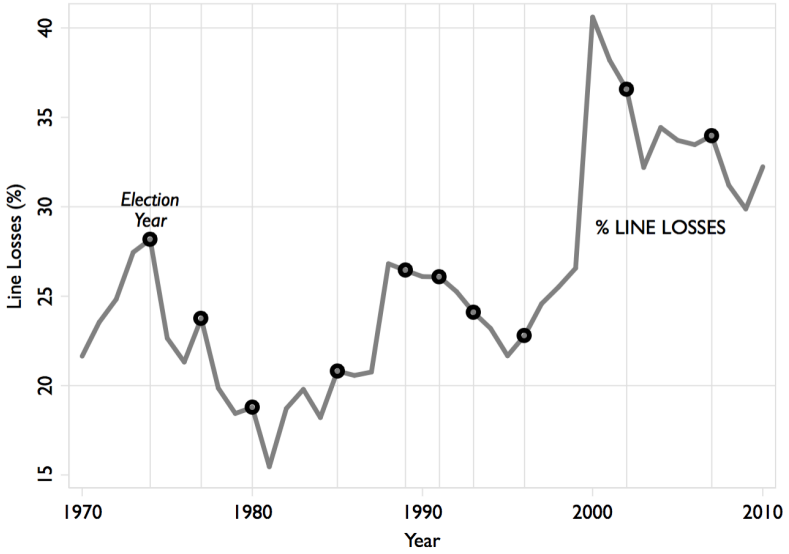
District	Line losses (%)	Energy Supplied (GWh)	Energy Billed (GWh)
Hathras	49.9	472.5	192.7
Mainpuri	49.9	241.7	118.5
Jhansi	45.8	662.2	364.8
Jalaun	45.7	419.2	231.9
Etawah	45.4	321.8	173.5
Bulandshahr	43.8	933.0	526.5
Saharanpur	42.8	1233.9	709.4
Firozabad	42.5	675.5	395.7
Rampur	42.3	370.7	216.6
Moradabad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

first place in line losses, is also a stronghold of the Singh Yadav family. The data reported in Table 1 suggests that line losses may be affected by political influence.

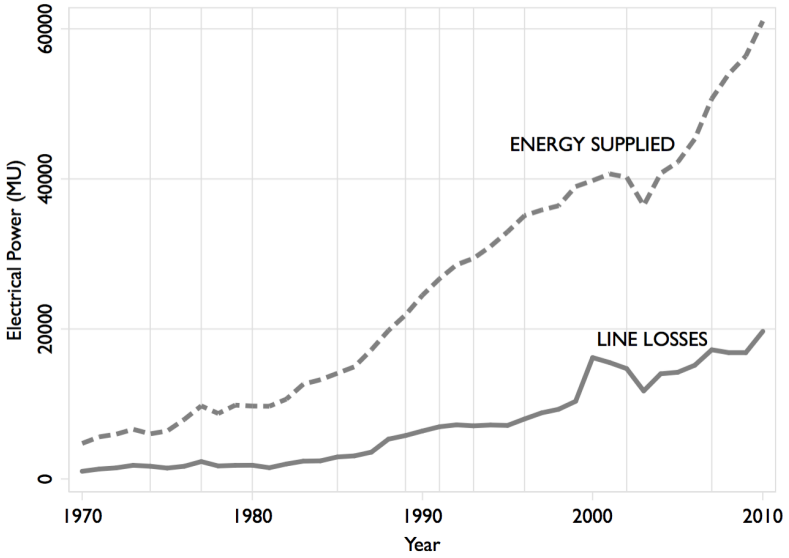
The districts with the lowest line losses on average during our study period are listed in Table 2. At the top of the list is Gautam Buddha Nagar, home to the bustling outsourcing hub of Noida, just east of New Delhi. The efficiency of collections in this district may reflect UPPCL's greater willingness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

3.2. Variations in Line Loss Over Time

In Figure 2a, we graph annual line losses in Uttar Pradesh as a percent of total electricity supplied in the state from 1970 through 2010. Overall, line losses are very high. By comparison, 2009 data from the International Energy Agency show that T&D losses were 5 percent in China, 15 percent in Argentina, and 16 percent in Kenya. More disturbingly, line losses in Uttar Pradesh are higher today than in the past, despite numerous regulatory reforms aimed at strengthening India's power sector.



(a) Statewide Losses as Percent of Total Electricity Supplied



(b) Statewide Line Losses and Electricity Supplied

Figure 2: Statewide Line Losses in Uttar Pradesh (1970–2010).
Source: Uttar Pradesh Power Corporation Ltd., *Statistics at a Glance*, various years.

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

District	Line losses (%)	Energy Supplied (GWh)	Energy Billed (GWh)
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

The figure also indicates years in which elections to the state assembly were held. Visual inspection of the data shows that election years are often marked by local peaks in T&D losses. It is important to observe that the UPPCL fiscal year runs from April to March and that state elections are typically held in the early months of the year.[4] As a result, the peak in T&D losses most often reflects an increase in line losses in the period leading up to an election. For example, the 1974 peak reflects 28 percent line losses observed in April 1973–March 1974 and an election held in February 1974.

The correspondence between election years and peaks in line losses are stronger in some periods than in others. During the 1970s and 1980s, state politics in Uttar Pradesh was dominated by the Congress party. By contrast, the 1990s was a period of highly fractured politics, characterized by short-lived coalition governments and periods of President's Rule for nearly

[4]State Assembly elections in Uttar Pradesh were held in Feb 1974, May-Jun 1977, Apr-May 1980, Feb-Mar 1985, Oct-Nov 1989, Apr-May 1991, Oct-Nov 1993, Jan-Feb 2002, Apr-May 2007.

all of 1993 and from October 1995–March 1997. Following the rise of the Bharatiya Janata Party (BJP) in the late 1990s, political power has since consolidated around the lower-Caste Bahujan Samaj Party (BSP) and the Samajwadi Party (SP). Strikingly, electoral peaks in line losses were most notable during the era of Congress dominance and look to have re-emerged in the last decade of BSP and SP rule. We interpret this to suggest that parties are most capable of facilitating higher line losses when they enjoy firm control of the state governing apparatus. The unusual spike in line loss around 2000 coincides with significant reorganization of the power corporation and the creation of the new state of Uttaranchal out of the northern hill districts of UP, and may be an artifact of these disruptions.

Data also suggest that peaks in line losses are not a result of increased power generation. We can see this in the data depicted in Figure 2b, which shows that electricity has increased most smoothly since 1970. We interpret these patterns to suggest that line loss peaks do not simply reflect more electricity being supplied around elections, but rather lower levels of billing to consumers for the electricity they consume in those periods. Such a pattern seems consistent with the technical constraints facing elected leaders and parties in managing the power supply. While it may be difficult for politicians to increase the volume or number of hours of electricity supplied to their constituents, no purely technical obstacle limits their ability to reduce billing or collection efforts during electorally critical periods. We explore this connection between line losses and the electoral cycle in UP more systematically below.

4. Statistical Analyses of Electoral Cycles and Line Loss

Using statistical tools, we investigate two questions: (1) whether line loss is affected by the occurrence of an election to the State Assembly; and (2) whether power theft pays politically; that is, whether political incumbents benefit electorally from power theft. The first hypothesis examines whether the power corporation, presumably acting under unobserved pressure from elected politicians, permits users more unbilled electricity in the year (approximately) prior to an election. The second examines whether the political party holding the state assembly seat is more likely to retain the seat as a result of the election where more power is unbilled prior to it. The second hypothesis helps us understand the first: because there are electoral benefits to allowing users more unbilled electricity in the run-up to the election, state assembly members have strong incentives to pressure power corporation officials to permit that. We cannot observe directly the interactions of politicians and power corporation officials. However, we can examine whether the data are consistent with patterns showing successful political pressures on the power corporation.

4.1. Electoral Cycles

Figure 3 plots fiscal year line losses in Uttar Pradesh from 2000 to 2009. The individual lines depict smoothed trends for individual service divisions, with the thick line showing the average across all divisions.[5] The overall

[5]The figure plots only divisions that could be consistently tracked across the time period, excluding newly created divisions. Also excluded are divisions that were extracted into the new state of Uttaranchal in 2000. These help explain the differences in overall averaged in Figures 2a and 3.

pattern shows slight increases in line losses during the 2002 and 2007 fiscal years, which mostly capture the period preceding elections in February 2002 and May 2007. A t-test in Table 3 shows that line losses at the division level are nearly 3 percentage points higher in the two election years than other years. The difference is highly statistically significant.

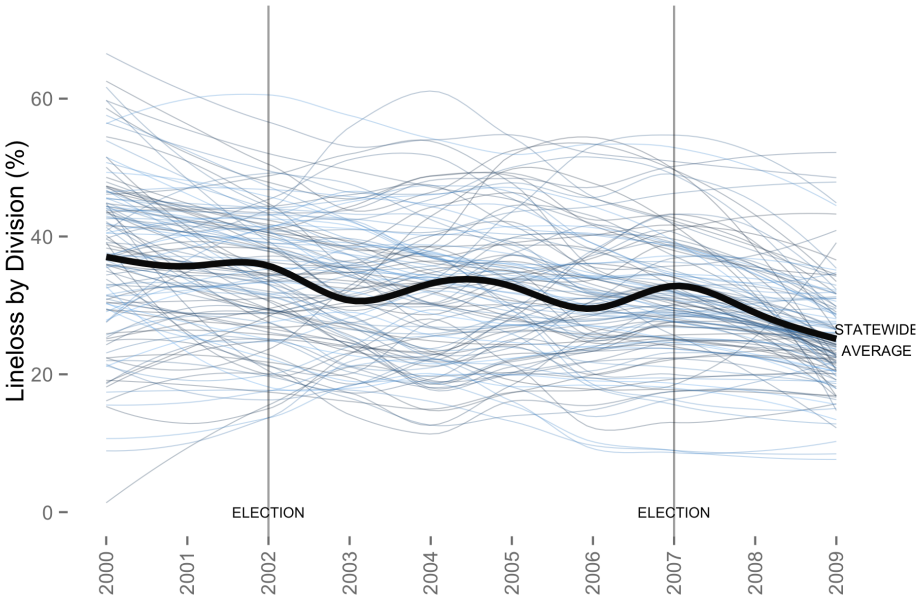
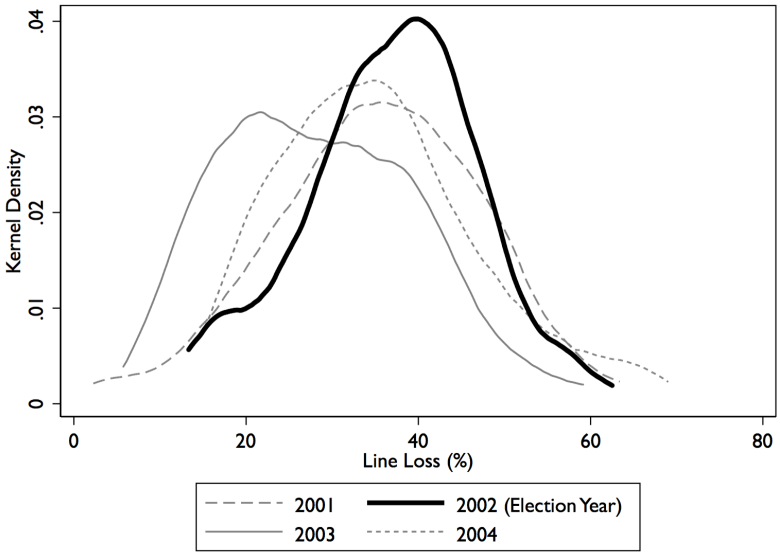
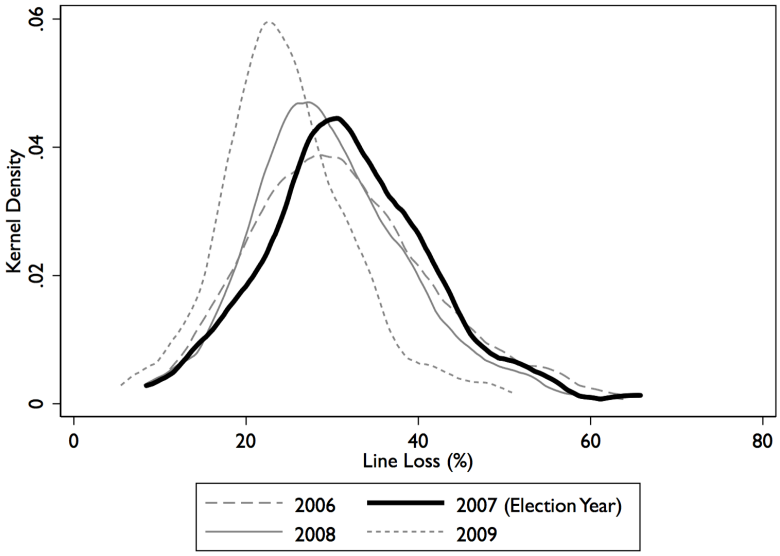


Figure 3: Division level line losses, 2000–2009.

The higher average losses in election periods is not driven by outliers. Figures 4a and 4b shows kernel density plots that reveal the distribution of line losses across all UPPCL divisions in the years surrounding the 2002 and 2007 elections. The overall distribution of losses in the election year is shifted towards the right, indicating that most divisions experienced higher line losses in that year than in the years prior and after.



(a) Kernel Density Plots of Line Losses Around 2002 Election



(b) Kernel Density Plots of Line Losses Around 2007 Election

Figure 4: Line Losses Around Election Years
Source: Uttar Pradesh Power Corporation Ltd.

Table 3: 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		$+2.7^{***}$	

Notes: State assembly elections held in 2002 and 2007. $^{***}p \leq 0.001$

Table 4 shows a fixed effects OLS regression that predicts division-level line losses using election year as regressors and indicator variables for each division to control for time-invariant division characteristics. [6] Model 2 adds a control for the total amount of electrical power supplied to the division, to account for the possibility that higher line losses are driven by an increase in electricity supply. In both models, line losses are about 3 points higher in election years than in other years, a result similar to the uncontrolled comparison of means above. These results provide additional circumstantial evidence that the provision of electricity is subject to political manipulation. Constituents appear to benefit from reduced efforts by the state to monitor electricity use in periods prior to elections.

4.2. The Electoral Returns to Line Loss

If politicians are involved in facilitating line losses prior to elections, such activities would make sense only if they were electorally advantageous. We evaluate the electoral returns to line loss by closely examining the May 2007

[6] The division fixed effects specification helps to account for differences in economic development, industrial/sectoral composition, rural/urban balance, population density, and other geographically-specific characteristics that do not vary much over time but may affect rates of line loss.

Table 4: Fixed Effects OLS Results Testing for Electoral Cycles in UP Line Loss, 2000–2009

	(1)	(2)
Election year	2.847***	3.107***
	(0.336)	(0.336)
Power supplied to division		-0.018**
		(0.006)
Division Fixed Effects	Yes	Yes
Constant	30.972***	35.792***
	(0.067)	(1.501)
Division-level Observations	1661	1661

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

election.[7] Previous research has documented a significant incumbency disadvantage for Indian state legislators (Uppal, 2009). The 2007 elections appear consistent with this expectation: across UP's 403 state assembly constituencies, only 146 of seats were retained by the same party that had held the seat since the prior 2002 election.

Were rates of line loss higher in areas where parties were able retain their seats? The geographic mismatch between assembly constituencies and UPPCL's service divisions makes it difficult to answer this question cleanly. We can, however, compare incumbency re-election rates against line losses measured at the larger administrative district level.[8] In general, districts where parties retained more seats had higher rates of line loss than those where most incumbents were replaced. In the five districts in which all

[7] In that contest, the BSP won an outright majority of seats, the first time in nearly two decades that a power sharing coalition was not required to govern the state.

[8] The typical district is comprised of five or six assembly constituency seats.

incumbents retained their seats, line losses were 42.8 percent compared to 26.7 percent in the nine districts in which no incumbent was reelected.

Since incumbency reelection is a function of several factors, we run regressions at the administrative district-level to control for other potential variables. Our dependent variable is the proportion of constituency seats retained by the same party in the May 2007 election. The main theoretically relevant independent variable is district-level line loss in fiscal year 2007 (April 2006 – March 2007). This tests whether greater line loss is associated with a higher probability of seat retention by the party holding the seat in the assembly constituency.[9] Results appear in Table 5.

The results document a positive and significant effect of line loss on the probability that incumbent parties retain seats within a district. This is true in Model 1, which is simply a bivariate estimation of the impact of line loss on party seat retention, and also in Models 2 and 3, where we add in socio-economic and then partisan control variables. The results imply that an increase in line loss of 10 points (roughly one standard deviation) is associated with a 12 percent increase in the proportion of seats in a district. Overall, parties retained only 38 percent of a district's seats on average, so the effect is substantively significant. Moreover, the association is notable given that few policy-related factors have been identified that predict incumbency reelection in Indian state assembly elections. In our analysis, the only other variable that attains conventionally acceptable levels of statistical

[9]We include as control variables the total amount of power supplied; a development index averaging district income, education, and health; the proportion of the population residing in urban areas, the size of the population, and controls for which party controlled the seat in the prior period.

Table 5: OLS Regressions Predicting Proportion of Seats in Each UP District Retained by Party, 2007 State Assembly Elections

Variable	Model 1	Model 2	Model 3
Line losses, FY 2007 (%)	0.012**	0.012**	0.011*
	(0.003)	(0.003)	(0.003)
Power supplied (GU)		0.133	0.102
		(0.098)	(0.095)
Level of development (HDI index)		0.632	-0.041
		(0.861)	(0.855)
Prop of pop urban		-0.926*	-0.041
		(0.458)	(0.447)
District pop (millions)		-0.030	-0.032
		(0.045)	(0.044)
District seats previously held by BSP			0.220
			(0.184)
District seats previously held by SP			-0.217
			(0.175)
District seats previously held by INC			-0.273
			(0.295)
District seats previously held by BJP			-0.131
			(0.206)
Intercept	-0.000	-0.213	0.245
	(0.108)	(0.495)	(0.557)
Observations	68	68	68

Standard errors in parentheses. Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

significance is urban population in Model 2. Partisan effects are not statistically significant, nor are interaction effects between line losses and parties (not reported here). One possible interpretation of the results reported in Table 5 is that when incumbent MLA's allow high rates of power theft, their party is more likely to be rewarded by voters and to achieve reelection.

5. Conclusions

Line losses are widespread in India, yet the variations in intensity across space and time can only partially be explained by technical and economic factors. Using disaggregated data from India's largest state, we provide evidence that line loss is politically correlated. It occurs more often around elections and proves advantageous to the political parties holding the legislative assembly seat. Our results underscore that line losses have become bound up with the intense electoral competition that now characterizes Uttar Pradesh. This suggests that power theft is part of deliberate political strategy and not a by-product of weak institutions or the product of random fluctuations in the ability of the public sector power corporation to enforce standard transmission or billing procedures. Although some line losses are unavoidable, our data suggest that much of it is not only a function of technical features of electricity provision, but rather an outcome of processes that may benefit politicians and consumers in the short-run, despite consequences to the state and its citizens in the long-run.

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