Estimating the Effects of Quotas Across India using Satellite Imagery

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Abstract

We estimate the effect of electoral quotas in India's state legislatures on the provision of public services to villages. To address endogeneity and selection concerns, we use a geographic discontinuity design, focusing on villages just inside and outside borders that delineate reserved and unreserved constituencies. By comparing villages that are on average highly similar except for reservation status, we estimate the effect of reservation on improving the provision of electricity from 1992 to 2009. Looking nationally, the average effect of reservation across India is negligible. Yet after unpacking the data, we show that the national average effect is in fact comprised of highly varying effects across states, swinging from positive to negative. We argue that the effects of reservation depends on whether reservation decreases political competition or not within state level politics.

1 Introduction

Quotas of seats in national and sub-national legislatures is one of the most widely used affirmative action programs around the world. Over 100 countries have mandated representation of women and over 30 countries have mandated representation of minorities in their parliaments (Krook & O'Brien 2010). However, the overall effect of affirmative action policies remains unclear, especially on the welfare of the marginalized groups quotas are designed to help. Theoretically, the expected impact of electoral quotas is unclear. On

the one hand, reserving seats for minority groups may enhance representation by insuring that elected leaders reflect the interests of marginalized segments that might otherwise be ignored. On the other hand, quotas can reduce political competitiveness by eliminating potential challengers and strengthening the re-election chances of poorly performing incumbents.

In this paper, we use data from India to evaluate the effects of electoral quotas on the provision of local public services. Specifically we compare electricity provision in villages located in open state assembly constituencies against villages in constituencies reserved for candidates from Scheduled Caste (SC) or Scheduled Tribe (ST) groups. Our unit of analysis is the village and we compare data across all of India's states. By analyzing a far broader set of cases than in previous research, we attempt to better understand why prior research has found such contradictory evidence for the effects of reservation.

In general, regressing an outcome of interest on a policy like political reservation is unlikely to yield the causal effect of reservation. Among other difficulties, factors that are associated with selection into reservation may also be correlated with outcomes of interest. For example, an important determinant of selection into reservation is the concentration of SCs within a constituency. But SC status is also correlated with economic disadvantage, which is likely to influence future outcomes. The endogeneity of reservation makes it difficult to identify the effects of affirmative action using observational data. We address endogeneity and selection effects by using a geographic discontinuity design in which we compare outcomes for villages just inside a reserved constituency against villages just outside.

We focus on tracking the effect of reservation on electricity provision to villages. Electricity is a critical public service that enhances productivity and quality of life. Yet despite its high value, many villages either lack electricity completely or suffer from low quality provision impeded by power cuts and equipment failures. By tracking improvements in

electricity provision over nearly two decades, we evaluate the effect of reservation, asking whether villages in reserved constituencies were more likely to benefit from access to this basic public service.

By exploiting this geographic discontinuity, we show that villages are extremely similar on observable covariates, especially across boundaries for SC reserved constituencies. Our findings show that reservation has negligible effects on average across India, but that the effects are large and vary in both directions across individual states.

We contend that the effects of reservation depend on its impact on political competitiveness. We present preliminary evidence showing that when political competition is diminished, reservation has negative effects on public service provision. By contrast, in states where reserved seats are as competitive as unreserved seats, reservation can enhance the provision of public services to marginalized villages.

The paper proceeds as follows. The next section reviews the literature on political reservation and quotas in India. We then describe our data, including our measure of electricity provision derived from nighttime satellite imagery. After describing our empirical strategy, we present results that compare outcomes for villages just inside and outside reserved constituency borders. We then document that the effects of reservation vary widely across states, and conclude by showing that effects depend highly on regional political context.

2 Literature Review

A vibrant literature finds contradictory evidence for the effects of electoral quotas on the welfare of socially disadvantaged groups.

From a theoretical standpoint, the effect of reserved seats for minorities is ambiguous. On the one hand, reservation may enhance political representation, resulting in elected

leaders that better understand and cater to the needs of their marginalized constituents. On the other hand, reservation may reduce political competition because of the severe restrictions it places on the pool of eligible candidates. Quotas can attract more low quality candidates to run or make it easier for poorly performing leaders to stay in office. Empirical research on reservation in India has not been able to provide a definitive answer on which of these effects — better representation or weakened competition — are stronger.

Pande (2003) examines the effect of constitutionally-mandated political quotas for SCs and STs in state legislatures in India and finds that mandated political representation increases spending targeted towards these groups. Banerjee & Somanathan (2007), while not explicitly focusing on reservation, report that districts with high proportion SCs (thus more likely to have been reserved), have improved remarkably in access to public goods over the 1970s and 1980s, while STs remain disadvantaged. By contrast, Chin & Prakash (2010) examine the overall effect of mandated representation on poverty in Indian states and find that political reservation reduces poverty for STs but has no effect for SCs.

Additional research has focused on the effects of reservation of village leadership, following the 73rd amendment to the Constitution of India in 1992, which made provisions for reservation of hitherto underrepresented sections, mainly women, SCs, and STs, in the village councils and village chief positions. Arguably, this may constitute the most aggressive policy in a country to establish political quotas for disadvantaged groups. Duflo (2005) provides a review of research findings of the Indian experiment. She identifies three conditions for a reservation policy to alter the distribution of public goods in favor of the disadvantaged groups. First, the preferences of the reserved groups must differ from the other groups. Second, the identity of the policymaker must affect the distribution of public goods, and policymakers must favor members of their groups. Third, without reservation, members of weaker groups must be underrepresented. She provides evidence that these conditions are true in the Indian case.

Using detailed survey data on the type and location of public goods provided in a district each in two Indian states of West Bengal and Rajasthan, Chattopadhyay & Duflo (2004a, 2004b) find that identity of village chiefs matter. A female village chief provides goods preferred by females. The same is true for chiefs belonging to the SC or ST category. Besley et al. (2004) examine survey evidence from 396 villages across the southern Indian states of Andhra Pradesh, Karnataka, and Tamil Nadu. They find that the likelihood of an SC/ST household getting a public good increases by seven percentage points in a reserved village compared to an unreserved village. Also, a village chief belonging to a seat reserved for SC/ST category allocate more resources towards targeted goods, which they call low spill over goods.

Using a detailed survey on the benefits received from local programs in 16 districts of of the state of West Bengal, Bardhan, Mookherjee & Parra Torrado (2009) find no evidence that a female village chief targets benefits towards female constituents. Moreover, the other marginalized groups, such as SCs and STs are worse off in such villages. In contrast, they find a significant positive effect of SC/ST chief reservation on per capita benefits in the village as a whole, and on intra-village targeting to female headed households, as well as the group (SC or ST) for whom the position is reserved. They also find that the adverse impact of Pradhan reservations for women on intra-village share of SC/ST groups was significantly smaller in villages more susceptible to elite capture (e.g., with greater land inequality and higher poverty within SC/ST groups), possibly due to election of inexperienced women disturbing the traditional capture-clientelism equilibrium. However, they concede that it is not clear what the effect would be in longer run. Munshi & Rosenzweig (2010) argues that randomization of reserved seats on a village council can enhance caste discipline and result in higher quality candidates.

Despite this string of findings, Dunning & Nilekani (2010) highlight how endogeneity can bias empirical estimates of quotas' effects. Exploiting the fact that reservation for

village council presidencies rotate over time, they use a regression discontinuity design to examine 200 village councils in Karnataka and find no strong effect of reservation on distributional outcomes.

The wide range of divergent findings seems surprising. We suggest that one reason for these contradictory findings is that the effect of reservation depends highly on the local and regional political context and that the effects are likely to vary across individual states.

We argue that the impacts of reservation are mediated by its effects on the political competitiveness of elections — and that competition can be weakened or strengthened depending on the process of political mobilization along Caste lines.

By imposing strict limits on qualifications for candidacy, reservation essentially eliminates the majority of the population from potential candidacy. The result is fewer qualified candidates and reduced competition for incumbents. Elections data show that this is indeed the case. Figure 1 summarizes these differences, based on all state assembly elections between 1991 and 2003 for 16 large states in India. In reserved constituencies, we observe that winning candidates have higher margins of victory, elections attract fewer candidates, and fewer voters turn out to vote. There is some indication that incumbents are slightly more likely to win re-election in ST areas, which is notable given that there is a significant disadvantage to incumbency in Indian state legislative elections overall (Uppal 2009).

On the other hand, reservation may improve outcomes if the screening mechanism results in elected officials that better represent constituent preferences.

The way in which these countervailing effects interact differ across India's states. In some areas of India, reservation has helped foster the rise of politically powerful low Caste parties. While in other areas, there remains no independent political movement organized around Caste.

One factor that affects these pathways is the relative size of groups in the political landscape and how it shapes the electoral viability of different group identities (Posner

	Unreserved Seats	Reserved (SC) Seats	Reserved (ST) Seats
Margin of Victory	14.1	15.4	18.4
Number of Candidates[a]	10.2	7.8	6.1
Turnout	63.8	59.2	55.4
# seat-election obs.	20,002	3,779	1,499

[a] Candidates winning more than 5% of the vote.

Table 1: Political Competitiveness in Reserved and Unreserved State Assembly Constituencies

2005, Eifert, Miguel & Posner 2010). The share of SCs varies widely across India's states. Where SCs are too small to make up a significant voting bloc, it is less likely that Caste-based identities will emerge as the most politically salient axis of cleavage. Yet, in states with larger SC populations, the power of a coordinated voting bloc can foster ethnic based identities (Chandra 2004). This has occurred in Uttar Pradesh, where the politicization of Caste has dominated electoral party politics. With strong voting support from Scheduled Castes, the Bahujan Samaj Party (BSP) has been the strongest party of the last decade.

3 Reservation in India

Political reservation for Scheduled Castes and Scheduled Tribes was mandated in 1950 in the Constitution of India, Article 332. The mandate required that a share of seats in the lower house of the Parliament (Lok Sabha) and state legislative Assemblies (Vidhan Sabha) were to be reserved for SC or ST candidates only. While the entire electorate may participate in the selecting their preferred candidate, only those candidates belonging to the reserved group may compete in the election. Though SCs and STs can stand for election in unreserved constituencies, some reports suggest that historically, virtually no seats have been won by SCs and STs in unreserved constituencies (Chin & Prakash 2010).

The Constitutional provision requires that the proportion of seats reserved for Sched-

uled Castes and Tribes in each elected body be roughly equal to their share in the population of that state. For example, if Scheduled Castes constitutes 25 percent of the population of a state, then one-fourth of the seats in the state assembly must be reserved for them.

The task of reservation is undertaken by an independent Delimitation Commission, which is also responsible for reapportionment of electoral constituencies. Under the Constitution of India, the Delimitation Commission in India is a high power body whose orders have the force of law and cannot be called in question before any court. The commission is headed by the chief election commissioner, who is the head of the semi-autonomous body for conducting elections, and two judges or ex-judges from the Supreme Court or High Court. The Commission is generally constituted following the decennial census. Since independence, India has formed Delimitation Commissions in the following years: 1952, 1963, 1972, 2002. The 42nd Amendment to the Constituition in 1976 fixed constituency boundaries until 2001. This was motivated by the aim to ensure that states' family-planning programs (to control population) would not affect their political representation in the Lok Sabha and Vidhan Sabhas, as population share is the main determinant of the number of seats allocated across each state. As a result, the reservation status too remained unchanged during that period.

On arrival of fresh Census data, the Delimitation Commission decides on changing the total number and boundaries of state legislative seats. The general rule is that each constituency with in a state should have roughly equal population. Once the total number and boundaries of seats is decided, a percentage of those are reserved for the Scheduled Castes and Scheduled Tribes. This share is roughly equal to the population share of each group in that state. This fixes the number of reserved seats in the state. These seats are then allocated to each district (geographical division below state) within the state, again equal to the share of population residing in each state. The selection of reserved seats is done within district. The constituencies within a district are arranged in descending order

of proportion of SCs or STs. The constituency with the largest proportion of SCs or STs is reserved first, proceeding down the ordered until the number of reserved seats allocated to that district has been met. A final additional rule is that the seats reserved for SCs, but not STs, be geographically dispersed.

Together, these rules imply that the likelihood that a village will find itself in a reserved constituency depend primarily on the concentration of SCs or STs at higher levels of geography: the state, district, and assembly constituency level. An individual village's characteristics, including the number of its villagers that are SC or ST, are in fact less important predictors. We exploit this institutional feature of reservation to identify villages alongside constituency borders that are likely to be highly similar in key respects except that some are in reserved areas and some are not.

4 Data

Our dataset is comprised of observations for the nearly 600,000 villages in India. All villages are located in one of 4,002 state assembly constituency seats. Of these seats, 542 (14%) of seats are reserved for SCs and 508 (13%) are reserved for STs. Table 2 shows the distribution of seats by reservation status across India. These seats are mapped in Figure 1. Our research design, described more fully below, aims to evaluate differences in electricity provision among villages right at the border of reserved and unreserved constituencies. Figure 2 highlights these border zones.

We are particularly interested in the reservation of seats in the state house because of the significant role members of the legislative assembly (MLAs) play in directing spending for local and regional development. In India's federal system, most public services are the responsibility of state governments, and MLAs are thus the elected officials with the most direct links to the state purse. While local village councils can play a critical role

in determining distributional outcomes within their villages, local councils are typically unable to afford large projects like paved road construction or electrification on their own. Even powerful locals councils are reliant on their MLAs to direct infrastructure projects and spending to their villages. This is especially true for electricity, our primary outcome.

Scheduled Castes make up about 15% of the Indian population and are geographically dispersed across India, typically residing in villages alongside other castes. By contrast, Scheduled Tribes, who make up 7.5% of the population, tend to be spatially concentrated with many villages inhabited by a single tribe. Given these patterns, we expect our research design to yield stronger causal inferences when comparing villages alongside borders for SC reserved seats than for ST seats. While we report key results for villages along both SC and ST borders, we focus most of the analysis on the effects of SC reservation.

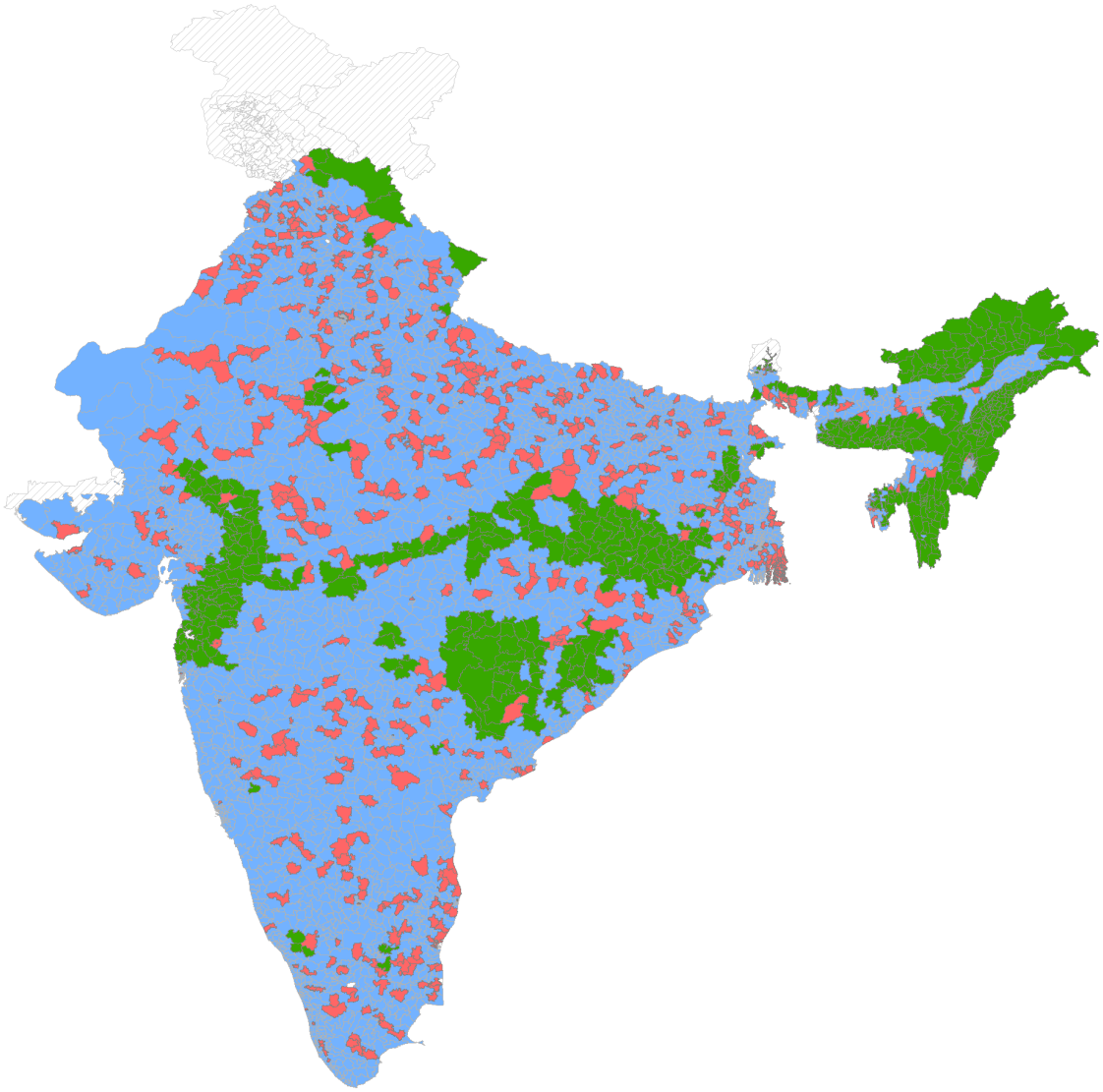
4.1 Dependent Variable

Our measures of electrification are derived from satellite imagery of the earth at night. The imagery are consistently recorded, enabling comparisons of changes over time. By contrast, data on public service provision recorded in the Census are difficult to compare over time, since villages cannot be easily matched across Censuses. Moreover, definitions are variable, including for electricity provision.

We construct our estimate of electrification status for all villages using a novel set of satellite imagery of the earth at night. The satellite images come from the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS), a set of military weather satellites that have been flying since 1970 in polar orbit recording high resolution images of the entire earth each night between 20:00 and 21:30 local time. Captured at an altitude of 830 km above the earth, 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 anal-

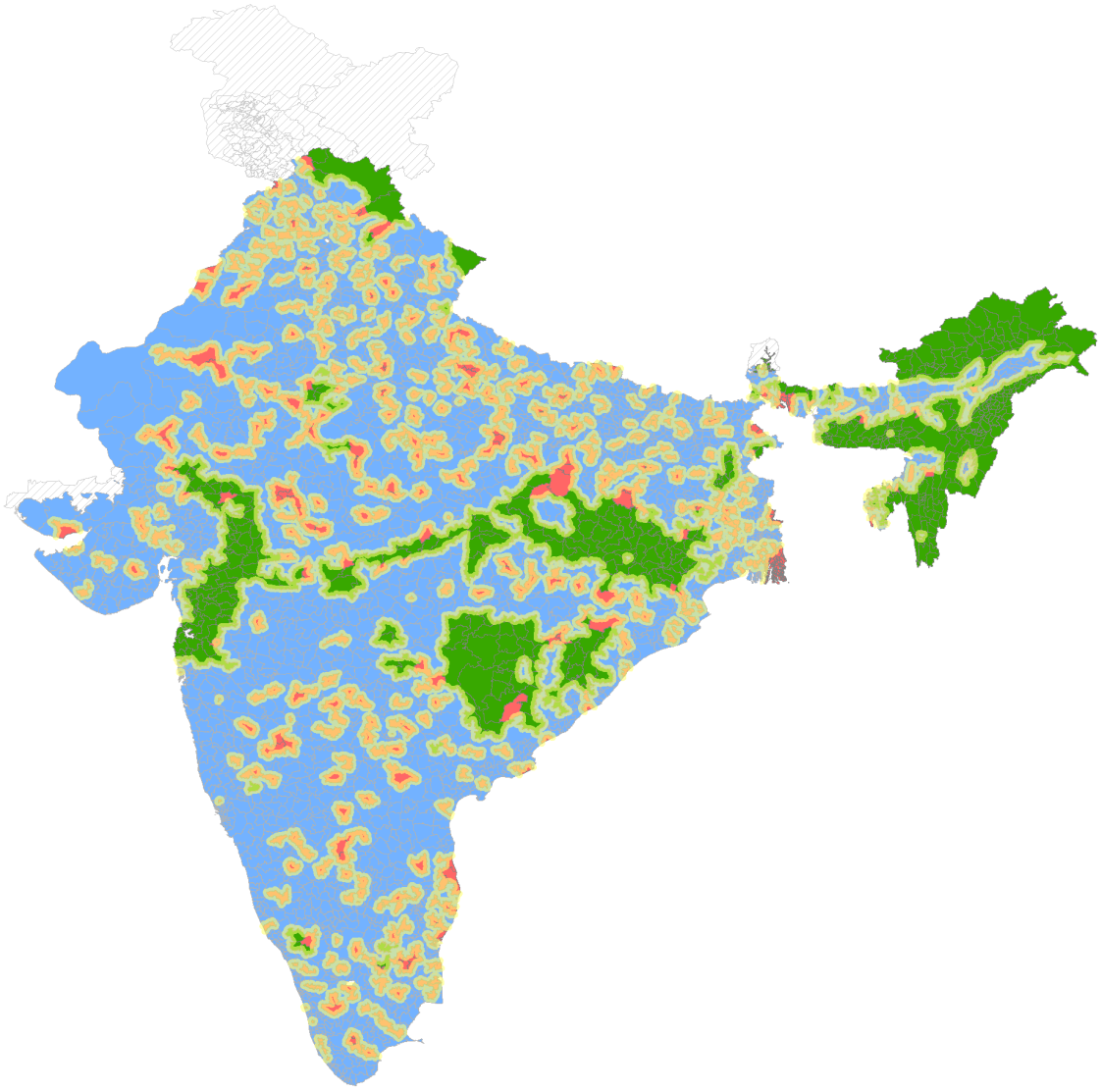
State	Unreserved	Res(SC)	Res(ST)	Total Seats
Andhra Pradesh	247	38	9	294
Arunachal Pradesh	1	0	59	60
Assam	101	8	16	125
Bihar	251	45	28	324
Chhattisgarh	51	9	30	90
Delhi	57	13	0	70
Goa	39	1	0	40
Gujarat	145	13	24	182
Haryana	73	17	0	90
Himachal Pradesh	50	15	3	68
Karnataka	197	25	2	224
Kerala	126	12	2	140
Madhya Pradesh	163	33	34	230
Maharashtra	248	18	22	288
Manipur	39	1	20	60
Meghalaya	4	0	56	60
Mizoram	2	0	38	40
Nagaland	1	0	59	60
Orissa	93	22	32	147
Punjab	88	29	0	117
Rajasthan	144	33	23	200
Sikkim	18	2	12	32
Tamil Nadu	190	42	2	234
Tripura	36	7	17	60
Uttar Pradesh	315	88	0	403
Uttarakhand	55	12	3	70
West Bengal	218	59	17	294
Total	2,952	542	508	4,002

Table 2: State Assembly Constituency Seats by Category



Blue = Unreserved seats
Red = Reserved (SC) seats
Green = Reserved (ST) seats
Source: MLInfomap. Map is of pre-2008 delimitation boundaries.

Figure 1: State Assembly Constituencies in India



Source: MLInfomap. Map is of pre-2008 delimitation boundaries.

Figure 2: State Assembly Constituencies
With Buffer Zones Around Reserved Borders Highlighted

ysis and use by the scientific community. While daily images are available, the primary data products used by most scientists are a series of annual composite images. These 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 like fires and other noise. The result is a series of images covering the globe for each year from 1992 to 2009 (Elvidge et al. 1997, Imhoff et al. 1997, Elvidge et al. 2001). Since the DMSP program may have more than one satellite in orbit at a time, some years have two annual images created from composites from each satellite, resulting in a total availability of 30 annual composite annual images. Images are scaled onto a geo-referenced 30 arc-second 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. Further image processing is performed to identify which pixels are consistently lit over time, dropping light values from pixels with unstable light signatures over time. This results in an image of time stable night lights. For this project, we use the average annual lights product to minimize the sensitivity of our results to image processing algorithms.

Compared with traditional data on energy production and consumption, the satellite image explicitly reveals the geographic distribution of electrical power, providing a clearer picture of the beneficiaries of public infrastructure across space. Moreover, since the satellite images are captured electronically through an automated process, the data have the virtue of being unbiased by human factors, consistently recorded, and complete with no missing data. Elsewhere, we document that satellite imagery of the earth at night correlates highly with local level electricity use in India (Min 2011).

Our primary dependent variable is the change in average annual light output from 1992 to 2009 for each village in India. Figures 3a and 3b illustrate how light output has changed over this timeframe. 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 contexts in which electricity provides positive externalities.

We use GIS software to spatially match and extract average annual nighttime light output for the nearly 600,000 villages in India. We also overlay a map of India's 4,000 state assembly constituencies to identify the state assembly constituency in which each village is located.[1] We also compute the Euclidean distance of each village to the nearest border between a reserved and unreserved constituency. The goal is to observe how light output and other characteristics vary by distance from this border.

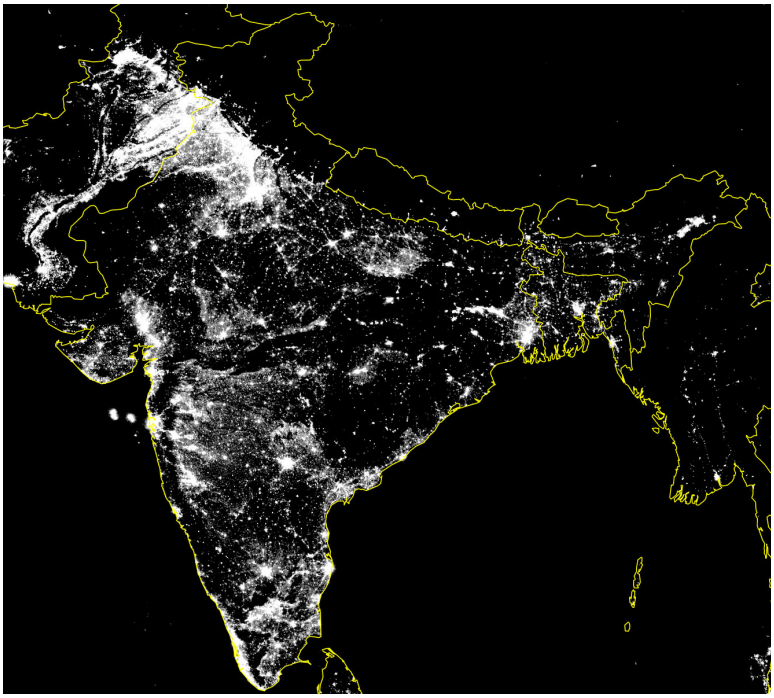
5 Empirical Strategy

Reservation of constituency seats for SCs and STs is determined by demographic and socioeconomic characteristics. Since reservation is not randomly assigned, differences in outcomes might be a result of the treatment but could also be a result of characteristics that differ systematically across treatment and control cases.

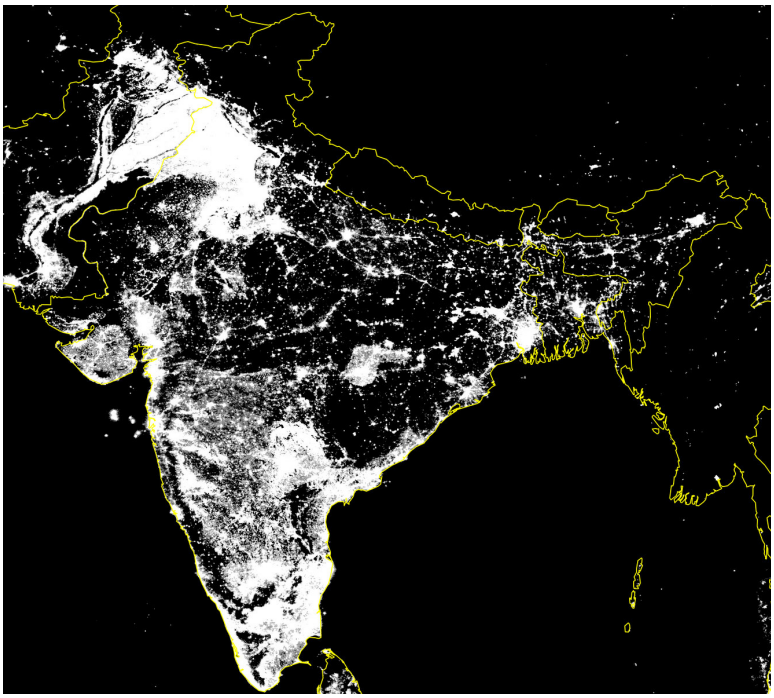
As described above, the likelihood that a village is assigned to a reserved constituency depends not on the concentration of SCs in the village but on the concentration of SCs in the state (which determines the total number of SC seats), in the district (which determines how many seats within the district will be reserved), and the relative rank in SC concentration of the constituency. This suggests that the concentration of SC voters within a village is likely to be a weak predictor of whether it is in a reserved constituency or not.

We employ a geographic discontinuity design in which we compare outcomes for villages that are just within and just outside borders of reserved assembly constituencies. Figure 4 illustrates how distance to relevant borders can be used to select proximate vil-

[1]The assembly constituency map and village point location data come from ML Infomap.



(a) 1992



(b) 2009

Source: DMSP-OLS imagery from NOAA's National Geophysical Data Center.

Figure 3: India at Night

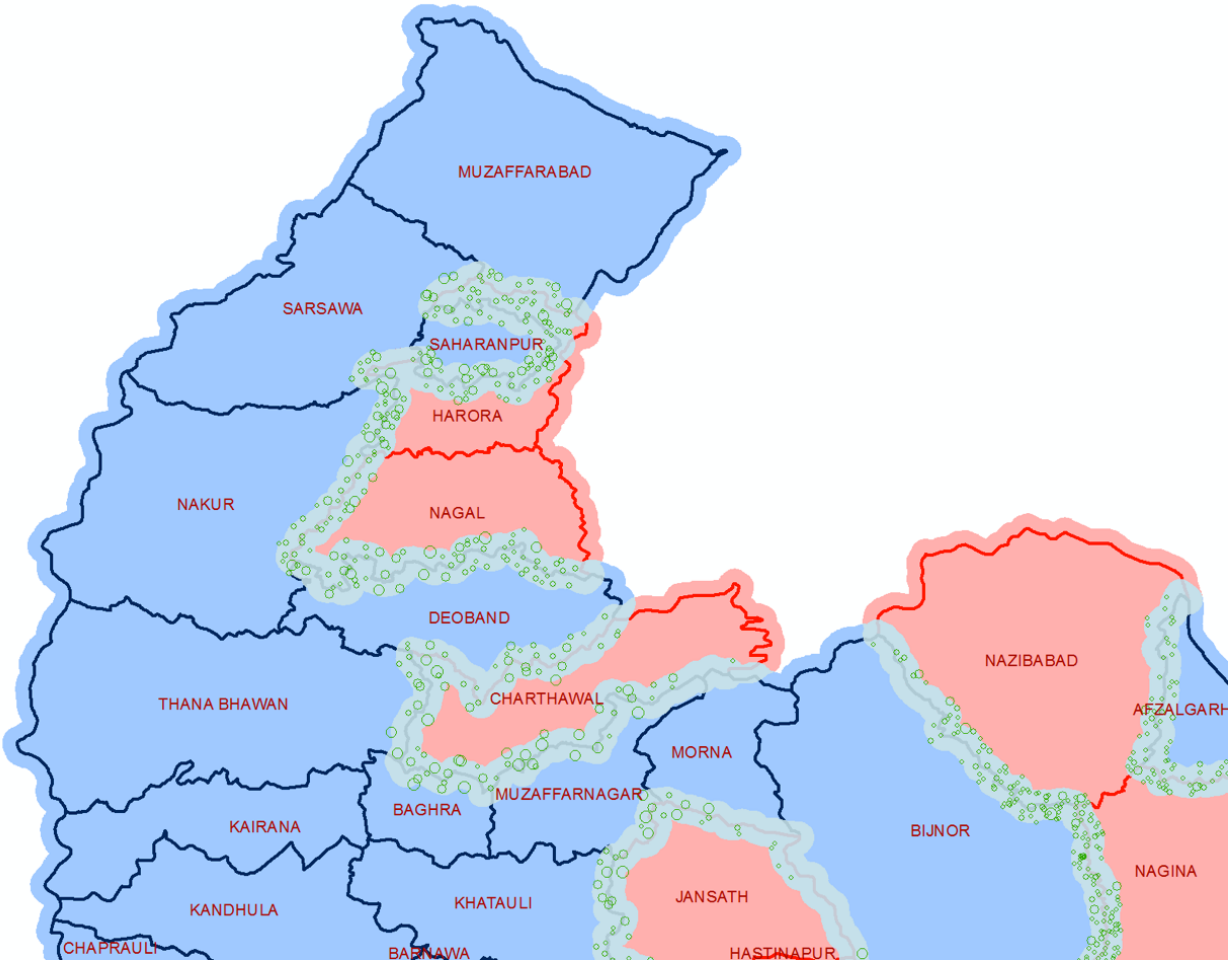
lages for comparison. In the figure, which shows the northern region of Uttar Pradesh, only villages within 2 kilometers of a border between a reserved and unreserved seat are highlighted. The key assumption is that villages are likely to be very similar on either side of such boundaries. In other words, near constituency borders, we suggest that assignment of a village into reservation status is determined as if there were random assignment.

Using village-level data from the 2001 Indian Census, we test the similarity assumption by examining village characteristics across a range of observed covariates, including proportion Scheduled Caste, employment, literacy rates, and population size. We also calculate the Euclidean distance of each village to the nearest constituency border dividing a reserved and unreserved constituency. Figure 5 shows that villages are indeed more similar the closer you get towards such a border.

In addition to the visual evidence, we can test the as-if random assumption statistically. Using a logit regression, we ask whether key village characteristics can predict reservation status of the constituency within which it is located. We ran separate logit regressions for each of India's 18 largest states to ask whether any of these four village characteristics predicted reservation status of the constituency within which it is located. We then ran a second set of regressions narrowing the sample to villages within 2km of a reserved (SC) constituency boundary.

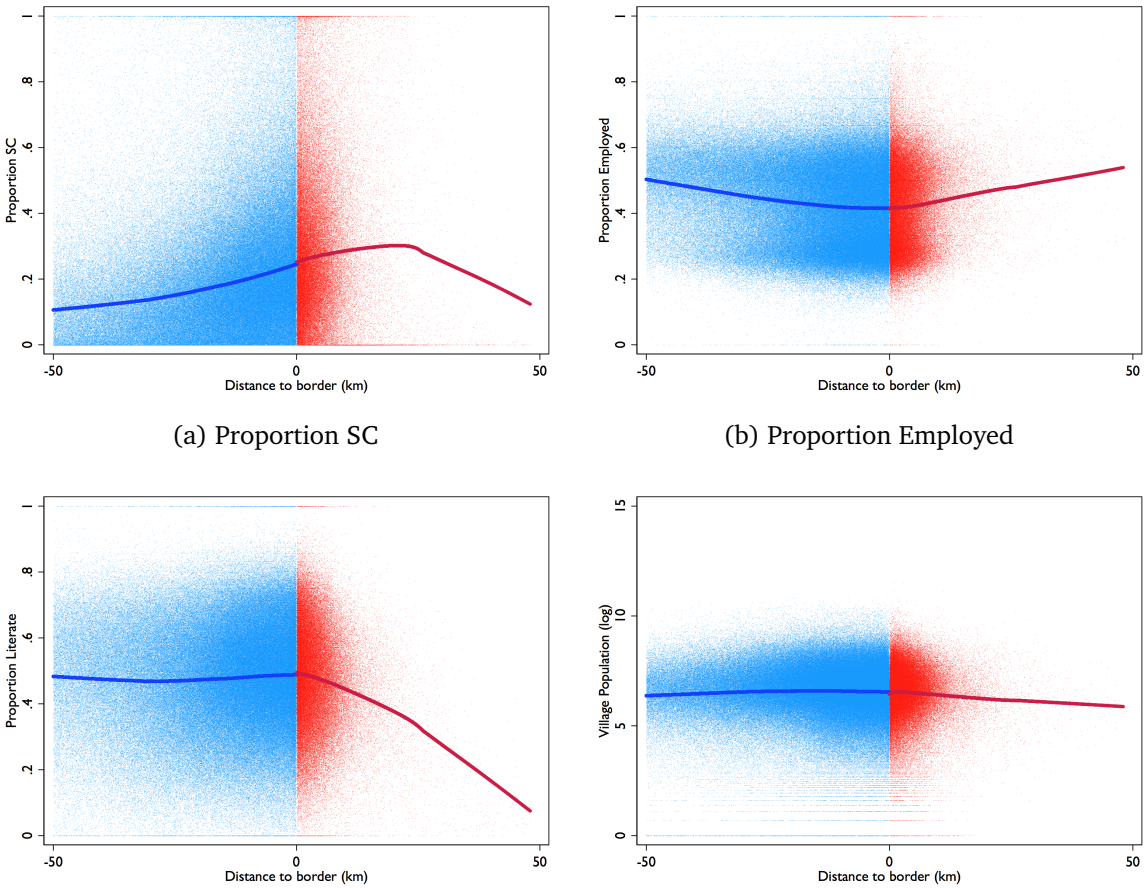
Of the combined 72 coefficients (4 village variables $\times$ 18 state regressions), 24 are statistically significant predictors of constituency reservation when all villages are included. After narrowing the sample to villages only within 2km of the border buffer zone, none of the 72 coefficients are significant. These results provide further confidence in our assumption that near borders, reservation appears to be assigned as-if randomly.

There are some caveats, however. Our comparison is based on 2001 Census village characteristics, and not on pre-treatment characteristics. This would require data from the 1971 Census to identify characteristics prior to the last delimitation in 1976. In fact, since



Villages denoted by green markers. Size of markers are scaled to village population.
Source: MLInfomap.

Figure 4: Villages within 2km of Boundary Between Reserved and Unreserved Constituencies



(a) Proportion SC

(b) Proportion Employed

(c) Proportion Literate

(d) Population

All India Villages by Distance to Border of Nearest Reserved (SC) Constituency.
Blue dots are villages in unreserved constituencies.
Red dots are villages in reserved (SC) constituencies.
Lines are lowess curves fit separately for reserved and unreserved villages.

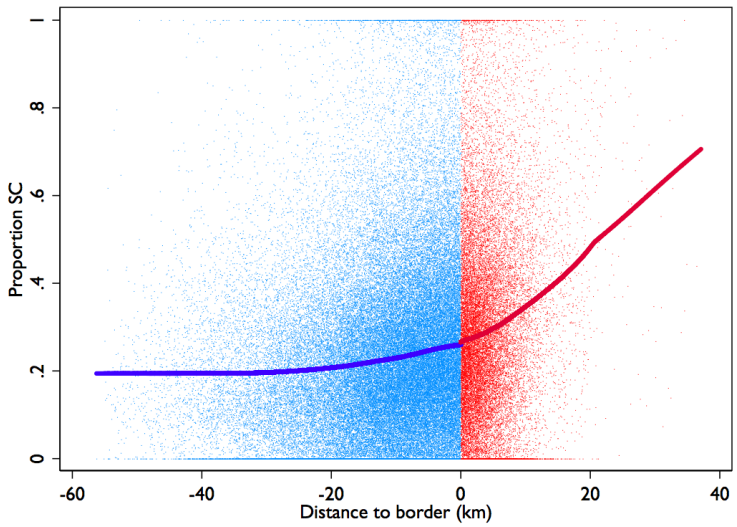
Figure 5: Balance Checks on Village Characteristics

villages may have been reserved even prior to that delimitation, earlier data at Independence would be necessary. Such historical data do not exist in electronic format and are unfortunately inaccessible. In addition, we are also making the assumption that villages are identical even across unobserved covariates that may influence the likelihood of receiving public services. This seems plausible for characteristics associated with geography (e.g. weather, soil fertility, remoteness from markets, local economic potential), since villages along borders are likely to be very similar along these variables. However, there may be other relevant but unobserved factors that we cannot evaluate to test for balance.

An additional concern is that citizens can move across borders once reservation decisions have been made. However, given the stability and deep family links that tie Indians to their villages, we assume that such Tiebout sorting does not frequently occur in rural areas. If such Tiebout sorting were to occur, we would expect that SC residents would be the most likely to move. An SC resident living in an unreserved constituency might consider it advantageous to move across the border into a reserved constituency. We might therefore expect a discontinuity in proportion SC right at the border, as SC citizens move into nearby reserved constituencies. We do not see this in our data. In Figure 6, we plot the proportion SC for all Uttar Pradesh villages by distance to a reserved border. Uttar Pradesh is significant given the growing politicization of Caste and the emergence of powerful low-Caste parties. Yet in UP, the proportion of SC citizens is very similar in villages on either side of a reserved constituency border.[2]

Acknowledging these important limitations, we proceed to examine levels of electricity use in villages on both sides of reservation boundaries. We employ a difference-in-difference design to compare changes in electrification from 1992–2009 for villages in reserved constituencies against those in non-reserved areas. This difference is the treatment

[2]A better test would be to compare the rates over time to see how demographic rates around the border have changed over time. We have not yet matched the 2001 village data to the 1991 Census to run this.



Uttar Pradesh Villages: Proportion SC by Distance to Border of Nearest Reserved (SC) Seat.
Blue dots are villages in unreserved constituencies.
Red dots are villages in reserved (SC) constituencies.
Lines are lowess curves fit separately for reserved and unreserved villages.

Figure 6: No Evidence of Tiebout Sorting in Uttar Pradesh

effect of reservation on the provision of electricity to villages.

6 Results

6.1 All Indian Villages

We begin by comparing raw differences in electrification rates across all villages in India. Of the roughly 600,000 villages in India, 31% were located in reserved state assembly constituencies. Among reserved villages, just over half were in constituencies reserved for Scheduled Castes, while the rest were in areas reserved for Scheduled Tribes.

Table 3 presents key summary statistics. In both 1992 and 2009, villages in reserved constituencies were dimmer than those in non-reserved constituencies. Yet rates of improvement over that time were slightly higher in reserved SC villages compared to their

Villages by Constituency Status:	Unreserved	Reserved (SC)	Reserved (ST)
Light output (1992 average)	4.22	4.06	3.00
Light output (2009 average)	5.75	5.63	3.80
Change in light, 1992–2009[a]	+1.53	+1.57	+0.80
Observations	406,625	93,327	88,608

[a] Differences in means between Unreserved and Reserved villages are statistically significant, $p \leq .05$.

Table 3: Village Light Output by Reservation Status, All India

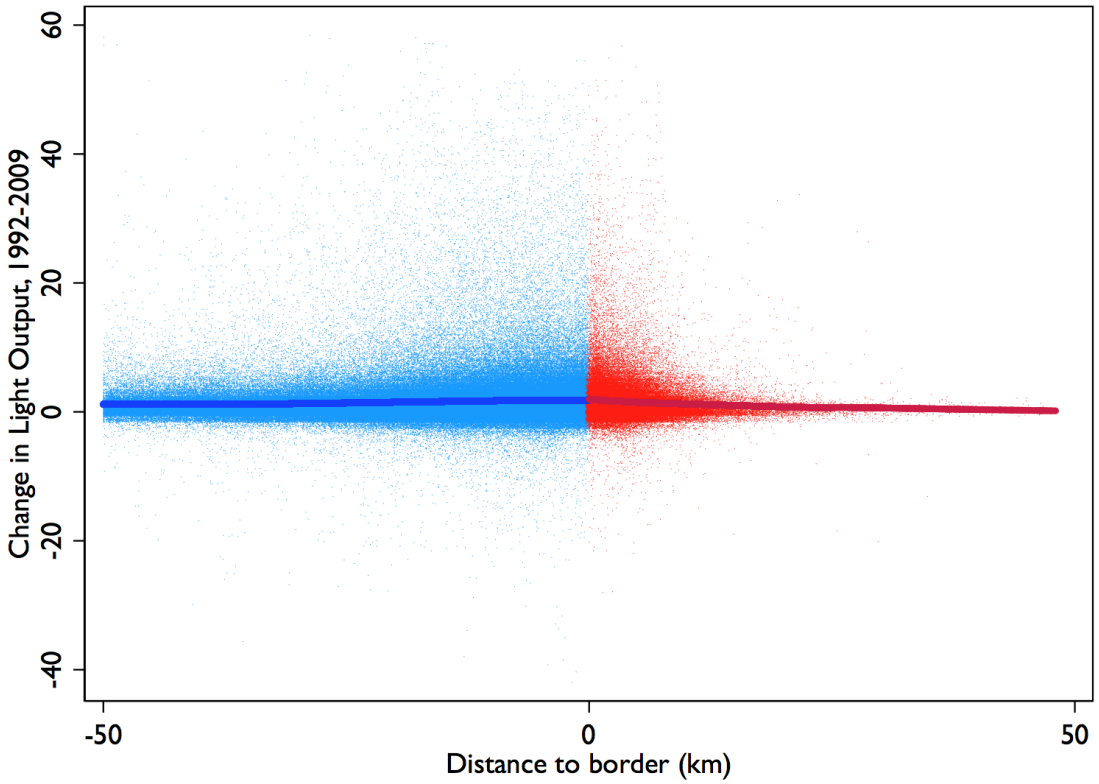
unreserved counterparts. By contrast, improvements in ST areas were slow, growing only at half the pace as other villages. The slow pace of improvement in ST areas appears consistent with Weiner's observation that STs represent "India's largest politically slumbering minority" (Weiner 1989, 53).

These results, however, do not reveal the causal effect of reservation because of endogeneity and selection concerns.

6.2 Treatment Effect for Villages Along Borders

Using our boundary maps, we proceed to analyze differences among a much narrower sample of villages that are closer to borders of reserved constituencies. Figure 7 shows change in light output from 1992 to 2009 for all villages within 50 km of a border of a reserved (SC) seat. [While the trends are unfortunately not easy to discern in this figure], the average change among unreserved and reserved villages shrinks as you get closer and closer, becoming statistically indistinguishable at the border.

Table 4 presents summary statistics for the narrow sample of villages only within 2km of the nearest reserved constituency border. The results show that in 1992, reserved (SC) villages appear slightly worse off than those in non-reserved areas, but the difference is not statistically significant. By 2009, villages in both reserved and unreserved areas had become brighter at exactly the same rate. The differences are more notable for villages



All India Villages by Distance to Border of Nearest Reserved (SC) Constituency.
Blue dots are villages in unreserved constituencies.
Red dots are villages in reserved (SC) constituencies.
Lines are lowess curves fit separately for reserved and unreserved villages.

Figure 7: Change in Light Output by Distance to Border of Reserved (SC) Seat

[Unfortunately, the y-axis scale makes it hard to see how the mean changes closer to the border. We will produce a clearer figure in a subsequent version.]

	WITHIN 2KM OF RESERVED (SC) SEATS		WITHIN 2KM OF RESERVED (ST) SEATS	
Villages by Constituency Status:	Unreserved	Reserved (SC)	Unreserved	Reserved (ST)
Light output (1992 average)	4.35	4.32	3.38	3.29
Light output (2009 average)	6.19	6.15	4.39	4.38
Change in light, 1992–2009	+1.84[a]	+1.83[a]	+1.01[b]	+1.09[b]
Observations	33,381	32,347	9,458	9,630

[a] Difference in means is not statistically different from zero.
[b] Difference in means is statistically significant, $p \leq .05$.

Table 4: Change in Village Light Output by Reservation Status, 2km Buffer Zones Only

Villages by Constituency Status:	Unreserved	Reserved (SC)	Reserved (ST)
Light output (1992 average)	4.22	4.06	3.00
Light output (2009 average)	5.75	5.63	3.80
Change in light, 1992–2009[a]	+1.53	+1.57	+0.80
Observations	406,625	93,327	88,608

[a] Differences in means between Unreserved and Reserved villages are statistically significant, $p \leq .05$.

Table 5: Village Light Output by Reservation Status, All India

around ST reserved borders. Growth in light for villages just inside the borders was in fact higher than for those just outside, and the difference is statistically significant.

Since these are average effects, it could be possible that while the mean changes are similar, the distribution of benefits might be quite different on either side of the border. For example, legislators in reserved constituencies might work harder to ensure improved electricity only for villages with large SC populations, while ignoring villages with fewer SCs. As we have shown above, villages vary widely in proportion SC in border zones, providing ample opportunities for targeting. However, when we further limit the sample to only villages that are majority SC, there is still no statistically meaningful difference in effects of reservation look sightly worse but the difference is not statistically different from zero. The results are shown in Table 6.

	WITHIN 2KM OF RESERVED (SC) SEATS ≥50% SC Villages only		WITHIN 2KM OF RESERVED (ST) SEATS ≥50% ST Villages only	
Villages by Constituency Status:	Unreserved	Reserved (SC)	Unreserved	Reserved (ST)
Light output (1992 average)	4.60	4.62	3.10	3.12
Light output (2009 average)	6.85	6.81	3.96	4.12
Change in light, 1992–2009	+2.25[a]	+2.19[a]	+0.86[b]	+1.00[b]
Observations	4,005	4,450	4,193	5,750

[a] Difference in means is not statistically different from zero.
[b] Difference in means is statistically significant, $p \leq .05$.

Table 6: Change in Village Light Output by Reservation Status
High SC/ST Villages in 2km Buffer Zones Only

Meanwhile for villages that are majority ST, being on the reserved side of the border is significantly better, improving light output by 1.0 points as opposed to 0.86 points. We interpret the ST results with some caution, however, since our geographic discontinuity design does not lead to balanced treatment and control samples, especially on the proportion of ST residents on each side of a reserved border.

Overall, the findings suggest that there is no detectable effect of reservation for Scheduled Castes on the provision of electricity across India over the last two decades. Meanwhile, there is some tentative evidence of a positive effect of reservation for Scheduled Tribes.

7 Heterogeneous Treatment Effects Across States

[In this version of the paper, we focus on the variation in outcomes around seats reserved for Scheduled Castes and leave evaluation of areas around ST seats for future analysis.]

While the overall effect of reservation for SCs appears to be negligible across India, our data reveal that there is substantial variation in the effect across states. Figure 8 shows

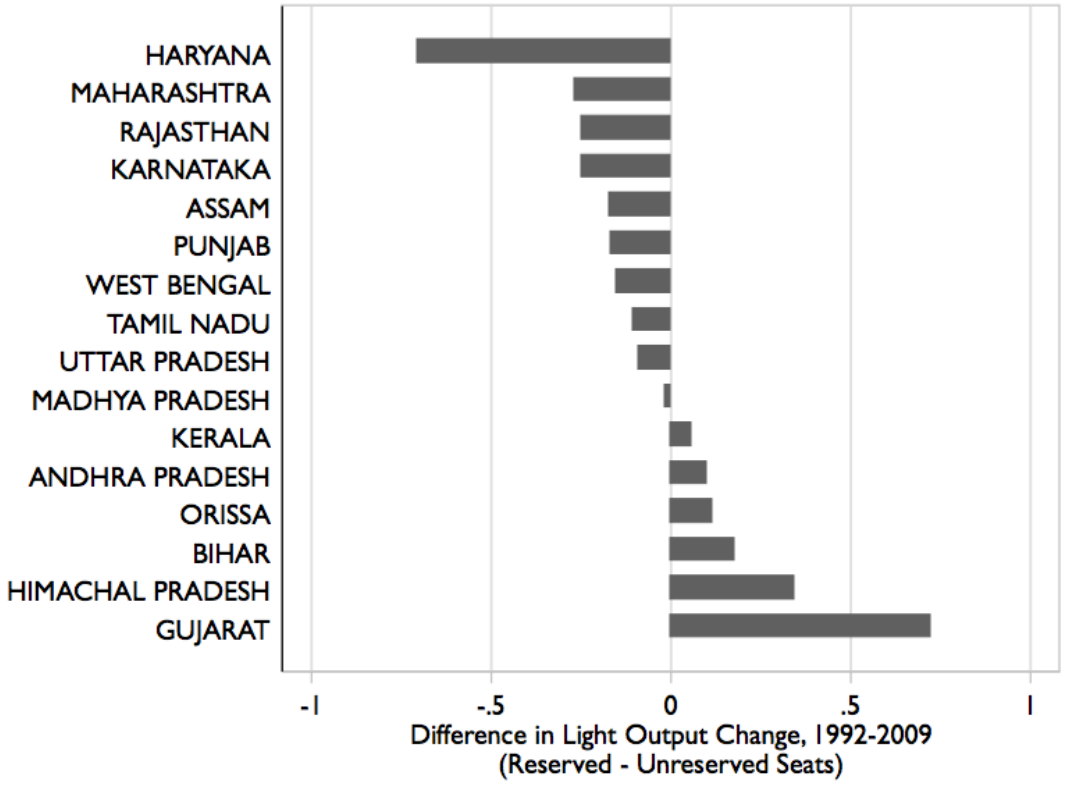


Figure 8: State-level Variations in Outcomes

how treatment effects of reservation vary in India's 15 largest states. The sample again is limited to villages within 2km of the nearest reserved (SC) border. In 9 of the states, reservation has negative effects on electricity provision, while in the other 6 the effects are positive.

In Haryana, average light output in villages on the unreserved side of the border increased from 8.9 in 1992 to 14.9 in 2009, a raw increase of 6.0 points. Yet villages just inside the reserved borders improved more slowly, going from 7.2 to 12.5, or 5.3 points from 1992 to 2009. Overall, the effect of reservation in Haryana was a decrease in light output of 0.7, worse than any other state.

At the other extreme is Gujarat. While unreserved villages at the border went from

6.0 to 7.0 over the study period, reserved villages just inside the boundary went from 5.7 to 7.4. The relative difference in rates indicates that reservation improved electricity provision by 0.4 points, the highest positive effect of any state in the nation.

These divergent results imply that there is no universal effect of reservation, but rather that its impact depends largely on local context and contingent political response. We suggest that political competition can be maintained when SC movements are incorporated into larger, cross-cutting social movements and parties. Yet when SC movements flourish and result in caste-based parties, the political environment becomes ossified, reducing the ability of other parties to field viable contenders, and thus reducing competition. The result is fewer candidates, higher incumbency reelection rates, and larger margins of victories for incumbents.

Our argument contradicts the narrative of Banerjee & Somanathan (2007), who suggest that improvement in public goods provision in high SC areas can be explained by the way SCs have abandoned the Congress Party and helped launch new caste-based parties. The success of these narrow parties like the BSP, they argue, has enabled SCs to extract public resources from the state. The absence of such mobilization among Scheduled Castes is the reason why they continue to garner state resources to their areas. From our perspective, while Caste-based parties can enhance the political voice of marginalized groups, the net effect on outcomes will also depend on the impact such parties have on shaping the competitive environment.

We present some preliminary evidence documenting that variations in the effect of reservation are correlated with measures of electoral competitiveness. Figure 9 compares the difference in light output improvement in reserved (SC) areas against unreserved areas versus the difference in competitiveness in reserved and unreserved areas. The competitiveness measures are calculated separately for each state, based on all assembly elections

between 1991 and 2003. [3]

Margin of victory compares the vote share of the winning candidate to the second-place candidate. In the plot, states with more positive values on the x-axis are places where the average margin of victory was *larger* in reserved constituencies relative to unreserved seats. In West Bengal, for example, MLAs in reserved areas enjoyed margins of victory that were more than 4 points higher than for their counterparts in unreserved areas. Larger margins of victory indicate less competitive elections. The downward sloping line is consistent with our expectation that lower competitiveness in reserved areas leads to lower relative improvements in public service delivery.

We also compared the number of candidates that compete in state assembly elections. In all states except Maharashtra, fewer candidates ran in reserved elections than in unreserved elections. In Uttar Pradesh, reserved constituencies had nearly 7 fewer candidates running than in unreserved areas. Our expectation is an upward sloping line, which would indicate more positive effects of reservation on light output in states where the number of candidates that run in reserved areas is closer to the rate in unreserved ares. This is indeed the pattern we observe.

An additional indicator of political competitiveness can be gleaned by comparing incumbency re-election rates. In India, incumbency election reduces the likelihood of re-election in in state legislative elections (Uppal 2009). Given this background, we compare incumbency rates for reserved constituencies against those in unreserved constituencies. In general, incumbency rates appear quite similar in most states, as evidenced by the clustering of points near zero difference on the x-axis. In a few states like West Bengal, incumbents in reserved constituencies enjoy substantially higher re-election rates. Meanwhile, states where incumbents win less in reserved areas, like Gujarat, have experienced much higher improvements in light output in those same reserved areas. Himachal Pradesh

[3] We are in the process of adding more recent election results through 2008 and for other states.

appears to be an outlier from the general pattern observed across the rest of the country.

We also compared rates of turnout to see whether voters are less inclined to vote in reserved constituencies. This is the case in all states except Tamil Nadu and West Bengal. However, as the scatter plot demonstrates, there is no discernible trend between differences in turnout and differences in light output. In this case, the turnout data are not consistent with our expectation that diminished competitiveness leads to negative effects of reservation on public service provision.

However, across these indicators, the data suggest that the effect of reservation is correlated with political competitiveness, as our theory expects. An obvious weakness in this analysis is that it compares only state level averages. A more compelling design, which we intend to pursue, is to examine within state variations to compare competitiveness measures at the constituency level.

8 Conclusion

We use a geographic discontinuity design to overcome the difficulties in using observational data to estimate the treatment effect of political reservation. By comparing villages just inside a reserved state assembly constituency border with villages just outside, we demonstrate that reservation has a negligible effect on average across India. However, by unpacking the data and looking within India's regions, we show that the effect is actually highly variable, swinging from positive in many states to negative in others.

These findings highlight one of the pitfalls of estimating and interpreting treatment effects in both experimental and quasi-experimental research. While sample size and other data limitations lead analysts to focus on identifying average treatment effects, ignoring the compositional variation underlying those effects can be treacherous. Our first look at the data suggested a null average treatment effect. Yet in fact, that null effect was

(a) Margin of Victory

(b) Number of Candidates

(c) Prior Wins by Incumbent

(d) Voter Turnout

Figure 9: Comparing Light Output Improvements to Political Competitiveness
State Average Differences Between Reserved (SC) and Unreserved Seats

comprised of effects varying from positive to negative across our state sub-samples.

We present tentative evidence suggesting that the effect of reservation depends on how severely political competition has diminished as a result of the policy. When the response has been the politicization of Caste and the formation of narrow Caste based parties, competition is more likely to have suffered. But where Scheduled Caste interests have been incorporated into the platforms of broad based parties, reserved seats have remained as competitive as in unreserved areas.

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