# Do roads bring votes? Democratic accountability in rural India (Do not cite or circulate)

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*A large scale (40 billion USD+) rural roads program in India has provided access to over two third of Indian villages (200,000) that lacked a paved road in 2001. Ongoing research finds that this program has drastically improved local economic and development outcomes. Do citizens reward incumbent governments for these massive improvements in connectivity that have positively impacted their well being? I combine electoral data at national, state and polling station level across India with an original dataset that contains information on provision of over 180,000 rural roads to investigate whether roads provision affects the change in incumbent vote shares across rural India over nearly two decades (2000-2017). While research on democratic governance in developing contexts has significantly bolstered our understanding of accountability, endogeneity concerns remain a major hinderance. Exploiting exogenous criteria of road placement that were based on pre-determined village population thresholds, I am able to use instrumental variables and diff-in-diff approach to deal with endogeneity of roads provision and contribute with fresh evidence from the World's largest elections. This is the first such large scale examination of democratic accountability and also the first one in the Indian context. I find that citizens do not reward incumbents for improving connectivity. The effect is consistent across national and state level elections, across states as well as time periods. I finally use polling station from Uttar Pradesh on over 90,000 booths and from Rajasthan to examine the effect using fuzzy regression discontinuity at the micro-level. I combine this with individual level survey data from election studies as well as qualitative data from interviews to supplement these findings.*

## I. Introduction

*"Every single voter in West Champaran this reporter spoke to knew of the roads revolution, and credited the state government with it. Even Mantu Tiwari, a BJP supporter, grudgingly admits: 'City roads were always fine, but yes. he [Nitish] has changed rural roads here.' Travelling through the district on a burning afternoon, one sees girls in school dress running by freshly tarred roads, a sight unimaginable a decade ago. Given this visible change, Nitish should have been winning easily. Instead, his candidate here is struggling, and opinion polls suggest his party might even place a lowly fourth in the state.[1] "*

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[1]Source: *Indian Express.* 12 May 2014. https://indianexpress.com/article/india/politics/long-bumpy-road-between-development-and-votes/

*A. PMGSY*

Nearly one third of people worldwide that lack access to an all weather road live in India. Over half of India's 600,000 villages lacked a paved road in 2001. To deal with this lack of connectivity within India, the Indian Central Government launched the Pradhan Mantri Gram Sadak Yojana (PMGSY), a centrally sponsored rural roads scheme scheme. The scheme was introduced by the then-prime minister Atal Behari Vajpayee during the first full term and majority Bhartiya Janta Party (BJP) government in December 2000. The goal of PMGSY was to connect all habitations over 500. Eligibility to receive a PMGSY road was based on population thresholds and the program aimed to ensure all-weather access to all habitations with populations over 1000 by the year 2003, all habitations with populations greater than 500 by 2007, and all habitations with population over 250 after that as per Indian census 2001.[2] In hilly states and, desert and tribal districts, and districts with Naxalite insurgent activity, habitations with a population over 250 were considered. A second phase of the scheme was launched in 2013, which targets all habitations with populations over 100. According to World Bank estimates, expenditures under PMGSY were approximately 14.6 billion USD by end of 2010, and are expected to reach close to 54 billion USD towards its completion scheduled in 2020. As of March 2018, 186,000 roads have been constructed (source: PMGSY administrative data).

PMGSY has been often described as remarkable, and exemplary in its level of planning, monitoring and control. Selection of PMGSY roads is based on a *core network of roads*, which was determined ex-ante in 2001 using the census 2001 as its base for population data. The core network and the Indian Census in 2001 therefore form the basis on which villages are granted rural roads till date.[3] While the funding for the PMGSY initially was sponsored solely by the central government, and later modified to include a contribution from the state, the uptake of the program and its implementation lies solely with the state government. The scheme is managed by district level programme implementation units, which are under the control of State Rural Roads Development Agencies, that are generally housed in the state level Public Works Department (PWD). The central controlling agency called National Rural Roads Development Agency (NRRDA), which is an independent national agency under the control of a central level senior bureaucrat (secretary level position from the Indian Administrative services) at the Department of Rural Development, monitors and approves the ongoing project.

The NRRDA ensures that the data for each and every road is timely updated on an online and publicly accessible website called the Online Management, Monitoring and Accounting System. Each road is subject to a quality check by the State Quality Monitors (SQM), while some roads are randomly selected for monitoring by the National Quality Monitors (NQM). SQM are often district level superintending, executive or assistant engineers, while the NQMs are nationally recruited and retired government engineers that are randomly allocated randomly selected roads to monitor and report. Special care is taken to not assign roads in the home state of the NQM (source: author interviews with NQMs and field visit for road inspection). Every PMGSY road is also eligible to receive a maintenance budget every year for a period of five years.

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[2]A Habitation or hamlet is a cluster of population, living in an area, the location of which does not change over time. A revenue village is composed of one or more habitations and is the lowest geographic marker used in the census, therefore making it the preferable unit to work with. Given that villages are the lowest unit of analysis in Indian census, in geographic maps and can be therefore mapped to political constituencies and compared across census surveys, I use villages for the purpose of analysis and spatially identify roads to villages as opposed to habitations. The mean population size of villages across India as per census 2001 is roughly 1200 inhabitants per village and on an average villages occupy only a few sq-kms of area, which means that on an average Indian villages are very small units.

[3]Although a later census was conducted in 2011 PMGSY continues to be based on census 2001 well into 2018 (Source : interview with PMGSY bureaucrats).

India is a parliamentary democracy in which elections are held every five years for both the central government in New Delhi and the 29 states that constitute the Indian Union (except Jammu & Kashmir where state level elections are held every 6 years). The national elections are called Lok Sabha elections and citizens across India elect politicians referred to as Members of Parliament (MPs) based on a first past the post simple plurality rule. Each state is guaranteed representation as per its population. Therefore, states that are large such as Uttar Pradesh elect 80 MPs while small states such as Sikkim elect only 1. The single member electoral unit for the Lok Sabha elections is called the Parliamentary (PCs) or Lok Sabha constituency. India currently has 543 PCs out of which 84 are reserved for Scheduled castes and 47 for scheduled tribes, the rest 412 are open seats referred to as *General*. From the year 1999-2004 BJP along with its coalition partners (called as the National Democratic Alliance , NDA) formed its first majority government under the leadership of Atal BiharI Vajpayee. PMGSY was a flagship program launched by him. From the year 2000-2014, the Indian National Congress (INC) along with its coalition partner (called collectively as United Progressive Alliance, UPA) ruled the country under the leadership of Dr. Manmohan Singh. Currently, the BJP is again in power under the leadership of Narendra Modi since 2014.

The state level elections called Vidha Sabha elections elect in the same fashion, Members of Legislative Assembly (MLAs) to electoral units called Assembly Constituencies (ACs) or Vidhan Sabha constituencies. The size of each state's state assembly is again determined via population and therefore each state has a different assembly size. Similarly, States that are large such as Uttar Pradesh elect 403 MLAs while small states such as Goa elect only 40. Due to differing incidence of midterm polls or hung assemblies across states has resulted in states' calendars being different from each other and from the national election calendar. As a result only a few states have a calendar that coincides neatly with the National elections. Most states hold elections at 1-2 year ahead or later than the national election. In terms of party systems, state politics is chequered by regional parties. While some states like Rajasthan, Karnataka see alteration of power between BJP and INC (and their partners), states like Orissa, Uttar Pradesh are dominated by regional or ethnic parties. Some states are dominated by BJP such as Gujarat, Madhya Pradesh, Chhattisgarh (BJP formed last 3 govt.) and some are dominated by INC such as Arunachal Pradesh. Each of the assembly constituency largely fits neatly into a parliamentary constituency.

Like all democracies, India undertakes a border re-districting process widely referred to as the delimitation. The last border delimitation was implemented in 1977 post India's emergency period and it was decided to not undertake any redistricting until 2001. This was agreed because states that were widely implementing family planning programmes and were experiencing changes in their population size felt threatened of losing representation in the National Parliament. As a result India's national as well as state level constituencies grew highly unequal in size. Because no delimitation occurred during 1977-2001 it makes it possible to compare ACs over this time period (given lack of data availability at lower levels). However, a delimitation based on census 2001 was carried out in 2008. This drastically changed borders for both ACs and PCs making them incomparable pre and post delimitation. Constituencies before the delimitation kicked in in 2008 are often referred to as pre-delimitation constituencies, while the new constituencies that were formed after the border delimitation process were complete are called post-delimitation constituencies. I use the same terminology in this paper and keep these two periods distinct.

India's political and administrative boundaries are distinct. The smallest unit of administration in India is the revenue village or village. Villages are embedded in development units called Blocks which are further embedded in Districts. The decennial Indian census last conducted in 2011 (and in 2001 prior to that) provides information at both the village and district level. In terms of overlap

of administrative and political boundaries the following applies- (a) villages always fit into one AC or PC (making it possible to aggregate village data to both these levels as done in this paper) (b) Most of the ACs fit neatly into districts (making it possible to add district fixed effects) (c) PCs generally spread over districts (making it impossible to cluster/ add fixed effects) (e) per definition ACs and PC remain within states. Districts also undergo redistricting and generally split over time. For the purpose of this paper I make use Census 2001 data and village/district boundaries throughout the analysis in line with the PMGSY program.

<center>*C. The role of National and State level politicians*</center>

A qualitative review of the PMGSY policy documents shows that politicians at both the national and state level have been assigned various responsibilities as well as ample room to claim credit for its success. Politicians have been noted to be actively involved in the program at various stages. There are two key and straightforward reasons for politician's to get involved in roads provision. First, roads provision provides a lucrative source of gaining a competitive electoral advantage over others. Several politicians (across states) that were interviewed underscored the importance of roads provision as a key priority for their constituency and openly talked about the shared belief that roads can bring them votes. Indian elections are competitive, with as high as a third being close elections (less than 5% vote margin) and several researchers have noted an incumbency disadvantage throughout the country Ravishankar (2009); Uppal (2009). In this context, roads provide a highly visible resource to lure voters in rural villages that have a very high demand for the resource. Second, recent research finds that PMGSY roads are a source of rents that state level politicians benefit from during contract allocation (Lehne, Shapiro and Eynde, 2018). While the program definitely limits the scope of corruption in some aspects such as road placement, and has checks and balances to monitor quality and actual provision of roads, costing and contracting remain an issue. In sum, the PMGSY program provide a win-win situation to politicians. Below I outline the ways in which politicians are involved in PMGSY.

The PMGSY program formally assigns various responsibility to Members of parliament or Lok Sabha (MPs), Members of state level legislative assembly or Vidhan Sabha (MLAs), as well as district level/ Zilla panchayat (ZP) representatives at several stages of the program. Firstly, the uptake of the program is up to the state level government. State level governments have to show agency in signing up for the program and putting bureaucratic structures in place that comply with the rule based and monitoring framework that participation in PMGSY necessitates. The ruling party in the state is credited (as well as blamed) with successful uptake and implementation of the program in parliamentary proceedings as well as in bureaucratic meetings.

Second, while the road allocation is primarily based on the identified core network and formal criteria of population thresholds, the PMGSY guidelines indicate that the proposals of the MPs and MLAs (that do not meet the formal criteria) would be taken into account by the team preparing the draft rural roads plan. *"A specific list would be made of the roads suggested by the MPs and MLAs and remarks indicated whether they are included or not; if not, the reasons thereof should be recorded."* MPs and MLAs sit through all district planning meetings and ensure that their constituencies are not disadvantaged or overlooked while the roads plans are drafted. This discretionary power granted to the politicians also leads voters to believe that MPs and MLAs are largely responsible for provision or lack of roads. In addition, both MPs and MLAs play a ceremonial role in laying the foundation stone for the road at its inception and are guests at the inauguration ceremony of the road post its completion. These are fairly public events and widely reported in local media (source: interviews with local political journalists and MLAs in Rajasthan and Uttar Pradesh). MPs and MLAs make use these opportunities to claim credit for the road (see Figure 1). The presence of standardised sign boards and such public events makes the attribution

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of PMGSY roads quite straightforward.

Figure 1. : Foundation and Inaugural public ceremony of PMGSY roads

(a) Jammu and Kashmir                                      (b) Sikkim



*Notes*:  (a)  *"Jugal Kishore Sharma Member of Parliament Lok Sabha Jammu Poonch today visited Akhnoor and Chamb Assembly segments along with MLA Akhnoor Rajeev Sharma and MLA Chamb Krishan Lal Bhagat and laid foundation stone for the construction of various roads under Pradhan Mantri Gram Sadak Yojna (PMGSY)."* Source: *Daily Excelsior.* 23 Feb 2017. http://www.dailyexcelsior.com/remote-areas-will-get-connectivity-pmgsy-jugal/ (b) *"Two Rural Connectivity Roads constructed under PMGSY were inaugurated by PD Rai, Lok Sabha MP on Friday and Saturday in the East District. In both the occasions, the area MLA, Bek Bahadur Rai was present along with the engineers of RM&DD headed by the Secretary, D R Nepal."* Source: *Northeast Today.* 21 May 2017. https://www.northeasttoday.in/sikkim-govt-constructing-pmgsy-roads-to-complete-rural-connectivity-by-2019/

Finally elected representatives play a role during the state level inspection of roads. While the MLAs are formally required to inspect the roads much more frequently (once in three months), the MPs are formally required to do so every 6 months. Whether actually representatives undertake this effort is not extensively monitored and differs across representatives and states. Beyond these three formal requirements several interviews that I conducted with bureaucrats at various levels as well as elected representative, suggest that although MLAs may not have influence over the geographic allocation of a PMGSY road they have considerable influence in the contracting process of roads via their control over state-level bureaucrats. This is confirmed by recent evidence that uncovers corruption in contract allocation for PMGSY roads (Lehne, Shapiro and Eynde, 2018).

The involvement of both the MPs and MLAs raises an interesting question about attribution and voter response in the context of a large federal democracy. *Within this context, do voters credit only the MPs or the MLAs or both actors for service provision?* Naturally one would expect both political actors to be able to benefit given their involvement. However, the context offers additional opportunities to examine for a more nuanced voter response. While the PMGSY, like other development schemes in India, has been formulated and and monitored at the national level, state level governments are constitutionally responsible for executing it. In developing contexts it is not policy formulation but poor and uneven execution of development programs that remains a key challenge World Bank (2004). Even when national governments formulate pro-poor policy and offer to provide basic public goods and services their actual provision is often marred with serious issues. Actual entitlement has often little to do with on the ground implementation, a fact that voters are well aware of. Actual policy implementation is therefore highly recognised and is a tool

which is often used by state level politicians or MLAs to distinguish themselves.

A significant body of research points to the central role MLAs play in service provision and policy implementation in the Indian context (Bussell, 2018; Jensenius, 2017). Inteviews with officials and citizens show that they largely attribute MLAs for the provision of PMGSY roads. In line with this discussion, while I expect both MPs and MLAs from ruling parties to receive some reward for their efforts, I expect the MLAs to draw more electoral credit relative to the MPs.[4] Existing evidence on other development schemes such as, the National Rural Employment Guarantee scheme called NREGS (Gulzar and Pasquale, 2016); or the success of the National Food Security Act (through public distribution systems) in the case of Chhattisgarh (Krishnamurthy, Pathania and Tandon, 2014) confirms this view. Moreover, politicians from the national party that announces the scheme, such as Indian National Congress in the case of NREGS are better able to claim credit for its implementation (Gulzar and Pasquale, 2016). PMGSY is a scheme that has been a flagship program of the Bharatiya Janta Party (BJP). I expect, BJP ruling party politicians at the state to be able to claim more votes relative to ruling party politicians from other parties. I also expect the MLAs to be able to benefit the most when the state is aligned with the centre as it makes it cognitively easier for voters to attribute outcomes to a single party.

### D. Rural roads : a most likely case of attribution

A theoretical advantage of studying rural roads is that they are highly desirable and visible public goods. Given the extreme lack of paved roads in rural India way into 2001 rural roads are highly coveted by villagers. Although there is no quantitative survey data or study that examines the extent to which citizens demand roads across India the desirability of roads is well documented. Anecdotally Indian newspapers even report stories of villagers heroic efforts in single handedly carving a road to connect their villages in neglected and remote corners such as in the Hindi heartland states of Bihar and Odisha. For example,

> "*Chief minister Nitish Kumar on Saturday exhorted youths to seek inspiration from Dashrath Manjhi, the 'Mountain Man' who claimed to have single-handedly flattened a 360-ft-long, 30-ft-wide and 25-ft-high rock in the Gahlor hillock to facilitate smooth passage for his wife.*"[5]

> "*Eight hours of gruelling work every day for two years, Jalandhar Nayak has been single-handedly moving mountains to construct a 15-km road, connecting his village Gumsahi to the main road in Phulbani town of Odisha's Kandhamal district.*"[6]

There is also some survey evidence to suggest that voters condition their votes on roads to at least some extent even in states that are dominated by caste politics such as Uttar Pradesh. For example in a recent electoral survey in Uttar Pradesh, over 50% respondents indicated that roads in particular influenced their vote choice in 2012 assembly elections (source: Lokniti post-poll Uttar Pradesh electoral survey 2012). Roads also lead to visible geographic changes that are hard to ignore. Images below are one example (from many) that document such large changes, that are specially felt in regions that have previously remained unconnected and exactly where the PMGSY program has made huge changes.

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[4]Data from interviews that I conducted with villagers in Rajasthan and Uttar Pradesh suggest that villagers are aware of the PMGSY program and primarily credit the local MLA for program implementation. However, in the case of Rajasthan BJP MPs were also mentioned in the course of the interview.

[5]*Times of India.* 27 Aug 2017. https://timesofindia.indiatimes.com/city/gaya/cm-dashrath-manjhi-was-a-man-of-action/articleshow/60237609.cms

[6]*Hindustan Times.* 10 Jan 2018. https://www.hindustantimes.com/india-news/another-dasrath-manjhi-odisha-man-carves-mountains-to-send-kids-to-school/story-Y1gd13LKVTOhEn0kNF4lgI.html.

Figure 2. : PMGSY roads in previously unconnected regions (before - top and after - bottom)

(a) Bhangya village in Indore (b) Dudhiya village in Indore



*Source*: Presentation at the World Bank by H. K. Srivastava, Director Projects, NRRDA Ministry of Rural Development Government of India in 2007. http://siteresources.worldbank.org

Another important feature specific to roads is that they are highly visible forms of public goods relative to other services such as improvements in healthcare or education. This means that success in provision of roads can be easily attributed to political actions, a condition which is necessary to be met for citizens to be able to hold government accountable for their provision (Harding, 2015).[7] Moreover specific features of PMGSY make these roads specially attributable. Each PMGSY road is marked by a standardised sign board that differentiates a PMGSY road from other types of roads since the onset of the program. The placement of the standardised board is also fixed and recent guidelines precisely lay down the criteria for various forms of road signage which provide clear information to local villagers to attribute a particular road to PMGSY (see Figure 3). Moreover, under the PMGSY program, citizens can report poor quality roads using a mobile app called *Meri Sadak* or *My Road* which was launched in July 2015. 80,000 citizens have registered complaints on the app since its inception till date (March 2018). This suggests citizens are aware of the program and care about it. In a quick qualitative review of the description of the complaints received via the formal complaint app, many citizens are seen to blame the MLA in the case roads are poorly built. For example,

this road is in very bad condition last 10-15 yes it have not been constructed.in rainy

[7] Mani and Mukand (2007) provide a useful way of categorising public goods in a way that is specially relevant for the focus of this paper. They classify public goods as visible and complex goods on the basis of how easy or hard citizens find it to attribute responsibility. In this scheme, visible goods are those that are easily observable and attributable to political actions, while complex goods are intrinsically hard to measure and a large number of factors apart from government competence affect their outcome. As per this scheme, the provision of roads is a highly visible public good.

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season people have to face a lot of problem.while MLA of this area belongs to this village but he never listen the complaint.

Figure 3. : PMGSY roads signages across Indian states

(a) Sign board in Haryana      (b) Full sign board in Orissa      (c) Extensive sign board in Jharkhand



*Notes*: (a) is a standardised logo sign board associated with every PMGSY road built across India. The text states the name of the scheme as PMGSY in Hindi. (b) and (c) are extensive information sign boards that list information such as length and cost of road and contact details of the contractor who built the road and were only introduced in 2014. (c) lists additional information on maintenance and road construction. They also mention the funding agency of the road as "Ministry of Rural Development" and identify the respective state level government as the project executing agency. Source: (a) and (b) PMGSY website. http://pmgsy.nic.in/pmg118.asp (c) Shaju John/World Bank. http://blogs.worldbank.org/category/tags/development

Lastly, since roads cannot be targeted to individuals as others cannot be excluded form their use and they cannot be taken back once provided, roads provision is relatively less amenable to clientelistic distortions compared to services like food coupons, employment guarantee scheme or cash transfers. This does not mean that roads provision cannot be clientelistically targeted but simply that they are analytically better suited for analysis for the purpose of this paper relative to other services or goods where tampering can occur at the individual level and is therefore harder to identify.

*E. Exogenous variation in road placement in PMGSY*

The key challenge in examining the impact of any public goods provision or policy program on political (or socio-economic) outcomes is the endogeniety of provision to political outcomes. This is specially true for roads provision. Roads are costly to provide and because of their high visibility and impact on people's live they are a valuable electoral resource. Further, in deprived rural contexts roads can offer incumbents a valuable resource which they can exchange in returns for votes (non-programatically or clientelistically) at broader levels. This means that the placement of a road is likely to be correlated with political (and also socio-economic) characteristics of the area (Asher and Novosad, 2018; Blimpo, Harding and Wantchekon, 2013). To investigate whether citizens use elections to hold governments accountable it is important to evaluate a service or good that has not been provided per clientelistic logic, or using a criteria that is endogenous to political outcomes (Harding, 2015). The study of PMGSY offers a identifying variation to deal with this problem: *at least some villages* across every Indian state were eligible to receive a rural road for

politically exogenous reasons that were pre-determined ex-ante using Census 2001. I summarise below the three broad criteria that form the basis on which villages became eligible to receive roads.

The first and foremost criteria that determines whether village is prioritised to receive a road depends on whether it is above the population threshold, with larger villages being prioritised first. The geographic locations of roads build under PMGSY was pre-determined and the allocation of PMGSY roads is based on population that is based on the independently and centrally conducted census 2001. This criteria offers an exogenous source of variation in roads placement that can be exploited for identifying the effect of programmatic roads provision on electoral returns for the incumbent. As stated earlier, the guidelines aimed to connect all habitations greater than 1000 by 2003, greater than 500 by 2007 and over 250 after that. The second phase of PMGSY (PMGSY-II) aims to connect all habitations over 100 by 2013 and aims for full connectivity by 2019/2020. The thresholds were lower in desert, tribal, hilly areas and in areas afflicted by left-wing extremism. Examining the impact of PMGSY roads on local economic opportunities, Asher and Novosad (2018) find that the threshold criteria increased the likelihood of receiving a rural road for villages that are just above the threshold by 21% observed over the span of a decade.

Census 2001 formed the basis of these thresholds till date and the conduct of the Indian census carries a favourable reputation of being free from political or other forms of tampering. Moreover, (Lehne, Shapiro and Eynde, 2018) find that a majority of politicians that are observed during actual PMGSY implementation were not in office at the time of determination of core network and therefore had no opportunity to participate in determine the planned network. They also find that political influence in PMGSY is largely concentrated in allocation of the road building contract or in completion outcomes rather than *where* a road is built or when it is built.

Apart from these thresholds, the second set of criteria that affected road placement are also non-political and exogenous in nature. For instance, smaller villages could be connected if they were in the path of a prioritised village or if they had a local weekly market of economic importance. There were some state level considerations to the thresholds. States that had already connected all larger villages prior to the onset of the program could proceed to smaller villages. So states that had few unconnected villages with over 1000 people used the 500-person threshold from the onset (Asher and Novosad, 2018), and while some states did adhere to some discrete thresholds (1000 and 500), some states completely disregarded these thresholds. However, data limitations only enable me to identify roads that purely met the thresholds criteria and there is no way of identifying roads that are not eligible on the basis of thresholds but gained priority due to being in path of a prioritised village or having a weekly market.

Lastly, as the PMGSY guidelines state that MPs and MLAs could make recommendations when approval for roads plan was being constructed at district/ state level. Therefore political motivation could have played a role in road placement. Moreover, it is impossible to asses whether recommendations from political representatives are programmatic or clientelistic in nature, and the context suggests that they are more likely to be latter. Similar to the above constrain, there is no way to identify roads that have been provided purely on this bases. In sum, there is ambiguity about the extent to which states followed the rules, and the state level threshold based criteria cannot predict with 100% certainty whether a village will receive a road or not as some roads may have been provided for either non-political or political reasons. To overcome these challenges I construct an instrument which consists of the number of villages in the constituency level (assembly as well as parliamentary) that are over the state level thresholds criteria for states that did adhere to observed thresholds to a large extent, and use the national level criteria for remaining states that did not adhere fully to criteria in particular years. This threshold based criteria of road placement allows me to use the proportion of villages that are over the threshold to instrument for the total villages that receive roads in that constituency. I thereby uncover a source of exogenous variation in road

placement.

*F. Existing studies on PMGSY*

Exploiting the exogenous placement of PMGSY roads several recent studies have examined the economic impacts of PMGSY at various levels of aggregation. Using this natural experiment and aggregating data to district levels, Aggarwal (2018) finds that roads significantly bolster village economy and finds that roads lead to better integration between rural and urban markets. Asher and Novosad (2018) is the first paper to use regression discontinuity based on population thresholds to examine the PMGSY and evaluate the impact of roads provision on local economic opportunities at the village level. They find that the main effect of new roads is to allow villages to find non-farm work, and that the overall effects of roads on economic opportunities are small but that they may still have other indirect positive effects on other social outcomes. Adukia, Asher and Novosad (2017) find large effects of roads on schooling and that new roads increased schooling in at least 59% of sample villages, concluding that roads increase educational investment.

Another set of studies examines the nature of political influence in allocation of roads contract in PMGSY. Lehne, Shapiro and Eynde (2018) find that while PMGSY severely restricted tampering opportunities in terms of allocation of roads, with no evidence of preferential allocation of roads before or after election dates, it failed to safeguard the program from corruption in contracting. *"Given that the location of PMGSY roads is officially predetermined, politicians are unlikely to influence where a road is built, but their informal control over who is awarded a contract may alter the welfare impacts"(p. 71).* They find evidence that politicians influenced the award of road contracts to plausibly related contractors, and this nature of political interference raised the cost of road construction. The foremost contribution of this paper is in being one of the first in the democratic accountability literature to causally estimate the impact of rural roads on political fortunes of incumbents and at a large scale.

## II. Data

The main source of data for rural roads is the PMGSY data on rural roads that is available online on omms.nic.in. I obtained consolidated internal data directly from the Ministry of Rural Development.[8] This gives me several advantages over online data. Data available online only provides information on road name or habitations and does not include a village names which are essential to merge with census data. Studies that use online data find that habitations often run into the problem that habitations do not map into census villages neatly and this often leads to data loss. More crucially, a good percentage of roads (over 40%) connect multiple villages whose names may not be inferred from using such strategies. The internal dataset that I obtained directly provides the village identifier for every village treated by a PMGSY road for over 80% of PMGSY roads thereby reducing data loss and mismatches. Yet, some roads (specially at the onset of the program) still lack village identifiers. For such roads that lack village identifier, I use an additional internal dataset on the entire core network of roads which is a superset of the entire Indian road network to identify villages for roads that lack identifier. I also use the internal dataset on habitation (2001 and 2011), village, block and district level to add more information to every road. This helps me to not only improve my merging but also enables to me to verify duplicate matches while merging with the official census 2001 data. To resolve duplicate matches, I use block name and actual village population as opposed to habitation population connected that is available online and cannot be used to verify against census data. The entire procedure of merging along with the matching results per state is available in the online appendix.

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[8]A check using random subset of roads reveals that the data tallies 100% with the data that is publicly available.

The electoral dataset for state and national elections is taken from the publicly available data on Lokdhaba website, which is a recent academic initiative to ensure easy access to clean electoral data for assembly and national elections across India since Independence and is based on data from the Election Commission of India. India underwent a major border delimitation exercise in 2009 which changed the boundaries of both assembly and parliamentary constituencies. This means that constituencies are no longer comparable pre and post delimitation. However, because I have data for roads from 2000 till date, I am able to make use of at least five electoral cycles and observe each constituency at least twice before delimitation and twice after delimitation. Because of differences in election timing across state, for some constituencies I am able to observe three continuous electoral periods that occur either pre or post delimitation. Finally, delimitation was deferred in four North-eastern states of Assam, Arunachal Pradesh, Nagaland, Tripura, and in Jammu and Kashmir and Jharkhand. I observe three of these in my sample - that is, Arunachal Pradesh, Jammu and Kashmir and Jharkhand. I am able to conduct additional robustness checks by using time series constituency fixed effect model for these three states.

I merge the roads dataset with census 2001 and 2011 village level data on basis of names. I then map village/ roads to assembly and parliamentary constituencies for the pre-delimitation (that is until 2008) using data from Jensenius (2015). For the post-delimitation period I locate census 2001 villages in constituencies by using village and constituency maps from NYU data services. Very few roads pass through more than one constituency. For instance only 6000 roads out of 180,000 roads pass through two assembly constituencies, and even fewer roads pass through two or more constituencies. I use data from Asher and Novosad (2017) for economic constituency level covariates such as night time lights estimate, wage and employment data.

The electoral dataset at polling booth level is only available for the state of Uttar Pradesh (UP) for two post delimitation state level elections in 2012 and 2017 and for National elections in 2009 and 2014. However, Uttar Pradesh is the largest state in India with a population of 200 million that is close to Brazil's population. A geo-coded dataset of all UP polling booths as well as electoral results at the booth level has been made available by Susewind (2014). For the state level elections, this is a dataset with 114,332 booths that are situated within 396 assembly constituencies (out of 403 assembly constituencies UP has originally). I verify the aggregation with officially available AC level dataset and find that for 348 constituencies the results are largely exact or within 5% of difference - the extent of coverage within UP is 86%. I then proceed to use NYU UP village boundary maps based on the Census 2001 to identify polling booths with villages and aggregate the electoral results to the village level to create a large census village level electoral dataset. I then merge this census village level electoral dataset with the UP roads dataset for roads sanctioned during these time periods to yield a comprehensive census village-PMGSY road-votes state elections dataset. The same exercise is repeated for the 2009 and 2014 National level elections within UP.

### III.   Empirical strategy

I am interested in estimating the effect of road provision on incumbency vote share. I start by using OLS to model change in incumbent vote share as a function of roads provision.

(1) $$\Delta Y_{cdst} = \beta_0 + \beta_1 \Delta V_{cdst} + \eta Z_{cdst} + \delta_s + \alpha_t + \epsilon_{cdst}$$

Where $\Delta Y_{cdst}$ is the change in incumbent vote share for constituency constituency $c$ in district $d$ in state $s$ over time period $t$, $\Delta V$ is the change in connectivity measured by the percentage of villages connected in the constituency (that is % of villages that receive a new PMGSY road or an upgrade) $c$ in district $d$ in states the time period $t$ between elections, Z is the set of controls such as political controls measured in the baseline time period $t_0$, public goods provision controls are

constant over time and measured prior to the onset of the program in 2001, economic controls are only available for the period before 2008 and are measured in both 1998 as well as 2005, therefore enabling to construct a change variable for a few states, $\delta_s$ is the state fixed effects and $\alpha_t$ is the time fixed effect.

Note, however, that in the above equation the estimated correlation between the road placement and political outcomes could suffer from endogeneity bias because road provision is likely to be endogenous. Constituencies that previously voted in greater/lesser number for the incumbency might be more/less likely to get a road provided in the subsequent period. Alternatively, the provision of roads and change in incumbency vote share may be jointly determined by political and economic reasons.

For an ideal test of the accountability hypothesis we would want roads to be randomly assigned to constituencies. However, as discussed previously this is not the case. In order to approximate this experiment, I exploit the fact that national guidelines in PMGSY dictate that rural roads have to (first) be build in larger villages according to arbitrary thresholds in the 2001 Population Census., that is they were provided on basis of a criteria that is exogenous to political outcomes. The design of the instrument closely mirrors a fuzzy regression discontinuity. I estimate two stage least squares regression models of the following form.

(2) $$\Delta V_{cdst} = \gamma_0 + \gamma_1 E_{cdst} + \eta Z_{cdst} + \delta_s + \alpha_t + \epsilon_{cdst}$$

(3) $$\Delta Y_{cdst} = \beta_0 + \beta_1 \Delta \hat{V}_i + + \eta Z_{cdst} + \delta_s + \alpha_t + \upsilon_{cdst}$$

Where $\Delta V$ is the number of villages connected per 100,000 villages in the constituency $c$ in district $d$ in state $s$ in a given time period $t$. The instrument $E$ is the average eligibility of constituency $i$ to build roads according to the arbitrary population thresholds in the national rural road program in the given time period $t$. This instrument consists of the number of villages in the constituency $i$ that had more than the specified threshold of inhabitants for that particular time period.

To design the instrument I followed the logic laid down in PMGSY guidelines. I estimate the eligibility as (i) percentage of villages that are over the threshold of 500 in pre-delimitation constituencies and the percentage of villages that are over the threshold of 250 in the post delimitation constituencies; (ii) in the case of hill states, that is, Arunachal Pradesh, Himachal Pradesh, Assam, Jammu and Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and Uttarakhand I use the stipulated threshold of percentage of villages that are over 250 inhabitants for the entire time period; (iii) for districts that have over 25% population that is Tribal as per census 2001, have desert area, and for districts that are affected by left-wing extremism I use the threshold of percentage of villages that are over 250 inhabitants throughout. To identify districts that are desert and left-wing extremism (LWE) I rely on the internal PMGSY dataset. As a robustness, I also use government's data on LWE districts that is available online prior to the program and is assembled external to the program. As a robustness check, I also create other instruments based on different population thresholds such as those that remain constant over time and only based on a village population level.

$\Delta Y_{cds}$ is the change in incumbent vote share for constituency $c$ in district $d$ in state $s$ between [t0] to [t1]. The coefficient of primary interest is $\beta_1$ which estimates the average *change* in incumbency vote share when an additional village is connected per total number of villages in the constituency. I expect this coefficient to be substantively and statistically greater than zero suggesting that constituencies that connect more villages (that is with exogenously allocated roads) will increase their vote for the incumbent (more) relative to the previous election.

I provide several robustness checks. First, I add a large number of constituency level controls such

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as public goods provision (schools, medical facility, power supply etc.), economic outcomes (growth in employment, economic activity based on night time lights), demographics such as percentage of scheduled castes/tribes, and political controls such as turnout, close elections and log of the electorate. Second, I cluster the standard errors at district as well as parliamentary constituency level as additional robustness. Third, I run several tests of over identifying restrictions. This is possible because roads in India's national roads program are also prioritised on population thresholds such as villages that have population that is over 1000 should be prioritised over those that have a population of 500, over 250 and then over 100. Last, I examine empirically the sensitivity of my IV estimates to violations of the exclusion restriction by using the method developed by Conley, Hansen and Rossi (2012).[9]

Fourth, there is a possibility that rural roads might cause selective migration that may lead to compositional changes in villages thereby biasing treatment estimates. Asher and Novosad (2018) examine this very possibility and find that new roads do not lead to major changes in out-migration. Fifth, a threat to identification can come from the possibility that other government policy used the same population thresholds as PMGSY. Asher and Novosad (2018) report that, *"one national government program did prioritise villages above population 1000: the Total Sanitation Campaign (Spears and Lamba, 2016), which attempted to reduce open defecation through toilet construction and advocacy."[p. 23]* However on examining this possibility they find no evidence that being above the population threshold was associated with open defecation or any measure of access to toilets. Their findings suggest that there is no discontinuity in the implementation of the program that affected their results which lends support to the validity of this empirical strategy.

## IV.  Results

I examine 15 large states in India.  These are:  Andhra Pradesh, Arunachal Pradesh, Bihar, Chhattisgarh, Gujarat, Jammu and Kashmir, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Uttar Pradesh and West Bengal. Together these comprise over 95% population of the country. For the states of Arunachal Pradesh, Jharkhand and Jammu and Kashmir delimitation has been deferred and therefore I observe them multiple time in the pre-delimitation period. In total, for Arunachal Pradesh and Jharkhand, I observe four consecutive elections which yields three observations per assembly constituency, all in the pre-delimitation period. For Jammu and Kashmir which has a longer electoral tenure of 6 years as opposed to 5 years for the rest of India, I observe three consecutive elections which yields two observations per assembly constituency both of which are in the pre-delimitation period. I drop constituencies that are: (a) primarily urban (as measured by low number of villages and low rural population) and therefore ineligible for the program; (b) where neither the incumbent party or coalition partner run in the next election; (c) uncontested elections.  This leads me to a sample of 5442 constituencies and in total, I present evidence from an anlysis of over 11,000 electoral races.

Table 1 presents the OLS estimate. Improving village connectivity does not have any impact on incumbent's vote share change in both pre and post delimitation period. Except for model 1 which has not controls or fixed effects, the effect is neither substantive nor significant in any of the model.  Table 2 presents OLS estimates in theoretically interesting subsamples.  In table 2,

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[9]Formally one can think of the exclusion restriction as being equivalent to the dogmatic prior belief that $\delta$ is precisely 0 in the follow equation:

$$(4) \qquad \Delta Y_{cds} = V_{cds}\varphi + E_{cds}\alpha + \varepsilon_{cds}$$

One can loosen the exclusion restriction by assuming that $\alpha$ is near to 0 but not exactly 0 and obtain confidence intervals in the conventional sense using Conley, Hansen and Rossi (2012).

Table 1—: Impact of Δ connectivity on Δ incumbent's vote share in State elections: First difference OLS estimates

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Period: pre-delimitation (1998-2018)[††] | | | | | | | | | |
| Δ connectivity | -0.147*** | -0.060 | -0.059 | -0.059 | -0.059 | -0.064 | -0.065 | -0.083 | -0.018 |
| | (0.030) | (0.033) | (0.032) | (0.039) | (0.034) | (0.039) | (0.044) | (0.050) | (0.038) |
| Observations | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 3,114 | 1,754 | 1,754 |
| Adj R-squared | 0.007 | 0.130 | 0.144 | 0.144 | 0.144 | 0.150 | 0.149 | 0.197 | 0.197 |
| Period: post-delimitation (2008-2018) | | | | | | | | | |
| Δ connectivity | 0.306*** | 0.035 | 0.078 | 0.078 | 0.078 | 0.071 | 0.054 | | 0.044 |
| | (0.039) | (0.041) | (0.040) | (0.051) | (0.047) | (0.050) | (0.052) | | (0.038) |
| Observations | 2,328 | 2,328 | 2,328 | 2,328 | 2,328 | 2,325 | 2,325 | | 2,325 |
| Adj R-squared | 0.025 | 0.318 | 0.359 | 0.359 | 0.359 | 0.364 | 0.365 | | 0.366 |
| Political controls | | | | | | ✓ | ✓ | ✓ | ✓ |
| Public goods | | | | | | | ✓ | ✓ | ✓ |
| Economic controls | | | | | | | | ✓ | ✓[†] |
| State fixed effects | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Time fixed effects | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Clustered SE | | | | ✓ | PC level | ✓ | ✓ | ✓ | ✓ |

*Notes:* The unit of analysis is the assembly constituency. The dependent variable is change in incumbent vote share measured in percentages. The independent variable Δ connectivity is measured as % villages connected in given time period for Model 1-8. In model 9 Δ connectivity is measured as % population connected in given time period. Robust standard errors are reported in parentheses. Standard errors are clustered at the district level except in Model 4 where they are clustered at parliamentary constituency level. All regressions contain a constant which is not reported. Political controls consist of: turnout, log of electorate, whether the race is close (under 5% margin) in the baseline election, dummy for AC type (General, SC or ST) and % population of SC and ST. Public good controls consist of % of villages in the AC that have following facilities: power supply, education, medical, paved roads prior to 2001, communication. [††]States of Arunachal Pradesh, Jammu and Kashmir, and Jharkhand did not undergo delimitation in 2008. [†]Economic controls are only available for the pre-delimitation states and for only one election cycle which was prior to 2001 and consist of log employment growth 1998-2005 and baseline employment in 1998-2005. *** $p<0.001$, ** $p<0.01$, * $p<0.05$

model 1 the sample is restricted to only include ruling party politicians. It is easier to attribute responsibility if the incumbent belongs from the ruling party vs. in cases where the incumbent belongs to opposition parties. In the latter cases, voters have to additionally resolve whether it was the ruling party that improved the provision or whether their local MLA should be credited with improvement in connectivity. Therefore, I expect attribution to be relatively easier in cases where incumbents are from the ruling party politicians. However, even in this case the effect of connectivity is null. In model 2, the sample is restricted to only include ruling party politicians that are from the BJP. Since the BJP launched the PMGSY program, voters might attribute some responsibility to the BJP government. In this case, MLAs from the ruling party in states where BJP is in the government, either in majority or in a coalition might benefit from this attribution. While the null effect persists in the post-delimitation period, the effect is significant and substantive in the pre-delimitation period. However, it is in contradiction to expectation. In Model 3, where I further restrict the sample to BJP ruling party politicians to only states where the BJP has a majority government, the contradictory effect becomes slightly stronger, while remaining null in the post-delimitation period.

In model 4, I restrict the sample to case where the states are aligned with centre. I expect that the line of attribution is clearer in these cases. This is because the state government and central government can both claim credit for the program and having the same party at both levels makes

Table 2—: First difference OLS estimates for theoretically relevant cases of attribution in State elections

|  | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | | | Sample: pre-delimitation (1998-2007) | | | |
| Δ connectivity | -0.052 | -0.166*** | -0.195*** | -0.058 | 0.020 | -0.090 |
| | (0.047) | (0.047) | (0.051) | (0.140) | (0.073) | (0.066) |
| Observations | 1,868 | 632 | 302 | 197 | 1,508 | 484 |
| Adj. R-squared | 0.322 | 0.054 | 0.062 | 0.103 | 0.113 | 0.063 |
| | | | Sample: post-delimitation (2008-2018) | | | |
| Δ connectivity | 0.017 | 0.021 | 0.021 | 0.058 | 0.118** | -0.213 |
| | (0.044) | (0.058) | (0.058) | (0.150) | (0.038) | (0.166) |
| Observations | 1,452 | 623 | 623 | 644 | 1,091 | 626 |
| Adj. R-squared | 0.478 | 0.318 | 0.318 | 0.269 | 0.157 | 0.334 |
| Sample | Ruling party MLAs | Ruling party MLAs in BJP govt. | Ruling party MLAs in BJP maj. govt. | State aligned with centre | Bimarou+ | Southern states |
| Theoretical nature of attribution | High | High | High | High | Low | High |

*Notes:* The unit of analysis is the assembly constituency. The dependent variable is change in incumbent vote share measured in percentages.The independent variable Δ connectivity is measured as % villages connected in given time period. Robust standard errors are reported in parentheses. Standard errors are clustered at the district level. All regressions contain a constant which is not reported. All models have political controls and controls for public goods provision. Political controls consist of: turnout, log of electorate, whether the race is close (under 5% margin) in the baseline election, dummy for AC type (General, SC or ST) and % population of SC and ST. Public good controls consist of % of villages in the AC that have following facilities: power supply, education, medical, paved roads prior to 2001, communication. *** p<0.001, ** p<0.01, * p<0.05

it easier for voters to attribute responsibility. In the case of a mismatch, that is different parties at central and state level, it becomes relatively harder for voters to attribute responsibility. Yet, the null effect is persistent in both samples. In model 5, I restrict the sample to the region known as *BIMAROU*, which roughly translates to *sickly*. BIMAROU is an acronym formed from the first letters of the names of the India states of Bihar, Madhya Pradesh, Rajasthan, Orissa and Uttar Pradesh. I also include the new states of Chhattisgarh, Jharkhand and Uttarakhand. Collectively this region has the worst literacy levels, low state capacity and poor economic development within India. It is also characterised by caste based politics, vote buying and other forms of clientelism. I expect voters in this region to have low levels of political awareness relative to citizens in other parts of India. While the null effect persists in the pre-delimitation period, it is substantive and significant in the post-delimitation period. This effect is also contradictory to expectations. In model 6, I restrict the sample to Southern Indian states of Andhra Pradesh and Karnataka. The Southern region is in many ways a mirror image of the BIMAROU region. The South is characterised by higher level of social and economic development and the highest literacy rates in the country. I expect higher levels of political awareness in this region and expect that voters will be relatively better in attributing responsibility for the program. Yet in both periods, I find a persistent null effect.

OLS estimates from models reported above may still suffer from endogeniety bias. To deal with this I use instrumental variables approach as outlined in the empirical strategy section. Table 3 reports the results. In majority of the models, the instrument is strong with high F-statistics generally over 10. The null effect is well identified and seen to largely persist across both samples and most models. The null effect also persists in theoretically relevant subsample (not reported) although the instrument becomes weak in a minority number of cases due to small sample sizes.

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Table 3—: Impact of $\Delta$ connectivity on $\Delta$ incumbent's vote share in State elections : 2SLS estimates

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | | Sample: pre-delimitation (1998-2018) | | | |
| | | Second stage | | | |
| $\Delta$ connectivity | -0.107 | -0.269* | -0.094 | -0.299 | -0.727 |
| | (0.112) | (0.133) | (0.110) | (0.319) | (0.441) |
| | | First stage | | | |
| %villages eligible | .151*** | .097*** | 0.153*** | .080*** | .081*** |
| | (0.016) | (0.012) | (0.067) | (0.017) | (0.021) |
| F-statistic | 81.44 | 69.44 | 82.72 | 14.30 | 14.30 |
| Adj. R-squared | 0.325 | 0.313 | 0.326 | 0.355 | 0.535 |
| Observations | 3,114 | 3,114 | 3,114 | 3,114 | 1,754 |
| | | Sample: post-delimitation (2008-2018) | | | |
| | | Second stage | | | |
| $\Delta$ connectivity | -0.071 | -0.071 | -0.089 | -1.878 | |
| | (0.256) | (0.256) | (0.243) | (1.373) | |
| | | First stage | | | |
| %villages eligible | .127*** | .127*** | .129*** | .056*** | |
| | (0.029) | (0.029) | (0.026) | (0.031) | |
| F-statistic | 18.01 | 18.01 | 23.56 | 3.15 | |
| Adj. R-squared | 0.395 | 0.395 | 0.401 | 0.408 | |
| Observations | 2,328 | 2,328 | 2,325 | 2,325 | |
| | | Eligibility measured as % villages that are | | | |
| Until 2008 | over 500 | over 1000 | over 500 | over 500 | over 500 |
| 2008 onwards | over 250 | over 500 over 250 | over 250 | over 250 | over 250 |
| Political controls | | | ✓ | ✓ | ✓ |
| Public goods | | | | ✓ | ✓ |
| Economic controls | | | | | ✓ |

*Notes:* The unit of analysis is the assembly constituency. The dependent variable is change in incumbent vote share measured in percentages. The independent variable $\Delta$ connectivity is measured as % villages connected during electoral period. The instrument is measured as % villages that meet the criteria of the threshold outlined in the table. In all eligibility criterion, the threshold is taken as around or over 250 in the case of hilly states and in tribal/ desert and districts affected by left-wing extremism. Robust standard errors are reported in parentheses. Standard errors are clustered at the district level. All regressions contain state and time fixed effects and a constant which is not reported. Political controls consist of: turnout, log of electorate, whether the race is close (under 5% margin) in the baseline election, dummy for AC type (General, SC or ST) and % population of SC and ST. Public good controls consist of % of villages in the AC that have following facilities: power supply, education, medical, paved roads prior to 2001, communication. †Economic controls are only available for the pre-delimitation cases that had elections prior to 2001 and consist of log employment growth 1998-2005 and baseline employment in 1998-2005. *** $p<0.001$, ** $p<0.01$, * $p<0.05$

Table 4—: Impact of $\Delta$ connectivity on $\Delta$ incumbent's vote share in National elections: First difference OLS estimates

|  | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | | | Period: pre-delimitation (1998-2018)[††] | | | |
| $\Delta$ connectivity | 0.065 | 0.096 | 0.039 | 0.026 | 0.086 | 0.097 |
| | (0.090) | (0.099) | (0.105) | (0.107) | (0.114) | (0.084) |
| Observations | 325 | 325 | 325 | 325 | 325 | 325 |
| Adjusted R-squared | -0.001 | 0.267 | 0.271 | 0.276 | 0.288 | 0.290 |
| $\Delta$ connectivity | 0.226* | -0.096 | -0.096 | -0.098 | -0.090 | -0.058 |
| | (0.104) | (0.103) | (0.103) | (0.104) | (0.106) | (0.085) |
| Observations | 326 | 326 | 326 | 326 | 326 | 326 |
| Adjusted R-squared | 0.011 | 0.534 | 0.534 | 0.547 | 0.536 | 0.545 |
| Political controls | | | | ✓ | ✓ | ✓ |
| Public goods | | | | | ✓ | ✓ |
| State fixed effects | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Time fixed effects† | | | ✓ | ✓ | ✓ | ✓ |

*Notes:* The unit of analysis is the parliamentary constituency. The dependent variable is change in incumbent vote share measured in percentages. The independent variable $\Delta$ connectivity is measured as % villages connected in given time period for Model 1-5. In model 6 $\Delta$ connectivity is measured as % population connected in given time period. Robust standard errors are reported in parentheses. All regressions contain a constant which is not reported. Political controls consist of: turnout, log of electorate, whether the race is close (under 5% margin) in the baseline election, dummy for PC type (General, SC or ST) and % population of SC and ST. Public good controls consist of % of villages in the PC that have following facilities: power supply, education, medical, paved roads prior to 2001, communication. †Time fixed effects only apply to pre-delimitation constituencies. States of Arunachal Pradesh, Jammu and Kashmir, and Jharkhand did not undergo delimitation in 2008 and are therefore observed for all four consecutive general elections in 1999,2004,2009,2014. *** p<0.001, ** p<0.01, * p<0.05

Table 5—: Impact of Δ connectivity on Δ incumbent's vote share in National elections : 2SLS estimates

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | | Sample: pre-delimitation (1998-2018) | | |
| | | Second stage | | |
| Δ connectivity | -0.449 | -0.545 | -0.507 | -1.370 |
| | (0.301) | (0.335) | (0.311) | (0.993) |
| | | First stage | | |
| %villages eligible | .125*** | .072*** | 0.122*** | 0.070** |
| | (0.016) | (0.011) | (0.016) | (0.028) |
| F-statistic | 58.17 | 38.64 | 57.20 | 5.97 |
| Observations | 325 | 325 | 325 | 325 |
| Adjusted R-squared | 0.219 | 0.197 | 0.215 | -0.110 |
| | | Sample: post-delimitation (1998-2018) | | |
| | | Second stage | | |
| Δ connectivity | -2.810 | -2.810 | -1.086 | -0.317 |
| | (2.970) | (2.970) | (1.261) | (2.043) |
| | | First stage | | |
| %villages eligible | 0.036 | 0.036 | 0.065** | 0.681 |
| | (0.033) | (0.033) | (0.030) | (0.045) |
| F-statistic | 1.16 | 1.16 | 4.43 | 2.20 |
| Observations | 326 | 326 | 326 | 326 |
| Adjusted R-squared | -0.508 | -0.508 | 0.412 | 0.538 |
| | | Eligibility measured as % villages that are | | |
| Until 2008 | over 500 | over 1000 | over 500 | over 500 |
| 2008 onwards | over 250 | over 500 | over 250 | over 250 |
| | | over 250 | | |
| Political controls | | | ✓ | ✓ |
| Public goods | | | | ✓ |

*Notes:* The unit of analysis is the parliamentary constituency. The dependent variable is change in incumbent vote share measured in percentages. The independent variable Δ connectivity is measured as % villages connected during electoral period. The instrument is measured as % villages that meet the criteria of the threshold outlined in the table. In all eligibility criterion, the threshold is taken as around or over 250 in the case of hilly states and in tribal/ desert and districts affected by left-wing extremism. Robust standard errors are reported in parentheses. All regressions contain state and time fixed effects and a constant which is not reported. Political controls consist of: turnout, log of electorate, whether the race is close (under 5% margin) in the baseline election, dummy for PC type (General, SC or ST) and % population of SC and ST. Public good controls consist of % of villages in the PC that have following facilities: power supply, education, medical, paved roads prior to 2001, communication. *** $p<0.001$, ** $p<0.01$, * $p<0.05$

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