

Political Representation, Forest Cover, and Development in Rural India

Onupurba Das

^aUniversity of Massachusetts, Amherst

Abstract

The reservation of political positions for members of historically marginalized groups is a policy approach used in many contexts to address persistent inequities in outcomes. This study investigates the impacts of caste-based political reservations for local leadership position on development and environmental outcomes in rural India. In 1992, India mandated that village council leadership positions be periodically reserved for members of historically oppressed caste groups on a rotational basis. These reservations result in quasi-random changes in local leadership, which I leverage to estimate the effect of marginalized groups in local leadership on measures of natural resource utilization and economic development across 4,500 villages in Karnataka for the elections from 1994-2010.

Using forest cover as a measure of environmental outcomes and nighttime lights as a proxy for economic activity, I find that leadership reservations are associated with statistically significant reductions in forest cover and increases in local economic activity. Specifically, councils with reservations for Scheduled Caste (SC) or Scheduled Tribe (ST) leadership experience a 1% increase in night lights intensity and a decrease in forest cover by 0.189 percentage point (3% at baseline forest cover) relative to villages without such reservations in the same period. These findings suggest that leaders from historically marginalized groups may rely more heavily on local environmental resources for economic advancement, allowing greater resource utilization to facilitate development within their

Email: odas@umass.edu (Onupurba Das)

URL: <https://onupurbadas.github.io> (Onupurba Das)

communities. Disaggregating these effects reveals larger impacts for ST-led councils compared to SC-led councils. This result is consistent with the idea that ST communities are more dependent on local natural resources, but challenges the notion that indigenous leadership might prioritize environmental conservation. Taken together, my results show that reservations for local leadership positions can provide access to meaningful political power for marginalized groups, which can lead to important community outcomes. However, my findings also serve as a reminder that external notions of the priorities and motives of marginalized groups may not always be correct or predictive of outcomes following increases in political power for such groups.

[For an updated version of the paper please access this link!](#)

1. Introduction

Equitable and inclusive representation in political decision-making is increasingly recognized as essential—not only for social justice but also for meaningful development and the sustainable management of shared resources [1, 2, 3, 4, 5, 6, 7]. In developing economies, in particular, political power plays a crucial role in determining how resources are allocated/distributed, shaping development outcomes and, in turn, both individual and community well-being. However, access to political representation is often restricted, particularly for marginalized groups, who frequently lack the power, status, or resources to advocate for their interests, especially against more powerful actors in society [8, 9]. In response to such persistent inequities, many countries have enacted electoral quota policies to empower historically excluded groups. In India, electoral quotas, called reservations, have been adopted to address the millennia old oppressive social structure known as the caste system. The caste hierarchy has relegated certain groups and tribal communities to the peripheries, where marginalization remains deeply entrenched, restricting access to social, political, and economic power. This study will evaluate the extent to which reservations for local political leadership positions yield meaningfully improved outcomes for the

communities in which they are applied.

In 1992, the Indian government mandated that the leadership position of village councils be reserved for members of two historically oppressed caste groups - Dalits (Scheduled Castes, SC) and Adivasis (Scheduled Tribes, ST) - on a rotating basis in rough proportion to the population share of these groups in each village. I will evaluate how the rotating application of these reservations from 1994-2007 impacted economic and environmental outcomes at the local level.

Here, reservation refers to the process where certain electoral positions can only be contested for by candidates from the castes for which it was “reserved”. Previous research on reservation policies has shown that these policies can enhance political participation and direct resources toward marginalized communities, while also influencing the distribution of and local access to public goods [10, 11, 12, 13, 14, 15]. Most studies on the efficacy of political reservations in India have focused on development and participatory outcomes, using survey or census data and qualitative insights from a few districts [16, 17]. While these studies provide insights into caste representation and document impacts in some domains, their generalizability is uncertain [18, 15]. I examine the impacts of SC/ST reservations on a large scale and find geographic granularity previously lacking in the literature.

In particular, I analyze a yearly dataset of over 4500 village spanning five electoral cycles in Karnataka, a southern state of India, to assess the impact of caste-based political representation for SC/ST groups on two outcomes: forest cover, indicating differences in impacts on local environmental resources, and night-time lights, serving as a proxy for local economic activity and development. Using village-year observations as my unit of analysis, I offer causal evidence on how caste-based leadership influences local forests and economic growth, contributing empirical evidence to the literatures on political representation, development, and environmental resources

I provide evidence that caste reservation assignments are quasi-random and then apply a difference-in-differences identification strategy to compare outcome changes between

reserved and unreserved village councils over time and across elections. Using a two-way fixed effects model with village and time fixed effects, I estimate the average causal effect of SC-ST leadership on local outcomes and also decompose the effect for SC and ST reservations separately. To allay concern of confounding from SC-ST population shares in the first election with reservations I show my results are robust to the exclusion of this time period from the analysis. I further demonstrate the validity of my main estimates by showing their close comparability with estimates from a pair of new identification approaches which address bias arising from heterogeneous treatment effects in two-way-fixed-effect difference-in-differences models.

My main estimates indicate that SC-ST leadership is associated with improvements in local economic outcomes and reductions in forest cover. In particular, I find that villages with SC-ST reservations realize a 0.10 percentage point (1%) increase in nighttime light brightness and a 0.189 percentage point decrease (3% relative to average of 6.21% at baseline) of forest cover relative to villages without reservations. Decomposition of these estimates reveals more pronounced effects for ST compared to SC castes. This contrasts with the conventional view that indigenous groups inherently protect forests, and may suggest that meeting basic needs for food and housing may take priority over environmental conservation, or that the utilization of forest resources is more important for the level or paths of economic advancement of ST communities.

The paper is organized as follows: Section II covers the caste reservation system and its implementation in Karnataka. Section III describes the empirical strategy and data sources. Section IV presents the results, and Section V discusses policy implications and concludes.

2. Background

Our analysis centers on reservations at the village council level. To provide context, the following section offers an overview of local governance, the role of caste in India's social

hierarchy, and the reservation system within local councils. We also outline the reservation process in Karnataka, which forms the foundation of our identification strategy.

2.1. Village Councils

The 1990’s in India introduced a range of political reforms aimed at decentralizing political power and establishing a more participatory governance structure, leading to the 73rd Constitutional Amendment Act of 1992. This act formalized Panchayati Raj Institutions (PRI) of local governance or established them where they previously did not exist. These reforms were a response to multiple reports highlighting previous efforts’ failures to engage rural communities in their own development, citing the lack of authority, resources, and autonomy in local institutions - and the “insufficient representation of weaker sections like Scheduled Castes, Scheduled Tribes and women”.

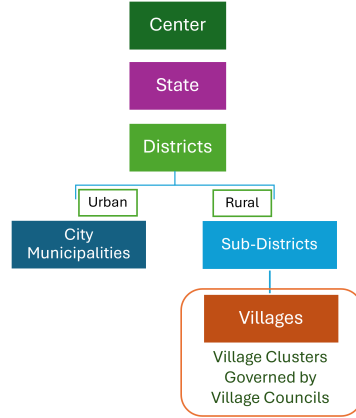


Figure 1: Administrative hierarchy in India

Figure 1 illustrates the multi-tiered governance structure in India, from the national level down to villages in rural areas, where a substantial portion of the population resides¹. Within this structure, each village cluster - comprising 1 to 20 villages - serves as an autonomous unit for local governance. Hereafter, we refer to this unit as a village cluster. The village council (Gram Panchayats or a village republic, referred to as village councils or councils hereafter) is the democratically elected body representing this cluster of villages, with authority over planning economic development, promoting social justice, managing community resources, and distributing government benefits for the villages under its purview. Councils play a crucial role in community well-being, delivering essential services like sanitation, healthcare, and education, managing local resources such as water

¹In 1990, 74%(≈ 648 million people) of India’s population was rural, and even today, rural communities make up a significant 65% (around 909 million people as of 2022).

bodies and pasture lands, and administering government funds for projects ranging from poverty alleviation to infrastructure, actively shaping India’s rural landscape.

The council is led by a Chairperson, who oversees its functions, presides over meetings, and represents the council at higher governance levels. As the only officially paid member, the Chairperson holds substantial influence, particularly in selecting beneficiaries for government schemes and directing the allocation of resources. Empirical studies confirm the Chairperson’s discretion significantly impacts local development outcomes, shaping the council’s priorities and the distribution of public goods within the village cluster [17, 12, 11, 14, 15].

2.2. Caste and Marginalization

Caste, a deeply rooted social hierarchy in the Indian subcontinent, has long defined India’s social structure. This system, comprising thousands of castes grouped into five broad categories, further divides these groups into “upper” and “lower” castes, with rigid social rules and endogamy reinforcing caste boundaries across generations. The resulting stratification imposes stark social, economic, and political implications from birth, limiting individuals’ rights to self-determination and shaping their economic class, social capital, and political representation.

This paper follows the Indian government’s caste classifications: General Category (upper castes with historical privilege), Other Backward Castes (OBCs, with disadvantaged socio-economic outcomes), Scheduled Castes (SC, or Dalits, who have historically faced severe discrimination and social exclusion, resulting in lower human development outcomes), and Scheduled Tribes (ST, indigenous communities who have also been socially marginalized and often live in isolated areas, such as hills and forests). Despite legal protections against caste discrimination and affirmative action policies, caste remains a substantial barrier to equitable outcomes, with SC and ST communities experiencing higher poverty rates, lower literacy levels, and limited access to essential services like healthcare and education. These persistent caste-based inequalities continue to impede economic mobility

and welfare, affecting one-third of the population. Addressing these disparities is both a key motivation for our work and underscores the need for ongoing policy improvements.

The architect of India’s constitution and a vocal critic of the caste system, Dr.B.R. Ambedkar, condemned village republics as the ‘ruination of India’, calling them ‘sinks of localism, ignorance, and communalism’. Caste hierarchies are often more overtly enforced in rural areas, where traditional social structures, economic reliance on caste-based occupations, and limited educational access reinforce these divides.² In response to these deep-rooted inequities, reservation policies were introduced to address historical injustices and provide marginalized castes with representation in governance.

2.3. Reservations

The 73rd Constitutional Amendment of 1992 introduced electoral quotas, known as reservations in South Asia, within local governing bodies, mandating reserved seats in village councils for Scheduled Castes (SC), Scheduled Tribes (ST), and women. For instance, a seat reserved for SC candidates is open only to those from the SC community. This paper focuses on caste-based reservations in local governance; although women’s reservations intersect with caste quotas, we treat them as a constant, as they apply uniformly within each caste group (with one-third of seats in each group reserved for women). A summary of the seat allocation process is included below, as it is integral to our identification strategy.

In the context of caste, the amendment establishes two types of reservations: one for council members and, more notably, one for the Chairperson of each council. For council members, the number of reserved seats for SCs and STs is proportional to the population of these groups in the area. For Chairperson positions, the amendment aims to ensure that (i) the proportion of Chairperson positions reserved for SCs and STs in councils reflects their population share within the state; (ii) at each level of governance, Chairperson

²It is important to note that caste discrimination is not absent in urban areas. Though the forms and intensity may differ, and while urbanization and modernization can mitigate some aspects of caste discrimination, systemic inequalities persist across rural and urban settings.

roles reserved for SCs and STs should match with their population percentages; and (iii) these reserved Chairperson positions rotate among councils, across election cycles, to allow multiple councils, not just a few, the chance to experience SC- and ST-led governance. Before examining how these stipulations were adopted, we turn to the specific context of Karnataka, where the implementation of reservations provides us a setting for our analysis.

2.4. Reservations in Karnataka

Responsibility for implementing the reservation stipulations in the 73rd Amendment fell to individual states, allowing flexibility in interpretation and assignment processes, resulting in variation across states, particularly in council and chair election procedures. Given these differences, we focus our analysis on Karnataka - a state with a long history of village governance, early adoption of reservations, significant council expenditure authority, geographic diversity, and robust reservation data—making it an ideal setting for us to explore effects of caste reservations.

The reservation process for chairperson positions in Karnataka’s village councils follows a structured approach to ensure fair representation for SC, Scheduled Tribes ST, and OBC and we describe this process here in some detail. First, the SC and ST populations are calculated as a percentage of the state total—approximately 18% for SC and 9% for ST—determining that these proportions of the ≈ 6000 councils will be reserved for each group, respectively. This proportionate reservation is replicated at the district and sub-district levels. Within each sub-district, councils are sorted by the proportion of SC or ST population, and reservations are assigned accordingly. For SC reservations, councils are ranked from highest to lowest SC population, with the top-ranked councils receiving SC chair reservations; if ties occur, selection is random. Once SC reservations are set, these councils are removed, and ST reservations are assigned following the same process, ensuring that SC and ST categories remain mutually exclusive. The same method is then applied for OBC reservations after excluding councils already reserved for SC or ST. In subsequent election terms, councils cannot receive the same reservation category twice in a

row, although SC-reserved councils may be allocated ST reservations, and vice versa. This rotation process ensures broader representation over time. While much of this information is drawn from secondary sources, our limited conversations with officials at the Ministry of Panchayati Raj confirmed many of these insights, even if not all specific details.

The first council election in Karnataka with reservations was held in 1994, with subsequent elections every five years. While council members serve five-year terms, beginning in 2000, chair reservations rotated every 2.5 years, leading to a new chair elected internally by council members every 30 months. This rotation resulted in chairs being elected in 1994 and after in 2000, 2002, 2005, and 2007. Although council elections are indirect—voters elect council members, who then select the chair (Adhyaksha) and vice-chair (Upadhyaksha) - it is generally well known who is likely to contest for the chair, especially because council elections happen locally. Additionally, Karnataka introduced reservations for OBCs (other Backward Castes mentioned in the previously) as well, adding further complexity to the council chair reservation process, which we describe next.

The introduction of these reservations led to rapid shifts in the composition of councils, where members from SC and ST castes, historically excluded from decision-making, began to assume leadership roles. This change creates a natural experiment for our analysis, providing the variation we leverage: councils transitioning from no SC/ST leadership to having rotating leaders from these marginalized groups. Notably, while the leadership rotates, the proportion of SC/ST members within each council remains consistent with their population share. This stability, along with multiple election terms in our dataset, supports the argument that SC/ST representation in the general council membership does not confound our analysis of the leadership effects.

3. Data and Descriptive Statistics

To estimate the effect of caste reservations on forests and development, we compile a panel dataset with reservations, tree cover, night-lights and census information at the GP1

level using five different datasets.

3.1. Reservation Data for Karnataka

Our reservation dataset includes the caste reservation status of village councils from 1994 to 2007 in Karnataka. Data were provided by the Karnataka State Election Commission and obtained by us from Dunning and Nilekani [15] (2013). This dataset contains information on council leadership reservation status in all the 5 reservation terms, which started with the first reservation in 1994, with the next in 2000, after which it was rotated every 18 month in 2002, 2005, 2007. We limit our analysis through the year 2010, which was when the next reservation rotation took place. The reservation status includes the particulars of the specific caste for which the council was reserved. This includes both chairperson, vice-chairperson and membership reservation for Scheduled Castes (SC), Scheduled Tribes (ST), Other Backward Classes castes (OBC). Table 1 shows the number of reservations for each of these caste groups by election terms. The total number of council chairperson positions reserved for castes in the state depend on the proportion of population of those castes in the state as evaluated in the last census before the reservation term (1991 and 2001 for this papers study period).

For our current analysis, we only consider the reservation status of the chairperson as the power of the chairperson is greater than individual council members and the the chairperson is also the only paid member of the council. We create two separate reservation variables, the first, is a 0/1 binary indicator to denote any reservation (SC or ST) for chair and the second is a set of indicators for a chair reservation for each specific caste group, which is discussed in more detail in the specifications in the next section. We only kept the 4863 councils that had complete information.

Election Term	Disaggregated into			
	Unreserved	SC/ST	SC	ST
1994	3868 (76.85%)	1165 (23.15%)	896 (17.80%)	269 (5.34%)
2000	3841 (76.32%)	1192 (23.68%)	923 (18.34%)	269 (5.34%)
2002	3843 (76.36%)	1190 (23.64%)	920 (18.28%)	270 (5.36%)
2005	3721 (73.93%)	1312 (26.07%)	903 (17.94%)	409 (8.13%)
2007	3704 (73.59%)	1329 (26.41%)	902 (17.92%)	427 (8.48%)

Table 1: Distribution of reserved and unreserved village council leadership positions across election terms, further disaggregated into Scheduled Caste (SC) and Scheduled Tribe (ST) reservations. The table shows the number and percentage of councils in each category for each election term.

3.2. Forest Cover Data

Our forest cover data measures are from the satellite-based MEaSURES³ Vegetation Continuous Fields V001 (VCF or simply forest cover going forward) dataset[19, 20], which provides annual global vegetation cover as a percent of each pixel covered by vegetation. This dataset has a 0.05-degree (≈ 5600 m) resolution and runs from 1982-2016. The VCF improves upon the landcover maps in accuracy because it is able to capture sub-pixel and within land-class variability and circumvents the dependency on having the appropriate land class classification. We choose this VCF product over it’s more granular successor, the MODIS/Terra VCF version, because it is a long, consistent data record that allows us to capture a significant portion of the pre-reservation period (1982-1993), providing a more reliable dataset for analyzing forest cover trends over time.

The VCF dataset captures tree cover, non-tree vegetation, and bare ground using machine learning algorithm applied to various daily AVHRR/MODIS measurements on Landsat⁴-based training data. For our forest cover variable, we use the tree cover layer which

³MEaSURES: Making Earth System Data Records for Use in Research Environments

⁴Landsat refers to a series of Earth-observing satellites that provide high-resolution imagery of the

gives percent of pixel covered by trees greater than or equal to 5 meters tall. Since the VCF data for the years 1994 and 2000 were not produced, we linearly interpolated these missing tree cover layers with the prior and subsequent annual maps on a per-pixel basis. We convert the VCF raster to polygons and extract the aggregate forest cover within the census village before aggregating to the entire village council area level. Considerable year-to-year noise exist in the VCF data, following others[21] we use a 3 year moving average as our main outcome measure.

Across the whole state of Karnataka, the VCF measures indicate a 15% increase in forest cover over the sample period, aligning with official and international estimates. The VCF dataset effectively captures partial forest loss, offering a nuanced view of forest cover changes. Since 98% of councils are larger than the VCF pixel size, the benefit of maintaining data continuity from 1982 to 2016 outweighs the potential gains from higher resolution MODIS/TERRA data available only post-2000. Geographically, while dense forests are concentrated in specific areas, regions with 20-40% forest cover are spread across the state. This distribution is illustrated in the Online Appendix Figure, which presents heat maps of forest cover in 1983, 1992 and 2010.

3.3. *Nightlights*

The nightlights data comes from the Earth Observation Group who use imagery taken by DMSP-OLS⁵ to produce global Nighttime Light maps. The DMSP-OLS data provide global annual nighttime light data from 1992 to 2013, making it the longest data series available for night-time remote sensing on human activities. This data has been widely used in areas of study such as urbanization monitoring, socio-economic parameters estimation, and disaster assessment[22]. The night-lights data is a unitless measure of night-time brightness, taking on values $\in [0, 63]$. Given the skewed distribution of the brightness measure, we use an inverse hyperbolic sine transformation.

Earth's surface, widely used for monitoring vegetation, land use, and environmental changes.

⁵Defense Meteorological Satellite Program's Operational Line Scan

3.4. Village Council Area Boundaries

Constructing accurate Gram Panchayat (GP1) boundaries was a critical step in this analysis. To address this, we combined village-to-GP1 mappings from the Ministry of Panchayati Raj’s administrative data[] with 2001 census village boundary maps from NASA’s SEDAC dataset[23]. This allowed us to aggregate village-level data, such as forest cover and census variables, to the GP1 level using area-weighted averages.

To validate these boundaries, we cross-referenced them with an alternative GP1 boundary dataset derived from spatial maps. The two methods produced highly correlated results, providing confidence in the constructed GP1 boundaries and their suitability for linking reservation allocations and outcomes in this study.

Our analytic dataset is a balanced panel of 4863 councils, with annual observations from 1983-2010⁶. The first reservation was in 1994 and we include data for reservation changes in 2000, 2002, 2005 and 2007.

4. Empirical Framework

This section outlines the empirical strategy used to estimate the short-run effects of caste-based political reservations on local forest cover and economic activity. Employing a difference-in-differences framework and a two-way fixed effects model, the analysis leverages the quasi-random assignment of reservations to identify causal impacts of leadership from marginalized castes on these key outcomes.

4.1. Main Specification 1: TWFE

The aim here is to estimate the contemporaneous (short-run) effects of having a council leader from a marginalized caste on local forest cover and night-time lights intensity. To

⁶Our dataset covers 4863 council in rural Karnataka, representing approximately 87% of councils and 85% of the rural population in the state.

achieve this, a difference-in-differences (*DiD*) identification strategy is employed, comparing changes in outcomes between reserved and unreserved councils over time to estimate the treatment effect of reservations.

This is implemented using a two-way fixed effects (TWFE) regression model, which accounts for both council-specific characteristics and common time shocks. The model is specified for each council i in year t , covering the pre-reservation periods and five election terms from 1983 to 2010:

$$Y_{it} = \beta \cdot Reservation_{it} + \gamma_i + \delta_t + \epsilon_{it} \quad (1)$$

Where Y_{it} is the outcome of interest, γ_i denotes council fixed effects, and δ_t the year fixed effects. The key parameter of interest is β , the coefficient on $Reservation_{it}$, which indicates whether the council leadership position in a given year is reserved for a candidate from a marginalized caste, capturing the average treatment effect of this reservation. Additionally, we consider several alternative definitions of this reservation variable to separately indicate specific types of reservations.

The estimates include council and year fixed effects to control for time-invariant characteristics, such as baseline geographical or demographic differences, initial forest cover, and year fixed effects account for any time-varying shocks common across councils in Karnataka. We also cluster standard errors at the treatment allocation level to address within-unit correlation, which, in this case, is at the council level.

4.2. Independent Variable Definitions

In all specifications, this paper considers two definitions of the key independent variable: the caste reservation status of council leadership. First, $Reservation_{it}$ is defined as a binary variable, where council leadership is considered reserved if the council has either Scheduled

Castes (SC) or Scheduled Tribes (ST) reservations, and is set as follows:

$$Reservation_{it} = \begin{cases} 1 & \text{if the leadership position is reserved for SC/ST} \\ 0 & \text{Otherwise} \end{cases}$$

This specification captures the overall effect of caste reservations by combining SC and ST reservations. Although these two groups are not homogeneous, this approach enables an estimation of the average impact of SC/ST-based reservations in leadership positions on forest cover and development outcomes. For this analysis, councils with BC reservations and those where the leadership position is unreserved (General category) are included as part of the control group. Additionally, as a robustness check, an alternate specification combines SC, ST, and BC reservations into a single treated group, contrasting it with the General (unreserved) category as the control group.

We also decompose the main estimates by caste categories (SC and ST) to assess the separate effects of leadership from each group. This distinction facilitates an analysis of how leadership from different castes influences outcomes. Considering the distinct histories and social contexts of SC and ST groups, evaluating SC reservations separately from ST reservations will yield valuable insights. Here, $Reservation_{it}$ is defined as a categorical variable:

$$Reservation_{it} = \begin{cases} SC & \text{if the position is reserved for Scheduled Castes} \\ ST & \text{if the position is reserved for Scheduled Tribes} \\ 0 & \text{Otherwise} \end{cases}$$

The effect of caste reservations is first estimated on forest cover, measured as the percentage of forest within the council area, and then on development, using night-time lights intensity as an indicator. In this context, β captures the same-year average treatment effect of reservations on these outcomes.

While β is interpreted as the average treatment effect of having marginalized caste leaders in councils, this estimate technically represents an Intent-to-Treat (ITT) effect. This distinction arises because the data reflect the reservation status assigned by the government rather than the actual caste of the council leader. While this paper does not directly verify that the assigned council leader is always from the reserved caste, nor can it entirely rule out the possibility of unofficial takeovers by members of dominant castes, it is important to note that adherence to the assigned reservation status is legally mandated. Conversations with senior bureaucrats in the department overseeing councils affirm that these reservations are generally followed in practice. This is further supported by numerous studies indicating that such reservations are often respected [24, 10, 15].

It is also worth noting that the estimates may not accurately reflect the impacts when a member of SC/ST wins a leadership role without reservations. In any case, the estimate still represents the effect of the reservation policy itself. In fact, since the analysis likely includes instances where reservations were disregarded, as well as cases where SC/ST members attained leadership positions without reservations, this estimate may understate the true effect of having genuine SC/ST leadership in place. By estimating the impact of the reservation policy, at least part of the leadership effect is captured, which may provide a lower bound on the overall impact.

In the baseline model, the focus is on estimating the short-run (same-year) causal effect of leadership reservations for marginalized castes, using minimal controls. A potential confounder in this analysis is the number of marginalized caste members in the council (and, by extension, the proportion of these caste groups within the village cluster), which could influence both reservation status and outcomes.

Since reservations in the first election term (1994) were assigned based on councils with the highest proportions of marginalized caste members within each sub-district, the representation of SC/ST members likely had a strong influence on reservation assignments during this initial period. However, from the data it is observed that SC/ST leadership

reservations are distributed across councils with varying numbers of SC/ST members. While councils with a higher SC/ST population were more likely to have SC/ST leaders in the first term, the distribution data indicates that reservations are not concentrated in councils with the highest SC/ST numbers but rather are spread across a broader range of SC/ST representation. Over subsequent terms, the rotation system within sub-districts introduced a degree of randomness, weakening the correlation between council demographics and reservation assignments.

To ensure that excluding SC/ST population shares does not bias the results, robustness estimates are included that account for the SC/ST council proportion, testing the sensitivity of the findings. Additionally, the robustness of the results is assessed by excluding the 1994 election period, when the correlation between SC/ST populations and reservation assignment was most direct.

Although the probability of reservation status was initially higher for councils with larger SC/ST populations, the subsequent allocation process introduced enough randomness to make exogeneity plausible. Thus, the identification strategy relies on the assumption that, in the absence of caste reservations, treated and control councils would have evolved along similar paths.

5. Results

5.1. TWFE Results

This section presents the estimated effects of SC-ST leadership reservations on forest cover and nightlight intensity, using the model in equation 1, which includes both council and year fixed effects. The analysis estimates the effects of SC-ST reservations by comparing outcomes during years with SC-ST leadership to years without, leveraging within-council variation while accounting for broader temporal trends across councils.

5.1.1. Impact of SC-ST Leadership on Forest Cover and Economic Activity

Table 2 presents the main effects of SC-ST leadership reservations, estimated using a two-way fixed effects model. Councils with SC-ST leadership show a decrease in forest cover by about 0.189 percentage points in its reserved years, compared to their unreserved years, indicating a slower rate of forest cover growth. Over the study period, average forest cover increased from 5.64% in 1983-84 to 8.41% in 2009-10, with years under SC-ST leadership experiencing smaller increases in forest cover compared to non-reserved years. This difference corresponds to a roughly 3% reduction in forest cover growth relative to a baseline of 6.21% in 1991-92, reflecting short-run effects.

	Forest cover		Nightlights	
SC-ST				
SC/ST	-0.189	***	0.010	***
	(0.032)		(0.003)	
Fixed Effects	Council & Year		Council & Year	
Obs	136164		92340	

*** p<.01, ** p<.05, * p<.1

Table 2: Estimated impact of combined SC/ST leadership reservations on forest cover and nightlights. The model includes council and year fixed effects, capturing the average contemporaneous effect of reservations.

In terms of economic activity, SC-ST leadership is associated with a 0.01 increase in night lights intensity (in the transformed measure), equivalent to a 1% relative increase. Night light intensity grew substantially across all councils from 1992 to 2010, with reserved years showing relatively higher increases in brightness compared to unreserved years, suggesting greater local economic activity during periods of SC-ST leadership.

5.1.2. Disaggregated Impact of SC and ST Leadership

Table 3 presents the disaggregated effects of SC and ST leadership on forest cover and nightlights. Relative to years with neither SC nor ST reservations, SC-led councils experience a 0.180 percentage point (roughly 2.90% relative to a mean of 6.21%) reduction in forest cover, while ST-led councils show a slightly larger reduction of 0.215 percentage points (approximately 3.46% at the same mean). For nightlights, SC-led councils see

a 0.9% increase in brightness, and ST-led councils show a 1.4% increase, both relative to unreserved years. Here, similar patterns of SC and ST reservations on outcomes are observed although with with differing magnitudes.

	Forest cover		Nightlights	
SC or ST				
SC	-0.180	***	0.009	**
	(0.034)		(0.004)	
ST	-0.215	***	0.014	**
	(0.063)		(0.006)	
Fixed Effects	Council & Year		Council & Year	
Obs	136164		92340	

*** p<.01, ** p<.05, * p<.1

Table 3: Estimated impact of disaggregated SC and ST leadership reservations on forest cover and nightlights. Council and year fixed effects are included, capturing the average contemporaneous effect of reservations for each group.

Notably, the disaggregated results show that impacts of SC and ST reservations move in the same direction, with both associated with reduced forest cover and increased nightlight intensity relative to unreserved years, though the magnitude is observed to be larger for ST leadership for both forest cover and nightlights. The consistency in direction across SC and ST leadership adds to the justification for treating SC and ST reservations as a unified category in the main estimates, while recognizing that ST leadership may produce more pronounced effects. So, these patterns suggest that both SC and ST leadership result in decreased forest cover and increased nightlight intensity, although ST-led councils may have relatively larger impacts on local outcomes compared to SC-led councils while giving us confidence in our main estimates.

The final results are based on the fourth columns of Appendix Tables [A.8](#), [A.9](#), [A.10](#), and [A.11](#), which display the stepwise addition of fixed effects. These tables show the impact of adding fixed effects for village council and year, with the fourth column reflecting the final regression model that includes both council and year fixed effects. By controlling for both time-invariant council characteristics and general yearly trends, this specification isolates the effects attributable to SC-ST leadership. This results section present these

final, fully controlled estimates, and further details on the incremental addition of fixed effects can be found in the appendix.

5.2. Robustness Checks

To assess the reliability of these findings, this subsection presents a series of robustness checks, including alternative time units, subsample analysis, and specification tests.

5.2.1. Aggregating Data by Council-Election Term

To test whether the main findings hold when the temporal unit of analysis is varied, I aggregate the data by council-election term rather than by individual years. Each election term spans approximately 2.5 years, aligning with the period of SC-ST leadership after each election cycle (see Appendix Table B.12 for term construction). This approach smooths out short-term yearly fluctuations, providing an average impact of SC and ST leadership over the election term.

Table 4 presents the term-level effects of combined SC/ST leadership reservations on forest cover and night lights, while Table 5 provides disaggregated effects for SC and ST reservations separately. The results are consistent with the yearly analysis: SC/ST leadership is associated with a statistically significant reduction in forest cover and an increase in night lights intensity, even when averaged over the election term. Specifically, SC-led councils show a reduction in forest cover of approximately 0.228 percentage points and an increase in night lights of 1.1%, while ST-led councils experience a slightly larger impact with a reduction in forest cover of 0.269 percentage points and an increase in night lights of 2.0%.

These findings confirm that the observed effects on forest cover and local economic activity are not driven by short-term fluctuations within the reservation period but reflect consistent short-run impacts of SC and ST leadership while the reservation is in effect. This robustness check supports the reliability of the main results, reinforcing that these effects are attributable to SC-ST leadership over the reservation period rather than to temporary

	Forest cover		Nightlights	
SC-ST				
SC/ST	-0.239	***	0.013	***
	(0.032)		(0.003)	
Fixed Effects	Council & Year		Council & Year	
Obs	58356		43740	

*** p<.01, ** p<.05, * p<.1

Table 4: Term-level regression results for the combined SC/ST reservation variable on forest cover and nightlights. Council and term fixed effects are included, capturing the average contemporaneous effect of reservations over electoral cycles.

	Forest cover		Nightlights	
SC or ST				
SC	-0.228	***	0.011	***
	(0.033)		(0.003)	
ST	-0.269	***	0.020	***
	(0.061)		(0.006)	
Fixed Effects	Council & Year		Council & Year	
Obs	58356		43740	

*** p<.01, ** p<.05, * p<.1

Table 5: Term-level regression results for the disaggregated SC and ST reservation variables on forest cover and nightlights. Council and term fixed effects are included, capturing the average contemporaneous effect of reservations for each group over electoral cycles.

variations.

5.2.2. Testing Robustness with Adjusted Samples and Controls

Tables 6 and 7, present three robustness checks. Two of these checks specifically assess whether the main estimates for SC and ST leadership effects could be confounded by the SC/ST population proportion, as discussed in the empirical section.

In tables 6 and 7, Columns (1) for both forest cover and night lights applies the main specification to a sub-sample that includes only the observations with census variables available. While this column provides a check on whether the inclusion or exclusion of certain data affects the results, it primarily serves as a baseline for comparison with Column 2. Column 2, is the main specification with SC and ST population proportions from the 1991 census included as controls using year-by-SC/ST population proportion interactions.

	Forest Cover (FC)			Nightlight Intensity (NL)		
	Main Estimate (Smaller Sample) (1)	Year \times SC/ST Proportion (2)	Excluding 1994 Term (3)	Main Estimate (Smaller Sample) (1)	Year \times SC/ST Proportion (2)	Excluding 1994 Term (3)
SC-ST						
SC/ST	-0.212 *** (0.033)	-0.212 *** (0.033)	-0.268 *** (0.040)	0.009 *** (0.003)	0.015 *** (0.003)	0.013 *** (0.003)
Year \times SC Proportion(1991)		-0.003 *** (0.000)			0.000 *** (0.000)	
Year \times ST Proportion(1991)		-0.004 *** (0.000)			0.000 *** (0.000) **	
Obs	129696	129696	106986	87989	87989	63180

*** p<.01, ** p<.05, * p<.1

Table 6: Robustness checks for SC-ST leadership effects on forest cover and nightlights, using adjusted samples and additional controls. Columns show various checks, including census-adjusted sample, year-specific demographic controls, and exclusion of early reservation years (1994–1999).

	Forest Cover (FC)			Nightlight Intensity (NL)		
	Main Estimate (Smaller Sample)	Year \times SC/ST Proportion	Excluding 1994 Term	Main Estimate (Smaller Sample)	Year \times SC/ST Proportion	Excluding 1994 Term
SC or ST						
SC	-0.203 *** (0.035)	-0.213 *** (0.035)	-0.254 *** (0.042)	0.008 ** (0.004)	0.016 *** (0.004)	0.010 *** (0.003)
ST	-0.239 *** (0.065)	-0.208 (0.065)	-0.307 *** (0.076)	0.013 ** (0.006)	0.011 * (0.006)	0.020 *** (0.005)
Year \times SC Proportion(1991)		-0.004 *** (0.000)			0.000 *** (0.000)	
Year \times ST Proportion(1991)		-0.000 (0.000)			0.000 ** (0.000)	
Obs	129696	129696	106986	87989	87989	63180

*** p<.01, ** p<.05, * p<.1

Table 7: Robustness checks for the impact of disaggregated SC and ST leadership reservations on forest cover (FC) and nightlight (NL). Column 1 presents the main TWFE estimate with a smaller sample, limited to councils with available census data. Column 2 adds year-by-SC/ST proportion interactions to account for demographic factors. Column 3 excludes the 1994 term to address potential correlations between SC/ST population proportions and reservation allocations.

The 1991 census likely informed the bureaucratic process of ranking villages by SC/ST population shares and it is clearly in the pre-reservations period.

6. Discussion and Conclusion

This study provides causal evidence that caste-based political reservations influence local environmental resources and economic growth in rural India. Using a difference-in-differences framework with two-way fixed effects, the analysis estimates the average treatment effect of SC-ST reservations on forest cover and economic activity, proxied by nightlight intensity. The results show that, relative to years without SC or ST reservations, SC-ST-led councils experience a 1% increase in economic activity, accompanied by a 0.189 percentage point reduction in forest cover (3% relative to the baseline mean of 6.21%). Robustness checks confirm these findings, showing that the results hold when the temporal unit of analysis is shifted from yearly to election term levels, when controlling for SC/ST population proportions from the census, and when excluding the term most likely to confound the outcomes. Together, these checks reinforce confidence in the main estimates presented in this paper.

The results suggest that reservations for marginalized groups are associated with increased economic development but come with a potential trade-off: reduced forest cover. Both Scheduled Castes (SC) and Scheduled Tribes (ST) often represent some of the poorest and most vulnerable populations. Their proximity to and reliance on local natural resources, particularly forests, may help explain the observed reductions in forest cover. Empowered through reservations, these groups may utilize forest resources to improve their living standards, driving the observed rise in development alongside declines in forest coverage. Meeting basic needs for food and housing may take priority over environmental conservation, with forest resource utilization playing a critical role in their economic advancement.

These findings offer an intriguing contrast to the conventional view that indigenous

groups inherently protect forests. Scheduled Tribes (ST) are historically associated with forested and hilly areas and are often more dependent on forests for their survival and livelihoods than other groups. At the same time, they are among the most vulnerable and economically disadvantaged populations in these contexts ⁷. When the main estimates are disaggregated, both SC and ST-led councils exhibit similar directional impacts on local outcomes, with increased economic development and reduced forest cover during reserved years. However, the magnitudes of these effects appear larger for ST-led councils. One explanation for this could be that ST communities, being more reliant on forests as a safety net for food, fuel, and income, may draw more heavily on forest resources when empowered through political representation. This increased resource utilization could drive more pronounced economic gains but also lead to greater reductions in forest cover. While the difference in magnitudes between SC and ST leadership is suggestive, it should be interpreted cautiously, as further research is needed to confirm and explore these patterns.

These results highlight the importance of balancing environmental conservation with poverty alleviation while addressing historical inequities. Local political reservations provide marginalized communities with opportunities to improve their living standards; however, the observed reduction in forest cover raises questions about how development goals can align with environmental sustainability. Historically, many of these groups have lived in and held stewardship of forests, but their ongoing marginalization has heightened their vulnerability. Meeting basic needs for food and housing could take precedence over conservation, where the utilization of forest resources may play a critical role in their economic advancement.

While these findings suggest that political reservations are an effective tool for improving economic outcomes, they also highlight the need to think about policies that can simultaneously support development and forest conservation. Achieving this balance would

⁷It is important to note that this observation does not imply greater marginalization of ST communities relative to Scheduled Castes (SC) in all areas; rather, it reflects their specific dependence on forests within the environmental and economic context of this study.

not only benefit the environment but also ensure the long-term sustainability of economic gains for these communities.

These findings open up avenues for future research. The next step is to examine the dynamic and long-term effects of caste-based political reservations, exploring how forest cover and economic outcomes evolve across different paths of reservation. Another promising direction is to investigate the intersection of caste and gender. In my other work, I find that gender significantly influences forest outcomes when women hold leadership positions for sustained periods and when more women are in positions of power. Building on this, it would be valuable to examine whether the intersection of caste and gender changes how leadership impacts forests and development. Expanding this research to other areas, such as the state of Jharkhand in India - where Scheduled Tribes represent a larger share of the population compared to Karnataka - could provide insights on how ST-led councils in regions with a stronger tribal presence effect forest cover outcomes and whether similar trade-offs exist. These directions offer ways to build on current research and understanding of how local political representation shapes both people's livelihoods and environmental outcomes.

Appendix A. Additional Tables for Fixed Effects Analysis

	1		2		3		4	
SC-ST								
SC/ST	-0.265	**	0.636	***	-1.137	***	-0.189	***
	(0.130)		(0.032)		(0.148)		(0.032)	
Fixed Effect	None		Council		Year		Council & Year	
Obs	136164		136164		136164		136164	

*** p<.01, ** p<.05, * p<.1

Table A.8: Stepwise fixed effects estimates for combined SC/ST reservation impact on forest cover, showing the progressive inclusion of controls to get to our main effect with both council and year fixed effects.

	1		2		3		4	
SC-ST								
SC/ST	0.166	***	0.166	***	0.028	***	0.010	***
	(0.010)		(0.007)		(0.009)		(0.003)	
Fixed Effect	None		Council		Year		Council & Year	
Obs	92340		92340		92340		92340	

*** p<.01, ** p<.05, * p<.1

Table A.9: Stepwise fixed effects estimates for combined SC/ST reservation impact on nightlights, showing the progressive inclusion of controls to get to our main effect with both council and year fixed effects.

	1		2		3		4	
SC or ST								
SC	-0.246	*	0.606	***	-1.092	***	-0.180	***
	(0.133)		(0.034)		(0.148)		(0.034)	
ST	-0.317		0.725	***	-1.265	***	-0.215	***
	(0.296)		(0.064)		(0.311)		(0.063)	
Fixed Effect	None		Council		Year		Council & Year	
Obs	136164		136164		136164		136164	

*** p<.01, ** p<.05, * p<.1

Table A.10: Stepwise fixed effects estimates for disaggregated SC and ST reservation impacts on forest cover, showing the progressive inclusion of controls to get to our main disaggregated effects with both council and year fixed effects.

These tables present the effect of SC-ST leadership on forest cover and nightlight intensity, progressively incorporating village council and year fixed effects. The final specification, including both council and year fixed effects, provides the primary estimates for

	1	2	3	4
SC or ST				
SC	0.177 *** (0.011)	0.150 *** (0.007)	0.050 *** (0.009)	0.009 ** (0.004)
ST	0.134 *** (0.019)	0.216 *** (0.013)	-0.034 ** (0.016)	0.014 ** (0.006)
Fixed Effect	None	Council	Year	Council & Year
Obs	92340	92340	92340	92340

*** p<.01, ** p<.05, * p<.1

Table A.11: Stepwise fixed effects estimates for disaggregated SC and ST reservation impacts on nightlights, showing the progressive inclusion of controls to get to our main disaggregated effects with both council and year fixed effects.

this study. The results indicate that adding fixed effects improves the precision of the estimates, giving us to twfe estimates of impact of SC and ST leadership.

Appendix B. Additional Details for Robustness Analysis

Term	Years	Election
1	82-84	
2	85-87	
3	87-89	
4	90-92	
5	92-94	
6	95-97	1994
7	97-99	1994
8	00-02	2000
9	02-04	2002
10	05-07	2005
11	07-09	2007
12	10-12	

Table B.12: Composition of term-level data used in robustness analysis, with years grouped into approximately 2.5-year electoral cycles. Each term aligns with election cycles to get election term level estimates estimates.

Table B.12 outlines the grouping of years into 2.5-year election terms for the robustness analysis, aligning each term with relevant election cycles. Terms are structured to capture

the impact of SC-ST leadership over each election period, providing a smoother average effect by minimizing annual fluctuations. Elections held in 1994, 2000, 2002, 2005, and 2007 correspond to specific terms, as shown.

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