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The impact of educated leaders on economic development: Evidence from India☆

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ABSTRACT

Although formal education is often considered an indicator of political leaders' quality, the evidence on the effectiveness of educated leaders is mixed. Besides, minimum education qualifications are increasingly being used as requirements for contesting elections, making it critical to understand the role of politicians' education in their performance. This study investigates the impact of electing an educated politician on economic development in the politician's constituency in India. The analysis uses constituency-level panel data on the intensity of night-time lights to measure economic activity. The identification strategy is based on a regression discontinuity design that exploits quasi-random outcomes of close elections between educated and less-educated politicians. The results show that narrowly electing a graduate leader, as compared to a non-graduate leader, in the state assembly constituency increases the growth rate of night-time lights by about 3 percentage points in the constituency. As pathways, graduate leaders are found to improve the provision of roads, electricity, and power; however, they do not significantly impact the overall provision of public goods. In comparison with findings from other studies in the literature, these results suggest that the impact of formal education of the leader is weaker than the leader's other characteristics, such as gender or criminality.

1. Introduction

In recent literature, education has been considered a marker of leader's quality, assuming that formal education equips leaders with the necessary skill and competence to execute complex functions associated with holding a political office. While much of empirical research has used leader's formal education level as a proxy for leadership quality, the evidence supporting this claim is ambiguous. Some studies claim a direct link (Besley and Reynal-Querol, 2011; Peveri, 2021; Yu and Jong-A-Pin, 2020) while others suggest that it is tenuous (Bastos and Sánchez, 2021; Carnes and Lupu, 2016; Curto-Grau and Gallego, 2019). The issue of the impact of educated leaders becomes far more relevant in a setting like India where minimum education requirements are increasingly being mandated for contesting elections. These mandates have been justified by courts and legislatures on the basis of assumed higher efficiency of educated political leaders, without much supporting evidence.

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The existing literature has highlighted several reasons why educated leaders, compared to less educated leaders, may have an ambiguous effect on economic development. Educated legislators may promote growth if education influences their policy preferences, technical skills or dedication to serving public interest (Besley and Reynal-Querol, 2011; Congleton and Zhang, 2013; Dreher et al., 2009). They may drive more investment from businesses leading to higher growth (Francois et al., 2020) or improve chances of reforms as educated leaders understand them better (Dreher et al., 2009). On the other hand, education may impart human capital but that may not transfer into political ability to carry out policy tasks efficiently (Carnes and Lupu, 2016; Lahoti and Sahoo, 2020) or there may be a mismatch between preferences of educated leaders and their constituents (Curto-Grau and Gallego, 2019).

In this paper, we investigate whether politicians with higher levels of formal education lend to better economic development outcomes in areas under their jurisdiction. To explore the different pathways, we also analyze if educated leaders who have spent time in office, create developmental infrastructure or reduce crime that ultimately affects the level of economic activity in a constituency.

To shed light on this issue, we use data on elections of leaders to state legislatures in India. We assemble a data set on the educational qualifications of candidates contesting elections along with the election results. For the main outcome variable, we use intensity of night-time lights captured in satellite imagery. In absence of reliable data that can measure economic development at the assembly constituency level, this measure serves as a proxy variable. Previous studies have established the use of nigh-time lights as a proxy for measuring sub-national GDP (Chen and Nordhaus, 2011; Doll et al., 2006; Donaldson and Storeygard, 2016; Henderson et al., 2012). Night-time lights data are available annually at a spatially granular level and can be aggregated to provide estimates at the constituency level. Combining data on leader's education and night-time lights outcome, we construct a comprehensive panel data at the constituency level for the period 2009–2013.[1]

A challenge in estimating the causal effect of legislator's education is that election of educated leaders to state legislature might be non-random and driven by unobserved voter preferences and other constituency level characteristics, thus making it an endogenous process. To overcome this challenge and estimate the casual effect of educated leaders, we use a regression discontinuity design (RDD) based on close elections between educated and less-educated candidates. The identification strategy relies on the quasi-random outcomes of close elections; this set-up has been widely used in the related literature (Lee, 2008; Eggers et al., 2015). Comparing constituencies where an educated leader wins by a narrow margin with constituencies where a less-educated leader wins by a narrow margin, we can isolate the casual effect of educated legislator.

Using the RDD we find that, on average, election of a graduate leader results in approximately 3 percentage points higher growth rate of annual average intensity of night-time lights in the constituency. The point estimates are stable and robust across alternate bandwidths and to the inclusion of fixed effects that control for unobserved heterogeneity at the regional level. Our results are also robust to alternate specifications and exclusion of extreme values of the outcome variable. Using existing estimates from the literature on the elasticity of GDP growth to night-time lights growth (Baskaran et al., 2021; Bickenbach et al., 2016), we find that election of an educated leader results in roughly 0.3 to 0.45 percentage points higher GDP growth rate per year in the constituency. Additionally, we find that the impact of educated leaders is driven by leaders who have a college-graduate degree and not by those who have only completed schooling. Among politicians with a graduate degree, only those with a degree in law seem to have a significant positive effect. Graduates with a degree in arts, commerce, or science do not have any significant effect. The estimate also varies by the initial level of development in the states, with the effect being larger in the least developed states. We also explore further heterogeneity in the effect of graduate leaders based on their gender, age, criminality, and affiliation with the state ruling party.

We examine the internal validity of our empirical strategy by performing a range of checks on the RD design. We show that constituency level pre-determined characteristics are balanced around the threshold of discontinuity. Besides, we find no evidence to suggest that educated leaders are more likely to win or lose in close elections, implying that the outcome of close elections are not manipulated. We also conduct balance check of candidate characteristics to isolate the effect of education from any other characteristics that may be correlated. In addition, we conduct various placebo tests and find that the placebo estimates are insignificant and smaller than the true estimate. These analyses help us establish that the outcome of close elections are indeed quasi-random and our estimates reflect the causal effect of leader's education. Further, we inspect the external validity and broader applicability of our results beyond close elections. We compare a range of candidate and constituency level characteristics across close and non-close elections and mixed and non-mixed elections, finding no substantive differences in them.

We also explore the mechanisms through which educated leaders may impact economic growth. We postulate that the theoretical channels through which an educated leader impacts economic growth are higher competency and skills, and better beliefs and values. Education improves leaders' skills, making them more competent. Through knowledge and exposure, their beliefs and values are also impacted. Given the nature of the data we cannot test these channels directly. We provide some indirect evidence supporting these hypotheses, although the relationships we test are essentially reduced-form in nature and we are unable to identify precise mechanisms for our main results.

We examine the impact of educated leader on provision of infrastructure facilities, crimes, and corruption. We find that election of graduate legislators result in around 0.3 standard deviation increase in access to both roads and power supply. Similarly, the percentage of households that have access to electricity as the main source of lighting is 5.3 percentage points higher if a graduate

[1] The choice of this period for the main analysis is due to restrictions in the availability of data for our key variables. We discuss this aspect further in the later sections.

candidate is elected. With regard to crime outcome, we find that a 10 percentage point increase in the proportion of graduate legislators in a district on average causes a 1.2 to 1.9 percent decline in the reported crime in the constituency. This result indicates that an educated legislator may lead to better environment for economic activity and growth. We do not find any statistically significant difference between graduate and non-graduate legislators' growth in private assets which we use as a proxy for corruption following Fisman et al. (2014).

Comparing our results to the existing literature on leader's identity in the Indian context, we find that the effect of leader's education on economic growth is relatively smaller. Prakash et al. (2019) show that electing a criminally accused politician lowers the growth rate in night-time lights by about 24 percentage points and Baskaran et al. (2021) estimate that electing a woman legislator increases growth in night-time lights by about 15 percentage points. As compared to these studies that follow a similar identification strategy and outcome variable, we find a relatively small impact of only 3 percentage point increase in night-time lights of electing an educated legislator.

Our paper contributes to various strands of literature. First and most directly, our paper contributes to the literature exploring whether education is an important marker in determining the skill and competence of leaders holding public office. Specifically, our findings contribute to whether educated leaders enhance economic development in their jurisdiction by facilitating provision of public infrastructure (Mitra, 2020; Bastos and Sánchez, 2021; Besley and Reynal-Querol, 2011; Carnes and Lupu, 2016; Curto-Grau and Gallego, 2019; Lahoti and Sahoo, 2020). Our estimates based on RD specification and data from a developing country add to the existing body of evidence. To the best of our knowledge, Lahoti and Sahoo (2020) is the only other paper that analyzes the effect of educated leaders in the Indian context. They investigate the impact of graduate legislators on quality of education in schools in the legislators' constituencies. In contrast, we analyze the impact on economic growth and its channels. Moreover, our study suggests that with regard to the level of formal education of the leader, attainment of a college-graduate degree is the main differentiating factor. We also go further than the literature by investigating the type of degree that matters. We show that the impact of graduate leaders is driven by those with a law degree.

Secondly, our findings add to the literature on the role of identity and characteristics of leaders in development and policy outcomes. We find evidence in support of citizen candidate models put forth in Besley and Coate (1997) and Osborne and Slivinski (1996). These models suggest that demographic characteristics contribute to the identity of a leader and they have the potential to significantly impact policy outcomes (Besley, 2005). Candidate characteristics that have been found to matter include gender (Chattopadhyay and Duflo, 2004; Bhalotra and Clots-Figueras, 2014; Bhalotra et al., 2014, 2018), caste (Pande, 2003), criminality (Prakash et al., 2019), political affiliation (Hill and Jones, 2017; Gulzar and Pasquale, 2017), and political alignment (Asher and Novosad, 2017). We add to this strand by considering education to be an important dimension of a leader's identity and add evidence to the related literature (Besley and Reynal-Querol, 2011; Carnes and Lupu, 2016; Lahoti and Sahoo, 2020).

Our analysis is motivated by policy measures being considered across Indian states to institute a mandate for minimum educational qualifications for candidates contesting elections. Haryana[2] and Rajasthan[3] put in place policies mandating minimum educational requirements for candidates contesting local body elections, and Assam and Maharashtra have considered incorporating a similar policy.[4] Policy mandates for minimum education are crucial as they have implications for equality and representation, especially for marginalized sections of the society.[5] Any restriction placed on limiting the ability of individuals to contest has been considered undemocratic, elitist and discriminatory.[6] It also affects political selection by changing the pool and subsequent selection of candidates contesting elections. Afzal (2014) and Curto-Grau and Gallego (2019) find that educational elitism has consequences for representation. Altering the identity of candidates who will hold office may change the nature of policies and the credibility with which policies are implemented (Arora, 2022; Besley, 2005). In this regard, although our paper bypasses the aspect of political selection by exploiting quasi-random variations emanating from close elections, we show that education level of leaders may have a limited impact compared to other characteristics of leaders. Thus, ballot access restriction by educational mandates may not have the intended consequence of vastly improving efficiency of the elected legislators.

The rest of the paper is organized as follows. In Section 2, we provide a note on background and context, in Section 3 we provide a description of the data set, and in Section 4, we lay out the identification strategy. Section 5 evidences validity of the RD design, and Sections 6–8 discuss the results. In Section 9, we conduct robustness and sensitivity checks on results from our main specification. Section 10 discusses the generalizability and limitations of our results. Finally, in Section 11, we discuss the relevance of our findings.

[2] For Haryana, the Panchayati Raj Amendment Act (2015) mandates general candidates to have completed at least 10 years of schooling, women and Dalit candidates to have completed 8 years and Dalit women candidates to have completed at least 5 years of schooling to contest in local body elections. https://www.thehindu.com/news/national/other-states/minimum-qualification-set-as-haryana-passes-panchayati-raj-bill/article7626719.ece.

[3] Rajasthan has since scrapped this policy, which was in place for one election term. https://www.thehindu.com/news/national/other-states/rajasthan-to-scrap-education-criterion/article26241205.ece.

[4] https://www.business-standard.com/article/pti-stories/assam-to-move-resolution-for-educational-qualification-to-118031401158_1.html and https://timesofindia.indiatimes.com/city/mumbai/directly-elected-sarpanch-now-schooling-till-class-vii-must/articleshow/59432314.cms.

[5] For instance, in Haryana, this mandate has led to disqualifying 68% of Dalit women and over 50% of all women from contesting panchayat elections (Bhaskar, 2016).

[6] https://indianexpress.com/article/opinion/columns/narendra-modi-pm-degree-arvind-kejriwal-delhi-university-ba-degrees-of-exclusion-2792374/.

2. Background

2.1. Conceptual framework

From a theoretical point of view, our paper contributes to the body of literature suggesting that identity and characteristics of the leaders matter for policy outcomes (Besley, 2005). The early literature on elected leaders followed a Downsian approach conceptualizing that candidates once elected to office fully commit to the policy preferences of the electorate (Downs, 1957). In such a model, leaders are willing to adopt the policy preference of the median voter and subsequently implement it. In contrast to Downsian approach, the citizen candidate models in the new political economy literature focus on the identity of politicians assuming that in a representative democracy, politicians are elected from a pool of candidates with varied preferences. Once elected, they implement policies according to their preference which may not align with the preference of the median voter. This idea, theoretically formalized in Besley and Coate (1997) and Osborne and Slivinski (1996), received empirical support by studies linking leaders' identity such as caste (Besley et al., 2004; Pande, 2003), gender (Chattopadhyay and Duflo, 2004), or political affiliation (Hill and Jones, 2017) to differences in the choice of policy outcomes.

Besley (2005) in a review of the literature argues that political selection and quality of leaders are important for two key reasons. First, given the limits to which a politician can commit and communicate a complete policy stance before elections, it is critical that the selected politician be able to choose a credible policy after election. Second, to increase the quality of government and governance it is critical to have leaders with more honesty, integrity and competence.

Education has been used as a proxy for leader quality in the literature (Atkinson et al., 2016; Kotakorpi et al., 2017; Besley and Reynal-Querol, 2011; Baltrunaite et al., 2014). Plato famously argued that governing is best left to those who are highly educated (Lippman, 1922). The potential mechanisms identified in the literature on how educated leader impacts economic outcomes are: (a) by being more competent and having higher skills, and (b) having higher beliefs and better values, i.e., being more public service oriented and less corrupt. We elaborate on these channels below.

Competence and skills: Educated leaders are argued to be more competent and skilled because of the education they have been imparted. There is a vast literature that shows that there is a positive return to education in the labor market (Harmon et al., 2003; Zimmerman, 2014; Fulford, 2014). According to human capital theory, education increases skills and hence improves productivity. A few of these skills like being able to develop logical arguments, assemble and assess evidence, make public arguments, and powers of persuasion that are gained during higher education are also important for good leaders. Higher education, especially graduate education, also gives individuals exposure to public issues through their interaction with diverse set of ideas, knowledge and people (Gift and Krcmaric, 2017; Krcmaric et al., 2020).

Some scholars view education as just a signaling mechanism for high-ability individuals to demonstrate that they are able (Spence, 1973; Sekhri, 2020). In the latter case also, one would expect educated leaders to be more competent, as education is serving as a signaling tool for individual's ability even if it does not enhance it.

Beliefs and values: Educated leaders are said to have higher beliefs and better values. They might be more publicly spirited and hence better able to serve their constituents and lead to more economic prosperity (Besley and Reynal-Querol, 2011). This view is grounded in the literature that shows that education leads to more politically engaged citizens. Education might impart skills that help in appreciating the needs of others and provide broader exposure to society and writings that make people civic-minded. Mayer (2011) uses propensity score matching techniques to show that educational advancement increases political participation. Using exogenous variation or instrumental variables, various studies have shown that education has a positive impact on voting, support for free speech, political and civic knowledge (Le and Nguyen, 2021; Milligan et al., 2004). Higher education can shape individual's political views and attitudes. Previous work has shown significant impact of higher education on political views (Campbell and Horowitz, 2016; Parreira et al., 2023) and political engagement (Perrin and Gillis, 2019). Besides, university experience is shown to have an impact on non-cognitive skills as well; using longitudinal data for Australia, Kassenboehmer et al. (2018) find a positive relationship between university education and individual's personality traits, including extraversion and agreeableness, associated with pro-social behavior.

There is also some evidence indicating that educated leaders might be less corrupt. Besley et al. (2004) use household data from Indian villages and find that better educated politicians exhibit less political opportunism.

There is literature across different countries and levels of government using quasi-experimental methods that has shown positive impact of educated leaders across a range of outcomes. Studies have used cross-national random leadership transitions to show that a leader's education level matters for economic performance and education (Besley et al., 2011; Congleton and Zhang, 2013; Yu and Jong-A-Pin, 2020; Diaz-Serrano and Pérez, 2013). Using differential timing of program and elections, Martinez-Bravo (2017) shows that school construction program in Indonesia led to an educated cohort of local leaders and it improved access to public goods. Using close elections regression discontinuity design, Mitra (2020) shows that Italian educated mayors invest more in public infrastructure.

On the other hand, there is a growing literature that questions the link between education, competence, and leadership. Carnes and Lupu (2016) argue that links between education and competence or civic engagement are not just due to skills gained during education, but also reflect pre-existing inequalities in the society that limit some talented people from pursuing education and signaling their competence. Recently, Peveri (2021) shows that a leader's educational attainment may not be a good proxy for their quality. Using data on national level leaders and controlling for the background characteristics, the study finds a positive effect of graduate leaders on growth but insignificant effects on other indicators of leader's performance.

Carnes and Lupu (2016) use random transitions in cross-national data, close elections in US congress, and random audit of municipalities in Brazil to show that across outcomes educated leaders are not more effective than less-educated leaders. Bastos and Sánchez (2021) using regression discontinuity design in close mayoral elections in Brazil shows that educated leaders do not produce better socio-economic outcomes and they also do not have higher likelihood of being re-elected, implying that educated leaders may not be perceived as better leaders by the citizens. Lahoti and Sahoo (2020) find no effect of leader's education on educational outcomes in Indian state elections. Curto-Grau and Gallego (2019) suggest that there is a possibility of mismatch in preferences of more educated leaders and their constituents, resulting in policies that may be far from being pro-social.

In light of theoretical ambiguity and conflicting evidence on the subject of leader's education, this remains an empirically interesting question to explore.

2.2. Political structure of India

This paper analyzes data on state assembly constituencies and representatives elected to state legislatures in India. Below, we provide a brief context on the political structure in India.

India is a federal republic consisting of 28 States and 8 Union Territories, and with a parliamentary system of government. At the national level, elected representatives to the Parliament of India are referred to as the Members of Parliament (MPs). Similarly, at the state level, elections are held to the State Legislative Assembly (or "Vidhan Sabha"). The elected representatives to state legislatures are referred to as Members of Legislative Assembly (MLAs). The states are sub-divided into assembly constituencies (each of which is represented by an MLA) based on population to ensure equal representation. Owing to the federal system of governance, every state has autonomy in deliberating upon and taking legislative action on certain subjects.[7]

Elections, at both the state and national levels, are conducted once every five years, with the electoral cycles being asynchronous across the states. The elections follow a "first-past-the-post" electoral system, and once elected, MLAs hold office for a term of five years. In this paper, our focus is on MLAs. Elected MLAs have legislative, executive, and financial powers conferred upon them by the Indian Constitution (Article 246).[8] All items of the state and concurrent lists fall under the purview of their responsibilities as elected officials, to debate and legislate upon. Legislative decisions at the state level are mostly made by the top leaders of the ruling party, and individual MLAs play a relatively smaller role in this process (Chopra, 1996). However, MLAs play an instrumental role in the developmental and political processes at the constituency level. Their regular activities include addressing the constituents' grievances, attending various functions in their constituencies, and getting funding from state and central government schemes for development-related work in their constituencies (Jensenius, 2013). MLAs also tend to have a significant control over bureaucracy as they influence decisions on assignments and transfers of officials (Iyer and Mani, 2012). The following paragraphs further elaborate on the different roles of MLAs in development outcomes relevant to this study.

2.3. The role of MLAs in development outcomes

There are several pathways through which the theoretical mechanisms of the impact of educated MLAs discussed in Section 2.1 can play out in the Indian context. Multiple studies establish the role of MLAs for a host of development outcomes (Bhalotra and Clots-Figueras, 2014; Bhalotra et al., 2014, 2018; Burchi, 2013; Clots-Figueras, 2011, 2012; Ejaz Ghani et al., 2013; Halim et al., 2016; Iyer et al., 2012; O'Connell, 2018; Pande, 2003). Drawing upon this literature and relevant policies, we discuss how different outcomes related to economic growth and development, analyzed in this paper, might be affected by MLAs.

Economic growth and nightlights: MLAs can impact economic growth by improving public services such as access to roads, electricity, attracting discretionary funds by lobbying the state government, and using networks and connections to attract new investment opportunities in the constituencies (Jensenius, 2015; Kukreja, 2022).[9]

Prakash et al. (2019) show that electing criminally accused MLAs hamper economic growth measured by night-time lights. They find that, on average, constituencies in which a criminally accused candidate barely wins experience roughly 24 percentage points lower yearly growth in the intensity of night-time lights as compared to those constituencies that barely elect a non-accused candidate. Baskaran et al. (2021) show that having women MLAs leads to a 15 percentage point higher growth in the intensity of nightlights than having a male MLA. They find lower corruption and higher efficiency among women leaders as mechanisms for higher economic growth in women leaders' constituencies. Using a close election regression discontinuity design, Asher and Novosad (2017) show that ruling-party affiliation of the local politician impacts the performance of firms through the politician's control over regulations, and hence it affects economic growth in India.

Public goods provision: MLAs wield significant influence in determining the allocation of infrastructure and welfare funds by India's Central and State governments (Khemani, 2007). Government spending on capital and welfare expenditure amounts to approximately 10–15 percent and 20 percent, respectively, of total government expenditure annually.[10] Due to the considerable needs and diverse interests, competition ensues among different regions to secure a share of these funds. MLAs hold sway

[7] The subjects where the states can independently legislate upon are laid out in the 7th Schedule of the Indian Constitution.

[8] https://legislative.gov.in/constitution-of-india.

[9] Such initiatives by the MLAs are often covered in the media as well, see for instance - https://www.dailypioneer.com/2022/state-editions/mla-assures-citizens-of-improvement-in-road-quality-in-doon.html, https://timesofindia.indiatimes.com/city/mumbai/mla-pushes-for-construction-of-2-new-underground-parking-spaces-in-south-mumbai/articleshow/95217097.cms.

[10] https://accountabilityindia.in/publication/special-edition-2023-accountability-initiative-centre-for-policy-research/.

over a considerable portion of this funding and are responsible, inter alia, for roads, electricity, law and order, education and health (Baskaran et al., 2021). These influences are often used to channel public goods (including access to electricity and roads) to specific regions and generate political gains.

Many development projects must be approved either directly by MLAs or through the influence of their nominees on Block Development Committees (Wilkinson, 2007). MLAs also affect how central and state level government programs and schemes are implemented in their constituencies. They are ex-officio members of various committees that oversee bureaucracy and implementation of various government programs at the constituency level. Since bureaucrats report to them and they play a significant role in determining bureaucratic transfers, MLAs can effectively monitor the performance of bureaucrats and, thus, the performance of various programs (Gulzar and Pasquale, 2017; Lahoti and Sahoo, 2020). Several studies have pointed out the importance of local bureaucrats in delivering public services (Bhavnani and Lee, 2018; Gulzar and Pasquale, 2017), and the influence of elected representatives over the bureaucracy that is used for developmental outcomes (Asher and Novosad, 2017; Min, 2015).

Besides, MLAs may impact public goods provision through the use of funds directly in their control. Under the Local Area Development Scheme (LADS) introduced in 1994–95, MLAs have access to an annual fund that they can use as per their discretion to sanction the construction of public goods and assets.[11]

Electricity: Given the importance of electricity to citizens, electricity provision is an important campaign issue and subject to political influence (Min, 2015). There is evidence showing that state governments influence power supply to specific constituencies for political gains (Baskaran et al., 2015). Studies have also documented the direct influence of local MLAs over electricity board officials (Sareen, 2018).

Roads: Using data from a major road construction program in India, literature has documented the influence of MLAs on road construction. The Pradhan Mantri Gram Sadak Yojana (translated as Prime Minister's Village Road Scheme), launched in 2000, is a nationwide plan to provide all-weather road connectivity to unconnected villages. This scheme has been extensively studied in the literature to understand the role of politicians in road construction. For example, Thomas (2021) finds that constituencies with MLAs affiliated to the ruling party tend to have longer roads constructed in the program. The control of politicians over bureaucracy is postulated as a mechanism for this result. Lehne et al. (2018) show that politicians affect the quality of roads through their influence on the selection of contractors in the rural road construction program.

Crime and corruption: Literature has also shown that crime and corruption are impacted by MLAs. This in turn can affect economic growth. Aneja and Ritadhi (2022) find that having more leaders from historically marginalized social groups in state government reduces violence against these groups. Other studies using regression discontinuity design find that crime is higher and officials are more corrupt in constituencies where criminally accused politicians are elected (Chemin, 2012; Prakash et al., 2022). Also, the election of criminal politicians leads to an increase in rural poverty and a decrease in household electrification and literacy rates (Cheng and Urpelainen, 2019).

While gender, caste, religion, and criminality of leaders have been extensively studied, the effect of educational qualification of leaders has not been adequately explored in the Indian context. Lahoti and Sahoo (2020) is one study that analyzes the effect of leaders' education on educational outcomes, finding heterogeneity in effect based on the initial level of development of the states.

We postulate that educated leaders are more competent, less corrupt, and more public-spirited. These qualities can translate into actions that lead to higher economic growth in their constituencies. More competent leaders would be better able to understand complex issues, put forth an argument and influence legislation. More competent and less corrupt leaders can better monitor development programs and oversee the bureaucracy. More public service spirited and less corrupt MLAs can utilize the funds they directly control in more effective ways and would be better at listening and resolving constituents' issues (Bussell, 2019). In this paper, we use extensive data and casual methods to test the impact of educated leaders on various development outcomes.

3. Data

For our analysis we merge data from various sources. In the following sub-sections we describe the different data sets used to measure the outcomes and main explanatory variables used in our analysis.

3.1. Night-time lights data

There is no reliable data set that measures economic activity or output at the assembly constituency level for India. National Income Accounts data is available at the national and state levels only, and the accuracy of this data is often debated (Subramaniam, 2019). Alternatively, the existing sample surveys may provide indicators for development outcomes at the district level; however, even these data sets are not available on an annual basis and are not always representative of the district population. The night-time lights data on the other hand, has the twin benefits of being available on an annual basis and being spatially granular, allowing us to construct time series data at a sub-regional level. Hence, we proxy for the level of economic activity in an assembly constituency by the intensity of night-time lights. Doll et al. (2006), Chen and Nordhaus (2011), and Henderson et al. (2012) have assessed

[11] The amount accessible to MLAs varies across states. States differ in terms of releasing information on how these funds are being utilized. Although it would be informative to investigate if more educated MLAs utilize their funds differently than less educated MLAs, we are unable to conduct this analysis due to limitations in data availability. Since MLAs are state level leaders, there is no harmonized data available across the states. Only a few states have made the data available for a few years, which is not adequate for our analysis. Possibly due to lack of data, we have also not found any studies in the existing literature analyzing the utilization of funds based on MLA's education levels.

the reliability of night-time lights as a proxy, analyzing the relationship between the intensity of night-time lights and regional GDP. Henderson et al. (2012), for instance, note that night-time lights serve as a useful proxy for economic growth as well as for measuring the short run fluctuations in growth. Recent studies, in this regard, have used night-time lights to predict various developmental outcomes (Alesina et al., 2016; Michalopoulos and Papaioannou, 2014; Hodler and Raschky, 2014; Storeygard, 2016; Weidmann and Schutte, 2017; Bruederle and Hodler, 2018).[12] Bruederle and Hodler (2018) and Weidmann and Schutte (2017) both note that a higher intensity of night-time lights is associated with better development outcomes at the local level.

Asher et al. (2021) conducted a comprehensive analysis to investigate the relationship between nightlights and economic development for India. They show that nightlights are a statistically significant proxy for a range of development outcomes including population, employment, per capita consumption, and electrification, even at the sub-district level. However, they point out a few caveats in this relationship. Firstly, nightlights have independent correlation with each of the development outcomes considered, hence it is better to conceptualize nightlights as a measure of overall development rather than ascribing it to any specific outcome. Secondly, the strength of the relationship between nightlights and other measures of development varies by geographic scale and context. Especially, the luminosity-to-GDP elasticity can be sensitive depending on whether cross-sectional or time-series variation in data is used in the analysis; thus, extrapolating the magnitude of effect on nightlights to that on GDP may be difficult. Overall, their analysis validates the use of nightlights as a proxy for local economic development. Among other studies, Bhandari and Roychowdhury (2011) and Bickenbach et al. (2016) have examined the association between night-time lights and district level GDP, reporting a high correlation between the two. Prakash et al. (2019) and Baskaran et al. (2021) use night-time lights data for India at the regional level to study the impact of leader's gender and criminality, respectively.

We use imagery of earth gathered at night by multiple satellites orbiting the earth under the U.S. Air Force Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS). The DMSP-OLS is equipped with the unique ability to capture low light imaging data. Since 1992, the data has been processed to remove the effect of late evening sunlight, moonlight and the presence of clouds from the images. Further, the images are filtered to remove the effect of forest fires and other ephemeral lights, and background noise is removed by setting thresholds based on visible band values found in areas known to be free of detectable lights. The images are projected onto geo-referenced 30 arc-second grid (roughly 1 km^2 at the equator) pixels. Each pixel is encoded with a Digital Number (DN) that signifies annual average brightness on a 6-bit scale from 0 to 63, where 0 signifies absence of detectable light and 63 signifies maximum measurable value for night-time light. The higher the number, the greater is the intensity of nightlight.[13]

To estimate light intensity at constituency level, we overlay a map of assembly constituency boundaries on the night-time lights file. We extract the sum of pixel values within the constituency boundary and divide by the total area of the constituency. This gives us annual estimates of mean night-time lights for constituencies. Since the DMSP-OLS program was discontinued in 2014, data on night-time lights is available for the period 1992–2013. Another aspect of the data is that the sensors measuring night-time lights might generate measurement error because of saturation and low sensitivity. Saturation occurs because of the limitation in the sensors in recording high level of brightness as the highest value recorded by the sensors is censored at 63. This might lead to underestimation in growth in large cities which have already reached the saturation value of night-time lights. To overcome this limitation, we conduct robustness analysis by dropping all observations having these extreme values.

3.2. Political data

We merge candidate level data from two different sources to construct a comprehensive political data set for all candidates contesting state assembly elections. We use detailed data on assembly constituency results from reports provided by the Election Commission of India (ECI). This includes information on all contesting candidates, affiliated political parties, the number of votes polled for each candidate and the size of electorate in each assembly constituency.

Following a Supreme Court judgment in 2003, all individuals contesting elections are required to file an affidavit with the ECI listing their education level,[14] assets, and criminal cases among other details.[15] This information has been processed and made available by the Association for Democratic Reforms (ADR), an election watchdog.[16] We merge the data from ECI and ADR at the candidate level to compile a panel data on election outcome for each individual candidate and their characteristics, including the number of votes polled in the election and their educational qualifications. We additionally extracted information on candidates' educational degrees and classified them into the following three categories: (a) an arts degree (includes Bachelors or Masters in Arts, Education, Commerce, Business administration, and Management), (b) a science degree (includes Bachelors or Masters in Sciences, Technology, Engineering, and Medicine), and (c) a law degree (includes Bachelors or Masters in Law).

[12] Further, Donaldson and Storeygard (2016) discuss various studies that have used night-time lights in different contexts in economics.

[13] Henderson et al. (2012) detail a discussion on the processing of night time images captured by the satellite into usable night-time lights and mention the limitations of interpreting economic activity from night-time lights.

[14] There exists no data or past evidence to understand if citizens are aware about political candidate's education in India. Although there is some data to support the idea that education is indeed considered an important trait — as part of a recent voter survey (Lokniti State election studies, 2022) conducted across four states (Goa, UP, Punjab, and Uttarakhand) in India. Voters were asked about the importance of candidate's education while casting their vote. Majority of the respondents, around 70 percent and more, across the four states responded that candidate's education is an important characteristic.

[15] https://globalfreedomofexpression.columbia.edu/cases/union-india-uoi-v-respondent-association-democratic-reforms-another-peoples-union-civil-liberties-pucl-another-v-union-india-uoi-another/.

[16] ADR has processed these affidavits from different state elections over time. The same are also available on the ECI website in PDF format.

Table 1
Summary statistics.

	Full sample			Mixed sample		
	N	Mean	SD	N	Mean	SD
Growth rate of night-time lights	13 909	7.15	24.85	6081	7.13	24.63
Constituency characteristics						
Electorate size (log)	13 909	11.88	0.79	6081	11.91	0.75
Voters (log)	13 909	11.48	0.71	6081	11.50	0.68
Turnout	13 903	68.35	13.80	6078	68.16	13.65
General constituency	13 909	0.72	0.45	6081	0.72	0.45
SC constituency	13 909	0.15	0.36	6081	0.15	0.35
ST constituency	13 909	0.14	0.34	6081	0.14	0.34
Candidate characteristics						
Graduate leader	13 909	0.60	0.49	6081	0.48	0.50
Graduate runner-up	13 278	0.62	0.49	6081	0.52	0.50
Winner's assets (log)	13 889	15.60	1.66	6064	15.61	1.63
Runner-up's assets (log)	13 838	15.36	1.73	6065	15.41	1.72
Winner's liabilities (log)	13 909	7.81	6.76	6081	7.77	6.72
Runner-up's liabilities (log)	13 906	7.79	6.68	6081	8.11	6.65
Winner's criminality	13 909	0.88	2.55	6081	0.89	2.48
Runner-up's criminality	13 906	0.69	1.90	6081	0.72	1.89
Winner's age	13 597	49.80	10.08	5948	49.60	10.28
Runner-up's age	13 597	49.62	10.44	5948	49.49	10.50
Male winner	13 909	0.92	0.27	6081	0.92	0.27
Male runner-up	13 909	0.91	0.28	6081	0.91	0.29
Winner's education	13 909	13.47	3.52	6081	12.83	3.57
Runner-up's education	13 278	13.52	3.61	6081	12.95	3.61
Female winner	13 909	0.08	0.27	6081	0.08	0.27

Full sample includes all constituencies and mixed sample includes constituencies where one of the top two candidates is a graduate while the other candidate is a non-graduate. The summary statistics on all variables are estimated using constituency-year level panel data spanning from 2009 to 2012, with data on nightlights spanning until 2013 to allow the calculation of growth rate for this period. Criminality measures the number of criminal cases against a candidate at the time of contesting the election.

3.3. Merged data

The main focus of our paper is on the educational qualification of the contesting candidates. Given that the Supreme Court judgement was implemented in 2004, we have information on candidate's educational qualification post 2004 only. In addition, elections to State Legislative Assembly take place once in five years and the election cycles are different across the states. Therefore, not all states have information on education levels of candidates from 2004 onwards; rather, this information becomes available when a state has election for the first time in the post-2004 period. Thus, in our data, 2009 is the initial year when we have information on the education level of MLAs in power for all the states.

Additionally, the Delimitation Act, passed in 2002, amended the assembly constituency boundaries based on population figures from the 2001 Census.[17] After much administrative delay, it was implemented from 2008 onwards, implying that elections post 2008 followed a newly drawn assembly constituency boundaries. This means that constituencies are not comparable across elections that took place in the pre-delimitation and post-delimitation periods. To tackle this issue, we take into consideration the constituency boundaries prior to delimitation as well as post it, and merge the political data with the night-time lights data for the respective year depending on whether delimitation was already implemented or not.[18] We construct an annual panel by merging the data on leader who is in power in a given year with the night-time lights outcome corresponding to that year. Thus, we have two sets of annual panel data at the constituency level, specific to pre- and post-delimitation periods. For our analysis, we pool these two data sets.[19] As explained earlier, owing to varied electoral cycles of states, we have political data on candidates from 2009 onwards. Discontinuation of the DMSP-OLS program from 2014 onwards results in night-time lights data being available till 2013. Thus, our analysis is restricted to the period 2009–2013. We report the descriptive statistics of the key variables in Table 1.

[17] The constituency boundaries account for the population. Given changes in population growth, the boundaries have been historically adjusted to ensure equal representation in legislature through the Delimitation Act of 1952, 1963, 1973, and 1977; following each decadal census. The last delimitation was conducted in 1977, before new boundaries were proposed in the Delimitation Act of 2002. Further, Iyer and Reddy (2013) study the delimitation enforcement in Rajasthan and find the redrawing of boundaries to be politically neutral.

[18] We use shape files for both pre- and post-delimitation assembly constituency boundaries and extract night-time lights data using QGIS. This data is then merged with the political data for the respective assembly constituencies. The post-delimitation shape files used have been sourced from Susewind (2014). The pre-delimitation shape files were made publicly available by Sandip Sukhtankar and Manasa Patnam https://uva.theopenscholar.com/sandip-sukhtankar/data.

[19] The pooled data essentially is a constituency-year panel data that is unbalanced due to the non-comparability of pre- and post-delimitation constituencies. Although constituency boundaries have changed after delimitation, no constituency is spread across multiple districts in both pre- and post-delimitation periods. Since constituencies are always contained within districts, we include district fixed effects in our regression presented in the next section.

3.4. Additional outcome variables

3.4.1. Data on public goods and infrastructure

In addition to investigating the relationship between educated leaders and night-time lights, we also explore the mechanisms through which educated leaders might have an effect on economic growth. Specifically, we explore the effect of electing educated leaders on availability of public goods and infrastructure in the assembly constituency. For this purpose, we use village level data from 2011 round of Census.[20] From the Census data, we obtain information on access to public goods and infrastructure such as schools, colleges, nutritional centers, hospitals, drinking water, sanitation facilities, financial institutions, roads connectivity, power supply, and electrification at the village level.[21] Provision of public goods and infrastructure might be influenced by the MLA in a constituency through channels discussed in Section 2.3.

Since our analysis is at the constituency level, we match villages from the census data to assembly constituencies.[22] We aggregate the village-level data at the constituency level to construct indices measuring availability of public goods and infrastructure. Table A1 (in the online supplementary appendix) provides information on the proportion of villages in a constituency that have access to a specific infrastructure facility captured in the data. Electricity, however, measures the percentage of households in an assembly constituency that have access to electricity as the main source of lighting. Based on these variables, we construct three indices at the constituency level using Principal Component Analysis (PCA). The first index captures overall access to public goods, considering all the variables mentioned in Table A1. The second index considers access to power supply, constructed using information on access to power for domestic, agricultural, and industrial use. The third index is for road infrastructure in the constituency, constructed using variables that measure access to national highways, state highways, paved roads, unpaved roads, all weather roads and other major roads that enable connectivity to agricultural markets and administrative offices. All the indices are standardized to have mean 0 and standard deviation 1. Additionally, we also consider an outcome variable measuring the percentage of households having access to electricity in a constituency. We merge these variables with the election data at the constituency level. Unlike our night-time lights outcome where we have an annual panel data at the assembly constituency level, the data from Census is a single cross section. Therefore, for the additional analysis, we estimate a cross sectional regression where leader of the previous year is used to estimate the effect.[23] We find that each of these four variables related to public goods and infrastructure is significantly and positively correlated with the constituency-level nightlights in 2010 (Figure A1 in the appendix). The strong positive relation between nightlights and these other indicators of development measured at the local level is consistent with the findings of Asher et al. (2021).

3.4.2. Data on crime

To investigate if educated leaders uphold law and order in the constituency, we use total number of documented crimes as an outcome variable. This variable is sourced from the "Crime in India" publication of the National Crime Records Bureau (NCRB), Government of India. We consider any crime under the Indian Penal Code, recorded at the police station in the form of First Information Report (FIR), and aggregated at the district level. Thus, we have a district level annual panel data on total crimes for the period from 2005 to 2018. We merge this variable with the political data aggregated at the district level to conduct the analysis.

3.4.3. Data on politicians' assets

We also consider an outcome variable that measures the growth in net asset of leaders over an election cycle. Candidates contesting elections must declare their assets and liabilities, in addition to other demographic details per law mentioned in Section 3.2. However, asset growth can only be estimated for candidates who decide to re-contest and file affidavits in two subsequent elections. This limits the analysis to a subset of leaders who re-contest.

We consider data on leader's assets and liabilities declared in election affidavits for all state elections in the period 2004–2021. We consider 30 states, covering asset growth of leaders who held political office for three election cycles in 11 states, two election cycles in 18 states and one election cycle in 1 state. We then match these leaders by their names with candidates who re-contested in subsequent elections in the same state. In this process, we use a probabilistic matching algorithm first and then manually verify the matches, as the commonalities between Indian names and different spellings in affidavits make it hard to find exact matches based on candidate names. We were able to match 6545 leaders out of a total of 7098 leaders re-contesting elections.[24]

[20] The census data can be accessed from: https://censusindia.gov.in.

[21] Power includes access to electricity for domestic, agricultural and commercial uses.

[22] We overlay village shape files on shape files for assembly constituency boundaries to match villages to assembly constituencies using QGIS.

[23] Here, the leader holds office in 2010, a year before Census 2011 was conducted. However, these leaders could have been elected to office at any time in the past five years. This gives the leader more than a year in office to effect change. In Table A2, we present the distribution of years in which leaders holding office in 2010 were elected, and our analysis controls for these election-year fixed effects.

[24] The list of all re-contesting leaders is obtained from the ADR data. A comparison of the matched and unmatched sample does not reveal any systematic pattern in terms of the candidate and constituency characteristics from the re-contesting election (Appendix Table A20). While the difference is statistically significant for some of the characteristics, the magnitude of the difference is negligible.

4. Empirical strategy

In this section, we present our empirical strategy for estimating the causal effect of electing an educated leader on the economic activity in a constituency. We use annual average growth rate of night-time lights in the constituency as our main outcome variable defined below:

$$Y_{idst} = log(l_{idst+1}) - log(l_{idst}) \quad (1)$$

l_{idst} measures the annual average intensity of night-time luminosity in assembly constituency i belonging to district d from state s in time period t.[25] The outcome variable Y_{idst} captures the growth rate of night-time lights in assembly constituency i in between the periods t and $t+1$. For each assembly constituency i, we use data on night-time lights for the period 2009–2013.

Using constituency-year level data, our basic specification exploring whether an educated MLA affects the growth rate of night-time lights in the constituency is given by the following equation:

$$Y_{idst} = \alpha + \delta_d + \gamma_t + \beta\, Graduate_{idst} + \epsilon_{idst} \quad (2)$$

where t identifies the time period while i, d, and s identify a constituency, district, and state, respectively. Our interest lies in the coefficient of the main explanatory variable $Graduate_{idst}$, taking the value 1 if the elected leader in constituency i in district d from state s at time t has a graduate degree and 0 otherwise. We define a graduate leader as one who has completed college education, using this as a cutoff to differentiate between a more educated leader from a less educated one.[26] In further analysis presented in Section 6.2, we also conduct the analysis considering alternative ways to define an educated leader. The coefficient β captures the marginal effect of having a graduate leader in constituency i during time period t on the growth of average night-time lights between time periods t and $t+1$. Thus, our model is similar to the one estimated by Prakash et al. (2019) to determine the effect of criminally accused leaders on economic growth.

In the set of explanatory variables, we include district fixed effects (δ_d) to control for various time invariant unobserved factors at the district level and year fixed effects (γ_t) to capture any secular change in the growth rate of night-time lights over time. Note that district fixed effects also subsume any unobserved heterogeneity at the state level, since districts are nested within states. To check the robustness of our results, we also present alternate estimates dropping the fixed effects in one specification, and including only state and year fixed effects in another specification. Note that we cannot control for constituency fixed effects in our analysis. To include constituency fixed effects, we need both outcome and explanatory variables to vary over time within the same constituency. The data on nightlights is measured on an annual basis, so the outcome variable varies on an year-to-year basis. On the contrary, the main explanatory variable, i.e., education level of the MLA, changes only when there is an election in the state. Elections happen once in five years and the election-years are different across the states. As we described in detail in Section 3.3, the delimitation was implemented when the first election happened in 2008 or later in each state, making the constituencies non-comparable before and after the delimitation was implemented. Due to the limited time span of our data, we do not have multiple elections in either pre- or post-delimitation period. In other words, when the leaders' education changes (owing to a new election), the constituency boundary also changes in our sample, making it impossible to use constituency fixed effects in the regression. Instead, we use district fixed effects as constituencies are always contained within districts.

The main identification problem in Eq. (2) is that the election of an educated leader may not be random and constituencies that elect an educated leader may systematically differ from those that do not. For example, constituencies with more educated electorate may have higher economic growth and also elect an educated politician. Thus, the election of an educated leader is likely to be correlated with unobserved voter and constituency specific characteristics, making the ordinary least squares (OLS) estimate biased and inconsistent.

4.1. Regression discontinuity design

To identify the causal effect of educated leaders, we utilize a Regression Discontinuity Design (RDD). In a first-past-the-post electoral system, among the top two contestants, the probability that a candidate wins is a function of the vote margin between the candidate and the opponent; this probability changes discontinuously at the point where vote margin is zero (Lee, 2008). Given the objective of this study, we consider elections where one of the top two candidates is a graduate while the other is not, and define the forcing variable as the vote margin between the graduate and the non-graduate candidate. The RDD framework assumes that in a close neighborhood of the discontinuity at zero margin, the difference between constituencies that elect a graduate leader and those that elect a non-graduate leader diminishes as the margin becomes smaller. Therefore, constituencies that barely elect a non-graduate candidate in a close election serves as a valid counterfactual for constituencies that barely elect a graduate candidate in a close election. Thus, the RDD framework allows us to estimate the causal effect of graduate leaders on outcomes.

[25] We add 1 to the value of nightlights before taking logarithm, since there are some observations with the value 0 (1.78% of the sample). We later show that our results are not sensitive to dropping extreme values of 0 and 63.

[26] The distribution of education level of candidates (considering the winner and runner-up for each election) is presented in Table A3. Nearly 61 percent of the top two candidates contesting in election have a graduate degree (i.e., at least 15 years of education) in our data; hence, compared to other education levels, the cutoff of graduate degree allows us to have a more balanced distribution between more educated and less educated leaders.

Accordingly, we define the forcing variable $Margin_{idst}$ as the difference in votes shares between the graduate and the non-graduate candidate for every election where either the winner or the runner-up is a graduate and the other is not. Owing to this definition:

$$Graduate_{idst} = \begin{cases} 1, & \text{if } Margin_{idst} > 0 \\ 0, & \text{if } Margin_{idst} \leq 0 \end{cases}$$

where $Margin_{idst} > 0$ implies that the graduate candidate has won the election, while $Margin_{idst} \leq 0$ would imply that the graduate candidate has lost. Thus, the probability of having a graduate leader changes discontinuously at the cutoff where $Margin_{idst} = 0$. We exploit this discontinuity in treatment assignment to identify the causal effect of electing a graduate leader on economic activity in the constituency. Given this set-up, we estimate the following specification using constituencies that lie in the close neighborhood (h) around the cutoff ($Margin_{idst} = 0$).

Finally, the estimated model as per the RDD specification is:

$$Y_{idst} = \alpha + \delta_d + \gamma_t + \beta\, Graduate_{idst} + f(Margin_{idst}) + \epsilon_{idst}, \quad \forall\ Margin_{idst} \in (-h, h) \tag{3}$$

where Y_{idst}, δ_d, γ_t and $Graduate_{idst}$ are all defined the same way as in Eq. (2). By construction, $Margin_{idst}$ is positive when graduate leader wins against a non-graduate leader and negative the other way around.

We estimate the model using local linear regression with triangular kernel as suggested by Gelman and Imbens (2019). Concurrently, we also report results for several bandwidth choices based on the optimal bandwidth procedures suggested by Calonico et al. (2014) and Imbens and Kalyanaraman (2012).

5. Validity of the RD design

In this section, we provide supporting evidence that the outcomes of close elections are quasi-random and other validity tests for the RD design. We conduct the various tests suggested by Imbens and Lemieux (2008). The first is a density test that investigates any evidence of sorting around the threshold (McCrary, 2008). For instance, if graduate politicians have the means to manipulate election outcomes, they may be more likely to win close elections against non-graduate politicians. If it were so, we would observe a larger frequency of graduate candidates compared to non-graduate candidates in the neighborhood of the cutoff of forcing variable, which in our analysis is margin of victory. The upper and lower panels in Fig. 1 plot the density of forcing variable and the density test, respectively. Both panels of Fig. 1 show that the difference in density of the victory margin above and below the cutoff is not statistically significant, indicating that there is no evidence of manipulation in the outcome of a close election.

The second test investigates whether pre-determined constituency level characteristics change at the threshold of discontinuity. If the RDD is internally valid, these factors should not change discontinuously at the cutoff. We conduct this test on a set of constituency level variables including growth rate of night-time lights in the previous election term, whether the constituency was reserved for Scheduled Caste or Scheduled Tribe candidates (SC/ST), total number of contestants, size of electorate, number of voters, and poll percentage. Fig. 2 shows that indeed, there is no significant discontinuity in these characteristics around the cutoff of zero margin of victory between the graduate and non-graduate candidate. Analogously, considering the sample of close elections involving a graduate and a non-graduate candidate, we conduct a t-test to compare the means of these characteristics between constituencies with a graduate winner and a non-graduate winner. Consistent with the graphical evidence, results from Table A4 shows no significant difference in these covariates across the two types of constituencies. In addition, we also find that the probability of a graduate candidate winning in close elections does not systematically depend on the constituency characteristics (Table A5), indicating that the outcomes of close elections are indeed random.

Further, we consider the possibility that education of a leader may be correlated with other characteristics of the leader. If other characteristics of the leader also change discontinuously at the cutoff, we will not be able to separate out the causal effect of leaders' education from these other characteristics. Fig. 3 shows continuity checks in terms of the leaders' gender, age, criminality, ruling party affiliation, assets, and liabilities. Additionally, the leader's political party affiliation is shown in Appendix Figure A2. The graphical evidence does not indicate any significant discontinuous change in these characteristics at the cutoff. The analogous comparison of means presented in Table A4 indicates minor differences in terms of leaders' criminality and gender; however, we later show in robustness analysis that our estimate of the effect of leaders' education is unlikely to be driven by these factors.

6. Results

6.1. Main results

Our main results are based on the RDD specification defined by Eq. (3).[27] We find that electing a graduate leader in close elections results in higher growth in night-time lights and the finding is robust across specifications. We report the point estimates in Table 2. First, we estimate the model without any fixed effects and present the results in Panel A. Results in panel B are from a specification

[27] We also present OLS results for Equation (2) in Table A6 of the Appendix.

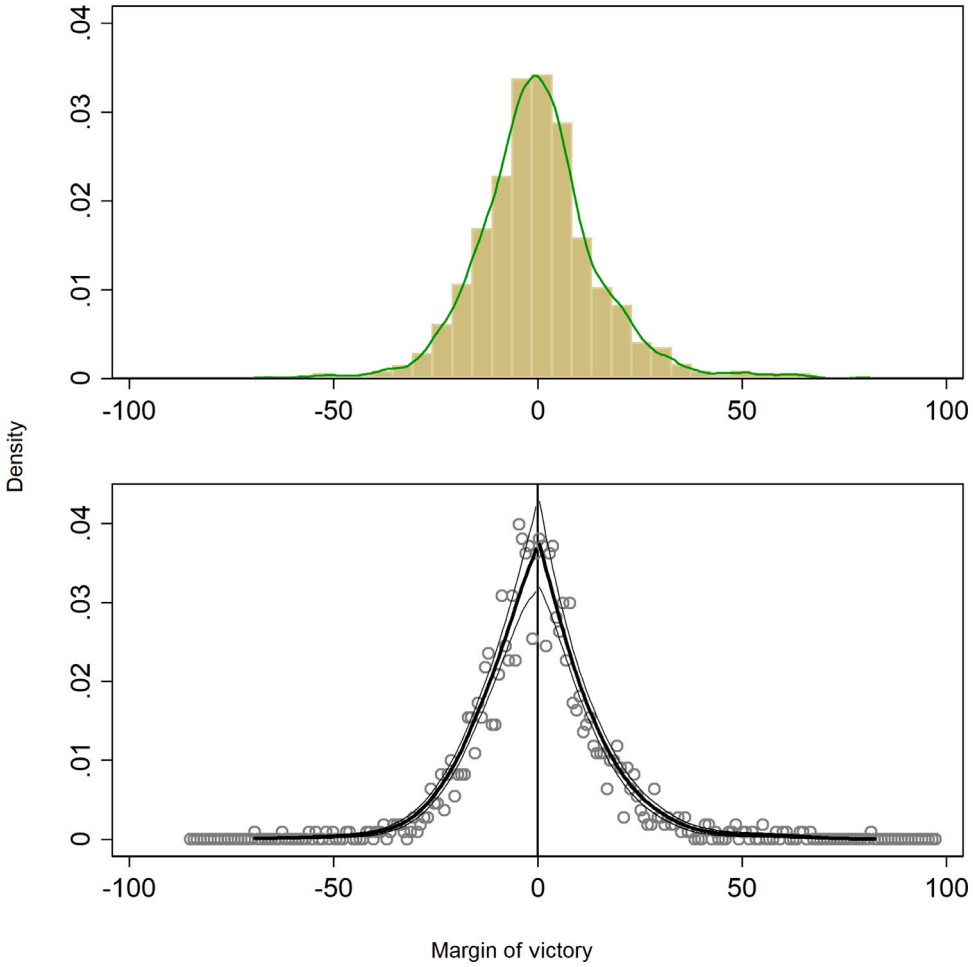

Fig. 1. Density test of the forcing variable. The figure shows the continuity of the forcing variable which is the margin of victory, defined as the difference in vote share between the graduate and the non-graduate candidates in mixed elections (i.e., elections where one of the top two candidates is graduate while the other is non-graduate). By construction, margin of victory is positive for graduate leaders and negative for non-graduate leaders. The upper panel plots the kernel density of victory of margin and the lower panel plots the density test for a discontinuity at the cutoff where margin of victory is 0. The figure shows that there is no significant discontinuity in the density of the victory margin above and below the cutoff.

that includes year and state fixed effects. Our preferred specification, presented in Panel C, controls for district fixed effects and thus takes into account any unobserved heterogeneity at the levels of state, district and year.[28]

In columns (1) and (2), we estimate the model using the optimal bandwidth criterion proposed by Imbens and Kalyanaraman (2012) (IK) and Calonico et al. (2014) (CCT), respectively. According to our preferred specification, there is around 3.2 percentage point increase in annual average growth rate of night-time lights resulting from electing a graduate candidate over a non-graduate candidate in close elections. This estimate is statistically significant at 1 percent level of significance. We show estimates using alternate bandwidths as well. In the last two columns, we double $(2h)$ and halve $(h/2)$ the IK bandwidth, and find that the estimated effects are 2.1 and 3.6 percentage points, respectively. Thus, the estimates are quantitatively similar and relatively stable across different bandwidths and inclusion of fixed effects. Using estimates of elasticity of GDP to night-time lights, a 3 percentage point difference in luminosity growth translates into a 0.3 to 0.45 percentage point difference in GDP growth, based on the elasticity

[28] In the sample of close elections defined according to the optimal bandwidth in our main specification, there are around 86 percent of cases where within the same district, we have at least one constituency where a graduate narrowly won and at least one constituency where a graduate narrowly lost. Thus, we have an adequate number of observations that contribute to the variation in the main treatment variable for identification when district fixed effects are used.

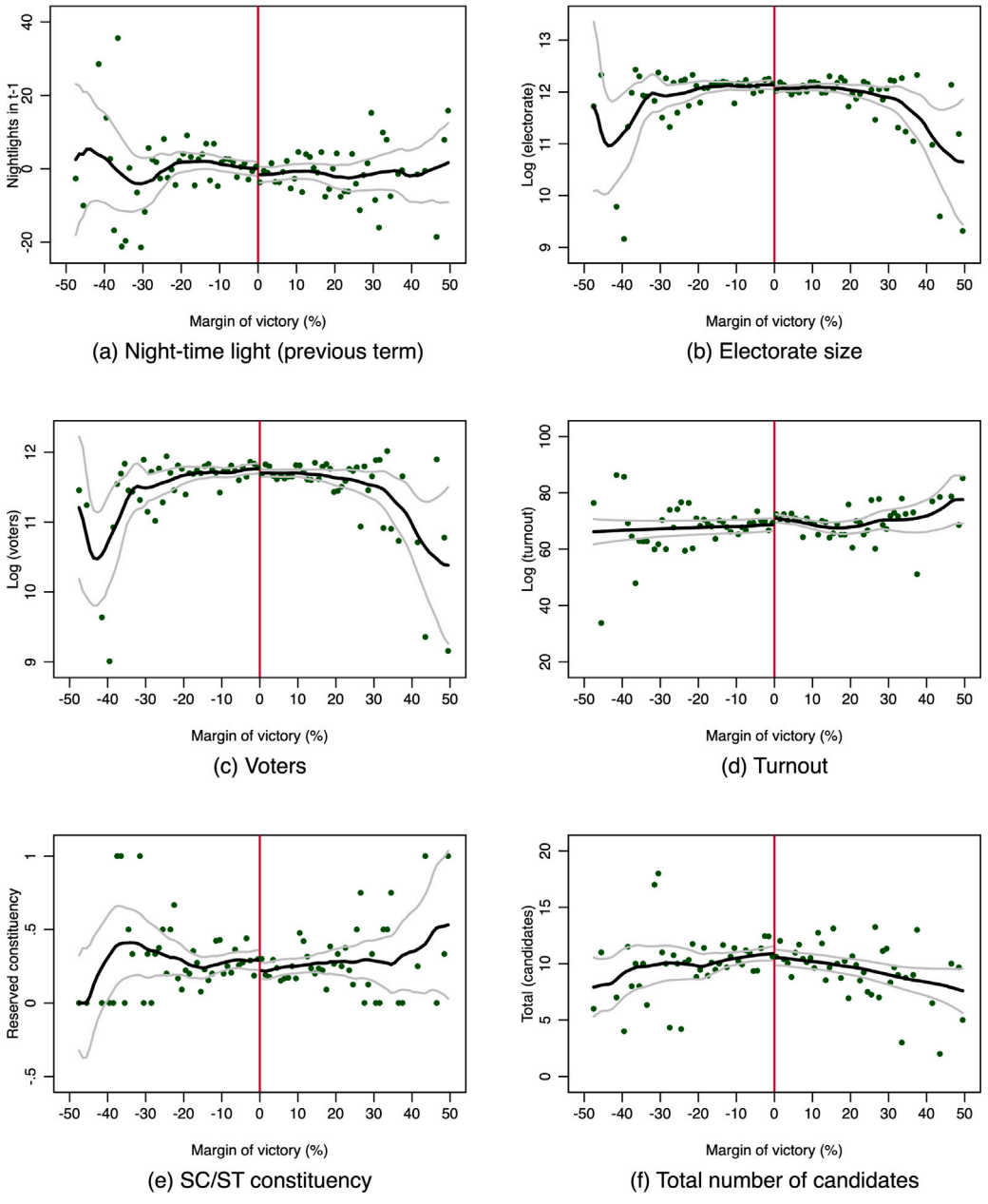

Fig. 2. Continuity checks of constituency level covariates. The figure plots the continuity checks for constituency characteristics. Each variable is plotted against margin of victory, which is the difference in vote share between the graduate and the non-graduate candidates in mixed elections. By construction, margin of victory is positive for graduate leaders and negative for non-graduate leaders. Each dot in the figure depicts the averages over successive intervals of 0.5% of margin of victory. The curves are local polynomial regressions (with 95% confidence intervals) fitted separately for positive and negative parts of the margin of victory variable.

used.[29] The average growth in India during the period of study was about seven percent per year. Our estimates hence indicate that the growth premium for constituencies stemming from them having a graduate legislator could be between 4 and 6 percent.

We also illustrate the impact graphically in Fig. 4. Each dot in the figure reflects the average annual growth rate in night-time lights in successive intervals of 0.5% of the margin of victory. In the plot, a positive margin of victory suggests that a candidate

[29] The potential impact on GDP growth should be interpreted as indicative at best. The elasticity has been estimated to be around 0.10 using district-year level panel data for a few years by Bickenbach et al. (2016) and around 0.15 using state-year level panel data by Baskaran et al. (2021); however, these estimates can vary when we consider smaller regions like constituencies in our case.

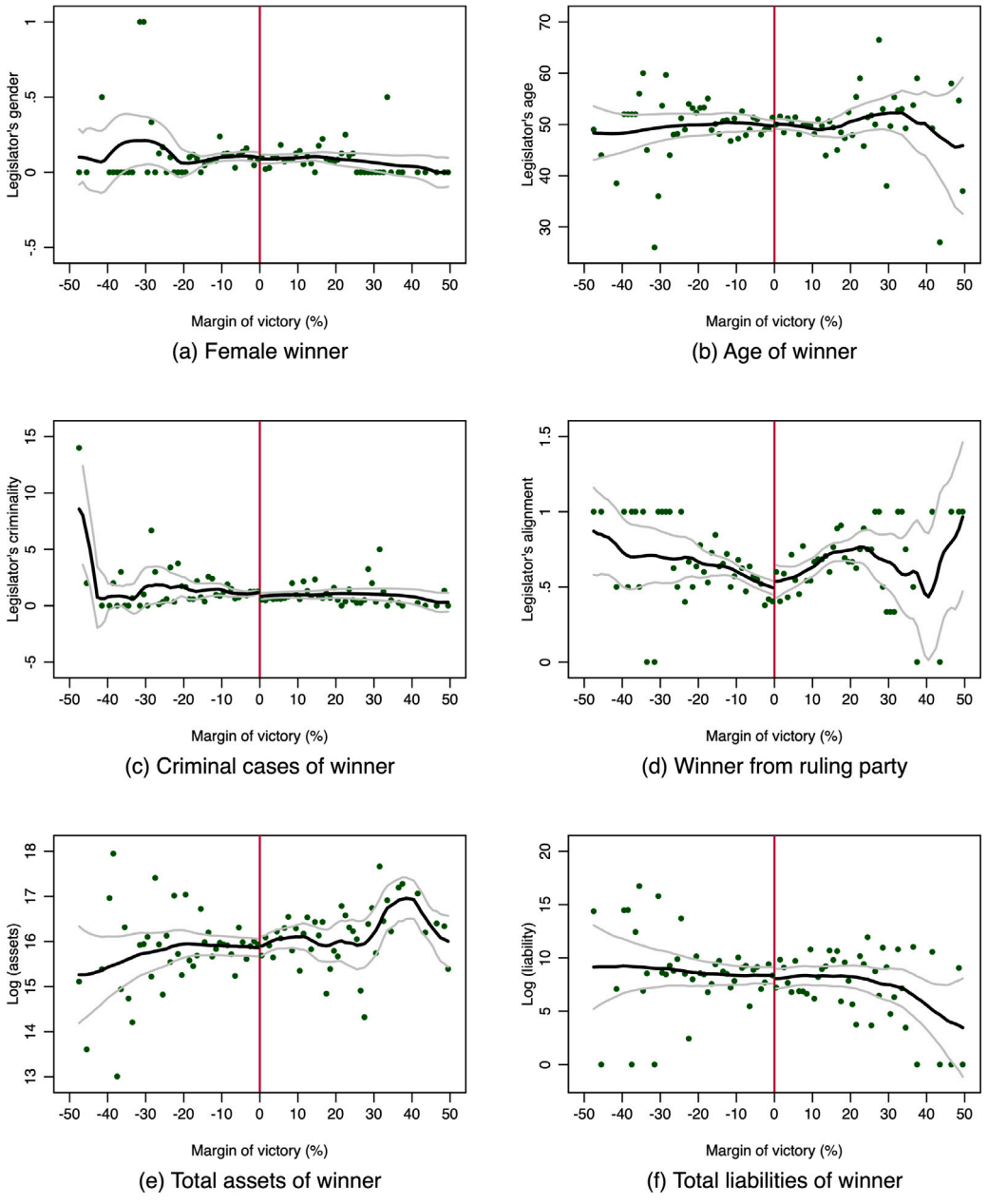

Fig. 3. Continuity checks of candidate characteristics. The figure plots the continuity checks for legislator characteristics. Each variable is plotted against margin of victory, which is the difference in vote share between the graduate and the non-graduate candidates in mixed elections. By construction, margin of victory is positive for graduate leaders and negative for non-graduate leaders. Each dot in the figure depicts the averages over successive intervals of 0.5% of margin of victory. The curves are local polynomial regressions (with 95% confidence intervals) fitted separately for positive and negative parts of the margin of victory variable.

with a graduate degree has been elected over a candidate without a graduate degree; the reverse would be true when the margin of victory is negative. The figure shows a discontinuous jump in growth rate of night-time lights at the cutoff (i.e., at $Margin_{idst} = 0$). The magnitude of the jump also corresponds to the effect size found in our main results presented in Table 2. This suggests that constituencies that elect a graduate leader in close elections experience higher growth in night-time lights, implying a higher level of economic activity, than constituencies that elect non-graduate leaders in close elections.

6.2. *Varying definition of educated leaders*

In this section, we consider alternative thresholds to compare more versus less educated leaders using a multi-cutoff RDD methodology explored in the recent literature (Bertanha, 2020; Cattaneo et al., 2016). Our main analysis presented above focuses

Table 2
Effect of electing a graduate leader on growth in night-time lights.

	(1)	(2)	(3)	(4)
Panel A				
Graduate leader	3.012**	2.830**	2.203**	2.096
	(1.276)	(1.115)	(0.942)	(1.765)
Observations	2883	3589	4517	1520
R-squared	0.002	0.001	0.001	0.003
Bandwidth	7.427	10.16	14.85	3.714
Year fixed effects	No	No	No	No
State fixed effects	No	No	No	No
District fixed effects	No	No	No	No
Panel B				
Graduate leader	3.055***	2.872***	2.256***	2.554
	(1.149)	(1.004)	(0.822)	(1.697)
Observations	2883	3506	4517	1520
R-squared	0.505	0.497	0.488	0.507
Bandwidth	7.427	9.782	14.85	3.714
Year fixed effects	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes
District fixed effects	No	No	No	No
Panel C				
Graduate leader	3.277***	3.137***	2.123**	3.612*
	(1.263)	(1.068)	(0.854)	(2.076)
Observations	2876	3499	4502	1516
R-squared	0.579	0.565	0.549	0.599
Bandwidth	7.427	9.782	14.85	3.714
Year fixed effects	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes
Bandwidth type	IK(h)	CCT	2h	h/2

Robust standard errors clustered at the constituency level are given in parentheses. In all panels, graduate leader is a dummy variable that is 1 if a graduate candidate wins against a non-graduate candidate and 0 if a non-graduate candidate wins against a graduate candidate. Panel A, B, C estimate the model using different fixed effects. In columns (1)–(4), the RD model is estimated by a local linear regression using a triangular kernel. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

on graduate degree, corresponding to 15 years of formal education, as the unique threshold to distinguish between leaders with higher and lower levels of education. Table A3 shows various levels of education that might be used as alternate thresholds to define educated leaders. However, it is not practically feasible to use each of the thresholds in the analysis; the distribution of education levels of leaders is such that the number of observations corresponding to some of the education levels is insufficient for estimating a RD model. For instance, only 9 percent of leaders have less than 10 years of education. Therefore, considering the distribution of sample size and the socio-economic significance of the education levels, we take 12 and 15 years of education as the two thresholds to define educated leaders. From a socio-economic angle, these are important milestones as 12 and 15 years of education mark the completion of school-education and college-degree, respectively. Based on these thresholds, we define three types of leaders with different levels of education: those who have not completed schooling ("not-12th-pass" or years of education < 12), those who have completed schooling but not graduate degree ("12th-pass" or years of education $\in [12, 15)$), and graduate leaders (years of education ≥ 15).

We estimate the multi-cutoff RD model following Cattaneo et al. (2016) and Cattaneo et al. (2020). Considering the education thresholds described above, the set of all elections where the top two contestants differ by their education levels can be categorized into three mutually exclusive types: (a) 12th-pass versus not-12th-pass candidate, (b) graduate versus not-12th-pass candidate, and (c) graduate versus 12th-pass candidate. The running variable is defined as the difference in vote share between more and less educated candidate in each type of election. Since an election can belong to only one of the three types, the RDD has noncumulative multiple cutoffs; we follow Cattaneo et al. (2020) to estimate the cutoff specific effects as well as the weighted effect showing the overall impact of educated leaders.[30]

The results presented in Table 3 show a positive and significant effect of educated leaders obtained as a weighted average of the multiple cutoff-specific effects. Educated leaders, compared to less-educated ones, increase the growth rate of nightlights by 3.28

[30] Specifically, we use the Stata package *rdmulti*; for further details, see Cattaneo et al. (2016, 2020).

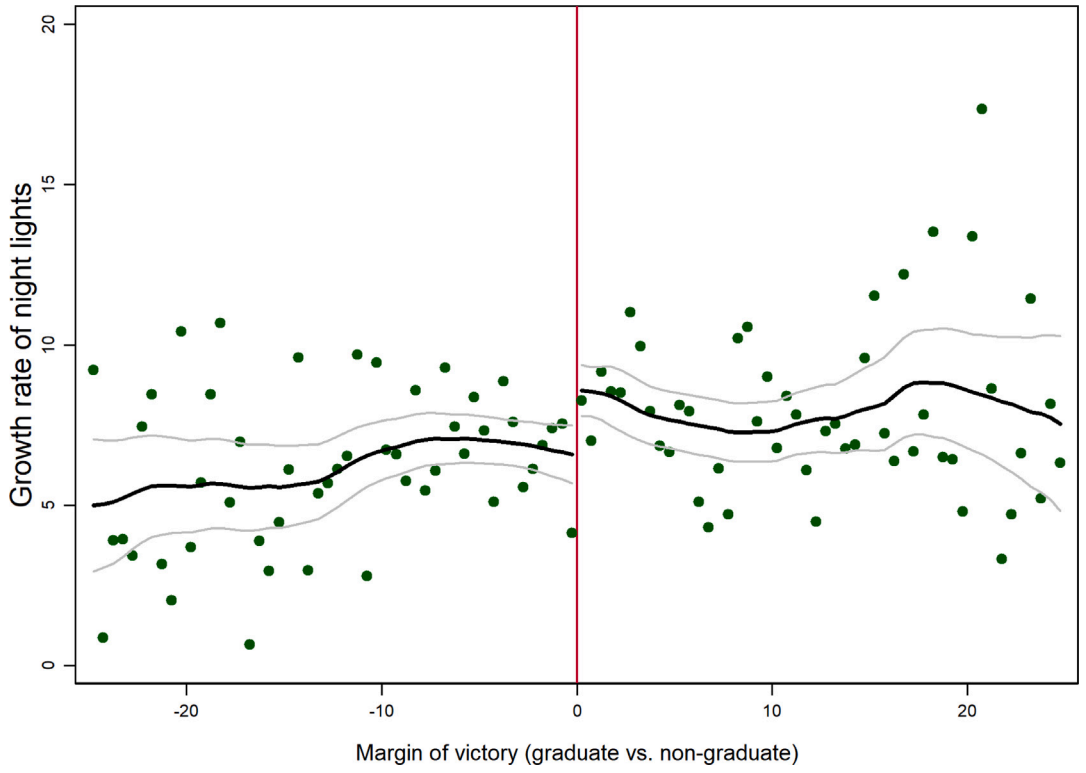

Fig. 4. Leader's education and effect on growth in night-time lights. The figure plots the dependent variable, annual growth rate of night-time lights, against margin of victory, which is the difference in vote share between the graduate and the non-graduate candidates in mixed elections. By construction, margin of victory is positive for graduate leaders and negative for non-graduate leaders. Each dot in the figure depicts the averages over successive intervals of 0.5% of margin of victory. The curves are local polynomial regressions (with 95% confidence intervals) fitted separately for positive and negative parts of the margin of victory variable.

Table 3
Effect of educated leaders considering multiple cutoffs to define more versus less educated leaders.

Alternative comparisons of more versus less educated leaders	Estimated effect (1)	Observations (2)	Weight (3)
12th-pass versus Not-12th-pass	−0.110 (0.790)	465	0.116
Graduate versus Not-12th-pass	3.620*** (0.000)	2076	0.519
Graduate versus 12th-pass	3.879*** (0.000)	1456	0.364
Weighted effect of educated leaders	3.281*** (0.000)	3997	
Bandwidth (CCT)	9.90		
Year fixed effects	Yes		
District fixed effects	Yes		

We estimate the regression discontinuity model considering noncumulative multiple cutoffs to define more versus less educated leaders, following the model proposed by Cattaneo et al. (2016). Specifically, we use *rdmc* command in Stata as part of the *rdmulti* package (Cattaneo et al., 2020). Robust bias-corrected p-values considering clustering at the constituency level are given in parentheses. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

percentage points. Turning to the three cutoff-specific estimates, we find that the overall impact is mainly driven by the comparison of graduates with 12th-pass and not-12th-pass candidates. The comparison between 12th-pass and not-12th-pass candidates yields an estimate that is statistically not significant and negligible in magnitude; this comparison also gets lower weight since the frequency of such elections is much lower than the ones involving a graduate candidate. The point estimates for graduate versus not-12th-pass

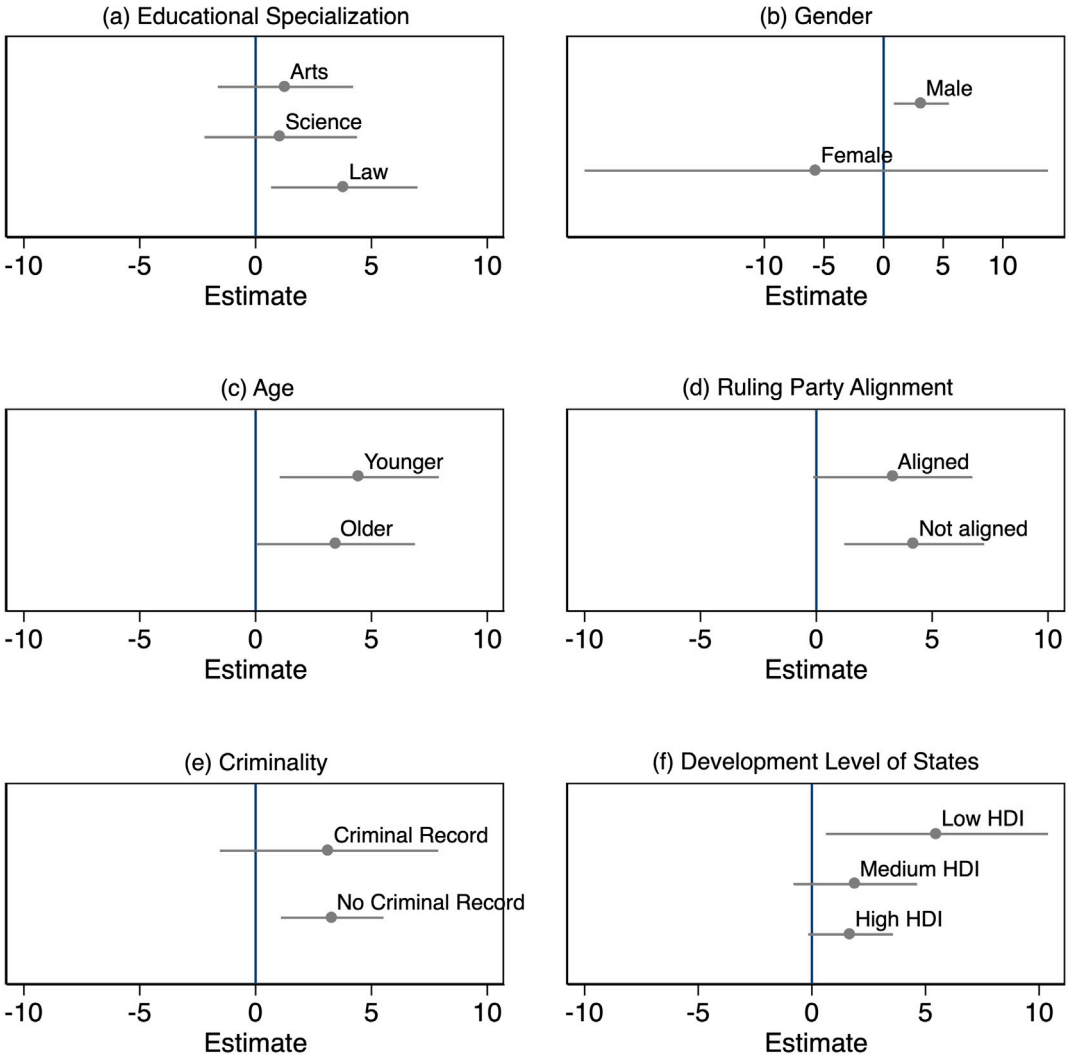

Fig. 5. Heterogeneity in the effect of graduate leader on night-time lights by leader's gender, age, party alignment with state government, and criminal record. The above figure plots the RD estimates of the effect of graduate leaders using CCT bandwidth on different subsamples. We consider different subsamples based on (a) educational specialization, (b) gender, (c) age of leader, (d) party alignment of elected leader with state government, (e) the criminal record of the leader and (f) development level of states. All regressions control for district and year fixed effects and RD estimates are calculated with a local linear regression using a triangular kernel.

comparison and graduate versus 12-pass comparison are statistically not different, which is consistent with the above finding that the return to school education is not significant.[31]

Our multi-cutoff RD estimates reveal that the impact of an educated leader on nightlights is a non-linear function of the leader's education level. The gain from having a school-educated leader, compared to a leader who has not completed schooling, is negligible. However, moving from a school-educated leader to a graduate leader yields a significant positive effect on nightlights. This non-linear pattern is consistent with the broader literature showing that the labor market returns to education are larger at higher levels of education in recent times (Agrawal and Agrawal, 2019; Colclough et al., 2010). In the next section, we delve deeper into understanding the nature of graduate degree that matters for the impact of graduate leaders on nightlights.

[31] We get similar results if we estimate the RD model separately for each of the three types of elections (Table A7), instead of a multi-cutoff setting. Also, taking 12 years of education as the single threshold yields significant effects since graduate leaders are included among those who have at least 12 years of education (Table A8).

Table 4
Heterogeneous effect of leader's education on growth rate of night-time lights by type of leader's education.

	(1)	(2)	(3)	(4)
Leader with arts degree				
Graduate leader	1.185	1.288	0.409	−2.515
	(1.776)	(1.487)	(1.108)	(2.804)
Observations	2291	2777	3593	1237
R-squared	0.559	0.546	0.533	0.585
Bandwidth	8.274	10.91	16.55	4.137
Leader with science degree				
Graduate leader	0.812	1.085	1.123	0.703
	(2.089)	(1.676)	(1.345)	(2.632)
Observations	1864	2275	2934	1055
R-squared	0.575	0.566	0.555	0.582
Bandwidth	7.781	10.17	15.56	3.891
Leader with law degree				
Graduate leader	4.992**	3.828**	3.635**	5.948*
	(2.281)	(1.610)	(1.662)	(3.081)
Observations	1696	2373	2695	899
R-squared	0.584	0.565	0.557	0.588
Bandwidth	6.717	10.87	13.43	3.358
Bandwidth type	IK(h)	CCT	2h	h/2
Year fixed effects	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes

Robust standard errors clustered at the constituency level are given in parentheses. In all panels, graduate leader is a dummy variable that is 1 if a graduate candidate wins against a non-graduate candidate and 0 if a non-graduate candidate wins against a graduate candidate. The upper panel includes only leaders with an arts degree, the middle panel includes only leaders with a science degree and the bottom panel includes only leaders with a law degree — each type compared with non-graduate leaders. Among the graduate leaders, around 53.81, 22.30, and 23.80 percent have arts, science, and law degree respectively. All panels control for district and year fixed effects. In columns (1)–(4), the RD model is estimated by a local linear regression using a triangular kernel. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

7. Heterogeneity analysis

In this section, we explore if the effect of graduate leader on growth rate of night-time lights varies by the type of leader's education, other characteristics of the leader, and the level of development of the state.

7.1. Heterogeneity based on the type of education

The impact of graduate leaders may vary depending on the type of education they had in college or university. We analyze the heterogeneous impact of graduate leaders based on their field of study. Recent literature has shown that labor market returns to education vary by the field of study (Jain et al., 2022); returns also depend on the reputation of the college indicating a signaling or networking effect rather than value-addition in human capital (Sekhri, 2020). While we analyze heterogeneity of effects based on the leader's field of study, data limitations preclude us from exploring the quality of education in this context.

Utilizing information on the type of degree, we categorize a graduate leader's education into arts, science, and law degrees, as described in Section 3.2. To estimate the heterogeneous effects, we compare leaders with each type of graduate degree with non-graduate leaders using the RDD; then, we conduct an F-test to check if the estimated effect of leaders with a particular degree is different from those with another degree. For example, considering close elections between arts graduates and non-graduates, we estimate the effect of leaders with an arts degree in comparison with leaders without a graduate degree. Similarly, we estimate the impact of leaders with graduate degrees in science and law. The estimates are provided in Table 4 and graphically shown in the first panel of Fig. 5 using the CCT bandwidth. We find that leaders with a graduate degree in law have a significant and positive impact on nightlights, compared to non-graduate leaders. Leaders with a graduate degree in either arts or science do not have a significant impact, and the estimated effects for them are also significantly lower than the effect of leaders with a law degree.[32]

[32] This finding remains unchanged even if we club the leaders with arts and science degrees together and keep law as a separate category. Therefore, lack of power is unlikely to be driving the non-significance in the effect of arts and science graduates.

7.2. Additional heterogeneity analysis

Apart from the type of education, we test if the effect varies by other characteristics that have been studied in the literature exploring the role of MLAs in economic outcomes (Asher and Novosad, 2017; Clots-Figueras, 2011; Lahoti and Sahoo, 2020; Prakash et al., 2019). Fig. 5 plots heterogeneity by leader's gender, age, party alignment with state ruling party, criminality, and the level of development of the state. The point estimates are reported in Tables A9–A13. Some of the heterogeneity analysis based on individual characteristics are to be interpreted with caution because the sample size of the sub-groups being studied are sometimes not large enough, and the comparison across sub-groups may lack statistical power.

We find that for the subsample consisting of male leaders, the effect of graduate leaders is a 3.4 percentage point higher growth rate of night-time lights, but the effect is not significant among female leaders. However, this result may be driven by the fact that the sample size for the subsample of female leaders is much lower than that of male leaders. We also do not find any significant difference in the effect of graduate leaders between the subsamples of criminally accused and non-accused legislators.

Next, we hypothesize that formal education may play a larger role in leadership skills of younger leaders, while it may be less relevant for older leaders who may acquire leadership skills from their experience, irrespective of their education. To examine this possibility, we categorize leaders into older and younger groups based on their age.[33] Indeed, graduate degree matters only for the subsample of younger leaders for whom the effect is precisely estimated. Although the effect of graduate leaders is slightly lower and imprecise among older leaders, it is statistically not distinguishable from the effect among younger leaders.

If the politicians' party is the same as the ruling party in the state, it might help them in gaining access to public resources and promote growth in their constituencies (Asher and Novosad, 2017). Depending on whether these additional resources are complementary or substitute for leaders' efficiency related to their education, the impact of educated leaders may vary depending on their ruling-party affiliation. So, we estimate the impact on growth in night-time lights for the aligned and not-aligned sample of legislators separately. We do not find any significant difference between these two types of leaders.

The pre-existing level of development of a state may moderate the effectiveness of educated leaders. On one hand, it may be easier for educated leaders to improve economic outcomes if the base level of development is low. On the other hand, more developed states may provide the required infrastructure to support educated leaders, resulting in greater impact. To explore this angle, we divide our sample into three groups of states based on Human Development Index (HDI) scores.[34] We estimate the RD model separately for each subsample and present the estimates in Table A13. We find that the effect is larger in the states with lowest HDI where electing a graduate leader results in 5.7 percentage point increase in growth rate of night-time lights. The effect is 1.9 percentage points in the highest HDI states, and the difference in the effect sizes between the highest and the lowest HDI states is statistically significant. Thus, underdeveloped states seem to benefit more from having an educated leader.

8. Mechanisms

We delve into exploring various pathways through which a graduate leader may affect economic activities in the constituency, resulting in higher growth rate of night-time lights, as found in our main analysis.

8.1. Effect on provision of public goods

First, we consider the effect of graduate leaders on the public goods index described in Section 3.4.1. The point estimates are presented in Table 5. We find that there is no significant effect of electing a graduate leader on overall provision of public goods in the constituency.

8.2. Effect on provision of roads, electricity, and power

We postulate that graduate leaders might be able to influence the provision of certain public goods as opposed to all, as some of these can be built easily and in a shorter span of time. Hence, we consider separate indices for roads, electricity and power supply; these variables are likely to be captured as a part of night-time lights in satellite images as well (Henderson et al., 2012). The point estimates for these outcomes are presented in Table 6. With regard to roads, we find that election of graduate leaders results in an increase in accessibility to roads by 0.35 standard deviation. Similarly, for power supply, we find that there is a statistically significant increase of 0.35 standard deviation in access. Estimates also suggest that election of a graduate leader over a non-graduate leader results in a 5.37 percentage point increase in the proportion of households having electricity as the main source of lighting in the constituency.

[33] Close elections between younger graduate leaders and non-graduates are used to estimate the impact of young graduate leaders. Analogously, close elections between older graduate leaders and non-graduates are used to estimate impact of older graduate leaders on nightlights.

[34] We classify Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Arunachal Pradesh, Assam, Meghalaya, Odisha, Rajasthan and Uttar Pradesh as least developed states; Andhra Pradesh, Delhi, Gujarat, Himachal Pradesh, Jammu and Kashmir, Karnataka, Mizoram, Manipur, Nagaland, Puducherry, Sikkim, Tripura and West Bengal to have a higher development than least developed states. Lastly, we classify Haryana, Uttarakhand, Maharashtra, Punjab, Tamil Nadu, Kerala and Goa as the most developed states.

Table 5
Leader's education and effect on provision of public goods.

	(1)	(2)	(3)	(4)
Graduate leader	0.071	0.049	0.043	0.037
	(0.109)	(0.067)	(0.081)	(0.126)
Observations	297	698	539	156
R-squared	0.834	0.806	0.817	0.846
Bandwidth	3.577	10.47	7.154	1.788
Election-year fixed effects	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes
Bandwidth type	IK(h)	CCT	2h	h/2

Robust standard errors clustered at the constituency level are given in parentheses. Graduate leader is a dummy variable that is 1 if a graduate candidate wins against a non-graduate candidate and 0 if a non-graduate candidate wins against a graduate candidate. The outcome variable is constructed by a Principal Component Analysis of availability of various public goods at the constituency level, as described in Section 3.4.1. The model controls for fixed effects at the levels of state and the year when the leader was elected. In columns (1)–(4), the RD model is estimated by a local linear regression using a triangular kernel. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 6
Leader's education and access to road, electricity, and power.

	(1)	(2)	(3)	(4)
Roads				
Graduate leader	0.355***	0.222**	0.256**	0.528***
	(0.135)	(0.090)	(0.101)	(0.164)
Observations	332	720	605	169
R-squared	0.656	0.622	0.629	0.695
Bandwidth	3.643	9.493	7.286	1.821
Power				
Graduate leader	0.345***	0.190**	0.151*	0.422***
	(0.116)	(0.096)	(0.089)	(0.145)
Observations	353	550	624	179
R-squared	0.729	0.697	0.695	0.733
Bandwidth	3.997	6.669	7.993	1.998
Electricity				
Graduate leader	5.368**	5.316**	3.279*	5.497*
	(2.373)	(2.336)	(1.713)	(3.314)
Observations	649	663	998	370
R-squared	0.821	0.821	0.818	0.817
Bandwidth	8.175	8.477	16.35	4.088
Election-year fixed effects	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes
Bandwidth type	IK(h)	CCT	2h	h/2

Robust standard errors clustered at the constituency level are given in parentheses. In all panels, graduate leader is a dummy variable that is 1 if a graduate candidate wins against a non-graduate candidate and 0 if a non-graduate candidate wins against a graduate candidate. The outcome variable is constructed using variables mentioned in Section 3.4.1 by Principal Component Analysis. Roads include state highways, national highways, paved roads, unpaved roads, all weather roads and other major roads. Power includes access to electricity for domestic, agricultural and industrial use. Electricity measures the percentage of households in a constituency that have access to electricity as the main source of lighting. All panels control for fixed effects at the levels of state and the year when the leader was elected. In columns (1)–(4), the RD model is estimated by a local linear regression using a triangular kernel. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

8.3. Effect on crime

Another mechanism through which graduate leaders might impact economic growth is through a reduction in the level of crimes in their constituency. To test for this channel, we estimate the impact of electing a graduate leader on aggregate crimes recorded. Since we do not have data for crimes being reported at the constituency level, we use district level annual panel data on the number of crimes recorded by the police. To carry out the estimation at the district level, we instrument the fraction of seats won by a graduate politician by the fraction of seats won by graduates in close elections. As additional control variables, the regression includes the district level proportion of close elections between graduate and non-graduate candidates, the vote margin between

Table 7
Leader's education and effect on total crimes.

	(1)	(2)	(3)	(4)
Fraction of seats won by graduates	−856.5* (494.0)	−725.1** (343.1)	−603.4** (261.5)	−546.9** (243.4)
Observations	6396	6396	6396	6396
First Stage Fstat	179.2	289.1	427.3	540.8
Bandwidth	3	5	9	14
Mean of Total Crime	4439	4439	4439	4439
Year fixed effects	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes

Robust standard errors clustered at the district level are given in parentheses. The regressions are estimated on district level annual panel data for the period from 2005 to 2018. The outcome variable measures the district level total number of crimes recorded by the police, including any crime mentioned in the Indian Penal Code. The data was obtained from the National Crime Records Bureau. The district level fraction of seats won by a graduate politician is instrumented by the fraction of seats won by graduates in close elections. Additional controls include the proportion of close elections and linear function of the vote margin between graduate and non-graduate contestants. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 8
Leader's education and effect on net asset growth.

	(1)	(2)	(3)	(4)
Graduate leader	−0.781 (0.692)	−1.345 (0.938)	1.063 (1.249)	−1.722* (0.935)
Observations	908	521	1571	454
R-squared	0.075	0.088	0.022	0.123
Bandwidth	5.455	3.124	10.91	2.728
Year fixed effects	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes
District fixed effects	No	No	No	No
Bandwidth type	IK(h)	CCT	2h	h/2

Robust standard errors clustered at the constituency level are given in parentheses. Graduate leader is a dummy variable that is 1 if a graduate candidate wins against a non-graduate candidate and 0 if a non-graduate candidate wins against a graduate candidate. Net asset is defined as difference between assets and liabilities of leaders. Here, the main dependent variable is the growth in net asset for the duration that a leader holds office. In columns (1)–(4), the RD model is estimated by a local linear regression using a triangular kernel. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

such candidates, district fixed effects, and year fixed effects.[35] We find that a 10 percentage point increase in the proportion of graduate legislators in a district leads to a 1.2 to 1.9 percent reduction in average incidence of crimes in the district (Table 7).

8.4. Effect on corruption

Besides crime, another potential mechanism through which a graduate leader might promote economic growth is through reduction in corruption. Leaders holding office may benefit from rent-seeking activities when they hold the political office, thus indicating higher financial returns and corruption during their tenure. A general reduction in corruption might lead to better business environment, and more competition and efficiency in implementing public works in the constituency. Following Fisman et al. (2014), we proxy for corruption by measuring change in net asset growth of candidates between two subsequent elections. Using the RDD, we find no statistically significant difference in net asset growth of graduate versus non-graduate leaders who won in close elections (Table 8).[36]

[35] This empirical strategy aggregates the constituency specific discontinuities at the district level to construct the instrumental variable. This method has been extensively used in the literature identifying the socio-economic effect of political leaders' identity using district level data (Bhalotra and Clots-Figueras, 2014; Clots-Figueras, 2012; Lahoti and Sahoo, 2020; Prakash et al., 2022).

[36] Further, considering alternate definitions of the dependent variable such as total change in net asset between two elections and growth rate of total assets of a leader, we find no significant effect in either.

9. Sensitivity analysis

In this section, we conduct a range of robustness and sensitivity tests, such as controlling for higher order polynomials of the forcing variable, excluding extreme values of the dependent variable, and placebo tests. We find that our main results remain unperturbed in terms of both magnitude and significance.

9.1. Sensitivity to higher order polynomial

We explore the sensitivity of the RD estimates to controlling for quadratic and cubic functions of vote margin (i.e., the forcing variable). We report these results for different bandwidths and fixed effects in Table A14. Across these specifications, we find that the estimates are positive, mostly significant, and quantitatively similar to the effects estimated in Table 2 where linear function of vote margin was controlled for.

9.2. Extreme values

As discussed in Section 3.1, night-time lights data captured through satellite imagery are top coded at 63, i.e., no pixel value in an image exceeds this number. While this is not a problem in less developed areas, this could be an issue in constituencies that have areas with high luminosity, where we cannot measure any changes in intensity of night-time lights beyond 63. Also in some dimly lit areas, satellites might not be able to capture dim lights and the measure could be coded as zero. For about 4.95 percent observations in our data, constituency level mean night-time luminosity has a value of either 0 or 63.

As a part of robustness check, we address this issue by excluding extreme values (both 0 and 63) and present the estimates from the RD model in Table A15. In column (1)–(4), we drop all observations where the constituency-year pixel mean take the value of 0 or 63. In column (5)–(8), we drop any constituency in which mean pixel intensity takes the value of 0 or 63 for any of the years in the period 2009–2013. We find that the results are unaffected by exclusion of extreme values and the estimates remain quantitatively similar and statistically significant.

9.3. Placebo tests

To evaluate the RD design, we conduct two placebo tests and find that the placebo coefficient estimates in both cases are insignificant and smaller in size than the true effect. In the first test, we estimate Eq. (3) with 22 placebo thresholds of the forcing variable. Specifically, we estimate 11 coefficients on a subsample of graduate leaders; here, instead of defining the threshold of discontinuity when margin of victory is zero, we redefine the cutoff in steps of 0.5 within the interval $[5, 10]$. Similarly, taking the subsample of non-graduate leaders, we redefine the cutoff in steps of 0.5 within the interval $[-10, -5]$ on the margin of victory variable. We plot these estimates based on the 22 placebo cutoffs and contrast them with the true coefficient of graduate leader in Figure A3. We find that the placebo estimates are insignificant and smaller in size than the true estimate of the causal effect of graduate leaders.

In the second placebo test, we consider the dependent variable to be defined as the growth rate of night-time lights in the previous election term. Thus, we estimate Eq. (3) for the effect of electing a graduate leader in the current election on economic outcomes in the previous election term. We find that the estimates are statistically insignificant and much smaller in magnitude than the true estimate (Table A16).

9.4. Candidate characteristics

If leader's education is systematically correlated with other characteristics, we may not be able to separate out the causal effect of education from those characteristics. In Section 5, we show that there is no major difference in most of the individual characteristics between graduate and non-graduate legislators winning in close elections. Nonetheless, in order to check if some of the impact on night-time lights of having a graduate candidate win in narrow election is driven by individual characteristics, we control for leader's gender, criminality, and party affiliation indicators in our model in Table A17. The effect of graduate leader remains almost unchanged in terms of both magnitude and statistical significance. This alleviates the concern that the impact we observe may be due to legislators' education bundled with other characteristics.

10. Generalizability and limitations of the RD estimates

Our broad results from the RD analysis show that economic growth is significantly affected by electing educated legislators as compared to less educated legislators in narrow elections. But do our results generalize and hold across all elections? Fig. 4 indicates a slightly higher growth rate of night-time lights associated with having a graduate leader across various margins of victory. Our OLS results for all (close and non-close) elections between graduate and non-graduate candidates also shows positive and significant association. Though, this correlation is lower in magnitude than RD estimates and loses significance when we include district fixed effects. These OLS results are also potentially contaminated by endogenous selection of graduate leaders. Since our identification strategy relies on close elections, we now investigate how representative our close election sample is to all elections in India.

We find that close elections between graduate and non-graduate candidates are largely representative of all mixed elections (i.e., all elections between graduate and non-graduate candidates) in India. Overall, we find that 47 percent of all mixed elections are close elections. The median margin of mixed elections is 7.9, and our RD estimates use a bandwidth between 3.7 and 14.85. Close elections are also geographically spread across the country. The percentage of close elections in various states varies from 28 to 75 percent. Further, we compare a range of constituency and candidate characteristics between mixed and non-mixed elections (Table A18) and between close and non-close elections (Table A19). In both cases, the different types of elections look comparable on the basis of most of the observable factors.

Even after showing this, there are some caveats with the interpretation of our results due to limitations in data and method. First, there is a possibility that our RD estimates are not capturing the causal impact of leaders' education but reflecting their unobserved ability or desire for greater public service. More able or public service oriented people may be more likely to pursue higher education than less able people to signal their ability to the society. Education by itself may not contribute to making them more effective leaders. Given the lack of data on inherent ability and no clear way to distinguish between inherent ability and gains in competence due to education, we cannot separate these two channels. Educated leaders, either through inherent ability or through knowledge and wisdom acquired through education, are more effective at providing better development outcomes. If there are other ways to indicate inherent ability or desire for public service, and if the reason for better performance of leaders is these traits and not education per se, then education mandates may miss out some individuals possessing these traits.

The second caveat is that low ability graduates might choose to enter politics given the returns to education for a graduate are high in the labor market, leading to a bias in the estimated effect of a graduate degree in our context. Holding political office is associated with significant financial (salaries), illicit (rents), future, and non-financial returns (Dal Bó and Finan, 2018). The total returns for an elected leader in India are high and comparable to high-earning non-politician graduates.[37] Besides, the probability of success in politics is uncertain and unknown. So, the expected returns from joining politics versus other options for a graduate are ambiguous. This means that it is not clear whether only low ability graduates join politics. Also, there might be other concerns like public service, ability and desire to connect with people that might be driving why someone joins politics, more than economic returns. Beyond that, we argue that if only low ability graduates join politics then our results are an underestimate of the impact of average graduates.

The third potential caveat with our RD analysis is that a graduate (or a non-graduate) candidate contesting in a *close election* may be different in unobservable characteristics from an average graduate (or non-graduate) politician. Thus, it is possible that our RDD identifies the effect of leader's education and all compensating differentials — candidate level characteristics that ensure elections remain close between graduate and non-graduate candidates (Marshall, 2022). For instance, it is possible that voters prefer competent leaders and they infer a politician's competence by observing their education level. It is also likely that voters would perceive graduate candidates to be more competent than non-graduate candidates. Then, a graduate candidate must possess a lower level of competence in order to be involved in a close contest with a non-graduate candidate. Similarly, since graduates are on average preferred by voters, non-graduate candidates need to be especially competent to overcome this disadvantage and be in a close election against graduate candidates. While this is a plausible scenario, it is likely to result in underestimation of the effect of graduate leaders when the empirical analysis is based on close elections; thus, our estimates might be a lower bound of the true effect of graduate leaders on growth of night-time lights. Given that the potential compensating differential is unobserved, we cannot provide evidence in this regard.

11. Discussion and conclusion

In the political economy literature, emphasis is placed on the importance of leader's education as it is assumed to instill more valuable skills in leaders, resulting in better performance. Recent academic as well as policy discourse has considered formal education of leader as a proxy for leader's quality, suggesting that education sets leaders apart. Using a detailed data set from India and a regression discontinuity design, we find a positive but small effect on growth in night-time lights due to the election of graduate leaders to state assembly constituencies. The estimated effect size of leader's education, however, is smaller in comparison with previous studies that have estimated the effect of leader's criminality (Prakash et al., 2019) and gender (Baskaran et al., 2021) on growth of night-time lights in the Indian context. Analyzing the various thresholds of education level to define an educated leader, we show that the positive effects are due to those leaders who have completed college education, whereas we do not find any effect of leaders who have completed only school education. We also provide evidence for heterogeneity in our results, especially showing that the effect of educated leaders is stronger in states with lower levels of development.

In comparison with the results in the literature on the impact of educated leaders, our results are somewhere in the middle. We cannot directly compare our point estimates with other papers due to differences in methodology and context. At the same time, we do find a small but significant impact of educated leaders as opposed to no significant impact in some studies. The studies that find no impact have investigated leaders at mayoral level in Brazil and in the US Congress (Carnes and Lupu, 2016) and using random national level leader transitions across countries (Peveri, 2021). Their country setting and level of the leader differ from our study.

We find that educated politicians who are lawyers have a significant positive impact on economic outcomes, whereas graduates of arts and science do not. Lawyers have better argumentation and persuasion skills; they are more exposed to the working of the

[37] In India most politicians are not full-time politicians but generally have other employment or business interests which they pursue in addition to being politicians.

public and political system. So this points to competence or/and higher skills being a mechanism through which educated leaders' impact is operating. The impact might also be operating by educated leaders being able to lobby better and manage bureaucracy efficiently as they are able to improve road infrastructure, enhance electricity supply and reduce crime, according to our results.

We find that ruling party affiliation does not have an impact on the performance of educated leaders, potentially indicating that their better performance is not due to political networks. We do not find that educated politicians are any different in terms of corruption as compared to less educated politicians. This finding goes against our hypothesis in the theoretical framework that educated leaders might have better values and exhibit less political opportunism. We are not able to fully test other potential mechanisms like whether better social networks – beyond the party affiliation – help educated leaders in obtaining economic outcomes for their constituents.[38]

We should also note that we do not directly test any of the theoretical mechanisms listed in the conceptual framework of how educated leaders impact economic outcomes. The existing data does not lend itself to causally testing whether competence and skills, and beliefs and values of educated leaders are different than less educated leaders. Our results are relatively reduced form, and we could not identify the precise mechanism to directly explain the difference in outcomes.

Our results should not be interpreted as justification for imposing education mandates for contesting elections. Other than the effectiveness of a leader, there are several other concerns one needs to take into account when deciding about imposing constraints on those contesting elections. Fairness, upholding of democratic values of being represented and being able to represent, and inclusiveness need to be considered before arriving at any judgement on the question of election mandates.[39] Also, the small size of the impact is not conclusive evidence that educated leaders are far superior to less-educated leaders.

There are some limitations of the study due to data availability and the nature of the analysis, that may be relevant for interpreting the results. Our data spans the period from 2009 to 2013 due to limits imposed by the availability of information on candidates' characteristics and comparable night-time lights. The data on public goods, roads, electricity, and power are cross-sectional in nature, limiting the extent to which we can draw conclusions based on these data. Also, our result that graduate leaders are not significantly different in terms of corruption than non-graduate leaders is based on a select sample of leaders who re-contest elections. We have asset data only on candidates who re-contest, so we cannot test this channel for all leaders.

We show that close elections are largely similar to non-close elections on observable characteristics, supporting the external validity of our findings. However, our empirical strategy cannot fully alleviate the concern that unobservable characteristics may vary across close and non-close elections, and we have discussed the caveats in interpreting our results.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jce.2023.05.001.

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[38] We show the impact of educated leaders on economic growth but do not directly test whether their 'usual' tasks such as attending parliament, voting in parliament, and listening to constituents' grievances are impacted in any way due to their focus on growth. But we investigate re-contesting probability and winning probability of educated leaders when they re-contest. We find these are not negatively impacted for educated leaders. This shows us that their popularity has not been impacted negatively and potentially they are doing their 'usual' tasks. Estimation results are available on request.

[39] Analogously, a finding that women are better at provision of public goods does not mean we mandate that only women can contest elections.

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